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ENVIRONMENTAL ASSESSMENT REPORT

Capricorn Copper

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Document status

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Megan Davis		31 July 2025

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1 INTRODUCTION

RPS AAP Consulting Pty Ltd has been engaged by Capricorn Copper Pty Ltd (CC) to seek an amendment to the existing Environmental Authority (EA) referenced EPML00911413 (dated 23 May 2025) at their site located at Lot 5 SP865892, Gunpowder, Northwest Queensland.

The current EA approves the following Environmentally Relevant Activities:

- Schedule 3 17 – Mining Copper ore
    - Ancillary 08 - Chemical Storage 1: Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a)
    - Ancillary 08 - Chemical Storage 3: Storing more than 500 cubic metres of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c)
    - Ancillary 31 - Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000t
    - Ancillary 33 - Crushing, milling, grinding or screening. Crushing, grinding, milling or screening more than 5000t of material in a year

1.1 Proposed amendment

RPS have been engaged by CC to prepare an Environmental Authority amendment application and compile associated supporting documentation for the proposed Tailings Storage Facility (TSF) in the Upper Esperanza Valley (TSF3), refer to Figure 1 below for the Site Location Plan below.

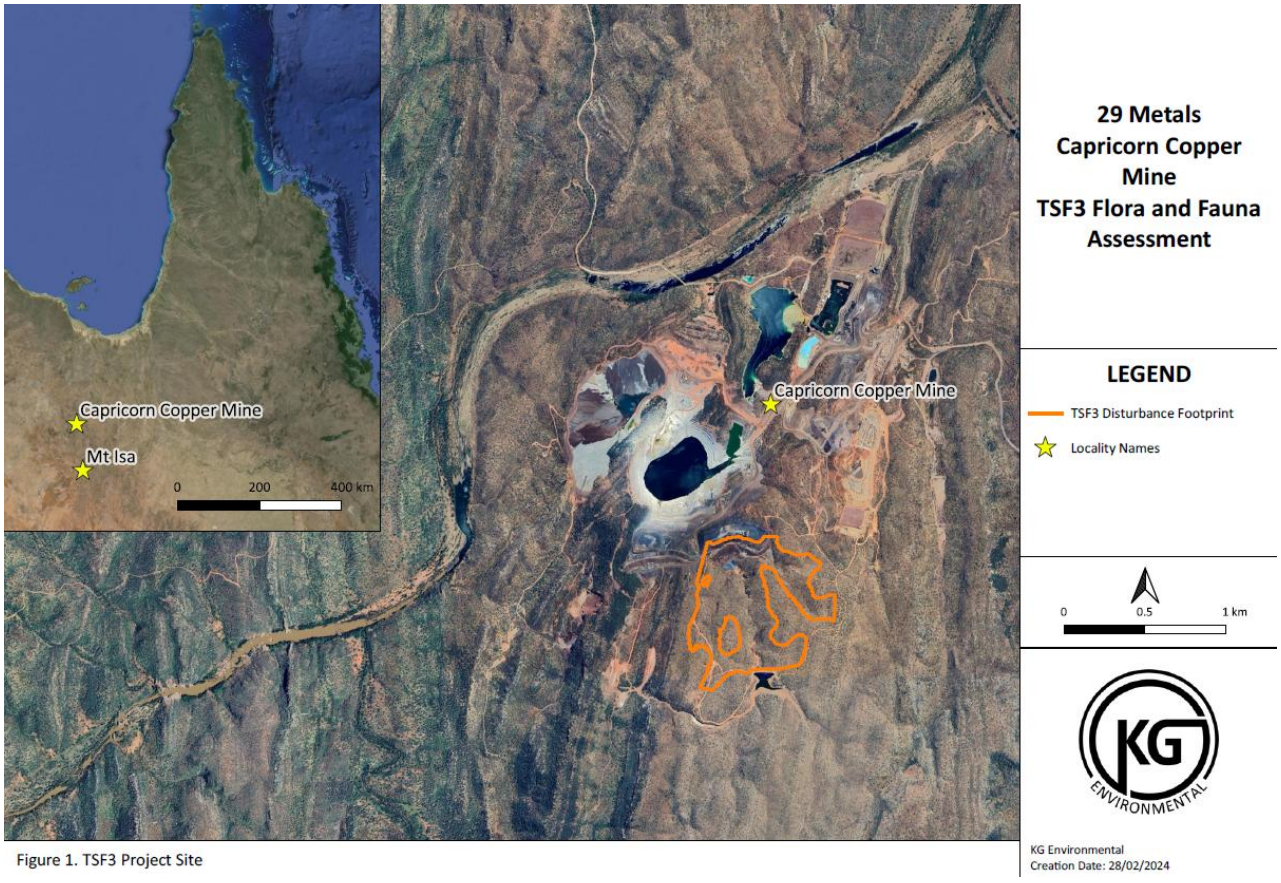


Figure 1 Site Location Plan (KG Environmental report 29M.CCM.002 TSF3 F&F V2.0 20250521)

Excessive site water inventory and the low remaining capacity in the current tailings storage facility (TSF), Esperanza TSF (ETSF) resulted in the suspension of mining and ore processing activities in March 2024.

The new facility will provide approximately 6.5 to 7.5 years of tailings storage capacity and allow CC to resume ore processing. Detailed design plans have been developed and are included in Appendix A.2.

1.2 Purpose

The proposed amendment is likely to be a Major Amendment to the existing EA in accordance with the *Environmental Protection Act 1994* (EP Act).

Under Section 226A of the EP Act, it is understood that the following details are required as part of the EA amendment application.

1. *If the amendment application is for the amendment of an environmental authority, the application must also—*

a. *describe any development permits in effect under the Planning Act for carrying out the relevant activity for the authority; and*

b. *state whether each relevant activity will, if the amendment is made, comply with the eligibility criteria for the activity; and*

c. *if the application states that each relevant activity will, if the amendment is made, comply with the eligibility criteria for the activity—include a declaration that the statement is correct; and*

d. *state whether the application seeks to change a condition identified in the authority as a standard condition; and*

e. *if the application relates to a new relevant resource tenure for the authority that is an exploration permit or GHG permit—state whether the applicant seeks an amended environmental authority that is subject to the standard conditions for the relevant activity or authority, to the extent it relates to the permit; and*

f. *include an assessment of the likely impact of the proposed amendment on the environmental values, including—*

   i. *a description of the environmental values likely to be affected by the proposed amendment; and*

   ii. *details of emissions or releases likely to be generated by the proposed amendment; and*

   iii. *a description of the risk and likely magnitude of impacts on the environmental values; and*

   iv. *details of the management practices proposed to be implemented to prevent or minimise adverse impacts; and*

   v. *if a PRCP schedule does not apply for each relevant activity—details of how the land the subject of the application will be rehabilitated after each relevant activity ends; and*

g. *include a description of the proposed measures for minimising and managing waste generated by amendments to the relevant activity; and*

h. *include details of any site management plan or environmental protection order that relates to the land the subject of the application.*

In accordance with the relevant provisions of the EP Act, the purpose of this report, and the technical reports attached, is to identify the existing environmental values of the site and surrounding area (Section 2), provide details of emissions or releases and a description of the risk and likely magnitude of impacts on the environmental values (Section 3) and assess the impacts of the proposed amendment on the identified environmental values (Section 4). Details of management practices have been included (Section 5). A rehabilitation assessment has been included in Section 6. Further detail is provided in Appendix A.1 to A.9 which are summarised below:

- A.1 EA Amendment Application Information Requirements
- A.2 TSF3 Preliminary Design Report, Engeny
- A.3 Life of Mine Tailings - Multi Criteria Analysis Decision Report, V1, Capricorn Copper
- A.4 TSF3 Flora and Fauna Assessment, KG Environmental
- A.5 TSF3 Air Quality Assessment, Trinity Consultants Australia
- A.6 Cultural Heritage Clearance Report and Maps
- A.7 TSF3 Risk Register
- A.8 GW Model Response to DETSI Comments
- A.9 Greenhouse Gas Emissions Assessment

1.3 Background

Capricorn Copper Mine (CCM) is located in Gunpowder, 120km north of Mt Isa, QLD. 29 Metals manages three underground mines and processes up to 2.0 Mt of ore per annum producing copper-silver concentrate. The site is bordered by Gunpowder creek to the west and north, refer to Figure 1 above. The Esperanza pit is located central to the mining operation, refer to Figure 2 below.

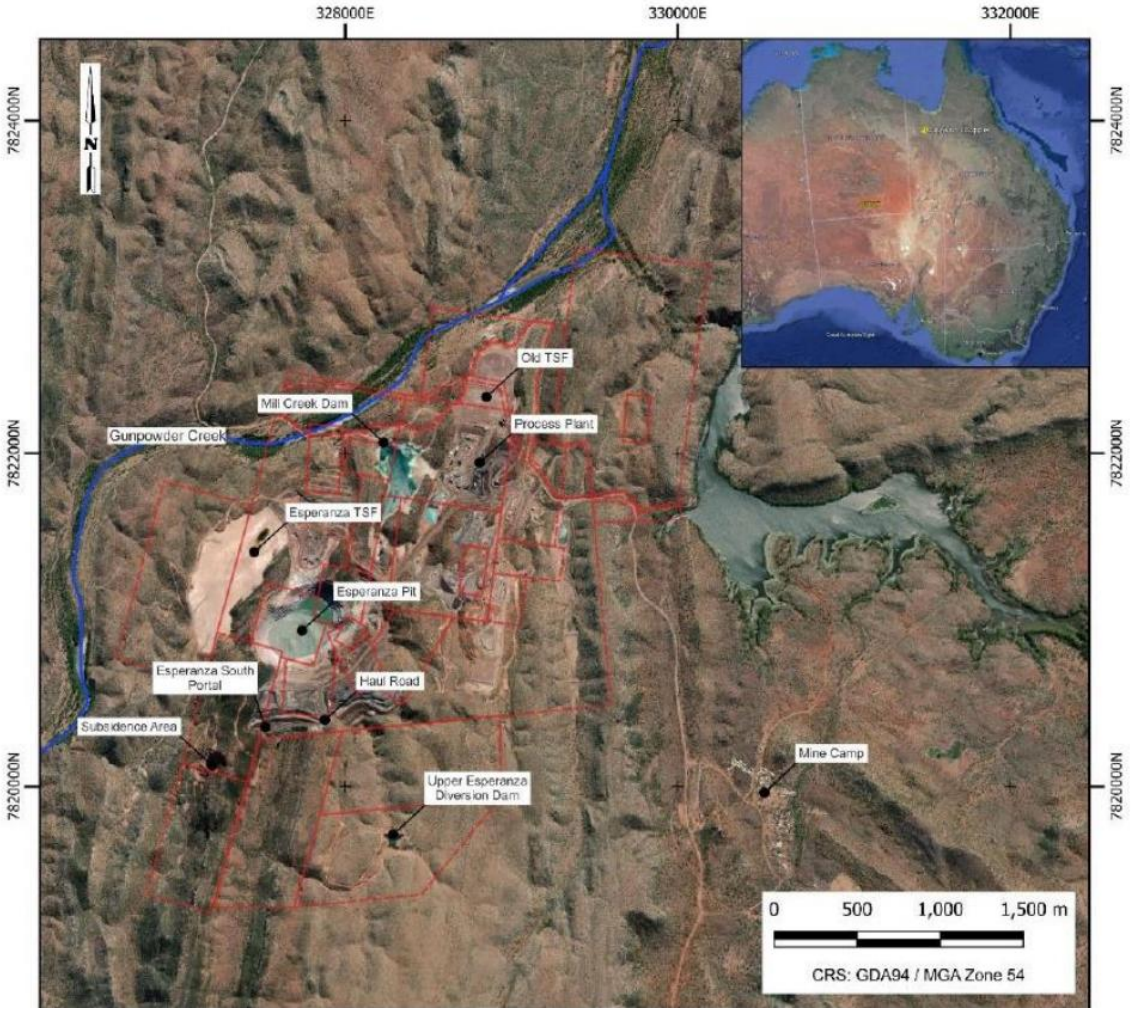


Figure 2 Site Layout Plan

CCM has been operated dis-continuously since 1927, including several major periods since the 1990s, where it was under care and maintenance. Periods of care and maintenance include 2001 –2003, 2009, 2010 – 2011, and 2013 – 2021. The site suspended operations in Q2 2024 to address water inventory issues and to determine a tailings strategy to support long term operation.

The proposed long-term tailings strategy will support the current LoM plan of 10 years following restart, however, CCM are actively developing a robust tailings strategy which includes provision for storage beyond the current LoM.

Two tailings storage facilities exist on the site, the Old (or Mammoth) TSF and the Esperanza TSF (ETSF), with the Esperanza Pit (EPit) also used as a previous tailings storage facility.

The Old TSF is situated to the northeast of the Mill Creek Dam (MCD), and it has been capped and decommissioned. The ETSF was the only active storage prior to suspension of operations and is located in a steep-sided valley running roughly from south to north, with the northern end abutting the North Waste Rock Dump (NWRD). ETSF currently has approximately two (2) months of residual tailings capacity.

CC has undertaken a detailed evaluation and selection process to determine the most appropriate long term tailings solution for CCM which included a Multi-Criteria Analysis (MCA) including the most appropriate tailings technology to be utilised and a number of locations for the TSF, refer to Appendix A.3 which is summarised briefly below. Further raises to ETSF were included as part of the MCA.

The process for development of the MCA included:

- **Define Objectives and Criteria**: Clearly identify the goals and list the criteria that are relevant to the decision (e.g., cost, efficiency, sustainability).
- **Assign Weights:** Establish the importance of each criterion relative to others. This often involves stakeholder input to reflect priorities.
- **Score Alternatives**: Rate each option against each criterion, either qualitatively or quantitatively.
- **Aggregate Scores**: Combine scores and weights to arrive at an overall ranking of alternatives.
- **Analyze Results:** Examine the rankings, possibly performing sensitivity analysis to understand how changes in weights or scores impact the outcome.

Options considered for the tailings technology included:

1) Conventional thickened tailings
2) High density thickened tailings
3) Paste Tailings
4) Filtered Tailings

Further detail on each option is provided in the report in Appendix A.3. The MCA criteria included:

- Capital Cost
- Operational Cost
- Timing and Availability
- Safety and Technical Risk
- Geotechnical Considerations
- Construction and Operational Complexity
- Water Management and Recovery
- Environmental Considerations
- Relocation and Closure.

The weighted MCA criteria determined that the preferred option to take forward as part of the analysis is that of conventional thickened tailings, i.e. tailings thickened to approximately 60% w/w and pumped to a new storage facility utilizing the existing process plant infrastructure but with the potential requirement for additional pumping infrastructure in the form of in-line booster stations depending on the final location of the TSF and associated deposition infrastructure.

Six proposed locations for the TSF3 were analysed, refer to Figure 3 below.

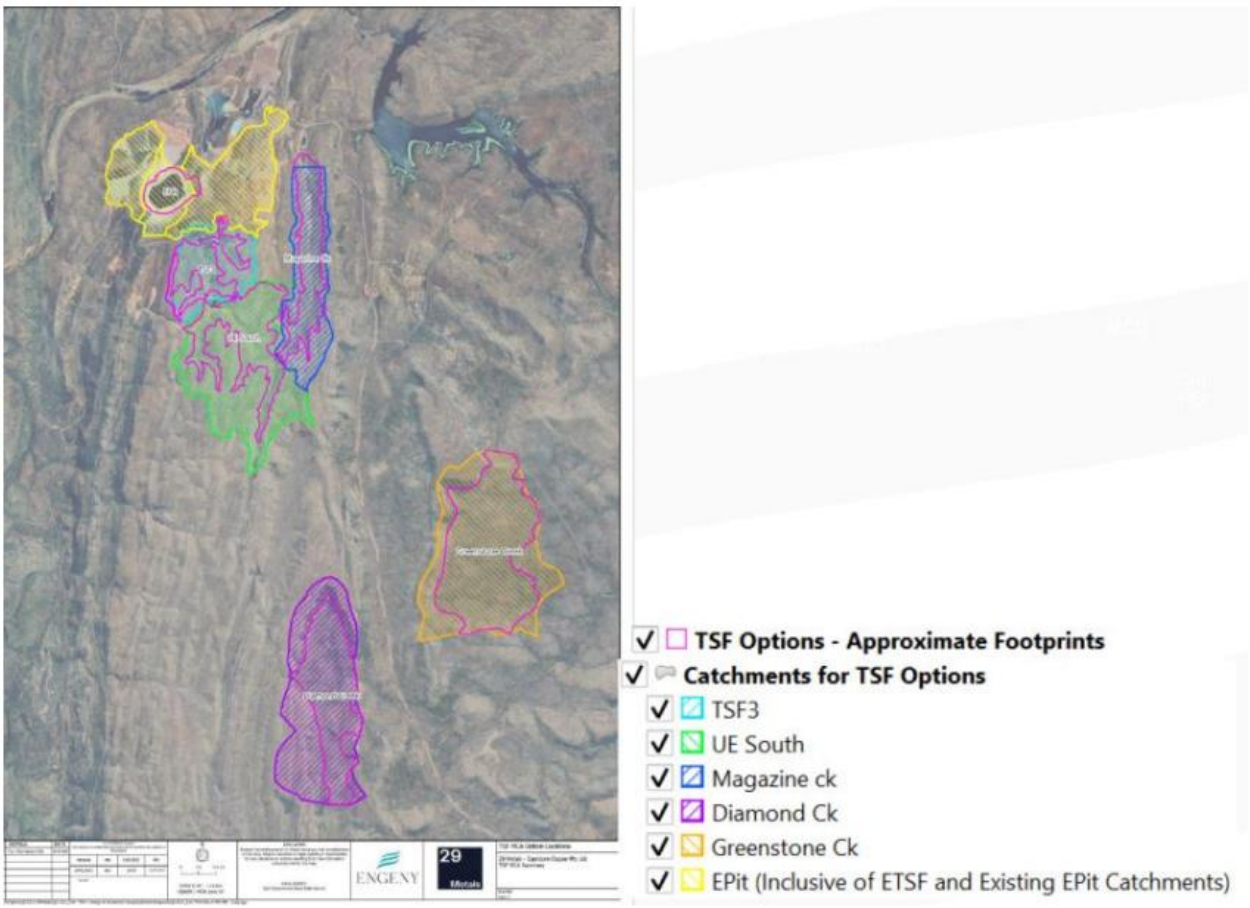


Figure 3 TSF Location Options

The MCA criteria included:

- Storage capacity
- Overall cost
- Geotechnical Conditions
- Consequence of Failure
- Land Disturbance
- Seepage Pathways
- Water Management
- Tenure
- Local Stakeholder Support
- Closure

The MCA assessment determined that TSF3 was favourable in that it utilises the existing Esperanza Waste Dump as a buttress to the main tailings embankment. It notes that seepage assessments and the feasibility of proposed seepage mitigation measures were required to determine the feasibility of this option which have now been undertaken, refer to Appendix A.2. Additionally, TSF3 is on the CCM ML and surveys have been previously undertaken to understand the ecological impacts associated with disturbance in this area. Surface water diversions are currently in place but will be upgraded to meet tailings storage requirements and local stakeholders are generally supportive of the option as it minimises impacts.

Storage capacity has been addressed as part of a CCM life of mine tailings strategy which could result in TSF3 being utilised in conjunction with a lift to ETSF and/or deposition of tailings in EPit once water management has been addressed. Further detail can be found in MCA report in Appendix A.3.

1.4 Project Description

TSF3 is proposed to be located in the Upper Ezperanza Valley, between the Ezperanza Waste Rock Dump (EWRD) and the Upper Ezperanza Diversion Dam (UEDD) and will be formed from the raising and reprofiling of the existing EWRD and UEDD, and include the construction haul roads. The Preliminary Design Report in Appendix A.2 summarises the key features of TSF3, as per Table 1 which is excerpted below.

1.4.1 Key Features

Table 1 STF3 Key Features

Parameter	Value
Name of Dam	Tailings Storage Facility 3 (TSF3)
Location	Capricorn Copper Mine
Nearest Town	Mt Isa
Owner	Capricorn Copper Mine Pty Ltd (subsidiary of 29 Metals Limited)
Operator	Capricorn Copper Mine Pty Ltd
Esperanza Waste Rock Dump (EWRD) Northern Embankment	
Type	Zoned Rockfill / Earthfill
Liner	Geomembrane (Type to be confirmed during Detailed Design) Option 1 – HDPE on Non-woven Geotextile Option 2 – LLDPE on Non-woven Geotextile Options 3 – Bituminous Geomembrane Liner (BGM). Integrated into foundation / abutments with concrete plinth / grout curtain.
Maximum Embankment Height	65m
Embankment Crest Level	RL 314.2 mAHD
Embankment Crest Length	780 m
Embankment Crest Width	8 m
Embankment Batter Slope	1V:3H
Embankment Intermediate Bench Width	10m
Upper Esperanza Diversion Dam (UEDD) Southern Embankment	
Type	Zoned Rockfill / Earthfill
Liner	Retain existing geosynthetic clay liner (GCL) and geomembrane liner / grout cut-off wall.
Maximum Embankment Height	32m
Embankment Crest Level	RL 317.0 m AHD
Embankment Crest Length	334 m
Embankment Crest Width	8 m
Embankment Batter Slope	1V:3H
Hydraulic / Hydrology / Storage	
Full Supply Level (Spillway Level)	RL 312.2 mAH
Full Supply Volume (Spillway Level)	6.6 GL
Spillway Depth	2m
Stored Contents	Fine metalliferous tailings, lime sludge (from proposed water treatment plant) plus decant pond (water) on top of tailings beach
Tailings Storage Capacity Total	6.3 Mm3
Catchment area	79 ha
Spillway	Provisional Bywash spillway (insitu rock cut with concrete sill)
Spillway Design Capacity	1:100,000 AEP plus 1:10 AEP Wind Wave Run-up or Probable Maximum Flood (PMF)
Environmental Containment	Design Storage Allowance (DSA) – Integrated Containment System – 5% AEP

	containment performance standard. Note DSA is less than ESS therefore the DSA is the ESS. Extreme Storm Storage (ESS) – 1:10 AEP 72hr duration – 171.4 ML
Outlet	
Outlet works	Nil
Decant Return infrastructure	
Type	Bank Mounted Pump – Power source to be confirmed.
Flow Rate	200 L/s - Dewaters ESS storm volume down to normal 1m normal decant pond operating depth within 10 days.
Destination	EPit, MCD, Pond 3, or the proposed new Water Treatment Plant (WTP) with the decant water destination dependent of the water quality and site water storage inventories.
Instrumentation	
Settlement	Yes – Survey Monuments
Piezometers (phreatic surface)	Provisional – Standpipe piezometers and/or vibrating wire piezometers (VWPs)
Seepage	Provisional – V-Notch Monitoring Weir at downstream toe of E-WRD (Northern Embankment
Groundwater Levels / Water Quality	Yes - Existing and proposed site wide groundwater bores. (Refer Section 15)

The general arrangement is shown in Figure 4 below with detailed drawings shown in Appendix A.2.

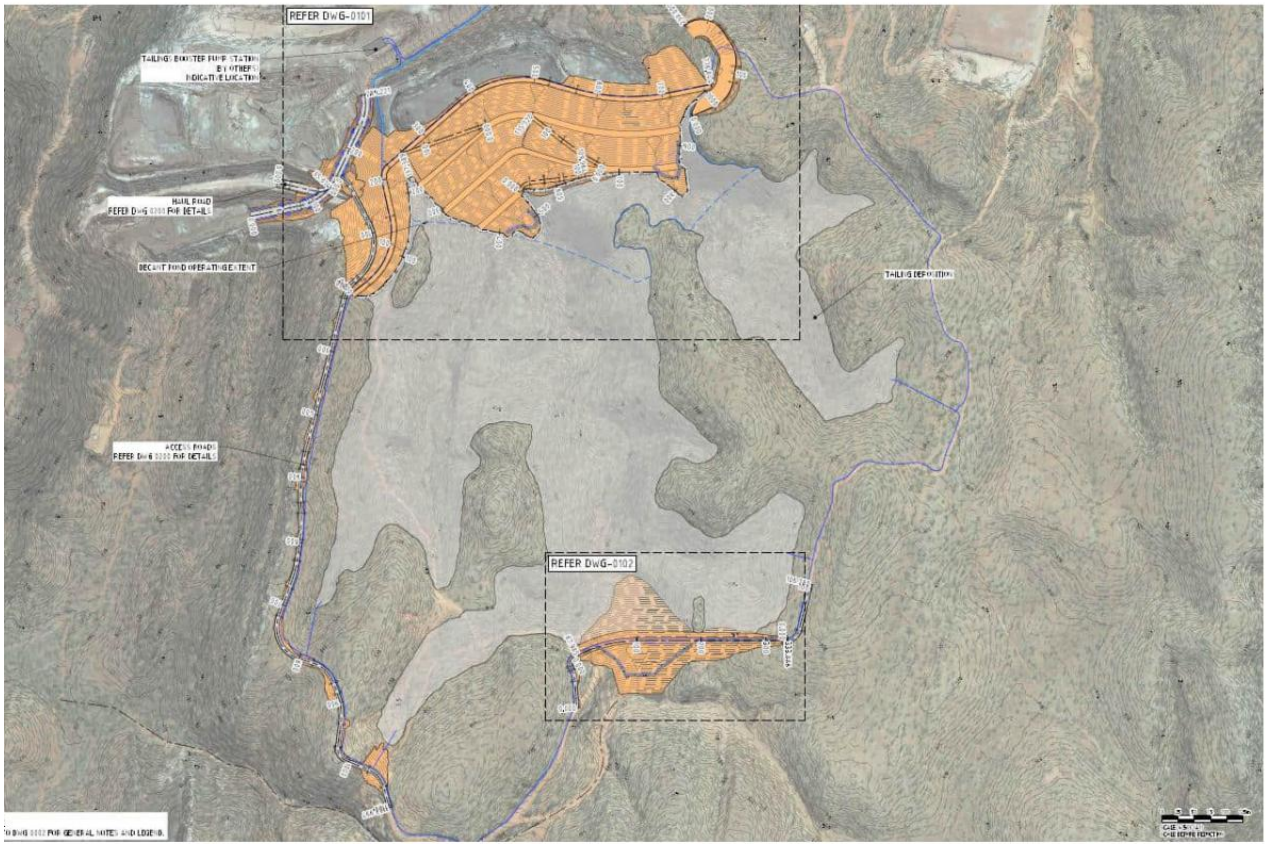


Figure 4 TSF3 General Arrangement (Engeny, 2025)

A new booster pump station will be constructed north of the EWRD. Tailings will be delivered via a ring pipeline with four discharge spigot locations around the southern extents of TSF3. Tailings will beach in a northern direction with the decant pond formed at the EWRD end of the TSF3 impoundment.

Key aspects of the TSF preliminary design include:

- Reprofiling of the EWRD embankment to enable construction of an upstream geomembrane liner tied into the foundation and abutment with an anchored concrete plinth and grout curtain. This is expected to reduce the rate of seepage through the EWRD embankment including additional acid generation during operation and closure, and to reduce the magnitude of saturation settlement in the EWRD.
- Centreline raise (which eliminates the requirement for an upstream raise on deposited tailings) of the UEDD embankment including incorporation or replacement / repair of the existing geomembrane liner and grout curtain as appropriate.
- Direction of the TSF3 spillway to EPit to reduce the likelihood of containment loss to the receiving environment.
- Reduction in the final tailings storage capacity to enable temporary accommodation of the Extreme Storm Storage (ESS).

Under normal operating conditions the decant pond will be maintained in a minimum condition (1m depth). Depending on conditions, decant water will be pumped to the following locations:

- Under normal operations decant water will be pumped to the EPit for treatment via the proposed new WTP.
- During and following rainfall events when the decant pond is subject to additional stormwater inflows, decant pumping will be directed to the EPit.
- In the event that water quality monitoring of the decant pond indicates sufficient water quality, decant water may be pumped directly to pond 3 or to the MCD (to avoid having to needlessly retreat through the WTP).

1.4.2 Northern Embankment (EWRD) Design and Construction

The Engeny Preliminary Design Report (Appendix A.2) states:

The typical design for the northern embankment is shown in Figure 5 below and the provision sequence is as follows:

1. Undertake bulk earthworks using NAF/PAF General Fill / Rock Fill to form the northern embankment and reprofile the upstream batter. Area of the northern embankment which may drain to a clean catchment (e.g. Upper Snakeskin Valley) to be constructed from NAF General Fill / Rock Fill.
2. Construct geomembrane liner cushion layer using Select Fill (Clayey Gravel / Gravelly Clay). The preliminary design allows for a typically 3m wide (1m thick) Select Fill layer, thickened to 2m thick at the batter benches to facilitate anchoring of the geomembrane liner. Where required the Select Fill layer may be separated into two material types to transition from the existing rock fill to the cushion layer to prevent loss of fines in the cushion layer during operation.
3. Construct concrete plinth and grout curtain and install geomembrane liner.

1.4.3 Southern Embankment (UEDD) Design and Construction

The typical design for the southern embankment is shown in Figure 6 below.

1. Verify adequacy of existing grout curtain (e.g. through conformation grouting) and existing HDPE geomembrane liner (e.g. through inspection and testing) and repair / replace / remediate where required. Extend grout curtain and concrete plinth to accommodation centreline raise.
2. Undertake centreline raise using NAF/PAF General Fill / Rock Fill (internal batter) and Select Fill (Clayey Gravel / Gravelly Clay) (crest and external batter). Tie low permeability Select Fill into concrete plinth / grout curtain extension. Existing HDPE liner to be protected by non-women geotextile or similar prior to Select Fill placement.

A detailed description of the TSF3 preliminary design is provided in the TSF3 Preliminary Design Report (Engeny, 2025), Appendix A.2.

Rehabilitation of the TSF will be managed through the Progressive Rehabilitation and Closure Plan, refer to Appendix A.2.

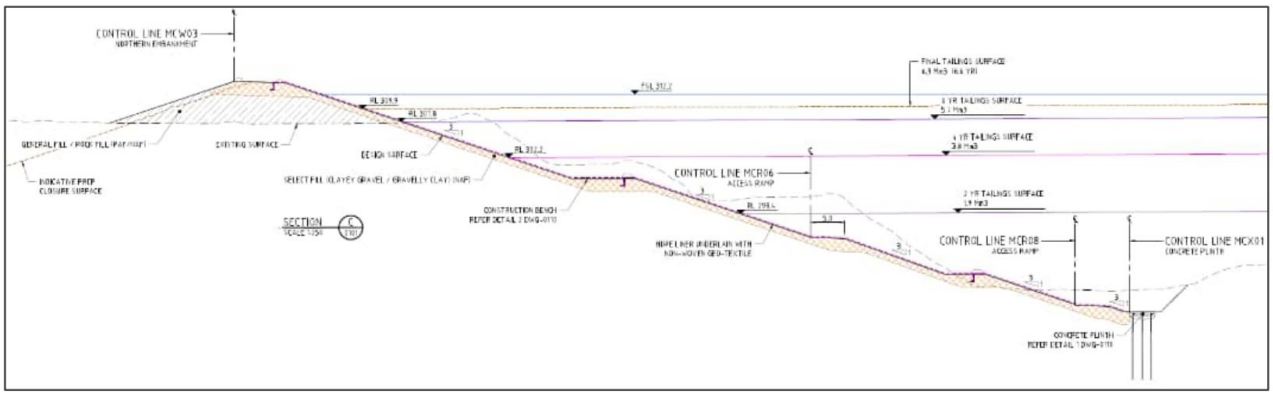


Figure 5 Tailings Deposition – Rate of Rise (Northern Embankment) (Engeny, 2025)

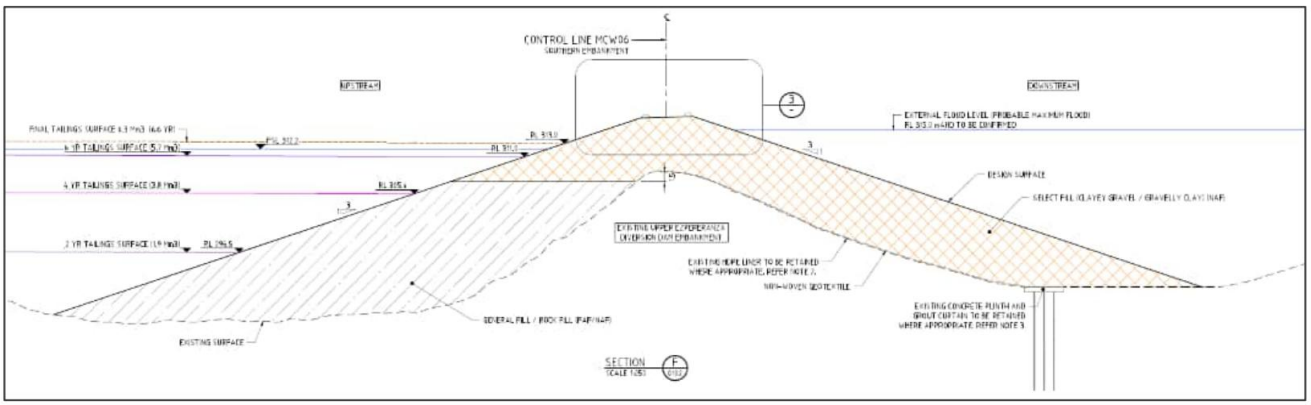


Figure 6 Tailings Deposition – Rate of Rise (Southern Embankment) (Engeny, 2025)

2 EXISTING ENVIRONMENTAL VALUES

Site-specific assessments were undertaken by a number of sub-consultants to inform the EA application and included site surveys, modelling, a review of relevant environmental documents, databases, scientific journals, books, technical reports, maps and legislation (Commonwealth, State and Local) to identify the environmental values that potentially occur within and surrounding the project area. This review has included an assessment of the following information:

- Aerial Photograph Interpretation (API) to determine the broad categorisation of vegetation within and surrounding the site and to review the extent of historical clearing and land use, and any other significant environmental features such as watercourses and wetlands.
- Regional Ecosystem and Essential Habitat mapping.
- Wildlife Online database of flora and fauna.
- Protected Matters database of Matters of State and National Environmental Significance (MSES and MNES).
- Queensland Globe online mapping tool.
- Review of relevant legislation and associated plans and policies, including but not limited to the EP Act, Nature Conservation Act 1992 (NC Act), Vegetation Management Act 1999 (VM Act), Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and Water Act 2000.
- Review and compilation of existing reports and databases including, but not limited to the following technical reports:
  - A.1 EA Amendment Application Information Requirements
  - A.2 TSF3 Preliminary Design Report, Engeny
  - A.3 Life of Mine Tailings - Multi Criteria Analysis Decision Report, V1, Capricorn Copper
  - A.4 TSF3 Flora and Fauna Assessment, KG Environmental
  - A.5 TSF3 Air Quality Assessment, Trinity Consultants Australia
  - A.6 Cultural Heritage Clearance Report and Maps
  - A.7 TSF3 Risk Register
  - A.8 GW Model Response to DETSI Comments
  - A.9 Greenhouse Gas Emissions Assessment

2.1 Site Description and Topography

The proposed new TSF3 covers an area of approximately 47 hectares, refer to Appendix B for the preliminary design drawings and Figure 4 below for an overview. The site is located from 270m AHD to 340m AHD, refer to Figure 5 below for a contour plan and Appendix A.2 for the Preliminary Design Report.

To support the preliminary design of TSF3 and required geotechnical and groundwater investigations for detailed design, a geological desktop review and targeted geological field mapping program were undertaken by Engeny. The outcomes of this investigation which includes a summary of the geological setting, potential borrow material targets, and TSF3 seepage risks are provided in the document 'QC1022_018-REP-001-1 Geological Mapping Report' (Engeny, 2024), refer to Appendix A.2.

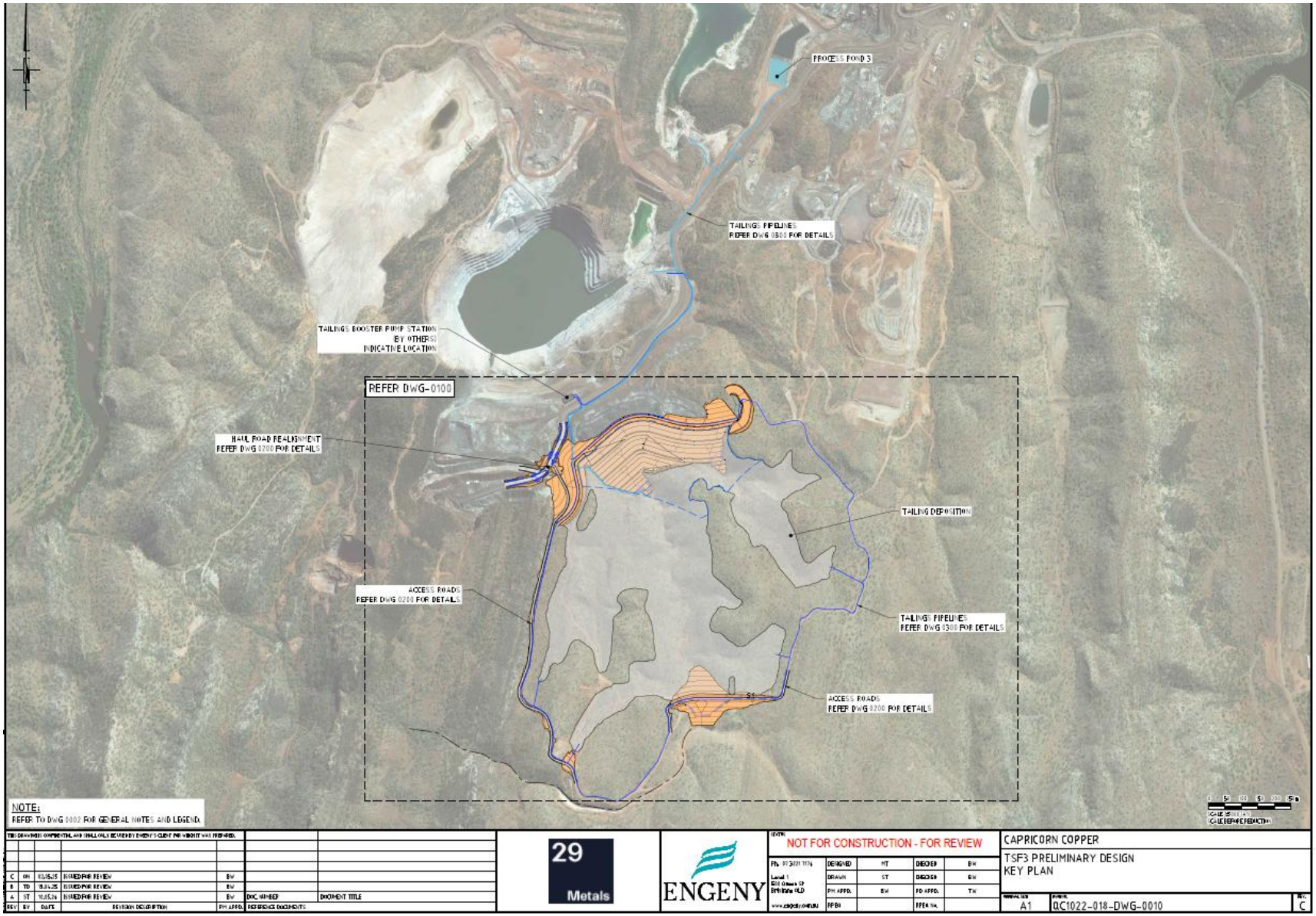


Figure 7 TSF3 Preliminary Design Key Plan, Engeny

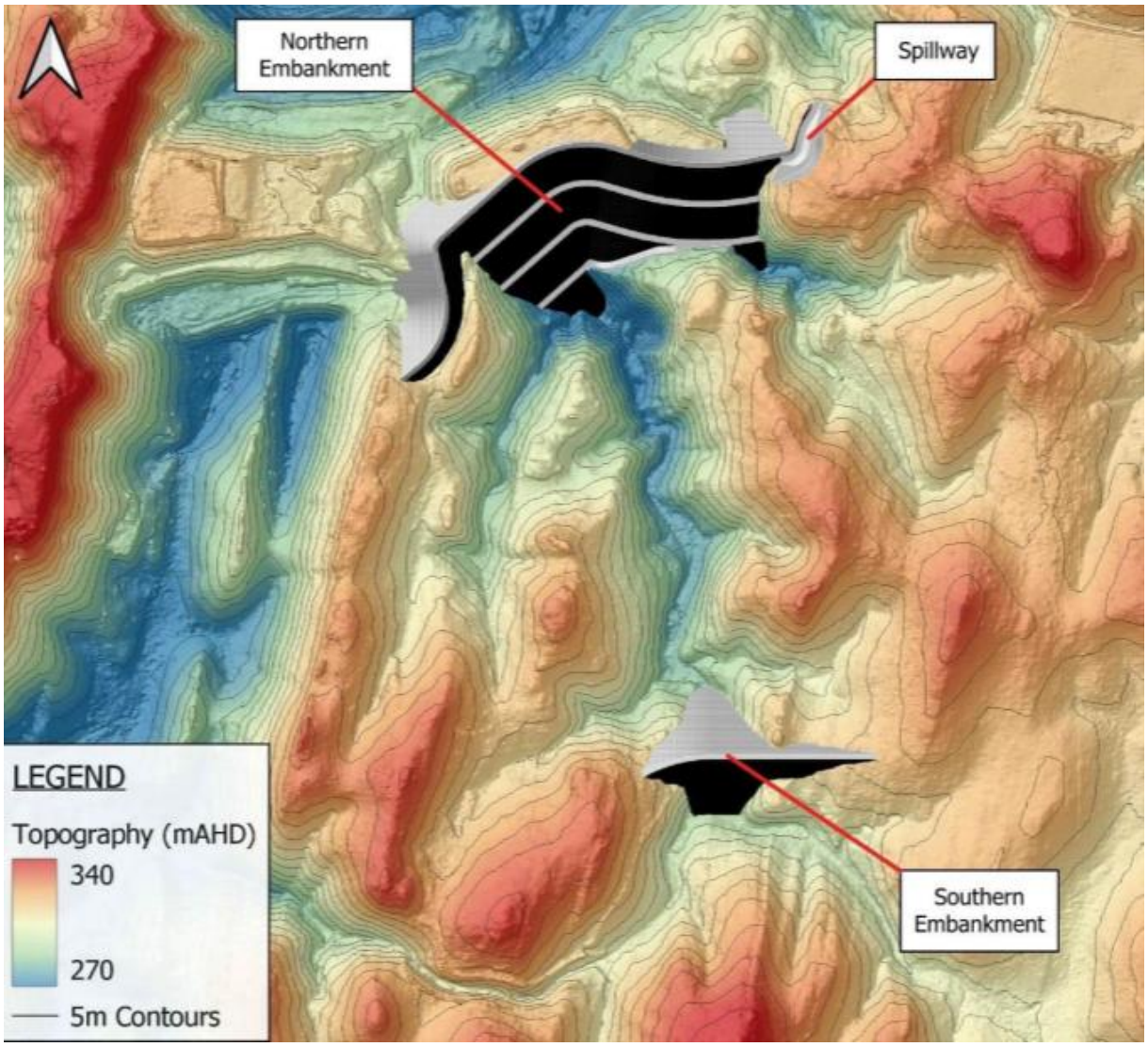


Figure 8 TSF General Arrangement showing Topography (Engeny, 2025)

2.2 Regional Climate

The site is within the Mount Isa City Council area and has a tropical continental climate. The region is subject to mild to hot temperatures throughout the year.

The nearest Bureau of Meteorology (BOM) Weather Stations is located at Lake Julius approximately 50km from the site. A review of the records confirms that approximately 70% of the annual rainfall falls between January and March.

The driest month is April and the annual mean rainfall is 533.5mm. Mean monthly maximum temperatures are highest in December at 39.2 ºC and lowest in July at 26.8ºC.

A summary of the regional climatic statistics is shown in Table 2 below.

Table 2 Summary of Regional Climate Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall (mm)													
Mean	117.4	156.2	100.8	3.2	5.3	11.6	12.5	5.2	12.9	23.1	42.5	61.2	533.5
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average Mean
Temperature (ºC)													

Mean max	37.7	36.2	35.6	33.8	29.8	27.2	26.8	29.3	33.4	37.2	38.1	39.2	33.7
Mean min	26.0	24.9	24.1	21.2	17.6	14.1	12.9	14.3	18.1	22.1	24.5	26.1	20.5

Source: Bureau of Meteorology 2025 (Lake Julius AWS 029181)

2.3 Air Quality

An air quality assessment has been undertaken by Trinity Consultants Australia, refer to Appendix A.5. Historical wind roses from the Bureau of Meteorology (BOM) station located at Lake Julius are summarised below in Plate 1 and Plate 2 below.

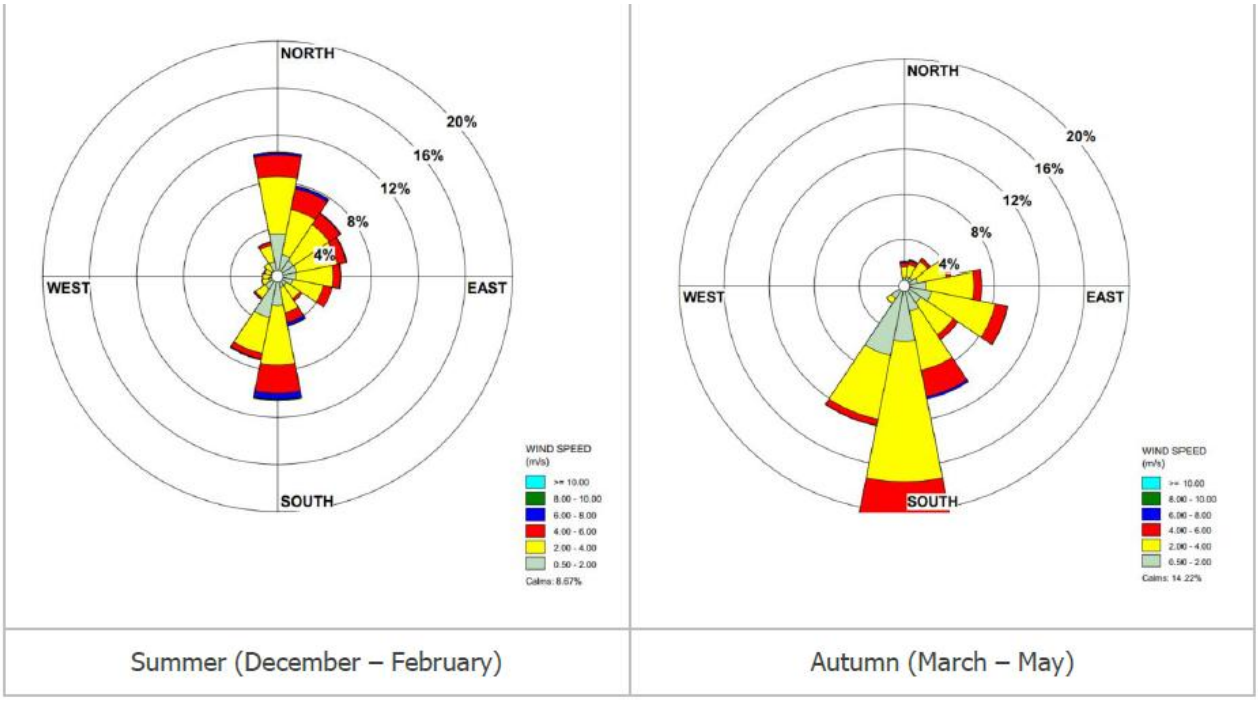


Plate 1 Summer and Autumn Seasonal Wind Roses (year 2018 – 2022) BoM Lake Julius Station

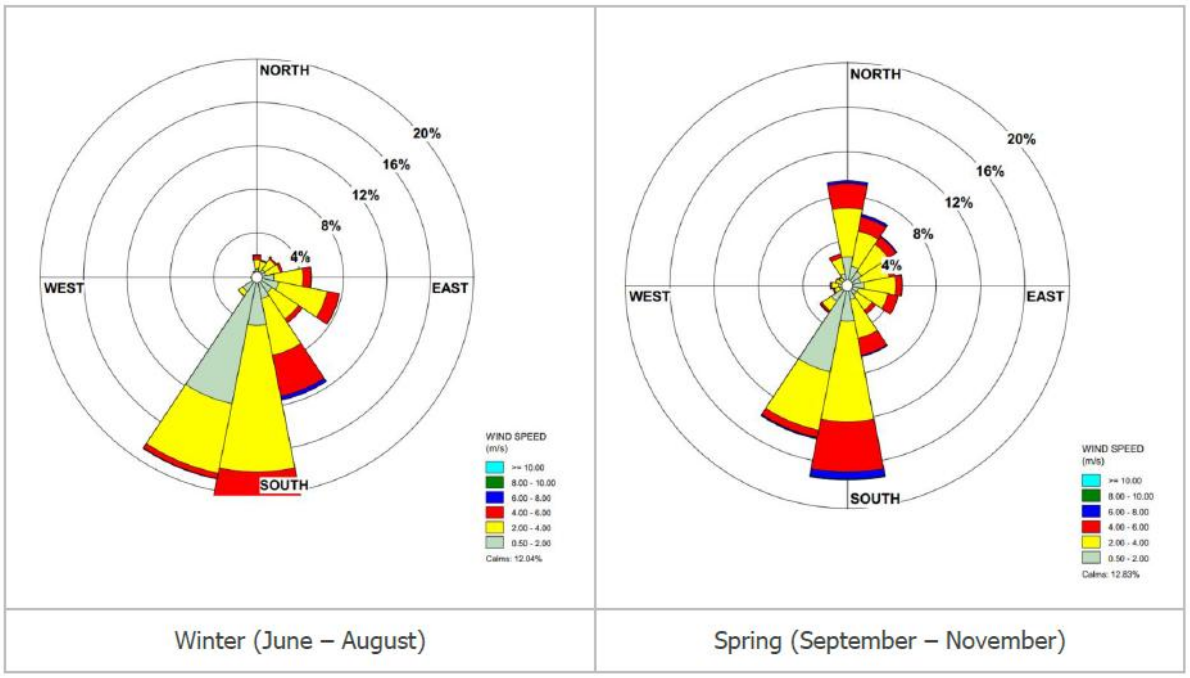


Plate 2 Winter and Spring Seasonal Wind Roses (year 2018 – 2022) BoM Lake Julius Station

Potential sensitive receptors are summarised in the Air Quality report (Appendix A.5), excerpted in Table 3 and shown in Figure 9 below.

Table 3 Air Quality Potential Receptors and Distance from Mining (Trinity Consultants Australia)

Receptor	Description	Distance From Mining Area
Mine Accommodation Camp	Residential	2.3km SE
Bortala	Homesteads	12.2 km E
Bar Creek	Homesteads	11.7km NW
New Chidna	Homesteads	21km NE
Riparian vegetation along Gunpowder Creek	Least Concern remnant vegetation	0.4km NW

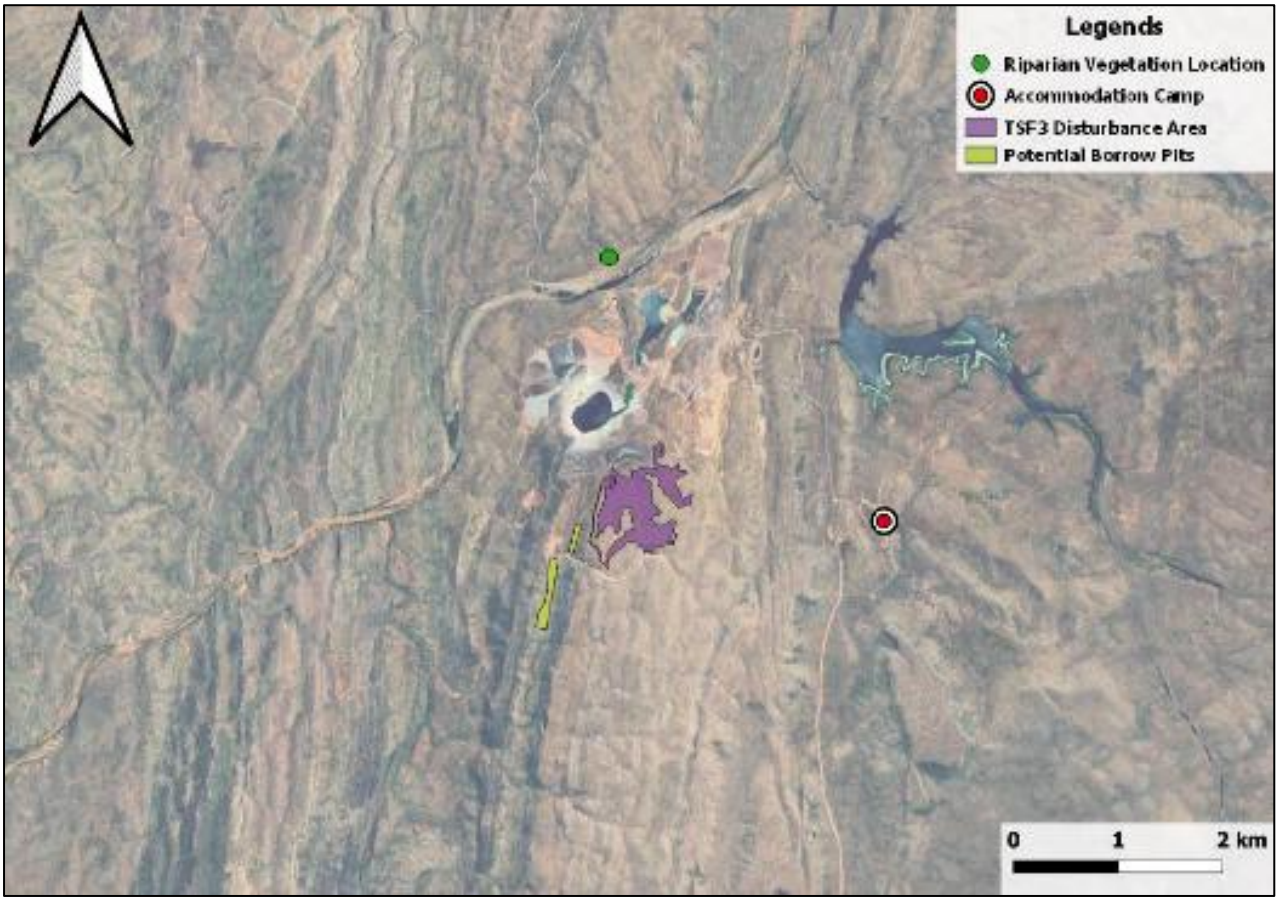


Figure 9 Location of Potentially Sensitive Receptors (Trinity Consultants Australia, 2025)

The report states that based on the rural nature of the regional area, it is expected that the air quality for the study area would be acceptable for the majority of the time. The existing air quality would be influenced by sporadic traffic on unsealed roads as well as bushfires, and controlled burning and dust from agriculture. Localised or short-term degradation of the air quality environment would most likely be due to smoke and dust from fires. Further detail is provided in Section 3.1 below and Appendix A.5.

2.4 Noise

Sensitive receptors have been summarised in Table 2 above. Given the distance to the nearest sensitive receptor as shown in Figure 6 above, it is not anticipated that the proposed TSF3 will result in operations that are different to existing mining activities that are currently conditioned under the existing EA.

A Construction Environmental Management Plan will be prepared and include mitigation measures for potential noise impacts during construction of TSF3 and is discussed further in Section 3 below.

2.5 Surface Water and Groundwater

2.5.1 Surface Water

To support the preliminary design of TSF3, hydrological and hydraulic assessments were undertaken including a surface water impact assessment by Engeny (Engeny, 2025) (Appendix A.2).

The Preliminary Design Report (Appendix A.2) states that the site currently flows to Gunpowder Creek, located to the west, and is part of the Leichhardt River drainage sub-basin which has a total catchment area of 32,882.2km. Gunpowder Creek (adjacent to CCM) has been classified as a highly disturbed aquatic ecosystem and is considered moderately disturbed downstream of the mine (NRA 2022).

Gunpowder Creek is utilised for primary industries (livestock drinking water) and mining activities. Recreational uses have been identified as visual recreational use and downstream of CCM, secondary recreation only e.g. boating and fishing with no swimming.

The outcomes of the investigation undertaken by Engeny (Appendix A.2) include a summary of the regional catchments and drainages, streamflow monitoring, water management system and surface water quality objectives. The report concluded that for surface water flow, TSF3 is not expected to result in any change to the existing flow regime in Gunpowder Creek, and no overflow events from the integrated containment system up to the P99 event. The 47ha catchment footprint removed from the 247,700 ha Gunpowder Creek catchment at CCM represents 0.3% of the total catchment.

Water balance modelling for TSF3 indicates that while overflows from TSF3 are expected, sufficient residual capacity remains in the integrated containment system (specifically EPit) such that overflows to Gunpowder Creek are considered unlikely, refer to Appendix A.2 for further detail.

With respect to surface water quality, TSF3 is not expected to result in any increase in seepage flow to Gunpowder Creek and is considered to have negligible impact on flow. REMP data indicates impacts to receiving environment and macroinvertebrate health are not increasing. CC is not seeking to increase the requirement for discharge of MAW to Gunpowder Creek and releases would continue to be in accordance with existing EA conditions.

2.5.2 Groundwater

Groundwater investigations were undertaken by Engeny (Engeny, 2025) (Appendix A.2). The groundwater within the extent of the site is expected within the shallow perched aquifer system and the deep fractured rock. Standing water levels (SWL) of TSF3 groundwater monitoring network bores range from 140.1 to 274.25mAHD and is expected to flow to the west from TSF3. Environmental values of groundwater can be identified in Section 6 of the Groundwater investigation undertaken by Engeny (Appendix A.2). Modelling indicates that the main control on infiltration and seepage from TSF3 will be the installation of a HDPE liner. The liner is required to limit the infiltration of groundwater through the Esperanza Waste Rock Dump to the Esperanza Pit, the receiving body for the groundwater (Engeny, 2024). A key assumption to the design of TSF3 is that all potential seepage from the TSF will be captured in EPit.

Discharging of seepage influxes to the environment will be relatively minimal and if required, will be managed in accordance with the requirements of the EA and the Groundwater Monitoring and Management Plan, further detail is provided in Appendix A.2. The mitigation measures to control the risk of seepage are considered appropriate to manage the potential seepage risk, provided the permeability of the base of the

proposed TSF3 is confirmed. Once the permeability of the base is confirmed, the likelihood of impacts to EV's and groundwater will reduce to unlikely, providing a greater level of confidence to the numerical model produced.

2.5.3 Matters of State Environmental Significance

The footprint of TSF3 does not include any mapped Matters of State Environmental Significance (MSES) other than a MSES regulated vegetation (defined watercourse), mapped as a green line in Figure 10 below. This is an unmapped tributary of Gunpowder Creek and mapped as a Level 2 watercourse under the *Water Act 2000.*

Regulated vegetation is discussed further in Section 2.5.4 below and it is noted that an ecological assessment was undertaken by KG Environmental in June 2023 (refer to Appendix A.4) which ground-truthed the regulated vegetation and ecological values within the TSF3 footprint.



Figure 10 MSES mapping on TSF3 (Qld Globe, 26 May 2025)

2.5.4 Vegetation

The footprint of TSF3 is mapped as Remnant Vegetation, refer to Figure 11 below.

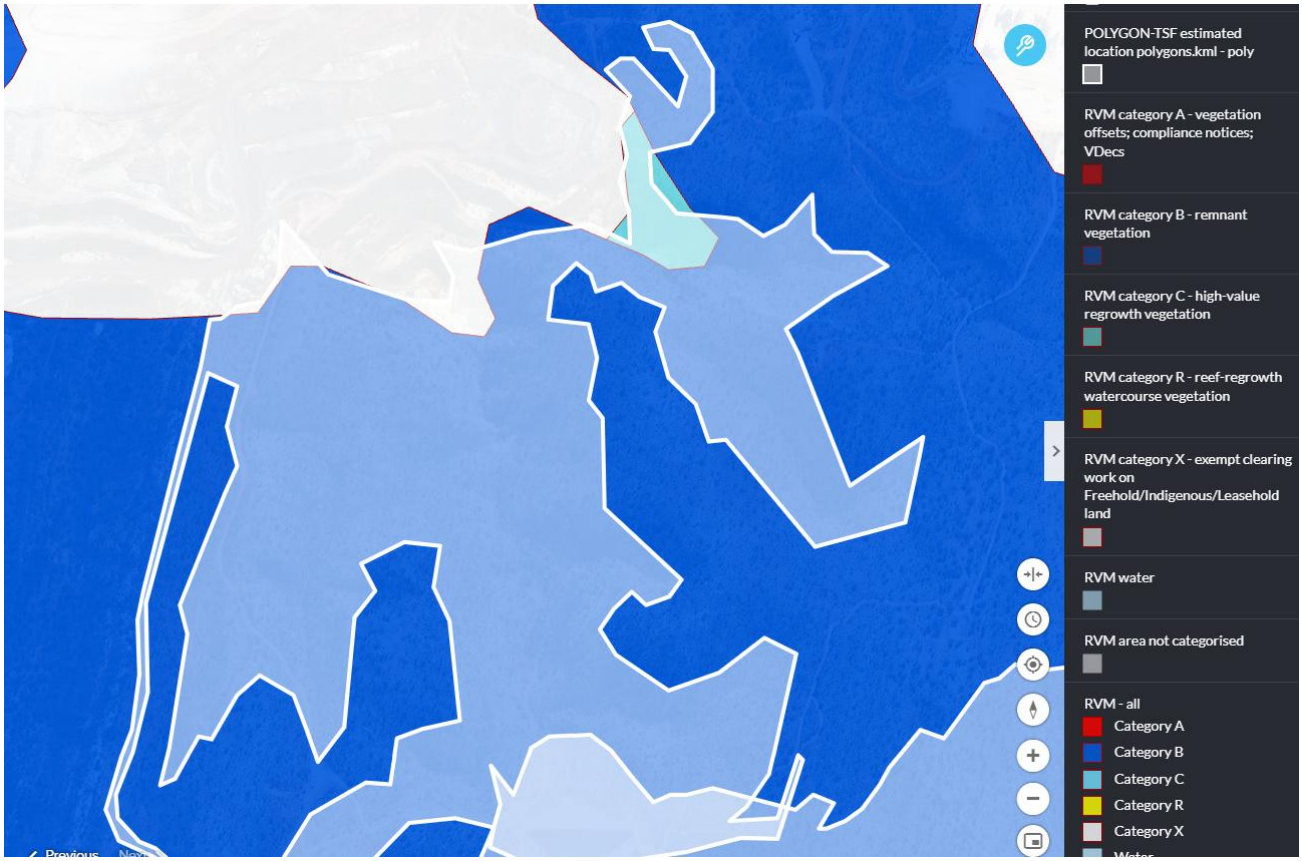


Figure 11 Regulated Vegetation Mapping (Qld Globe, 26 May 2025)

The TSF3 footprint is mapped as Least Concern Regional Ecosystem (RE), refer to Figure 12 below.



Figure 12 Regulated Vegetation Mapping (Qld Globe, 26 May 2025)

The RE is mapped as a mixed polygon of 1.7.7/1.11.2/1.7.5 at 75/20/5%. A dry season flora survey confirmed the RE as per Table 1 excerpted below, refer to the full report in Appendix A.4.

Table 1. Regional Ecosystems present within the TSF3 footprint

Regional Ecosystem	Description	Area of Disturbance Footprint
1.3.7b	Northern Swamp Box gully	1 ha
1.7.7a	Small-fruited Ghost Gum hills	33 ha
1.11.2a	Snappy Gum hills	6 ha
NA	Non-remnant/cleared	7 ha
Total		47 ha

The three REs have a Least Concern VM Act status.

The Flora and Fauna Assessment (Appendix A.4) determined that there is 0.9 ha of Endangered Biodiversity Status RE1.3.7b that will be disturbed by TSF3, which is overlayed by 0.6 km of regulated vegetation (intersecting a watercourse), associated with a stream order 2. Appendix 3 of the Queensland Environmental Offsets Policy nominates 25m distance from defining banks for stream order 1 and 2 within the non-coastal bioregions of Queensland. This calculates approximately 3 ha of regulated vegetation.

The Queensland Environmental Offsets Policy Significant Residual Impact Guideline provides a criteria of 2 ha of clearance within sparse regional ecosystems. The Flora and Fauna Assessment concluded that, according to the Queensland Environmental Offsets Policy Significant Residual Impact Guideline, the clearance of calculated regulated vegetation for this project (3 ha) exceeds the criteria and triggers consideration of an environmental offset. However, the actual extent of riparian vegetation as measured on-ground (0.9 ha) falls below the criteria of 2 ha.

2.5.5 Protected Plants

The site is not mapped as High Risk for Protected Plants. No threatened flora species was recorded within the TSF3 disturbance footprint or greater survey area during the dry season flora survey (Williams 2023b), refer to the TSF3 Flora and Fauna Assessment report in Appendix A.4.

One flora species listed as Near Threatened under the NC Act has been recorded onsite, including within the TSF3 footprint. *Ipomoea antonschmidii* was observed in two locations during the dry season survey. A total of two dozen *Ipomoea antonschmidii* plants were counted, with 14 plants spanning about 100 m in a northwestern location (within the TSF3 footprint) and 10 plants growing along about 30 m of track edge in a more eastern location in the larger survey area. This silver-hairy trailing vine was only observed growing on the edge of graded dirt tracks during the dry season (Williams 2023b).

The Flora and Fauna Assessment report has recommended that a Protected Plant Permit to clear the protected plant species *Ipomoea antonschmidii* is obtained by June 2025 as the flora survey was undertaken in June 2023.

2.5.6 Threatened Fauna

The wet season survey, undertaken in January 2024 by KG Environmental, recorded 67 species of terrestrial vertebrate in the site, comprised of 17 mammal (including 12 bat species), 31 bird, 12 reptile and seven frog species.

Two threatened fauna species have been recorded within the TSF3 footprint (Figure 13), Purple-necked Rock-wallaby and Orange Leaf-nosed Bat, which are both listed as Vulnerable under the NC Act.

The following species were assessed against the Queensland Environmental Offsets Policy Significant Residual Impact Guideline (QG 2014):

- Vulnerable Purple-necked Rock-wallaby (*Petrogale purpureicollis*)
- Vulnerable Orange Leaf-nosed Bat (*Rhinonicteris aurantia).*

The report concluded that a Significant Residual Impact to the two listed vulnerable species was not expected, although the size and extent of the local Purple-necked Rock Wallaby was not documented. It is recommended that a Species Management Plan is developed for this species.

The following species were assessed against the EPBC Act Significant Impact Guidelines 1.1 (AG 2013):

- Vulnerable Ghost Bat (*Macroderma gigas)*
- Vulnerable Grey Falcon (*Falco hypoleucos)*
- Endangered Carpentarian Grasswren (*Amytornis dorotheae)*
- Endangered Gouldian Finch (*Erythrura gouldiae)*
- Critically Endangered Northern Blue-tongue Skink (*Tiliqua scincoides intermedia).*

The Flora and Fauna Report recommends that 29 Metals attend a pre-referral meeting with DCCEEW to discuss the requirement to submit an EPBC Referral based on the presence of habitat for Carpentarian Grasswren and Northern Blue-tongue Skink. The report identifies that a Significant Residual Impact is not considered likely, however a precautionary approach may be required and referral is likely.

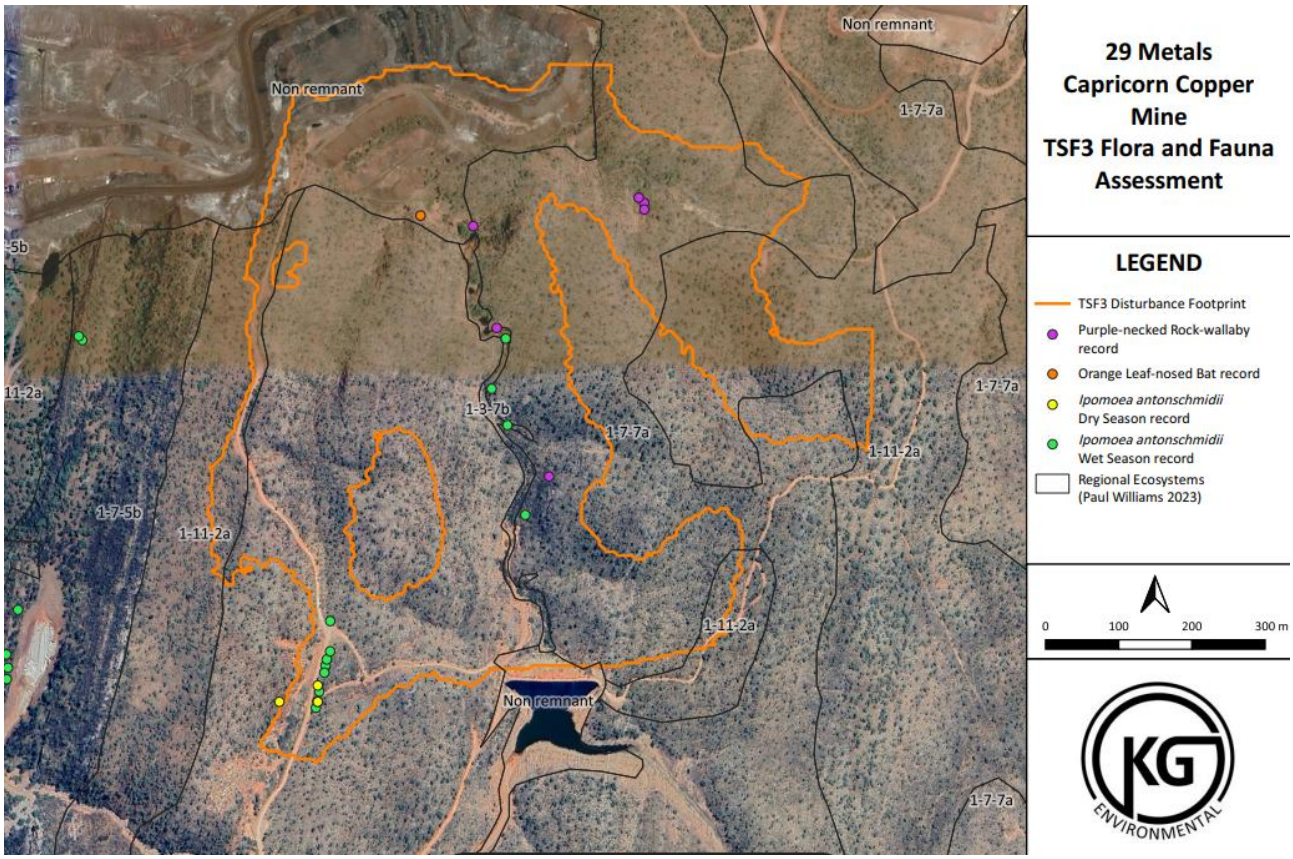


Figure 13 TSF3 Threatened and Near Threatened Species Observations (KG Environmental, 2024)

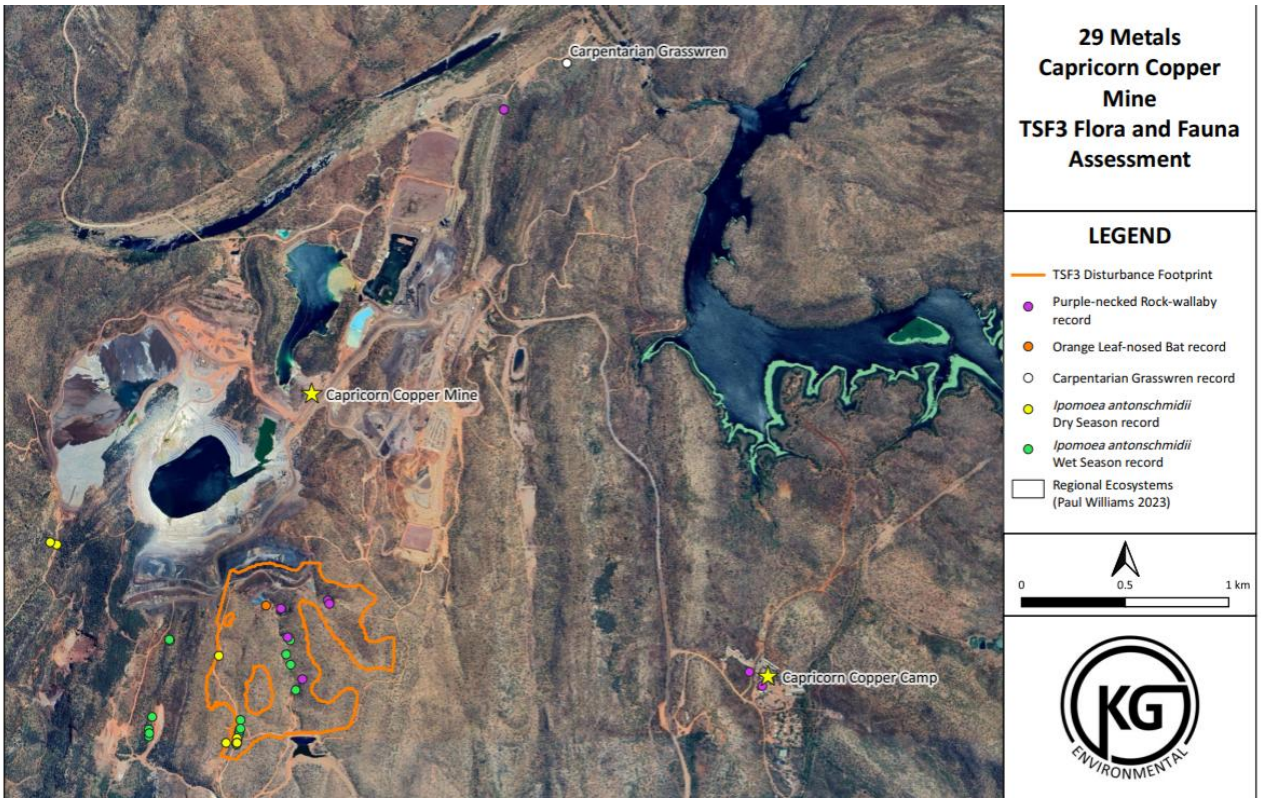


Figure 14 CCM Threatened and Near Threatened Species Observations (KG Environmental, 2024)

2.6 Cultural Heritage

Cultural heritage clearance surveys were undertaken by Kalkadoon PBC representatives between 7 – 11 July 2025 who inspected the Upper Esperanza proposed TSF3 following up from inspections conducted in September 2023 and June 2016. This area was approximately 46 hectares not including stockpile areas. In addition, the on-lease and off-lease borrow investigation areas were inspection along with magazine creek for the proposed TSF for Life of Mine and borrow area for TSF3. Maps of the areas inspected along with photographs and reports are included in Appendix A.6.

3 ENVIRONMENTAL OBJECTIVE ASSESSMENT

The following section assesses the proposed activity against the environmental objectives and performance outcomes for Air, Water, Wetlands, Groundwater, Noise, Waste and Land environmental values as per Schedule 8, Part 3 of the *Environmental Protection Regulation 2019* (EP Reg).

It also describes the risks to environmental values and likely magnitude of the impacts generated by the proposed amendment.

3.1 Air

The Environmental Objective for Air detailed within Schedule 8, Part 3, Division 1 of the EP Reg states:

"The activity will be operated in a way that protects the environmental values of air."

Performance outcomes for Air as detailed in the EP Reg include:

1. There is no discharge to air of contaminants that may cause an adverse effect on the environment from the operation of the activity.

2. All of the following:

- Fugitive emissions of contaminants from storage, handling and processing of materials and transporting materials within the site are prevented or minimised;
- Contingency measures will prevent or minimise adverse effects on the environment from unplanned emissions and shut down and start up emissions of contaminants to air;
- Releases of contaminants to the atmosphere for dispersion will be managed to prevent or minimise adverse effects on environmental values.

The *Environmental Protection (Air) Policy 2019* (EPP (Air)) prescribes the environmental values that are to be protected or enhanced, which are:

a. The qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems;

b. The qualities of the air environment that are conducive to human health and well being;

c. The qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures and other property; and

d. The qualities of the air environment that are conducive to protecting agricultural use of the environment.

An air quality assessment has been undertaken by Trinity Consultants Australia, refer to Appendix A.5.

The report states that based on the rural nature of the regional area, it is expected that the air quality for the study area would be acceptable for the majority of the time. Potential air quality issues arising from the project are likely to be from dust from construction and from open surfaces including dry tailings surfaces. The existing air quality would be influenced by sporadic traffic on unsealed roads as well as bushfires, and controlled burning and dust from agriculture.

The predicted concentrations and levels of all indicators are within the relevant criteria at the modelled receptors as summarised in Table 4 and Table 5 below. Section 6.4 of Trinity Consultants Australia Air Quality Assessment (Appendix A.5) identifies the potential sources of dust in the construction of TSF3 and from existing tailings storage facilities (TSF) as a baseline for proposed TSF3.

Table 4 Air Quality Potential Receptors and Distance from Mining (Trinity Consultants Australia)

	Annual Average TSP (ug/m^3)	Max 24hr Average PM_{10} (ug/m^3)	Annual Average PM_{10} (ug/m^3)	Max Average $PM_{2.5}$ (ug/m^3)	Annual Average $PM_{2.5}$ (ug/m^3)	Dust deposition (mg/m2/day)
Criterion	**90**	**50**	**25**	**25**	**8**	**120**
Background	51.3	21	20	7.4	7	50
Source Only	0.2	20.2	0.5	1.4	0.04	19.6
Cumulative (Source + Background)	51.5	41.2	20.5	8.8	7.04	69.6

Table 5 Predicted Flouride Concentrations at the Least Concern Riparian Vegetation

	Max 24hr Average fluoride (ug/m^3)	30 day average flouride (ug/m^3)	90-average fluoride (ug/m^3)
Criterion	**2.9**	**0.84**	**0.1**
Background	-	-	-
Source Only	0.02	0.002	0.001

The environmental objective for dust is proposed to be met via Performance Outcome 2.

The construction phase of the project will include internal access roads at the site have been identified as the most critical sources, contributing to the majority of emissions which will be managed through the implementation of a Construction Environmental Management Plan.

All other sensitive receptors are located approximately 11 to 21 kilometres from the Project site and are not likely to be impacted. Fluoride emission criteria have been focused on protecting health and biodiversity of ecosystems. Presented results in Table 4 show fluoride emissions comply with the relevant criteria at the riparian vegetation.

The results have shown that predicted cumulative concentrations arising from mining operations are within the required criteria.

3.2 Water

The Environmental Objective for Water detailed within Schedule 8, Part 3, Division 1 of the EP Reg states:

"*The activity will be operated in a way that protects environmental values of waters*".

Performance Outcomes for Water as detailed in the EP Reg include:

1. There is no actual or potential discharge to waters of contaminants that may cause an adverse effect on an environmental value from the operation of the activity.

2. All of the following:

a. The storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks;

b. Contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water;

c. The activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment;

d. The disturbance of any acid sulfate soil, or potential acid sulfate soil, will be managed to prevent or minimise adverse effects on environmental values;

e. Acid producing rock will be managed to ensure that the production and release of acidic waste is prevented or minimised, including impacts during operation and after the environmental authority has been surrendered;

f. Any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland;

g. For a petroleum activity, the activity will be managed in a way that is consistent with the coal seam gas water management policy, including the prioritisation hierarchy for managing and using coal seam gas water and the prioritisation hierarchy for managing saline waste;

h. The activity will be managed so that adverse effects on environmental values are prevented or minimised.

The environmental objective for water is proposed to be met via Performance Outcome 2. The risk to surface water flow and water quality from TSF3 is low, as per Appendix A.2. Water generated by CC and management strategies are identified in Table 4.1 of the Surface Water Impact Assessment undertaken by Engeny (Appendix A.2). Monitoring and mitigation will be undertaken for TSF3, similar to the existing management measures. A tailored OMS and CEMP will be prepared to meet the conditions of the EA once approved and the risk register in Appendix A.7 provide further details on mitigation measures for each phase of the project.

3.3 Wetlands

The Environmental Objective for Wetlands detailed within Schedule 8, Part 3, Division 1 of the EP Reg states:

"*The activity will be operated in a way that protects the environmental values of wetlands*".

Performance Outcomes for Wetlands as detailed in the EP Reg include:

1. There will be no potential or actual adverse effect on a wetland as part of carrying out the activity.

2. The activity will be managed in a way that prevents or minimises adverse effects on wetlands.

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water)) defines wetland as an area shown as a wetland on the 'Map of Queensland wetland environmental values', published on the department's website. The 'Map of Queensland wetland environmental values' is a state-wide statutory map under the EPP (Water) which identifies wetlands of high ecological significance (HES) and general ecological significance (GES) across the state. HES wetlands are identified as MSES under the Planning and Environmental Offsets legislation.

There are no HES wetlands within the receiving environment of the site, therefore the application will achieve the environmental objective for water through Performance Outcome 1.

3.4 Groundwater

The Environmental Objective for Groundwater detailed within Schedule 8, Part 3, Division 1 of the EP Reg states:

"*The activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.*"

Performance Outcomes for Groundwater as detailed in the EP Reg include:

1. Both of the following apply:
   a. There will be no direct or indirect release of contaminants to groundwater from the operation of the activity;
   b. There will be no actual or potential adverse effect on groundwater from the operation of the activity.
2. The activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems.[1]

The application will achieve the environmental objective for groundwater through Performance Outcome 2 as the activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems. Manual and ongoing surface water and groundwater will continue to be undertaken as per the EA with additional monitoring locations surrounding the TSF3 to ensure no impacts

will occur, refer to Appendix A.2 for proposed groundwater monitoring program and Appendix A.7 for the risk register. It is also proposed that routine inspections be carried out to monitor for potential seepage from the TSF3 embankment. If seepage is detected from TSF3, further seepage management measures may be required to be implemented. A summary of the proposed groundwater monitoring to be completed is included in *Section 11* of Appendix A.2.
A tailored OMS and CEMP will be prepared to meet the conditions of the EA once approved.

3.5 Noise

The Environmental Objective for Noise detailed within Schedule 8, Part 3, Division 1 of the EP Reg states:

"*The activity will be operated in a way that protects the environmental values of the acoustic environment*".

Performance Outcomes for Noise as detailed in the EP Reg include:

1. Sound from the activity is not audible at a sensitive receptor.

2. The release of sound to the environment from the activity is managed so that adverse effects on environmental values, including health and wellbeing and sensitive ecosystems, are prevented or minimised.

The *Environmental Protection (Noise) Policy 2019* (EPP (Noise)) prescribes the environmental values that are to be protected or enhanced, which are:

a. The qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems;
b. The qualities of the acoustic environment that are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following:
    i. Sleep;
    ii. Study or learn; or
    iii. Be involved in recreation, including relaxation and conversation; and
c. The qualities of the acoustic environment that are conducive to protecting the amenity of the community.

The Environmental Objective for noise is proposed to be met via Performance Outcome 1. Earthmoving machinery including excavators, loaders, trucks and dozers are expected to be used in the construction of TSF3. Similarly, machinery will be used in the ongoing operations of CCM as per Section 6 of Trinity Consultants Australia Air Quality Assessment (Appendix A.5). As identified in Section 4.2 of the Air Quality Assessment (Appendix A.5) sensitive receptors to noise are located approximately 11 to 21 kilometres from the Project site and are not likely to be impacted.

3.6 Waste

The Environmental Objective for Waste detailed within Schedule 8, Part 3, Division 1 of the EP Reg states:

"*Any waste generated, transported, or received as part of carrying out the activity is managed in a way that protects all environmental values*".

Performance Outcomes for Waste as detailed in the EP Reg include:

1. Both of the following apply:

    a. Waste generated, transported or received is managed in accordance with the waste and resource management hierarchy in the *Waste Reduction and Recycling Act 2011* (WRRA); and
    b. If waste is disposed of, it is disposed of in a way that prevents or minimises adverse effects on environmental values.

The Environmental Objective for waste is proposed to be met via Performance Outcome 1. It is proposed that any waste likely to be generated, transported, or received as a result of the activity will be managed in accordance with the waste and resource management hierarchy and the risk register detailed in Appendix A.7.

3.7 Land

The Environmental Objective for Land detailed within Schedule 8, Part 3, Division 1 of the EP Reg states:

"*The activity is operated in a way that protects the environmental values of land, including soils, subsoils, landforms and associated flora and fauna*".

Performance Outcomes for Land as detailed in the EP Reg include:

1. There is no actual or potential disturbance or adverse effect to the environmental values of land as part of carrying out the activity.

2. All of the following apply:

    a. Activities that disturb land, soils, subsoils, landforms and associated flora and fauna will be managed in a way that prevents or minimises adverse effects on the environmental values of land;

    b. Areas disturbed will be rehabilitated or restored to achieve sites:

        i. That are safe and stable;

        ii. Where no environmental harm is being caused by anything on or in the land; and

        iii. That are able to sustain an appropriate land use after rehabilitation or restoration;

    c. The activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants; and

    d. The application of water or waste to the land is sustainable and is managed to prevent or minimise adverse effects on the composition or structure of soils and subsoils.

The Environmental Objective for land is proposed to be met via Performance Outcome 2. The detailed assessments have determined that the potential environmental risks will be effectively regulated through the implementation of environmental monitoring and management practices to avoid and mitigate any potential environmental impacts with a detailed Rehabilitation and Closure Plan in Appendix A.2.

The Risk Register in Appendix A.7 details the emergency response procedure for unexpected releases (spill response), flooding and stormwater management, fire management and cyclone management. It also details the management actions, routine monitoring programs and nominates persons responsible for delivering on land and rehabilitation management objectives for the site.

A tailored OMS and CEMP will be prepared to meet the conditions of the EA once approved.

4 ENVIRONMENTAL VALUES RISK ASSESSMENT

The following section describes risks to environmental values and likely magnitude of the impacts generated by the proposed development which was identified during a risk workshop undertaken on 10 July 2025.

The risk register utilised Capricorn Coppers Risk Assessment Criteria which is summarised in Figure 15 below and the risk matrix in Table 6 below. It assessed the risks from the construction, operational and closure phases of the project, refer to Appendix A.7 for the full risk register.

Table 6 Risk Matrix

Risk Matrix	Likelihood				
Consequence	A. Rare	B. Unlikely	C. Possible	D. Likely	E. Almost Certain
5. Catastrophic	15 - High	19 - High	22 - Extreme	24 - Extreme	25 - Extreme
4. Major	10 - Medium	14 - High	18 - High	21 - Extreme	23 - Extreme
3. Moderate	6 - Low	9 - Medium	13 - Medium	17 - High	20 - High
2. Minor	3 - Low	5 - Low	8 - Medium	12 - Medium	16 - High
1. Insignificant	1 - Low	2 - Low	4 - Low	7 - Medium	11 - Medium

29Metals **DRAFT** Risk Assessment Criteria

29 Metals

1. CONSEQUENCE RATING

When assessing consequence, consider the most credible worst-case impact. Where a risk has multiple impacts, select the category with the highest rating.

Rating / Category	Group Financial	Site Financial	Health, safety & well-being	Environment	Social/Cultural Heritage	Legal & Compliance	Reputation
5. Catastrophic	>$75M	>$35M	Multiple fatalities or terminal illnesses/ Multiple total permanent disabling injuries	Irreversible impact to ecosystem/ long term harm to highly valued species/ecosystem	Irreparable damage to tangible/intangible heritage of significance	Loss of licence to operate. Imprisonment of directors/officers	Sustained local, state or national condemnation by media, public, government/non government organisations
4. Major	$15M-$75M	$7M-$35M	Fatality/ Total permanent disabling injury / multiple LTI's > 2 weeks	Long term impact to species/ecosystem	Ongoing impact to tangible/ intangible heritage of significance	Material breach of regulation. Civil litigation/prosecution	Wide spread adverse local or state attention from media, public, government/ non government organisations
3. Moderate	$5M-$15M	$2M-$7M	Lost time injury or illness	Short term impact, not affecting ecosystem function	Recoverable impact to tangible/intangible heritage	Breach of regulation with fines and penalties	Adverse attention from media or heightened concern by local community
2. Minor	$750K-$5M	$500K-$2M	Medical treatment injury or illness	Immediately recoverable environmental impact	Immediately recoverable impact to tangible/intangible heritage	Breach of low level commitment that is reportable	Limited adverse local public or media attention and complaints
1. Insignificant	<$750k	<$500K	First aid treatment injury or illness	Inconsequential environmental impact	No tangible/intangible heritage impact	Procedural non reportable breach	Public concern restricted to localised complaints

CONSEQUENCE RATING

RISK MATRIX

CONSEQUENCE RATING	A. Rare	B. Unlikely	C. Possible	D. Likely	E. Almost certain
5. Catastrophic	15- High	19- High	22- Extreme	24- Extreme	25- Extreme
4. Major	10-Medium	14-High	18- High	21- Extreme	23- Extreme
3. Moderate	6-Low	9- Medium	13- Medium	17- High	20- High
2. Minor	3-Low	5-Low	8- Medium	12- Medium	16- High
1. Insignificant	1-Low	2-Low	4-Low	7- Medium	11- Medium

2. LIKELIHOOD RATING

Determine the likelihood of the risk occurring and resulting in the credible worst-case impact

	A. Rare	B. Unlikely	C. Possible	D. Likely	E. Almost certain
Description (High level business risk)	The event may occur in exceptional circumstances	The event could occur	The event should occur	The event will probably occur	The event is expected to occur
Frequency (Operations)	>25 years	Once every 10-25 years	Once every 5-10 years	Once every 2-5 years	More than once a year
Probability (Projects)	<1%	1%-10%	10%-20%	20%-50%	>50%

LIKELIHOOD RATING

Select the rating that best applies to the individual risk. Rows not intended to correlate.

3. CONTROL EFFECTIVENESS RATING

Qualitative assessment of the effectiveness of the overall control environment for individual risks

ID	Rating	Description
1	Effective	All viable key controls are in place and operating as intended.
2	Partially effective	Some key controls are in place and are working with partial effect. Additional controls required.
3	Ineffective	Few key controls are in place. Reliant on individual practices. Further development of key controls required.

4. HSEC RISK TREATMENT HIERARCHY

Practical initiatives that should be undertaken to improve existing controls. As a general principle, risks should be managed to As Low As Reasonably Practicable (ALARP), having regard for the nature of the risk.

1. **Eliminate** — Remove the hazard completely
2. **Substitute** — Replace the hazard with a less hazardous alternative
3. **Isolate** — Separate the hazard from personnel and other processes
4. **Engineering controls** — Physical controls e.g. guarding/barricading/bunding
5. **Administrative controls** — Signage, procedures, notifications, training
6. **PPE** — Gloves, earplugs etc

*Refer Group Risk Management Standard for non HSEC risk treatment options

5. RISK ACCEPTANCE CRITERIA

Recognition of the magnitude of the risk and the required control effectiveness, reporting and validation activities

Risk Rating	Control Requirement	Group Reporting Requirement*	Site Reporting Requirement	Validation Guidance
20-25 Extreme	Effective	Audit, Governance & Risk Committee	COO	Independent/expert person validation and assurance
14-19 High	Effective	CEO & Line Executive	Site General Manager	Risk owner validation and assurance
7-13 Medium	Partially effective	Line Executive/ Site GM	Manager/ Superintendent	Self-assurance review
1-6 Low	Partially effective	Not required	Supervisor	Informal monitoring

* Excludes risks assessed using **site financial** consequence category

APPROVED 16.12.2021

Figure 15 CCM Risk Assessment Criteria

5 RISK MITIGATION AND CONTROL MEASURES

CC has undertaken a detailed evaluation and selection process to determine the most appropriate long term tailings solution for CCM which included a Multi-Criteria Analysis (MCA) including the most appropriate tailings technology to be utilised and a number of locations for the TSF, refer to Appendix A.3.

Engeny were engaged to undertake a preliminary Consequence Category Assessment (CCA) as per guidance set out in the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933), Version 5.03 (The Manual) (DESI, 2024), refer to Appendix A.2.

Key findings of the CCA are:

- Under the failure to contain scenario TSF3 has a preliminary consequence category of 'significant'; and
- Relevant key required hydraulic performance criteria for TSF3 are therefore:
  - A mandatory reporting level (MRL) corresponding to an extreme storm surge (ESS) volume resulting from the 1:20 AEP 72-hour storm volume assuming 100% runoff; and
  - A design storage allowance (DSA) equivalent to the 1:20 AEP wet season increase:
    - CC have chosen to adopt the method of operational simulation to estimate the DSA volume for the system of integrated regulated storages at CCM.
    - The system of integrated storages comprises the existing ETSF, Mill Creek Dam (MCD) and EPit as well as the proposed TSF3.
- The preliminary TSF3 ESS volume of 171.4 ML will be allocated to TSF3.
- Using the method of operational simulation, DSA for the integrated containment system has preliminarily been estimated as 434 ML. This volume has increased since the previous assessment due to:
  - Reduction in the number of evaporators (approximately 130 ML increase to DSA).
  - Changes to runoff parameters resulting from model calibration update (approximately 80 ML increase in DSA)
  - General updates and improvements to the WBM to better represent the WMS including the water treatment system and release functions, revised storage curves for EPit and MCD
- A DSM of 25% has been applied to the DSA volume which results in a total system DSA volume of 543 ML.
- The total estimated combined MRL volume for the system is 849 ML and would therefore also be the DSA volume as the DSA cannot be less than the MRL volume.
- DSA volumes for MCD, EPit and TSF3 would therefore be equivalent to the MRL.
- In the unlikely event of an exceedance of an inflow volume exceeding the proposed combined DSA/MRL volume, significant contingency storage is available within the integrated containment system. This volume of approximately 2.6 GL is available within EPit and, while not used for normal operations, may act as a temporary storage to contain additional inflows in excess of the DSA/MRL volume.
- Practical considerations of operating MCD and EPit with the same RL for DSA and MRL have not been considered in this assessment however it is recommended that CCM consider implementation of a normal operating level lower than DSA/MRL. Under normal operations this would limit incoming transfers to MCD or EPit and provide for a rainfall/runoff buffer and reduce the likelihood of frequent MRL exceedances.

As part of this assessment Engeny prepared a water management schematic which summarises the proposed water management system arrangement, refer to Figure 16 below and Appendix A.2 for further detail.

A Risk Register has also been prepared for each operational phase of the project, refer to Appendix A.7.

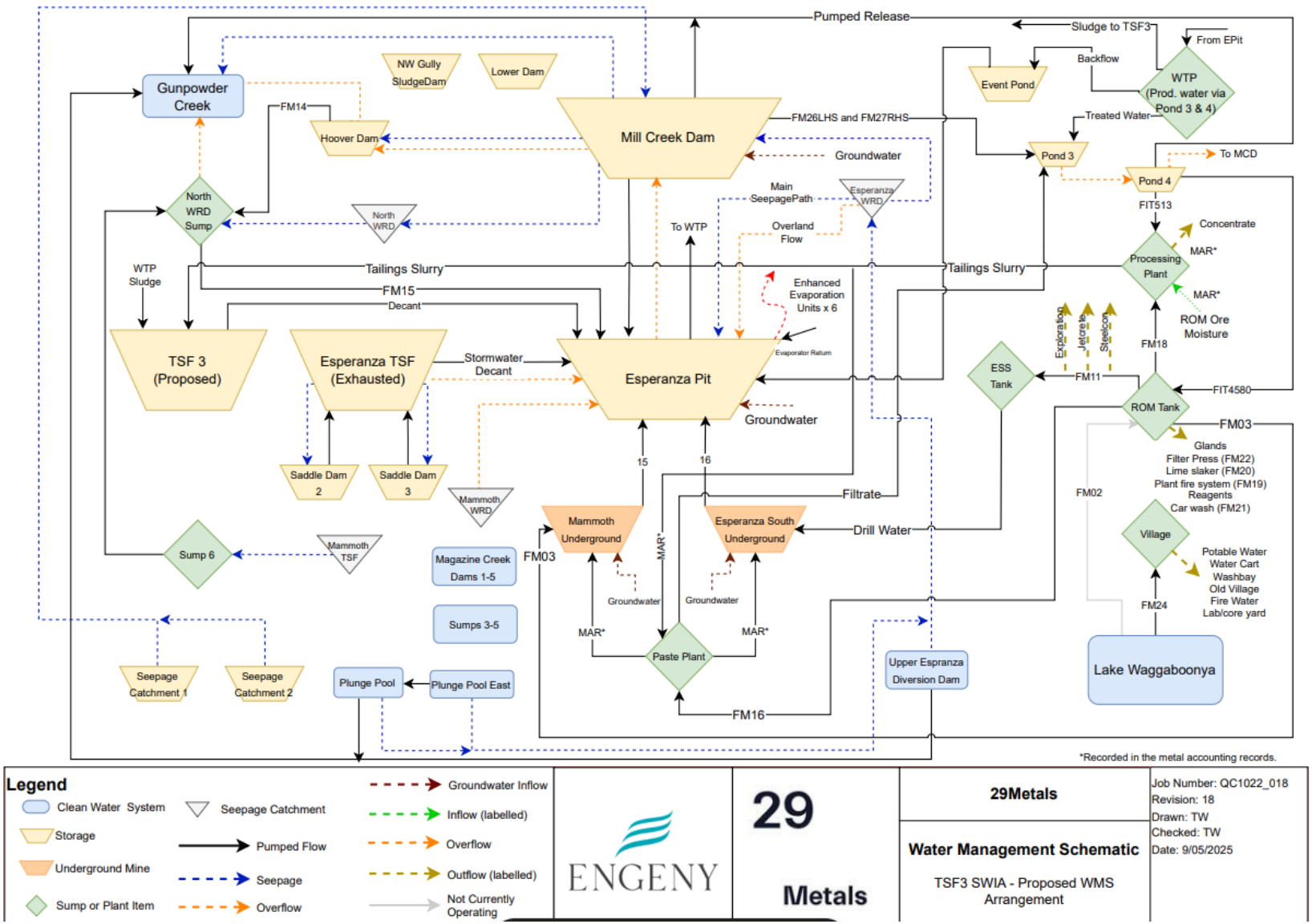


Figure 16 Water Management Schematic TSF3SWIA – Proposed WMS Arrangement (Engeny, 9/5/25)

The preliminary design report in Appendix A.2 provides further detail on the risk assessment and management for select environmental values.

29 Metals will prepare a comprehensive Construction Environmental Management Plan (CEMP) for TSF3 once the EA is approved.

The management plan will include:

- Description of activities
- Environmental Commitments
- Roles and Responsibilities of all involved
- Management of Environmental Values including air, water, noise, waste and land
- Inductions and training
- Emergency Response
- Complaints
- Incident Management.

Detailed mitigation measures for each risk are identified the risk register in Appendix A.7.

6 REHABILITATION

A detailed Rehabilitation and Closure Plan has been prepared for the TSF3, refer to Appendix A.2 to address the legislative framework and Progressive Rehabilitation and Closure Framework and Guidelines.

The purpose of the Rehabilitation and Closure Plan is to establish a structured, risk-based framework for the safe, environmentally responsible, and sustainable closure and rehabilitation of the facility at the end of its operational life.

The scope included:

- Closure objectives and design criteria.
- Rehabilitation methods, including cover systems and landform reshaping.
- Monitoring, maintenance, and contingency measures.
- Risk management and stakeholder engagement.
- Implementation schedule and cost estimates.

Exclusions include detailed engineering for ancillary infrastructure (e.g., tailings delivery systems) and site-wide PRCP integration, which will be addressed in future updates.

The report states that key closure objectives include:

- **Stability**: Achieve long-term geotechnical and geochemical stability to prevent structural failures, erosion, or contaminant mobilization. This includes designing the final landform with factors of safety ≥1.5 under static conditions and ≥1.0 under seismic loading (as per ANCOLD guidelines for "Significant" consequence category facilities). Geochemical stability will be ensured through cover systems that limit acid mine drainage (AMD) from potentially acid-forming (PAF) tailings and waste rock, informed by geochemical testing (e.g., acid-base accounting). PRCP compliance is met by incorporating progressive stability assessments during operations and post-closure, with milestones for certification of embankment integrity and landform reshaping.
- **Contaminant Control**: Minimize the release of contaminants to protect environmental values, limiting net percolation through the cover system to <1% of mean annual rainfall (~5 mm/year, based on site-specific climate data). Engineered barriers, such as compacted clay layers (hydraulic conductivity ≤10^{-7} m/s) or geomembranes, will restrict water infiltration and oxygen ingress, preventing AMD generation and metal leaching (e.g., Cu, Zn from tailings). Seepage controls (e.g., liners and grout curtains) will be retained to maintain low seepage rates (~0.05 m^3/day/m to EPit, as modeled in GWIA). This aligns with PRCP requirements for risk-based contaminant management and EA limits on groundwater triggers. Milestones include geochemical monitoring during progressive rehabilitation to confirm no off-site migration.
- **Water Management**: Restore natural drainage patterns and manage surface water and groundwater to prevent uncontrolled releases post-closure, ensuring compliance with the Environmental requirements. Surface runoff will be directed via the retained spillway to EPit, avoiding ponding and erosion, while MAW will be contained within the ICS to protect Gunpowder Creek. Groundwater flow alterations (e.g., potential divide from TSF3) will be mitigated through design adjustments informed by the 3D transient groundwater model.
- **Rehabilitation**: Establish a self-sustaining ecosystem (native bushland) through progressive and final rehabilitation, minimizing erosion, dust, and habitat disruption. Disturbed areas will be reshaped to stable slopes (1–3%), covered with an enhanced store-and-release cover system, and revegetated with native species adapted to the site's arid conditions and low-quality soils (Class VII land). Erosion controls (e.g., rock armoring) and dust suppression (e.g., early seeding) will be implemented. This supports PRCP goals for progressive rehabilitation.
- **Post-Mining Land Use (PMLU)**: Transition the site to native bushland, consistent with surrounding landforms and stakeholder expectations, excluding grazing or other intensive uses initially (e.g., 10–20 years) to allow vegetation establishment and ecosystem recovery. This PMLU is compatible with the site's low carrying capacity and existing land use.

- **Performance Criteria**: Define measurable indicators for closure success, including meeting EA water quality limits (e.g., no exceedances in groundwater bores per Schedule C, Table 6), achieving vegetation cover and species diversity within 5 years (monitored annually), and confirming no adverse impacts to EVs (e.g., aquatic ecosystems in Gunpowder Creek per REMP). Criteria also include seepage rates below modeled thresholds and landform stability via geotechnical inspections.
- **Sustainability**: Design for minimal long-term maintenance, with passive systems (e.g., self-sustaining covers) ensuring the site poses low residual risks in perpetuity. Relinquishment criteria will be demonstrated after 20 years of monitoring (e.g., no trigger exceedances, stable vegetation), allowing handover to the state or Traditional Owners. This meets PRCP sustainability principles, incorporating adaptive management from SWIA/GWIA data and stakeholder engagement for ongoing refinements.

Further detail is provided in Appendix A.2.

7 GREENHOUSE GAS EMISSIONS ASSESSMENT

CCA are seeking to amend the EA for the Tailings Storage Facility 3 and under the *Environmental Protection Act Greenhouse Gas Emissions Guidelines*, this amendment requires a Greenhouse Gas Emissions assessment is undertaken. Earthtrade was engaged to undertake this assessment which must encompass Scope 1 and Scope 2 direct emissions from the operation as they relate to the amendment. Furthermore, if Scope 1 and Scope 2 emissions exceed 25,000tCO2e per annum, the project/facility will be classified as a medium-large emitter and will be required to disclose Scope 3 estimates and abatement plans.

The assessment concluded that the total emissions from the project are expected to amount to 20,884 tCO2e (excluding clearing) over its entire construction and operational life. This includes Scope 1 (Construction Phase) and Scope 2 (limited to Operational Phase), refer to Appendix A.9.

Earthtrade advised that Scope 1/Construction emissions are predominantly limited to sources from the operation of vehicles and machinery requiring the combustion of diesel oil. This has been estimated at 2,272tCO2e over the 14-month construction phase of the project. Impacts to vegetation could amount to 4,072tCO2e however it has been indicated that this area will be rehabilitated after the project is complete, therefore offsetting these impacts and bringing their ultimate impact to 0tCO2e.

Scope 2/Operational emissions arise due to the use of electrically powered pumps and evaporation equipment to be installed at the TSF3 facility. This amounts to a constant 2,659tCO2e/annum throughout the operational life the project (7 years upon commissioning).

With total annual emissions being below 25,000tCO2e, Scope 3 emissions have been excluded from the analysis. Average annual emissions from the project amount to 2,611tCO2e/annum, refer to Appendix A.9 for further detail and Plate 3 below.

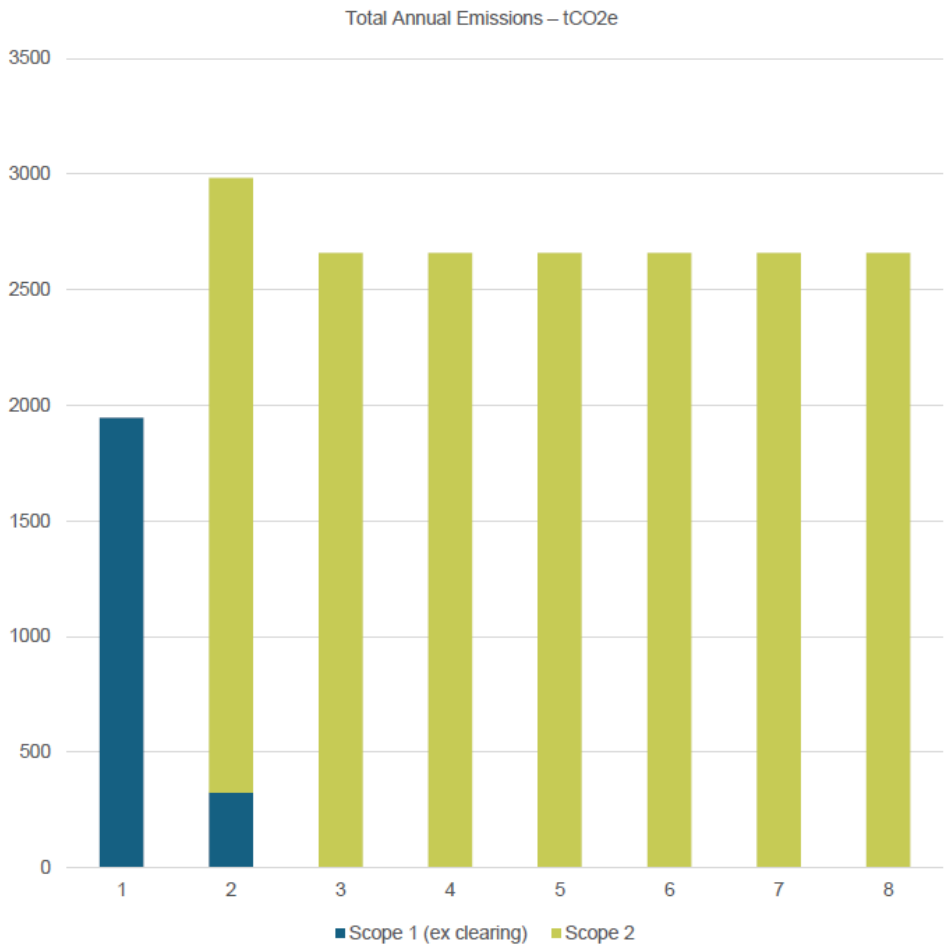


Plate 3 Total Emissions Scope 1 and Scope 2 (Earthtrade)

8 CONCLUSION

This Environmental Assessment Report has been prepared to support the application for Environmental Authority amendment on behalf of Capricorn Copper for the proposed Tailings Storage Facility 3 to ensure that the application is considered 'properly made' under the *Environmental Protection Act 1994.*

Detailed assessments have been undertaken including risk analysis and multi-criteria analysis to determine the preferred solution for tailings management for the site that avoids, reduces, or mitigates the potential impacts on the receiving environment. These detailed assessments are included in Appendix A.1 to A.9 of this report.

The detailed assessments have determined that the potential environmental risks will be effectively managed through the effective implementation of environmental monitoring and management practices to avoid and mitigate any potential environmental impacts on the relevant environmental values.

A.1 EA Amendment Application Information Requirements

Requirement	Guidance	Response
Section 226 - Requirements for amendment applications generally		
☐ Be made to the administering authority	The administering authority for an application depends on the nature of the activity and the proposed amendment. • For ERA 2, ERA 3, or ERA 4 – The administering authority is the Department of Agriculture and Fisheries • For a mining ERA where the proposed amendment impacts upon the resource tenure - Applications should be submitted to the Mining Registrar, Department of Resources • For all other ERAs - The administering authority is the Department of Environment, Science and Innovation	The EA amendment application will be lodged to DETSI via Online Services.
☐ Be in the approved form	The approved form depends on the type of amendment application: • Application to amend an EA (ESR/2015/1733) • Application to amend a PRCP schedule or joint PRCP and EA (ESR/2019/4956) Note: For applications to the Department of Environment, Science and Innovation, you can apply through Online Services at: https://business.qld.gov.au/running-business/environment/online-services.	The approved form will be accessed and completed via Online Services.
☐ Be accompanied by the fee prescribed by regulation	Refer to section 9 of this Guideline for fee information. Information about the fees for amendment applications is also included in: • Forms and fees for environmental authorities | Business Queensland • Schedule 10 of the Environmental Protection Regulation 2019.	The fee will be paid as directed on lodgement.
☐ Describe the proposed amendment	The approved form will prompt the applicant to describe the proposed amendment. Applicants should ensure that full details of the proposed amendment are included so that the administering authority can clearly determine the requested changes to the EA or PRCP schedule. Applicants should also include justification of how the proposed amendment meets the criteria for a major or minor amendment and attach any supporting information to the application.	**Section 1.4**
☐ Describe the land that will be affected by the proposed amendment.	The approved form will prompt the applicant to describe the land that will be affected by the proposed amendment. This includes describing if: • the activity will be carried out within the existing designated areas of the EA; or	**Section 1.4**

Requirement	Guidance	Response
	• a new area; or • if the activity is mobile or temporary. Applicants should ensure that full details are included so that the administering authority understands the land that will be affected by the proposed amendment. Additional supporting information can be attached to the amendment application.	
☐ Include any other document relating to the application prescribed by regulation.	There are currently no other documents that are prescribed by regulation to be included as part of an amendment application.	Not applicable.
Section 226AA - Requirement for amendment application by holder of environmental authority and PRCP schedule		
☐ If approval of an amendment application for an EA or PRCP (each a relevant environmental requirement) would result in inconsistencies between the two relevant environmental requirements, an application must be made to amend both the EA and the PRCP schedule.	This section only applies where: • Both an EA and PRCP schedule is held; • The holder is proposing to amend only the EA or PRCP; and • The amendment to one relevant environmental requirement would mean an inconsistency with the other relevant environmental requirement. This section is aimed at reducing any inconsistencies between EAs and PRCP schedules and is intended to ensure applicants take responsibility for assessing their EAs and PRCP schedules for consistency prior to making an amendment application.	Not applicable. There is no currently approved PRCP associated with EPML00911413. A rehabilitation assessment has been undertaken, refer to Section 6 and Appendix A.2 which includes a Rehabilitation and Closure Plan developed by Engeny.
Section 226A - Requirements for amendment applications for environmental authorities		
☐ The application must describe any development permits in effect under the Planning Act for carrying out the relevant activity for the authority.	This requirement is relevant to EA amendment applications where the activity is a prescribed ERA. The approved form will prompt the applicant to provide details of the development permits in effect under the Planning Act for carrying out the relevant activity for the EA. Applicants must have appropriate land use approvals or be in the process of applying for an approval. DESI may seek advice from the applicant about what checks they have undertaken to determine that a material change of use for a development approval is not required.	Not applicable. The EA is related to a resource authority, not a prescribed ERA.
☐ The application must state whether each relevant activity will, if the	This requirement is only relevant where the relevant ERA has eligibility criteria and	Not applicable.

Requirement	Guidance	Response
amendment is made, comply with the eligibility criteria for the activity.	standard conditions. The approved form will prompt the applicant to state whether the eligibility criteria or standard conditions can be complied with if the amendment is made.	There are no applicable eligibility criteria or standard conditions.
☐ If the application states that each relevant activity will, if the amendment is made, comply with the eligibility criteria for the activity, the application must, include a declaration that the statement is correct.	The approved form will prompt the applicant to provide a declaration.	Not applicable.
☐ The application must state whether the application seeks to change a condition identified in the authority as a standard condition.	Any changes to conditions identified in the EA as standard conditions must be detailed in the amendment application.	Not applicable.
☐ If the application relates to a new relevant resource tenure for the authority that is an exploration permit or GHG permit, the application must state whether the applicant seeks an amended environmental authority that is subject to the standard conditions for the relevant activity or authority, to the extent it relates to the permit.	This requirement only applies where the application relates to a new exploration permit or GHG permit. Where the applicant seeks the standard conditions for the relevant activity, this must be clearly stated in the application material.	Not applicable. The application does not relates to a new exploration permit or GHG permit.
☐ The application must include an assessment of the likely impact of the proposed amendment on the environmental values, including: ☐ A description of the environmental values likely to be affected by the proposed amendment. ☐ Details of emissions or releases likely to be generated by the proposed amendment. ☐ A description of the risk and likely magnitude of impacts on the environmental values. ☐ Details of the management practices proposed to be implemented to prevent or minimise adverse impacts. ☐ If a PRCP schedule does not apply for each relevant activity, details of how the land that is the subject of the application will be rehabilitated after each relevant activity ends.	The approved form will prompt the applicant to provide an assessment of the likely impact of the proposed amendment on the environmental values. An assessment is required for all environmental values. Where there are no likely impacts to an environmental value, this must be stated and justified in the application material. Several technical guidelines have been developed to assist applicants to submit site-specific and variation applications for EAs. These guidelines may also assist in preparation of EA amendment application depending on the nature of the proposed EA amendment: • Application requirements for activities with impacts to air (ESR/2015/1840) • Application requirements for activities with impacts to land (ESR/2015/1839) • Application requirements for activities with noise impacts (ESR/2015/1838) • Application requirements for activities with impacts to water (ESR/2015/1837) • Application requirements for activities with waste impacts (ESR/2015/1836) • Requirements for site-specific and amendment applications—underground water rights (ESR/2016/3275) A specific guideline has also been developed which outlines the application	**Section 2** – Description of environmental values **Section 3** – Details of emissions or releases **Section 4** – Risk assessment **Section 5** – Risk mitigation and control measures **Section 6**Error! R eference source not found. – Rehabilitation

Requirement	Guidance	Response
	requirements for petroleum activities. This guideline may also assist in preparation of EA amendment applications for petroleum activities depending on the nature of the proposed EA amendment.	
☐ The application must include a description of the proposed measures for minimising and managing waste generated by amendments to the relevant activity.	The approved form will prompt the applicant to describe the proposed measures for minimising and managing waste generated by amendments to the relevant activity. The guideline Application requirements for activities with waste impacts (ESR/2015/1836) may assist applicants to prepare this information.	Refer to the Risk Assessment in Appendix A.7
☐ The application must include details of any site management plan or environmental protection order that relates to the land the subject of the application.	The approved form will prompt the applicant to identify whether the relevant land is currently subject to an environmental protection order or a site management plan. Applicants should provide details including: • The document reference number • And a description of the land including lot and plan numbers and local government area.	Not applicable. Relevant land is not currently subject to an environmental protection order or site management plan.
Section 226B - Requirements for amendment applications for PRCP schedules		
☐ The application must be accompanied by an amended rehabilitation planning part for the holder's PRC plan that complies with s. 126C of the EP Act in relation to the proposed amendment including: ☐ Be in the approved form. ☐ Describe each resource tenure, including the area of each tenure, to which the application relates. ☐ Describe the relevant activities to which the application relates. ☐ Describe the likely duration of the relevant activities. ☐ Include a detailed description, including maps, of how and where the relevant activities are to be carried out. ☐ Include details of the consultation undertaken by the applicant in developing the proposed PRC plan. ☐ Include details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan. ☐ State the extent to which each proposed PMLU for land, or NUMA, identified in the proposed PRCP schedule for the plan is consistent with:	The approved form will prompt the applicant to provide details about amendments to the rehabilitation planning part of the applicant's PRCP. While the rehabilitation planning part of the PRCP is not approved, it must meet the content requirements under the EP Act and is necessary to give the regulator, the community, and the mine operator a clear understanding of how the site will be rehabilitated progressively to support post mining land uses. Where a content requirement is not applicable, this must be stated and justified in the application material. Applicants should refer to the guideline Progressive rehabilitation and closure plans (ESR/2019/4964) to prepare their application material.	Not applicable. A detailed Rehabilitation and Closure Plan has been prepared by Engeny and is included in Appendix A.2.

Requirement	Guidance	Response
• The outcome of consultation with the community in developing the plan. • Any strategies or plans for the land of a local government, the State, or the Commonwealth. ☐ State, for each proposed PMLU for land, the applicant's proposed methods or techniques for rehabilitating the land to a stable condition in a way that supports the rehabilitation milestones under the proposed PRCP schedule. ☐ Identify the risks of a stable condition for land not being achieved, and how the applicant intends to manage or minimise the risks. ☐ State, for each proposed NUMA, the reasons the applicant considers the area cannot be rehabilitated to a stable condition. ☐ Include copies of reports or other evidence relied on by the applicant for each proposed NUMA. ☐ State, for each proposed NUMA, the applicant's proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRCP schedule for the area. ☐ Include the other information the administering authority reasonably considers necessary to decide whether to approve the PRCP schedule for the plan.		
Section 227 - Requirements for amendment applications - CSG activities (water management)		
☐ The application must state the matters mentioned in s. 126(1) of the EP Act including: ☐ The quantity of CSG water the applicant reasonably expects will be generated in connection with carrying out each relevant CSG activity. ☐ The flow rate at which the applicant reasonably expects the water will be generated. ☐ The quality of the water, including changes in the water quality the applicant reasonably expects will happen while each relevant CSG activity is carried out.	This section only applies for an amendment application if: • The application relates to an EA for a CSG activity; and • The proposed amendment would result in changes to the management of CSG water; and • The CSG activity is an ineligible ERA. The approved form will prompt the applicant to provide details about changes to CSG water management. This information is required as a change in the activity may significantly affect the amount and quality of the water produced and the regime necessary to manage it. Applicants can refer to the CSG Water Management Policy 2012 (ESR/2016/2381)	Not applicable. The amendment application does not relate to a CSG activity.

Requirement	Guidance	Response
☐ The proposed management of the water including, for example, the use, treatment, storage, or disposal of the water. ☐ The measurable criteria (the management criteria) against which the applicant will monitor and assess the effectiveness of the management of the water, including, for example, criteria for each of the following: ☐ The quantity and quality of the water used, treated, stored, or disposed of. ☐ Protection of the environmental values affected by each relevant CSG activity. ☐ The disposal of waste, including, for example, salt, generated from the management of the water. ☐ The action proposed to be taken if any of the management criteria are not complied with, to ensure the criteria will be able to be complied with in the future.	for further details about the government's position on the management and use of CSG water.	
☐ The application must comply with s.126(2) of the EP Act which prohibits the use of a CSG evaporation dam in connection with carrying out a relevant CSG activity unless: The application includes an evaluation of: ○ Best practice environmental management for managing the CSG water; and ○ Alternative ways for managing the water; and The evaluation shows there is no feasible alternative to a CSG evaporation dam for managing the water.		
Section 227AA Requirements for amendment applications - <u>Underground water rights</u>		
☐ The application must state the matters mentioned in s. 126A(2) of the EP Act including: ☐ Any proposed exercise of underground water rights during the period in which resource activities will be carried out under the relevant tenure. ☐ The areas in which underground water rights are proposed to be exercised. ☐ For each aquifer affected, or likely to be affected, by the	This section only applies for an amendment application if: • The application relates to a site-specific EA for: ○ A resource project that includes a resource tenure that is a mineral development licence, mining lease or petroleum lease; or ○ A resource activity for which the relevant tenure is a mineral development licence, mining lease or petroleum lease; and • The proposed amendment involves changes to the exercise of underground water rights. The approved form will prompt the applicant to provide details about changes to the	Not applicable. The proposed amendment does not involve changes to the exercise of underground water rights.

Requirement	Guidance	Response
exercise of underground water rights: ☐ A description of the aquifer. ☐ An analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers and surface water. ☐ A description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights. ☐ The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights during the period in which resource activities are carried out. ☐ The environmental values that will, or may, be affected by the exercise of underground water rights and the nature and extent of the impacts on the environmental values. ☐ Any impacts on the quality of groundwater that will, or may, happen because of the exercise of underground water rights during or after the period in which resource activities are carried out. ☐ Strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or the impacts on the quality of groundwater.	exercise of underground water rights. This information is required to ensure that the environmental impacts of the exercise of underground water rights by mining and petroleum tenure holders are appropriately assessed as part of an EA amendment application. An EA amendment application will only need to include information relating to the changes to the proposed exercise of underground water rights which will occur, or are predicted to occur, as a result of the proposed amendment to the EA. A proposed amendment may, for example, involve a change to the exercise of underground water rights where there is a change in tenure, where there is a significant change to the nature or scale of activities or volumes of water proposed to be taken or where there are likely to be different impacts on environmental values. Applicants can refer to the guideline Requirements for site-specific and amendment applications—underground water rights (ESR/2016/3275) for further details about exercising underground water rights or the associated requirements.	

A.2 TSF3 Preliminary Design Report, Engeny

ENGENY

29 METALS CAPRICORN COPPER MINE

Tailings Storage Facility 3

Preliminary Design Report

QC1022-018-REP-005-2

30 JULY 2025

DISCLAIMER

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	29/07/2024	Issued for Review	Brendan Wallace	Travis Warren	Brendan Wallace	Travis Warren
1	16/05/2025	Client Issue	Brendan Wallace	Travis Warren	Brendan Wallace	Travis Warren
2	30/07/2025	Client Issue	Brendan Wallace	Travis Warren	Brendan Wallace	Travis Warren
Signatures:						

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1. INTRODUCTION

1.1 General

Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29 Metals Limited (29M), has engaged Engeny Australia Pty Ltd (Engeny) to undertake the preliminary design of the proposed Tailings Storage Facility 3 (TSF3) located at Capricorn Copper Mine (CCM) in north-west Queensland. CCM is operated under Environmental Authority EPML00911413 (EA) as in effect on 23 May 2025. This preliminary design report is provided to support a major EA amendment and as the basis for any subsequent detailed design of TSF3. Based on the preliminary design, the design life of TSF3 is expected to be approximately 6.5 – 7.5 years.

1.2 Site History

CCM has been subject to mining activities dating back to 1927 with mining effort varied over the life of the mine. Mining activity included active underground mining within the Mammoth and Esperanza South underground mines up until January 2009. CCM was placed in care and maintenance in February 2009 until February 2011, with underground mining recommencing in May 2011. Operations then continued until April 2013, when the site was again returned to care and maintenance. CCPL acquired the site in 2015 and successfully recommenced operations in 2017.

Due to multiple extreme wet weather events during both the 2022 and 2023 wet seasons, and exhaustion of the existing tailings storage facility (TSF), Esperanza TSF (ETSF) in March 2024, mining and ore processing activities ceased and the site entered a period of care and maintenance. The extreme wet weather events resulted in the loss of critical infrastructure (flooding of the Esperanza Underground Mine, loss of the existing reverse osmosis water treatment plant (WTP), workshops and warehouse area) as well as significant increases to the mine affected water (MAW) inventory which is primarily contained within Esperanza Pit (EPit).

In addition to the proposed TSF3, CCPL have initiated a program of water management system (WMS) improvements aimed at reducing the use of raw water, minimising the generation of MAW, increasing the utilisation of existing EA conditions to release more treated water to Gunpowder Creek and increasing the rate of water destruction through mechanical evaporators.

1.3 Scope of Work

The TSF3 Preliminary Design Scope of Work (SoW) is summarised below:

- Develop a preliminary design for TSF3 with the intent to maximise tailings storage capacity within the limitations of the project constraints.
- Preliminary assessment of seepage, spillway overflow and dam break risks including undertaking a preliminary Department of Environment, Science, and Innovation (DESI), Queensland Consequence Category Assessment and Australian National Committee on Large Dams (ANCOLD) Consequence Category Assessment to inform the design basis of TSF3.
- Undertake a project design risk assessment, gap assessment, and develop a basis of design for the TSF3 preliminary design to be updated throughout the design process.
- Advance the concept level design developed by ATC Williams (ATCW, 2023) of TSF3 to a preliminary design level including:
  - Reprofiling and raising of the existing Esperanza Waste Rock (EWRD) to form the northern boundary of TSF3 including the incorporation of seepage controls, including an upstream grout curtain and upstream geomembrane liner.
  - Centreline raise of the existing Upper Ezperanza Diversion Dam (UEDD) embankment to form the southern boundary of TSF3, including the incorporation (where suitable) or replacement of the existing geomembrane liner and grout curtain.
  - Inclusion of an emergency overflow spillway near the eastern end of the EWRD.
  - Realignment of the haul road adjacent the EWRD to accommodate the EWRD raise and reprofiling works.
  - Realignment and/or construction of new access tracks and tailings delivery pipeline routes.
  - Identification of decant return pump and return water pipeline routes / access tracks.
  - Preliminary identification and design of TSF monitoring instrumentation.

- Undertake preliminary surface water assessments to inform requirements for spillway design, external flood ingress protection, and provide water storage capacity requirements for wet season containment in line with EA commitments including Design Storage Allowance (DSA) and Extreme Storm Storage (ESS) for the *integrated containment system* comprising the Esperanza Pit (EPit), Mill Creek Dam (MCD), the ETSF and the proposed TSF 3.
- Develop a 2D numerical groundwater model (SEEP/W) of the proposed TSF3 and undertake a preliminary seepage assessment to analyse the potential seepage risks from TSF3 and inform the design of seepage controls. A site wide 3D transient groundwater model incorporating TSF3 is being developed to further inform potential seepage risks and required seepage controls, and the GWIA.
- Prepare design documentation including preliminary design level drawings and capital cost estimates for civil works to assist CCM with approvals, budgeting, environmental approvals and schedule planning.
- Prepare a Limited Surface Water Impact Assessment (SWIA), and Limited Groundwater Impact Assessment (GWIA) to support the amendment of the EA and inform any mitigation of risks and impacts from the proposed TSF3 as relevant.
- Develop a Groundwater Monitoring and Management Plan (GMMP) to inform the systemic review and improvement of the groundwater monitoring and management throughout the life of the TSF3 design and operational phases.
- Prepare a conceptual design of the TSF3 closure strategy and capping arrangement, and detailed closure and rehabilitation plan.
- Undertake a review of borrow material availability, geochemical suitability, and topsoils based on available data.
- Undertake a topsoil and land capability assessment within the TSF3 footprint to determine the availability and value of stripping topsoils prior to tailings deposition for future use in closure activities.
- Identification of the expected approximate disturbance footprint including potential borrow areas.

1.4 Exclusions

The following exclusions apply to this preliminary design report:

- Enabling mechanical and electricals works including tailings processing and delivery infrastructure are beyond Engeny's scope and are not covered in this report. CCM has made provisional allowances for tailings processing and delivery infrastructure in the capital cost estimate.

1.5 Project Context

This preliminary design report and associated documents have been prepared based on information available at the time of writing. Further works are planned to support detailed design. Key activities proposed which are not yet available include:

- Finalisation of a site wide 3D transient numerical groundwater flow model incorporating TSF3.
- Completion of further detailed borrow / geotechnical / groundwater investigations and testing programs if required to support the detailed design of TSF3 including the embankment designs and seepage controls, and to identify potential borrow materials areas including geochemical suitability. A detailed geotechnical investigation was undertaken to inform the preliminary design of TSF3. The geotechnical investigation details are provided in the document 'QC1022_018-REP-001-1 Factual Geotechnical Report' included in **Appendix A**.

2. ABBREVIATIONS

The following abbreviations are used throughout this report:

- 29M - 29 Metals
- AEP - Annual Exceedance Probability
- AF - Acid Forming
- ANCOLD - Australian National Committee on Large Dams
- BoD - Basis of Design
- CCA - Consequence Category Assessment
- CCM - Capricorn Copper Mine
- CCPL - Capricorn Copper Mine Propriety Limited
- DESI - Department of Environment, Science, and Innovation, Queensland
- DSA - Design Storage Allowance
- EA - Environmental Authority
- EPit - Esperanza Pit
- ESS - Extreme Storm Storage
- ETSF - Esperanza Tailings Storage Facility
- EWRD - Esperanza Waste Rock Dump
- ICS - Integrated Containment System
- LoM - Life of Mine
- LV - Light Vehicle
- MCA - Multi Criteria Assessment
- MCD - Mill Creek Dam
- ML - Mining Lease
- MSES - Matters of State Environmental Significance
- NAF - Non-Acid Forming
- PAF - Potentially Acid Forming
- PRCP - Progressive Rehabilitation and Closure Plan
- TSF - Tailings Storage Facility
- TSF3 - Tailings Storage Facility 3
- UEV - Upper Esperanza Valley

3. SITE SELECTION

3.1 Multi Criteria Assessment

As part of the design process, a multicriteria assessment (MCA) was completed by CCM, with input from Engeny to assist in shortlisting potential tailings storage facility locations. The MCA was based on previous MCA work by GHD circa 2022 undertaken as part of an earlier Life of Mine Study (GHD, 2020), and a later Life of Mine Study (ATCW, 2023). The MCA was updated to incorporate new data and improved understanding since the original MCA. The updated MCA and supporting presentation are included in **Appendix B**.

The following tailings storage options were considered in the MCA.

- Upper Esperanza TSF3 (TSF3).
- Greenstone Creek.
- Diamond Creek.
- EPit RL270m.
- Magazine Creek.
- Upper Esperanza TSF South.
- Esperanza TSF Raise (ETSF Raise).

Based on the MCA, several options were considered comparable, with TSF3 and Magazine Creek assessed as the preferred options. Key advantages for TSF3 include:

- **Location** – The TSF3 is located remote from relevant surface water features including Gunpowder Creek. Any seepage or surface water flows paths from TSF3 to Gunpowder Creek are expected to be highly convoluted, and would be largely subject to interception in EPit, therefore reducing the risk of surface water and groundwater impacts from TSF 3 to receiving waters.
- **Geology** – TSF3 is sited within the Whitworth Quartzite, which is expected to be of lower overall permeability compared to the surrounding geological units.
- **Stability** – TSF3 will utilise the existing EWRD as the northern embankment. Due to the geometry of the EWRD, overall stability is expected to be greater when compared to a conventional embankment with a narrow crest width.
- **Water Management** – An existing clean water diversion (UEDD Diversion) is currently in place to divert the majority of the clean upstream catchment areas.
- **Mining Tenure** – The TSF3 option is on existing MLs.
- **Local Stakeholders** – Feedback from local stakeholders to date has been generally supportive of the TSF3 option.

4. GEOLOGICAL SETTING

4.1 Desktop Assessment and Geological Field Mapping

To support the preliminary design of TSF3 and required geotechnical and groundwater investigations for detailed design, a geological desktop review and targeted geological field mapping program were undertaken. The outcomes of this investigation which includes a summary of the geological setting, potential borrow material targets, and TSF3 seepage risks are provided in the document 'QC1022_018-REP-001-1 Geological Mapping Report' (Engeny, 2025) included in **Appendix C**.

The outcomes of the geological desktop assessment and field mapping program include:

General:

- Access to the TSF3 impoundment area is limited due to high strength rock at surface and undulating terrain, which dictates the requirement for advanced planning for future access tracks to potential borehole drilling locations and placement of light vehicle (LV) tracks around the proposed TSF3 impoundment extents.
- Review of historic aerial imagery from 1972 shows the waste rock dump to be constructed over and infilled drainage line which connects to the Upper Esperanza Valley (UEV). It is unclear what preparation was completed to remove unfavourable materials (alluvium, organic detritus, etc) prior to the placement of waste rock.

Lithology, Structures and Seepage Pathways (Rock):

- The upstream extents of the proposed TSF3 embankments and the TSF3 impoundment area is contained within Quartzite, quartzose sandstones and chert lithologies (belonging to the Whitworth Quartzite, Lochness Formation and Torpedo Creek Quartzite respectively). These rock units appear to be well cemented, have low porosity, are high strength and with tight or healed discontinuities (joints and faults). This indicates an overall low permeability (defect controlled or similar) and likely presents a low risk to seepage.
- Defined joint sets are noted within the Whitworth Quartzite are summarised as follows:
  - Bedding: 73° / 294.
  - Joint Set 1: 69° / 173.
  - Joint Set 2: 71° / 008.
  - Joint Set 3: 28° / 088.
- Geological structures intersecting the TSF3 impoundment showed to have no surface expression and the discontinuities (joints and bedding) in these areas appear to remain unchanged from the typical descriptions. Generally, structures such as shear zones and faults would need to exhibit open jointing and/or a halo of weak and weathered material to allow for increased hydraulic conductivity, which is not consistent with the findings of the assessment.
- Some discrete areas of Breccia (higher permeability) were noted, however these areas were not wide-spread and appeared to be discontinuous in nature and do not present a material risk of seepage within the TSF 3 footprint.
- The geological mapping program was expanded on site to areas outside of the TSF3 embankment and impoundment area to increase understanding of adjacent geological conditions in the Paradise Creek Formation. In general, these appears to be less favourable for a TSF location for the following reasons:
  - Higher degree of weathering and lower strength was noted, i.e less competent materials.
  - Highly brecciated material and open fractures noted adjacent identified fault areas, (which is different to the TSF3 areas which showed no surface expression).
- The outcomes of this program helped form the basis of the conceptual hydrogeological model (Section 13.3), and subsequent 2D numerical modelling.
- Further mapping of this unit will be required during subsequent phases of design to confirm the hydrogeological characteristics of the materials at depth. Near surface weathering processes are likely to result in a more permeable horizon, which should improve (i.e. become less permeable with depth). A baseline (sentinel) monitoring bore will be required in this unit, ideally drilled along, and through, one of the priority faults mapped as extending from the proposed TSF3 reservoir to the west.

Borrow Areas (Low permeability soils) (Refer Figure 4.2 for described borrow locations).

- Borrow areas 1, 3, 5 and 6 showed little to no soil development at surface and do not present viable options for low permeability borrow sources.
- Borrow areas 2 and 4 appear to be a viable borrow source for a small amount of clay and potential crushed aggregate or bedding material. The volume of clay available, rock aggregate sizes and breaking habit of rocks will need to be confirmed by a follow up test pitting program. The test pitting program should follow the bedding strike of the Paradise Creek Formation, which is the source rock.
- Areas immediately north-east of the access road adjacent the airstrip appear to have the highest available quantities of suitable clay, along with previous areas identified by GHD in 2019 (GHD, 2019).

4.2 Stratigraphy

Available stratigraphic geological descriptions of the site have been previously detailed by (Keyser, 1958), (Carter, 1961) and (Keys, 2008). The stratigraphic column is shown in Figure 4.1 and detailed surface mapping of all units is shown in Figure 4.2 which displays the Geological Survey of Queensland 1:100,000 dataset. Relevant units are described in detail in the following sections from oldest to newest, which trend from east to west over the site.

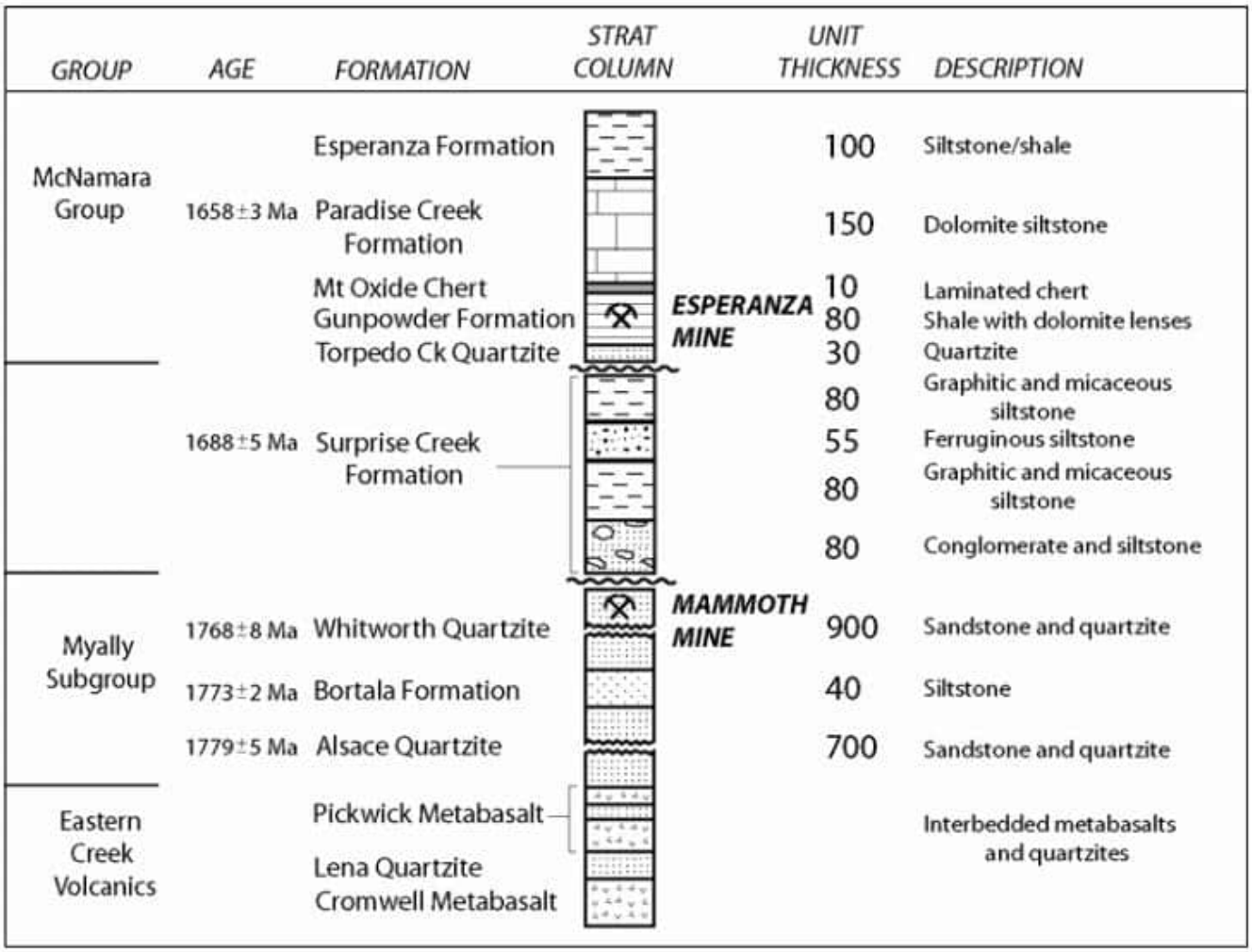


FIGURE 4.1: STRATIGRAPHIC COLUMNS (AFTER KEYS, 2008)

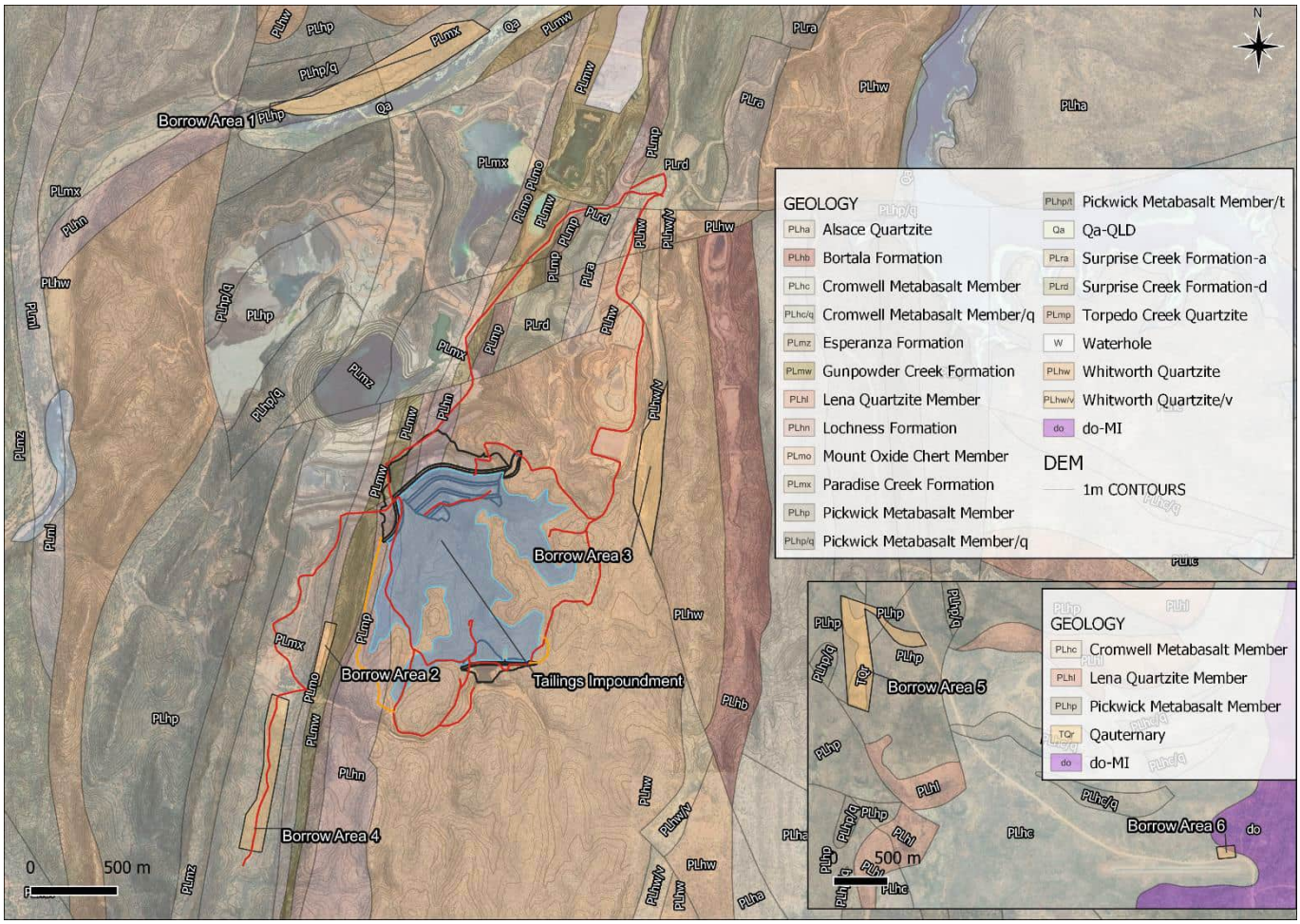


FIGURE 4.2: DETAILED GEOLOGICAL MAPPING

Eastern Creek Volcanics (ECV)

Outcrop extends over an extensive area south-east of CCM and includes the Cromwell Metabasalt, Lena Quartzite, and Pickwick Metabasalt. Generally, these are fine to medium grained meta-basalts and meta-andesites with porphyritic and amygdaloidal structures. Interbeds of quartzites and minor grey fissile shales occur throughout these units. Towards the top of the unit, the sediment to volcanic ratio increases and the volcanics contain a considerable amount of andesites and trachytes, indicating a change in magmatic chemistry. The upper limit of the ECV is taken as the last volcanic flow before transitioning to the Myally Subgroup.

Myally Subgroup

Conformably overlying the ECV are the Myally subgroup. The dominant rock is the Whitworth Quartzite which is a massive, poorly bedded, homogenous quartzite formed by regional metamorphism of the original arenite rock. Composition is variable and rocks can range from lithic, to arkosic, and chloritic arenites. Arenites with high clay content are largely unmetamorphosed (interpreted here as the Lochness Formation) and occurs toward the top of the sequence. The important feature of these being the lithic sandstone at the top of the formation which is the host rock for the mineralisation at the Mammoth deposit. Metamorphism appears to be limited to silicification of the more silica rich elements of the unit, with original sedimentary textures and bedding clearly recognisable, with ripples, cross beds, and trough cross beds abundant in outcrop.

The Whitworth Quartzite dips to the west between 60° and 80°, striking roughly north-south in the mine area. Lensing, load casts, ripple marks and mud cracks and intraformational brecciation have been recorded within the Whitworth quartzite. The most significant mineralisation is hosted by several discrete orebodies in dilational veins and breccias (Keys, 2008). The mineralisation is comprised of a range of copper species, dominantly chalcopyrite, bornite and chalcocite.

McNamara Group

The Whitworth Quartzite is unconformably overlain by the McNamara Group sediments including Torpedo Creek Quartzite, Gunpowder Creek, Paradise Creek Formation, and Esperanza Formation, all of which outcrop directly west of the TSF3 embankment. The unconformity strikes approximately north-south but dips at approximately 50° to the west giving an angular separation of 20° to 30° between the units above and below (Keys, 2008).

There are no detailed descriptions available for the Torpedo Creek formation as the formation was previously grouped with Gunpowder Creek formations. Lithological descriptions for Gunpowder Creek are noted as being divisible into three lithological sequences including:

- Upper sequence of micaceous siltstone-shale with dolomite lenses.
- Central siltstone-ferruginous sandstone-quartzite sequence.
- Lower conglomerate-siltstone-sandstone sequence.

These sequences are unlikely to outcrop within the project area as the formation thins south of the Mammoth Extended Fault (MEF) and Mammoth Fault (MF).

The Paradise Creek Formation consists of a basal chert marker bed and a finely bedded white siltstone, followed [upward] by a sequence of finely bedded, brown, dolomitic siltstones, and cherts. The formation sediments strike roughly north-south and dip at 60°-70°. Ripple marks and other sedimentary structures indicate a shallow water, restricted environment. These are overlain by a sequence of ferruginous siltstones and shales which are graphitic at depth. The top of the sequence in the area is the stromatolitic chert which is silicified and contains both columnar and laminae types of stromatolite.

5. GEOTECHNICAL INVESTIGATIONS

5.1 Overview

5.1.1 GHD, 2008

A geotechnical investigation was undertaken for the Upper Esperanza Diversion Dam (UEDD) and bypass overflow channel on Esperanza Creek. The investigation was undertaken in 2008 with the dam being located approximately 500 m south of the Esperanza Waste Rock Dump. The investigation is presented in the report titled Report on Esperanza Creek Diversion – Geotechnical Investigation (GHD, 2008). Following a review of the report, the investigation scope deemed relevant to the current TSF3 project includes:

- Drilling of six vertical boreholes (of which only three are applicable to the project);
- Water pressure testing at the dam foundations (UEDD);
- Laboratory testing of bulk rock samples and
- Engineering logging and recording observations during the field investigation.

5.1.2 Engeny, 2024

A project specific geotechnical investigation was proposed under the Geotechnical Investigation Brief (QC1022_018-SOW-001-1, March 2024). A Geotechnical Factual Report (QC1022_018-REP-001-0, September 2024) was prepared following the field investigation and subsequent laboratory testing phase. The Geotechnical Factual Report is included in **Appendix A.**

The following sections present a summary of the brief and the subsequent findings with specific focus on potential TSF3 seepage risks and borrow material availability.

5.2 Geotechnical Investigation Brief

A project specific geotechnical investigation was proposed under the Geotechnical Investigation Brief (QC1022_018-SOW-001-1, March 2024). The proposed geotechnical investigation included the following scope of work:

- Drilling of 15 boreholes (vertical and sub-vertical).
- In-situ Packer / Lugeon permeability testing in rock.
- Installation of piezometers to monitoring standing groundwater levels.
- In situ slug falling head permeability testing in the installed piezometers.
- Geophysical wireline logging.
- Excavation of 24 test pits.
- Collection of disturbed soil samples and rock core.
- Engineering logging and recording observations during the field investigation.

5.3 Geotechnical Factual Report

5.3.1 Investigation Summary

A Geotechnical Factual Report (QC1022_018-REP-001-0, September 2024) was prepared following the field investigation and subsequent laboratory testing phase. The geotechnical investigation undertaken included the following scope of work:

- Excavation of nineteen (19) test pits to assess earthworks properties of potential borrow materials.
- Drilling of fourteen (14) boreholes within the proposed TSF3 footprint, which included:
  - In-situ standard penetration testing (SPT) within soils.
  - Downhole wireline logging including, Acoustic Televiewer (ATV), Optical Televiewer (OTV) down-hole imaging and down-hole gamma survey.
  - Field Point Load Testing (PLT) on recovered core samples (28 in total).

- Standpipe Piezometer installation in one (1) location (TSF_BH_14).
- Laboratory testing was completed on core and soil samples, consisting of:
  - Three (3) Unconfined Compression Strength Tests (UCS).
  - Twenty (20) Particle Size Distribution Tests.
  - Fourteen (14) Emerson Class Tests.
  - Nine (9) Atterberg Limits tests.

Figure 5.1 below presents the geotechnical investigation location plan which presents the available geotechnical data points from the current and relevant historical investigations.

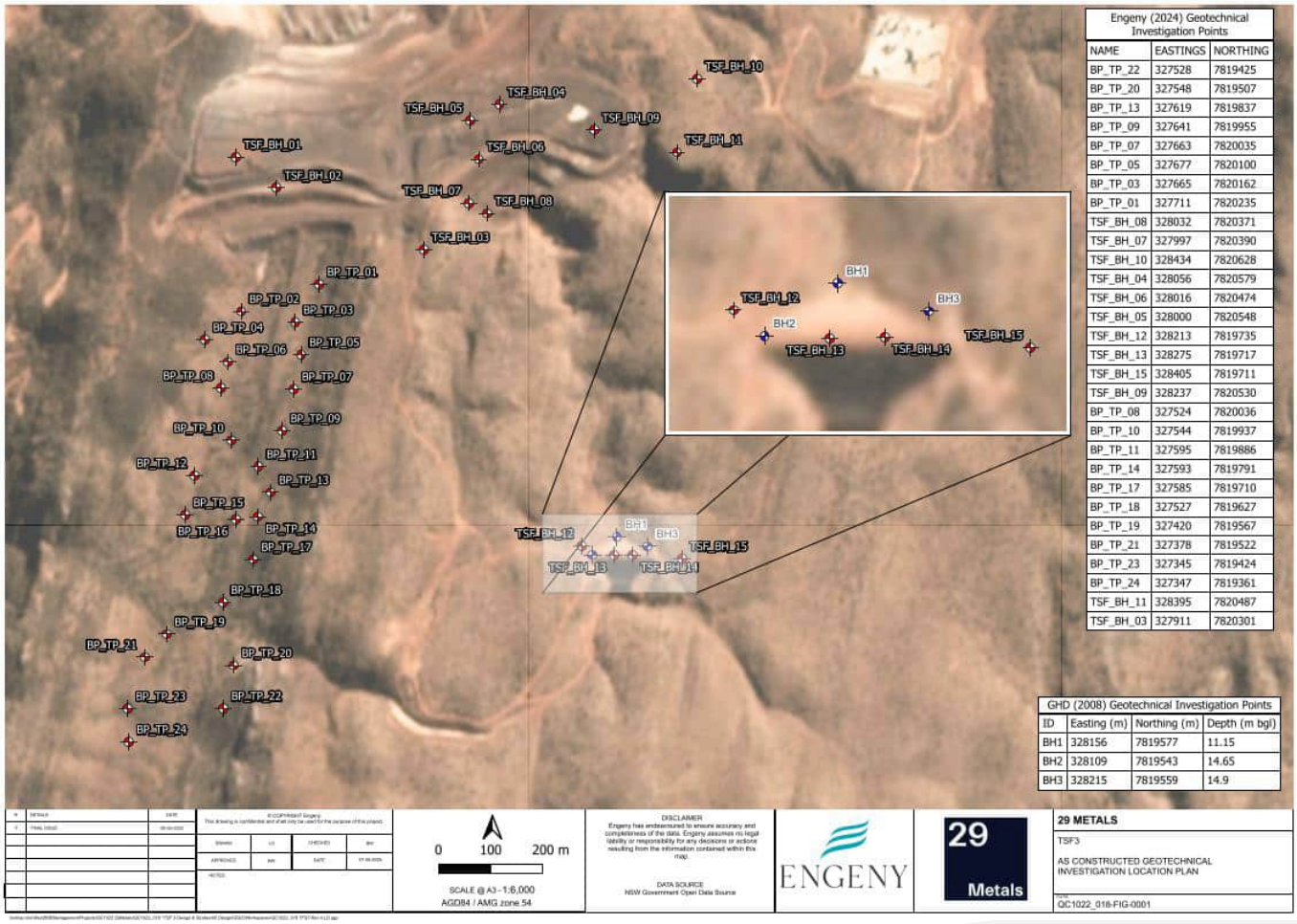


FIGURE 5.1: AS CONSTRUCTED GEOTECHNICAL INVESTIGATION LOCATION PLAN

5.4 Geotechnical Preliminary Interpretation – Seepage Risk

5.4.1 Field Observations – Water Loss

Water loss was observed in some boreholes, mainly at locations in waste rock (Fill) or at the interface of Fill/XW Rock/HW Rock and the MW Rock Interface where the rock is less competent / more fractured. Observed Water loss is summarised in Table 5.1 including relevant remarks.

TABLE 5.1: WATER LOSS SUMMARY

Investigation Phase	BH ID	Depth (m bgl)	Water Loss (%)	Water Loss in Fill or at Fill/XW/HW and MW Interface
Engeny (2024)	TSF_BH_05	49.5 - 60.3	100%	Yes
Engeny (2024)	TSF_BH_09	48	100%	Yes
Engeny (2024)	TSF_BH_04	74.6 - 80.2	100%	Yes
Engeny (2024)	TSF_BH_06	0.0 - 44.0	100%	Yes
Engeny (2024)	TSF_BH_06	44.0 - 49.0	50%	Yes
Engeny (2024)	TSF_BH_12	0.0 - 15.2	50%	Yes
Engeny (2024)	TSF_BH_15A	0.0 - 20.0	100%	-
Engeny (2024)	TSF_BH_14	17.4 - 22.5	100%	Yes
Engeny (2024)	TSF_BH_13	18.4	100%	Yes
Engeny (2024)	TSF_BH_07	4.15-4.4	50%	Yes

5.4.2 Packer Testing Review

Packer testing, also known as Lugeon testing, is an in-situ hydraulic test used to assess the permeability of rock masses or confined soils. The test involves isolating a section of a borehole using inflatable packers and injecting water under pressure to measure the rate of water loss. Results are typically reported as Lugeon values (Lugeon units), which represents water intake in Liters per meter per minute of test section normalised to a pressure of 10 bars.

Packer testing has been undertaken on site historically and as part of the most recent investigation. A summary of the test results is presented in Table 5.2 and Figure 5.2 presents a plot of the lugeon values with depth. The results indicate that the permeability of the rock is variable, generally in the range of 10^{-6} to 10^{-7} m/s with occasional outliers, with higher Lugeon values typically reported near the UEDD as part of the GHD, 2008 investigation. A high Lugeon value > 100 was observed in a single borehole (TSF_BH_08, Engeny, 2024). It is considered that the high Lugeon value is possibly the result of inaccurate field testing (e.g. incomplete packer seal).

No correlation is discernible in the full data set relative to depth as presented in Figure 5.2. A further data review of closely located boreholes from the historical (GHD, 2008) data and the project specific testing data (Engeny, 2024) also does not appear to show any correlation. Given the regional geological conditions, well cemented, low porosity, and high strength rock, it is likely that permeability in the rock is controlled by the presence and orientation of defects.

TABLE 5.2: PACKER TESTING SUMMARY

Investigation Phase	BH ID	Test Depth (m bgl)	Length (m)	Average Lugeons (L/m/min)
GHD (2008)	BH2	3.1 – 6.5	3..4	0
GHD (2008)	BH2	6.5 – 11.2	4.7	0
GHD (2008)	BH3	3.4 – 5	1.6	20.1
GHD (2008)	BH3	5 – 10	5	18.6
GHD (2008)	BH3	10 – 14.7	4.7	49.5

Investigation Phase	BH ID	Test Depth (m bgl)	Length (m)	Average Lugeons (L/m/min)
Engeny (2024)	TSF_BH_12	6 – 11	5	0.9
Engeny (2024)	TSF_BH_12	9 – 15.2	6.2	0.7
Engeny (2024)	TSF_BH_15A	6 – 12	6	4.9
Engeny (2024)	TSF_BH_15A	15 – 20	5	1.5
Engeny (2024)	TSF_BH_07	18 – 24.5	6.5	3.9
Engeny (2024)	TSF_BH_08	13 – 18	5	106
Engeny (2024)	TSF_BH_08	18 – 24.3	6.3	3.6
Engeny (2024)	TSF_BH_10A	19 – 23.85	4.85	0.4
Engeny (2024)	TSF_BH_07	20 – 26	6	4.8
Engeny (2024)	TSF_BH_13	20 – 26	6	4.8
Engeny (2024)	TSF_BH_13	26.6 – 32.6	6	3.3

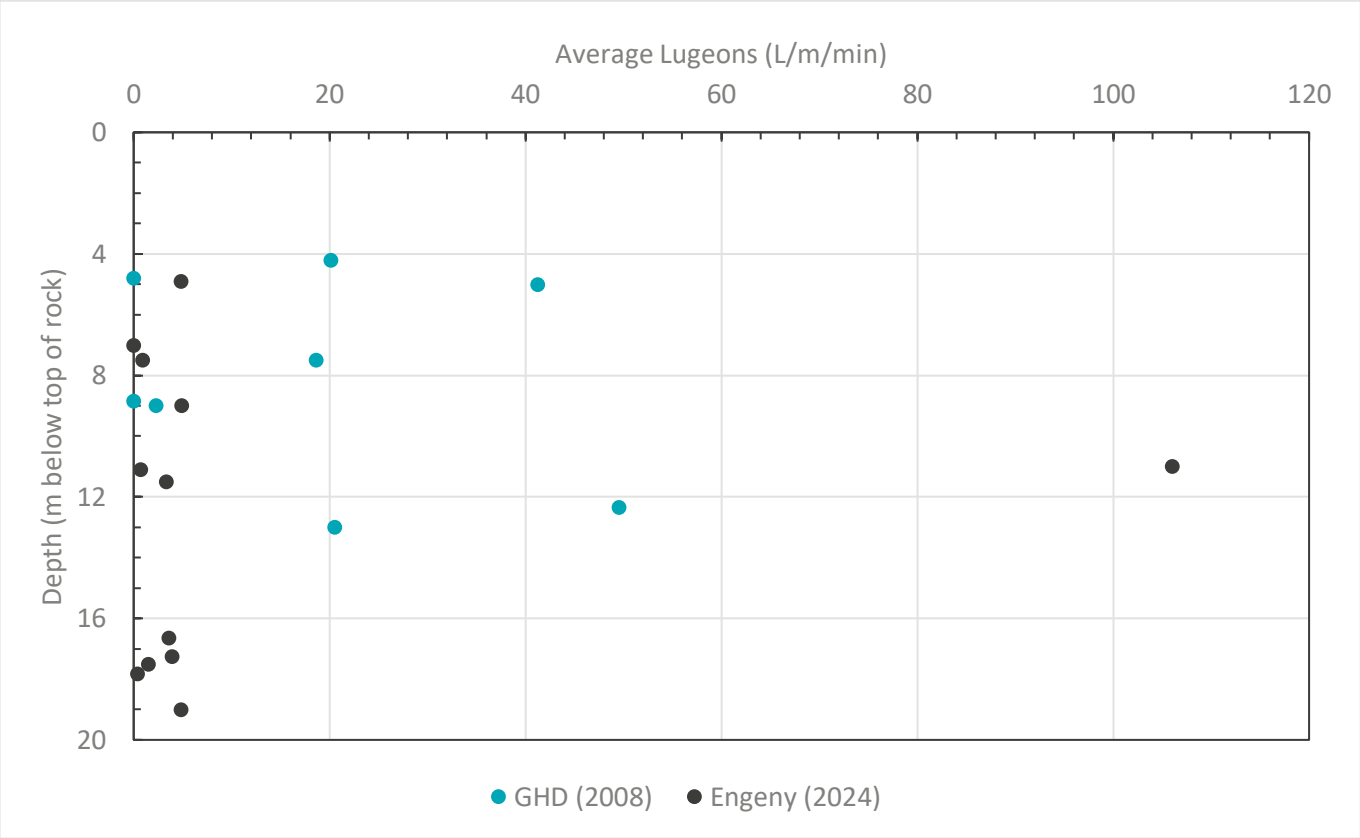


FIGURE 5.2: AVERAGE LUGEON VALUES RELATIVE TO DEPTH BELOW GROUND LEVEL

5.4.3 Structural Defects Review

A preliminary review of the oriented core borehole measurements was undertaken to review the orientation and domains of bedding and structural defects against that recorded during the geological field mapping program. The review indicated that there is a fair amount of data scatter, with variations in defect orientations from that mapped during the field geology program, with likely spatially varying geological domains across the northern embankment. The data scatter is possibly due to limitations with oriented borehole measurements (e.g. rotation of the core / variations in borehole alignment), and some bias due to the borehole orientations. It is recommended that during detailed design the wireline logging (ATV / OTV) is reviewed to confirm the geological domains. Due to the limited geotechnical investigations, it is recommended that additional boreholes along the final grout curtain alignments are undertaken during detailed design to confirm the optimal grouting design (e.g depths / orientations) and to improve confidence in the grouting methodology and cost estimates.

5.4.4 Defect Spacing Review

Figure 5.3 presents a plot showing the average defect spacing observed in the geotechnical investigation data (average of logged ranges including <20 mm, 20 – 60 mm, 60 – 200 mm, and 200 – 600 mm), specifically the boreholes within which the packer testing was conducted. Note, the depth corresponds to depth from top of rock. No direct relationship is observable in the defect spacing with depth, however three distinct data zones are observable in the defect spacing plot. Zone 1 between the surface and an approximate depth of 5 m, which appear to show a relatively high fracture frequency, i.e. more defects, while Zone 2, is a section with relatively sparse defects, i.e. defect spacing is greater. The fracture frequency again increases between 10 m and 15 m below top of rock but with significantly more variability relative to Zone 1 – this zone is referred to as Zone 3. Finally, Zone 4 is the final extent of the available defect spacing results from the borelogs which is consistent with Zone 2.

The plot also presents, on the secondary vertical axis, the Lugeon test values at the corresponding depth below top of rock level. Similar to the defect spacing, and as presented in Section 5.4.1, a relationship with depth is not observable in the dataset. Zone 1 has a single data point in the depth range, GHD_BH_03. Which shows a higher permeability value in the section of the rock with a higher fracture frequency. Zone 2 includes a few data points for permeability, which shows some variability, from very low to medium permeability. Such permeability values are coincident with the variability observed in the defect spacing in this particular zone. Zone 3 has two data points, of which 1 point shows a very high permeability result. However, this value does not correspond to the relatively wider defect spacing observed in the borelogs. Zone 4 is the section of the bore depth range, which has the highest numbers of packer testing undertaken. The packer testing permeability values in this range, however, appear to relatively higher, than those observed in Zone 2 or 3.

Given the limited datapoints available and the limited depths over which the packer testing had been undertaken in previous investigations, determining a correlation with confidence is challenging. Therefore, additional investigations that incorporate more packer testing over a range of depths is recommended as part of detailed design to further refine the available data and inform foundation design.

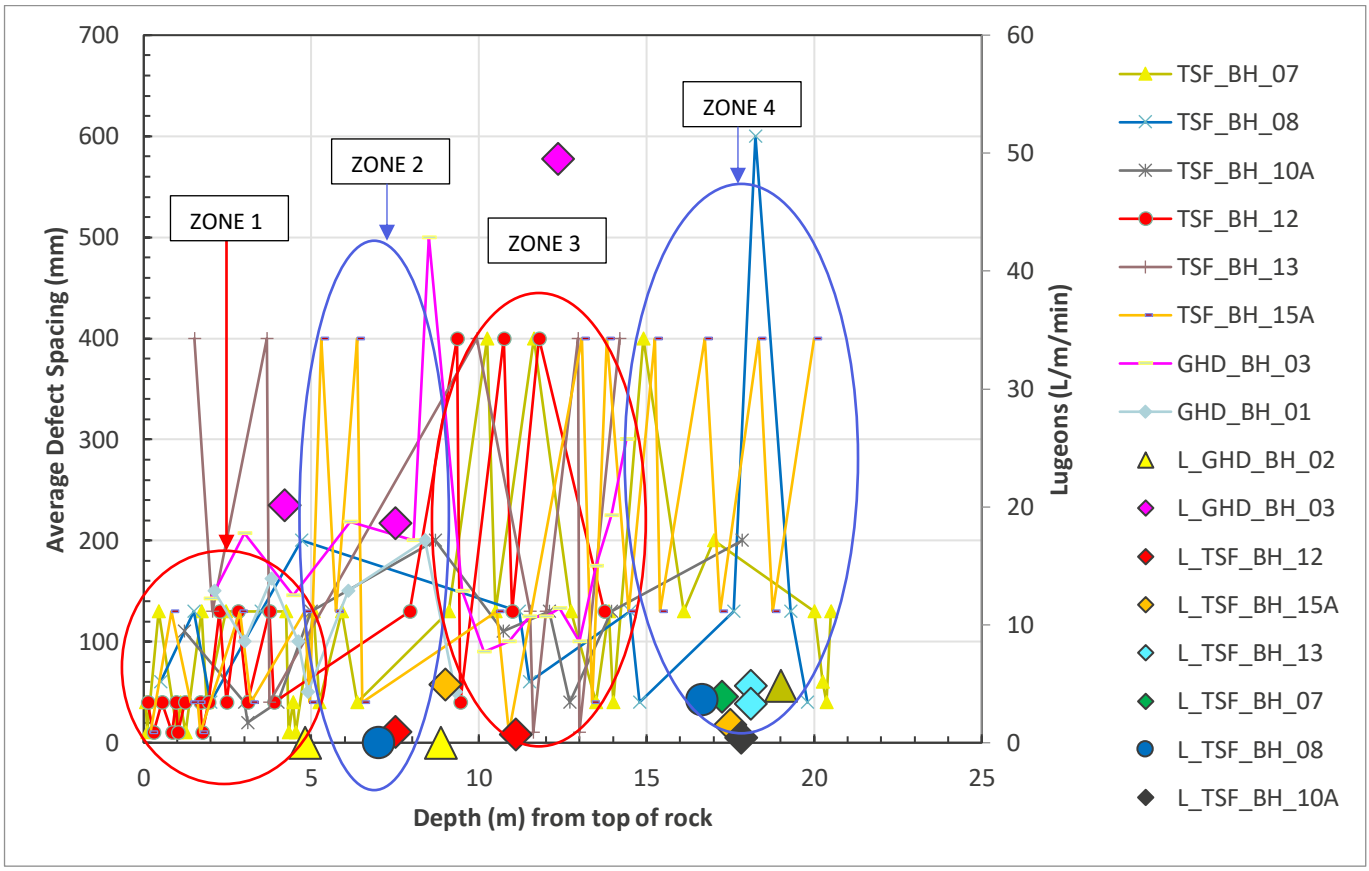


FIGURE 5.3: AVERAGE DEFECT SPACING AND LUGEON DALUE WITH DEPTH

5.5 Geotechnical Preliminary Interpretation – Select Fill Availability

5.5.1 General

A total of 16 test pits were excavated as part of the project specific geotechnical investigation. The test pits targeted the valley west of the proposed TSF3 site, a potential borrow source for use as Select Fill in the embankments. A summary of the investigation findings is presented in the subsections below.

5.5.2 Subsurface Profile

The typical subsurface profile of the investigated area comprises of the following:

- Fill: Clayey GRAVEL or Sandy GRAVEL – brown, fine to coarse grained subangular to angular siltstone clasts or Sandy GRAVEL: red brown, subangular, moderately to highly weathered siltstone gravel, coarse sand, trace low plasticity silt. Observed in TSF_TP_21 to a depth of 0.6 m bgl from surface and the test pits undertaken at the waste rock dump (TSF_TP_WRD1, TSF_TP_WRD2) to termination depth of 3.5 m bgl and 1.1 m bgl respectively.
- Topsoil: Silty SAND with gravel: brown, fine to medium grained, low plasticity silt, gravel is fine to coarse, sub-angular, trace organics. Observed in a single test pit (TSF_TP_23) to a depth of 0.1 m from surface.
- Alluvium: Sandy GRAVEL with silt or clay – red-brown, medium to coarse grained, angular to sub-angular quartzite clasts, medium to coarse grained sand, with medium plasticity silt or clay. Depths for alluvial material typically range from surface level to 2.7 m bgl (TSF_TP_10).
- Residual: GRAVEL with sand or silt – Fine to medium grained, angular siltstone gravel, pale brown, sand is coarse grained, low plasticity silt. Depths for residual material typically range from surface level to 0.6 m bgl (TSF_TP_11).

- Weathered Rock: SILTSTONE of the Paradise Creek Formation – pale brown to white, laminated at 85 degrees, moderately weathered, medium strength, fine grain, excavated in block sizes 60-200mm, iron staining on some parting defects, planar parting defects, lenses of clayey gravel 100mm thick, low plasticity clay, red brown. The rock level ranges from surface (TSF_TP_17) to depth.

5.5.3 Groundwater

Groundwater was not encountered during the test pitting investigation.

5.5.4 Laboratory Testing

Laboratory testing of soil samples retrieved from the geotechnical investigation typically comprised of classification testing (particle size distribution, Atterberg limits), dispersivity (Emerson class) testing, and moisture content testing.

Figure 5.5 and Figure 5.6 present the Particle Size Distribution (PSD) and Casagrande plots, respectively. Consistent with field observations and the desktop review presented in the Geological Mapping Report [QC1022_018-REP-001-1] (Engeny, 2025), the particle size distribution testing undertaken on select samples indicate that a majority of the subsurface material generally consists of granular material. It should be noted that, although the PSD chart presents predominantly gravel and sand size particles, photographs of test pits indicate that significant oversized material is present (refer Figure 5.4). Therefore, the PSD results are assumed to be characteristic of only a portion of the material excavated in the test pits and not indicative of material composition in its entirety.

Where sufficient quantities of fine material was available, the Atterberg limits typically presented in the low plasticity clay or silt range. Emerson class testing undertaken on soil samples retrieved from the test pit investigation indicate that on average, the soils are non-dispersive with Emerson Class Numbers (ECN) ranging between 4 and 6.



FIGURE 5.4: OVERSIZED MATERIAL OBSERVED IN TEST PIT PHOTOS

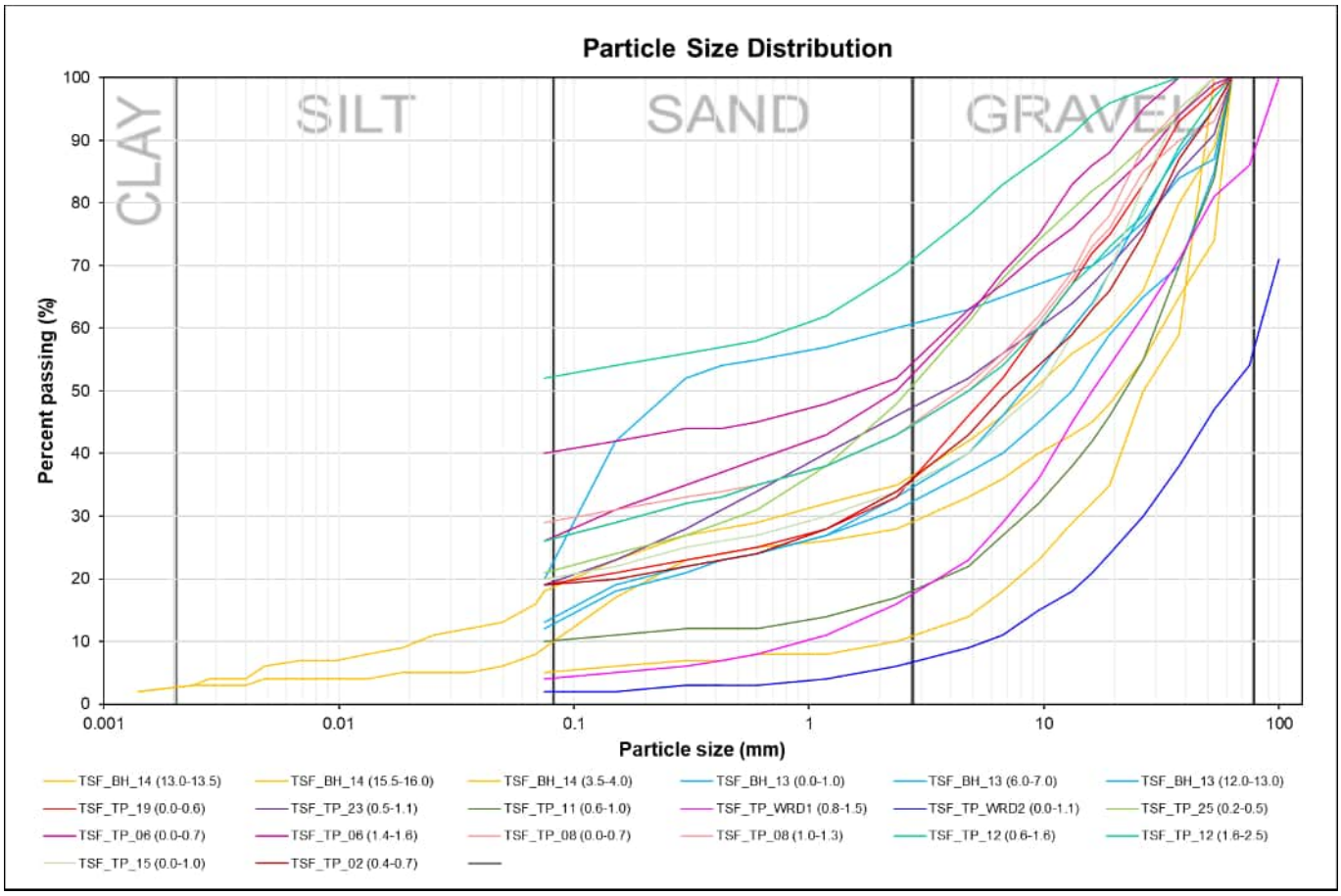


FIGURE 5.5: PARTICLE SIZE DISTRIBUTION RESULTS

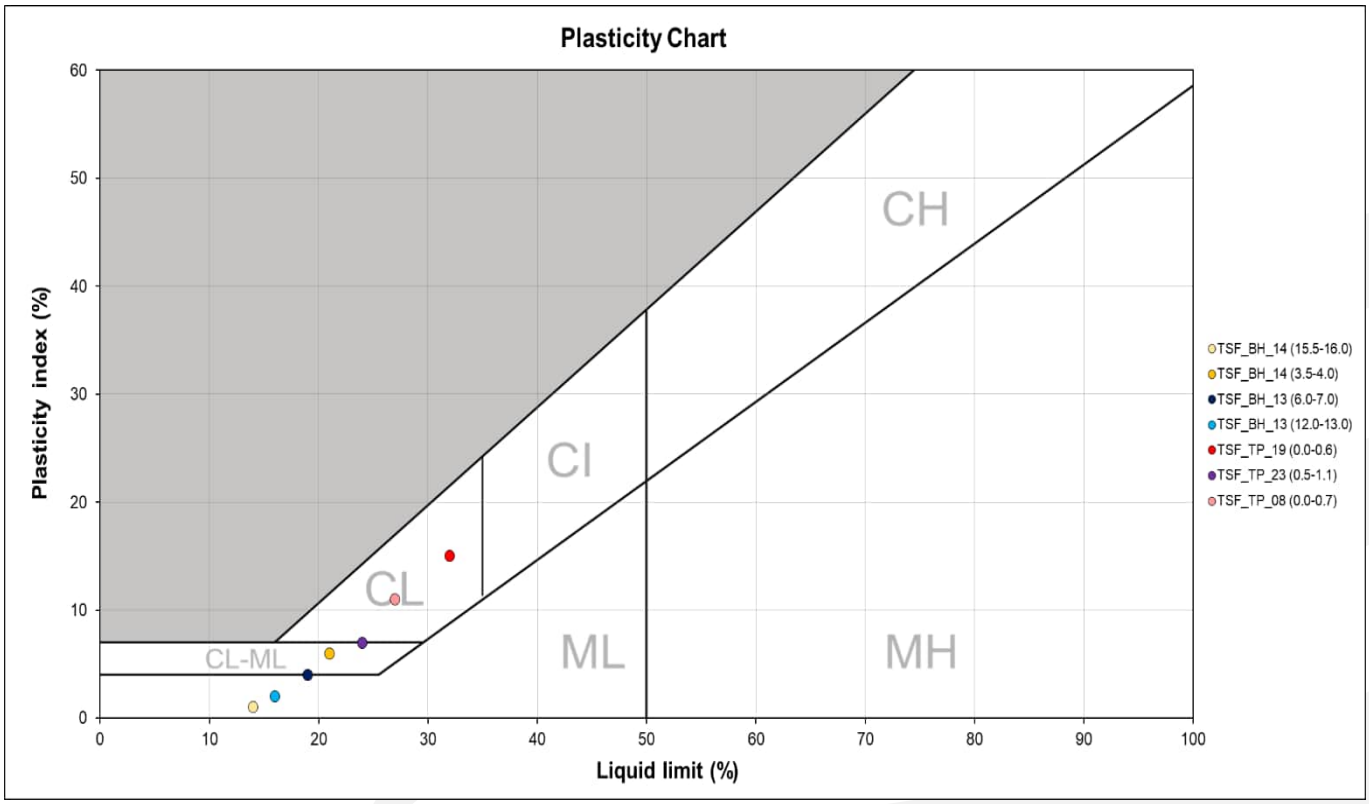


FIGURE 5.6: CASAGRANDE CHART

5.5.5 Summary

The material encountered during the test pitting, consistent with the borehole drilling, show that the subsurface material is primarily fractured rock with a relatively thin layer of regolith. The weathered soil of residual or alluvial origin is typically less than 1.5 m in depth and is generally granular with a minor fines component. As such, rockfill is the most likely material type to be won from the proposed borrow areas given the shallow depth to competent rock; without difficulty and to the volumes required for the construction of TSF3.

Select Fill material, to act as a low permeability, cushioning layer between the rockfill and the geomembrane liner and to construct the southern side of the UEDD centreline raise, can be won from the nominated borrow areas. A preliminary review of the available laboratory indicates that, material for reuse is available in the residual and alluvial material, however, will require working, mixing, and screening prior to placement to achieve the material specification for Select Fill. However, based on a review of the anticipated borrow extents, the quantity of material available in the surficial soils is expected to be insufficient. Based on an approximate borrow area of 100,000 m^2 and typical 0.5 – 1.0 m depth of alluvial / residual soil, it is expected that approximately 50,000 m^3 to 100,000 m^3 may be won from the proposed borrow at best. Based on the required Select Fill quantity from the preliminary design of ~200,000 m^3, there is currently a Select Fill deficit of approximately 100,000 m^3 to 150,000 m^3.

To identify additional Select Fill Borrow sources to construct TSF3, CCM plan to undertake additional site wide (on and off lease) geotechnical investigations. These investigations will also focus on proving up material inventories to support closure planning.

6. PREVIOUS WORK

6.1 Overview

A concept design for TSF3 was prepared by ATCW in 2023 as part of a Life of Mine (LoM) Options Study (ATCW, 2023). The preliminary design is an extension of the work previously completed by ATCW, however Engeny were not engaged to undertake a detailed review the study and have therefore assumed that the previous work by ATCW is accurate and can be relied upon. The preliminary TSF3 design has departed significantly from the ATCW concept design, primarily due to the incorporation of additional seepage controls to reduce seepage rates from TSF3 through the existing Esperanza Waste Rock Dump (EWRD) to EPit.

6.2 Concept Design Summary

The ATCW TSF3 Concept Design is shown in Figure 6.1. The concept design consisted of a raised UEDD embankment, an eastern and western saddle dam, and two embankments at the EWRD to raise the eastern and western margins of the EWRD to the required level. Tailings was proposed to be discharged in a down valley fashion from the raised UEDD and the eastern and western saddle dams and beach towards the EWRD. A nominal emergency overflow spillway was proposed across the EWRD. Under normal operating conditions the decant pond would form at the northern end of the beach near the EWRD, where decant water would be pumped to the process plant or to other site water storages as needed. The ATCW Concept Design was supported by laboratory rheology testing and beach slope parameters were developed by ATCW for two options, with a new tailings thickener and without. The ATCW TSF3 Concept Design concluded that the any seepage associated with the TSF3 was expected to ultimately discharge to EPit and would not require any further mitigation from a design perspective.

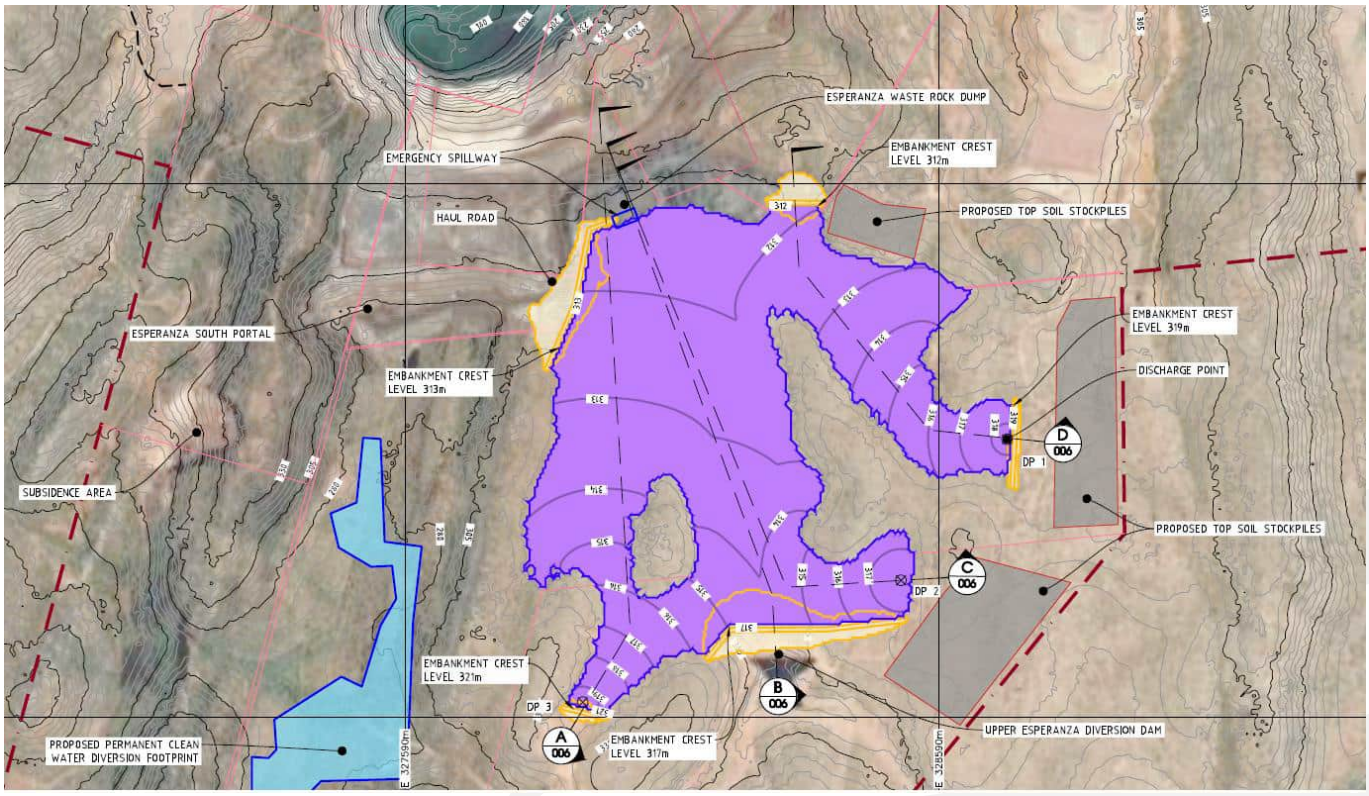


FIGURE 6.1: TSF3 CONCEPT DESIGN (NEW THICKENER OPTION) – EXCEPT FROM LOM STUDY (ATCW, 2023)

6.3 Key Changes / Updates

During the preliminary design phase, a number of key changes / updates were made to the concept design. The primary change was to include upstream seepage controls (upstream geomembrane liner and concrete plinth / grout curtain) to be installed on the upstream batter of the EWRD. This key design change was proposed by CCM and indicates the willingness of CCM to design and construct TSF3 to a higher performance standard than may be required based on the seepage risk profile of the TSF. The preliminary DESI Consequence Category Assessment undertaken for TSF3 assessed the Failure to Contain – Seepage scenario as 'Low' consequence. Where the outcomes of the proposed site wide 3D transient groundwater model incorporating TSF3 are materially different from that assumed as part of the preliminary consequence category assessments, the consequence category assessments are required to be revised, including any associated design requirements for seepage mitigation and monitoring.

Based on the current 'Low' DESI consequence category for the Failure to Contain – Seepage scenario, additional seepage controls are not mandatory under the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance (DESI, 2016) (Refer Section 9 for details). The additional seepage controls as discussed in more detail below.

Key changes/updates from the concept design include:

- The eastern and western saddle dam embankments were removed from the design. Based on topography, the saddle dam embankments provided little function and did not effectively divert clean catchment surface water away from TSF3. Direct tailings discharge into the natural valleys at these locations has been adopted for the preliminary design.
- Additional seepage control measures for the EWRD embankment have been incorporated into the preliminary design. These seepage control measures include a low permeability ($\leq 10^{-9}$m/s) geomembrane liner tied into the foundation and abutments with an anchored concrete plinth and grout curtain (nominally primary, secondary, and tertiary grouting). This is expected to reduce the rate of seepage through the EWRD embankment to EPit and associated generation of contaminated seepage waters during operation and closure and reduce the magnitude of saturation / degradation settlement of the EWRD. To support the liner installation and grout curtain construction, the EWRD has been profiled to a batter of 1V:3H with intermediate benches. The final details of the EWRD re-profiling, liner type, and grout curtain depth and extents will be determined during the detailed design phase. Based on the preliminary geological desktop assessment and field mapping program undertaken as part of the preliminary design phase, no additional seepage control measures for the TSF3 floor are proposed at this time.
- A centreline raise of the existing UEDD has been adopted in lieu of an internal (upstream) raise. This methodology reduces material quantities while enabling the existing seepage control measures (Geosynthetic Clay Liner (GCL), High Density Polyethylene (HDPE) liner, concrete plinth and grout curtain) to be retained centrally within the raise design and provide bi-directional seepage control (i.e. internal seepage originating from the clean Upper Esperanza Valley South catchment and external seepage originating from TSF3). It is noted that there are current concerns regarding the integrity and effectiveness of the existing UEDD grout curtain and HDPE liner. As part of the detailed design, it is proposed to investigate the apparent seepage, and during construction to verify the adequacy of the existing UEDD grout curtain and HDPE geomembrane liner (e.g. through verification grouting along the existing grout curtain alignment, and through inspection and testing of the existing HDPE geomembrane). Where required the existing grout curtain and HDPE geomembrane will be repaired / replaced as appropriate to ensure they function as intended.
- The EWRD crest level has been raised to accommodate the design spillway overflow event and the final tailings deposition surface has been lowered to accommodate the Extreme Storm Storage (ESS) allowance and a nominal 1m operating decant pond depth.
- The spillway location was from the original central location across the EWRD to the eastern side of the EWRD through a natural rock cut.

6.4 Existing UEDD Summary

The preliminary TSF3 design incorporates a centreline raise of the existing UEDD embankment. There is no as-constructed documentation for the original embankment, however there is an as-constructed report (no as-constructed drawings) for the remediation works undertaken to address identified seepage issues through the UEDD (GHD, 2011). Based on review of available documentation, the most likely composition of the existing UEDD is shown in Figure 6.2 and has been used as the basis for the preliminary TSF3 design.

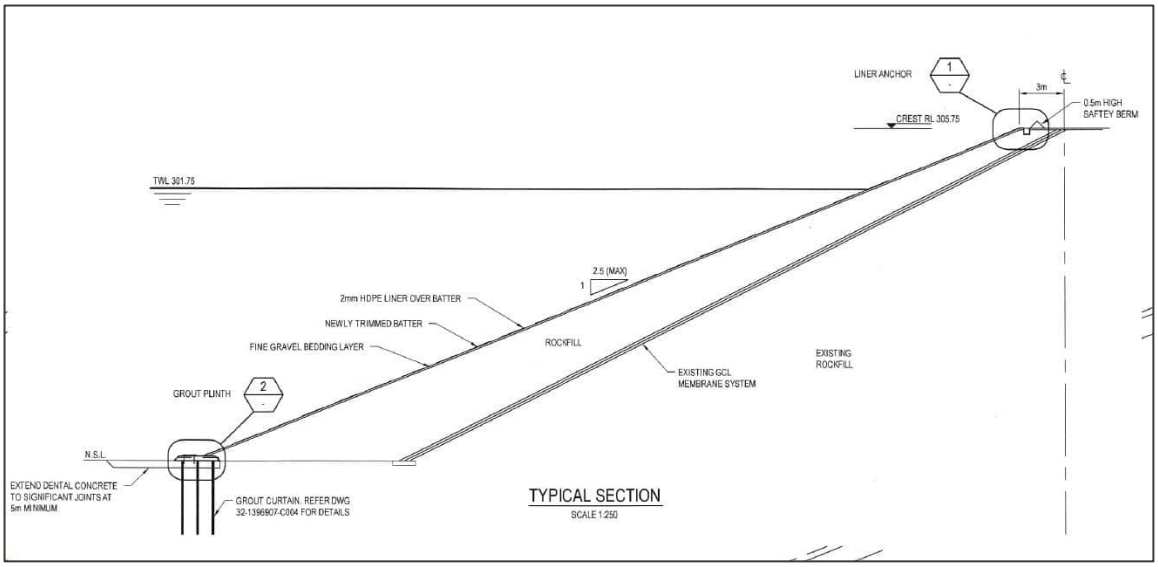


FIGURE 6.2: EXISTING UEDD EMBANKMENT

7. BASIS OF DESIGN

7.1 Overview

The basis of design has been informed by a number of inputs and discussions throughout the preliminary design process including:

- ATC Williams (ATCW) conceptual TSF3 design.
- Department of Environment, Tourism, Science, and Innovation – Queensland (DETSI) pre-lodgement meetings.
- Stakeholder consultation within CCM.
- Preliminary design risk assessment.
- Preliminary DESI and Australian National Committee on Large Dams (ANCOLD) consequence category assessments.

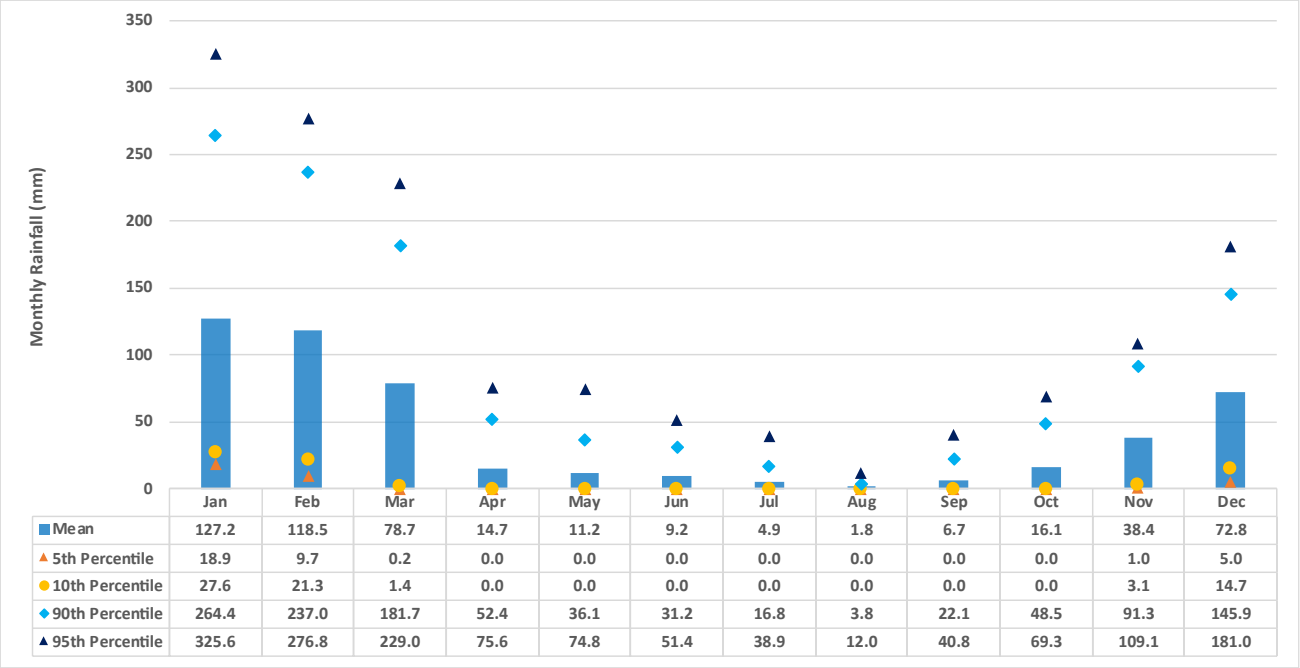
7.2 Basis of Design

The TSF3 preliminary design Basis of Design (BOD) is summarised in Table 7.1. The BOD was developed on project commencement in consultation with CCM, with due consideration of available data and known constraints and limitations. Throughout the preliminary design process, changes / updates to the BOD were made as new information became available, and design decisions were made in consultation with CCM.

TABLE 7.1: TSF3 KEY DESIGN CRITERIA

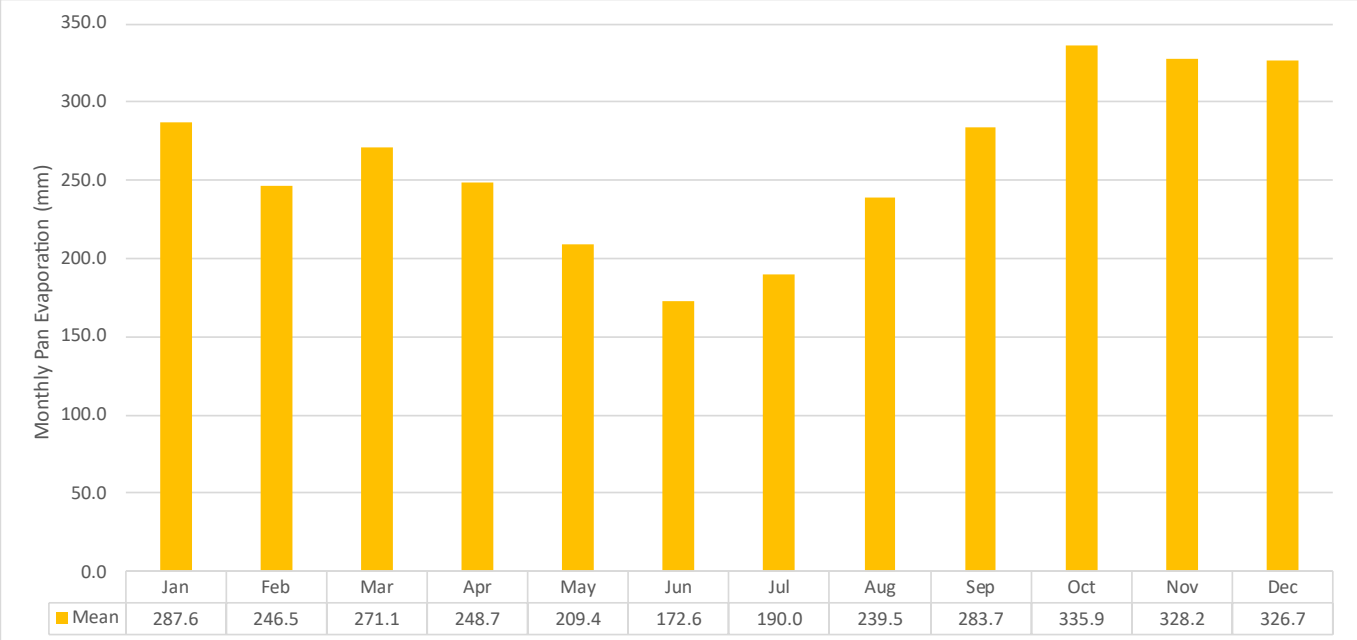
Parameter	Value
Design Life	• 6.5 – 7.5 years
Design Standards, Guidelines and Specifications	• ANCOLD Guidelines on Tailings Dams, May 2012 • ANCOLD Guidelines on the Consequence Categories for Dams (Oct 2012) • ANCOLD Tailings Guideline Addendum_July 2019 • DETSI Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) • Engeny Construction Specification • CCM Standard Specifications
Rainfall / Evaporation	• Rainfall – Refer Figure 7.1 • Evaporation – Refer Figure 7.2
Battery Limits	• TSF3 Civil Works only.
Production	• Full production assumed for duration • Ore processed - 140 Kt/mon • Concentrate – 8.4 Kt/mon • Tailings produced – 131.6 Kt/mon • Tailings to paste – 11% • Tailings to TSF3 – 117.1 Kt/mon
Tailings Characteristics	• Settled density – 1.65 tonne/m^3 • Tailings specific gravity – 2.82 tonne/m^3 • Soilds Concentration – 60% (No High Density Thickener Option) • Tailings Type – Variable CL-ML Typ. • Potentially Acid Forming (PAF)
Tailings Beach Slopes	• 1.2% 150 m then; • 0.9% 150 m then;

Parameter	Value
	• 0.7% for 100 m then; • 0.5% for remainder
Deposition System	• Ring main with 4 discharge spigot locations • Sub-aerial deposition
DESI Hazard Consequence Category (Preliminary)	• Failure to Contain – Seepage – Low • Failure to Contain – Overtopping – Significant • Dam Break – High • Overall - High
ANCOLD Consequence Category (Preliminary)	• High A
Stability Modelling Criteria / FoS Acceptance Criteria	• Long-term drained – 1.5 • Short-term undrained (no potential loss of containment – 1.3 • Post-seismic – 1.0 – 1.2
Seismic Loading Summary	• Operating Basis Earthquake (OBE) – 1:475 AEP to 1:1,000 AEP • Safety Evaluation Earthquake (SEE) – 1 in 10,000 AEP • Maximum Credible Earthquake (MCE) - 1 in 10,000 AEP
Catchment Characteristics	• Catchment Area – 79 ha • Catchment Characteristics (Tailings 39 ha, natural 40 ha – at final tailings deposition)
Freeboard	• Operational Freeboard – Min 1 m • Total Freeboard – Extreme Storm Storage + Spillway Design Event
Extreme Storm Storage (ESS)	• Integrated Containment System • TSF3 ESS 1:10 AEP, 72 hr Design Rainfall Event (171.4 ML)
Design Storage Allowance (DSA)	• Integrated Containment System - Combined 1:20 AEP (95th percentile or 5% AEP) wet season inventory increase in EPit, ETSF, MCS and TSF3.
Spillway Criteria	• Most conservative of: - 1:100,000 AEP plus 1:10 AEP Wind Wave Run-up or - PMF
External Flood Ingress Prevention	• PMF plus 0.5 m freeboard (Final) • 1:1,000 AEP (Interim)
Spillway Design	• Spillway Level – 312.2 mAHD • Embankment Crest Level – 314.2 mAHD • Peak Flood Rise (1.54 m) • Peak Spillway Outflow (84.8 m^3/s)
Decant	• Normal Decant Pond Depth – Max 1 m (~25 ML / 7.4 ha for Final Tailings Deposition Surface) • Decant Dewatering Rate – 200 L/s • ESS to normal decant pond operating level dewatering time – 10 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	127.2	118.5	78.7	14.7	11.2	9.2	4.9	1.8	6.7	16.1	38.4	72.8
5th Percentile	18.9	9.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	5.0
10th Percentile	27.6	21.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	14.7
90th Percentile	264.4	237.0	181.7	52.4	36.1	31.2	16.8	3.8	22.1	48.5	91.3	145.9
95th Percentile	325.6	276.8	229.0	75.6	74.8	51.4	38.9	12.0	40.8	69.3	109.1	181.0

FIGURE 7.1: MONTHLY RAINFALL (SILO DATA DRILL, 1889-2025)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	287.6	246.5	271.1	248.7	209.4	172.6	190.0	239.5	283.7	335.9	328.2	326.7

FIGURE 7.2: MONTHLY PAN EVAPORATION (SILO DATA DRILL, 1970-2024)

8. DESIGN OVERVIEW

8.1 Site Location

CCM is located in Gunpowder, North Queensland, approximately 130 km north of Mount Isa. TSF3 is proposed to be located in the UEV between the Ezperanza Waste Rock Dump (EWRD) and the UEDD. The site location within CCM is shown in Figure 8.1.

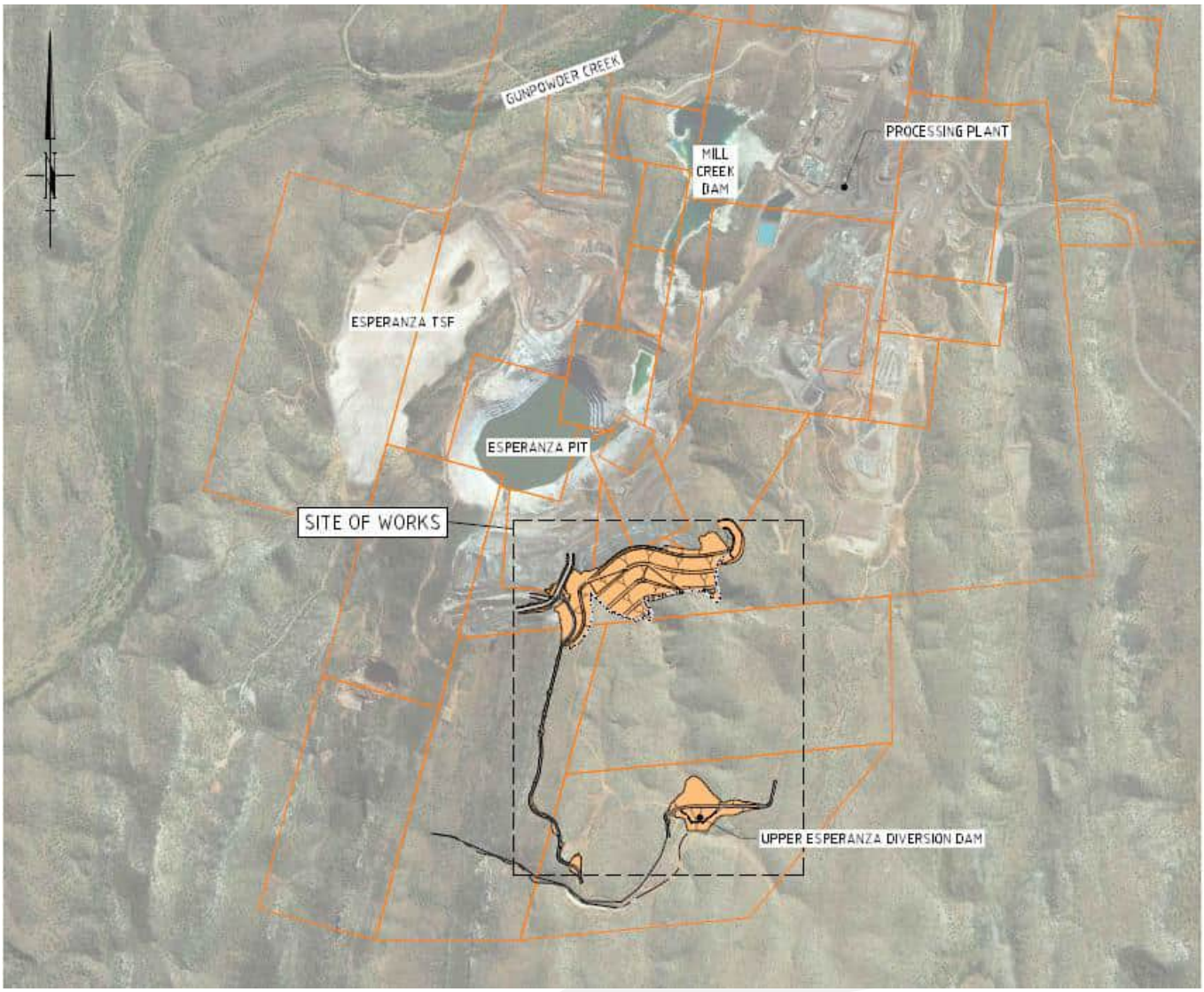


FIGURE 8.1: TSF3 LOCALITY PLAN

8.2 Key Features

Key features of the TSF3 preliminary design are summarised in Table 8.1.

TABLE 8.1: TSF3 KEY FEATURES

Parameter	Value
General	
Name of Dam	Tailings Storage Facility 3 (TSF3)
Location	Capricorn Copper Mine
Nearest Town	Mount Isa
Owner	Capricorn Copper Mine Pty Ltd (subsidiary of 29 Metals Limited)
Operator	Capricorn Copper Mine Pty Ltd
Esperanza Waste Rock Dump Northern Embankment	
Type	Zoned Rockfill / Earthfill
Liner	Geomembrane (Type to be confirmed during Detailed Design) Option 1 – HDPE on Non-woven Geotextile Option 2 – LLDPE on Non-woven Geotextile Options 3 – Bituminous Geomembrane Liner (BGM). Integrated into foundation / abutments with concrete plinth / grout curtain.
Maximum Embankment Height	65m
Embankment Crest Level	RL 314.2 mAHD
Embankment Crest Length	780 m
Embankment Crest Width	8 m
Embankment Batter Slopes	1V:3H
Embankment Intermediate Bench Width	10 m
Upper Esperanza Diversion Dam Southern Embankment	
Type	Zoned Rockfill / Earthfill
Liner	Retain existing geosynthetic clay liner (GCL) and geomembrane liner / grout cut-off wall.
Maximum Embankment Height	32 m

Parameter	Value
Embankment Crest Level	RL 317.0 m AHD
Embankment Crest Length	334 m
Embankment Crest Width	8 m
Embankment Batter Slopes	1V:3H
Hydraulic / Hydrology / Storage	
Full Supply Level (Spillway Level)	RL 312.2 mAHD
Full Supply Volume (Spillway Level)	6.6 GL
Spillway Depth	2 m
Stored Contents	Fine metalliferous tailings, lime sludge (from proposed water treatment plant) plus decant pond (water) on top of tailings beach
Tailings Storage Capacity Total	6.3 Mm3
Decant Pond Depth	Nominally 1 m maximum operating decant depth
Catchment area	79 ha
Spillway	Provisional Bywash spillway (insitu rock cut with concrete sill)
Spillway Design Capacity	1:100,000 AEP plus 1:10 AEP Wind Wave Run-up or Probable Maximum Flood (PMF)
Environmental Containment	Design Storage Allowance (DSA) – Integrated Containment System – 5% AEP containment performance standard. Note DSA is less than ESS therefore the DSA is the ESS. Extreme Storm Storage (ESS) – 1:10 AEP 72hr duration – 171.4 ML
Outlet	
Outlet works	Nil
Decant Return Infrastructure	
Type	Bank Mounted Pump – Power source to be confirmed.
Flow Rate	200 L/s - Dewaters ESS storm volume down to normal 1m normal decant pond operating depth within 10 days.
Destination	EPit, MCD, Pond 3, or the proposed new Water Treatment Plant (WTP) with the decant water destination dependent of the water quality and site water storage inventories.

Parameter	Value
Instrumentation	
Settlement	Yes – Survey Monuments
Piezometers (phreatic surface)	Provisional – Standpipe piezometers and/or vibrating wire piezometers (VWPs)
Seepage	Provisional – V-Notch Monitoring Weir at downstream toe of E-WRD (Northern Embankment)
Groundwater Levels / Water Quality	Yes - Existing and proposed site wide groundwater bores. (Refer Section 15)

8.3 General Arrangement

The general arrangement of TSF3 is shown in Figure 8.2. The Preliminary Design Drawings are included in **Appendix D**. Key elements of the design include:

- Raising and reprofiling of the existing EWRD to form the northern extent of the storage and incorporation of an upstream geomembrane liner, concrete plinth and/or grout curtain.
- Centreline raising of the existing UEDD embankment to form the southern extent of the storage including retaining the existing geosynthetic clay liner, geomembrane liner and grout curtain centrally within the centreline raise to provide bi-directional seepage control. As part of the works, the adequacy of the existing geomembrane liner and grout curtain will be verified by conformation grouting of the existing grout curtain and through inspection and testing of the existing geomembrane liner. Where required the existing grout curtain and geomembrane liner will be repaired / replaced. The existing grout curtain will also be extended to facilitate the raise of the UEDD embankment, tieing into low permeability Select Fill. The UEDD raise also provides flood ingress protection to TSF3 from external flooding to the same design hydraulic performance standard as the TSF3 emergency spillway (Refer Section 13.1 for details). The existing flood ingress protection prior to raising of the UEDD is the 1:1,000 AEP design event.
- Following the construction of supporting tailings infrastructure including a booster pump located north of the EWRD, tailings will be deposited in a down valley discharge manner along the southern extents of TSF3 via a new tailings delivery ring pipeline to four discharge spigots. Tailings will beach in a northern direction (varying beach slopes) with the decant pond formed against the EWRD.
- Under normal operating conditions the decant pond will be maintained in a minimum condition (nominally 1m maximum normal operating depth), with decant water pumped to either EPit, MCD, Pond 3, or the proposed new Water Treatment Plant (WTP) with the decant water destination dependent of the water quality and site water storage inventories.
- An emergency overflow spillway is located near the eastern side of the of the northern embankment. The spillway alignment and design are provisional, however are intended to reduce the risks of embankment instability and erosion. The spillway is proposed to also form part of the closure design of TSF3 to convey surface flows from the TSF3 capped surface. During the operational phase, in the unlikely event spillway overflows should occur they will report to EPit. Based on water balance modelling undertaken, with the incorporation of TSF3, no overflows from the terminal dam of the CCM *integrated containment system* (Hoover Dam) to Gunpowder creek were seen. (Refer Section 13.2 for details).
- The maximum tailings surface has been limited to allow containment of the nominal decant pond operating depth and the ESS event based on site wide operational simulation water balance modelling undertaken as part of the preliminary design process. It is intended that the decant return pump and pipeline will be sized to enable a dewatering capacity of approximately 200 L/s to return elevated TSF3 water levels from the ESS event back to normal operating levels within 10 days.

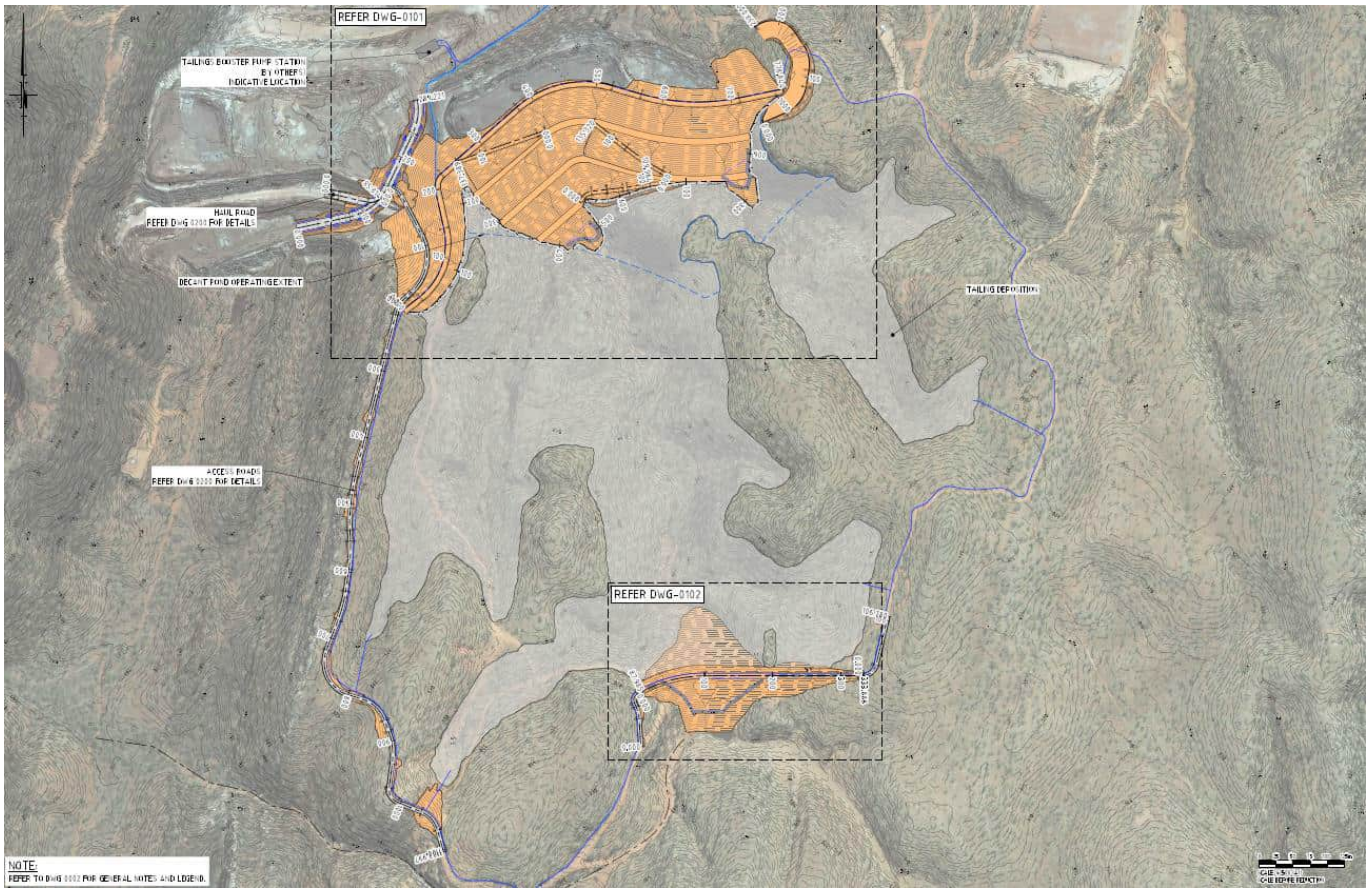


FIGURE 8.2: TSF3 GENERAL ARRANGEMENT

8.4 Tailings Storage Capacity

For preliminary design, the final tailings storage capacity of TSF3 was assessed for two options:

- Option 1 – New High-Density Thickener is approximately 6.4 Mm^3.
- Option 2 – No new High-Density Thickener is approximately 6.3 Mm^3.

The storage capacities for the options were estimated based on approximation of the tailings beach slope contours presented in the ATCW Concept Design (ATCW, 2023). The results indicate that based on current assumptions, there are only marginal gains in storage capacity to be made from the installation of a new High-Density Thickener. Tailings production and storage details adopted for the TSF3 preliminary design are summarised in Table 8.2.

TABLE 8.2: TAILINGS PRODUCTION AND STORAGE DETAILS

Parameter	Unit	Value
Milled Ore	t / month	140,000
Tailings Produced	t / month Mt / year	131,600 1.58
Tailings Diverted to Paste Plant	% t / yr	0 – 11% 0 – 174,000
Tailings Settled Density	t / m3	1.65 – 1.75

8.5 Design Life

Based on the preliminary design, the design life of TSF3 is expected to be in the range of 6.5 – 7.5 years. The actual design life is dependent on a number of assumptions including ore throughput, the percentage of the tailings stream diverted to paste backfilling operations, the percentage of TSF3 storage consumed by deposition of lime sludge produced as part of the proposed new water treatment plant, and the actual beaching slopes and settled densities for Option 1 – New High-Density Thickener and Option 2 – No New High-Density Thickener options.

8.6 Water Storage Capacity

The water stage-storage relationship for TSF3 above the final tailings deposition surface to the northern embankment crest level is shown in Figure 8.3. The total spare capacity for wet season containment (ESS and DSA) between the normal 1m deep operating decant pond and the full supply level is approximately 171.4 ML.

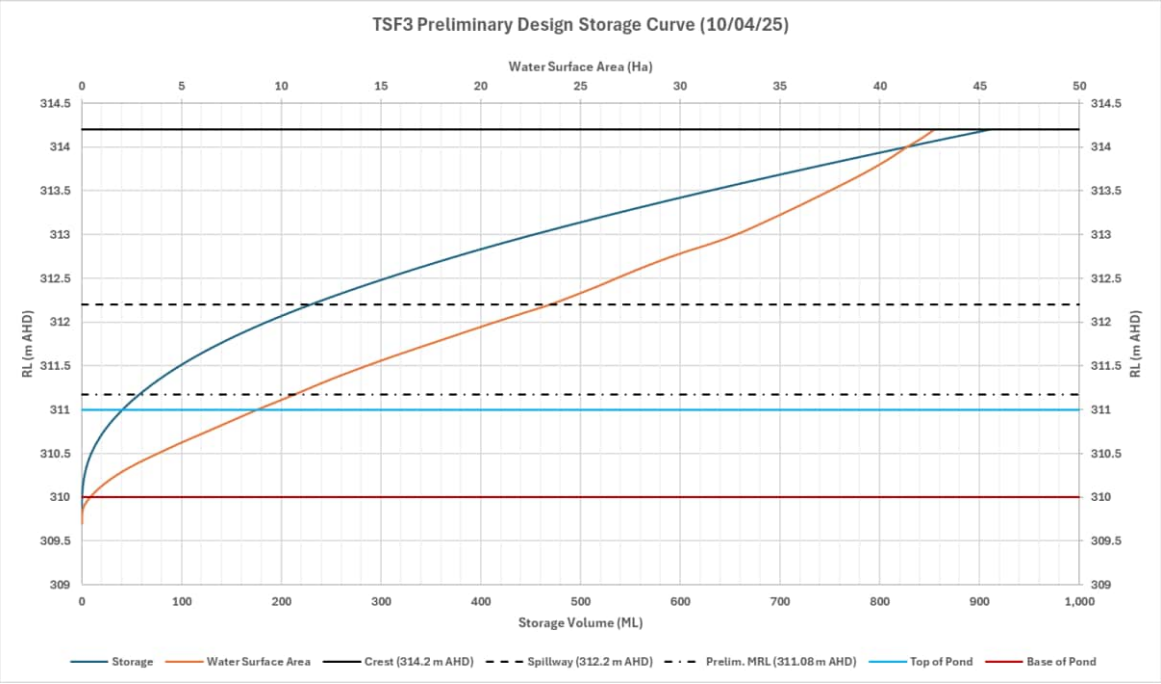


FIGURE 8.3: TSF3 – STAGE STORAGE

8.7 Deposition Staging

The approximate rate of tailings rise against the embankments is summarised in Table 8.3 and shown in Figure **8.4** and Figure 8.5 for the northern and southern embankments respectively. Time periods shown are based on the no High Density Thickener option, with no allowance for diversion of tailings to paste.

TABLE 8.3: TAILINGS STORAGE STAGING

Time (years)	Tailings Storage Volume (Mm^3)	Approximate Tailings Surface (EWRD)	Approximate Tailings Surface (UEDD)
2yr	1.9	RL 293.7 (44.7 m)[1]	RL 296.5 (11.6 m)[2]
4yr	3.8	RL 302.6 (52.9 m)	RL 305.4 (20.5 m)

[1] Denotes approximate height of tailings surface above base of EWRD embankment.

[2] Denotes approximate height of tailings surface above base of UEDD embankment.

6 yr	5.7	RL 308.2 (58.5 m)	RL 311.0 (26.1 m)
6.6 yr	6.3	RL 310.3 (61.3 m)	RL 313.0 (28.1 m)

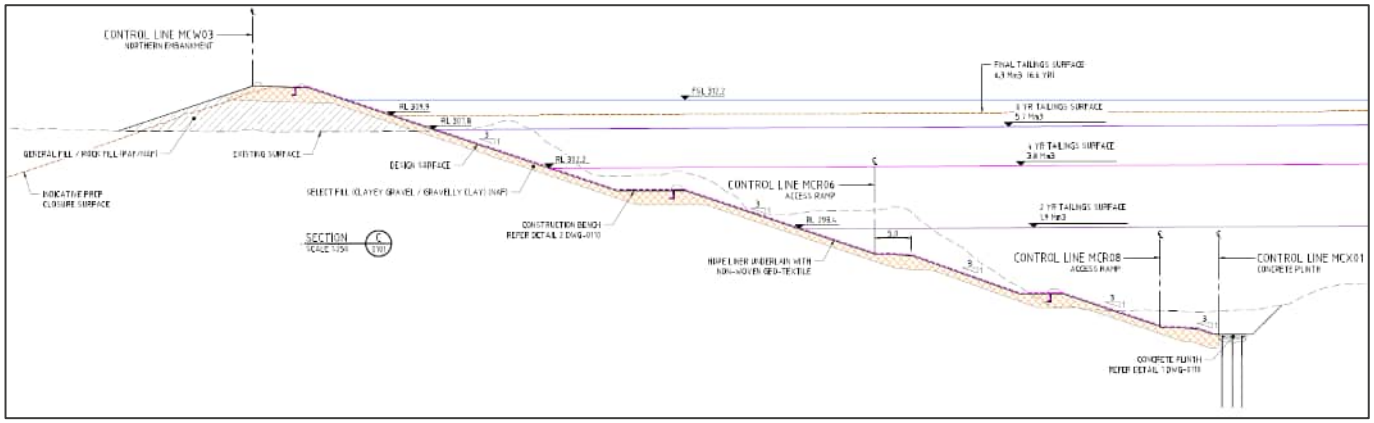


FIGURE 8.4: TAILINGS DEPOSITION – RATE OF RISE (NORTHERN EMBANKMENT)

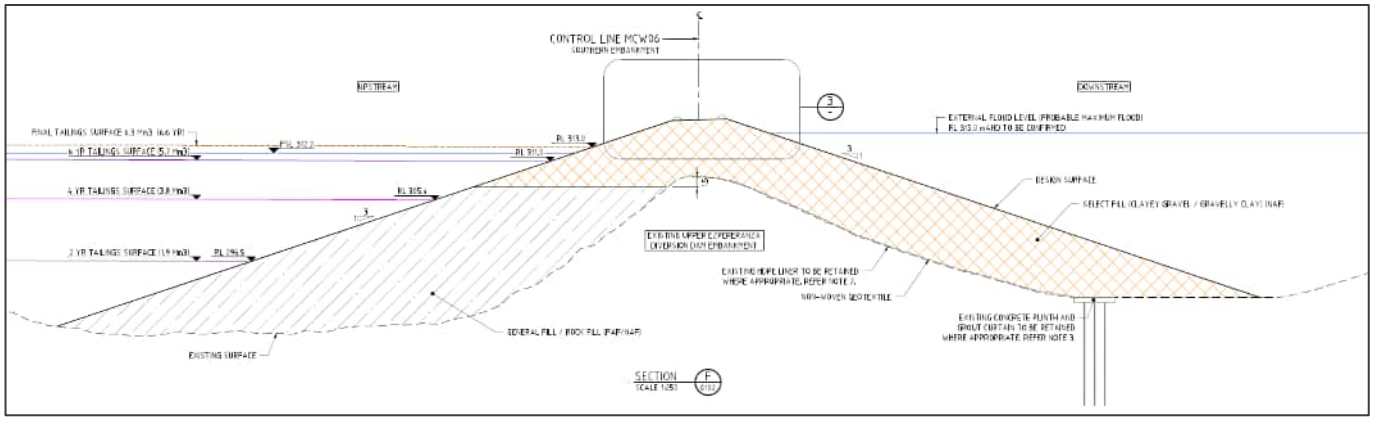


FIGURE 8.5: TAILINGS DEPOSITION – RATE OF RISE (SOUTHERN EMBANKMENT)

8.8 Northern Embankment (EWRD) Design and Construction

The typical design for the northern embankment is shown in Figure **8.4**. The provisional construction sequence is as follows:

1. Undertake bulk earthworks using NAF/PAF General Fill / Rock Fill to form the northern embankment and reprofile the upstream batter. Areas of the northern embankment which may drain to a clean catchment (e.g. Upper Snakeskin Valley) to be constructed from NAF General Fill / Rock Fill.
2. Construct geomembrane liner cushion layer using Select Fill (Clayey GRAVEL / Gravelly CLAY). The preliminary design allows for a typically 3m wide (1m thick) Select Fill layer, thickened to 2m thick at the batter benches to facilitate anchoring of the geomembrane liner. Where required the Select Fill layer may be separated into two material types to transition from the existing rock fill to the cushion layer to prevent loss of fines in the cushion layer during operation.
3. Construct concrete plinth and grout curtain and install geomembrane liner.

8.9 Southern Embankment (UEDD) Design and Construction

The typical design for the southern embankment is shown in Figure 8.5. The provisional construction sequence is as follows:

1. Verify adequacy of existing grout curtain (e.g. through conformation grouting) and existing HDPE geomembrane liner (e.g through inspection and testing) and repair / replace / remediate where required. Extend grout curtain and concrete plinth to accommodate centreline raise.

2. Undertake centreline raise using NAF/PAF General Fill / Rock Fill (internal batter) and Select Fill (Clayey Gravel / Gravelly Clay) (crest and external batter). Tie low permeability Select Fill into concrete plinth / grout curtain extension. Existing HDPE liner to be protected by non-woven geotextile or similar prior to Select Fill placement.

8.10 Spillway Design

The provisional spillway design cross section is shown in Figure 8.6. The intent is the spillway would be cut through insitu materials (competent rock), with the excavated rock used along the toe of the embankment to reduce the likelihood of erosion during spillway overflow events. A nominal concrete sill has been incorporated into the design as a hard spillway level control. CCM is exploring alternative spillway alignments and configurations due to the significant volumes of rock excavation expected based on the preliminary design. The spillway design is therefore considered provisional and subject to change during the detailed design phase. The spillway has been designed to convey the most critical of either the 1:100,000 AEP Design Event plus 1:10 wind wave run up or the Probable Maximum Flood (PMF) event as per the CCA outcomes (Section 9.1).

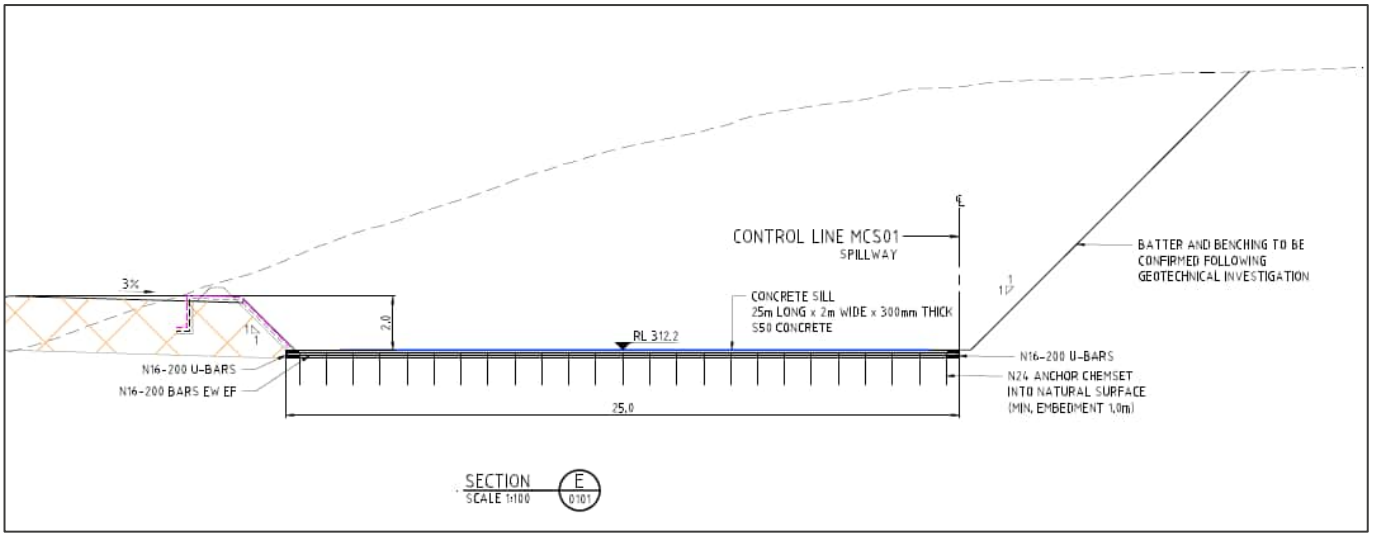


FIGURE 8.6: PRELIMINARY SPILLWAY DESIGN

8.11 Grout Curtain Design

A concrete plinth and grout curtain has been incorporated into the preliminary design to tie the upstream geomembrane liner of the northern embankment into the foundation and abutments (Refer Figure 8.7). The grout curtain design shown in the preliminary drawings is provisional. The depth of the grout curtain has been approximated at between 5 m and 25 m deep based on previous work undertaken as part of the UEDD embankment seepage remediation works. The extents, arrangement, and depth of grout curtain for the northern embankment will be confirmed during detailed design. For the purposes of preparing an initial cost estimate, an average 10 m grout curtain depth has been assumed. The preliminary grouting arrangement has been nominally based on 3 rows of grout holes (primary / secondary / tertiary) spaced 1.5 m apart laterally and 3 m apart along the alignment of the grout curtain.

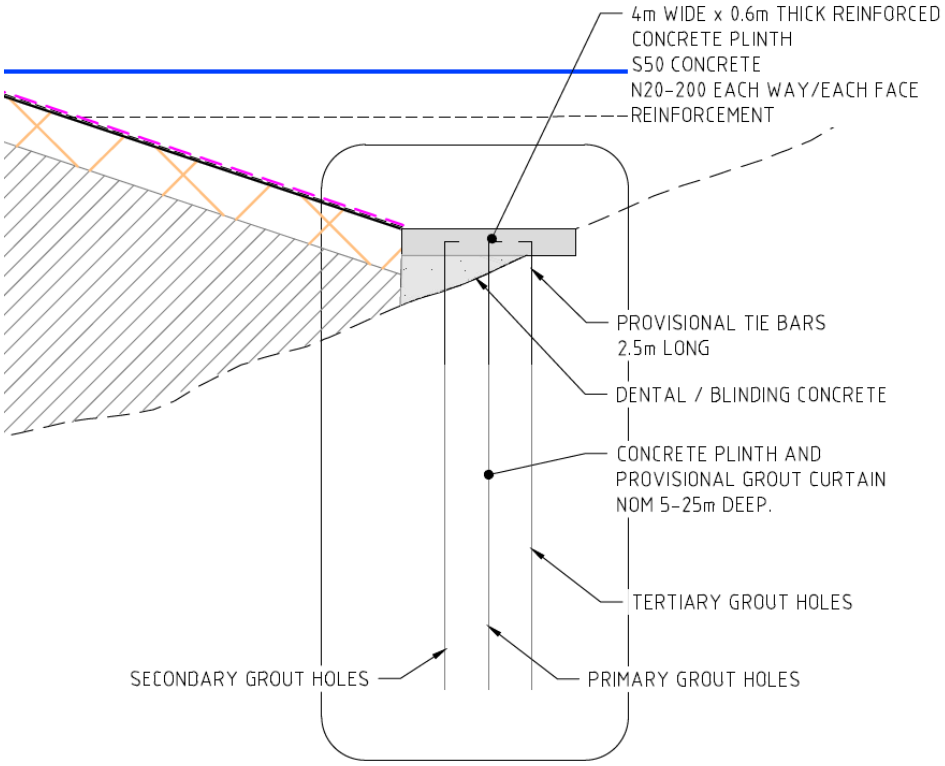


FIGURE 8.7: GROUT CURTAIN TYPICAL DETAIL

9. CONSEQUENCE CATEGORY ASSESSMENT

9.1 Consequence Category Assessment

Consequence category assessments (CCAs) have been undertaken to inform the preliminary design of TSF3 including a Queensland Department of Environment, Tourism, Science and Innovation (DETSI), Queensland CCA and an Australian National Committee on Large Dams (ANCOLD) CCA. The DETSI CCA was undertaken in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)*, Version 5.03. The ANCOLD CCA was undertaken in accordance with the *Guidelines on the Consequence Categories for Dams* (ANCOLD, 2012).

Details of the certified CCAs are provided in **Appendix E** and are summarised in Table 9.1 and Table 9.2**.**

TABLE 9.1: TSF3 DETSI CONSEQUENCE CATEGORY ASSESSMENT

Failure Scenario	Consequence Category
Failure to Contain – Seepage	Significant
Failure to Contain – Overtopping	Significant
Dam Break	High
Overall	**High**

TABLE 9.2: TSF3 ANCOLD PRELIMINARY CONSEQUENCE CATEGORY ASSESSMENT

Failure Scenario	PAR	PLL	Severity of Damage and Loss	Consequence Category
Sunny Day Failure / Flood Day Failure	<20	<20	Major	High B (based on PAR) High A (based on PLL)

9.2 Design Outcomes from CCA

Based on the CCAs the following design outcomes are adopted.

- Spillway capacity design criteria are governed by the ANCOLD CCA. Adopted design criteria to be the most conservative of either the 1:100,000 AEP design event plus 1:10 AEP wind wave run-up or Probable Maximum Flood (PMF). External flood ingress protection to be designed to the same performance standard as the spillway.
- Containment performance is governed by the DETSI CCA. The required containment performance is consistent with the existing integrated site water management plan (Engeny, 2024) containment performance of 5% AEP. The DSA will be shared across the *integrated containment system* as determined during detailed design and detailed water balance modelling. The ESS will be contained on TSF3 (temporarily) prior to being dewatered to other site water storages.
- Seepage control measures are governed by the DETSI CCA. Based on the outcomes of the CCA, containment and detection measures are required. A number of containment and detection measures have been incorporated into the design, in particular the inclusion of an upstream geomembrane liner and grout curtain for the northern embankment.
- Seismic design criteria are governed by the ANCOLD CCA.
- Instrumentation and monitoring requirements are governed by the ANCOLD CCA.

10. MANAGEMENT STRATEGIES

10.1 Life of Mine Tailings Strategy

The CCM Life of Mine Tailings Strategy is dynamic and dependent on operational requirements, site water inventory management, and approvals timeframes. The 2025 Tailings Management Plan (CCM, 2025) details the current proposed tailings strategy, summarised as follows:

- A Life of Mine (LoM) tailings strategy has been provided up to and including 2051 which covers published reserves and inferred mineralization up to 2043 as well as resource opportunities beyond this to 2051. The current strategy is for tailings to be deposited in TSF3, located immediately south of the existing EWRD and north of the existing UEDD which will provide ~6.5 years of tailings storage capacity. Preliminary design works and approval for this option are currently ongoing.
- Beyond TSF3, Magazine Creek TSF, located approximately 3 km southeast of the CCM Process Plant, has been identified as the next tailings storage facility with a downstream staged embankment raise ultimately providing ~11 years of storage. This option is currently at concept design stage. Esperanza Pit (E Pit) TSF will provide the remaining tailings storage for the mine life (~6 years) but is contingent on dewatering this area and relocation of infrastructure.

10.2 Water Management Strategy

For the purposes of informing the TSF3 preliminary design the following Water Management Strategy has been adopted (Refer to the SWIA included in **Appendix I** for details):

- During TSF3 operation, under normal operating conditions, the decant pond will be maintained in a minimum condition (nominal 1m deep maximum normal decant operating water depth) with water pumped to either EPit, MCD, Pond 3, or the proposed new Water Treatment Plant (WTP) with the decant water destination dependent of the water quality and site water storage inventories.
- DSA containment requirements shared across the integrated containment system (EPit, MCD, ETSF and TSF 3) to achieve 5% site containment performance as per the EA.
- TSF3 ESS (1:10 72 hr rain event) to be temporarily contained within TSF3, prior to being dewatered to other site water storages. Decant return pump and pipelines sized to enable dewatering of the ESS volume within 10 days.
- Spillway overflows to be directed towards EPit.
- UEDD embankment levels to provide external flood ingress from southern UEV diversion up to the same design event as the TSF3 spillway.

11. CULTURAL HERITAGE

The proposed footprint and borrow areas for TSF3 are located within three mining leases - ML90180, ML90181 and ML90812.

Cultural Heritage Surveys of these areas were undertaken in June 2016 by Traditional Owner Elders appointed Kalkadoon Native Title Aboriginal Corporation as the registered native title body corporate (PBC). The surveys were conducted as a precursor to a Native Title agreement between Capricorn Copper Pty Ltd (CCPL) and Kalkadoon PBC for three new mining leases - ML90180, ML90181 and ML90812 and was signed on 30 May 2017. The Kalkadoon elders who surveyed the mining leases found a water hole and grinding stone which were recorded on 10 June 2016 (Refer Figure 11.1). The surveys and clearances were undertaken in accordance with arrangements set out in the 2017 Native Title Agreement between CCPL and Kalkadoon PBC. The two locations recorded are outside the proposed TSF3 footprint.



FIGURE 11.1: CULTURAL HERITAGE SURVEY

12. ENVIRONMENT

12.1 Matters of State Environmental Significance

Mapping of Matters of State Environmental Significance (MSES) in the vicinity of TSF3 and CCM are provided in the SWIA included in **Appendix I**.

12.2 Ecological Survey

A high-level ecological survey undertaken by CCM in November 2023 within the proposed TSF3 footprint identified 1 threatened species plant (Ipomoea antonschmidii). The location of the plant is shown in Figure 12.1.

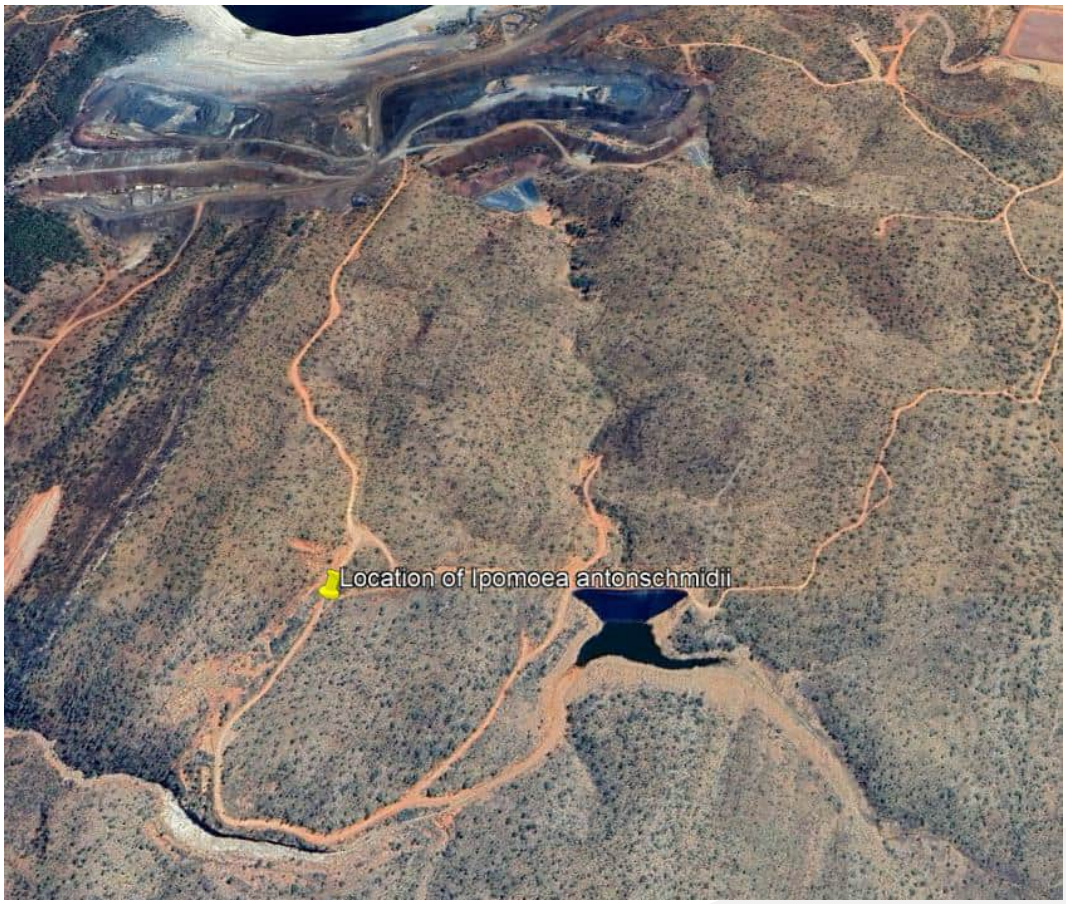


FIGURE 12.1: ECOLOGICAL SURVEY

13. ENGINEERING ASSESSMENTS

13.1 Surface Water Assessments

To support the preliminary TSF3 design, hydrological and hydraulic assessments were undertaken including:

- Estimation of peak flood levels up to the Probable Maximum Flood (PMF) for the clean southern UEV catchment, to determine the minimum embankment height for the southern embankment of TSF3 (UEDD).
- Preliminary assessment of expected velocities against the UEDD to inform requirements for erosion protection.
- Assessment of spillway design flows for the 1:100,000 AEP design flood event plus 1:10 AEP wind wave run-up allowance and the PMF to support the preliminary design of the emergency spillway.

Details of the surface water assessments are provided in the document 'QC1022_018-MEM-002-1-TSF3 Hydraulic Modelling Assessment (Engeny, 2025) included in **Appendix F**.

Based on the assessments:

- The spillway will be capable of conveying the 1:100,000 AEP design flood event plus an allowance for 1:10 AEP wind wave run up and the PMF design flood event.
- Velocities against the UEDD southern batter are low. Specific erosion protection is not expected to be required and will be confirmed during detailed design.
- The southern embankment crest level is sufficient to provide external flood ingress protection up to the PMF design flood event including a 0.5 m freeboard allowance.

13.2 Water Balance Assessments

To support the preliminary TSF3 design, a preliminary water balance assessment was undertaken to estimate the TSF3 storage required for wet season containment. Details of the assessments are provided in the document QC1022_018-MEM-003-2-TSF3 Preliminary DSA Assessment (Engeny 2025) included in **Appendix G**.

Based on the assessment:

- The DSA (5% site wide containment) is less that the ESS, therefore the ESS volume is taken to be the DSA volume as the DSA cannot be less than the ESS. The ESS for TSF3 is 171.4 ML (equivalent MRL RL 311.18 mAHD). The MRL requirement of the manual (DESI, 2016) to also consider a wave allowance for the determination of the ESS/MRL has not been undertaken on the basis that TSF3 overflows report to EPit, and not directly offsite. As such overall site containment performance is volumetrically controlled. A similar approach was adopted for the determination of the EPit ESS/MRL.
- The final tailings deposition surface has been based to provide spare water storage capacity for a nominal 1 m maximum operating decant depth and the ESS (171.4ML).
- The water balance assessment was based on the final TSF3 deposition surface. During initial operation spare water storage capacity will be available within TSF3 resulting in improved containment performance.

13.3 Seepage Assessments

A seepage assessment for TSF3 was undertaken using a 2D numerical seepage model (SEEP/W). The purpose of the model was to provide an indication of potential seepage rates from TSF3 to EPit to assess the impacts from TSF3, and the effectiveness of proposed seepage control measures (upstream liner and concrete plinth / grout curtain). The model was also used as the basis for the Limited Groundwater Impact Assessment for TSF3 included in **Appendix J**. Based on current understanding the major seepage flow direction from TSF3 is expected to be towards EPit, which under normal operating conditions acts as a groundwater sink for the CCM site. The seepage assessment is detailed in QC1022_018-MEM-004-1-TSF3 Groundwater Seepage Modelling (Engeny, 2024) included in **Appendix H**.

Based on the assessment:

- The expected baseline (no TSF3) seepage rate from the UEV to EPit is approximately 0.01 m^3/day/m. Based on the northern embankment crest length of 780m this is roughly equivalent to 8 m^3/day.

- The expected seepage rate from TSF3 at final deposition to EPit with no seepage controls is approximately 0.30 m^3/day/m (234 m^3/day)
- The expected seepage rate from TSF3 at final deposition to EPit with seepage controls is approximately 0.05 m^3/day/m (39 m^3/day). This represents an 84% reduction in seepage flows compared to the no seepage controls case.

The 2D numerical seepage model (SEEP/W) is intended to be used for initial assessment. CCM is progressing the development of a site wide transient 3D groundwater flow model to further inform the detailed design and assessment of the proposed TSF3. Where the outcomes of the transient groundwater flow model materially vary from the preliminary 2D numerical seepage model, the GWIA and TSF3 seepage controls will be revised. As part of the update, any recommendations from the SEEP/W report shall be reviewed / revised to reflect the current understanding of CCM groundwater from the site wide transient 3D groundwater flow model.

14. IMPACT ASSESSMENTS

14.1 Limited Surface Water Impact Assessment (SWIA)

As part of the preliminary design process and to support the EA amendment approvals, a limited Surface Water Impact Assessment (SWIA) was undertaken for TSF3. The details of the Limited SWIA are contained in the document QC1022_018-REP-003-2-Limited SWIA (Engeny, 2025) included in **Appendix I**. As additional data is gathered throughout the detailed design process, the SWIA, and site Water Management Plan (WMP) will be updated as required.

Based on the SWIA, the following observations are made.

Surface Water Flow:

- TSF3 is not expected to result in any material change to the existing flow regime in Gunpowder Creek. The 79Ha of the TSF3 footprint removed from the 247,700 Ha Gunpowder Creek catchment at CCM represents 0.3% of the total catchment.
- Water balance modelling for TSF3 indicates that while overflows from TSF3 are expected, sufficient residual capacity remains in the integrated containment system (specifically EPit) such that overflows to Gunpowder Creek are considered unlikely.

Surface Water Quality:

- TSF3 is not expected to result in any increase in seepage flow to Gunpowder Creek and is considered to have negligible impact on flow.
- REMP data indicates impacts to receiving environment and macroinvertebrate health are not increasing.
- CCPL is not seeking to increase the requirement for discharge of MAW to Gunpowder Creek and releases would continue to be in accordance with existing EA conditions.

Overall, the risk of TSF3 to surface water is expected to be **Low**.

14.2 Limited Groundwater Impact Assessment (GWIA)

As part of the preliminary design process and to support the EA amendment approvals, a limited Groundwater Impact Assessment (GWIA) was undertaken for TSF3. The details of the Limited GWIA are contained in the document QC1022_018-REP-004-1-Limited GWIA (Engeny, 2025) included in **Appendix J**. As additional data is gathered, and more detailed analyses undertaken throughout the detailed design process (e.g. update to the site wide numerical transient 3D groundwater model), the GWIA will be updated as required.

Based on the GWIA, the following observations are made.

Surface Water:

- TSF3 is not expected to result in any change to the existing flow regime in Gunpowder Creek, and no overflow events from the integrated containment system up to the P99 event.
- TSF3 is not expected to result in any increase in seepage flow to Gunpowder Creek and is considered to have negligible impact on flow.
- Proposed seepage controls (Grout curtain and liner) are expected to manage any major seepage from TSF3. EPit will be the major receiving environment for any seepage resulting from TSF3.
- REMP data indicates impacts to receiving environment and macroinvertebrate health are not increasing.
- Confirmation of the permeability of the base of the TSF is recommended.

Groundwater Dependent Ecosystems:

- Terrestrial and aquatic GDEs are mapped within the mining lease areas and project footprint. Low and moderate potential aquatic GDEs are mapped within Gunpowder Creek adjacent to the site. Moderate potential terrestrial GDEs on the site relate to vegetation relying on groundwater based on national assessment. Discharging of seepage fluxes to the environment will be relatively minimal and if required, will be managed in accordance with the requirements of the EA.
- The *TSF3 Flora and Fauna Assessment* report by KG Environmental (2025) provides assessment of the ecology and RE mapping for TSF3. The TSF3 UEV has limited potential for GDEs primarily due to thin colluvial soils, low-permeability Whitworth Quartzite foundations and arid conditions reducing groundwater dependency. RE mapping identifies RE 1.3.7b (Northern Swamp Box gully) along ephemeral drainage lines, suggesting possible localized GDEs, but these are highly ephemeral with no permanent waterholes and already impacted by the UEDD. Dominant REs (1.7.7a and 1.11.2a) feature species like Corymbia capricornia and Eucalyptus leucophloia have root depths (3–4.5 m) indicating adaptation to surface moisture rather than deep groundwater.

Groundwater:

- Potential changes to the groundwater flow direction have been identified in the seepage modelling.
- TSF3 is predicted to result in a minor increase in seepage to EPit.
- TSF3 is expected to result in a minor increase in seepage flow and is considered to have minimal impact on existing flow and salt loads.
- TSF3 is predicted to result in a minor change in groundwater flow to the west of TSF3.
- A Groundwater Monitoring and Management Plan (GMMP) has been developed for the TSF3 project, to inform the ongoing review and improvement of the groundwater monitoring program and management measures as they design matures, and informed by the outcomes of the numerical groundwater flow model. The GMMP is an attachment to the GWIA (**Appendix J**:).

Overall, the risk of TSF3 to groundwater is expected to be **Low** to **Medium**.

15. MONITORING AND INSTRUMENTATION

15.1 Overview

The requirements from recommended monitoring and instrumentation have been assessed against the ANCOLD Guidelines on Dam Safety Management (ANCOLD, 2003) based on the outcomes of the preliminary ANCOLD CCA, and with due consideration of the dam structure type. The adopted monitoring instrumentation for preliminary design includes:

- Surface Movement.
- Pore Pressure.
- Seepage Monitoring.

Expected locations and details of monitoring instrumentation are included in the Preliminary Design Drawings in **Appendix D**.

15.2 Surface Movement

Settlement monitoring stations are expected to consist of a base station and select settlement monitoring stations on the embankment and intermediate benches (where present) of the northern and southern embankments. The design of the settlement monitoring stations are expected to consist of a concrete plith and survey prism located at key points of interest and away from areas of potential damage or covering with tailings / water.

15.3 Pore Pressure

Pore pressure measurement is expected to be undertaken in the embankment fill and foundation for the UEDD, and in the foundation for the EWRD embankment. Due to the expected high permeability of the existing WRD rock fill, excess pore pressures are unlikely to develop within the rock fill. It is expected that the piezometers will be vibrating wire type at the request of CCM, to enable integration with the site monitoring system.

15.4 Seepage Monitoring

Seepage monitoring is expected to consist of the existing groundwater monitoring bore network (Refer Figure 15.1), and embankment piezometers. (Refer Figure 15.2 and Figure 15.3). Provisional allowance has been made for the incorporation of a V-notch seepage monitoring weir downstream of the EWRD should a preferential seepage path develop on the former UEV valley line.

The GMMP defines the process for the review and improvement of the adequacy of the groundwater monitoring program, inclusive of the refinement of the groundwater model.

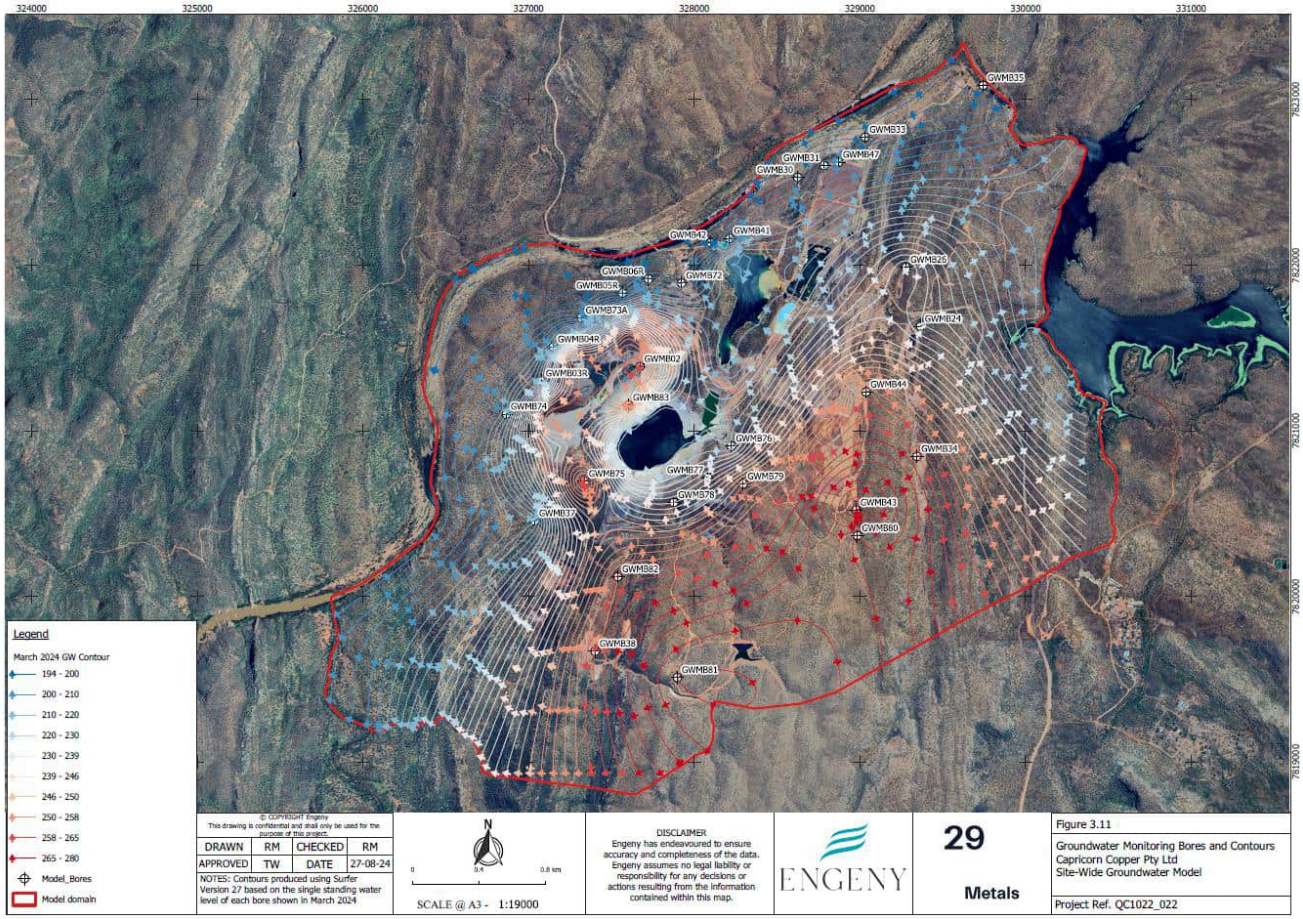


FIGURE 15.1: EXISTING GROUNDWATER MONITORING BORES

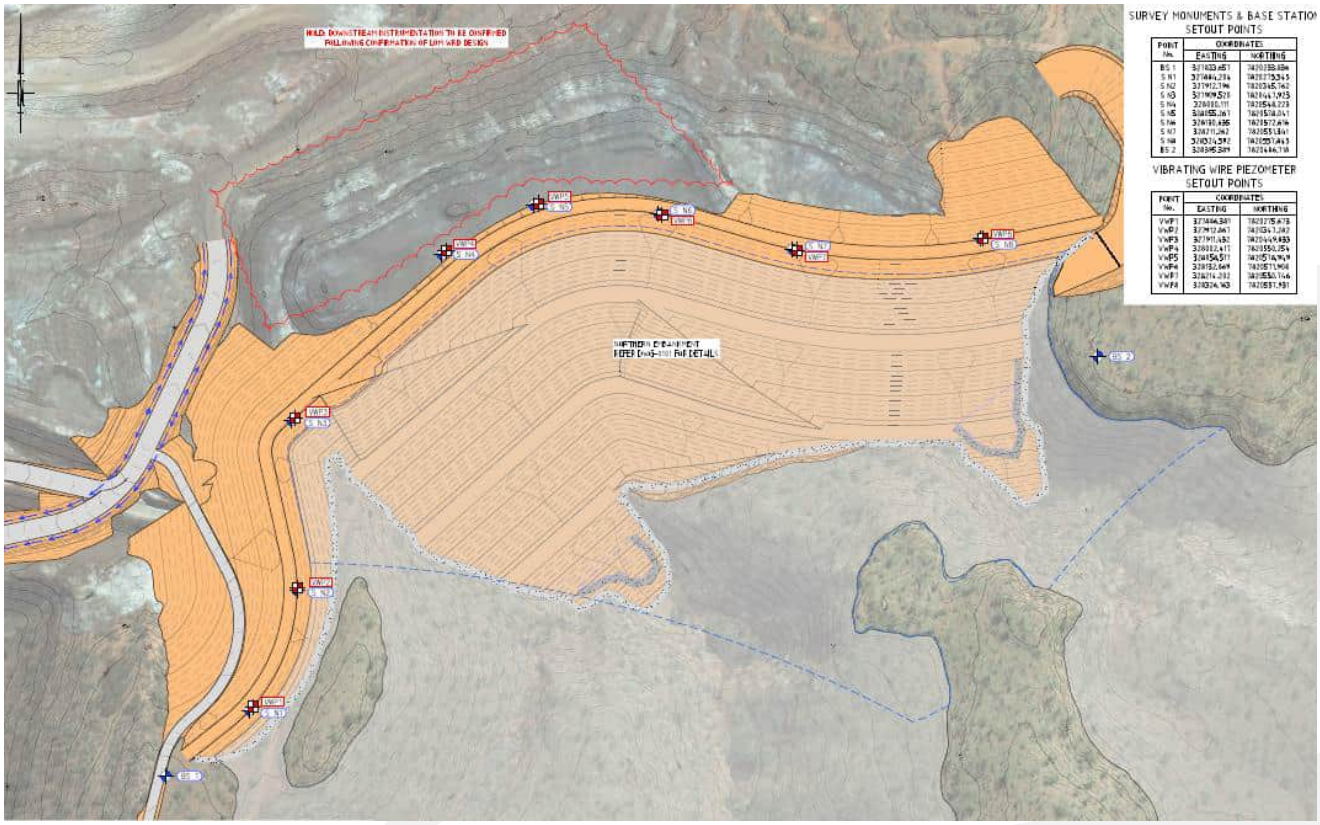


FIGURE 15.2: PROPOSED INSTRUMENTATION (EWRD)



FIGURE 15.3: PROPOSED INSTRUMENTATION (UEDD)

16. BORROW AREAS

16.1 Overview

The expected quantities of materials required to construct TFS3 have been informed by preliminary level civil modelling. Quantities of borrow materials required are included in the Bill of Quantities / Cost Estimate included in **Appendix K.** The required borrow materials are expected to consist of NAF / PAF General Fill / Rock Fill and Select Fill (Gravelly CLAY / Clayey GRAVEL). The NAF / PAF General Fill / Rock Fill will be used to form the bulk of the EWRD reprofiling and UEDD internal batter reprofiling, with the Select Fill (Clayey GRAVEL / Gravelly Clay) used as a cushion layer for the northern embankment geomembrane liner, and to construct the external batter of the UEDD raise.

16.2 Previous Investigations and Assessments

Some previous geotechnical / borrow investigations have been undertaken including:

- Rehabilitation of Old TSF and HELP#2 Geotechnical Investigation Report (GHD, 2019).
- Field Geological Mapping Report (Engeny, 2025).
- Geotechnical Investigation Factual Report (Engeny, 2024)

16.3 General Fill / Rock Fill – NAF / PAF

General Fill / Rock Fill – NAF/PAF is expected to be selectively sourced from either the Esperanza Waste Rock Dump (EWRD) or the North Waste Rock Dump (NWRD). The intention is that the material will be initially screened for sulphur content (with subsequent acid base accounting testing) to confirm the material is NAF. Anecdotal information suggests that NAF is unlikely to be sourced in significant quantities from the EWRD but may be sourced from the NWRD.

16.4 Select Fill (Gravelly CLAY / Clayey GRAVEL)

Available investigation and assessments indicate that good quality CLAY Fill is not economically available in significant quantities within the current CCM ML's, however Gravelly CLAY / Clayey GRAVEL may be potentially sourced from the following locations:

- Snake Skin Valley – located to the west of TSF3.
- Airfield Borrow – located near the airfield on the main access road to CCM. Previous assessment (GHD, 2019) of the airfield borrow indicates up to 210,000 m^3 of clayey material may be available with the option for expansion. It is not known how much of the airfield source has previously been borrowed for site projects.
- All borrow sources may require working to breakdown larger rock particles to achieve specification requirements.

16.5 Topsoil

As part of the preliminary design phase, a topsoils and land capability assessment for the TSF3 footprint was undertaken and included a desktop review of available information, a field inspection and investigation, and laboratory testing. The assessment is detailed in QC1022_018-MEM-005-0 'Topsoil Sampling Program Report' (Engeny, 2024).

Based on the outcomes of the assessment:

- From a traditional soil quality point of view, the topsoil resource within the TSF3 footprint is low. The attributes of the soil would render the area as Class VII Land that is not suitable for cultivation but on which pastoral use is possible only with careful management. Indications are that the carrying capacity of the entire CCM site in terms of stocking would be very low, and almost negligible from TSF3 alone.
- The relief from which the topsoil can be safely salvaged from within the footprint limits the recoverable volumes. The lowest risk PMLU will most likely be the restoration of a native bushland from which cattle should be excluded, at least for the foreseeable future.
- Based on quality, practicality, and safety, it is difficult to justify the recovery of the topsoils from within the TSF3 disturbance area.

17. DISTURBANCE EXTENT

17.1 Overview

Until the borrow locations for TSF3 are determined, the disturbance extent of TSF3 is not known with certainty. To provide a preliminary indication of disturbance extents the following has been assumed:

- General Fill / Rock Fill (NAF / PAF) would be sourced from existing disturbed areas (NWRD / EWRD).
- Select Fill (Clayey GRAVEL / Gravelly CLAY) would be sourced from the Upper Snake Skin Valley to the limit of the current ML boundaries.
- Topsoil would be opportunistically stripped and placed outside of surface water flow paths (i.e. ridges surrounding TSF3).

Based on the above assumptions the expected disturbance extents are summarised in Table 17.1 and shown in Figure 17.1.

TABLE 17.1: DISTURBANCE EXTENT SUMMARY

Area	Unit	Value
TSF3 (Pink Polygon)	ha	43
Select Fill Borrow (Green Polygon)	ha	10[3]
Topsoil Stockpiles (Blue Polygon)	ha	1
Total	**ha**	**54**

[3] The geotechnical investigation (Engeny, 2024) of the proposed Snake Skin Valley borrow, indicates sufficient volumes of Select Fill for TSF3 are unlikely to be sourced solely from the proposed Snake Skin Valley borrow. As such, additional disturbance for additional Select Fill borrows (on / off ML) is expected.

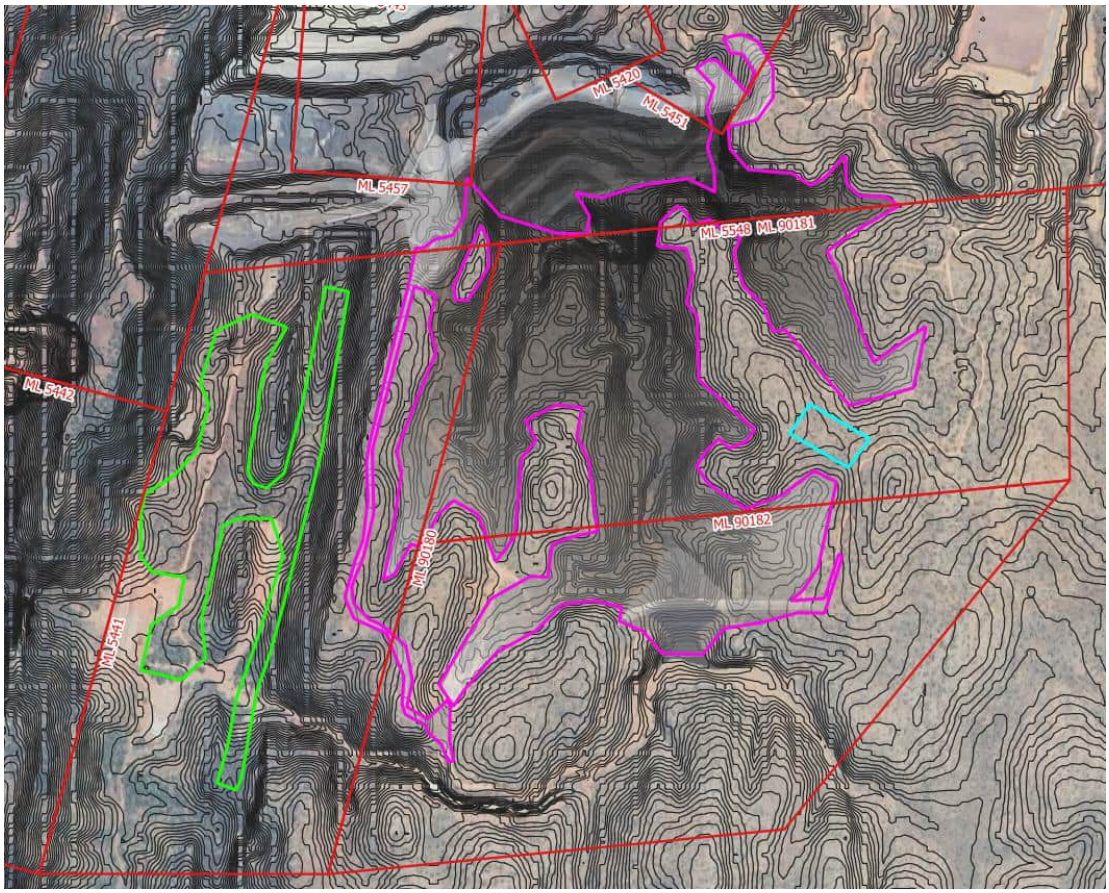


FIGURE 17.1: TSF3 DISTURBANCE EXTENT

18. REHABILITATION AND CLOSURE STRATEGY

18.1 Overview

The TSF3 Rehabilitation and Closure Plan (QC1022_018-REP-006-0, Engeny, 2025, **Appendix M:**) (RCP) outlines a comprehensive, risk-based approach for the closure of TSF3. The plan integrates closure into the facility's lifecycle (6.5–7.5 years operational life), focusing on achieving a stable, self-sustaining native bushland post-mining land use (PMLU) while minimizing long-term liabilities and environmental harm.

The purpose of the RCP is to establish a structured, risk-based framework for the safe, environmentally responsible, and sustainable closure and rehabilitation of the facility at the end of its operational life. The plan integrates closure considerations into the whole lifecycle of TSF 3, ensuring compliance with regulatory requirements, minimizing long-term liabilities, and facilitating post-closure land uses that align with stakeholder expectations and environmental values. By addressing potential physical, chemical, and ecological risks, the plan aims to transform the site into a stable, self-sustaining landscape that requires minimal ongoing maintenance while protecting public health and the environment.

Key objectives of the plan include:

- Achieving long-term geotechnical and geochemical stability of the TSF to prevent failures, erosion, or contaminant releases, including the implementation of engineered covers to limit water infiltration, oxygen diffusion, and acid generation.
- Redirecting surface water runoff and managing seepage to avoid accumulation on the facility, and minimize impacts on groundwater and surface water quality, ensuring no unacceptable off-site effects on receptors.
- Progressively rehabilitating disturbed areas during operations to reduce residual risks at closure, such as dust generation or habitat disruption, and to restore natural drainage patterns and vegetation consistent with surrounding landforms.
- Ensuring the site meets or exceeds environmental standards for air, soil, and water quality post-closure, with specific criteria for radiation levels (if applicable), pest control, and ecological recolonization.
- Conducting comprehensive post-closure monitoring and maintenance for a defined period (e.g., 20 years) to verify the achievement of closure criteria, identify any emerging issues, and demonstrate that the rehabilitated site poses acceptably low risks in perpetuity.
- Engaging stakeholders, including regulatory authorities, local communities, and Traditional Owners, throughout the planning and execution phases to incorporate diverse perspectives and support sustainable post-mining outcomes.

The RCP has been developed in consideration of the *Progressive Rehabilitation and Closure Plan Guideline* (ESR2019/4957, Version 3.01) (PRCP Guideline), with a schedule for closure of the TSF3 and determination of appropriate rehabilitation milestones included.

Closure activities commence post-deposition cessation (estimated 2032) and span 4–5 years, divided into five sequential steps:

- Decommissioning
- Landform Reshaping and Stabilization
- Cover System Installation
- Revegetation.
- Monitoring and maintenance.

A detailed summary of each phase is provided below.

The proposed final landform inclusive of the rehabilitated TSFs are shown below in Figure 18.1.

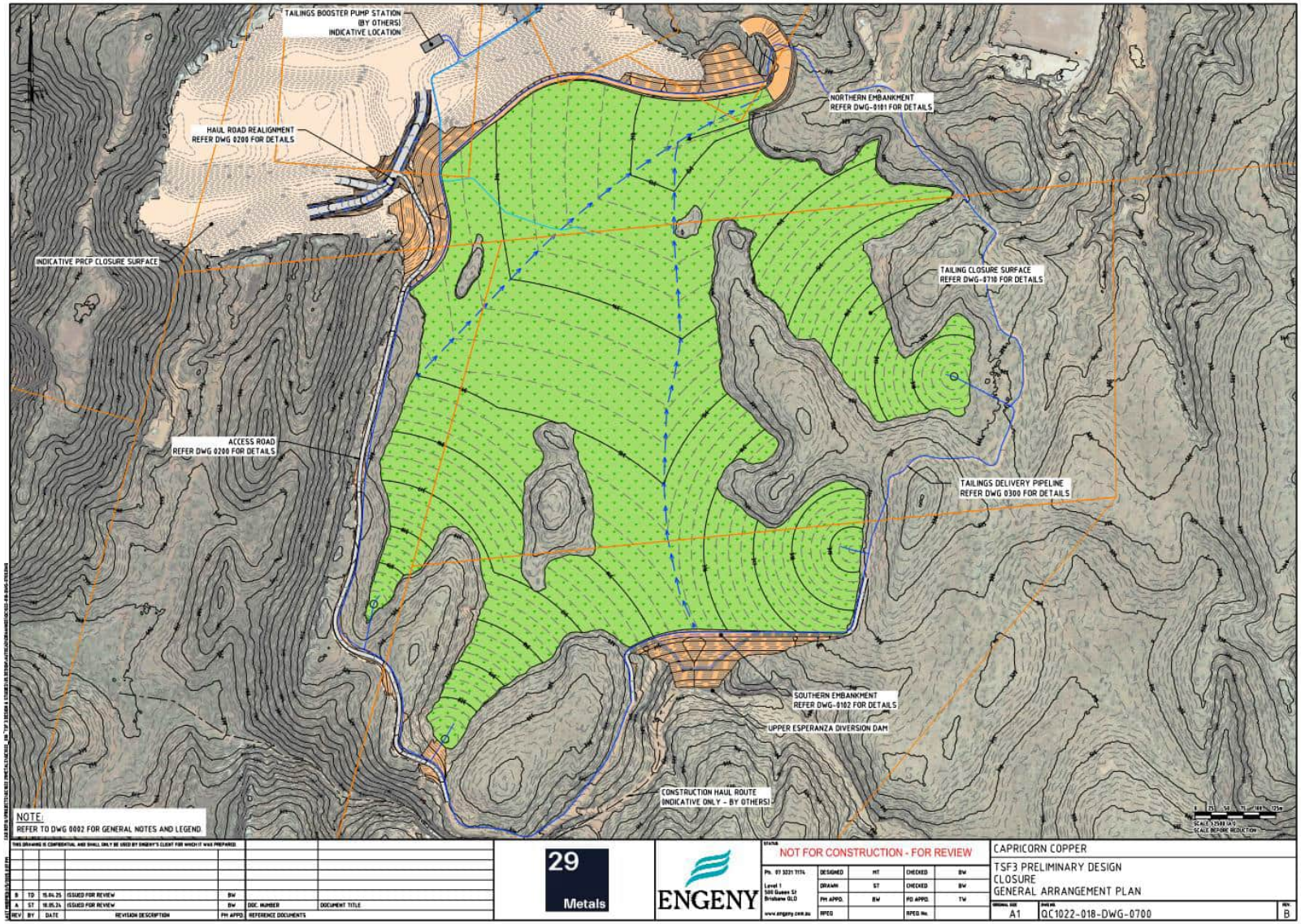


Figure 18.1: Final Landform Layout

18.2 Decommissioning

Decommissioning is the initial phase of TSF3 closure, transitioning the facility from operational to inactive status while ensuring immediate risks are mitigated and the site is prepared for subsequent rehabilitation steps. It addresses potential hazards identified in site assessments, such as ponding leading to seepage and erosion from exposed surfaces. Activities will be overseen by an Appropriately Qualified Person (AQP) and integrated with stakeholder consultations. This is expected to take 3–6 months post-deposition cessation allowing for tailings settlement and weather-dependent access.

The primary objectives are to cease all operational activities, safely remove or secure infrastructure, and implement interim controls to prevent environmental harm or safety risks during the transition to reshaping. This includes dewatering the decant pond, dismantling non-essential structures, and stabilizing exposed areas to avoid immediate issues like uncontrolled seepage, dust generation, or erosion. No active hazards (e.g., ponding >1 m depth, unstable embankments) must remain, with the site assessed as safe for heavy machinery access in later phases. Environmental protection focuses on containing any residual MAW within the integrated containment system and protecting EV's.

Decommissioning follows a sequential, risk-assessed process, starting with operational shutdown and ending with approval for the subsequent rehabilitation phase. All steps incorporate PRCP adaptive management, with routine inspections for compliance. The key activities in this phase include:

(1) **Cease Tailings Deposition**: Confirm cessation via topographic survey (integrate LiDAR for accuracy); monitor tailings beach consolidation. Allow natural settling for 1–2 months, maintaining decant pond at ≤1 m depth to minimize pore pressures and hydraulic gradient.

(2) **Dewater**: Pump supernatant to EPit/MCD using existing 200 L/s capacity pumps; route via pipelines to avoid spills. Treat if quality exceeds EA limits (Schedule C, Table 6; e.g., metals like Cu <0.005 mg/L). Monitor volumes and cease if ICS levels approach maximum operating level (MOL).

(3) **Remove Infrastructure**: Dismantle pipelines, pumps, decant systems, and access tracks using controlled demolition; salvage reusable components (e.g., pumps for site reuse). Excavate contaminated areas (if identified via testing) and backfill with NAF fill.

(4) **Install Temporary Controls**: Place erosion barriers along embankments and exposed beaches; apply interim seeding to stabilize surfaces (focus on pioneer species for rapid cover). Install monitoring instruments as required.

(5) **Inspection and Approval**: Conduct geotechnical survey (stability analysis per ANCOLD FoS >1.3 undrained); integrate GWIA baseline data (e.g., no active seepage pathways). Approval by SQP that the site is hazard-free and ready for reshaping, and that the tailings beach is trafficable.

18.3 Landform Reshaping and Stabilisation

Landform reshaping and stabilisation is a critical phase in the closure of TSF3, focusing on transforming the operational topography into a safe, stable, and erosion-resistant landform that integrates with the surrounding environment and supports subsequent installation of the engineered cover and revegetation. This phase builds on the decommissioning works, ensuring the facility meets long-term geotechnical criteria while addressing potential risks such as settlement, erosion, and seepage-induced instability. Activities will be supervised by an AQP and incorporate adaptive risk management per AS ISO 31000:2018, with input from stakeholders (e.g., Kalkadoon Native Title Aboriginal Corporation for landform compatibility with cultural values). The expected duration of this phase is 6–12 months, allowing for seasonal access and iterative stability verification.

The scope encompasses reshaping the TSF3 surface and embankments to achieve geotechnical stability, preventing subsidence, erosion, or failure modes that could compromise closure objectives. This includes reshaping embankments (where needed), shaping the tailings beach to achieve a gentle and uniform profile, and preparing a uniform base for the cover system, ensuring the landform aligns with the native bushland PMLU (e.g., gentle slopes for vegetation establishment). Informed by geotechnical the works address risks like seismic loading (FoS ≥1.0–1.2 post-seismic per BOD) and potential groundwater flow alterations.

Reshaping follows a systematic, sequenced approach, starting with surveys and ending with stability verification, to minimize risks and ensure integration with downstream phases (e.g., cover tie-ins). The key activities in this phase include:

(1) **Survey**: Conduct pre- and post-works 3D topographic mapping using LiDAR or drone surveys for precision (±10 cm accuracy); establish benchmarks for monitoring settlement.

(2) **Treat Highwalls and Voids**: Reduce highwall slopes to 1–3% for drainage; backfill voids/depressions with compacted NAF fill to prevent ponding or subsidence; scarify surfaces for bonding with covers.

(3) **Reshape Tailings Beach**: undertake reshaping of the tailings beach as required to ensure the surface is ready for installation of the cover system, and that slopes are in accordance with the final closure design. This may also include the establishment of a working layer as needed,

(4) **Compaction**: Place fill in layered lifts (300 mm max), compact to 95% standard Proctor density (AS 1289); moisture condition per optimal range (OMC ±2%).

18.4 Cover System Installation

18.4.1 Cover Design

For semi-arid or seasonally dry climates in Queensland, a store and release cover is appropriate for tailings facilities typically comprising a nominal 0.5 m thick reduced permeability layer (RPL) overlain by a loose 1.5 to 2 m thick rocky soil mulch growth medium, giving a total thickness for this relatively simple two-layer cover of 2 to 2.5 m (Williams, 2022). Attention should focus on climatic extremes, the waste materials, and the design, materials selection, and the construction of such store and release covers to ensure that they restrict the net percolation of rainfall where AMD may occur.

Store and release cover systems are also recommended by GARD Guide for long-term management in climate regions where evapotranspiration dominates, such as the semi-arid region where CGM is located as shown in Figure 18.2.

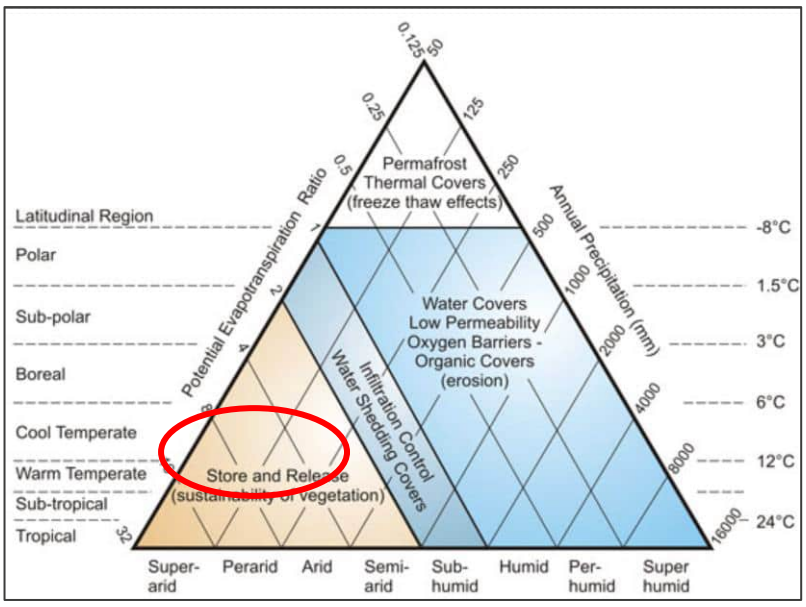


Figure 18.2: Cover Systems and Climate Types (INAP, 2011)

The cover systems adopted for waste structures at CCM follows the prescribed risk categories defined in the Queensland Government's Guideline: *Estimated rehabilitation cost under the Environmental Protection Act 1994 (ESR/2018/4425, V6.0)* (ERC Guideline). Under the ERC Guideline, and as part of Progressive Rehabilitation and Closure Planning (PRCP), the design objectives of covers installed over waste landforms is driven by the need to:

- Support vegetation consistent with the proposed Post-Mining Land Use (currently assumed to be Native Bushland).
- Promote infiltration and storage of rainfall within the upper cover layers during the wet season.
- Reduce rainfall infiltration and oxygen ingress into underlying waste.
- Prevent upward migration of contaminants.
- Support plant and equipment constructing the cover.

For the preliminary design of TSF3, an enhanced store and release cover system has been adopted. Due to the expected limited inventory of materials to undertake closure of TSF3, CCM propose to undertake cover trials to optimise the cover design where possible. This may include the incorporation of geomembranes where appropriate. As such the cover design presented herein is considered provisional.

The adopted cover layers for TSF3 are presented in Figure 18.3.

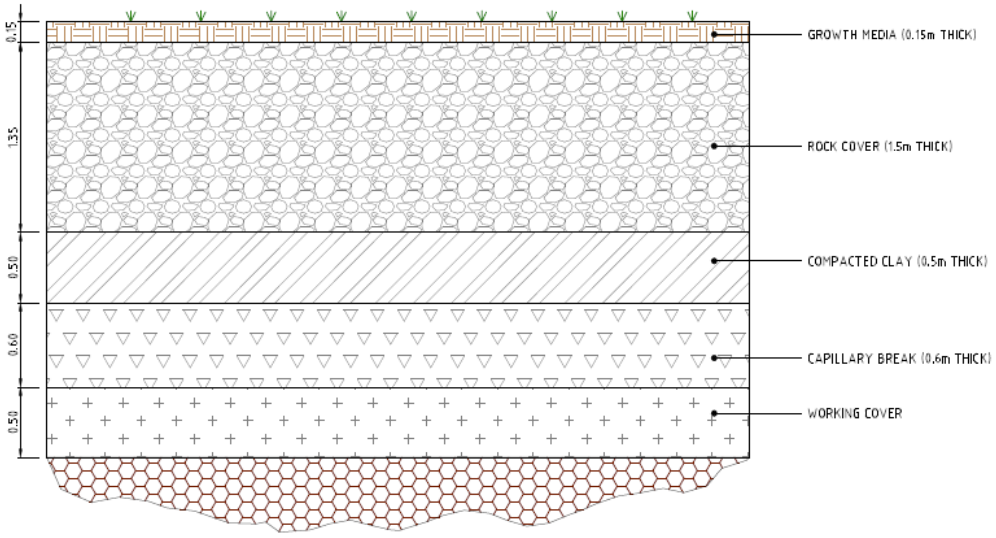


FIGURE 18.3: TSF3 COVER LAYERS

The TSF3 northern embankment comprises the EWRD. Following cessation of tailings deposition, the remaining exposed EWRD surface will also require installation of a cover system. All layers except the working cover are required over the EWRD.

18.4.2 Working Cover

A working cover is required to facilitate earthworks on soft to very soft tailings deposits, to maintain factors of safety against engulfment and undesired movement. Material for this layer will be comprised of NAF material won from existing stockpiles or borrow areas and will be pushed directly over the tailings beach surface with a low ground bearing pressure dozer (e.g. D6 / D7 Low Ground Pressure (LGP) of similar).

18.4.3 Capillary Break

The intent of a capillary break layer is twofold. It increases negative pore-water pressure within the cover, allowing the overlying compacted clay layer to maintain a higher water content, whilst preventing upward rise of underlying pore water within the tailings.

18.4.4 Compacted Clay

The compacted clay layer will act as a low hydraulic conductivity layer to limit ingress of rainfall and atmospheric oxygen. Clay materials should be compacted to achieve an in-situ saturated hydraulic conductivity of 1 x 10-7 cm/s or lower (INAP, 2017). Selection of the overlying rock material and growth media should be such so that the clay is not subject to excessive wetting and drying cycles, causing desiccation and ultimately increasing potential for infiltration to the waste material. The grade of the clay layer is such that any excess water stored in the overlying layers can be shed, rather than further increasing hydraulic head and risking percolation through to the capillary layer.

In the event that there is an absence of suitable clay material, geosynthetic membranes can be adopted. Modelling undertaken by GHD (2018) for Old TSF and HLP#2 demonstrated that a bituminous geomembrane (BGM) could be substituted to achieve the same decrease in net percolation through to the tailings material as a compacted clay layer.

18.4.5 Rock Cover and Growth Media

The rock cover and growth media layers are intended to promote infiltration and storage of rainfall until atmospheric and biotic demands can remove the water through evaporation and transpiration.

18.4.6 Material Availability & Cover Trials

Unavailability of materials available for rehabilitation has been identified as a major risk to success of the closure strategy at CCM. Rehabilitation trials are planned to identify potential materials within the lease areas, as well as engineered strategies such as design optimisation of the cover system through adoption of geosynthetics in replace of compacted clay layers.

18.4.7 Revegetation Strategy

The revegetation strategy for TSF3 is tailored to the proposed native bushland PMLU drawing on site-specific soils data from the Soil Mapping Report (QC1022_020-REP-009-A) and TSF3 soil sampling. These assessments, combined with regional ecosystem (RE) mappings and biodiversity studies (e.g., Northwest Highlands Bioregion Expert Panel Report, Queensland Government, 2018; Mount Isa Biodiversity Strategy 2023–2033), highlight soils that are sandy to sandy loam in texture, strongly acidic, skeletal with high coarse fragments (7–50%), low fertility and low effective cation exchange capacity. While these conditions present challenges such as poor nutrient retention, limited water-holding capacity (~50–75 mm PAWC/1.2 m), and potential aluminum toxicity, they align with arid, rocky rangelands supporting sparse Snappy Gum (Eucalyptus brevifolia) woodlands, spinifex grasslands, and shrublands typical of REs 1.7.5b, 1.7.7, and 1.11.8.

These studies identified that the site's soils can be suitably ameliorated to support the establishment of native bushland species consistent with the proposed PMLU. The strategy emphasizes resilient, drought-tolerant species adapted to low-nutrient, rocky environments, promoting self-sustaining ecosystems that protect EVs and aquatic habitats in Gunpowder Creek.

To achieve a stable, self-sustaining landform capable of supporting native bushland, a targeted soil amelioration program will be implemented as part of rehabilitation works. Indicative amelioration measures include:

- Lime application (2–6 t/ha) to address soil acidity and improve nutrient availability, applied where pH ($CaCl_2$) is below 5.0, reducing aluminum toxicity and enhancing microbial activity.
- Gypsum application (1–4 t/ha) if dispersive attributes emerge (though non-sodic per tests; ESP <6%), to improve soil structure, flocculation, and infiltration on clayey subsoils.
- Organic matter addition (30–60 t/ha) in the form of compost, mulch, or biosolids (NAF-compliant), to increase soil organic carbon, boost water-holding capacity, and stimulate soil biology.
- Starter fertiliser application (N: 10–20 kg/ha; P: 10–20 kg/ha; K: 15–30 kg/ha) to supply essential nutrients for initial establishment, with rates refined based on soil testing and avoiding over-fertilization to prevent weed invasion in natives.

These ameliorants will be incorporated into the upper soil profile (0–30 cm) during final landform shaping, using borrow materials blended with organics for uniform distribution and optimal conditions for revegetation.

18.4.8 Seed Mix

The revegetation strategy will focus on establishing a species mix that is:

- Compatible with regional REs and pre-mining bushland (e.g., spinifex-dominated grasslands on rocky hills).
- Suited to the rehabilitated soil conditions and arid climate (mean rainfall 498.9 mm, summer-dominant; low fertility).
- Capable of providing adequate groundcover (>70% by Year 1, >80% by Year 5) to limit erosion, enhance biodiversity, and support wildlife (e.g., for moderate-potential GDEs).

The seed mix targets species tolerant of sandy, acidic, low-nutrient soils (e.g., *Triodia spp.* for skeletal profiles, *Acacia spp.* for nitrogen fixation). Amendments (lime 2–6 t/ha, organic matter 30–60 t/ha) address acidity and fertility, as detailed in the revegetation strategy. Flat surfaces of the TSF are proposed to be seeded with grass species such as spinifex and other deep-rooted tussock species that bind unconsolidated slopes, reduce surface runoff and trap sediment, along with shrubs and forbs to provide a diverse mid-story to rebuild habitat complexity for fauna and increase rooting depth diversity. Rehabilitation of TSF embankments seeks to recreate the structure and species composition of Regional Ecosystems (REs) 1.11.2a (*Eucalyptus leucophloia* woodland) and 1.7.7a (*Corymbia capricornia* woodland).

The proposed seed mix is provided below in Table 18.1.

An overview of the rationale for revegetation and the native bushland seed mix is summarised below:

- Total Seeding Rate: ~8 kg/ha (adjustable based on trial outcomes and local conditions).
- Application methods: Broadcast seeding post-amelioration, with hydro-seeding on erosion-prone slopes (>20% gradient).
- Sourcing: Local provenance seeds from nurseries (e.g., Mount Isa region, Bush Heritage Australia guidelines) to ensure adaptability and compliance with biodiversity goals.
- Monitoring: Assess cover (>70% by Year 1, >80% by Year 5) and diversity metrics in consideration of approved rehabilitation milestones.

TABLE 18.1: NATIVE BUSHLAND SEED MIX

Functional group	Scientific name	Common name	Application rate*	Timing
Ground-layer grasses and spinifex (slope-binding)	*Heteropogon contortus*	Black speargrass	20% of grass mix	Wet-season onset seeding window (November to early December)
	Themeda triandra	Kangaroo grass	20%	
	Cymbopogon bombycinus	Lemon grass	10%	
	Eulalia aurea	Silky brown-top	10%	
	Enneapogon lindleyanus	Bottle-washer grass	10%	
	Sporobolus australasicus	Fairy grass	10%	
	Triodia longiceps	Giant grey spinifex	10%	
	Triodia pungens	(Soft) spinifex	5%	
	Enteropogon acicularis	Curly windmill grass	2.5%	
	Paspalidium jubiflorum	Warrego summer grass	2.5%	
Nitrogen-fixing wattles	*Acacia orthocarpa*	Needle-leaf wattle	~0.05 kg per ha	
	Acacia phlebocarpa	Velvet-leaf wattle		
	Acacia retivenea	Silky wattle		
Mid-storey shrubs/forbs	*Cullen balsamicum*	Balsam cullen	~0.05 kg per ha	
	Ipomoea antonschmidii	—		
	Polycarpaea spirostylis	Copper bush		
	Senna notabilis	Cockroach bush		
	Triumfetta plumigera	Native burr		
	Grevillea wickhamii	Holly-leaved grevillea		
Canopy trees (reference RE 1.11.2a & 1.7.7a)	*Eucalyptus leucophloia*	Snappy gum	~0.5 kg per ha	
	Eucalyptus leucophylla	Cloncurry box		
	Corymbia dallachiana	Dallachy's gum		
	Corymbia aperrerinja	North-west ghost gum		
	Corymbia capricornia	Small-fruited ghost gum		
	Corymbia gummifera	Red bloodwood		
	Corymbia terminalis	Desert bloodwood		

The successful implementation of the revegetation strategy for native bushland requires careful planning, execution, and adaptive management to address the site's challenging soil conditions (e.g., very strongly acidic pH 3.98–4.95, low fertility, and skeletal profiles with 7–50% coarse fragments) and arid climate. Detailed guidance on timing, trials, maintenance, and iterative adjustments is summarised below:

- **Revegetation Timing:** Seeding should occur pre-wet season to maximize natural soil moisture and germination success, capitalizing on the site's summer-dominant rainfall pattern (November–March, ~87% of annual total). Optimal windows are November-December prior to wet season runoff that enhances infiltration in sandy loam textures. This timing reduces drought stress on seedlings, aligns with native species' natural cycles (e.g., Triodia spp. post-rain establishment), and minimizes erosion risks on reshaped slopes. Pre-seeding preparations (e.g., ameliorant incorporation 1–2 months prior) should coincide with dry periods (April–October) for machinery access. Delays due to extreme events will be managed via contingency seeding in April-May if moisture persists, informed by site-specific monitoring.
- **Revegetation Trials:** Conduct comprehensive field trials to refine seed rates, species viability, and amelioration efficacy, ensuring long-term self-sustaining ecosystems. Trials (e.g., 0.5–1 ha plots on representative landforms like TSF3 embankments) will test variables such as seeding density (6–10 kg/ha variations), mix compositions (e.g., higher Triodia spp. for rocky areas), and amendments (lime 2–6 t/ha for pH; organics 30–60 t/ha for organic C boost from 0.3–0.8%). Monitor metrics like germination (>50% within 6 months), survival (>70% after first dry season), and cover (>50% by Year 1) using quadrats. Trials will inform adaptive adjustments (e.g., species swaps if <30% survival).
- **Maintenance:** Post-seeding maintenance will prioritize ecosystem establishment, excluding disturbances for 5–10 years to allow root development in low water-holding soils (~50–75 mm PAWC/1.2 m) and prevent erosion/AMD from PAF materials. Exclude grazing via temporary fencing and pest control. Annual rehabilitation monitoring will assess PRCP compliance, with adaptive interventions like reseeding (<50% cover) or supplementary watering during droughts. Integrate groundwater/surface water monitoring (per GWIA/SWIA) to verify no-harm to EVs. Long-term (Years 11–20) shifts to passive management, demonstrating relinquishment criteria (e.g., self-sustaining cover >80%, no ongoing inputs).
- **Iterative Adjustments:** This seed mix provides a starting point, with adjustments based on ongoing sampling (e.g., RE analogue soils for cover analogs) and trials to optimize revegetation success for CCM's native bushland PMLU. Annual reviews will incorporate new data and feedback (e.g., Kalkadoon for cultural species), ensuring >90% alignment with target REs (e.g., Snappy Gum/spinifex dominance). If trials show <60% survival (e.g., due to acidity), escalate amendments. This adaptive approach supports long-term stability (no seepage impacts per GWIA/SWIA), facilitating site relinquishment.

19. RISK ASSESSMENT

As part of the preliminary design development process a Project Risk Assessment was undertaken and is included in **Appendix L**. The risk assessment was undertaken in accordance with 29M Risk Framework. Key risks with a High residual risk rating are summarised as follows:

- No clear closure plan for CCM mine including TSF3, Epit and EWRD.
- Insufficient material to close and rehabilitate TSF3 (NAF, Clay Fill, Capillary Break Layer, Topsoil).
- Seepage through southern embankments / natural topography and dam floor.
- EA amendment rejected by DETSI.
- Dam Break (potentially non-credible for failures reaching off site).
- Poor / inadequate construction practices.
- Grout curtain not able to be constructed as per design intent.
- Settlement of EWRD leading to damage to liner, particularly at liner - grout curtain connection.

The project risk register is considered a live document. It is expected that the register will be updated on commencement of detailed design.

20. CAPITAL COST ESTIMATE

20.1 Overview

A Class 5 Capital Cost Estimate has been prepared for TSF3 by CCM, based on preliminary level design quantities developed by Engeny and is included in **Appendix K.** The cost estimate is sensitive to the assumptions around the grout curtain arrangement and depth, and drilling rates as well as the percentages applied for indirect, contingency and owner's costs. The Cost Estimate should therefore be used with this context in design making and planning. The current capital cost estimate is $M 86 AUD.

20.2 Basis of Estimate

The capital cost estimate was based on the following:

- Class 5 accuracy level -30% to +50%.
- Cost estimate developed based on preliminary design civil model quantities and benchmark all-in unit rates from recent similar projects.
- Indirect Costs 35% of Direct Costs.
- Contingency Costs 30% of Direct and Indirect Costs.
- Owners Costs 7.5% of Direct and Indirect Costs.
- All soil materials won / manufactured on lease.
- Pavement materials manufactured on site (Crushed / screened).
- Concrete / grout manufactured on site (Batch plant).
- The following items were excluded in the capital cost estimate:
  - Fuel (to be supplied by CCM).
  - Escalation (where construction is deferred).

21. FORWARD WORK PLAN

The suggested TSF3 forward work plan is summarised below:

- Complete site wide transient 3D numerical groundwater flow modelling including incorporation of TSF3 to improve understanding of groundwater flow / quality changes due to TSF3 and potential groundwater impacts.
- Where required undertake additional groundwater, geotechnical, and borrow investigations to close data gaps and to inform detailed design.
- Undertake early engagement with contractors to undertake constructability review and to refine cost estimate.
- Implement the requirements and process outlined in the GMMP.

22. REFERENCES

- (DESI, 2023) Environmental Authority EMPL 00911413 (EA), Department of Environment, Science and Innovation, December 2023.
- (DESI, 2016) Manual for Assessing Consequence Categories and Hydraulic Performance of Structures, Version 5.03, ESR/2016/1933, Department of Environment, Science and Innovation, February 2016.
- (ANCOLD, 2012) Guidelines on the Consequence Categories for Dams, Australian National Committee on Large Dams, October 2012.
- (ANCOLD, 2019) Tailings Guideline Addendum, Australian National Committee on Large Dams, July 2019.
- (ANCOLD, 2012) Guidelines on Tailings Dams, Australian National Committee on Large Dams, May 2012.
- (ANCOLD, 2003) Guidelines on Dam Safety Management, Australian National Committee on Large Dams, August 2003.
- (ATCW, 2023) Capricorn Copper Mine, Life of Mine Tailings Storage Facility Options Study, Rev 0, ATC Williams, November 2023.

23. 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.

(c) 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.

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(g) This Report does not provide legal advice.

APPENDIX A: GEOTECHNICAL INVESTIGATION FACTUAL REPORT

ENGENY

29 METALS

TSF3 Investigation

Factual Geotechnical Report

QC1022_018-REP-001-1

9 JULY 2025

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1. INTRODUCTION

1.1 General

29 Metals (29M), Capricorn Copper Pty Ltd (CCPL) have engaged Engeny Australia (Engeny) to undertake investigations at Capricorn Copper Mine to inform the detailed design of the proposed Tailings Storage Facility 3 (TSF3). The intent of this scope of work is to assess for significant or fatal flaw geotechnical risks associated with the Upper Esperanza Valley as a TSF, and to assess the earthworks properties of borrow materials adjacent to, and within the proposed TSF3 footprint. The geotechnical assessments were broken into two main objectives including:

(1) Carrying out geotechnical investigations of the area comprising the Upper Esperanza Valley (UEV), located between the Esperanza Waste Rock Dump (EWRD) and the Upper Esperanza Diversion Dam (UEDD); and,

(2) Interpreting the investigation results to inform the detailed design of TFS3.

1.2 Scope

The scope of the geotechnical investigation work is summarised as follows:

- Completion of desktop review of available information.
- Carrying out a site investigation program, including:
  - Excavation and logging of nineteen (19) test pits to assess the earthworks properties of borrow materials.
  - Drilling and logging of fourteen (14) boreholes to determine depths of subsurface soil and rock profiles, inclusive of weathering profile and structural features.
  - The completion of downhole wireline logging to identify the presence and orientation of geologic structures e.g. bedding and joints. Additionally, this was used to verify the structures noted in geotechnical logging.
  - Installation of a standpipe piezometer in one (1) borehole (TSF_BH_14) to understand groundwater levels.
  - Completion of on-site testing, including packer-lugeon testing and point load testing of rock.
  - Development of a laboratory testing program to inform general material parameters.
- Preparation of the geotechnical investigation summary factual report (this report).

Geotechnical interpretive reporting is outside the scope of this report.

1.3 Standards

The investigations and testing were undertaken with reference to the following standards:

- AS1726:2017: Geotechnical site investigations.
- AS1289:1989: Methods of testing soils for engineering purposes.
- AS4133:2019: Methods of testing rocks for engineering purposes.

1.4 Conventions

The following conventions apply to this report:

- All geometric measurements are metric.
- Coordinates are in metres and relative to GDA94 MGAz54 horizontal datum and all Reduced Levels (RL) report to Australian Height Datum (AHD).
- All logging data is consistent with AGS 4.1 data format standard and can be supplied in digital format upon request.
- All bearings (unless noted otherwise) are presented as degrees clockwise from true north and have been adjusted for site magnetic declination. All inclination data is measured and noted in degrees relative to horizontal.
- All geological measurements regarding the geometry of surfaces present within the rock mass (unless noted otherwise) such as bedding, joints or other structural features provided in this report are presented as Dip Angle / Dip Direction (°). The apparent Dip Angle / Dip Direction (°) for inclined boreholes (TSF_BH_07, TSF_BH_08 and TSF_BH_10A) have been corrected to true Dip Angle / Dip Direction (°).

2. BACKGROUND

2.1 Location

Capricorn Copper Mine is located approximately 130km north of Mt Isa, Queensland and is accessible via Gunpowder Road. The proposed TSF3 embankments (EWRD and UEDD) are located approximately 1.8km and 2.5km south of the main site offices respectively. They are accessed via the mine access tracks and haul roads shown below in Figure 2.1.



Figure 2.1: Site Location

2.2 Site Topography

The site topography consists of roughly north-south striking undulating ridges which are incised by a main drainage line which forms the Upper Esperanza Valley (UEV) and is bound by the EWRD in the north and by the UEDD in the south. TSF3 is proposed to be located between the EWRD and UEDD and bound by the surrounding ridges.

The UEV runs roughly south-east / north-west and drains waters to the north toward the E-Pit. The base of the UEV beneath the Upper UEDD exists at approximately RL 287 mAHD and drops to RL 249 mAHD beneath the EWRD, falling at a grade of approximately 5%. Valley sides which form the abutments of the TSF3 and UEDD rise at approximately 37% and 20% [grade] respectively. Figure 2.3 below illustrates the main topographic features within the study area.

Valley sides in the tributary lines either side of the UEV (denoted by blue arrows in Figure 2.2) have similar properties to the UEV. The topography in the UEV and adjacent valleys present difficulty for LV access and the ability to build access tracks.

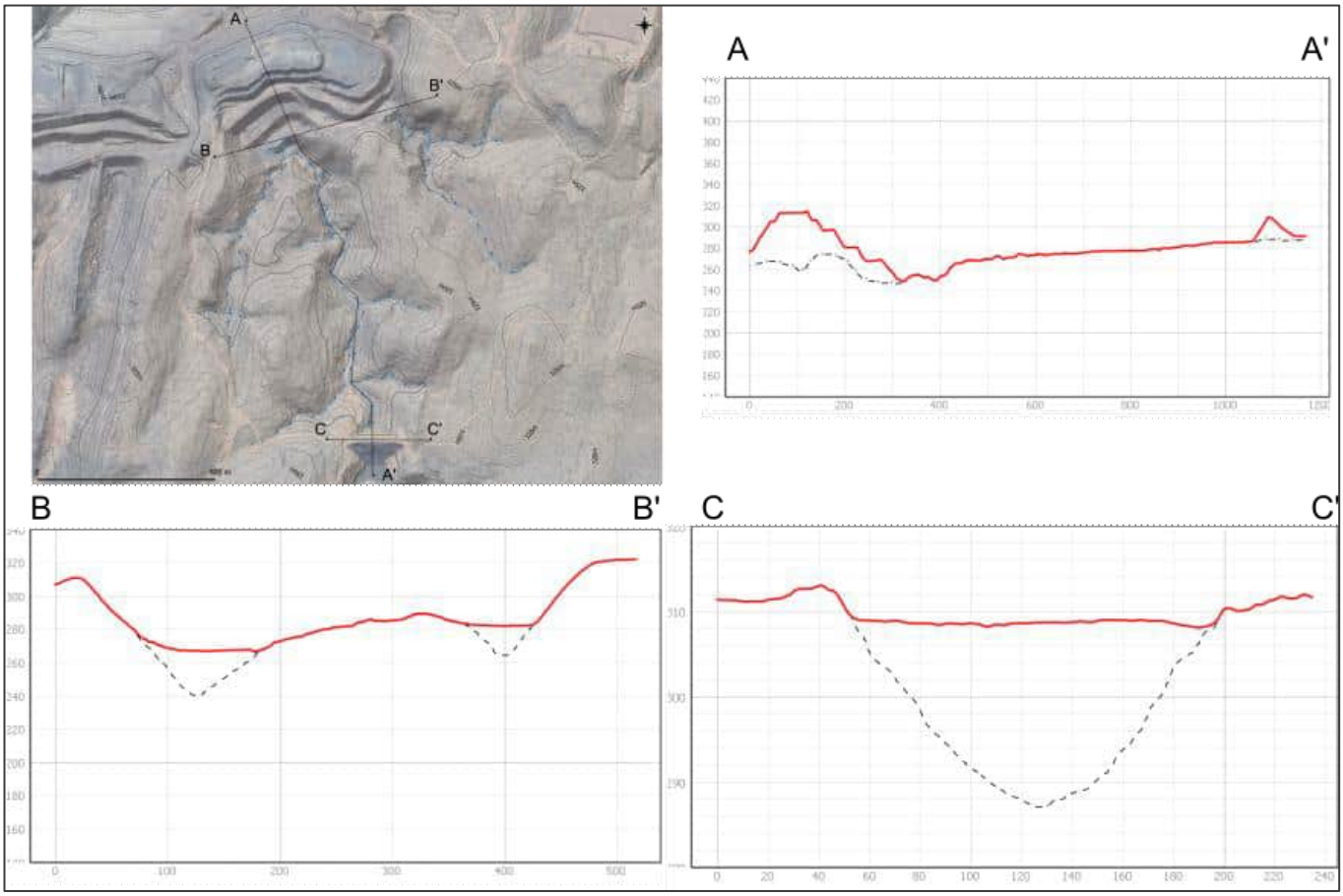


Figure 2.2: Topographical Sections Through the UEV.

Note: Inferred ground surface beneath the embankments based on historical imagery are shown in the dashed line above.

2.3 Regional Geology

Reference shall be made to the QC1022_018-REP-001-1Geological Mapping Report (Engeny, 2025) for all geological details and relationships between individual units.

3. SITE INVESTIGATION METHODOLOGY

3.1 Overview

3.1.1 Scope

The field investigation was undertaken between 30th March and 24th May 2024, with logging, sampling and in-situ testing undertaken by a Mining & Exploration Consulting (M&EC) Engineering Geologist (subconsultant to Engeny), and a Senior Engineering Geologist and Geotechnical Engineer from Engeny. The investigation consisted of the following components:

- Excavation and logging of nineteen (19) test pits to assess the earthworks properties of borrow materials.
- Drilling of fourteen (14) boreholes with the proposed TSF3 footprint, which included:
  - In-situ standard penetration testing (SPT) within soils.
  - Downhole wireline logging including, Acoustic Televiewer (ATV), Optical Televiewer (OTV) down-hole imaging and down-hole gamma survey.
  - Field Point Load Testing (PLT) on recovered core samples (28 in total).
- Standpipe Piezometer installation in one (1) location (TSF_BH_14). Laboratory testing was schedule on core and soil samples, consisting of:
  - Three (3) Unconfined Compression Strength Tests (UCS).
  - Twenty (20) Particle Size Distribution Tests.
  - Fourteen (14) Emerson Class Report Tests.
  - Nine (9) Atterberg Limits tests.

The investigation locations and coordinates are presented in Figure 3.1 and Table 3.1, respectively. Figures detailing as-constructed locations are provided in Appendix A:.

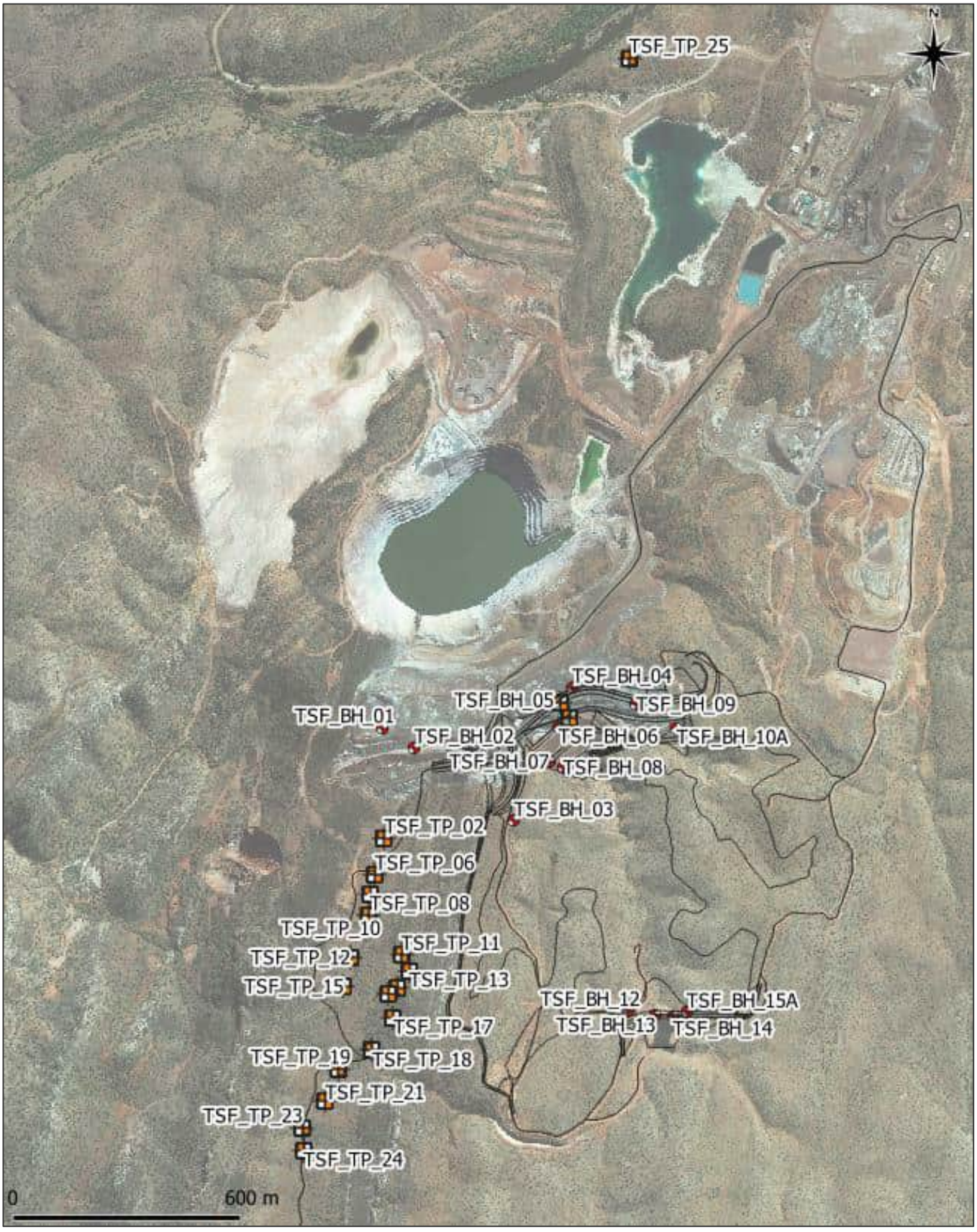


Figure 3.1: General Arrangement of Investigation Locations

Table 3.1: Investigation Location Summary

ID	Location	Easting[1]	Northing	Elevation (mAHD)[2]	Depth (m)	Dip / Azimuth	Termination Remark	In-Situ Testing
			Test Pits					
TSF_TP_02	Borrow Pit	327,562	7,820,183	265.63	1.1	-	Refusal	-
TSF _TP_06	Borrow Pit	327,537	7,820,087	273.53	1.3	-	Refusal	-
TSF _TP_08	Borrow Pit	327,524	7,820,036	272.57	0.45	-	Refusal	-
TSF _TP_10	Borrow Pit	327,519	7,819,979	270.04	1.3	-	Refusal	-
TSF_TP_11	Borrow Pit	327,606	7,819,876	271.73	1.3	-	Refusal	-
TSF _TP_12	Borrow Pit	327,473	7,819,870	269.09	0.9	-	Refusal	-
TSF _TP_13	Borrow Pit	327,628	7,819,835	277.29	1.3	-	Refusal	-
TSF _TP_14	Borrow Pit	327,595	7,819,790	281.58	0.3	-	Refusal	-
TSF_TP_15	Borrow Pit	327,455	7,819,794	266.63	3.5	-	Refusal	-
TSF _TP_16	Borrow Pit	327,574	7,819,773	284.55	0.5	-	Refusal	-
TSF _TP_17	Borrow Pit	327,586	7,819,711	280.20	2.6	-	Refusal	-
TSF _TP_18	Borrow Pit	327,530	7,819,625	268.74	2.5	-	Refusal	-
TSF _TP_19	Borrow Pit	327,440	7,819,577	265.75	0.7	-	Refusal	-
TSF _TP_21	Borrow Pit	327,406	7,819,491	266.45	1.6	-	Refusal	-
TSF _TP_23	Borrow Pit	327,347	7,819,422	267.99	1.3	-	Refusal	-
TSF _TP_24	Borrow Pit	327,349	7,819,362	270.11	3	-	Refusal	-

[1] Coordinate System: GDA94 MGAz54.

[2] Elevation derived from survey *Gunpowder 20Jul2021 WV3 50cm DTM GDA94 MGA54 1m Extended.*

ID	Location	Easting[1]	Northing	Elevation (mAHD)[2]	Depth (m)	Dip / Azimuth	Termination Remark	In-Situ Testing
TSF _TP_25	Borrow Pit	328,206	7,822,236	229.55	1.2	-	Refusal	-
TSF_TP_WRD1	Waste Rock Dump	328,026	7,820,540	313.01	1.1	-	Refusal	-
TSF_TP_WRD2	Waste Rock Dump	328,048	7,820,499	296.16	2.7	-	Refusal	-
				Boreholes				
TSF_BH_01	UEV	327,556	7,820,474	318.35	25.0	-90° / -°	Termination Depth reached	-
TSF_BH_02	UEV	327,641	7,820,420	297.81	15.0	-90° / -°	Abandoned	-
TSF_BH_03	UEV	327,995	7,820,231	309.90	20.0	-90° / -°	Termination Depth reached	-
TSF_BH_04	UEV	328,056	7,820,579	312.68	80.2	-90° / -°	Termination Depth reached	-
TSF_BH_05	UEV	328,008	7,820,547	312.94	60.3	-90° / -°	Termination Depth reached	-
TSF_BH_06	UEV	328,020	7,820,476	296.05	49	-90° / -°	Termination Depth reached	-
TSF_BH_07	UEV	327,995	7,820,385	279.76	24.5	60° / 205°	Termination Depth reached	Packer Test 18-24.5m Packer Test 20-26m
TSF_BH_08	UEV	328,050	7,820,376	268.45	21.4	60° / 025°	Termination Depth reached	Packer Test 9-14m Packer Test 13-18m Packer Test 18-24.3m

ID	Location	Easting[1]	Northing	Elevation (mAHD)[2]	Depth (m)	Dip / Azimuth	Termination Remark	In-Situ Testing
TSF_BH_09	UEV	328,224	7,820,536	307.80	54.34	-90° / -°	Termination Depth reached	-
TSF_BH_10A	UEV	328,331	7,820,474	282.14	23.85	60° / 025°	Termination Depth reached	Packer Test 19-23.85m
				TSF_BH_11 **(OMITTED)**				
TSF_BH_12	UEV	328,202	7,819,729	309.09	15.2	-90° / -°	Termination Depth reached	Packer Test 6-11m Packer Test 9-15.2m
TSF_BH_13	UEV	328,278	7,819,707	308.80	32.6	-90° / -°	Termination Depth reached	Packer Test 20-26m Packer Test 26.6-32.6m
TSF_BH_14	UEV	327,595	7,819,790	308.55	22.5	-90° / -°	Termination Depth reached	-
TSF_BH_15A	UEV	328,357	7,819,725	309.02	20	-90° / -°	Termination Depth reached	Packer Test 6-12m Packer Test 15-20m

3.2 Survey

Survey set out was completed by 29 Metals Project team using a handheld GPS. Elevations shown on logs have been derived from the GPS positions and Gunpowder 20Jul2021 WV3 50cm DTM GDA94 MGA54 1m Extended.

3.3 Geotechnical Drilling

3.3.1 Borehole Details

Borehole logging was undertaken by Mining & Exploration Consulting (M&EC) and Engeny. All boreholes were completed using either sonic drilling methods or HQ Coring methods, with some boreholes using a combination of the two methods by Groundwave Drilling and was completed with a Boart Longyear Delta Base 520 (DB520) Multipurpose Drill Rig and a Boart Longyear LS250 Multipurpose Sonic Drill Rig. All boreholes were drilled to a minimum borehole diameter of 61 mm to allow for installation of HQ casing and subsequent instrumentation. (refer to geotechnical logs in Appendix B: for details).

3.3.2 Drilling, Sampling and In-situ Testing

3.3.2.1 Drilling and SPT Testing

Boreholes were advanced using sonic drilling methods through soils or as deemed appropriate for the encountered materials. While drilling through soil strength material, SPTs were carried out at approximately 1.5 m intervals.

Upon encountering bedrock, boreholes were advanced using HQ wireline diamond coring equipment, producing rock core with a nominal diameter of 61 mm.

Boreholes were generally drilled to the nominated termination depth detailed in the project Geotechnical Brief (Engeny, 2024). One (1) borehole (TSF_BH_02) was abandoned prior to achieving termination depth due to risk of damaging / losing drilling equipment as a result of the ground conditions encountered.

3.3.2.2 Sampling and Logging

Drilling was supervised on a full-time basis by an Engineering Geologist and Geotechnical Engineer who was responsible for logging the encountered strata in accordance with AS 1726-2017 logging standards, supervising drilling, nominating depths for in-situ testing and collecting suitable representative samples for laboratory testing.

Groundwater strikes were recorded where identifiable, however, this was not possible after cored borehole methods (which use drilling water) were commenced. The estimated return or loss of drilling fluids was recorded, whilst drilling. Water loss may indicate fractured/permeable zones in the rock where groundwater may also be present. Significant water loss was encountered in some holes (TSF_BH_03, TSF_BH_04, TSF_BH_05, TSF_BH_06, TSF_BH_07, TSF_BH_09, TSF_BH_12, TSF_BH_13, TSF_BH_14, TSF_BH_15A) and at varied depths (refer to the logs for details).

All rock core was boxed on site in accordance with Engeny's standard procedures. To maintain core integrity, abundantly fractured core was placed in PVC splits prior to boxing. The core was photographed on site by placing each box of core in a well-lit, unshadowed area.

3.3.2.3 Field Testing

Following photography, Point Load Testing (PLT) testing was conducted on the rock core at a frequency of approximately one (1) test per three metre interval or at significant changes in strata, in both axial and diametrical direction. Point load test are presented on the logs within Appendix C:

3.4 Borehole Downhole Imagery and Geophysical Wireline Logging

Upon completion of drilling, boreholes were flushed with clean water until the water returned from the hole was also clean in preparation for downhole wireline logging. To prevent collapse of borehole walls, temporary casing was left in the each of the nominated boreholes (TSF_BH_07, TSF_BH_08 and TSF_BH_10A) to the base of the waste rock fill profile for imaging as summarised in Table 3.2. Borehole imaging and geophysical logging involves measuring the geo-physical properties of the surrounding medium with a sensor located in the borehole.

GeoLog Pty Ltd (subcontractor Mining & Exploration Consulting) completed these surveys under the direct supervision of an Engeny representative. WellCAD has been used to assimilate and process the data, and the consolidated results of the borehole geophysical logging are provided in Appendix D:

Table 3.2: Downhole Survey Summary

Borehole ID	Optical Televiewer	Acoustic Televiewer	Downhole Natural Gamma
TSF_BH_07	Undertaken	Undertaken	Undertaken
TSF_BH_08	Undertaken	Undertaken	Undertaken
TSF_BH_10A	Undertaken	Undertaken	Undertaken

3.4.1 Optical Televiewer

The Optical Televiewer (OTV) tool produces a clear 360° continuous high resolution, unwrapped digital image (similar to a photograph) of the borehole wall in clear water. Together with the Acoustic Televiewer (ATV) tool, OTV provides a detailed picture of the borehole wall with the capability to define fractures in high definition, provided optimum borehole conditions exist (clear water in the hole).

Along certain segments of the OTV survey, insufficient flushing of drilling mud from the boreholes have obscured or prevented a clear survey of the borehole wall. This also applied to the Acoustic Teleview survey which prevented clear interpretation of the defects.

The OTV interpreted structures are orientated to magnetic north and no correction for magnetic declination has been applied.

3.4.2 Acoustic Televiewer

Acoustic Televiewer (ATV) imaging was carried out in boreholes nominated in the scope. The ATV scanning was typically undertaken on completion of the coring to generate an interpreted image of the borehole walls based on refracted frequencies of the acoustic probe. The imaging has been processed using WellCAD and interpreted geological defects such as joints, foliations and shears have been identified.

The geological structures dip and dip direction orientations have been calculated and is reported on the wireline logs presented in Appendix D:.

The ATV interpreted structures are oriented to true north. Any thickness measured is indicative only. Depth measurements refer to length down the hole.

3.4.3 Natural Gamma

Natural gamma is primarily a lithology Identification tool that measures naturally occurring gamma radiation in the rocks of the borehole wall. The natural gamma logs are applicable to investigations in both sedimentary and crystalline rocks, particularly for stratigraphic correlation.

3.4.4 Packer Permeability Testing

Packer / lugeon permeability testing was undertaken at twelve (12) locations. Results are included within Appendix C:.

3.5 Borehole Reinstatement

All boreholes were reinstated using the backfill techniques specified within Section 5.11 of the Geotechnical Investigation Brief. HWT casing was left in TSF_BH_07, TSF_BH_08 and TSF_BH_10A. PVC casing was left in TSF_BH_05. A standpipe piezometer was installed in TSF_BH_14 and all other boreholes were backfilled using cuttings.

3.6 Test Pitting

3.6.1 Test Pit Details

Test Pit logging was undertaken by Mining & Exploration Consulting (M&EC) and Engeny. All test pits were excavated using a 30 tonne or 45 tonne excavators fitted with a 600 mm tooth and 1200 mm straight bucket, respectively. All test pits were excavated to a depth of practical refusal and were logged in accordance with AS 1726-2017 logging standards (refer to geotechnical logs in Appendix B: for details).

3.6.1.1 Sampling and Logging

Test pit excavation was supervised on a full-time basis by either an Engineering Geologist or a Geotechnical Engineer, who was responsible for logging the encountered strata in accordance with AS 1726-2017 logging standards, supervising excavation and collecting suitable representative samples for laboratory testing.

3.7 Laboratory Testing

A program of laboratory testing was carried out on samples obtained during the geotechnical site investigations to classify and assess the engineering characteristics of the soil and rock encountered.

The geotechnical laboratory testing completed is summarised in Table 3.3.

Table 3.3: Laboratory Testing Summary

Test Type	Standard / Method	No. Tests
	Soil Testing	
Moisture Content	AS 1289.2.1.1	20
Atterberg Limits (including Linear Shrinkage)	AS 1289.3.1.1	9
Particle Size Distribution	AS 1289.3.6.1 & 3.6.2	20
Emerson Class Report	AS 1289.3.8.1	14
	Rock Testing	
Direct Shear (Multistage)	ASTM D5607	4
Unconfined Compressive Strength	AS 4133.4.2.1	3
Point Load (Undertaken in field)	AS 4133.4.1.	28
	Geochemical Testing	
pH (field/fox)	Ahern et al	17
Net Acid Production Potential	USEPA 600/2-78-054 & Miller, Coastal Research (mod), In house	17
Net Acid Generation	Miller	17
Acid Neutralising Capacity	-	17
Soluble Major Anions	APHA 3120	17
Total Sulfate by ICPAES	APHA 3120	17

Test Type	Standard / Method	No. Tests
Total Sulfur by LECO	APHA 3120	17
Total Metals by ICP-AES	USEPA 6010	17
Total Recoverable Mercury by FIMS	-	17
Sulfide as S2	APHA 4500-S2 D	17
Total Organic Carbon (TOC) in Soil	-	17
Total Inorganic Carbon (TIC) in Soil	-	17
Leachable Metals by ICPAES	-	34
Leachable Mercury by FIMS	-	10
ASLP Leaching Procedure – Inorganics / Non-Volatile Organics (Glass Vessel)	-	34

3.8 Standpipe Piezometer Installation

A standpipe piezometer was installed in TSF_BH_14. Details of the installation are provided in Appendix E:.

4. GEOTECHNICAL INVESTIGATION RESULTS

4.1 Overview

Factual investigation data are presented in the Appendices, as summarised in Table 4.1.

Table 4.1: Summary of Factual Data

Appendix	Content	Summary
A	Figures	QC1022_018-SKE-0003 - As Constructed investigation Locations.
B	Geotechnical Logs (includes in-situ SPT results) and Photos.	The ground conditions encountered are described in detail on the borehole logs. Site and TP / BH photos are also presented.
C	In-Situ Testing	Results include: • Point Load Test Results. • Packer Test Results.
D	Geophysical Logs	The detailed borehole imaging results from the televiewer are presented.
E	Standpipe Piezometer Installation	Details on Standpipe Piezometer installation.
F	Laboratory Test Certificates	The test certificates for the laboratory test results received.

QUALIFICATIONS

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

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

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(g) This Report does not provide legal advice.

APPENDIX A: FIGURES

631,200 631,400 631,600 631,800 632,000

7,520,600 7,520,400 7,520,200

TSF_BH_04
TSF_BH_05
TSF_TP_WRD1
TSF_BH_09
TSF_TP_WRD2
TSF_BH_01
TSF_BH_10A
TSF_BH_06
TSF_BH_02
TSF_BH_07
TSF_BH_08
TSF_BH_03
TSF_TP_02
TSF_TP_06
TSF_TP_08
TSF_TP_10
TSF_TP_12
TSF_TP_11
TSF_TP_13
TSF_TP_15
TSF_TP_14
TSF_TP_16
TSF_TP_17
TSF_TP_18
TSF_TP_19
TSF_TP_21
TSF_TP_23
TSF_TP_24
TSF_BH_12
TSF_BH_15A
TSF_BH_13
TSF_BH_14

TSF_TP_25
TSF_BH_01
TSF_BH_09
TSF_BH_02
TSF_BH_06
TSF_BH_10A
TSF_TP_02
TSF_BH_03
TSF_TP_10
TSF_TP_06
TSF_TP_13
TSF_TP_12
TSF_BH_15A
TSF_TP_14
TSF_TP_19
TSF_BH_14
TSF_TP_18
TSF_TP_23
TSF_TP_24

TSF_TP_25

LEGEND

240320 CONCEPT DESIGN

QC1022_018 ASCON LOCATIONS 260624

TESTPIT

BOREHOLE

R	DETAILS	DATE
1	Final Issue	17-09-2024

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This drawing is confidential and shall only be used for the purpose of this project.

DRAWN	TM	CHECKED	BW
APPROVED	BW	DATE	17-09-2024

NOTES:

N

0 100 200 m

Scale in metres (5,000 @ A3)
GDA94 / MGA zone 54

DISCLAIMER
Engeny has endeavoured to ensure accuracy and completeness of the data. Engeny assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DATA SOURCE
QLD Government Open Data Source

ENGENY

29 Metals

ASCON BOREHOLE & TEST PIT LOCATIONS

29 Metals
TSF 3 Geotechnical Investigation
ASCON Investigation Locations

Drg Ref.
QC1022_018-SKE-0003

Q:\Projects\QC1022 29Metals\QC1022_018 ^TSF 3 Design & Studies\05 Design\QGIS\Workspaces\QC1022_018 TFS3 Rev A AL-TM (BW).qgz

APPENDIX B: GEOTECHNICAL LOGS AND PHOTOS



TSF_BH_01 / Sonic Core photo 00.00-02.00.jpg



TSF_BH_01 / Sonic Core Photo 02.00-04.00.jpg



TSF_BH_01 / Sonic Core Photo 04.00-06.00.jpg



TSF_BH_01 / Sonic Core Photo 06.00-08.00.jpg



TSF_BH_01 / Sonic Core Photo 08.00-10.00.jpg



TSF_BH_01 / Sonic Core Photo 10.00-12.00.jpg



TSF_BH_01 / Sonic Core Photo 12.00-14.00.jpg



TSF_BH_01 / Sonic Core Photo 14.00-16.00.jpg



TSF_BH_01 / Sonic Core Photo 16.00-18.00.jpg



TSF_BH_01 / Sonic Core Photo 18.00-20.00.jpg



TSF_BH_01 / Sonic Core Photo 20.00-22.00.jpg



TSF_BH_01 / Sonic Core Photo 22.00-24.00.jpg



TSF_BH_01 / Sonic Core Photo 24.00-25.00.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_01



TSF_BH_01 / Site Photo Post Drill East.jpg



TSF_BH_01 / Site Photo Post Drill West.jpg



TSF_BH_01 / Site Photo Pre Drill North.jpg



TSF_BH_01 / Site Photo Setup 2.jpg



TSF_BH_01 / Site Photo Setup.jpg



TSF_BH_01 / SPT 18.00-18.45.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_01



TSF_BH_02 / Sonic Core photo 00.00-02.00.jpg



TSF_BH_02 / Sonic Core photo 02.00-04.00.jpg



TSF_BH_02 / Sonic Core photo 04.00-06.00.jpg



TSF_BH_02 / Sonic Core photo 06.00-08.00.jpg



TSF_BH_02 / Sonic Core photo 08.00-10.00.jpg



TSF_BH_02 / Sonic Core photo 10.00-12.00.jpg



TSF_BH_02 / Sonic Core photo 12.00-14.00.jpg



TSF_BH_02 / Sonic Core photo 14.00-15.00.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_02



TSF_BH_03 / Dry Core photo 00.00-04.00.jpg



TSF_BH_03 / Dry Core photo 04.00-08.00.jpg



TSF_BH_03 / Wet Core photo 04.00-08.00.jpg



TSF_BH_03 / Dry Core photo 08.00-12.00.jpg



TSF_BH_03 / Wet Core photo 08.00-12.00.jpg



TSF_BH_03 / Dry Core photo 12.00-16.00.jpg



TSF_BH_03 / Wet Core photo 12.00-16.00.jpg



TSF_BH_03 / Dry Core photo 16.00-20.00.jpg



TSF_BH_03 / Wet Core photo 16.00-20.00.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_03



TSF_BH_03 / Site Photo 1.jpg



TSF_BH_03 / Site Photo 2.jpg

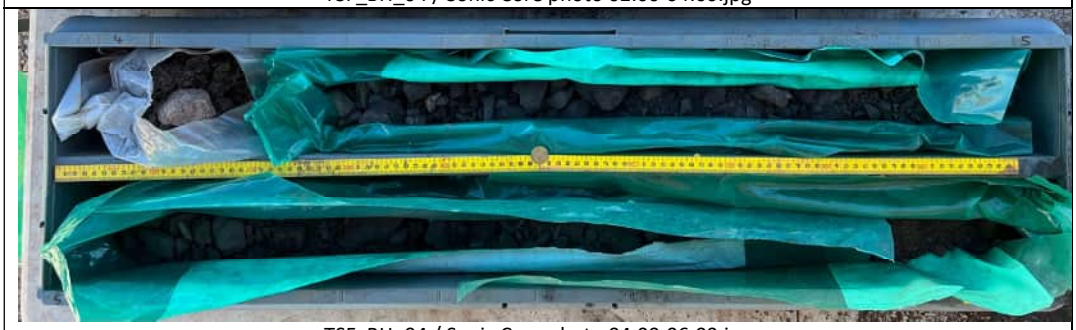
Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_03



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TSF_BH_04 / Sonic Core photo 02.00-04.00.jpg



TSF_BH_04 / Sonic Core photo 04.00-06.00.jpg



TSF_BH_04 / Sonic Core photo 06.00-08.00.jpg



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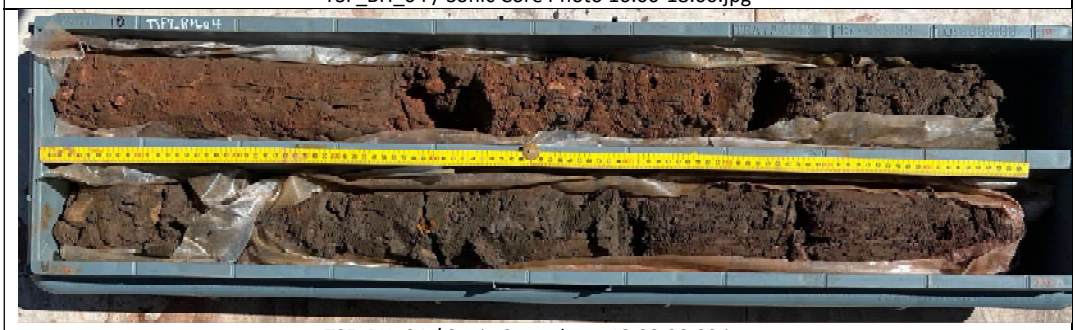
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TSF_BH_04 / Sonic Core Photo 12.00-14.00.jpg



TSF_BH_04 / Sonic Core Photo 16.00-18.00.jpg



TSF_BH_04 / Sonic Core photo 18.00-20.00.jpg



TSF_BH_04 / Sonic Core photo 20.00-22.00.jpg



TSF_BH_04 / Sonic Core photo 22.00-24.00.jpg



TSF_BH_04 / Sonic Core photo 24.00-26.00.jpg



TSF_BH_04 / Sonic Core Photo 26.00-28.00.jpg



TSF_BH_04 / Sonic Core Photo 26.00-28.00.jpg



TSF_BH_04 / Sonic Core Photo 28.00-30.00.jpg



TSF_BH_04 / Sonic Core Photo 30.00-32.00.jpg



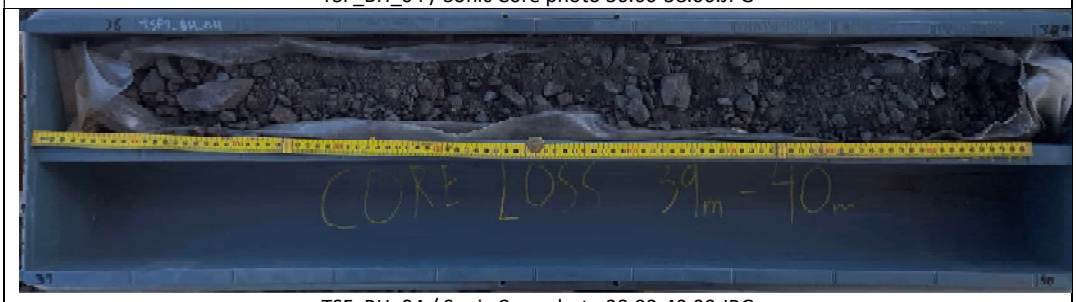
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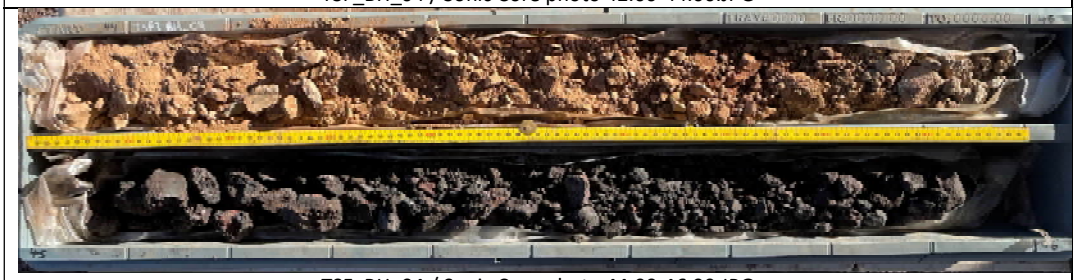
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TSF_BH_04 / Sonic Core photo 40.00-42.00.JPG



TSF_BH_04 / Sonic Core photo 42.00-44.00.JPG



TSF_BH_04 / Sonic Core photo 44.00-46.00.JPG



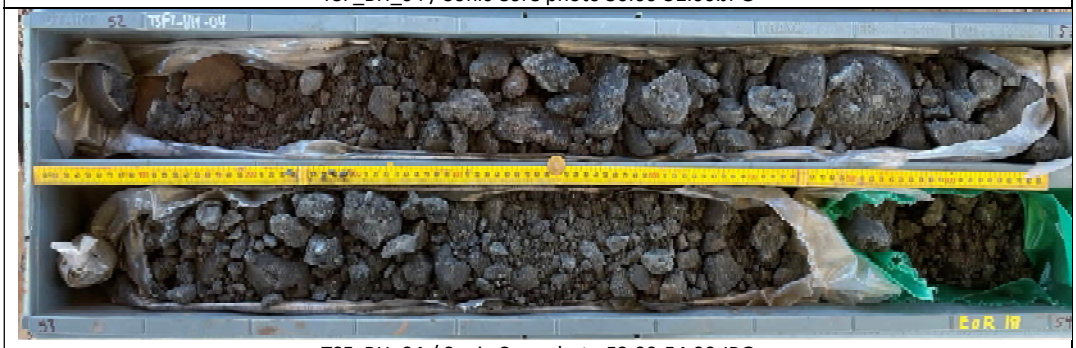
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TSF_BH_04 / Sonic Core photo 48.00-50.00.JPG



TSF_BH_04 / Sonic Core photo 50.00-52.00.JPG



TSF_BH_04 / Sonic Core photo 52.00-54.00.JPG



TSF_BH_04 / Sonic Core photo 54.00-56.00.JPG



TSF_BH_04 / Sonic Core photo 56.00-58.00.JPG



TSF_BH_04 / Sonic Core photo 58.00-60.00.JPG



TSF_BH_04 / Sonic Core photo 60.00-62.00.JPG



TSF_BH_04 / Sonic Core photo 62.00-64.00.JPG



TSF_BH_04 / Sonic Core photo 64.00-66.00.JPG



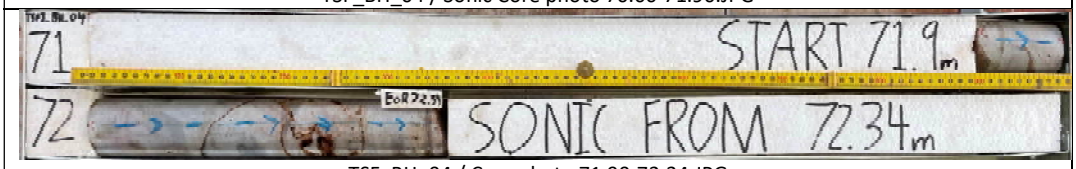
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TSF_BH_04 / Sonic Core photo 68.00-70.00.JPG



TSF_BH_04 / Sonic Core photo 70.00-71.90.JPG



TSF_BH_04 / Core photo 71.90-72.34.JPG



TSF_BH_04 / Sonic Core photo 72.00-74.00.jpg



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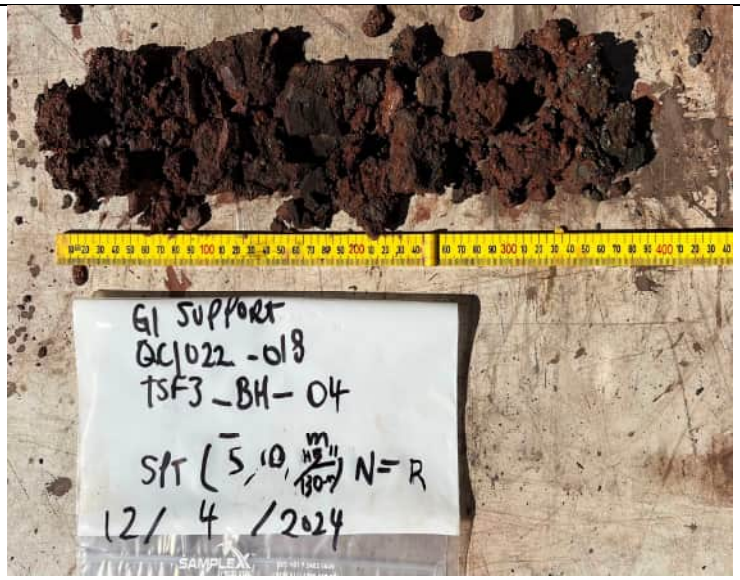


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TSF_BH_04 / Core photo 79.00-80.20.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_04



TSF_BH_04 / SPT 21.00-21.45.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_04



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TSF_BH_05 / Sonic Core photo 02.00-04.00.jpg



TSF_BH_05 / Sonic Core photo 04.00-06.00.jpg



TSF_BH_05 / Sonic Core photo 06.00-08.00.jpg



TSF_BH_05 / Sonic Core photo 08.00-10.00.jpg



TSF_BH_05 / Sonic Core photo 10.00-12.00.jpg



TSF_BH_05 / Sonic Core photo 12.00-14.00.jpg



TSF_BH_05 / Sonic Core photo 14.00-16.00.jpg



TSF_BH_05 / Sonic Core photo 16.00-18.00.jpg

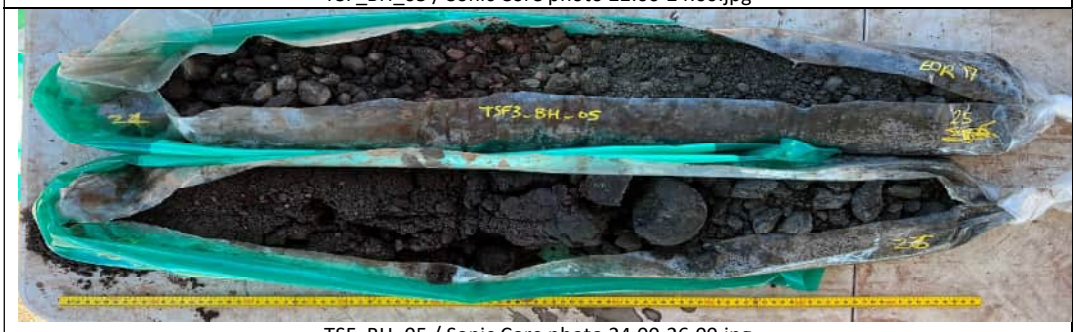


TSF_BH_05 / Sonic Core photo 18.00-20.00.jpg



TSF_BH_05 / Sonic Core photo 20.00-22.00.jpg


TSF_BH_05 / Sonic Core photo 22.00-24.00.jpg



TSF_BH_05 / Sonic Core photo 24.00-26.00.jpg


TSF_BH_05 / Sonic Core photo 26.00-28.00.jpg



TSF_BH_05 / Sonic Core photo 28.00-29.50.jpg



TSF_BH_05 / Sonic Core photo 29.50-31.00.jpg



TSF_BH_05 / Sonic Core photo 31.00-32.50.jpg



TSF_BH_05 / Sonic Core photo 32.50-34.00.jpg



TSF_BH_05 / Sonic Core photo 44.50-46.00.jpg



TSF_BH_05 / Sonic Core photo 46.00-48.00.jpg



TSF_BH_05 / Sonic Core photo 48.00-50.00.jpg



TSF_BH_05 / Wet Core photo 49.00-53.00.jpg



TSF_BH_05 / Dry Core photo 49.00-53.00.jpg



TSF_BH_05 / Wet Core photo 53.00-57.00.jpg



TSF_BH_05 / Dry Core photo 53.00-57.00.jpg



TSF_BH_05 / Wet Core photo 57.00-60.30.jpg



TSF_BH_05 / Dry Core photo 57.00-60.30.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_05



TSF_BH_05 / SPT 20.50-20.60.jpg



TSF_BH_05 / SPT 29.50-29.95.jpg



TSF_BH_05 / SPT 29.50-29.60.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_05



TSF_BH_06 / Sonic Core photo 00.00-02.00.JPG



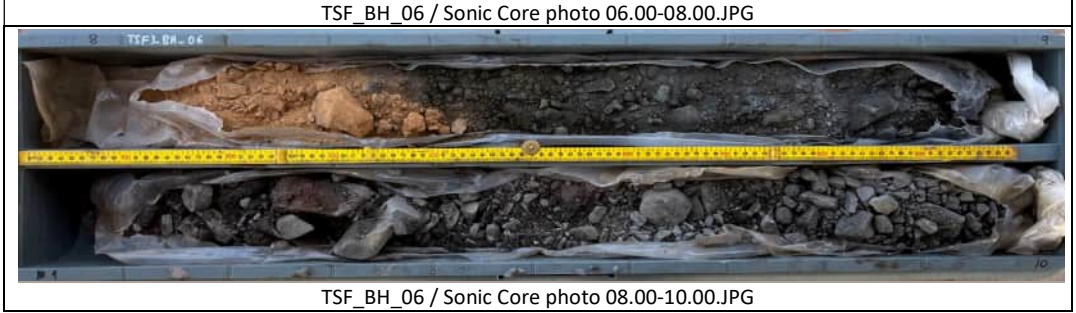
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TSF_BH_06 / Sonic Core photo 06.00-08.00.JPG



TSF_BH_06 / Sonic Core photo 08.00-10.00.JPG



TSF_BH_06 / Sonic Core photo 10.00-12.00.JPG



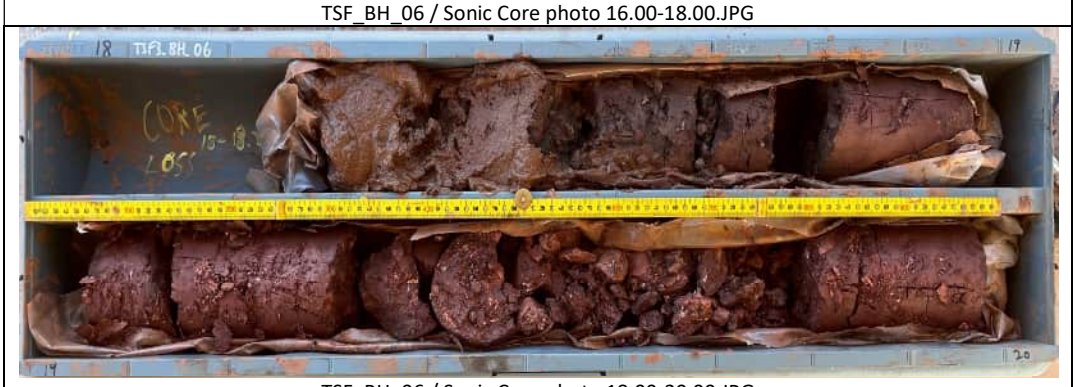
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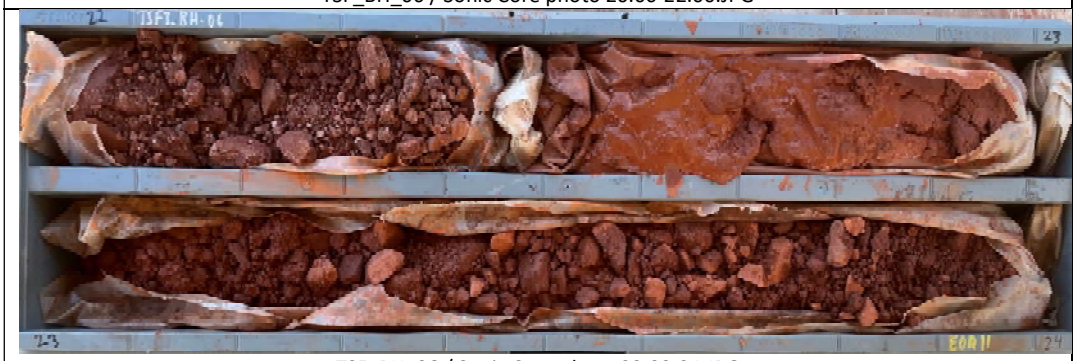
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TSF_BH_06 / Sonic Core photo 20.00-22.00.JPG



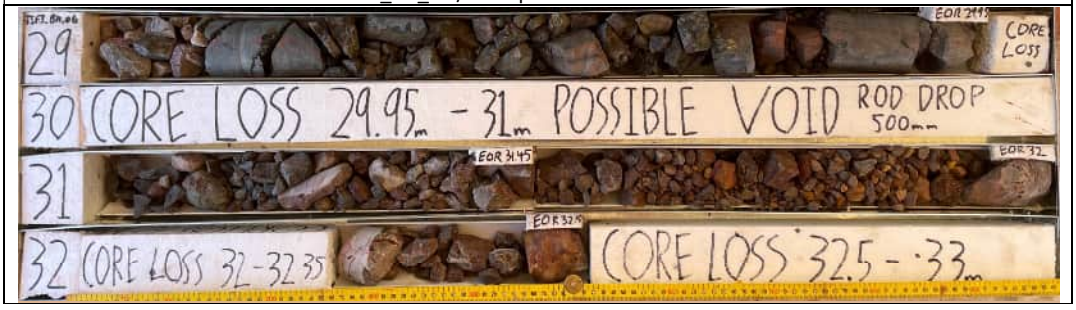
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TSF_BH_06 / Core photo 25.00-29.00.JPG



TSF_BH_06 / Core photo 29.00-33.00.JPG



TSF_BH_06 / Core photo 33.00-36.00.JPG



TSF_BH_06 / Sonic Core photo 36.00-38.00.jpg



TSF_BH_06 / Sonic Core photo 38.00-40.00.jpg



TSF_BH_06 / Sonic Core photo 40.00-42.00.jpg



TSF_BH_06 / Core photo 41.00-45.00.jpg



TSF_BH_06 / Core photo 45.00-49.00.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_06



TSF_BH_06 / Site Photo 1.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_06



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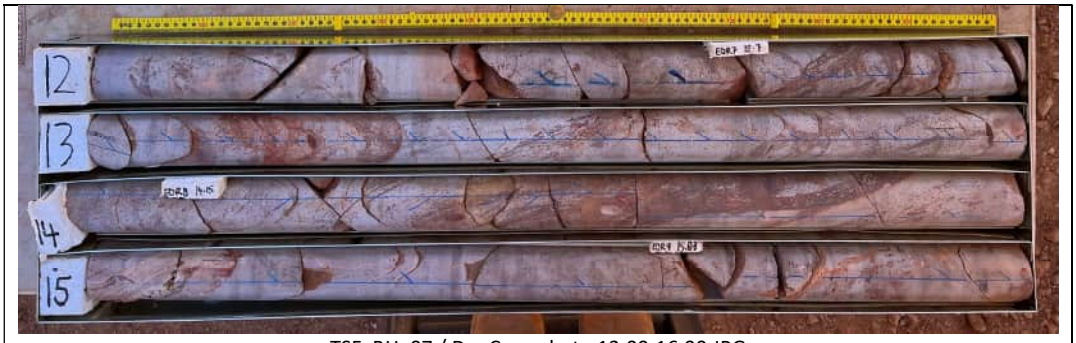
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TSF_BH_07 / Dry Core photo 08.00-12.00.JPG



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TSF_BH_07 / Dry Core photo 12.00-16.00.JPG



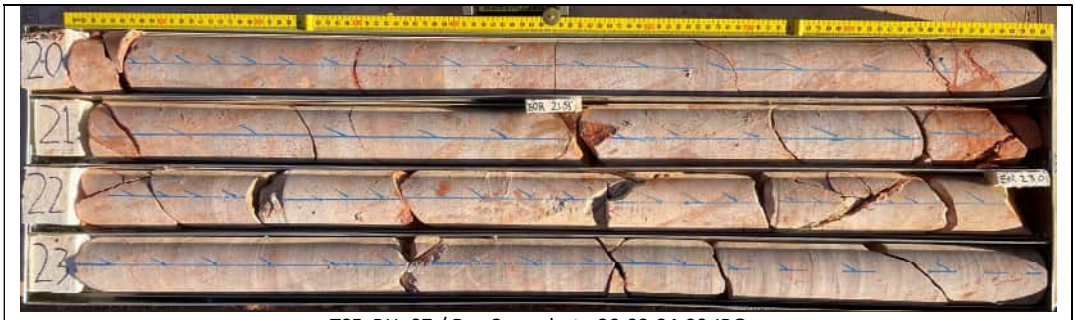
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TSF_BH_07 / Wet Core photo 16.00-20.00.JPG



TSF_BH_07 / Dry Core photo 20.00-24.00.JPG



TSF_BH_07 / Dry Core photo 24.00-24.50.JPG

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_06



TSF_BH_07 / Site Photo 1.jpg



TSF_BH_07 / Site Photo 2.jpg



TSF_BH_07 / Site Photo 3.jpg

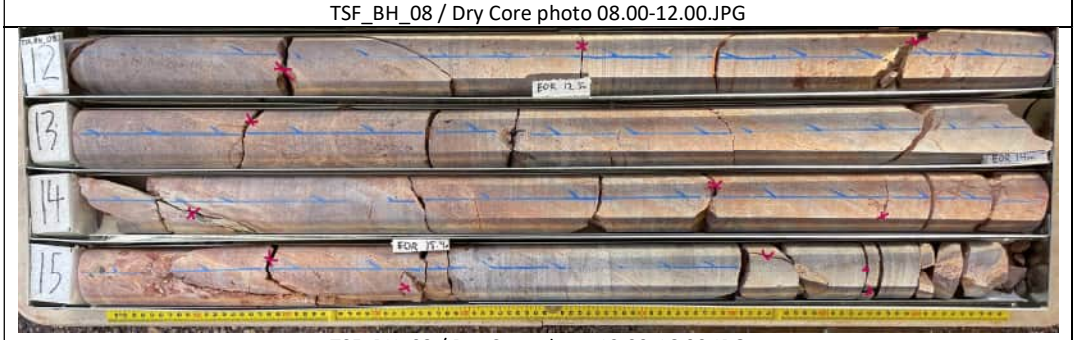
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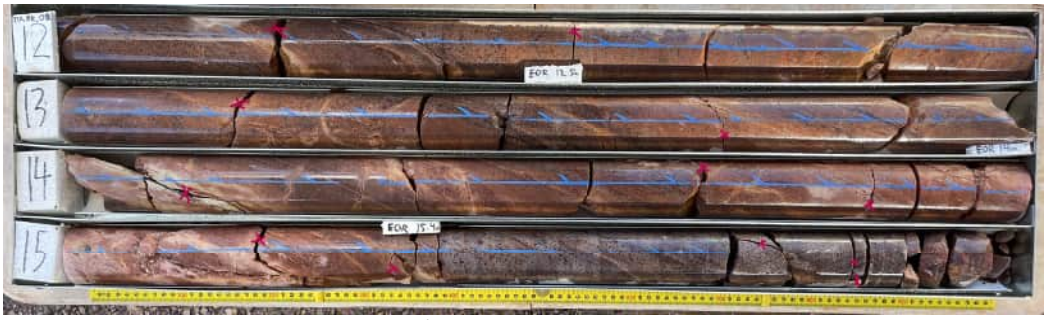
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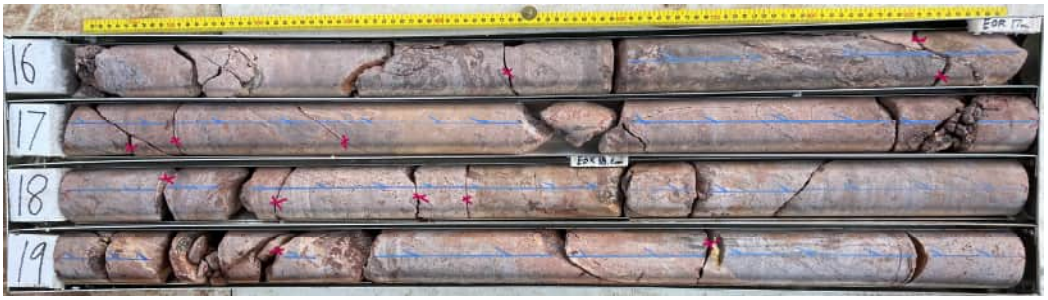
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TSF_BH_08 / Dry Core photo 16.00-20.00.JPG



TSF_BH_08 / Wet Core photo 16.00-20.00.JPG



TSF_BH_08 / Dry Core photo 20.00-24.00.JPG



TSF_BH_08 / Wet Core photo 20.00-24.00.JPG



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Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_06



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TSF_BH_09 / Sonic Core photo 02.00-04.00.jpg



TSF_BH_09 / Sonic Core photo 04.00-06.00.jpg



TSF_BH_09 / Sonic Core photo 06.00-08.00.jpg



TSF_BH_09 / Sonic Core photo 10.00-12.00.jpg



TSF_BH_09 / Sonic Core photo 12.00-14.00.jpg



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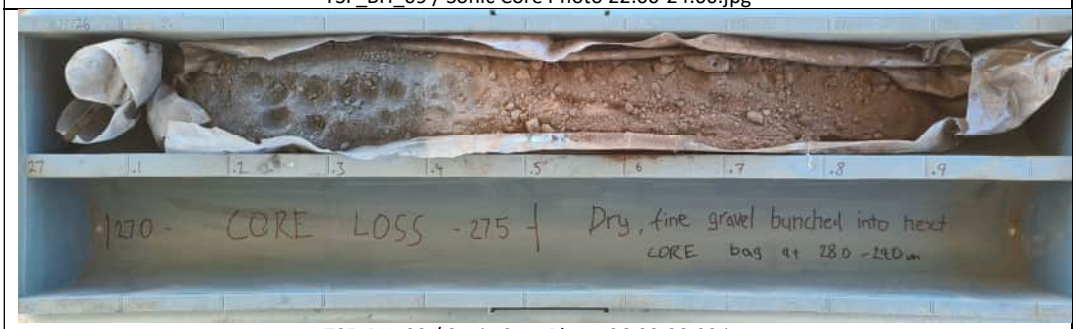
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TSF_BH_09 / Sonic Core Photo 26.00-28.00.jpg



TSF_BH_09 / Sonic Core Photo 28.00-30.00.jpg



TSF_BH_09 / Sonic Core Photo 30.00-32.00.jpg



TSF_BH_09 / Sonic Core Photo 32.00-34.00.jpg



TSF_BH_09 / Sonic Core Photo 34.00-36.00.jpg



TSF_BH_09 / Sonic Core Photo 36.00-38.00.jpg



TSF_BH_09 / Sonic Core photo 38.00-40.00.jpg



TSF_BH_09 / Sonic Core photo 40.00-42.00.jpg



TSF_BH_09 / Sonic Core photo 42.00-44.00.jpg



TSF_BH_09 / Sonic Core photo 46.00-48.00 DRY.jpg



TSF_BH_09 / Sonic Core photo 46.00-48.00 Wet.jpg



TSF_BH_09 / Dry Core photo 48.00-52.00.jpg



TSF_BH_09 / Wet Core photo 48.00-52.00.jpg



TSF_BH_09 / Dry Core photo 52.00-54.34.jpg



TSF_BH_09 / Wet Core photo 52.00-54.34.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_09



TSF_BH_09 / Site Photo Set Up SE.jpg



TSF_BH_09 / Site Photo Post Drill.jpg

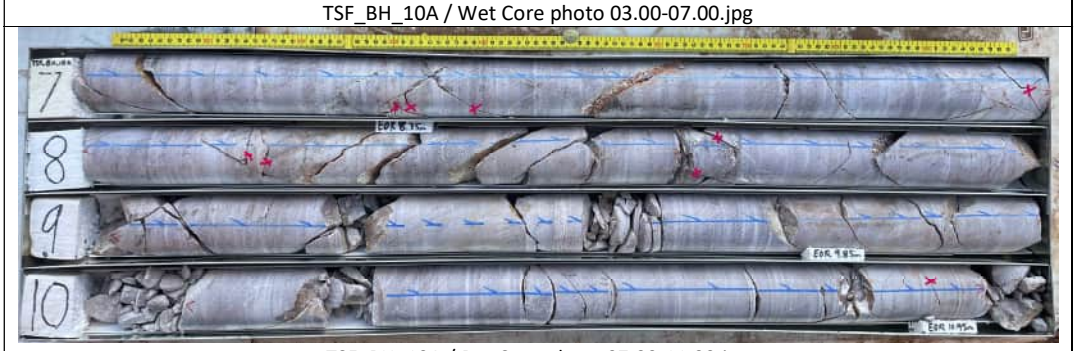
Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_09



TSF_BH_10A / Dry Core photo 03.00-07.00.jpg



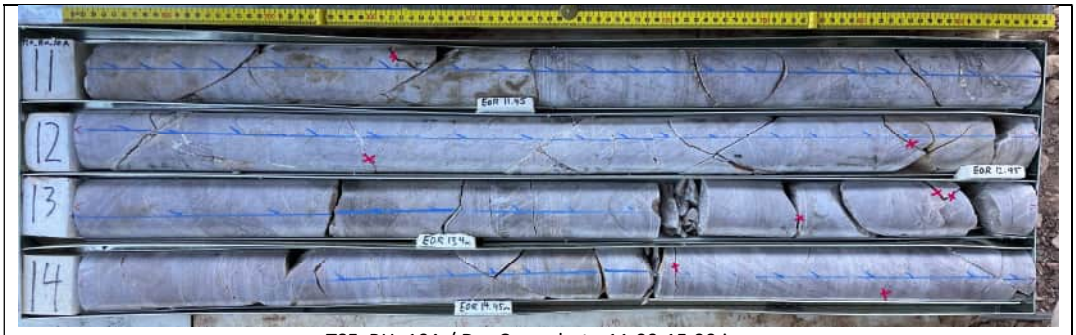
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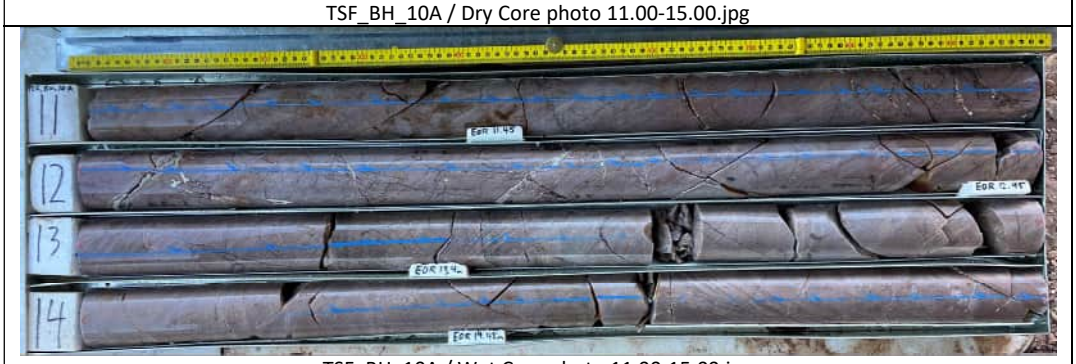
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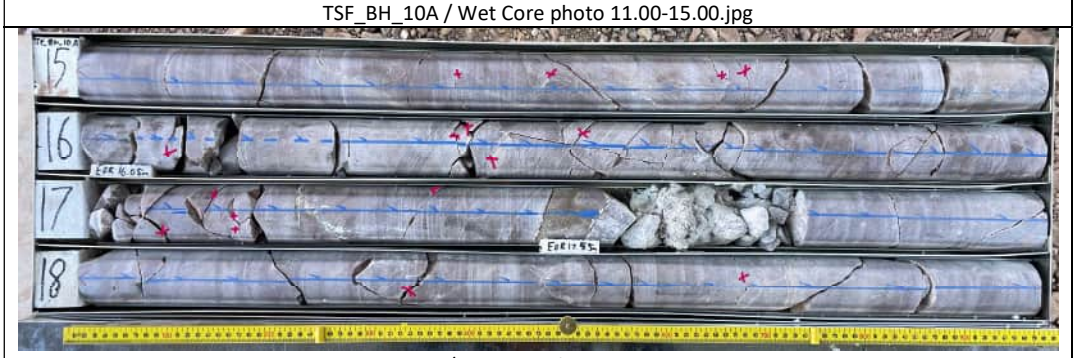
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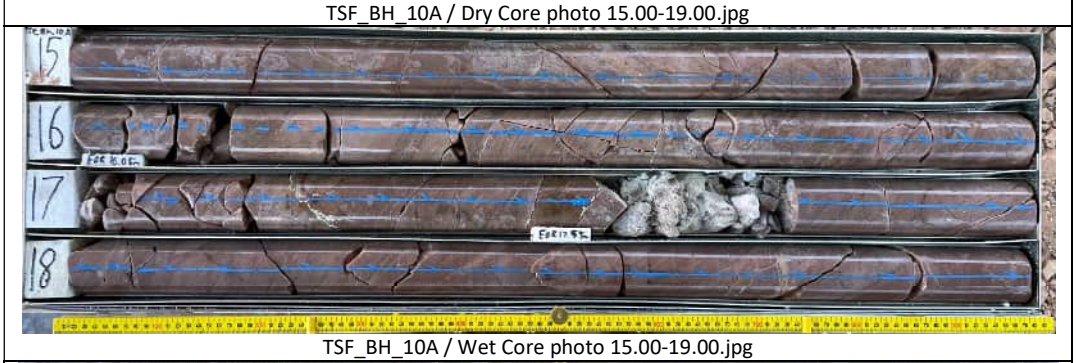
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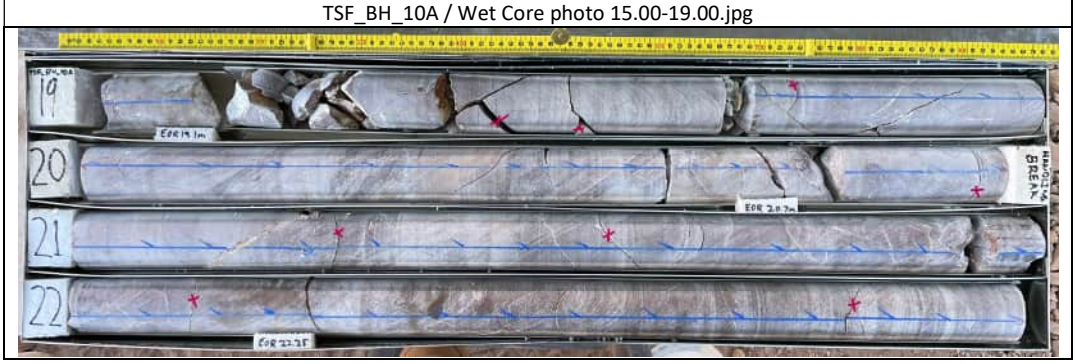
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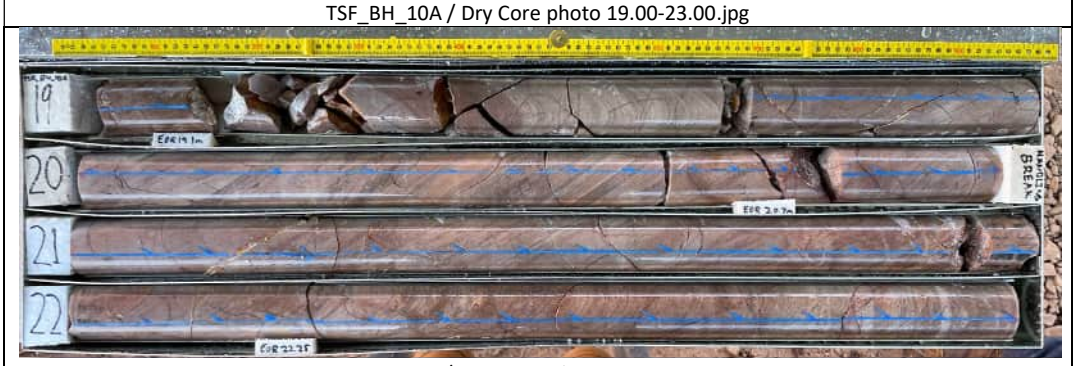
TSF_BH_10A / Dry Core photo 15.00-19.00.jpg



TSF_BH_10A / Wet Core photo 15.00-19.00.jpg



TSF_BH_10A / Dry Core photo 19.00-23.00.jpg



TSF_BH_10A / Wet Core photo 19.00-23.00.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_10A



TSF_BH_10A / Site Photo.jpg



TSF_BH_10A / Site Photo Post Drill.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_10A



TSF_BH_12 / Dry Core photo 00.00-04.00.jpg



TSF_BH_12 / Wet Core photo 00.00-04.00.jpg



TSF_BH_12 / Dry Core photo 04.00-08.00.jpg



TSF_BH_12 / Wet Core photo 04.00-08.00.jpg



TSF_BH_12 / Dry Core photo 08.00-12.00.jpg



TSF_BH_12 / Wet Core photo 08.00-12.00.jpg



TSF_BH_12 / Dry Core photo 12.00-15.20.jpg



TSF_BH_12 / Wet Core photo 12.00-15.20.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_12



TSF_BH_12 / Site Photo Post Drill East.jpg



TSF_BH_12 / Site Photo Post Drill North.jpg

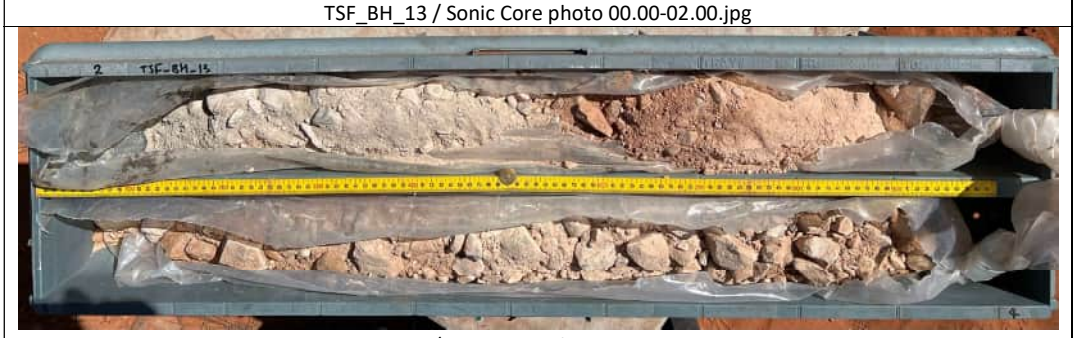


TSF_BH_12 / Site Photo Set Up North.jpg

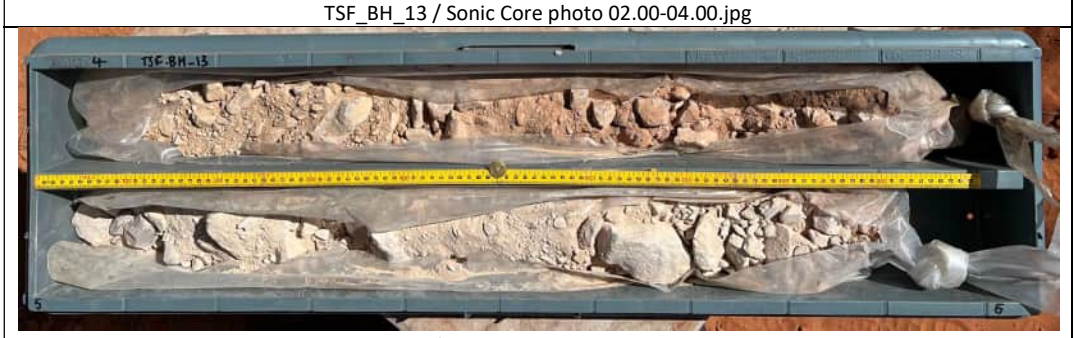
Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_12



TSF_BH_13 / Sonic Core photo 00.00-02.00.jpg



TSF_BH_13 / Sonic Core photo 02.00-04.00.jpg



TSF_BH_13 / Sonic Core photo 04.00-06.00.jpg



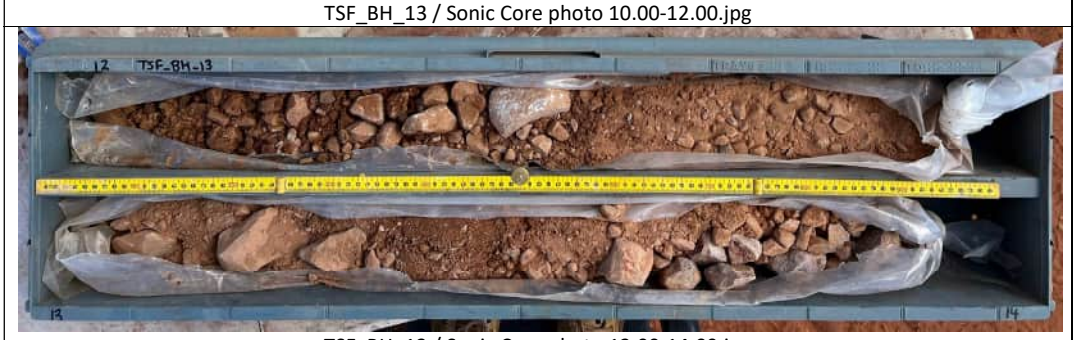
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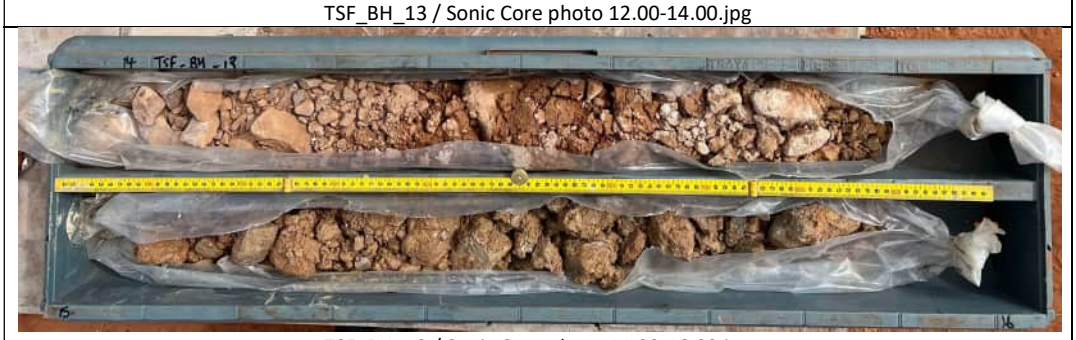
TSF_BH_13 / Sonic Core photo 08.00-10.00.jpg



TSF_BH_13 / Sonic Core photo 10.00-12.00.jpg



TSF_BH_13 / Sonic Core photo 12.00-14.00.jpg

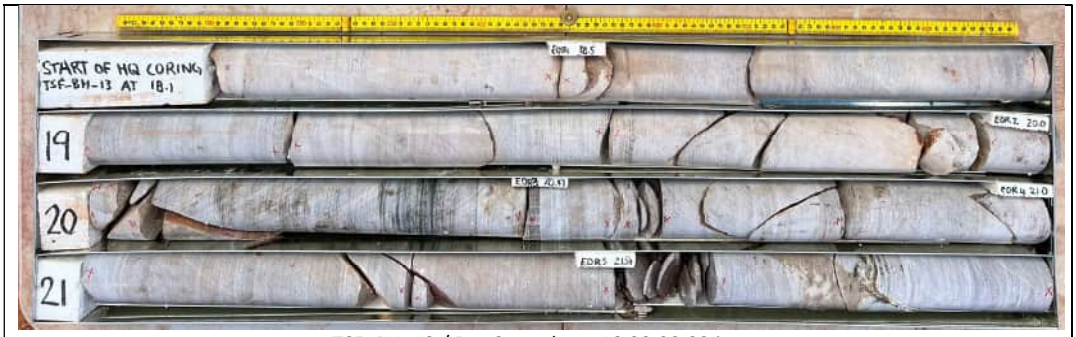


TSF_BH_13 / Sonic Core photo 14.00-16.00.jpg



TSF_BH_13 / Sonic Core photo 16.00-18.00.jpg





TSF_BH_13 / Dry Core photo 18.00-22.00.jpg



TSF_BH_13 / Wet Core photo 18.00-22.00.jpg



TSF_BH_13 / Dry Core photo 22.00-26.00.jpg



TSF_BH_13 / Wet Core photo 22.00-26.00.jpg



TSF_BH_13 / Dry Core photo 26.00-30.00.jpg



TSF_BH_13 / Wet Core photo 26.00-30.00.jpg



TSF_BH_13 / Dry Core photo 30.00-32.60.jpg



TSF_BH_13 / Dry Core photo 30.00-32.60.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_13



TSF_BH_13 / Site Photo borehole.jpg



TSF_BH_13 / Site Photo E-SE.jpg



TSF_BH_13 / Site Photo E.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_13



TSF_BH_14 / Sonic Core photo 00.00-02.00.jpg



TSF_BH_14 / Sonic Core photo 02.00-04.00.jpg



TSF_BH_14 / Sonic Core photo 04.00-06.00.jpg



TSF_BH_14 / Sonic Core photo 06.00-08.00.jpg



TSF_BH_14 / Sonic Core photo 08.00-10.00.jpg



TSF_BH_14 / Sonic Core photo 10.00-12.00.jpg



TSF_BH_14 / Sonic Core photo 12.00-14.00.jpg



TSF_BH_14 / Sonic Core photo 14.00-16.00.jpg



TSF_BH_14 / Sonic Core photo 16.00-17.40.jpg



TSF_BH_14 / Core photo 17.00-21.00 DRY.jpg



TSF_BH_14 / Core photo 17.00-21.00 WET.jpg



TSF_BH_14 / Core photo 21.00-22.50 DRY.jpg



TSF_BH_14 / Sonic Core photo 21.00-22.50 WET.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_14



TSF_BH_14 / Site Photo E.jpg



TSF_BH_14 / Site Photo N.jpg



TSF_BH_14 / Site Photo NW.jpg



TSF_BH_14 / Site Photo SW.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_14



TSF_BH_15A / Dry Core photo 00.00-04.00.jpg



TSF_BH_15A / Wet Core photo 00.00-04.00.jpg



TSF_BH_15A / Dry Core photo 04.00-08.00.jpg



TSF_BH_15A / Wet Core photo 04.00-08.00.jpg



TSF_BH_15A / Dry Core photo 08.00-12.00.jpg



TSF_BH_15A / Wet Core photo 08.00-12.00.jpg



TSF_BH_15A / Dry Core photo 12.00-16.00.jpg



TSF_BH_15A / Wet Core photo 12.00-16.00.jpg



TSF_BH_15A / Wet Core photo 16.00-20.00.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Core Photos BH ID: TSF_BH_15A



TSF_BH_15A / Site Photo Pre-Drill East.jpg



TSF_BH_13 / Site Photo Pre-Drill North.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_BH_15A



TSF_TP_02 / Post Excavation Site Photo.jpg



TSF_TP_02 / Pre Excavation Site Photo.jpg



TSF_TP_02 / Spoil Photo.jpg



TSF_TP_02 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_02



TSF_TP_06 / Post Excavation Site Photo.jpg



TSF_TP_06 / Pre Excavation Site Photo.jpg



TSF_TP_06 / Spoil Photo.jpg



TSF_TP_06 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_06



TSF_TP_08 / Post Excavation Site Photo.jpg



TSF_TP_08 / Pre Excavation Site Photo.jpg



TSF_TP_08 / Spoil Photo.jpg



TSF_TP_08 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_08



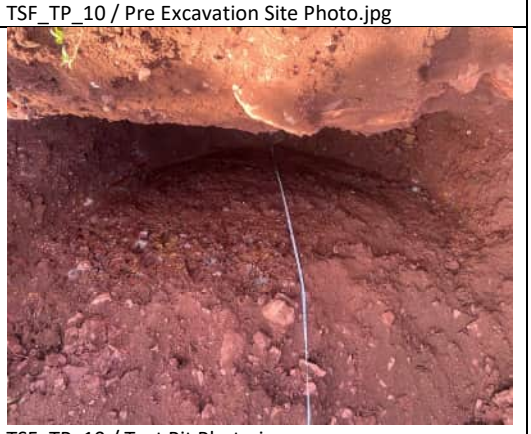
TSF_TP_10 / Post Excavation Site Photo.jpg



TSF_TP_10 / Pre Excavation Site Photo.jpg



TSF_TP_10 / Spoil Photo.jpg



TSF_TP_10 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_10



TSF_TP_11 / Post Excavation Site Photo.jpg



TSF_TP_11 / Pre Excavation Site Photo.jpg



TSF_TP_11 / Spoil Photo.jpg



TSF_TP_11 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_11



TSF_TP_12 / Post Excavation Site Photo.jpg



TSF_TP_12 / Pre Excavation Site Photo.jpg

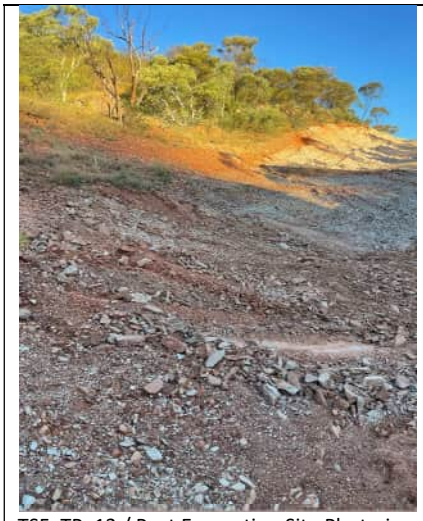


TSF_TP_12 / Spoil Photo.jpg



TSF_TP_12 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_12



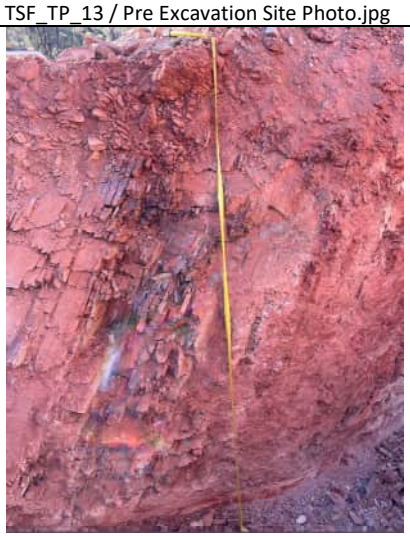
TSF_TP_13 / Post Excavation Site Photo.jpg



TSF_TP_13 / Pre Excavation Site Photo.jpg

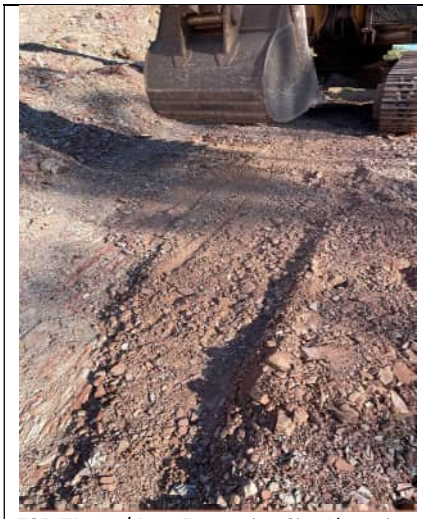


TSF_TP_13 / Spoil Photo.jpg



TSF_TP_13 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_13



TSF_TP_14 / Post Excavation Site Photo.jpg



TSF_TP_14 / Pre Excavation Site Photo.jpg



TSF_TP_14 / Spoil Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_14



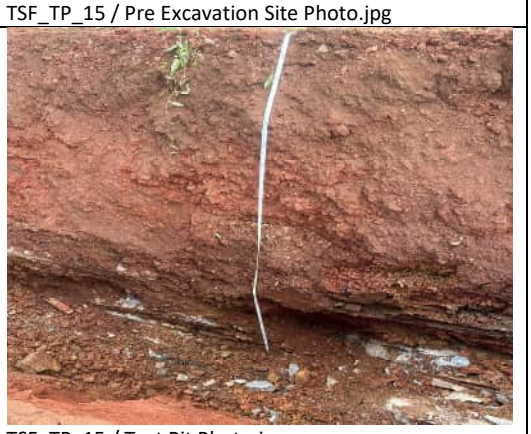
TSF_TP_15 / Post Excavation Site Photo.jpg



TSF_TP_15 / Pre Excavation Site Photo.jpg



TSF_TP_15 / Spoil Photo.jpg



TSF_TP_15 / Test Pit Photo.jpg

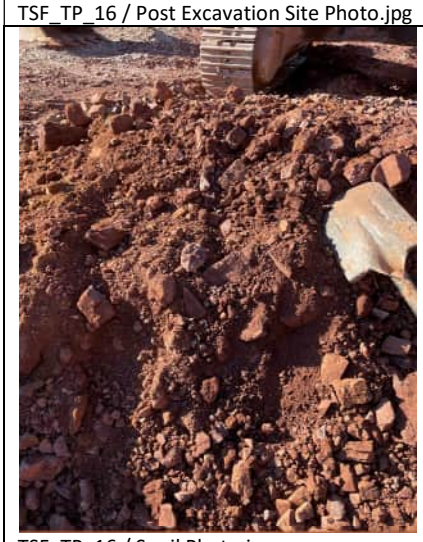
Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_15



TSF_TP_16 / Post Excavation Site Photo.jpg



TSF_TP_16 / Pre Excavation Site Photo.jpg



TSF_TP_16 / Spoil Photo.jpg



TSF_TP_16 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_16



TSF_TP_17 / Post Excavation Site Photo.jpg



TSF_TP_17 / Pre Excavation Site Photo.jpg



TSF_TP_17 / Spoil Photo.jpg



TSF_TP_17 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_17



TSF_TP_18 / Post Excavation Site Photo.jpg



TSF_TP_18 / Pre Excavation Site Photo.jpg



TSF_TP_18 / Spoil Photo 2.jpg



TSF_TP_18 / Spoil Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_18



TSF_TP_19 / Pre Excavation Site Photo.jpg



TSF_TP_19 / Spoil Photo.jpg



TSF_TP_19 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_19



TSF_TP_21 / Post Excavation Site Photo.jpg



TSF_TP_21 / Pre Excavation Site Photo.jpg

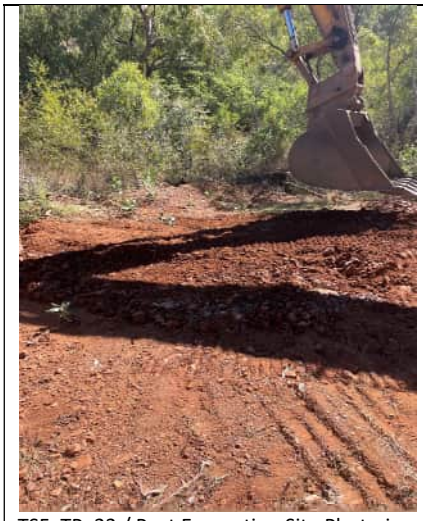


TSF_TP_21 / Spoil Photo.jpg



TSF_TP_21 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_21



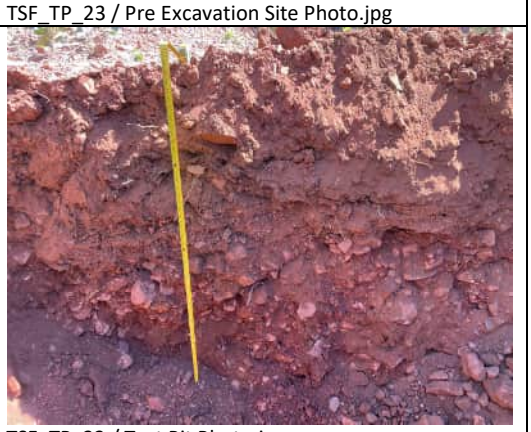
TSF_TP_23 / Post Excavation Site Photo.jpg



TSF_TP_23 / Pre Excavation Site Photo.jpg



TSF_TP_23 / Spoil Photo.jpg



TSF_TP_23 / Test Pit Photo.jpg

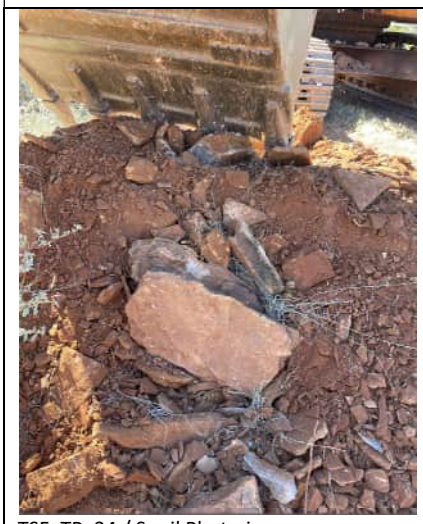
Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_23



TSF_TP_24 / Post Excavation Site Photo.jpg



TSF_TP_24 / Pre Excavation Site Photo.jpg



TSF_TP_24 / Spoil Photo.jpg



TSF_TP_24 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_24



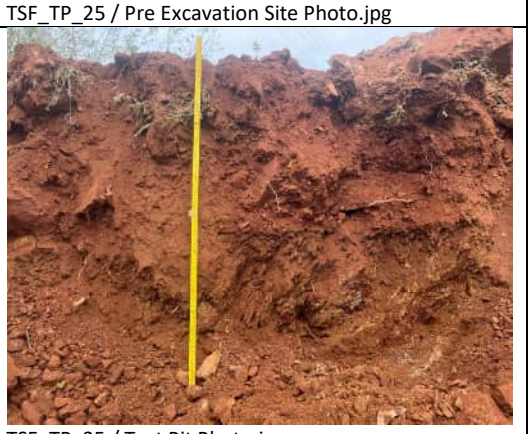
TSF_TP_25 / Post Excavation Site Photo.jpg



TSF_TP_25 / Pre Excavation Site Photo.jpg



TSF_TP_25 / Spoil Photo.jpg



TSF_TP_25 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_25



TSF_TP_WRD1 / Pre Excavation Site Photo.jpg



TSF_TP_WRD1 / Spoil Photo.jpg



TSF_TP_WRD1 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_WRD1



TSF_TP_WRD2 / Post Excavation Site Photo.jpg



TSF_TP_WRD2 / Pre Excavation Site Photo.jpg



TSF_TP_WRD2 / Spoil Photo.jpg



TSF_TP_WRD2 / Test Pit Photo.jpg

Date: September 12, 2024 Scale: NTS Original Size: A4	ENGENY	Client: 29 Metals Project: TSF 3 Geotechnical Investigation Title: Site photos and Material photos BH ID: TSF_TP_WRD2

ENGENY

Cored Borehole Log

TSF_BH_01

Sheet: **1** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327556 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**30/3/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 318.4 m**	Date completed:	**31/3/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**25.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0	318.3		100		**Sandy GRAVEL with silt:** red-brown, fine to medium grained, angular to sub-angular quartzite clasts, medium to coarse grained sand	M	GW	L			
					Sandy GRAVEL with silt: dark grey, fine to medium grained, angular to sub-angular quartzite clasts, medium to coarse grained sand	M					
	317.7		(0)		**Sandy CLAY:** medium plasticity, dark brown, medium to coarse grained sand, trace fine grained angular to subangular gravel	w< PL	CI	H			
1	317		100		**GRAVEL with sand:** dark grey, fine to medium grained, angular to sub-angular carbonaceous siltstone, fine to coarse sand, trace silt, trace pyrite	D	GW	L			
	316.6				**Sandy GRAVEL:** dark red-brown, fine to medium grained, angular to sub-angular quartzite clasts, medium to coarse grained sand, with silt						
2	316.2		(0)		**Sandy GRAVEL with clay:** dark red-brown, fine to medium grained, angular to sub-angular clasts of siltstone, medium to coarse grained sand, low plasticity clay						
	315.8		90		**Gravelly SAND with silt:** dark red-brown, medium to coarse grained sand, fine to medium grained, angular to sub-angular clasts of siltstone		SW				
	315.5				**Gravelly SAND with silt:** pale brown, fine to medium grained sand, fine to medium grained, angular to sub-angular clasts of siltstone						
3	315.4				**Sandy CLAY with gravel:** low plasticity, dark grey, medium to coarse grained sand, fine to medium, angular to sub-angular siltstone clasts	w< PL	CI	H			
	314.6				**Sandy GRAVEL:** dark grey, fine to medium, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt	D	GW	L			
4	314.4		(0)		**Sandy GRAVEL:** pale grey, fine to medium grained, anuglar to sub-angular siltstone clasts, medium to coarse grained sand, trace silt						
	314.1				**Sandy GRAVEL with silt:** dark brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand	M					
	313.8				**Sandy CLAY with gravel:** medium plasticity, dark red, medium to coarse grained sand, fine grained, angular siltstone clasts	w< PL	CI	H			
5	313.4	Sonic									

ENGENY

Cored Borehole Log

TSF_BH_01

Sheet: **2** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327556 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**30/3/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 318.4 m**	Date completed:	**31/3/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**25.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5			100		**Sandy GRAVEL:** dark red-brown, fine to medium grained, angular to sub-angular quartzite and siltstone clasts, medium to coasre grained sand, with silt	M	GW	L			
6			(0)								
			100			W					
7	311.4				**Sandy GRAVEL:** dark grey, fine to medium grained, angular to sub-angular quartzite and siltstone clasts, medium to coasre grained sand,with silt						
			(0)								
8						D					
	310.1		100		**Clayey GRAVEL with sand:** dark brown, fine to medium grained, angular to sub-angular siltstone clasts, medium plasticity clay, medium to coarse grained sand	M	GC	D			
9	309.4		(0)		**Clayey GRAVEL with sand:** dark red-brown, fine to medium grained, angular to sub-angular siltstone clasts, low plasticity clay, medium to coarse grained sand		GW				
			94								
10											

ENGENY

Cored Borehole Log

TSF_BH_01

Sheet: **3** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327556 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**30/3/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 318.4 m**	Date completed:	**31/3/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**25.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10			(0)								
11	307.4	Sonic	100		**CLAY with sand:** high plasticity, dark red-brown, fine to medium grained sand	w< PL	CH	St			
12			(0)					VSt			
13			100								
14			(0)								
	304.1		100		**Sandy CLAY:** medium plasticity, dark grey-brown, medium to coarse grained sand, trace fine grained, angular clasts of siltstone		CI				
15	303.4		(0)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_01

Sheet: **4** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327556 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**30/3/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 318.4 m**	Date completed:	**31/3/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**25.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15					**Sandy GRAVEL with silt:** dark brown, fine to medium, angular to sub-angular siltstone, quartzite and chert clasts, medium to coarse grained sand		GW	D			
			100								
16	302.4				**Sandy CLAY with gravel:** medium plasticity, dark red-brown, medium to coarse grained sand, fine to medium grained, angular to sub-angular siltstone clasts		Cl	St			
	302				**Sandy GRAVEL with silt:** dark grey, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand	M	GW	D			
			(0)								
17											
			100								
	300.7				**Gravelly CLAY with sand:** low plasticity, dark red-brown, fine to medium, angular to sub-angular siltstone clasts	w= PL	Cl	VSt			
18	300.4		(0)		**CLAY with gravel:** medium plasticity, dark red-brown, fine grained, angular to sub-angular siltstone clasts, trace medium to coarse grained sand						
	300.2				**Sandy GRAVEL with clay:** dark grey, fine to medium, angular to sub-angular siltstone clasts, medium to coarse grained sand, medium plasticity clay	M	GW	D			
			100								
	299.9				**Sandy SILT:** low plasticity, mottled grey-brown, fine to medium grained sand, trace fine grained, angular weathered siltstone clasts	w< PL	ML	H			
			(0)								
19	299.4		100		**Sandy GRAVEL with silt:** dark grey, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, common chalcopyrite	M	GW	D			
			(0)								
20											

ENGENY

Cored Borehole Log

TSF_BH_01

Sheet: **5** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327556 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**30/3/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 318.4 m**	Date completed:	**31/3/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**25.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20	298		100 / (0)		**Sandy GRAVEL:** dark red-brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace clay			VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		
21											
22	295.9		100 / (0)		**Clayey SAND with gravel:** dark red-brown, medium to coarse grained sand, medium plasticity clay, fine to medium, angular to sub-angular siltstone clasts		SC				
23	295.5		100		**Sandy GRAVEL with silt:** pale brown, fine to medium grained, angular to sub-angular silstone clasts, medium to coarse grained sand	D	GM	L			
24	294.9		100 / (0)		**Clayey GRAVEL with sand:** dark red-brown, fine to medium, angular to sub-angular siltstone clasts, low plasticity clay, medium to coarse grained sand	M	GC	D			
25	293.4										

ENGENY

Cored Borehole Log

TSF_BH_02

Sheet: **1** of: **3**

Project:	**TSF3 GI Support**	Easting:	**327641 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820420 m**	Date commenced:	**31/3/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 297.8 m**	Date completed:	**1/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**15.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**Sandy GRAVEL with silt:** pale brown, fine to medium grained, angular to subangular clasts of siltstone and quartzite, medium to coarse grained sand	D	GW	L			
			100		becoming dark grey						
1	296.8		(0)		**Clayey GRAVEL with sand:** dark red-brown, fine grained, angular to sub-angular siltstone clasts, medium pasticity, medium to coarse grained sand, trace siltstone cobbles	M	GC	MD			
			100								
2	295.8				**Sandy GRAVEL:** dark grey, fine to medium grained, angular to sub-angular siltstone clasts, trace silt	D	GW				
	295.5				**Sandy GRAVEL:** dark red-brown, fine to medium grained, angular to sub-angular siltstone clasts, trace cobbles	M					
			(0)								
3			64								
	294.3				**CORE LOSS:**						
4	293.8		(0)		**Sandy GRAVEL:** dark red-brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt, trace cobbles	M	GW	MD			
			100								
5		Sonic									

ENGENY

Cored Borehole Log

TSF_BH_02

Sheet: **2** of: **3**

Project:	**TSF3 GI Support**	Easting:	**327641 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820420 m**	Date commenced:	**31/3/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 297.8 m**	Date completed:	**1/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**15.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03/0.6, L 0.1/2, M 0.3/6, H 1/20, VH 3/60, EH 10/200	Average Defect Spacing (mm): <20, 20-60, 60-200, 200-600, 600-2000, >2000	Discontinuity Description	Field Records / Remarks
5			(0)								
			100								
6			(0)								
			100								
7			(0)								
		Sonic	100								
8			(0)								
			100								
9			(0)								
10											

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Cored Borehole Log

TSF_BH_02

Sheet: **3** of: **3**

Project:	**TSF3 GI Support**	Easting:	**327641 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820420 m**	Date commenced:	**31/3/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 297.8 m**	Date completed:	**1/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**15.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10			100 / (0)					VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		
11	286.8		33 / (0)		**CORE LOSS:**						
12	285.8		67 / (0)		**COBBLES (50%) in a Sandy GRAVEL matrix (50%):** dark red-brown, angular to sub-angular silststone clasts, gravel is fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt, trace boulders, sub-angular silstone clasts, trace rubber and wire	M	-	D			
13	284.8				**CORE LOSS:**						
	284.3		67 / (0)		**COBBLES (50%) in a Sandy GRAVEL matrix (50%):** dark red-brown, angular to sub-angular siltstone and quartzite clasts, gravel is fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt, trace boulders, sub-angular silstone clasts	M	-	D			
14											
15	282.8										

ENGENY

Cored Borehole Log

TSF_BH_03

Sheet: **1** of: **4**

Project:	**TSF3 GI Support**	Easting:	**327903 m**
Client:	**29 Metals**	Northing:	**7820228 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.9 m**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**
		Drill depth:	**20.0 m bgl**
Driller:	**GROUNDWAVE**		
Date commenced:	**25/4/2024**		
Date completed:	**26/4/2024**		
Logged by:	**TM**		
Checked by:	**AL**		

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**GRAVEL:** pale red grey, fine to coarse, subangular quartzite gravel	M	GP	L			0 - 1.3m: Surface gravel, full water return
			100								
1			(0)								
	308.6		100		**QUARTZITE:** red grey, medium grained, highly weathered, high strength, fragmented		HW				1.3 - 2.2m: Logged as rock, may be boulders
			(0)								
2											
	307.7		100		**QUARTZITE:** grey with red staining, coarse grained, highly weathered, low strength, fractured					2.44-2.49m: Jt 50° St, Ro, Cl 2.45-2.46m: Jt 10° St, Ro, Cl 2.5-2.55m: Jt 40° Pl, Ro, Cl 2mm 2.59-2.56m: Jt 10° Un, Ro, St	2.2 - 2.8m: handling breaks.
	307.1				**Gravelly SAND:** dark red brown with white staining, fine to medium grained sand, gravel is fine to medium, subangular highly weathered sandstone, trace low plasticity clay		SW	L		2.68-2.71m: cs 10° Ir, Ro, fine subangular gravel In	
3	306.9		(10)		**CORE LOSS:** rod drop 500mm, no return in barrel						
	306.4				**QUARTZITE:** pale grey with dark red staining, fine grained, moderately to highly weathered, medium to high strength,highly fractured		HW			3.5-3.75m: Fz 20° Ir, Ro, St 3.79-3.82m: Sz 60° St, Ro, St	
4			75				MW			4-4.05m: Jt 60° Un, FeO St 4.08-4.1m: Jt 25° Un, Ro, FeO St 4.14-4.19m: Jt 40° Pl, Ro, FeO St 4.16-4.23m: Pt 55° Pl, Ro, FeO St 4.33-4.36m: Jt 30° Un, Ro, FeO St 4.37-4.38m: Jt 10° Un, FeO St 4.45-4.5m: Jt 60° Un, FeO St 4.48-4.52m: Jt 35° Un, FeO St 4.48-4.63m: Jt 75° Un, clay, FeO st Vn 4.66-4.68m: Jt 30° Un, FeO St 4.77-4.82m: Jt 70° Un, FeO St 4.8-4.83m: Jt 40° Un, FeO St 4.86-5m: Jt 80° Pl, FeO St	
5			(22)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_03

Sheet: **2** of: **4**

Project:	**TSF3 GI Support**	Easting:	**327903 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820228 m**	Date commenced:	**25/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.9 m**	Date completed:	**26/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**20.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5										5.23-5.26m: Jt 45° Un, Ro, FeO St 5.25-5.26m: Jt 10° Un, Ro, FeO St 5.32-5.35m: Jt 30° Un, Ro, FeO St 5.38-5.39m: Jt 20° Un, Ro, FeO St 5.46-5.48m: Jt 30° Un, Ro, FeO St 5.51-5.52m: Jt 15° Pl, Ro, FeO St	
	304.2										
			100		**QUARTZITE:** pale grey with dark red staining, fine grained, slightly to moderately weathered, high strength, fractured					5.75-5.77m: Jt 25° Un, FeO St 5.82-5.92m: Jt 80° Un, FeO St 5.85-5.86m: Jt 20° Un, Ro, FeO St 5.95-6m: Jt 40° Un, Ro, FeO St 6-6.06m: Jt 80° Un, Ro, FeO St 6.02-6.24m: Jt 70° Un, Ro, FeO St	
6										6.05-6.07m: Jt 20° Un, Ro, FeO St 6.17-6.18m: Jt 10° Un, Ro, FeO St 6.18-6.34m: Jt 60° Un, Ro, FeO St 6.2-6.33m: Jt 80° Un, Ro, FeO St 6.2-6.42m: Jt 80° Un, Ro, FeO St 6.34-6.4m: Jt 60° Un, Ro, FeO St 6.37-6.5m: Jt 70° Un, Ro, FeO St 6.41-6.45m: Jt 65° Un, FeO St 6.45-6.52m: Jt 80° Un, FeO St 6.59-6.65m: Jt 60° Un, Ro, FeO St: clay Vn	
			(11)							6.75-6.77m: Jt 20° Un, FeO St 6.77-6.93m: Jt 80° Un, Ro, clay Vn: FeO st 6.81-6.82m: Jt 20° Un, Ro, FeO St	
7										7-7.06m: Jt 60° Un, Ro, clay Vn: FeO st 7.06-7.14m: Jt 60° Un, Ro, clay Vn: FeO st 7.11-7.2m: Jt 70° Un, FeO St	
			100							7.2-7.22m: Jt 20° Un, Ro, FeO St 1.5mm 7.21-7.29m: Jt 60° Un, Ro, FeO St 7.29-7.33m: Jt 50° Pl, Ro, FeO St 7.45-7.49m: Jt 40° Un, Ro, FeO St: clay Vn 7.49-7.51m: Jt 25° Un, Ro, clay Vn: FeO st 7.51-7.52m: Jt 10° Un, FeO St 7.61-7.65m: Jt 50° Un, Ro, FeO St 7.64-7.73m: Sz	
										7.88-7.89m: Jt 20° Un, Ro, clay Vn: FeO st 7.92-7.96m: Jt 40° Un, Ro, clay Vn: FeO st	
8			(0)				SW			8.04-8.07m: Jt 70° Un, FeO St 8.11-8.12m: Jt 10° Un, FeO St 8.12-8.13m: Jt 10° Un, FeO St 8.15-8.16m: Jt 30° Un, FeO St 8.16-8.31m: Jt 80° Un, FeO St 8.19-8.22m: Jt 35° Pl, FeO St 8.28-8.32m: Jt 40° Pl, Ro, FeO St 8.31-8.34m: Jt 50° Un, Ro, FeO St 8.42-8.45m: Xwsm 60° Un, Ro, FeO St 8.47-8.5m: Jt 35° Un, Ro, FeO St 8.53-8.59m: Jt 60° Un, Ro, FeO St 8.55-8.67m: Jt 60° Un, FeO St	
			100							8.61-8.68m: Jt 60° Un, FeO St 8.67-8.71m: Jt 40° Un, Ro, clay Vn: FeO st 8.7-8.77m: Jt 60° Un, clay Vn: FeO st 8.73-8.83m: Jt 65° Un, FeO St 8.79-8.8m: Jt 20° Un, Ro, FeO St 8.81-8.82m: Jt 10° Un, FeO St 8.88-8.89m: Jt 10° Un, FeO St	
9										9.04-9.11m: Jt 70° Un, FeO St	
			(51)							9.42-9.43m: Jt 10° Un, Ro, FeO St 9.55-9.58m: Jt 45° Un, Ro, FeO St 9.56-9.65m: Jt 70° Un, FeO St 9.62-9.63m: Jt 29° Un, clay Vn: FeO st 9.66-9.67m: Jt 25° Pl, Ro, FeO St 9.76-9.78m: Jt 20° Un, Ro, FeO St 9.81-9.82m: Jt 10° Pl, Ro, FeO St 9.82-9.91m: Jt 65° Un, FeO St 9.83-9.93m: Jt 75° Un, FeO St	
10		HQ3									

ENGENY

Cored Borehole Log

TSF_BH_03

Sheet: **3** of: **4**

Project:	**TSF3 GI Support**	Easting:	**327903 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820228 m**	Date commenced:	**25/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.9 m**	Date completed:	**26/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**20.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10		HQ3	100				SW	VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200	< 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000	10.05-10.06m: Jt 20° Un, Ro, FeO St 10.09-10.16m: Jt 60° Pl, Ro, FeO St 10.12-10.23m: Jt 80° Un, FeO St 10.13-10.19m: Jt 90° Pl, FeO St 10.18-10.21m: Jt 25° Un, FeO St 10.21-10.27m: Jt 60° Un, FeO St 10.29-10.35m: Jt 80° Un, FeO St 10.37-10.47m: Jt 60° Pl, Ro, FeO St 10.5-10.51m: Jt 10° Pl, Ro, FeO St 10.56-10.57m: Jt 15° Un, FeO St	10.5 - 11m: Sand lense caused rods to bog, drilling mud added
11	298.9		(71)		**SAND:** dark brown, medium grained		SP	L		11-11.19m: Xwsm 1.5mm	
	298.7				**QUARTZITE:** grey with red staining, coarse grained, slightly to moderately weathered, moderate to high strength, fractured		SW			11.55-11.6m: Vn 50° Un, clay Ct 1.5mm 11.56-11.64m: Jt 80° Un, clay Ct 1.5mm	
12			100							11.66-11.95m: Jt 80° Un, Ro, clay Ct: <2mm, FeO st 12.16-12.49m: Jt 75° Un, Ro, FeO St	
13			(73)							12.44-12.46m: Jt 30° Un, Ro, FeO St 12.53-12.54m: Jt 20° Ir, Ro, 12.63-12.64m: Jt 20° Un, FeO St 12.75-12.91m: Pt 65° Pl, Ro, FeO St 12.77-12.88m: Jt 80° Un, FeO St 13.02-13.04m: Jt 20° Un, Ro, FeO St 13.1-13.16m: Jt 60° Un, FeO St 13.2-13.23m: Jt 20° Un, Ro, clay Vn	
14			100							13.56-13.6m: Jt 40° Pl, Ro, FeO St 13.6-13.67m: Jt 65° Pl, Ro, FeO St 13.65-13.68m: Jt 60° Un, clay Vn 13.68-13.75m: Jt 60° Pl, clay Vn 13.75-13.8m: Jt 70° Pl, clay Vn 13.85-13.86m: Jt 40° Un, Ro, clay Vn	
15			(89)							14.09-14.13m: Pt 50° Pl, Ro, FeO St 14.29-14.35m: Jt 40° Un, Ro, FeO St 14.31-14.39m: Jt 50° Un, Ro, FeO St 14.47-14.56m: Jt 40° Pl, Ro, clay Vn 14.58-14.6m: Jt 20° Pl, FeO St	
			100							14.69-14.77m: Pt 50° Pl, Ro, FeO St 14.74-14.81m: Pt 50° Pl, Ro, FeO St 14.84-14.91m: Jt 70° Un, clay Vn 14.87-14.94m: Jt 70° Un, clay Vn 14.88-14.92m: Jt 40° Un, Ro, FeO St	

ENGENY

Cored Borehole Log

TSF_BH_03

Sheet: 4 of: 4

Project:	TSF3 GI Support	Easting:	327903 m	Driller:	GROUNDWAVE
Client:	29 Metals	Northing:	7820228 m	Date commenced:	25/4/2024
Location:	Proposed TSF3 Site / Borrow	Ground elevation:	RL 309.9 m	Date completed:	26/4/2024
Job number:	QC1022_018	Dip: -90° Azimuth: -°		Logged by:	TM
		Drill depth:	20.0 m bgl	Checked by:	AL

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15									Vl 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000	14.97-15.02m: Jt 25° Un, Ro, FeO St 15.02-15.05m: Jt 50° Un, clay Vn 15.1-15.11m: Jt 20° Un, FeO St 1.5mm 15.19-15.2m: Jt 30° Un, FeO St 15.22-15.31m: Pt 50° Pl, Ro, clay Ct: <2mm	
			(82)								15.44-15.48m: Jt 35° Un, Ro, FeO St 15.49-15.5m: Jt 10° Pl, Ro, FeO St: clay Vn 15.5-15.56m: Jt 40° Un, Ro, FeO St 15.54-15.56m: Jt 20° Ir, Ro, FeO St 15.55-15.63m: Jt 70° Un, FeO St 15.61-15.7m: Jt 60° Un, clay Vn 15.64-15.75m: Jt 70° Un, Ro, clay Vn 1.5mm 15.66-15.73m: Jt 45° Un, clay Vn 15.66-15.75m: Jt 60° Un, clay Ct 15.67-15.79m: Jt 60° Un, Ro, FeO St	
16											15.94-16.06m: Jt 65° Un, Ro, FeO St 1.5mm 16.02-16.09m: Jt 60° Un, clay Ct 1.5mm 16.03-16.16m: Jt 70° Un, clay Ct 1.5mm	
			100								16.1-16.18m: Jt 45° Un, FeO St 16.12-16.16m: Jt 60° Un, FeO St 16.16-16.19m: Jt 35° Un, Ro, FeO St: clay Vn 16.18-16.31m: Jt 80° Un, FeO St 16.19-16.28m: Jt 80° Un, FeO St: clay Vn 16.2-16.21m: Jt 10° Un, FeO St: clay Vn 16.24-16.28m: Jt 10° Un, FeO St: clay Vn 16.32-16.35m: Jt 30° Un, FeO St 16.44-16.47m: Jt 40° Un, Ro, FeO St 16.49-16.51m: Jt 20° Un, Ro, FeO St	
											16.69-16.73m: Jt 50° Pl, FeO St 16.73-16.76m: Jt 30° Un, Ro, 16.77-16.83m: Jt 50° Un, Ro, FeO St 16.8-16.84m: Jt 60° Un, FeO St 16.87-16.9m: Jt 40° Un, FeO St: clay vn	
17			(85)								16.95-17m: Xwsm 2mm 17-17.04m: Jt 25° Pl, Ro, FeO St	
			100								17.07-17.14m: Pt 50° Un, clay Ct 2mm: FeO st 17.11-17.16m: Jt 60° Un, clay Vn: FeO st 17.14-17.16m: Jt 35° Un, clay Vn 17.16-17.18m: Jt 25° Un, clay Vn: FeO st 17.19-17.26m: Jt 60° Un, FeO St 17.22-17.27m: Jt 40° Pl, clay Vn: FeO st 17.3-17.39m: Jt 40° Pl, Ro, clay Vn: FeO st 17.31-17.39m: Jt 55° Un, clay Vn: FeO st 17.32-17.44m: Jt 80° Un, clay Vn: FeO st 17.36-17.43m: Jt 70° Pl, clay Vn 2mm: FeO st 17.43-17.47m: Jt 40° Un, Ro, FeO St 2mm: clay Vn 17.45-17.47m: Jt 20° Pl, Ro, clay Ct 4mm: 2mm 17.51-17.53m: Jt 20° Pl, Ro, clay Ct: 2mm 17.59-17.6m: Jt 10° Pl, Ro, clay In: 4mm 17.62-17.69m: Jt 70° Pl, Ro, clay Vn: FeO st 17.64-17.66m: Jt 30° Pl, Ro, FeO St: clay Vn 17.7-17.71m: Jt 10° Un, clay Vn: FeO st 17.71-17.88m: Jt 70° Un, clay Ct 1.5mm: FeO st 17.73-17.75m: Jt 20° Un, clay Ct 1.5mm: FeO st 17.78-17.79m: Jt 10° Un, Ro, clay Vn: FeO st 17.85-17.8m: Jt 40° Un, clay Vn: FeO st 17.81-17.85m: Jt 50° Pl, clay Vn 4mm: FeO st 17.84-17.87m: Jt 30° Un, FeO St 10mm 17.88-17.9m: Jt 20° Pl, Ro, clay In: 4mm 17.9-17.96m: Jt 40° Un, Ro, clay In: 10mm 18.01-18.03m: Jt 20° Un, FeO St 18.05-18.14m: Jt 60° Un, FeO St 18.11-18.21m: Jt 60° Pl, clay Vn: FeO st 18.26-18.35m: Jt 60° Pl, Ro, clay Vn: FeO st 18.28-18.31m: Jt 30° Un, clay Vn: FeO st 18.32-18.35m: Jt 50° Pl, clay Ct 1.5mm: FeO st 18.36-18.4m: Jt 30° Pl, Ro, FeO St 18.36-18.45m: Jt 50° Pl, Ro, FeO St: clay Vn 18.52-18.58m: Jt 45° Pl, Ro, clay Vn 2mm: FeO st 18.55-18.62m: Jt 60° Pl, FeO St 18.6-18.72m: Pt 60° Un, clay Ct 2mm 18.65-18.71m: Jt 70° Un, clay Vn 18.69-18.78m: Jt 65° Un, clay Vn 18.71-18.76m: Jt 70° Un, clay Vn 18.71-18.81m: Jt 60° Un, clay Ct 2mm 18.75-18.81m: Jt 45° Un, Ro, clay Vn 18.81-18.85m: Jt 35° Pl, Ro, FeO St 18.82-18.88m: Jt 40° Cv, Ro, FeO St 18.84-18.91m: Jt 70° Un, clay Vn: FeO st 18.89-18.95m: Jt 50° Un, Ro, clay Vn: FeO st 18.9-19.03m: Jt 75° Pl, clay Vn 18.92-18.94m: Jt 15° Un, Ro, FeO St 19.09-19.11m: Jt 20° Pl, Ro, clay Vn 19.11-19.15m: Jt 40° Un, clay Vn 19.12-19.15m: Jt 20° Un, Ro, clay Vn 19.13-19.18m: Jt 80° Cv, clay Vn 19.15-19.17m: Jt 20° Cv, clay Vn 2mm 19.18-19.27m: Jt 55° Un, clay Vn 19.21-19.3m: Jt 50° Pl, Ro, clay Ct: 2mm, FeO st 19.25-19.26m: Jt 10° Un, Ro, FeO St 19.28-19.31m: Jt 50° Un, FeO St 19.3-19.31m: Jt 10° Un, clay Vn: FeO st 19.38-19.39m: Jt 10° Pl, clay Vn: FeO st 19.39-19.43m: Jt 30° Pl, Ro, clay Vn: FeO st 19.39-19.55m: Jt 80° Un, clay Vn: FeO st 19.52-19.57m: Jt 50° Un, Ro, FeO St: clay Vn 19.53-19.57m: Jt 45° Un, Ro, FeO St: clay Vn 19.58-19.59m: Jt 0° Un, clay Vn	
18												
			(70)									
19												
			100									
20	289.9		(75)									

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Cored Borehole Log

TSF_BH_04

Sheet: **1** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**Sandy GRAVEL:** dark grey, fine to medium, angular to sub-angular quartzite and siltstone clasts, medium to coarse grained sand, trace silt, trace sub-angular quartzite cobbles	D	GW	VL			
1			100								
2					carbonaceous siltstone clasts						
3	309.7		(0)		**COBBLES and GRAVEL:** brown, angular to sub-angular siltstone clasts, medium to coarse grained, angular to sub-angular silstone clasts, trace coarse grained sand	M					
4	308.5				**Sandy GRAVEL:** dark grey, fine to medium, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt		GW				
5		Sonic	100								

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Cored Borehole Log

TSF_BH_04

Project:	**TSF3 GI Support**	Easting:	**328056 m**
Client:	**29 Metals**	Northing:	**7820579 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**
		Drill depth:	**80.2 m bgl**
Driller:	**GROUNDWAVE**		
Date commenced:	**12/4/2024**		
Date completed:	**19/04/204**		
Logged by:	**CM/TM**		
Checked by:	**AL**		

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5											
6			(0)								
7											
	305.2		100		**Sandy GRAVEL:** dark brown, fine to medium, angular to sub-angular weathered siltstone clasts, medium to coarse grained sand, trace silt		GP				
8											
9	303.7		(0)		**Sandy GRAVEL with clay:** dark brown, fine to medium, angular to sub-angular weathered siltstone clasts, medium to coarse grained sand, low plasticity clay			D			
10	302.7										

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

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Cored Borehole Log

TSF_BH_04

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10			100		**Sandy GRAVEL:** dark brown, fine to medium, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace clay, trace plastic			L			
11											
12			(0)								
13			100								
14											
15			(0)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

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Cored Borehole Log

TSF_BH_04

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15								VL 0.03 / 0.6, L 0.1 / 2, M 0.3 / 6, H 1 / 20, VH 3 / 60, EH 10 / 200	< 20, 20 - 60, 60 - 200, 200 - 600, 600 - 2000, > 2000		
	297.2				**Gravelly SAND with clay:** dark brown, medium to coarse grained sand, gravel is fine to medium, angular to sub-angular weathered silstone clasts, low plasticity clay		SP	D			
16			100								
17					pale orange brown						
18	294.7		(0)		**Clayey SAND:** red-brown, medium to coarse grained sand, medium plasticity clay, trace gravel, fine to medium, sub-rounded to sub-angular weathered siltstone clasts		SC				
19			100								
20											

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Cored Borehole Log

TSF_BH_04

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20	292.2										
					Sandy GRAVEL with clay: dark brown, fine to medium, angular to sub-angular weathered siltstone clasts, medium to coarse grained sand, low plasticity clay		GP				
21			(0)								
	291.4				**Sandy GRAVEL:** dark grey brown, fine to medium grained, sub-angular to sub-rounded siltstone clasts, medium to coarse grained sand, trace silt						
22											
			100								
	290.1				**Clayey SAND:** dark red-brown, medium to coarse grained sand, low plasticity clay, trace fine to medium grained gravel, angular to sub-angular siltstone clasts		SC				
23	289.7				**Sandy GRAVEL:** dark grey, fine to medium grained, angular to sub-angular silstone clasts, medium to coarse grained sand, trace silt		GP				
24			(0)								
	288				**Clayey SAND:** dark red-brown, medium to coarse grained sand, low plasticity clay, trace fine to medium grained gravel, angular to sub-angular siltstone clasts, trace pyrite, trace cobbles		SC				
25											

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Cored Borehole Log

TSF_BH_04

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
25			100								
26											
27	285.7		(0)		**CORE LOSS:**						
28	284.7		67		**Sandy GRAVEL:** dark brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace low plasticity clay		GP				
	284				**Sandy CLAY:** high plasticity, dark brown, medium to coarse grained sand, trace fine to medium, angular to sub-angular silstone clasts		CH	ST			
29	283.7				**Gravelly SAND:** dark brown, medium to coarse grained sand, fine to medium, angular to sub-angular siltstone clasts, trace clay		SP	D			
	283				**Sandy GRAVEL:** dark grey, fine to medium grained, angular to sub-angular silstone clasts, medium to coarse grained sand, trace silt		GP	L			
30	282.7		(0)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

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Cored Borehole Log

TSF_BH_04

Sheet: **7** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
30					**Clayey SAND with gravel:** dark red-brown, medium to coarse grained sand, medium plasticity clay, fine to medium, angular to sub-angular siltstone clasts		SC	MD			
31					becoming pale grey / red brown						
	281.1		87		**Gravelly SAND:** dark red-brown, medium to coarse grained sand, gravel is fine to medium, angular to sub-angular weathered siltstone clasts, trace clay		SP	D			
32	280.3				**Gravelly SAND:** fine to coarse grained, grey, gravel is fine to coarse grained, angular, fresh siltstone	D	SW	L			
	280.1				**CORE LOSS:**						
33	279.7		(0)		**Clayey SAND:** dark brown, fine to medium sand, low plasticity clay, trace fine to medium grained, angular to subangular siltstone clasts, trace clay	M	SC	D			
	279.4				**Sandy GRAVEL:** dark grey, fine to medium grained, angular to subangular siltstone clasts, medium to coarse grained sand, trace silt	D	GW	L			
	279.2				**Clayey SAND:** dark brown, fine to medium sand, low plasticity clay, trace fine to medium grained, angular to subangular siltstone clasts	M	SC	D			
34	278.3				**Sandy GRAVEL:** pale brown, fine to medium, angular to subangular siltstone, medium to coarse grained sand, trace silt	D	GW	L			
			100								
35											

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Cored Borehole Log

TSF_BH_04

Sheet: **8** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
35								VD			
	277.2				**Sandy GRAVEL:** dark brown, fine to medium grained, angular to subangular siltstone clasts, medium to coarse grained sand, trace clay	M		L			
36			(0)			D					
	275.7										
37		Sonic			**Gravelly SAND with clay:** dark brown, fine to coarse grained, gravel is fine to coarse grained, angular to subangular, fresh siltstone clasts, medium plasticity clay	M	SW	MD			
			100								
38	274.7				**Gravelly SAND:** grey, medium to coarse grained, gravel is fine to medium grained, angular to subangular, siltstone clasts, trace silt	D		L			
						M					
39	273.7		(0)		**CORE LOSS:**						
40	272.7										

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Cored Borehole Log

TSF_BH_04

Sheet: **9** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
40					**Gravelly SAND:** dark grey, medium to coarse grained,fine to medium grained, angular siltstone clasts,trace clay	M	SW	MD			
			67								
41											
	271.4				**Clayey SAND with gravel:** dark grey, medium to coarse grained sand, medium plasticity clay, gravel is fine to medium grained, angular to subangular siltsone clasts, trace cobble		SC	D			
42	270.7		(0)		**GRAVEL with cobbles:** pale brown, medium to coarse grained, angular to subangular, weathered siltstone, trace silt	D	GP				
43											
	269.2		100		**Gravelly SAND with silt:** grey brown, medium to coarse grained, gravel is fine to medium grained, subangular to subrounded siltstone clasts,	M	SW				
44	268.7				**Gravelly SAND with silt:** pale brown, medium to coarse grained, gravel is fine to medium grained, subangular to subrounded, weathered sltstone			L			
						D					
45	267.7		(0)								

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Cored Borehole Log

TSF_BH_04

Sheet: **10** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
45					**Gravelly SAND:** dark grey, medium to coarse grained, gravel is fine to medium grained, subangular to subrounded siltstone clasts, trace silt			D			
46			100								
	265.9				**Gravelly SAND with clay:** dark red brown, medium to coarse grained, gravel is fine to medium grained, subangular to subrounded siltstone clasts, low plasticity clay		GC				
47											
48	264.7		(0)		**Gravelly SAND:** dark grey, medium to coarse grained, gravel is fine to coarse grained, subangular to subrounded siltstone clasts, trace silt		SP	L			
49			100								
50											

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6; L 0.1 / 2; M 0.3 / 6; H 1 / 20; VH 3 / 60; EH 10 / 200

Average Defect Spacing (mm): < 20; 20 - 60; 60 - 200; 200 - 600; 600 - 2000; > 2000

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Cored Borehole Log

TSF_BH_04

Sheet: **11** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
	262.2										
					Gravelly SAND with silt: pale brown and dark brown, medium to coarse grained, gravel is fine to coarse grained, subangular weathered siltstone, trace cobbles		GP				
51	261.7		(0)		**Sandy CLAY:** low plasticity, dark grey, sand is medium to coarse grained, trace fine , weathered siltstone angular gravel	w< PL	Cl	VST			
52	260.7				**Gravelly SAND:** dark grey, medium to coarse grained, gravel is fine to medium grained, subangular to subrounded siltstone clasts, trace silt	D	SW	L			
	260.2		100		**Gravelly CLAY:** low plasticity, dark grey to blue, gravel is fine to medium grained, moderately weathered siltstone clasts	w< PL	Cl	F			
53											
54			(0)			W~ pl					
	258.4				**Sandy GRAVEL:** dark grey , fine to medium grained, angular siltstone, sand is medium grained, trace silt	M	GW	VD / L			
55	257.7										

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Cored Borehole Log

TSF_BH_04

Sheet: **12** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
					Clayey GRAVEL: dark grey to blue, fine to medium grained, angular siltstone, medium plasticity clay		GC	VD			
	257.5				**Sandy GRAVEL:** dark grey brown, fine to medium grained, subangular siltstone, sand is medium grained, trace silt		GW	L			
			100								
56	256.7				**CLAY with Gravel:** low plasticity, dark grey, angular, fine grained gravel, trace medium grained sand.	w< PL	CI	VST			
57			(0)								
	255.1				**CLAY with SAND:** low plasticity, dark grey brown, medium grained sand, trace fine grained, angular siltstone gravel.						
58											
			92								
59											
	253.1				**GRAVEL with sand:** fine to medium grained, pale brown, subangular to subround siltstone clasts, sand is medium grained, trace silt	D	GW	L			
60			(0)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6; L 0.1 / 2; M 0.3 / 6; H 1 / 20; VH 3 / 60; EH 10 / 200

Average Defect Spacing (mm): < 20; 20 - 60; 60 - 200; 200 - 600; 600 - 2000; > 2000

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Cored Borehole Log

TSF_BH_04

Sheet: **13** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
					trace low plasticity clay			VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		
	252.4				**Sandy GRAVEL:** fine to medium grained, dark grey, subangular to subround siltstone clasts, sand is medium grained, trace clay, trace slightly weathered siltstone cobbles						
61			100								
62	250.5				**Gravelly SAND:** grey, fine to medium grained, gravel is fine to medium grained, subangular siltstone clasts, trace siltstone cobbles		SW				
					trace silt						
63	249.7		(0)		**Sandy GRAVEL:** fine to medium grained, dark grey, subangular to subround siltstone clasts, sand is medium grained, trace clay, trace slightly weathered siltstone cobbles	M	GW				
64			100								
65	247.7										

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Cored Borehole Log

TSF_BH_04

Sheet: **14** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**
Client:	**29 Metals**	Northing:	**7820579 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**
		Drill depth:	**80.2 m bgl**

Driller:	**GROUNDWAVE**
Date commenced:	**12/4/2024**
Date completed:	**19/04/204**
Logged by:	**CM/TM**
Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
66			(0)		**Sandy GRAVEL :** red brown, angular to subangular siltstone clasts, moderately to highly weathered, sand is fine to medium grained, trace low plasticity clay, trace high strength quartzite cobbles and boulders			VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
67	245.6				**GRAVEL with clay:** red brown, fine to coarse grained, subangular quartzite gravel, low plasticity clay, trace fine to medium grained sand		GP				
	245.1		100		**Sandy GRAVEL:** pale brown, fine to coarse grained, subangular quartzite gravel, fine to medium grained sand, trace silt						
68	244.8				**GRAVEL with clay:** red brown, fine to coarse grained, subangular quartzite gravel, low plasticity clay, trace fine to medium grained sand		GC				
69			(0)								
70	242.7										

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Cored Borehole Log

TSF_BH_04

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
71	241		93	**COBBLES and BOULDERS:** pale brown, sub-angular to sub-rounded quartzite clasts with gravel, medium to coarse grained, sub-rounded to sub-angular, quartzite clasts				VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		
	240.8		(0)	**CORE LOSS:**							
72			100	**QUARTZITE:** pale brown, medium to coarse grained, iron staining along discontinuities, moderately weathered, very high strength	D	SW				72.1-72.15m: Jt 50˚ Un, Ro, St	71.9 - 72m: Handling and drill breaks 71.9 - 72.34m: Core recovered
	240.3		(100)								
73			100	**Sandy GRAVEL:** pale brown, fine to coarse grained, subangular quartzite, sand is medium to coarse grained	M	GW		L			72.34 - 75.1m: Casing and rods jammed, switched to sonic.
74											
75	237.7	HQ3	(0)								

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Cored Borehole Log

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Sheet: **16** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Material Description	Discontinuity Description	Field Records / Remarks
			100	**QUARTZITE:** dark red-brown, very thinly laminated to thinly bedded, at 70-80 degrees, brecciated fine to medium grained quartzite, iron staining along discontinities, fractured to highly fractured, slightly weathered, very high strength	75.1-75.5m: : Fragmented core	75.1 - 75.5m: Core recovered as fragments <20mm
	237.2		(0)			
				CORE LOSS:		75.1 - 75.5m: fragmented core 75.5 - 75.76m: Core Loss, HS to VHS fragmented rock causing jams in casing
	236.9					
				QUARTZITE: dark red-brown, very thinly laminated to thinly bedded, at 70-80 degrees, brecciated fine to medium grained quartzite, iron staining along discontinities, fractured to highly fractured, slightly weathered, very high strength		75.76 - 76.28m: Core recovered as fragments <20mm
76			87		75.76-76.28m: : Fragmented core	
					76.31-76.32m: Jt 10° Un, Ro, St: Fe stained	75.76 - 76.28m: fragmented core 76.28 - 76.44m: Fractured,
					76.4-76.44m: Jt 60° Pl, Ro, St: Fe stained 76.44-76.46m: Sz 0° St, Ro, St 76.48-76.49m: Sz 0° St, Ro, St	76.44 - 76.7m: Highly fractured
					76.56-76.57m: Sz 50° St, Ro, St 76.58-76.6m: Sz 10° St, Ro, St	
			(0)			76.7 - 77m: Handling and drill breaks
					76.8-76.8m: Pt 0° Un, Ro, St: Fe stained	
					76.92-76.93m: Jt 10° Cv, Ro, St	
77						77 - 78m: Fractured core
					77.1-77.11m: Jt 10° Pl, Ro, St 77.12-77.15m: Jt 40° Un, Ro, St 77.17-77.19m: Jt 40° Un, Ro, St	
					77.23-77.24m: Jt 40° Un, Ro, St 77.26-77.28m: Jt 40° Un, Ro, St	
		HQ3	100		77.38-77.39m: Jt 10° Ir, Ro, St 77.41-77.42m: Jt 20° St, Ro, St 77.44-77.52m: Sz 30° Un, Ro, St	
78			(45)			78 - 78.25m: Drilling induced breaks/Spun core
					78.07-78.14m: Sz 70° Un, Ro, St	
					78.17-78.18m: Pt 10° Un, Ro, St	78.25 - 79.5m: Fractured core
					78.3-78.31m: Pt 10° St, Ro, St 78.35-78.37m: Jt 15° St, Ro, St	
					78.41-78.42m: Jt 10° Pl, Ro, St 78.41-78.47m: Jt 70° St, Ro, St 78.46-78.48m: Jt 20° Pl, Ro, St 78.5-78.53m: Sz 10° St, Ro, St	
					78.6-78.63m: Sz 10° Un, Ro, St	
			100		78.68-78.69m: Jt 10° Un, Ro, St 78.72-78.73m: Jt 20° St, Ro, St 0.8mm	
					78.78-78.82m: Jt 30° St, Ro, St	
79					78.9-78.91m: Cs 10° Ir, Ro, In: Fine sand infill, <1mm thick	
					79.1-79.12m: Pt 10° Pl, Ro, St: Fe stained 79.14-79.15m: Jt 10° Un, Ro, St 79.17-79.18m: Jt 20° St, Ro, St 79.22-79.23m: Jt 10° Un, Ro, St 79.24-79.25m: Jt 10° Un, Ro, St	
					79.32-79.34m: Jt 30° Un, Ro, St 79.35-79.36m: Jt 10° Un, Ro, St 79.39-79.4m: Jt 10° Un, Ro, St	
			(47)			79.5 - 80.2m: Fractured core
					79.65-79.69m: Jt 60° Pl, Ro, Vn: Clay <1mm	
					79.7-79.71m: Jt 10° Un, Ro, St 79.72-79.73m: Jt 10° Un, Ro, St	
			100		79.81-79.83m: Sz 10° Ir, Ro, St	
80					79.87-79.88m: Jt 10° St, Ro, St	

Soil Moisture / Water Loss (%) / USCS / Weathering

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

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Cored Borehole Log

TSF_BH_04

Sheet: **17** of: **17**

Project:	**TSF3 GI Support**	Easting:	**328056 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820579 m**	Date commenced:	**12/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.7 m**	Date completed:	**19/04/204**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM/TM**
		Drill depth:	**80.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
	232.5		(29)						VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		

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Cored Borehole Log

TSF_BH_05

Sheet: **1** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820547 m**	Date commenced:	**1/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**	Date completed:	**7/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**60.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**Sandy GRAVEL:** dark grey, fine to medium grained, angular to sub-angular quartzite clasts, medium to coarse grained sand, trace silt	D	GW	L			
			100		becoming pale red-brown	M					
1			(0)								
	311.2		47		**CORE LOSS:**						
2											
	310.4		(0)								
					COBBLES (60%) in a gravelly matrix (40%): brown, sub-angular to sub-rounded quartzite clasts, gravel is medium to coarse grained, sub-angular to sub-rounded quartzite clasts, trace silt	D		L			
	310.2				**CORE LOSS:**						
3			13								
	308.9		(0)								
4					**COBBLES (50%) in a sandy GRAVEL matrix (50%):** dark grey-brown, medium to coarse, angular to sub-angular quartzite and silstone clasts, cobbles are sub-angular to sub-rounded quatzite clasts, medium to coarse grained sand, trace silt, trace plastic	D		L			
		Sonic	100			M					
5											

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Cored Borehole Log

TSF_BH_05

Sheet: **2** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820547 m**	Date commenced:	**1/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**	Date completed:	**7/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**60.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5								VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		
			(0)								
6			100								
7			(0)								
			100								
8			(0)								
9			80								
	303.2				**CORE LOSS:**						
10	302.9		(0)								

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Cored Borehole Log

TSF_BH_05

Project:	**TSF3 GI Support**	Easting:	**328008 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820547 m**	Date commenced:	**1/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**	Date completed:	**7/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**60.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10					**COBBLES (40%) in a matrix of GRAVEL with sand (60%):** dark red-brown, medium to coarse, angular to sub-angular quartzite and siltstone clasts, cobbles are sub-angular to sub-rounded quartzite clasts, medium to coarse grained sand, trace silt, trace plastic	M			L			
			87									
11												
	301.6				**CORE LOSS:**							
	301.4		(0)									
					COBBLES (40%) in a matrix of GRAVEL with sand (60%): dark red-brown, medium to coarse, angular to sub-angular quartzite and siltstone clasts, cobbles are sub-angular to sub-rounded quartzite clasts, medium to coarse grained sand, trace silt, trace plastic	M			L			
12			53									
13			(0)									
			73									
14	298.8				**CORE LOSS:**							
	298.4		(0)									
					COBBLES (40%) in a matrix of GRAVEL with sand (60%): dark red-brown, medium to coarse, angular to sub-angular quartzite and siltstone clasts, cobbles are sub-angular to sub-rounded quatzite clasts, medium to coarse grained sand, trace silt, trace plastic	M			L			
15												

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Cored Borehole Log

TSF_BH_05

Project:	**TSF3 GI Support**	Easting:	**328008 m**
Client:	**29 Metals**	Northing:	**7820547 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**
		Drill depth:	**60.3 m bgl**

Driller:	**GROUNDWAVE**
Date commenced:	**1/4/2024**
Date completed:	**7/4/2024**
Logged by:	**CM**
Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15			93									
	297											
	296.9		(0)		**CORE LOSS:**							
16					**COBBLES (50%) in a GRAVEL matrix (50%):** dark red-brown, angular to sub-angular quartzite cobble sized clasts, gravel is medium to coarse grained, angular to sub-angular quartzite clasts, trace silt	D			L			
			100									
17												
			(0)									
18						M						
			100									
	293.9		(0)		**Sandy GRAVEL with silt:** dark red-brown, medium to coarse grained, sub-angular to sub-rounded siltstone and quartzite clasts, medium to coarse grained sand		GW		MD			
19	293.5				**CLAY with sand:** low plasticity, dark grey-brown, fine to medium grained sand, trace gravel, fine to medium grained, sub-rounded quartzite clasts, angular to sub-angular chert clasts	w< PL	Cl		VSt			
			100									
20												

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Cored Borehole Log

TSF_BH_05

Sheet: **5** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**
Client:	**29 Metals**	Northing:	**7820547 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**
		Drill depth:	**60.3 m bgl**

Driller:	**GROUNDWAVE**
Date commenced:	**1/4/2024**
Date completed:	**7/4/2024**
Logged by:	**CM**
Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20									Vl 0.03 / 0.6, L 0.1 / 2, M 0.3 / 6, H 1 / 20, Vh 3 / 60, Eh 10 / 200	< 20, 20 - 60, 60 - 200, 200 - 600, 600 - 2000, > 2000		
			(0)									
	292.3				**COBBLES and GRAVEL with sand:** dark brown, sub-angular to sub-rounded quartzite clasts, gravel is medium to coarse grained, angular to sub-angular quartzite clasts, sand is coarse grained, trace silt	W			L			
21			93									
	291				**CORE LOSS:**							
	290.9		(0)		**Sandy GRAVEL with clay:** red-brown, fine to medium, angular to sub-angular siltstone clasts, medium to coarse grained sand, low plasticity clay	D	GW		MD			
22	290.5				**Sandy GRAVEL:** dark brown-grey, medium to coarse grained, angular to sub-angular quartzite clasts, medium to coarse grained sand, trace clay				L			
			100									
23						M						
			(0)									
24					dark red-brown to dark grey							
			100			D						
		Sonic										
25			(0)									

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Cored Borehole Log

TSF_BH_05

Sheet: **6** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**
Client:	**29 Metals**	Northing:	**7820547 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**
		Drill depth:	**60.3 m bgl**

Driller:	**GROUNDWAVE**
Date commenced:	**1/4/2024**
Date completed:	**7/4/2024**
Logged by:	**CM**
Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
25						W					
						M		VD			
			100								
26	286.9				**Gravelly SAND with silt:** dark grey, medium to coarse grained sand, fine to medium, angular to sub-angular siltstone clasts		SW				
			(0)								
			100								
27	285.9		(0)		**Sandy GRAVEL with silt:** dark grey-brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand		GW				
			100								
28			(0)					L			
			100								
	284				**Clayey GRAVEL with sand:** dark red-brown, fine to medium grained, angular to sub-angular weathered siltstone clasts, low plasticity clay, medium to coarse grained sand		GC	D			
29	283.7				**CLAY with sand:** low plasticity, grey-brown, fine to medium grained sand, trace fine grained, sub-angular weathered siltstone clasts	w< PL	CI	VSt			
	283.4		(0)		**Sandy GRAVEL with silt:** dark brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand	W	GW	L			
30											

ENGENY

Cored Borehole Log

TSF_BH_05

Sheet: **7** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820547 m**	Date commenced:	**1/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**	Date completed:	**7/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**60.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
30			100					MD			
	282.4				**CLAY with gravel:** low plasticity, dark red-brown, fine to medium grained, angular weathered siltstone clasts, trace fine to medium grained sand	w< PL	CI	Vst			
31	281.9		(0)		**Sandy GRAVEL with silt:** dark brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand	M	GW	VD			
	281.4				**Gravelly SAND with clay:** pale grey, medium to coarse grained sand, gravel is fine to medium, angular to sub-angular siltstone clast, trace silt	D	GP				
32			100								
			(0)			W					
33						M					
			100								
34	278.9		(0)		**Sandy GRAVEL:** dark red-brown, fine to medium grained, angular to sub-angular weathered siltstone clasts, medium to coarse grained sand, trace clay, trace angular Quartzite cobbles		GW				
			100								
35											

ENGENY

Cored Borehole Log

TSF_BH_05

Sheet: **8** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820547 m**	Date commenced:	**1/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**	Date completed:	**7/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**60.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
35											
			(0)		dark grey-brown			L			
36											
					dark red-brown						
37			100								
	275.7				**Sandy GRAVEL with clay:** dark red-brown, fine to medium grained, sub-angular to sub-rounded, weathered silstone clasts, medium to coarse grained sand, medium plasticity clay		GP				
38											
			(0)			W					
39											
40	272.9										

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_05

Sheet: **9** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**
Client:	**29 Metals**	Northing:	**7820547 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**
		Drill depth:	**60.3 m bgl**
Driller:	**GROUNDWAVE**		
Date commenced:	**1/4/2024**		
Date completed:	**7/4/2024**		
Logged by:	**CM**		
Checked by:	**AL**		

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
40			90		**Sandy GRAVEL:** pale grey, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt		GW	VD			
41	271.8					D					
					Gravelly SAND with clay: dark grey-brown, medium to coarse grained, gravel is fine to medium grained, angular to sub-angular weathered siltstone clasts, medium plasticity clay, trace quartzite cobbles	M	SW				
			(0)								
42											
43			110			D		L			
						M		VD			
44											
			(0)					D			
45											

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Cored Borehole Log

TSF_BH_05

Project:	**TSF3 GI Support**	Easting:	**328008 m**
Client:	**29 Metals**	Northing:	**7820547 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**
		Drill depth:	**60.3 m bgl**

Driller:	**GROUNDWAVE**
Date commenced:	**1/4/2024**
Date completed:	**7/4/2024**
Logged by:	**CM**
Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
45								VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
46			87								
47	265.8				**CORE LOSS:**						
	265.4		(0)								
			100		**Sandy GRAVEL:** dark red-brown, fine to medium grained, angular to sub-angular, quartzite clasts, medium to coarse grained sand, trace clay	M	GP	VD			
	265.1		(0)		**Clayey SAND:** dark red-brown, medium to coarse grained sand, low plasticity clay, trace gravel fine to medium, angular to sub-angular siltstone clasts		SC				
48			100								
	264				**Sandy CLAY:** low plasticity, dark red-brown, medium to coarse grained sand, trace fine grained, sub-angular weathered siltstone clasts, trace cobbles	w< PL	CI	F			
49	263.5		(0)		**CORE LOSS:**						
					SILTSTONE: dark red-brown, iron staining, moderately weathered, moderate strength, highly fractured		MW			49.69-49.74m: Jt 75° Un, Ro, St: Fe staining	49.55 - 49.83m: Drilling induced and handling breaks
	263.1		62		**CORE LOSS:**						
50	262.9	HQ3	(0)								

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Cored Borehole Log

TSF_BH_05

Sheet: **11** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820547 m**	Date commenced:	**1/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**	Date completed:	**7/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**60.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Material Description	Discontinuity Description	Field Records / Remarks
51		HQ3	100	**QUARTZITE interbedded with SILTSTONE:** dark red-brown, very thinly laminated to thinly bedded, at 70-80 degrees, fine to medium grained quartzite, iron staining along discontinities, fractured to highly fractured, moderately weathered, moderately weathered, medium strength	50.19-50.23m: Jt 60° Un, Ro, St: Fe staining 50.34-50.35m: Jt 10° Un, Ro, St: Fe staining 50.36-50.38m: Jt 30° Pl, St: Fe staining 50.38-50.39m: Jt 30° Pl, St: Fe staining 50.47-50.5m: Jt 30° Un, Ro, St: Fe staining 50.61-50.63m: Jt 30° Un, Ro, St: Fe staining	50 - 50.19m: Drilling breaks 51 - 51.1m: Drilling Induced
52			89		51.16-51.25m: Jt 70° Pl, Ro, St: Fe staining 51.2-51.23m: Jt 30° Pl, Ro, St: Fe staining 51.25-51.33m: Jt 80° Un, St: Fe staining 51.28-51.38m: Jt 50° Un, St: Fe staining 51.32-51.38m: Jt 65° Un, St: Fe staining 51.38-51.39m: Jt 20° Un, Ro, St: Fe staining 51.68-51.7m: Jt 20° Un, Ro, St: Fe staining 51.73-51.74m: Jt 30° Un, Ro, : Fe staining 51.74-51.8m: Jt 50° Un, Ro, Vn: Fe staining, Clay Vn 51.76-51.83m: Jt 50° Un, Ro, Vn: Fe staining, Clay Vn 51.8-51.83m: Jt 30° Un, Ro, Vn: Fe staining 51.83-51.88m: Jt 70° Un, Ro, : Fe staining 51.88-51.91m: Sz 51.92-51.97m: Jt 40° Un, Ro, Vn: Fe staining, Clay Vn 51.95-51.96m: Jt 0° Un, : Fe staining 51.97-51.98m: Jt 0° Un, : Fe staining 52-52.03m: Jt 40° Un, : Fe staining 52.05-52.19m: Jt 70° Un, : Fe staining 52.1-52.13m: Jt 25° Un, Ro, Vn: Fe staining, Clay Vn 52.15-52.21m: Jt 70° Un, : Fe staining 52.26-52.3m: Bd 60° Pl, Vn: Fe staining, Clay Vn 52.28-52.32m: Jt 30° Pl, Ro, Vn: Fe staining, Clay Vn 52.32-52.34m: Jt 40° Un, Vn: Fe staining, Clay Vn 52.37-52.4m: Jt 30° Pl, Ro, Vn: Fe staining, Clay Vn 52.41-52.46m: Jt 70° Pl, : Fe staining 52.44-52.47m: Jt 60° Pl, : Fe staining 52.49-52.51m: Jt 20° Un, St: Fe staining 52.52-52.54m: Jt 30° Un, Vn: Fe staining, Clay Vn 52.52-52.64m: Jt 60° Pl, St: Fe staining 52.56-52.59m: Jt 40° Pl, St: Fe staining 52.62-52.65m: Jt 35° Un, St: Fe staining 52.66-52.69m: Jt 40° Pl, St: Fe staining 52.7-52.73m: Jt 40° Pl, St: Fe staining 52.77-52.81m: Jt 50° Pl, St: Fe staining 53.08-53.09m: Jt 30° Pl, St: Fe staining 53.11-53.18m: Jt 50° Un, St: Fe staining 53.14-53.23m: Jt 65° Un, St: Fe staining 53.16-53.24m: Jt 50° Un, St: Fe staining 53.19-53.26m: Jt 60° Un, St: Fe staining 53.26-53.28m: Jt 30° Pl, St: Fe staining 53.27-53.28m: Jt 30° Un, Ro, St: Fe staining, clay ct 2mm 53.29-53.32m: Jt 40° Pl, St: Fe staining 53.31-53.36m: Jt 30° Un, St: Fe staining 53.36-53.41m: Jt 60° Un, St: Fe staining 53.44-53.49m: Jt 50° Un, St: Fe staining 53.49-53.5m: Jt 10° Un, Ro, St: Fe staining, clay vn 53.66-53.7m: Jt 50° Un, : Fe staining 53.7-53.72m: Jt 30° Un, St: Fe staining, clay VN 53.78-53.8m: Jt 25° Un, St: Fe staining 53.81-53.88m: Jt 65° Un, St: Fe staining 53.88-53.9m: Jt 30° Un, St: Fe staining 54-54.02m: Jt 25° Pl, St: Fe staining 54.03-54m: Jt 50° Pl, St: Fe staining 54.04-54.06m: Jt 50° Un, St: Fe staining 54.05-54.07m: Jt 35° Pl, St: Fe staining 54.12-54.17m: Jt 50° Un, Ro, St: Fe staining 54.21-54.23m: Jt 30° Pl, St: Fe staining 54.22-54.26m: Jt 60° Un, Ro, St: Fe staining 54.26-54.4m: Sz 54.64-54.68m: Jt 50° Ir, VRo, St: Fe staining 54.7-54.75m: Jt 60° Un, VRo, St: Fe staining 54.75-54.76m: Jt 10° Ir, Ro, St: Fe staining 54.76-55.07m: Jt 80° Un, Ro, St: Fe staining	51.22 - 51.23m: Drilling Induced 51.5 - 51.57m: Drilling Induced 54.24 - 54.4m: Core recovered as fragments 54.5 - 54.64m: Core recovered as fragments
53	261 260.1 259.9		(58) (59)	**BRECCIA:** oligomictic, clast supported **CORE LOSS:**		
54	258.5 258.4		93 (71)	**QUARTZITE interbedded with SILTSTONE:** dark red-brown, very thinly laminated to thinly bedded, at 70-80 degrees, brecciated fine to medium grained quartzite, iron staining along discontinities, fractured to highly fractured, moderately weathered, medium strength **CORE LOSS:**		
55				**QUARTZITE interbedded with SILTSTONE:** dark red-brown, very thinly laminated to thinly bedded, at 70-80 degrees, brecciated fine to medium grained quartzite, iron staining along discontinities, fractured to highly fractured, medium strength		

Soil Moisture / Water Loss (%) / USCS / Weathering

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

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Cored Borehole Log

TSF_BH_05

Sheet: **12** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820547 m**	Date commenced:	**1/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**	Date completed:	**7/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**60.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
			96								54.88-54.9m: Jt 20° Un, Ro, St: Fe staining 54.95-54.98m: Jt 40° Un, Ro, St: Fe staining	
											55.22-55.3m: Pt 50° Un, Ro, Vn: clay	
											55.24-55.26m: Xwsm 60° 55.32-55.33m: Jt 30° Pl, Ro, Cl 55.33-55.37m: Jt 30° Pl, Ro, St	
											55.4-55.52m: Sz	55.4 - 55.51m: Core recovered as fragments
											55.52-55.62m: Jt 80° Pl, Ro, St	
	257.2										55.52-55.59m: Jt 90° Un, Ro, St 55.54-55.61m: Jt 60° Un, Ro, St	55.61 - 55.7m: Core recovered as fragments
	257.2		(0)		**CORE LOSS:**							
56			93		**QUARTZITE interbedded with SILTSTONE:** dark red-brown, very thinly laminated to thinly bedded, at 70-80 degrees, brecciated fine to medium grained quartzite, iron staining along discontinities, fractured to highly fractured, moderately weathered, medium strength						55.82-55.88m: Jt 60° Un, Ro, Vn: Clay veneer Fe staining 55.88-55.94m: Sz	55.88 - 55.95m: Core recovered as fragments
											56-56.06m: Sz	56 - 56.06m: Core recovered as fragments
											56.06-56.11m: Jt 70° Pl, Ro, St 56.09-56.16m: Jt 70° Un, Ro, St 56.11-56.13m: Jt 20° Un, Ro, St 56.17-56.19m: Xsm 70° 56.2-56.27m: Jt 50° Pl, Ro, Vn: clay 56.22-56.27m: Jt 80° Un, Ro, St 56.24-56.29m: Jt 60° Un, Ro, Cl 56.32-56.33m: Jt 10° Un, Ro, St 56.33-56.43m: Jt 60° Pl, Ro, Cl 56.38-56.46m: Jt 75° Un, Ro, St	
											56.44-56.8m: Jt 70° Un, Ro, St	
	255.9										56.48-56.5m: Jt 20° Un, Ro, Cl 56.52-56.53m: Jt 10° Un, Ro, St 56.56-56.57m: Jt 10° Un, Ro, St 56.73-56.74m: Jt 15° Un, Ro, St 56.76-56.8m: Jt 40° Un, Ro, St 56.84-57m: Sz	56.84 - 57m: Core recovered as fragments
57			(0)		**CORE LOSS:**							
			0									
			(0)									
			0									
58												
	254.8		(0)		**QUARTZITE interbedded with SILTSTONE:** dark red-brown, very thinly laminated to thinly bedded, at 70-80 degrees, brecciated fine to medium grained quartzite, iron staining along discontinities, fractured to highly fractured, moderately weathered, medium strength						58.22-58.29m: Jt 70° Un, Ro, St 58.28-58.35m: Jt 40° Un, Ro, St	
			91								58.34-58.43m: Cz 40° Ir, Ro, St	
											58.67-58.83m: Xsm 0° : XW Siltstone xsm, returned as gravelly clay, lp red brown	
			(0)									
59											59.04-59.09m: Jt 50° Ir, Ro, St	
			100								59.51-59.55m: Jt 40° Pl, Ro, St: Fe staining	
											59.84-59.9m: Jt 60° Pl, Ro, St	
60												

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Cored Borehole Log

TSF_BH_05

Sheet: **13** of: **13**

Project:	**TSF3 GI Support**	Easting:	**328008 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820547 m**	Date commenced:	**1/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 312.9 m**	Date completed:	**7/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**60.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03/0.6, L 0.1/2, M 0.3/6, H 1/20, VH 3/60, EH 10/200	Average Defect Spacing (mm): < 20, 20 - 60, 60 - 200, 200 - 600, 600 - 2000, > 2000	Discontinuity Description	Field Records / Remarks
	252.6		(96)								

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Cored Borehole Log

TSF_BH_06

Sheet: **1** of: **10**

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**COBBLES and GRAVEL:** brown, angular to sub-angular siltstone clasts, medium to coarse grained, angular to sub-angular silstone clasts, trace coarse grained sand	D		L			0 - 25.4m: Sonic drilling through wasterock fill
	295.4				**sandy GRAVEL:** dark grey, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt		GW				
1			67								
2	294.1				**CORE LOSS:**						
3	293.1		(0)		**Sandy GRAVEL:** dark grey, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt	D	GW	L			
4	292.1				**CORE LOSS:**						
			53								
5		Sonic									

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6; L 0.1 / 2; M 0.3 / 6; H 1 / 20; VH 3 / 60; EH 10 / 200

Average Defect Spacing (mm): < 20; 20 - 60; 60 - 200; 200 - 600; 600 - 2000; > 2000

ENGENY

Cored Borehole Log

TSF_BH_06

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5	290.7				**GRAVEL :** dark grey, fine to coarse grained, angular to sub-angular siltstone clasts, trace low plasticity clay	D	GP	L			
6	290.1		(0)		**Sandy GRAVEL:** dark grey, fine to coarse grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt	M					
	289.4				**Sandy GRAVEL:** brown, fine to coarse grained, angular to sub-angular quartzite clasts, medium to coarse grained sand, trace clay						
7			100								
8			(0)			D					
	287.7				**Sandy GRAVEL:** dark grey, fine to coarse grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt						
			100								
9			(0)								
10											

ENGENY

Cored Borehole Log

TSF_BH_06

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10			100								
			(0)			M					
11			100								
			(0)								
12		Sonic	100								
13	283.1				**Clayey GRAVEL:** dark red brown, fine to coarse grained, angular to subangular quartzite clasts, low plasticity clay, trace fine to medium grained sand		GC				
	282.6				**Gravelly SAND:** dark grey, medium to coarse grained, gravel is fine to medium subangular siltstone clasts		GW				
14	282.1		(0)		**Sandy GRAVEL:** brown, fine to coarse grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace clay		GP				
			100								
15			(0)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_06

Sheet: **4** of: **10**

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15	280.6										
					CLAY with gravel: low plasticity, dark grey mottled brown, gravel is fine to medium grained, subangular quartzite clasts		CI	F			
16	279.9										
					Clayey GRAVEL: dark red brown, fine to coarse grained, angular to subangular quartzite clasts, low plasticity clay, trace fine to medium grained sand		GC	L			
			100								
17	279					D					
					Sandy GRAVEL: pale grey to red brown, fine to coarse grained, angular to sub-angular quartzite clasts, medium to coarse grained sand, trace clay		GP				
18	278.1		(0)		**CORE LOSS:**						
	277.9				**Clayey SAND:** dark brown, medium to coarse grained, clay is low plasticity	W	SC	VST			
	277.6				**CLAY with gravel:** low plasticity, dark grey becoming dark red with lenses of white from 18.8m, gravel is fine to medium grained, subangular, highly weathered quartzite clasts, trace extremely weathered siltstone clasts returned as white, low plasticity silt	w< PL	CI				
19			93								
20											

ENGENY

Cored Borehole Log

TSF_BH_06

Sheet: **5** of: **10**

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20									Vl 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 Vh 3 / 60 Eh 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
21	275.1		(0)		**Sandy CLAY with gravel:** low plasticity, red brown, sand is medium to coarse grained, gravel is fine grained, subangular highly to moderately weathered quartzite clasts	W> PL			VS			
									VST			
	274.3				**Clayey SAND with Gravel:** red brown, medium to coarse grained, low plasticity clay, gravel is fine to medium grained, subangular, highly weathered quartzite	D	SC		L			
22												
	273.7				**GRAVEL with sand:** red,medium to coarse grained, angular, highly weathered quartzite clasts, sand is medium to coarse grained, trace low plasicity clay		GW					
			100			W						
23						M						
24			(0)									
	271.5		100		**COBBLES and BOULDERS:** brown, sub-angular, quartzite clasts with gravel, medium to coarse grained, sub-rounded to sub-angular, quartzite clasts							
25												

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Cored Borehole Log

TSF_BH_06

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
25			(0)									
			100									
			(0)									25.4 - 26m: Highly fractured to fragented core, drilling induced
			100									
26	270.1		(0)		**CORE LOSS:**							26 - 26.2m: Core loss
	269.9				**COBBLES and BOULDERS:** returned as pale grey, coarse grained, subangular, siltstone gravel	M			L			26.2 - 26.6m: Highly fractured to fragented core, drilling induced
	269.5				**CORE LOSS:**							26.6 - 26.75m: CORE LOSS
	269.3		77		**COBBLES and BOULDERS:** returned as brown and grey, coarse grained, subangular, siltstone gravel	M			L			26.75 - 27m: fractured
27	269				**COBBLES and BOULDERS:** returned as dark grey and grey, coarse, subangular siltstone and quartzite gravel							27 - 27.2m: Highly fractured to fragented core, drilling induced
												27.2 - 27.5m: fractured
			(0)									27.5 - 28.25m: Highly fractured to fragented core, drilling induced
28												
			73									28.25 - 28.42m: fractured
	267.6				**CORE LOSS:**							28.42 - 28.82m: Core loss
	267.2				**COBBLES and BOULDERS:** returned as dark grey and grey, coarse, subangular siltstone and quartzite gravel	M			L			28.82 - 29.3m: fragmented
29			(0)									
			100									29.13 - 29.95m: fractured to fragmented
	266.1	HQ3	(0)		**CORE LOSS:** likely voids, rods dropped rapidly							
30												

ENGENY

Cored Borehole Log

TSF_BH_06

Sheet: **7** of: **10**

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
30					500mm							
		HQ3	30									
31	265.1				**COBBLES and BOULDERS:** returned as dark grey and grey, coarse, subangular siltstone and quartzite gravel	M			L			31 - 32m: fragmented
			(0)									
			100									
32	264.1		(0)		**CORE LOSS:** likely voids							
			30									
	263.7				**COBBLES and BOULDERS:** returned as dark grey and grey, coarse, subangular siltstone and quartzite gravel	M			L			32.35 - 32.5m: fragmented
	263.6		(0)		**CORE LOSS:** Likely void							32.5 - 33m: Core loss
33	263.1		50		**COBBLES and BOULDERS:** returned as dark grey and grey, coarse, subangular siltstone and quartzite gravel	M			L			33 - 33.5m: fragmented core
	262.6		(0)		**CORE LOSS:** Likely void							33.5 - 33.87m: Core loss
	262.2				**COBBLES and BOULDERS:** returned as dark grey and grey, coarse, subangular siltstone and quartzite gravel	M			L			33.87 - 34.45m: fragmented core
34			100									
			(0)									34.45 - 35.95m: fragmented core, decided to change to sonic at 35.95m due to ground conditions
			100									
35			(0)									

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Cored Borehole Log

TSF_BH_06

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
35			100								
	260.1		(0)								
36					**Gravelly SAND:** brown, medium to coarse grained, gravel is fine to coarse grained, angular, high strength breccia, trace cobbles		GW				36 - 41.75m: Sonic drilling through wasterock fill
37			100								
38											
	257.6				**Clayey GRAVEL:** dark grey with red brown streaks, fine to medium grained, subangular to subround quartzite gravel, clay is low plasticity, trace medium to coarse sand		GC				
39		Sonic	(0)								
	256.5				**GRAVEL with sand:** red,medium to coarse grained, angular, highly weathered quartzite clasts, sand is medium to coarse grained, trace low plasicity clay	D	GW				
40											

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_06

Sheet: **9** of: **10**

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
40		Sonic	100								
	255.4				**COBBLES and BOULDERS:** brown, sub-angular, quartzite clasts with gravel, medium to coarse grained, sub-rounded to sub-angular, quartzite clasts						
41						M					
	254.3		(0)		**QUARTZITE:** pale red brown, fine grained, highly fractured to fragmented, moderately weathered, high strength,		MW				41.75 - 42m: Fractured
42											42 - 43m: slightly fractured, fracture zones of multiple healed defects<10mm apart
	253.9		100		**QUARTZITE:** dark brown, highly weathered, moderate to high strength, foliated, fine quartz grains cemented					42.13-42.13m: Pt 0° Ir, Ro, fine sand <1mm veneer In	
			(71)							42.24-42.25m: Pt 10° Ir, Ro, fine sand <1mm veneer In 42.31-42.32m: Cs 50° Ir, Ro, St 42.33-42.35m: Jt 10° Ir, Ro, St	
										42.42-42.45m: Jt 30° Cv, Fe stained,healed St 42.45-42.49m: Jt 70° Pl, Fe stained,healed St 42.48-42.55m: Jt 80° St, Fe stained,healed St	
	253.3				**QUARTZITE:** grey, fine grained, highly fractured to fragmented, moderately weathered, high strength,					42.64-42.75m: Jt 20° Pl, Healed,defect groups spaced <10mm St	
	253.1				**QUARTZITE:** grey and red brown, fractured, moderately weathered, moderate to high strength, healed joints of fragmented to fractured degree, iron staining along healed and open defects					42.75-42.77m: Jt 20° Ir, Ro, St 42.85-42.87m: Jt 30° Ir, Ro, St 42.94-42.95m: Jt 20° Pl, healed St	
43			100							43.03-43.08m: Jt 70° Pl, healed St 43.12-43.15m: Jt 40° Un, Ro, St	43 - 46.3m: fractured, 20-200mm, as well as fracture zones of extensive healed defects<10mm apart, zones oc cemented graveland coarse sand within quartzite profile
										43.42-43.43m: Jt 20° Ir, Ro, St	
										43.67-43.7m: Jt 10° Un, Ro, St	
										43.81-43.83m: Jt 70° Pl, Ro, St 43.83-43.84m: Jt 0° St, Ro, St	
44			(83)							44.06-44.07m: Fz 10° Ir, Ro, Fracture Zone St 44.1-44.11m: Fz 10° Ir, Ro, Fracture Zone St 44.17-44.19m: Cz 70° Ir, Ro, St	
										44.19-44.34m: Jt 90° St, Ro, St	
										44.23-44.25m: Jt 20° Un, Ro, St	
										44.4-44.46m: Jt 80° Un, Ro, St 44.45-44.46m: Jt 10° Un, Ro, St 44.46-44.48m: Jt 40° Cv, healed St 44.46-44.6m: Jt 80° Un, healed St	
										44.52-44.56m: Sz 10° Pl, St 44.54-44.84m: Fz 80° St, Ro, Fragments missing St	
45		HQ3	100								

Discontinuity Description scale: < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_06

Sheet: **10** of: **10**

Project:	**TSF3 GI Support**	Easting:	**328020 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820476 m**	Date commenced:	**20/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 296.1 m**	Date completed:	**24/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**TM**
		Drill depth:	**49.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
45		HQ3	(66)				MW	VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000	44.88-45.22m: Cz Ir, Ro, Defect magnified by handling breaks St 45.36-45.37m: Jt 10° Un, Ro, St 45.45-45.46m: Jt 10° Un, Ro, St 45.6-45.63m: Jt 50° St, Ro, St 45.67-45.73m: Jt 80° St, Ro, St 45.74-45.78m: Vg Vugh	
46	249.8		100		**QUARTZITE:** pale red grey, fractured, slightly weathered, high strength, iron staining along defects		SW			46.06-46.08m: Vg Vugh 46.17-46.18m: Jt 70° Pl, Ro, St 46.23-46.34m: Cz 60° , RoCemented fine subangular gravel 46.56-46.63m: Jt 80° Pl, Healed St 46.57-46.6m: Jt 20° Pl, Ro, Partially healed St 46.63-46.65m: Jt 20° Un, Ro, St 46.67-46.68m: Jt 20° Un, Ro, St 46.68-46.74m: Jt 80° Pl, Ro, St 46.72-46.75m: Jt 30° Pl, Ro, Defect magnified by handling breaks St 46.8-47m: Jt 60° Pl, Ro, Defect magnified by handling breaks St 46.83-46.86m: Jt 20° St, Ro, St 46.91-46.94m: Jt 30° Cv, Ro, St	46.3 - 47.8m: slightly fractured, multiple healed defects, slightly weathered, very high strength
47			(65)							47.27-47.38m: Sz 60° Un, Ro, St 47.3-47.37m: Jt 50° Pl, Healed St 47.33-47.45m: Jt 70° Pl, Healed St 47.4-47.6m: Jt 70° Pl, Healed St 47.57-47.62m: Jt 70° Pl, Healed St 47.62-47.7m: Sz 60° Un, Ro, St	
			100								
			(98)							47.85-47.96m: Jt 70° Un, healed St	
48			100							48.04-48.07m: Jt 60° Cv, healed St 48.04-48.1m: Jt 60° Cv, healed St 48.09-48.2m: Jt 70° Pl, healed St 48.15-48.25m: Jt 70° Pl, healed St 48.3-48.33m: Jt 50° Cv, healed 48.3-48.37m: Jt 50° Cv, healed 48.4-48.43m: Jt 50° Cv, healed 48.4-48.57m: Sz 80° St, healed	
			(1E+02)								
			(1E+02)							48.7-48.76m: Jt 80° St, healed St 48.76-48.78m: Jt 60° Cv, healed St 48.78-48.82m: Jt 60° Cv, healed St	
			100							48.87-48.9m: Jt 40° Un, Ro, St 48.9-48.92m: Jt 40° Un, Ro, St	
49	247.1		(77)								

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Cored Borehole Log

TSF_BH_07

Sheet: **1** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327995 m**
Client:	**29 Metals**	Northing:	**7820385 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 279.8 m**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**205°**
		Drill depth:	**24.5 m bgl**
Driller:	**GROUNDWAVE**		
Date commenced:	**12/5/2024**		
Date completed:	**14/5/2024**		
Logged by:	**CM/TM**		
Checked by:	**AL**		

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**FILL:** not boxed, cobbles and boulders			VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		
1											
2			0								
3											
4	272		(0)								
			100		**QUARTZITE:** pale red brown, medium to coarse grained, fractured, iron staining along discontinuities, moderately weathered, medium strength		MW			4-4.06m: Jt 31° , 209° Pl, FeO St	4.08 - 4.11m: Drilling induced breaks
			(25)							4.19-4.25m: Jt 45° , 221° Pl, FeO St 4.2-4.23m: Jt 60° , 236° Un, FeO St 4.28-4.3m: Jt 38° , 216° Un, FeO St	4.28 - 4.4m: Handling breaks
										4.4-4.44m: Jt 36° , 214° Pl, FeO St	
			100							4.43-4.62m: Jt 36° , 214° Un, clay Vn	
5	273.8	HQ3								4.44-4.51m: Jt 48° , 225° Pl, FeO St 4.46-4.6m: Jt 31° , 209° Un, FeO St 4.51-4.57m: Jt 30° , 205° Pl, FeO St 4.65-4.77m: Jt 36° , 214° Un, clay In 4.72-4.9m: Jt 38° , 216° Un, clay Vn	
										4.91-5m: SZ 30° , 205° ,	

ENGENY

Cored Borehole Log

TSF_BH_07

Sheet: **2** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327995 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820385 m**	Date commenced:	**12/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 279.8 m**	Date completed:	**14/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**205°**	Logged by:	**CM/TM**
		Drill depth:	**24.5 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5			(0)		**QUARTZITE:** grey, fine grained, highly fractured to fragmented, massively bedded at 60 degrees, iron staining along discontinuities, slightly weathered, high strength		SW	VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		5 - 5.1m: Handling breaks 5.1 - 5.22m: Drilling induced breaks
										5.22-5.27m: Jt 60° , 205° Pl, clay Vn 5.27-5.31m: Jt 60° , 200° Pl, FeO St 5.29-5.31m: Jt 73° , 215° Pl, FeO St 5.32-5.38m: Jt 36° , 155° Un, FeO St 5.35-5.39m: Jt 60° , 190° Pl, FeO St 5.33-5.41m: Jt 31° , 145° Un, FeO St 5.44-5.49m: Jt 45° , 211° Un, FeO St 5.41-5.45m: Jt 31° , 145° Un, Cl 5.52-5.61m: Jt 30° , 155° Un, FeO St	
										5.52-5.6m: Jt 41° , 154° Un, FeO St	
										5.62-5.63m: Jt 81° , 215° Un, FeO St	
			97							5.62-5.77m: Jt 31° , 209° Un, FeO St 5.65-5.72m: Pt 41° , 219° Pl, FeO St 5.67-5.74m: Jt 36° , 214° Un, FeO St 5.77-5.81m: Jt 31° , 209° Un, FeO St 5.79-5.86m: Jt 48° , 225° Pl, FeO St 5.83-5.86m: Jt 73° , 254° Un, FeO St 5.86-6m: Jt 38° , 203° Un, clay Vn 6.04-6.05m: jt 73° , 183° Un, FeO St	
6										6.05-6.25m: Jt 36° , 133° Un, clay Vn	
										6.28-6.33m: Jt 56° , 219° Un, FeO St	
	271.9									6.3-6.4m: jt 48° , 49° Pl, FeO St	
	273.2				**CORE LOSS:**						
			(6.7)		**QUARTZITE:** Grey, fine grained, highly fractured to fragmented, massively bedded at 60 degrees, iron staining along discontinuities, slightly weathered, very high strength		SW			6.32-6.35m: Jt 56° , 185° Pl, FeO St	
										6.5-6.54m: Jt 48° , 225° un, FeO St 6.6-6.65m: jt 41° , 219° Un, FeO St 6.61-6.66m: jt 48° , 225° Pl, FeO St	
										6.67-6.73m: jt 36° , 214° Un, FeO St	
										6.71-6.85m: Jt 41° , 323° Un, FeO St 6.75-6.83m: Jt 48° , 306° Un, FeO St 6.75-6.78m: Jt 31° , 201° Un, FeO St 6.78-6.87m: Jt 52° , 295° Un, FeO St 6.92-6.96m: Jt 64° , 205° pl, FeO St	
7										6.94-7.12m: Jt 36° , 109° Un, clay Vn 7.07-7.13m: Jt 36° , 183° Un, FeO St 7.13-7.17m: Jt 41° , 175° pl, clay Vn 7.17-7.23m: Jt 48° , 111° pl, FeO St 7.19-7.23m: Jt 73° , 143° Pl, FeO St	
			103							7.22-7.33m: Jt 41° , 323° Pl, FeO St 7.26-7.38m: Jt 41° , 219° Un, FeO St 7.29-7.33m: Jt 56° , 232° pl, FeO St 7.31-7.46m: Jt 36° , 214° Un, FeO St 7.39-7.44m: jt 60° , 179° Pl, FeO St 7.46-7.53m: Jt 41° , 143° Un, FeO St 7.5-7.56m: Jt 56° , 82° PL, FeO St	
										7.56-7.63m: Jt 48° , 45° Pl, FeO St	
										7.57-7.69m: Jt 41° , 223° Un, clay Vn 7.67-7.74m: Jt 31° , 145° Un, clay Vn	
										7.73-7.8m: Jt 52° , 228° pl, FeO St 7.74-7.78m: Jt 56° , 149° Un, FeO St 7.77-7.83m: Jt 56° , 195° Un, FeO St 7.73-7.81m: Jt 48° , 225° Un, FeO St 7.79-7.86m: Jt 41° , 175° PL, FeO St 7.82-7.91m: Jt 41° , 165° Un, FeO St 7.85-7.93m: Jt 41° , 175° Un, FeO St 7.88-7.98m: Jt 36° , 214° Pl, FeO St 7.86-7.99m: Jt 36° , 214° Pl, FeO St	
8										8.08-8.19m: Jt 36° , 214° Un, FeO St 8.09-8.2m: Jt 41° , 219° Un, FeO St 8.18-8.24m: Jt 48° , 225° Un, FeO St 8.24-8.27m: Jt 81° , 272° Pl, FeO St 8.25-8.34m: Sz 64° , 241° Pl, FeO St 8.33-8.37m: Jt 41° , 219° Un, FeO St	
			(23)							8.34-8.44m: Jt 41° , 219° Un, FeO St 8.37-8.39m: Jt 73° , 254° Cu, FeO St 8.43-4.48m: Jt 56° , 232° Un, FeO St 8.44-8.52m: Jt 81° , 272° ir, FeO St 8.52-8.56m: Jt 36° , 214° Ir, FeO St 8.55-8.59m: Jt 41° , 219° Un, FeO St 8.58-8.63m: Jt 56° , 232° Pl, FeO St 8.61-8.67m: Jt 52° , 228° Un, Cl	
										8.66-8.83m: Jt 38° , 216° Un, FeO St 8.72-8.76m: Jt 41° , 219° Pl, FeO St 8.8-8.84m: Jt 64° , 241° Pl, FeO St 8.86-8.91m: Jt 56° , 232° Un, FeO St 8.89-8.95m: Jt 48° , 225° Pl, FeO St	
			100							8.92-8.96m: Jt 41° , 219° Un, clay Vn	
9										9-9.14m: Jt 36° , 214° Pl, clay Ct 9.02-9.16m: Jt 36° , 214° Pl, FeO St	
										9.14-9.25m: Jt 38° , 216° Un, FeO St	
										9.2-9.38m: Jt 36° , 214° Un, FeO St 9.27-9.3m: Jt 73° , 254° Un, FeO St 9.3-9.32m: Jt 64° , 241° Cv, FeO St 9.34-9.36m: Jt 73° , 254° pl, FeO St 9.4-9.41m: Jt 81° , 272° Un, FeO St 9.44-9.48m: Jt 64° , 241° Un, FeO St 9.49-9.52m: Jt 73° , 254° Un, FeO St 9.52-9.57m: Jt 41° , 219° Pl, FeO St	
			(13)							9.65-9.71m: Jt 31° , 209° Un, FeO St 9.72-9.73m: Jt 81° , 272° Un, FeO St 9.78-9.8m: Jt 81° , 272° Pl, FeO St 9.84-9.88m: Jt 56° , 232° Pl, FeO St	
10											

ENGENY

Cored Borehole Log

TSF_BH_07

Sheet: **3** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327995 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820385 m**	Date commenced:	**12/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 279.8 m**	Date completed:	**14/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**205°**	Logged by:	**CM/TM**
		Drill depth:	**24.5 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%) / USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10							Vl 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · Vh 3 / 60 · Eh 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000	9.87-9.97m: Jt 36° , 214° Un, FeO St 9.94-10m: Jt 48° , 225° Pl, FeO St	
			100						10-10.05m: Jt 31° , 209° Un, FeO St 10.05-10.08m: Jt 64° , 241° Pl, FeO St 10.07-10.1m: Jt 56° , 232° Un, FeO St 10.1-10.13m: Jt 56° , 232° Un, FeO St 10.1-10.17m: Jt 45° , 221° Un, FeO St 10.14-10.18m: Jt 64° , 241° Pl, FeO St 10.17-10.22m: Jt 56° , 232° Pl, FeO St 10.2-10.23m: Jt 56° , 232° Pl, FeO St 10.19-10.23m: Jt 64° , 241° Pl, FeO St 10.23-10.26m: Jt 48° , 225° Un, FeO St 10.23-10.28m: Jt 48° , 225° Pl, clay Vn 10.28-10.3m: Jt 73° , 254° Pl, clay Vn 10.28-10.33m: Jt 56° , 232° Un, FeO St 10.28-10.37m: Jt 31° , 209° Un, clay Vn 10.31-10.4m: Jt 41° , 219° Un, clay St 10.34-10.35m: Jt 73° , 254° Un, clay Vn 10.37-10.35m: Jt 81° , 272° Pl, FeO St 10.38-10.46m: Jt 36° , 214° Un, FeO St 10.4-10.44m: Jt 52° , 228° Un, FeO St 10.46-10.47m: Jt 73° , 254° Cv, FeO St 10.51-10.54m: Jt 64° , 241° St, FeO St 10.55-10.64m: Jt 31° , 209° Un, FeO St 10.64-10.65m: Jt 81° , 272° Un, FeO St 10.67-10.68m: Jt 81° , 272° Un, FeO St 10.67-10.71m: Jt 36° , 214° Pl, FeO St 10.7-10.71m: Jt 81° , 272° Cv, FeO St 10.7-10.78m: Jt 36° , 214° Un, FeO St 10.77-10.79m: jt 81° , 272° Pl, FeO St 10.79-10.8m: Jt 81° , 272° Pl, FeO St 10.8-10.86m: Jt 41° , 219° Pl, FeO St 10.86-10.87m: Jt 81° , 272° Pl, FeO St 10.87-10.88m: Jt 73° , 254° Cv, FeO St 10.89-10.9m: Jt 81° , 272° Pl, FeO St 10.9-10.98m: jt 31° , 209° Un, FeO St 10.98-10.99m: jt 81° , 272° pl, FeO St 11.04-11.05m: Jt 81° , 272° ir, FeO St 11.28-11.29m: Jt 73° , 254° Cv, FeO St 11.3-11.31m: Jt 73° , 254° Cv, FeO St 11.3-11.38m: Jt 56° , 232° Un, clay Ct 11.3-11.34m: Jt 73° , 254° Un, FeO St 11.4-11.42m: Jt 73° , 254° Un, clay Ct 11.43-11.45m: Jt 73° , 254° Un, clay Ct 11.45-11.46m: Jt 36° , 214° Cv, FeO St 11.45-11.49m: Jt 36° , 214° Cv, FeO St 11.48-11.51m: Jt 56° , 232° Un, clay Ct 11.48-11.55m: Jt 56° , 232° Un, clay Ct 11.55-11.57m: Jt 64° , 241° Un, FeO St 11.57-11.58m: Jt 64° , 241° Un, FeO St 11.6-11.62m: jt 73° , 254° Un, FeO St 11.63-11.64m: jt 73° , 254° Un, FeO St 11.65-11.67m: Jt 73° , 254° Cv, FeO St 11.67-11.68m: Jt 56° , 232° PL, FeO St 11.68-11.7m: Jt 81° , 272° ir, FeO St 11.7-11.75m: Jt 64° , 241° Un, FeO St 11.75-11.87m: Jt 36° , 214° Un, FeO St 11.82-11.83m: Jt 73° , 254° Un, FeO St 11.82-11.85m: Jt 73° , 254° Un, FeO St 11.92-11.93m: Jt 73° , 254° Un, FeO St 11.92-11.95m: Jt 64° , 241° PL, FeO St 11.94-11.96m: Jt 56° , 232° Un, FeO St 12.1-12.1m: jt 41° , 219° Un, FeO St 12.16-12.22m: Jt 64° , 241° Pl, FeO St 12.22-12.26m: Jt 64° , 241° Un, FeO St 12.22-12.28m: Jt 64° , 241° Un, FeO St 12.28-12.3m: Jt 81° , 272° Pl, FeO St 12.38-12.41m: Sz 64° , 241° ir, FeO St 12.5-12.52m: Jt 73° , 143° Pl, FeO St 12.55-12.57m: Jt 73° , 250° Cv, FeO St 12.68-12.71m: Jt 73° , 171° Un, FeO St 12.82-12.87m: Jt 64° , 326° Un, FeO St 12.85-12.91m: Jt 64° , 241° Pl, FeO St 12.89-12.92m: Jt 64° , 241° Pl, FeO St 12.98-13m: Jt 73° , 254° Pl, FeO St 13.02-13.05m: jt 73° , 74° Cv, FeO St 13.03-13.1m: Jt 48° , 45° Un, FeO St 13.07-13.09m: Jt 73° , 254° Un, FeO St 13.1-13.18m: Jt 36° , 214° Un, FeO St 13.16-13.19m: Jt 41° , 207° Cv, FeO St 13.19-13.33m: Fz 64° , 241° ir, FeO St 13.23-13.26m: Jt 56° , 231° Un, FeO St 13.29-13.32m: Jt 64° , 239° Cv, FeO St 13.37-13.38m: Jt 86° , 283° Un, FeO St 13.39-13.43m: Jt 64° , 160° Pl, FeO St 13.4-13.44m: Jt 64° , 241° Cv, FeO St 13.5-13.57m: Jt 48° , 225° Un, FeO St 13.58-13.59m: Jt 86° , 103° Un, FeO St 13.62-13.69m: Jt 56° , 232° St, FeO St 13.69-13.77m: Jt 48° , 225° Cv, FeO St 13.7-13.73m: Jt 73° , 248° Cv, FeO St 13.75-13.77m: Jt 56° , 241° st, FeO St 13.79-13.84m: Jt 56° , 39° st, FeO St 13.89-13.91m: Jt 64° , 234° Cv, FeO St 13.89-13.95m: Jt 48° , 229° Un, FeO St 14.04-14.05m: Jt 90° , 85° Un, FeO St 14.08-14.11m: Jt 64° , 146° Un, FeO St 14.11-14.13m: Jt 73° , 238° Un, FeO St 14.13-14.22m: Jt 41° , 228° Cv, FeO St 14.23-14.29m: Jt 52° , 157° Un, FeO St 14.26-14.35m: Jt 41° , 323° Un, FeO St 14.29-14.34m: Jt 41° , 4° Pl, FeO St 14.35-14.43m: Jt 48° , 194° Un, FeO St 14.4-14.42m: Jt 73° , 58° Un, FeO St 14.43-14.46m: Jt 56° , 231° Un, FeO St 14.48-14.5m: Jt 73° , 158° Un, FeO St	
11			(15)							
12		HQ3	100							
	261.2		(51)		**QUARTZITE:** Grey, fine grained, highly fractured to fractured, thinly bedded at 65 degrees, iron staining along defects, slightly weathered, very high strength					
13			100							
14			(83)							
			100							
15										

ENGENY

Cored Borehole Log

TSF_BH_07

Sheet: **4** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327995 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820385 m**	Date commenced:	**12/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 279.8 m**	Date completed:	**14/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**205°**	Logged by:	**CM/TM**
		Drill depth:	**24.5 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): Vl 0.03 / 0.6; L 0.1 / 2; M 0.3 / 6; H 1 / 20; VH 3 / 60; EH 10 / 200	Average Defect Spacing (mm): < 20; 20 - 60; 60 - 200; 200 - 600; 600 - 2000; > 2000	Discontinuity Description	Field Records / Remarks
15											14.52-14.55m: Jt 64° , 353° Cv, FeO St 14.64-14.72m: Jt 48° , 257° Un, FeO St 14.82-14.86m: Jt 64° , 146° Un, FeO St 15-15.05m: Jt 41° , 117° St, FeO St 15.02-15.08m: Jt 48° , 306° Un, clay Vn 15.04-15.1m: Jt 48° , 320° Un, clay Vn 15.11-15.16m: Jt 48° , 257° Un, FeO St 15.19-15.22m: Jt 56° , 231° Un, FeO St 15.24-15.32m: Jt 41° , 200° Un, FeO St 15.24-15.35m: Jt 41° , 253° Un, FeO St	
			(72)								15.24-15.39m: Jt 41° , 223° Un, FeO St 15.41-15.43m: Jt 56° , 52° Pl, FeO St 15.42-15.45m: Jt 56° , 119° Pl, FeO St	
16											15.54-15.63m: Jt 48° , 227° Un, FeO St 15.6-15.6m: Jt 90° , 295° Pl, Cl 15.67-15.69m: Jt 64° , 353° Pl, FeO Ct 15.92-15.99m: Jt 41° , 89° Un, FeO St 16.06-16.09m: Jt 48° , 59° Un, FeO St 16.15-16.27m: Jt 41° , 4° Un, FeO St	
			100								16.17-16.3m: Jt 41° , 253° St, FeO St 16.27-16.3m: Jt 73° , 100° Pl, FeO St 16.3-16.42m: Jt 41° , 323° Un, FeO St 16.38-16.39m: Jt 73° , 254° Pl, FeO St	
17											16.4-16.47m: Jt 56° , 232° Un, FeO St 16.45-16.48m: Jt 41° , 219° Un, FeO St 16.47-16.62m: Jt 36° , 133° Un, FeO St 16.73-16.76m: Jt 73° , 224° Pl, FeO St 16.76-16.8m: Jt 64° , 291° Pl, FeO St 16.76-16.81m: Jt 64° , 241° Pl, FeO St 16.85-16.85m: jt 90° , 275° Un, FeO St 16.86-16.89m: Jt 64° , 234° Pl, FeO St 16.86-16.91m: Jt 64° , 269° Pl, FeO St 16.94-16.95m: Jt 81° , 244° Cv, FeO St	
			(50)								17.02-17.02m: Jt 90° , 295° PL, FeO St 17.03-17.09m: jt 41° , 334° Un, FeO St 17.04-17.16m: Jt 36° , 133° St, FeO St 17.21-17.24m: Jt 64° , 160° Un, FeO St 17.27-17.32m: Jt 56° , 52° Un, FeO St 17.32-17.35m: Jt 56° , 241° Un, FeO St 17.38-17.42m: Sz 64° , 241° ir, FeO St 17.43-17.45m: Jt 73° , 171° Un, FeO St 17.45-17.49m: Fz 81° , 272° Un, FeO St	
			100								17.49-17.51m: Jt 73° , 250° Un, FeO St 17.6-17.62m: Jt 56° , 149° St, FeO St 17.67-17.69m: Jt 64° , 89° Un, FeO St	
18											17.76-17.77m: jt 64° , 59° Un, FeO St	
			(55)								17.86-17.89m: jt 73° , 183° Un, FeO St 17.89-17.98m: Fz 73° , 254° Un, FeO St 18.11-18.13m: Jt 56° , 82° Cv, FeO St 18.4-18.44m: Jt 48° , 210° St, FeO St 18.48-18.48m: Jt 90° , 325° Cv, FeO St 18.58-18.62m: Fz 81° , 261° ir, FeO St 18.64-18.67m: Jt 48° , 225° Un, FeO St	
19			100								18.66-18.67m: Jt 48° , 225° Un, FeO St 18.67-18.7m: Jt 73° , 14° Un, FeO St 18.69-18.72m: Jt 56° , 212° Un, FeO St 18.87-18.9m: Jt 73° , 3° Un, FeO St 18.94-18.98m: jt 56° , 185° Pl, FeO St 19.02-19.06m: Jt 56° , 24° Un, FeO St 19.05-19.1m: Jt 56° , 225° Un, FeO St 19.13-19.15m: Jt 56° , 135° Un, FeO St 19.2-19.22m: Jt 73° , 14° Un, FeO St	
											19.25-19.26m: Jt 81° , 73° Pl, FeO St 19.26-19.29m: Jt 81° , 121° ir, FeO St 19.32-19.35m: Jt 56° , 342° Un, FeO St 19.35-19.55m: Sm 48° , 45° Pl, clay In 19.54-19.57m: Sm 56° , 174° Pl, assumed clay washed out In 19.65-19.66m: Jt 73° , 351° Pl, FeO St 19.65-19.69m: Jt 48° , 164° Un, FeO St	
20			**(69)**									

ENGENY

Cored Borehole Log

TSF_BH_07

Sheet: **5** of: **5**

Project:	**TSF3 GI Support**	Easting:	**327995 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820385 m**	Date commenced:	**12/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 279.8 m**	Date completed:	**14/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**205°**	Logged by:	**CM/TM**
		Drill depth:	**24.5 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20								VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		
										19.75-19.78m: Sm 56° , 282° Pl, assumed clay washed out In 19.78-19.82m: Sm 56° , 195° Pl, assumed clay washed out In 19.84-19.98m: Jt 36° , 192° Un, FeO St 20.03-20.05m: Jt 81° , 272° St, FeO St 20.05-20.06m: Jt 81° , 272° Un, FeO St	
										20.06-20.15m: Jt 31° , 209° Un, FeO St	
										20.13-20.16m: Jt 81° , 215° Un, FeO St	
			100							20.29-20.3m: Jt 81° , 92° Cv, clay Ct	
										20.5-20.5m: Jt 90° , 115° Un, FeO St 20.65-20.69m: Jt 56° , 185° Un, FeO St 20.74-20.75m: Jt 81° , 71° Un, FeO St 20.88-20.91m: Jt 73° , 124° Un, FeO St 20.91-20.91m: Jt 90° , 295° Pl, FeO St	
21										20.92-20.94m: Jt 56° , 61° Un, FeO St	
										21-21.05m: Jt 52° , 228° Pl, FeO St 21-21.07m: Jt 64° , 89° Un, FeO St	
			(79)							21.16-21.21m: Jt 56° , 135° Un, FeO St 21.23-21.24m: Jt 81° , 158° Un, FeO St 21.28-21.31m: Jt 64° , 130° Pl, FeO St	
										21.49-21.52m: Jt 64° , 239° Un, FeO St	
										21.5-21.54m: Jt 64° , 111° Pl, FeO St	
										21.52-21.54m: Jt 81° , 194° Pl, FeO St 21.59-21.73m: Jt 36° , 250° Un, FeO St 21.86-21.88m: Jt 81° , 253° Cv, FeO St	
22										21.88-21.89m: Jt 56° , 162° Pl, FeO St 21.88-21.89m: Jt 64° , 353° Pl, FeO St 21.94-21.95m: Jt 56° , 232° Cv, FeO St	
										22-22.04m: Jt 41° , 323° Un, FeO St	
			100							22-22.08m: Jt 41° , 283° Un, FeO St 22.07-22.11m: Jt 64° , 310° Pl, FeO St 22.17-22.18m: Jt 81° , 92° Cv, FeO St	
										22.25-22.27m: Jt 73° , 250° Cv, FeO St	
										22.28-22.29m: Jt 56° , 32° Cv, FeO St	
										22.32-22.37m: Jt 60° , 124° Pl, FeO St	
23	247		**(43)**		**QUARTZITE:** grey, fine grained, thinly bedded, fractured, iron staining along discontinuities, slightly weathered, very high strength					22.7-22.73m: jt 73° , 183° ir, FeO St	
										22.74-22.85m: Jt 41° , 297° Un, clay Ct	
										22.88-22.9m: Jt 81° , 253° ir, FeO St	
										22.95-23m: Jt 81° , 142° Pl, FeO St	
										23.06-23.2m: Jt 48° , 36° ir, FeO St	
			100							23.34-23.36m: Jt 81° , 14° Un, FeO St 23.55-23.58m: Jt 64° , 15° Un, FeO St	
24										23.66-23.68m: Jt 73° , 143° ir, FeO St 23.82-23.89m: Jt 64° , 4° Un, FeO St 23.85-23.88m: Jt 64° , 173° Pl, FeO St 24.06-24.07m: Jt 90° , 295° Pl, Cl	
										24.07-24.11m: Jt 52° , 228° Pl, Cl	
	253.8		**(93)**							24.12-24.17m: Jt 64° , 241° Cv, FeO St 24.17-24.21m: Jt 52° , 228° Un, FeO St	

ENGENY

Cored Borehole Log

TSF_BH_08

Sheet: **1** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328032 m**
Client:	**29 Metals**	Northing:	**7820370 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 268.4 m**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**
		Drill depth:	**21.4 m bgl**
Driller:	**GROUNDWAVE**		
Date commenced:	**15/5/2024**		
Date completed:	**18/5/2024**		
Logged by:	**TM**		
Checked by:	**AL**		

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**FILL:** not boxed, cobbles and boulders			VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		
1											
2											
3											
4											
	259.7										
5	263	HQ3	100 / (0)		**QUARTZITE:** pale red brown, medium to coarse grained, fractured, iron staining along discontinuities, moderately weathered, medium strength		MW				4.5 - 5m: Drilling / handling breaks

ENGENY

Cored Borehole Log

TSF_BH_08

Sheet: **2** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328032 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820370 m**	Date commenced:	**15/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 268.4 m**	Date completed:	**18/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**	Logged by:	**TM**
		Drill depth:	**21.4 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5					**QUARTZITE:** pale grey and red, medium grained, slightly fractured, iron staining along discontinuities, high strength, moderately weathered			VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000	5.12-5.15m: Jt 81° , 272° Un, Cl 5.15-5.17m: Jt 48° , 225° Un, Cl 5.15-5.26m: Jt 41° , 219° Un, FeO St 5.18-5.29m: Jt 41° , 219° Un, FeO St 5.35-5.36m: Jt 73° , 254° Pl, sand In 5.45-5.5m: Jt 73° , 254° Cv, FeO St 5.62-5.62m: Jt 90° , 295° Pl, FeO St	5 - 6.6m: No orientation
			100							5.82-5.89m: Jt 56° , 232° Pl, FeO St	
6										6-6.23m: Jt 33° , 211° Un, FeO St 6.04-6.06m: Jt 73° , 254° Un, FeO St 6.07-6.08m: Sm 90° , 295° Pl, clay In 6.19-6.2m: Jt 81° , 272° Pl, FeO St 6.27-6.29m: Jt 90° , 295° Ir, clay Vn 6.28-6.35m: Jt 41° , 219° Un, FeO St 6.35-4.46m: Jt 41° , 219° Un, sand In 6.42-6.43m: Jt 81° , 272° Un, FeO St 6.46-6.53m: Jt 36° , 214° Un, FeO St 6.5-6.56m: Jt 41° , 219° Un, FeO St	
			(58)								6.6 - 7.74m: Core spin, no ori
										6.78-6.85m: Jt 41° , 219° Pl, FeO St	
7										6.9-6.98m: Jt 48° , 225° Un, FeO St 7-7.08m: Jt 48° , 225° Un, FeO St	
			100							7.22-7.28m: Jt 41° , 219° Un, FeO St 7.28-7.35m: Jt 48° , 225° Un, FeO St	
	258.5									7.49-7.54m: Jt 56° , 232° Un, FeO St	
					QUARTZITE: grey, medium grained, slightly fractured, iron staining along discontinuities. Massive bedding at 60-70 degrees. slightly weathered, high strength					7.74-7.75m: Jt 81° , 261° Pl, Cl	
							SW			7.85-7.86m: Jt 64° , 61° Cv, FeO St 7.88-7.93m: Jt 41° , 154° Un, FeO St	
8			**(53)**							7.96-8.01m: Jt 56° , 149° Ir, FeO St 8.24-8.26m: Jt 73° , 158° Cv, FeO St	
										8.26-8.42m: Fz 56° , 174° Un, FeO St	
			100							8.58-8.62m: Jt 64° , 326° Un, Cl 8.68-8.7m: Jt 81° , 194° Cv, FeO St 8.68-8.82m: Jt 41° , 73° Pl, FeO St 8.78-8.8m: Jt 81° , 171° Cv, FeO St 8.82-8.86m: Jt 41° , 175° Pl, FeO St	
9										8.86-8.9m: Jt 56° , 195° Cv, FeO St 9.2-9.31m: Jt 41° , 297° Un, FeO St 9.25-9.26m: Jt 90° , 295° Pl, FeO St 9.27-9.28m: Sm 90° , 295° Pl, clay In	
			(97)		Bedding 60 degrees					9.43-9.46m: Jt 64° , 326° Pl, clay Vn 9.5-9.54m: Jt 36° , 227° Pl, FeO St	9.55 - 9.68m: Matched up bedding plane, joint doesn't fit so medium conficence in orientation
										9.54-9.56m: Jt 81° , 273° Pl, FeO St 9.66-9.7m: Jt 73° , 205° Un, FeO St	
10										9.75-9.76m: Jt 81° , 92° Un, FeO St	

ENGENY

Cored Borehole Log

TSF_BH_08

Sheet: **3** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328032 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820370 m**	Date commenced:	**15/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 268.4 m**	Date completed:	**18/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**	Logged by:	**TM**
		Drill depth:	**21.4 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Material Description	Discontinuity Description	Field Records / Remarks
10					9.86-10m: Jt 41° , 154° Pl, FeO St	
					10.05-10.1m: Jt 48° , 164° Un, FeO St	
			100		10.17-10.19m: Jt 73° , 205° Pl, FeO St	
					10.2-10.31m: Jt 41° , 283° Un, FeO St	
					10.25-10.25m: Jt 90° , 185° Un, FeO St	10.4 - 10.58m: incipient fracture stockwork, 50 degrees
					10.38-10.41m: Jt 73° , 253° Pl, FeO St 10.45-10.46m: Jt 73° , 253° Pl, FeO St 10.48-10.5m: Jt 81° , 251° Pl, FeO St 10.5-10.55m: Jt 48° , 229° Un, FeO St	
		HQ3			10.55-10.58m: Jt 81° , 251° Un, FeO St	
					10.64-10.66m: jt 73° , 233° Pl, FeO St	
					10.66-10.81m: Jt 31° , 226° Un, FeO St	
11			(70)		10.81-10.82m: Jt 90° , 295° Pl, FeO St	
				Frequent veins, 20-50 degrees	11-11.1m: Jt 36° , 227° Un, FeO St 11.35-11.37m: Jt 77° , 330° Pl, Cl 11.37-11.39m: Jt 48° , 239° Cv, FeO St	
					11.43-11.45m: Jt 64° , 291° Un, FeO St	
					11.53-11.63m: Jt 41° , 103° Pl, FeO St	
			100		11.55-11.64m: Jt 41° , 103° Pl, FeO St 11.7-11.73m: Jt 56° , 119° St, FeO St	
					11.73-11.78m: Jt 41° , 89° Pl, FeO St	
					11.79-11.84m: Jt 41° , 117° Pl, FeO St 11.86-11.87m: Jt 64° , 326° Ir, FeO St	
12					11.9-11.96m: Jt 64° , 173° Pl, FeO St	
					12.02-12.04m: Jt 64° , 34° Un, Cl	
					12.14-12.22m: Jt 41° , 283° Un, FeO St	
					12.22-12.25m: Jt 81° , 251° Ir, FeO St	
			(93)		12.32-12.4m: Pt 48° , 194° Un, Cl	
					12.5-12.52m: Jt 81° , 251° Un, FeO St 12.66-12.69m: Jt 81° , 64° Pl, FeO St	
				blotches of red iron staining	12.7-12.72m: Jt 73° , 53° Pl, FeO St	
13					12.82-12.86m: Sm 56° , 15° Un, FeO St	
					12.94-12.96m: Jt 73° , 25° Un, FeO St 13.17-13.18m: Jt 60° , 179° Pl, FeO St	
			100	veins	13.18-13.19m: Jt 81° , 338° Un, Cl	
					13.26-13.27m: Jt 81° , 91° Un, FeO St	
	249.3				13.36-13.37m: Jt 81° , 14° Un, Ct	
				QUARTZITE: grey and pale red, fine grained, fractured to slightly fractured, thinly to medium bedded at 45 - 60 degrees, slightly weathered, very high strength	13.44-13.46m: Jt 81° , 3° Un, Ct	
					13.46-13.59m: Pt 45° , 107° Pl, FeO St	
				veins	13.63-13.8m: Jt 38° , 160° Un, Dark grey St	
					13.84-13.88m: Jt 64° , 234° Un, FeO St	
14			(93)		13.9-13.98m: Pt 38° , 100° Pl, FeO St 13.92-13.98m: Pt 38° , 100° Pl, FeO St	14.03 - 14.23m: laminated to thinly laminated, pale brown staining
					13.96-14.05m: Jt 48° , 126° St, FeO St	
					14.02-14.2m: Pt 38° , 138° Pl, clay Vn 14.23-14.25m: Jt 64° , 353° Un, FeO St	14.23 - 14.4m: very thinly bedded
					14.23-14.33m: Pt 38° , 318° Pl, FeO St 14.25-14.37m: Pt 38° , 306° Pl, FeO St 14.29-14.3m: Jt 73° , 25° Un, FeO St 14.34-14.36m: Jt 73° , 183° St, FeO St	14.4 - 15.4m: thinly bedded
					14.4-14.42m: Jt 81° , 194° Un, FeO St	
			100		14.43-14.56m: Pt 41° , 323° Un, FeO St 14.52-14.55m: Jt 64° , 173° Pl, FeO St	
					14.64-14.67m: Jt 73° , 3° Ir, Cl	
15					14.66-14.7m: Jt 48° , 14° Pl, FeO St	

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Cored Borehole Log

TSF_BH_08

Sheet: **4** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328032 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820370 m**	Date commenced:	**15/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 268.4 m**	Date completed:	**18/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**	Logged by:	**TM**
		Drill depth:	**21.4 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15									Vl 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · Vh 3 / 60 · Eh 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		
											14.83-14.84m: Jt 81° , 45° Pl, FeO St	
			(66)		Veins, 10-60 degrees, iron stained						14.93-14.94m: Jt 90° , 305° Pl, FeO St 15.08-15.33m: Sm 36° , 70° Un, FeO St 15.12-15.23m: Jt 36° , 40° Un, FeO St 15.2-15.21m: Jt 81° , 71° Un, FeO St	14.88 - 14.89m: Handling break
											15.25-15.36m: Jt 36° , 27° Un, FeO St 15.36-15.37m: Jt 81° , 338° St, Cl	15.7 - 16.6m: No ori
16											15.39-15.4m: Jt 90° , 115° Un, Cl 15.69-15.7m: Jt 81° , 215° Pl, Cl 15.7-15.79m: Jt 41° , 219° Un, FeO St 15.74-15.75m: Jt 73° , 254° Pl, Cl 15.82-15.82m: Jt 90° , 295° Pl, Cl	
			100								15.83-15.83m: Jt 90° , 295° Pl, Cl 15.87-15.87m: Jt 90° , 295° Pl, Cl	
											15.89-15.89m: Jt 90° , 295° Pl, Cl 16-16.06m: Fz 30° , 205° ,	
											16.06-16.08m: Jt 56° , 232° Pl, FeO St	
											16.13-16.16m: Jt 56° , 232° Cv, FeO St 16.16-16.22m: Fz 48° , 225° Pl, clay Ct 16.3-16.66m: Jt 56° , 232° Pl, FeO St 16.36-16.41m: Jt 31° , 209° Un, FeO St 16.41-16.42m: Jt 81° , 272° Pl, FeO St 16.47-16.48m: Jt 81° , 272° Un, FeO St 16.47-16.51m: Jt 31° , 209° Un, FeO St 16.58-16.59m: Jt 81° , 272° Pl, clay Vn 16.67-16.68m: Jt 81° , 322° Pl, FeO St 16.7-16.71m: Jt 81° , 322° Pl, FeO St 16.76-16.94m: Pt 41° , 89° Un, clay Vn 16.87-16.89m: Jt 81° , 272° Un, Cl 16.9-16.91m: Jt 77° , 199° Un, Cl 16.97-17.03m: Jt 73° , 338° Pl, Cl	16.16 - 16.22m: incipient fracture stockwork, 40 degrees
17			(44)								17.05-17.12m: Jt 48° , 140° Un, Cl 17.08-17.09m: Jt 73° , 254° Pl, Cl	
											17.13-17.14m: Jt 86° , 286° Un, Cl	
					dark veins						17.26-17.34m: Jt 48° , 140° Un, FeO St 17.27-17.41m: Jt 48° , 229° Un, FeO St	
			100								17.5-17.53m: Jt 64° , 160° Ir, FeO St 17.58-17.61m: Jt 73° , 44° Un, Cl	
18											17.6-17.78m: Jt 36° , 345° Un, Dark staining St	
			(61)		dark veins							
											17.84-17.86m: Jt 73° , 183° Un, Cl 17.89-17.97m: Sm 64° , 4° Un, clay In 18.02-18.7m: Jt 64° , 240° Un, FeO St 18.11-18.13m: Jt 73° , 3° Un, FeO St 18.16-18.19m: Jt 73° , 338° Un, FeO St 18.18-18.21m: Jt 81° , 351° Ir, Cl 18.24-18.25m: Jt 73° , 3° Un, Cl	
19											18.38-18.4m: Jt 81° , 121° Un, Cl 18.44-18.44m: Jt 90° , 75° Pl, Cl 18.51-18.52m: jt 90° , 125° Un, FeO St 18.59-18.65m: Jt 36° , 324° Cv, FeO St 18.6-18.61m: Jt 73° , 351° Un, FeO St 18.67-18.69m: Jt 73° , 351° Pl, FeO St 18.76-18.81m: Jt 56° , 15° Un, Cl	
			100								19.05-19.12m: Pt 48° , 175° Cv, 19.05-19.07m: Jt 81° , 50° Un, FeO St 19.13-19.14m: Jt 81° , 272° Un, FeO St 19.15-19.19m: Fz 30° , 205° , 19.2-19.25m: Pt 73° , 70° Pl, FeO St 19.23-19.27m: jt 73° , 70° Pl, FeO St	
											19.29-19.35m: Jt 41° , 253° Pl, FeO St	
											19.34-19.36m: Jt 73° , 248° Un, FeO St 19.35-19.39m: Jt 48° , 59° Pl, FeO St	
20											19.47-19.48m: Jt 81° , 253° St, FeO St 19.53-19.63m: Jt 41° , 103° Un, FeO St	

ENGENY

Cored Borehole Log

TSF_BH_08

Sheet: **5** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328032 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820370 m**	Date commenced:	**15/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 268.4 m**	Date completed:	**18/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**	Logged by:	**TM**
		Drill depth:	**21.4 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20			(66)					VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000	19.69-19.71m: Jt 81° , 338° Un, FeO St 19.71-19.75m: Pt 41° , 238° Pl, Cl 19.88-19.88m: Jt 90° , 300° Un, FeO St 19.89-19.91m: Jt 86° , 286° Pl, FeO St 20.03-20.09m: Jt 56° , 354° Un, Cl 20.06-20.06m: Jt 90° , 5° Un, Cl 20.17-20.17m: jt 90° , 115° Pl, Cl 20.23-20.31m: Jt 41° , 310° Un, FeO St 20.25-20.28m: Jt 48° , 126° Pl, FeO St	
			100							20.29-20.3m: Jt 90° , 295° Un, FeO St 20.3-20.32m: Jt 73° , 215° St, FeO St 20.4-20.48m: Jt 48° , 126° Pl, FeO St 20.42-20.47m: Jt 73° , 171° Un, FeO St 20.49-20.63m: Pt 36° , 220° Pl, FeO St 20.53-20.66m: Pt 36° , 47° Pl, FeO St	
21										20.69-20.72m: Jt 48° , 227° St, Cl 20.85-20.86m: jt 90° , 295° Un, Cl	
	239.5		(56)							20.76-20.82m: Jt 36° , 122° Un, FeO St 20.82-20.91m: Jt 41° , 219° Un, FeO St	

ENGENY

Cored Borehole Log

TSF_BH_09

Sheet: **1** of: **11**

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**GRAVEL with CLAY:** dark grey, fine to coarse, angular, well graded gravel with low plasticity fines. Gravel comprised of MW to HW dark grey siltstone clasts, sand sized fragments likely broken by sonic drilling action	D	GP	D			
1			100								
2	305.8				**GRAVEL:** dark grey, coarse, angular, well graded gravel. Gravel comprised of MW to HW dark grey siltstone clasts, sand sized fragments likely broken by sonic drilling action		GW				
3			(0)								
4	304				**CORE LOSS:**						
			78								
5	302.8	Sonic									

ENGENY

Cored Borehole Log

TSF_BH_09

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5					**GRAVEL:** dark grey, coarse, angular, well graded gravel. Gravel comprised of MW to HW dark grey siltstone clasts, sand sized fragments likely broken by sonic drilling action	D	GW	D			
	302.2				**CORE LOSS:**						
6	301.8		(0)		**Sandy GRAVEL:** red, fine to medium, angular, well graded gravel, fine to medium grained sand. Gravel and sand both comprised of MW to HW ferruginized siltstone clasts	D	GW	D			
7			80								
8	299.3				**CORE LOSS:** mine waste: tyre						8.5 - 9m: Fast rod drop. Likely void where tyre is located.
9	298.8		(0)		**Sandy GRAVEL with clay:** dark grey, fine to medium, angular, well graded gravel, fine to medium grained sand. Gravel and sand both comprised of MW to HW siltstone clasts	D	GW	D			
10											

Consistency Density: VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Inferred Rock Strength MPa (IS_{50}/UCS)

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_09

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10			100					VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
11											
12	295.8		(0)		**Clayey GRAVEL:** red, fine to coarse, angular, well graded gravel with medium plasticity fines. Gravel comprised of MW to HW ferruginized siltstone or sandstone clasts. Fines content up to 30%.		GC	VD			
13			100								
14											
15			(0)								

ENGENY

Cored Borehole Log

TSF_BH_09

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15								VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
16	291.8										
					Cobbles and Boulders (50%) in a clayey Gravel matrix (50%): cobbles and boulders range from 50mm to 150mm in core and are comprised of HW and low strength dark grey and red siltstone breccia. Gravel is fine to coarse, angular elongated clasts, low plasticity fines.			D			
			100								
17											
18			(0)								
19					500mm layer of coarse gravel clasts comprised of SW, HS chert/quartzite						
			100		likely a boulder of HW, LS siltstone which has been pulverised to clayey GRAVEL/Gravelly CLAY layer.						
20	287.8										

ENGENY

Cored Borehole Log

TSF_BH_09

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20					**Sandy GRAVEL with clay:** dark pale brown, fine to coarse, angular, well graded gravel, fine to medium grained sand. Gravel and sand both comprised of MW to HW feldspathic sandstone clasts		GW				
21			(0)								21 - 21.5m: Not core loss. Samples taken over this range likely bunched in to bags at 22.0m
22			100								
23											
24	283.8	Sonic	(0)		**Gravelly CLAY:** low plasticity, dark grey, fine to coarse, angular gravel comprised of SW, MS siltstone and quartzite clasts. Drilling returns resemble pulverised rock, likely drilling through moderately to highly weathered, low strength siltstone.	w< PL	Cl	H			
25											

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6; L 0.1 / 2; M 0.3 / 6; H 1 / 20; VH 3 / 60; EH 10 / 200

Average Defect Spacing (mm): < 20; 20 - 60; 60 - 200; 200 - 600; 600 - 2000; > 2000

ENGENY

Cored Borehole Log

TSF_BH_09

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
25			100								
26											
27	280.8		(0)		**CORE LOSS:**						
	280.3				**Gravelly CLAY:** low plasticity, dark grey, fine to coarse, angular gravel comprised of SW, MS siltstone and quartzite clasts. Drilling returns resemble pulverised rock, likely drilling through moderately to highly weathered, low strength siltstone boulders.	w< PL	Cl	H			
28											
			83								28.4 - 29.5m: Difficult drilling, likely coring through MW, MS feldspathic sandstone boulder
29											
30			(0)								

ENGENY

Cored Borehole Log

TSF_BH_09

Project:	**TSF3 GI Support**	Easting:	**328224 m**
Client:	**29 Metals**	Northing:	**7820536 m**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**
		Drill depth:	**54.3 m bgl**

Driller:	**GROUNDWAVE**
Date commenced:	**8/4/2024**
Date completed:	**11/4/2024**
Logged by:	**CM**
Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
30								VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
31			100								
	276.1				**Clayey GRAVEL:** pale grey to dark grey, fine to coarse, angular, well graded gravel, low plasticity fines, trace sand. Gravel comprised of MW to HW siltstone clasts	D	GC	D			
32											
33			(0)								
34			100								
35											

ENGENY

Cored Borehole Log

TSF_BH_09

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
35											
36	271.8		(0)		**CLAY with Gravel:** low plasticity, dark grey, angular, fine grained gravel, trace medium grained sand.	w< PL	Cl	H			
	271.2				**CORE LOSS:**						
37											
	270.6				**GRAVEL with CLAY:** pale grey to dark grey, fine to coarse, angular, well graded gravel, low plasticity fines, trace sand. Gravel comprised of MW to HW siltstone clasts	D	GW				
			73								
38											
39	268.8		(0)		**Gravelly CLAY:** low plasticity, pale red brown, fine to coarse, angular gravel comprised of SW, MS siltstone and quartzite clasts. Drilling returns resemble pulverised rock, likely drilling through moderately to highly weathered, low strength feldspathic boulders.	w< PL	Cl				
40	267.8										

ENGENY

Cored Borehole Log

TSF_BH_09

Sheet: **9** of: **11**

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
40					**Clayey GRAVEL:** red, fine to coarse, angular, well graded gravel with medium plasticity fines. Gravel comprised of MW to HW ferruginized siltstone clasts. Fines content up to 30%.	D	GW				
			100		clay content ~30%, likely pulverised weathered rock.						
41											
42	265.8		(0)		**Sandy GRAVEL:** dark grey, fine to medium, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt			VD			
	265.6				**CORE LOSS:**						42.2 - 45m: Core Loss. Core stuck in barrel
43											
			7								
44											
45			(0)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_09

Sheet: **10** of: **11**

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
45											45 - 46.5m: Core Loss. Core stuck in barrel
			0								
46											
	261.3		(0)								
					COBBLES and BOULDERS: pale brown, sub-angular to sub-rounded quartzite clasts with gravel, medium to coarse grained, sub-rounded to sub-angular, quartzite clasts	D		L			45.5 - 48m: Quartzite Cobbles and boulders. Natural not Fill
47			100								
48	259.8		(0)								
					QUARTZITE: pale brown, medium to coarse grained, iron staining along discontinuities, high strength, slightly weathered		SW				48 - 48.4m: Drilling induced breaks/Spun core
			63							23.74-23.81m: Jt 41° , 219° Un, FeO St	
			(0)							23.78-23.78m: Jt 90° , 295° Pl, FeO St 23.82-23.89m: Fz 30° , 205° , 23.93-23.95m: Jt 90° , 295° Pl, Cl 24.13-24.13m: Jt 90° , 295° Pl, FeO St 24.17-24.21m: Jt 73° , 254° Pl, FeO St 24.19-24.25m: Jt 56° , 232° Un, FeO St 48.58-48.61m: Jt 50° Pl, 48.61-48.63m: Jt 40° Pl,	
49										48.88-48.89m: Jt 10° Pl, Ro, St: Fe staining 48.91-48.92m: Jt 10° Pl, Ro, In: Qtz 1mm Fe staining 49-49.1m: Jt 80° Un, Ro, St: Fe staining	
			100							49.1-49.15m: Sz 49.2-49.21m: Jt 10° Un, Ro, St: Fe staininf 49.21-49.24m: Jt 40° Un, Ro, St: Fe staining 49.23-49.34m: Jt 70° Un, Vn: Qtz 49.38-49.49m: Jt 60° Pl, Ro, St: Fe staining 49.46-49.46m: Jt 10° Pl, Ro, St 49.51-49.54m: Jt 20° Pl, Ro, St 49.53-49.54m: Jt 10° Un, Ro, St: Fe staining 49.55-49.67m: Jt 80° Pl, St 49.62-49.63m: Jt 10° Pl, Ro, St: Fe 49.66-49.83m: Jt 90° Un, St	49.1 - 49.15m: Core recovered as fragments <20mm
			(27)							49.66-49.77m: Jt 70° Un, Ro, St 49.77-49.78m: Jt 25° Un, Ro, St 49.81-49.82m: Jt 10° Pl, Ro, St 49.84-49.92m: Jt 70° Un, Ro, St	
50		HQ3									

ENGENY

Cored Borehole Log

TSF_BH_09

Sheet: **11** of: **11**

Project:	**TSF3 GI Support**	Easting:	**328224 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820536 m**	Date commenced:	**8/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 307.8 m**	Date completed:	**11/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**54.3 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
51		HQ3	100 (65)						Vl 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · Vh 3 / 60 · Eh 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000	49.92-50m: Jt 80° Un, Ro, St 50.03-50.04m: Jt 35° Ir, Ro, St 50.04-50.18m: Jt 80° Un, St 50.07-50.17m: Jt 60° Un, St 50.18-50.19m: Jt 20° Un, Ro, St 50.19-50.2m: Jt 20° Un, Ro, St 50.21-50.24m: Jt 40° Un, St 50.24-50.26m: Jt 30° Un, St 50.26-50.36m: Jt 75° Un, St 50.27-50.28m: Jt 30° Un, St 50.42-50.43m: Jt 10° Un, Ro, St 50.46-50.59m: Pt 60° Un, Ro, Cl 50.67-50.68m: Jt 10° Un, Ro, St 50.68-50.69m: Jt 10° Un, Ro, St 50.75-50.82m: Jt 60° Un, St 50.8-50.86m: Jt 70° Un, Ro, St 50.82-50.92m: Jt 70° Un, Ro, Vn: Qtz 50.82-50.91m: Jt 70° Un, Ro, St 50.91-50.94m: Jt 30° Pl, Ro, St	50.93 - 50.95m: Drilling induced. <20mm
52			100 (73)								51-51.15m: Jt 70° Un, Ro, St 51.13-51.16m: Jt 35° Pl, St 51.16-51.2m: Jt 60° Un, Ro, St 51.19-51.22m: Jt 30° Un, Ro, St 51.21-51.27m: Jt 50° Un, Ro, St 51.27-51.33m: Jt 70° Un, St 51.27-51.37m: Jt 70° Un, St 51.35-51.36m: Jt 10° Un, St 51.37-51.38m: Jt 20° Un, Ro, St 51.4-51.41m: Jt 20° Un, Ro, Vn: Clay fe stn 51.47-51.49m: Jt 20° Un, Ro, Vn: Clay fe stn 51.56-51.61m: Jt 70° Pl, St 51.62-51.66m: Jt 35° Cv, Ro, St 51.64-51.65m: Jt 10° Un, Ro, Vn: Clay fe stn 51.76-51.78m: Jt 40° Un, St 51.79-51.9m: Jt 70° Un, St 51.83-51.84m: Jt 20° Un, Ro, Vn 52-52.07m: Jt 70° Un, Ro, St	51.95 - 52m: Handling and drill breaks
53			100 (50)								52.33-52.39m: Jt 75° Un, St 52.4-52.52m: Jt 80° Un, Ro, Vn: Clay fe stn 52.44-52.48m: Jt 30° Un, Ro, St 52.49-52.57m: Jt 55° Un, Ro, St 52.56-52.67m: Jt 60° Un, Ro, Vn: Clay fe stn 52.6-52.85m: Jt 75° Un, Ro, St 52.69-52.8m: Jt 70° Un, Ro, St 52.78-52.82m: Jt 40° Un, Ro, St 52.81-52.85m: Jt 50° Un, Ro, Vn: Clay fe stn 52.82-52.86m: Jt 80° Un, St 52.83-52.9m: Jt 70° Pl, Ro, Vn: Clay fe stn 52.83-52.88m: Jt 90° Un, St	52.18 - 52.32m: Handling and drill breaks
54			100 (0)								53.25-53.3m: Jt 55° Un, Ro, St 53.27-53.33m: Jt 40° Un, Ro, St 53.35-53.45m: Pt 65° Un, Ro, Cl 53.47-53.56m: Pt 65° Pl, Ro, Vn: clay 53.56-53.68m: Pt 65° Pl, Ro, Vn: clay 53.67-53.79m: Pt 65° Un, Ro, Vn: clay 53.82-53.92m: Jt 70° Un, Ro, St 53.83-53.97m: Pt 70° Un, Ro, Vn: clay 53.83-53.84m: Jt 10° Un, Ro, St 53.87-53.88m: Jt 20° Un, Ro, St	
	253.5		100 (52) 100 (0)								54.08-54.2m: Pt 70° Un, St 54.12-54.22m: Pt 65° Un, Ro, Cl	54.17 - 54.34m: Handling and drill breaks

ENGENY

Cored Borehole Log

TSF_BH_10A Sheet: 1 of: 5

Project:	**TSF3 GI Support**	Easting:	**328331 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**18/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 282.1 m**	Date completed:	**21/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**	Logged by:	**TM**
		Drill depth:	**23.9 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03/0.6, L 0.1/2, M 0.3/6, H 1/20, VH 3/60, EH 10/200	Average Defect Spacing (mm): <20, 20-60, 60-200, 200-600, 600-2000, >2000	Discontinuity Description	Field Records / Remarks
0					**FILL:** not boxed, cobbles and boulders						
1											
2											
3											
	275.1										
4			100		**QUARTZITE:** grey, medium grained, highly fractured,laminated to thinly bedded at 50 degrees, iron staining along discontinuities, slightly weathered, very high strength		SW			3.7-3.8m: Fz 30° , 25° , 3.76-3.85m: Jt 33° , 31° Pl, FeO St 3.84-3.88m: Jt 64° , 61° Un, FeO St 3.85-3.9m: Jt 64° , 61° Un, FeO St 4.01-4.06m: Jt 64° , 61° Un, FeO St 4.01-4.07m: Jt 36° , 34° Pl, FeO St 4.04-4.11m: Jt 56° , 52° Pl, FeO St 4.09-4.13m: Jt 56° , 52° Pl, FeO St 4.1-4.11m: Jt 81° , 92° St, FeO St 4.12-4.13m: Jt 56° , 52° Pl, FeO St 4.13-4.16m: Jt 64° , 61° St, FeO St 4.16-4.23m: Jt 48° , 45° Un, FeO St 4.21-4.28m: Jt 41° , 39° Pl, Cl 4.31-4.37m: Fz 56° , 52° Un, FeO St 4.41-4.42m: Jt 73° , 74° Pl, FeO St 4.43-4.52m: Jt 48° , 45° Un, FeO St 4.53-4.56m: Fz 56° , 52° Un, FeO St 4.57-4.62m: Jt 64° , 61° Un, FeO St 4.65-4.7m: Fz 56° , 52° Un, FeO St 4.75-4.79m: Jt 48° , 45° Pl, FeO St 4.75-4.8m: Jt 48° , 45° Pl, FeO St	
5		HQ3									

ENGENY

Cored Borehole Log

TSF_BH_10A Sheet: 2 of: 5

Project:	**TSF3 GI Support**	Easting:	**328331 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**18/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 282.1 m**	Date completed:	**21/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**	Logged by:	**TM**
		Drill depth:	**23.9 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03/0.6, L 0.1/2, M 0.3/6, H 1/20, VH 3/60, EH 10/200	Average Defect Spacing (mm): <20, 20-60, 60-200, 200-600, 600-2000, >2000	Discontinuity Description	Field Records / Remarks
5			(19)								4.82-4.9m: Fz 48° , 45° , FeO St 4.87-4.91m: Jt 73° , 74° Un, FeO St 5-5.13m: Fz 30° , 25° , 5.13-5.17m: Jt 48° , 45° Pl, Cl 5.21-5.23m: Jt 73° , 74° Pl, Cl 5.29-5.32m: Jt 73° , 74° Pl, Cl 5.36-5.46m: Fz 30° , 25° , 5.46-5.56m: Jt 41° , 39° Un, FeO St	5 - 5.13m: Drilling breaks
6			100								5.54-5.65m: Fz 30° , 25° , 5.65-5.82m: Jt 64° , 50° Cv, FeO St 5.68-5.69m: Jt 81° , 81° Un, FeO St 5.69-5.78m: jt 56° , 162° Un, FeO St 5.82-5.91m: Jt 36° , 289° St, FeO St 5.9-5.92m: Jt 81° , 81° St, FeO St 5.91-5.93m: Fz 30° , 25° , 5.93-5.95m: Jt 81° , 215° Un, FeO St 5.94-60m: Jt 64° , 54° Un, FeO St 6-6.03m: Fz 30° , 25° , 6.05-6.11m: Jt 56° , 204° Pl, Cl 6.14-6.24m: Jt 48° , 175° Un, FeO St 6.24-6.33m: Jt 41° , 143° Un, FeO St 6.33-6.36m: Jt 64° , 340° Pl, Cl	
7			(16)								6.36-6.39m: Jt 73° , 3° Un, Cl 6.5-6.57m: Jt 48° , 175° Un, FeO St 6.52-6.62m: Jt 36° , 183° Pl, FeO St 6.66-6.74m: Jt 56° , 212° Un, FeO St 6.68-6.72m: Jt 56° , 354° Un, FeO St 6.75-6.78m: Jt 81° , 92° Ir, FeO St 6.8-6.85m: Jt 41° , 89° Pl, FeO St 6.86-6.9m: Fz 81° , 3° Ir, FeO St 6.92-6.92m: Jt 56° , 354° Un, FeO St 7-7.07m: Jt 41° , 73° Pl, FeO St 7.05-7.1m: Jt 56° , 342° Un, FeO St	
8			100								7.15-7.18m: Jt 81° , 91° Un, FeO St 7.23-7.35m: Jt 48° , 175° Pl, clay Vn 7.23-7.24m: Jt 48° , 355° Pl, FeO St 7.3-7.33m: Fz 69° , 9° Pl, FeO St 7.35-7.43m: Jt 48° , 225° Pl, FeO St 7.43-7.52m: Jt 48° , 332° Pl, FeO St 7.44-7.52m: Jt 48° , 332° Pl, FeO St 7.51-7.63m: Sm 48° , 164° Pl, clay In 7.53-7.54m: Jt 81° , 322° Un, FeO St 7.66-7.67m: Jt 81° , 322° Un, FeO St 7.72-7.73m: Jt 81° , 92° St, FeO St 7.76-7.81m: Jt 56° , 232° Pl, clay Vn 7.77-7.82m: Jt 36° , 57° Pl, FeO St 7.89-7.93m: Jt 48° , 45° St, FeO St 7.9-7.99m: Jt 41° , 269° St, FeO St 7.95-8m: Jt 56° , 241° St, FeO St	
9			(42)								8-8.06m: Jt 38° , 149° Pl, Cl 8.09-8.13m: Jt 69° , 30° Pl, FeO St 8.12-8.22m: Jt 41° , 334° Pl, Cl 8.16-8.17m: Jt 90° , 65° Pl, Cl 8.18-8.19m: Jt 81° , 301° Un, Cl 8.22-8.31m: Jt 48° , 152° Un, FeO St 8.28-8.35m: Jt 48° , 152° Un, FeO St 8.37-8.47m: Jt 48° , 152° Un, FeO St 8.45-8.55m: Jt 48° , 152° Un, FeO Cl 8.53-8.61m: Jt 41° , 20° Pl, FeO St 8.6-8.67m: Fz 30° , 25° , Cl 8.67-8.7m: Jt 81° , 251° Pl, Cl 8.75-8.8m: Jt 64° , 54° Pl, Cl	
10			100								8.81-8.85m: Jt 48° , 229° Pl, FeO St 8.92-8.95m: Jt 48° , 47° Pl, FeO St 8.96-9.06m: Fz 30° , 25° , 9.09-9.12m: Jt 64° , 25° Pl, FeO St 9.12-9.13m: Jt 81° , 92° Cv, FeO St 9.16-9.18m: Jt 81° , 92° Ir, FeO St 9.21-9.26m: Jt 48° , 152° Pl, White staining St 9.25-9.3m: Fz 30° , 25° , 9.43-9.47m: Jt 64° , 340° Un, FeO St 4.47-4.8m: Sz 90° , 115° Pl, Cl 9.5-9.6m: Fz 64° , 61° , Cl	

ENGENY

Cored Borehole Log

TSF_BH_10A Sheet: 3 of: 5

Project:	**TSF3 GI Support**	Easting:	**328331 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**18/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 282.1 m**	Date completed:	**21/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**	Logged by:	**TM**
		Drill depth:	**23.9 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%) / USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03/0.6, L 0.1/2, M 0.3/6, H 1/20, VH 3/60, EH 10/200	Average Defect Spacing (mm): <20, 20-60, 60-200, 200-600, 600-2000, >2000	Discontinuity Description	Field Records / Remarks
10									9.7-9.74m: Jt 52° , 230° Pl, FeO St 9.78-9.81m: Jt 64° , 291° Un, FeO St 9.86-9.88m: Jt 64° , 15° Un, Cl 9.88-9.95m: Jt 48° , 229° Un, Cl 10-10.1m: Fz 30° , 25° ,	10 - 10.1m: drilling breaks returned as fine to medium gravel, subangular
			100						10.1-10.13m: Jt 56° , 52° Pl, Cl 10.13-10.17m: Jt 41° , 39° Un, FeO St 10.18-10.24m: Jt 41° , 39° Un, FeO St 10.25-10.29m: Fz 30° , 25° , 10.44-10.45m: Jt 81° , 272° Un, FeO St 10.46-10.48m: Jt 81° , 92° Un, FeO St 10.48-10.51m: Jt 69° , 48° Pl, Cl	
									10.49-10.53m: Jt 81° , 64° Cv, Cl 10.53-10.55m: Jt 81° , 64° Pl, FeO St 10.54-10.61m: Jt 48° , 126° Pl, FeO St 10.68-10.69m: Jt 86° , 50° Un, FeO St 10.75-10.77m: Jt 86° , 60° Un, FeO St 10.77-10.8m: Jt 64° , 61° Ir, FeO St 10.8-10.88m: Jt 36° , 237° Un, FeO St	
			(27)							
11	264.1				**QUARTZITE:** pale grey, fine grained, fractured, thinly bedded at 50 degrees, iron staining along discontinuities, slightly weathered, very high strength, some infilled seams with clayey sand				10.82-10.85m: Jt 41° , 39° Cv, FeO St 10.85-10.88m: Jt 48° , 45° Ir, FeO St 10.93-11m: Fz 30° , 25° , 11-11.04m: Jt 36° , 34° Pl, Cl	
			100						11.1-11.18m: Jt 41° , 89° St, clay Vn 11.17-11.2m: Jt 64° , 291° Pl, FeO St 11.23-11.26m: Jt 36° , 97° Cv, FeO St 11.26-11.33m: Jt 41° , 39° Pl, FeO St	
			(68)						11.3-11.37m: Jt 41° , 103° Un, FeO St	
									11.31-11.38m: Jt 36° , 313° Un, FeO St 11.32-11.35m: Jt 48° , 45° Un, FeO St	
									11.46-11.47m: Jt 90° , 285° Un, FeO St 11.5-11.6m: Jt 64° , 205° Pl, FeO St 11.63-11.66m: Jt 64° , 310° Pl, clay Vn 11.69-11.74m: Jt 64° , 54° Pl, clay Vn 11.81-11.86m: Jt 48° , 320° Pl, clay In	
12		HQ3							11.84-11.85m: Jt 64° , 340° Cv, clay In	
			100						11.85-11.9m: Jt 73° , 280° Un, FeO St 11.88-11.92m: Jt 64° , 244° Un, clay In	12.1 - 12.6m: Incipient stockwork, multiple infilled joints with clayey sand
									11.91-11.93m: Jt 64° , 244° Un, clay In	
									11.94-11.95m: Jt 64° , 244° Un, clay In 12.04-12.11m: Sm 56° , 135° Pl, sand In 12.07-12.08m: Jt 73° , 74° Pl, sand Vn	
									12.1-12.21m: Fz 36° , 324° Un, clay In	
									12.14-12.2m: jt 48° , 344° Pl, FeO St 12.26-12.3m: Jt 73° , 338° Un, FeO St 12.43-12.52m: Sm 56° , 135° Pl, sand In 12.47-12.51m: Jt 48° , 164° Pl, FeO St 12.52-12.55m: Jt 48° , 227° Pl, FeO St 12.55-12.6m: Jt 36° , 313° Un, clay In 12.61-12.72m: Jt 48° , 77° Pl, FeO St	
			(67)							
13									12.73-12.75m: Jt 73° , 215° Cv, FeO St	
			100							
									12.81-12.84m: Jt 56° , 24° Cv, FeO St 12.83-12.89m: Jt 48° , 291° Pl, FeO St 12.85-12.89m: Jt 81° , 194° Cv, FeO St 12.88-12.94m: Jt 41° , 143° Un, FeO St 12.88-12.94m: Jt 41° , 143° Pl, FeO St 12.95-12.97m: Jt 64° , 291° St, Cl 13.07-13.18m: Jt 36° , 220° Pl, Cl 13.25-13.27m: Jt 81° , 194° Un, Cl 13.28-13.34m: Jt 48° , 291° Un, FeO St 13.3-13.37m: Fz 48° , 344° Un, FeO St 13.37-13.39m: Jt 73° , 158° St, Cl 13.39-13.41m: Fz 81° , 14° Un, FeO St 13.42-13.43m: Jt 81° , 261° Ir, Cl 13.46-13.47m: Jt 81° , 338° Ir, Cl	
			(100)							
			100							
14									13.54-13.6m: Jt 41° , 269° Cv, FeO St 13.6-13.65m: Fz 30° , 25° , 13.65-13.72m: Jt 41° , 39° Pl, FeO St 13.73-13.75m: Jt 90° , 115° Ir, Cl 13.76-13.77m: Jt 90° , 115° St, Cl 13.78-13.85m: Sm 48° , 45° Un, clay Vn 13.81-13.9m: Jt 30° , 25° Pl, Cl 13.86-13.9m: Jt 48° , 45° Pl, Cl 13.89-13.9m: Jt 73° , 74° St, Cl 13.93-13.95m: Fz 30° , 25° ,	
			(47)						14.03-14.03m: Jt 90° , 115° Pl, Cl	
									14.05-14.08m: Jt 48° , 45° Pl, Cl 14.14-14.16m: Jt 81° , 92° Un, Cl 14.17-14.18m: Jt 81° , 92° Un, Cl 14.18-14.23m: Jt 48° , 140° Un, Cl 14.24-14.26m: Jt 73° , 254° Cv, FeO St	
									14.28-14.32m: Jt 81° , 171° Un, FeO St 14.38-14.49m: Jt 41° , 283° Pl, Cl	
15									14.38-14.5m: Jt 38° , 100° Pl, Cl 14.48-14.53m: Jt 38° , 100° Pl, Cl	

ENGENY

Cored Borehole Log

TSF_BH_10A Sheet: 4 of: 5

Project:	**TSF3 GI Support**	Easting:	**328331 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**18/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 282.1 m**	Date completed:	**21/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**	Logged by:	**TM**
		Drill depth:	**23.9 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): Vl 0.03/0.6, L 0.1/2, M 0.3/6, H 1/20, Vh 3/60, Eh 10/200	Average Defect Spacing (mm): < 20, 20 - 60, 60 - 200, 200 - 600, 600 - 2000, > 2000	Discontinuity Description	Field Records / Remarks
15											14.53-14.54m: Jt 77° , 330° Pl, FeO St 14.62-14.62m: Jt 90° , 205° Pl, Cl 14.74-14.77m: Jt 73° , 183° Pl, FeO St 14.77-14.84m: Jt 48° , 152° Pl, Cl	
			100								14.84-14.86m: Jt 73° , 183° St, FeO St 14.91-15m: Jt 41° , 323° Pl, Cl 14.96-14.97m: Jt 81° , 171° Pl, Cl 14.96-14.97m: Jt 81° , 92° Un, Cl 14.98-14.98m: Jt 90° , 115° Un, Cl 15.08-15.09m: Jt 81° , 271° Pl, Cl 15.08-15.17m: Jt 48° , 320° Un, Cl 15.12-15.15m: Jt 73° , 171° Pl, Cl	
											15.15-15.18m: Jt 56° , 5° Pl, Cl	
											15.17-15.2m: Jt 73° , 183° Un, Cl 15.22-15.32m: Jt 41° , 297° Un, Cl	
											15.28-15.3m: Jt 64° , 160° Cv, Cl	
											15.33-15.35m: Jt 77° , 189° Pl, Cl 15.36-15.38m: Jt 73° , 194° Pl, FeO St	
											15.44-15.48m: Jt 73° , 143° Un, Cl	
16			(53)								15.47-15.57m: Jt 52° , 337° Un, FeO St 15.51-15.55m: Jt 48° , 344° Un, Cl 15.5-15.58m: Jt 56° , 5° St, Cl 15.64-15.68m: Fz 48° , 49° , Cl 15.68-15.72m: Jt 64° , 146° Un, Cl 15.75-15.78m: Jt 56° , 61° Pl, Cl 15.79-15.82m: Jt 73° , 280° Un, Ct 15.88-15.9m: Jt 86° , 189° Pl, Cl 16.02-16.06m: Jt 56° , 61° Ir, clay Vn 16.08-16.09m: Jt 81° , 71° Un, Cl 16.09-16.11m: Jt 77° , 73° Pl, Cl 16.09-16.13m: Jt 36° , 34° Pl, Cl 16.13-16.16m: Fz 81° , 92° , Cl	
			100								16.16-16.21m: Jt 41° , 117° Pl, Cl 16.18-16.25m: Jt 41° , 143° Pl, Cl 16.24-16.26m: Jt 64° , 59° Pl, Cl 16.25-16.27m: Jt 73° , 248° Un, Cl 16.33-16.36m: Jt 64° , 146° Pl, Cl 16.37-16.41m: Jt 64° , 61° Un, Cl 16.37-16.4m: Jt 73° , 74° Pl, Cl 16.4-16.6m: Jt 33° , 309° St, Cl 16.41-16.44m: Jt 81° , 194° Un, Cl 16.43-16.44m: Jt 81° , 92° Cv, Cl 16.49-16.43m: Jt 52° , 130° Pl, Ct 16.5-16.52m: Jt 64° , 61° Pl, Cl 16.5-16.51m: Jt 86° , 178° Pl, Cl 16.51-16.53m: Jt 64° , 61° Pl, Cl 16.53-16.57m: Jt 73° , 44° Pl, Cl 16.6-16.61m: Jt 81° , 251° Pl, clay Vn 16.63-16.71m: Jt 41° , 39° Un, FeO St 16.64-16.66m: Jt 56° , 52° St, Cl 16.67-16.68m: Jt 73° , 68° Cv, Cl 16.71-16.78m: Jt 48° , 257° Pl, Cl 16.75-16.77m: Jt 73° , 171° Pl, Cl 16.83-16.86m: Jt 73° , 100° Cv, Cl 16.84-16.88m: Jt 69° , 246° Pl, Cl 16.88-16.89m: Jt 86° , 19° St, Cl 16.89-16.98m: Fz 81° , 92° Pl, Ct 17-17.06m: Fz 30° , 25° , 17.06-17.09m: Jt 81° , 215° Pl, Cl 17.11-17.18m: Jt 48° , 227° Pl, Cl	
17											17.12-17.14m: Jt 73° , 158° Un, Cl	
											17.15-17.17m: Jt 48° , 332° Un, Cl	
											17.22-17.27m: Sm 52° , 349° Ir, clay In 17.33-17.38m: Jt 56° , 162° Pl, FeO St 17.39-17.4m: Jt 86° , 249° Un, FeO St	
											17.41-17.42m: Jt 73° , 224° Ir, Cl	
			100								17.47-17.49m: Jt 73° , 171° Un, Cl 17.51-17.52m: Jt 73° , 171° Pl, clay Vn	
											17.54-17.74m: Sm 30° , 25° , 17.84-17.85m: Jt 77° , 330° Pl, FeO St 17.9-18m: Jt 41° , 117° Un, silt Vn 18-18.02m: Jt 36° , 97° Pl, clay Vn 18.03-18.05m: Jt 73° , 143° Ir, FeO St	
18											18.05-18.08m: Jt 48° , 59° Cv, Cl	
											18.18-18.22m: Jt 56° , 342° Un, Cl	
											18.27-18.35m: Jt 41° , 219° Un, FeO St 18.32-18.36m: Jt 56° , 61° Un, Cl	
											18.42-18.48m: Jt 36° , 214° Pl, Cl 18.47-18.51m: Jt 48° , 225° Un, Ct	
19			(70)								18.51-18.53m: Jt 56° , 52° Pl, FeO St	
											18.53-18.56m: Jt 48° , 47° Un, Cl	
											18.55-18.56m: Jt 86° , 103° Pl, Cl 18.63-18.73m: Jt 41° , 154° Un, silt Vn 18.66-18.68m: Jt 86° , 30° Un, FeO St 18.73-18.73m: Jt 90° , 185° Ir, silt Vn 18.72-18.8m: jt 41° , 143° Un, clay Vn 18.82-18.88m: Jt 73° , 70° Pl, clay Vn 18.88-18.9m: Jt 56° , 39° Cv, FeO St 18.94-19m: Jt 36° , 289° Cv, FeO St 19-19.04m: Jt 56° , 204° Un, FeO St 19.13-19.3m: Fz 30° , 25° Pl, Clay Vn 19.3-19.37m: Jt 41° , 39° Un, FeO St 19.37-19.4m: Jt 90° , 115° Pl, clay Vn 19.37-19.38m: Jt 48° , 45° Pl, FeO St 19.39-19.47m: Jt 45° , 41° Un, clay Vn 19.42-19.45m: Jt 64° , 61° Un, Cl	
			100									
20												

ENGENY

Cored Borehole Log

TSF_BH_10A Sheet: **5** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328331 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7820474 m**	Date commenced:	**18/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 282.1 m**	Date completed:	**21/5/2024**
Job number:	**QC1022_018**	Dip: **60°** Azimuth:	**25°**	Logged by:	**TM**
		Drill depth:	**23.9 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20								VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000	19.47-19.52m: Jt 41° , 39° Un, Cl 19.5-19.5m: Jt 90° , 115° Pl, Cl 19.52-19.54m: Jt 81° , 92° St, FeO St 19.59-19.6m: Jt 81° , 92° Un, FeO St	
										19.61-19.61m: Jt 73° , 74° Pl, FeO St 19.63-19.64m: Jt 81° , 92° Un, FeO St	
			(61)							19.67-19.7m: Sm 30° , 25° , 19.72-19.78m: Jt 48° , 257° Ir, FeO St 19.74-19.75m: Jt 81° , 272° Pl, FeO St 19.75-19.75m: Jt 90° , 115° Pl, FeO St 19.76-19.81m: Jt 41° , 283° Pl, Cl	
21										19.78-19.88m: Jt 48° , 126° Un, silt In	
										19.82-19.93m: Jt 41° , 117° Un, clay Vn 19.9-19.98m: Jt 41° , 310° Un, Cl	
			100							20.71-20.74m: Jt 64° , 239° Ir, FeO St	
22										20.05-20.06m: Jt 90° , 295° Un, Cl 20.06-20.14m: Jt 36° , 302° Un, Cl 20.38-20.48m: Jt 52° , 144° Un, FeO St 20.48-20.51m: Jt 77° , 243° Un, Cl 20.62-20.62m: Jt 90° , 5° Pl, Cl 20.64-20.69m: Jt 52° , 230° Pl, Vn 20.75-20.82m: Jt 41° , 297° Un, FeO St 20.76-20.79m: Jt 81° , 3° Un, FeO St 20.82-20.88m: Jt 36° , 250° Un, Cl 20.93-20.93m: Jt 86° , 249° Pl, FeO St 21.9-21.13m: Jt 64° , 326° Pl, FeO St 21.12-21.15m: Jt 64° , 50° Pl, FeO St	
			(78)							21.12-21.24m: Sm 48° , 152° Pl, clay In 21.26-21.27m: Jt 86° , 90° Un, FeO St	
										21.27-21.33m: jt 41° , 345° Un, Cl 21.31-21.45m: Jt 33° , 261° Un, silt Vn 21.48-21.52m: Jt 64° , 4° Un, silt Vn	
										21.55-21.6m: Jt 56° , 39° Un, FeO St 21.6-21.64m: Jt 56° , 61° Pl, FeO St	
23			100							21.6-21.65m: Jt 56° , 119° Pl, Cl	
										21.74-21.79m: Jt 48° , 49° Pl, FeO St	
										21.79-21.9m: Fz 30° , 25° , 21.9-21.95m: Jt 90° , 115° Ir, silt Vn 21.98-22.1m: Jt 90° , 305° Ir, silt Vn	
										22-22.1m: Fz 30° , 25° ,	
										22.12-22.2m: Jt 90° , 105° Un, FeO St 22.14-22.19m: Jt 38° , 30° Un, Cl	
										22.24-22.26m: Jt 73° , 3° Pl, Cl 22.25-22.45m: Jt 36° , 324° Un, Cl 22.46-22.5m: Jt 36° , 227° Ir, Cl	
	246.1		(89)								

ENGENY

Cored Borehole Log

TSF_BH_12

Sheet: 1 of: 4

Project:	**TSF3 GI Support**	Easting:	**328202 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819729 m**	Date commenced:	**27/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.1 m**	Date completed:	**29/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**15.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**CORE LOSS:**						0 - 1m: CORE LOSS, soil
1	308.1				**QUARTZITE:** pale brown, medium to coarse grained, iron staining along discontinuities, thinly bedded, highly fractured		HW			1.47-1.52m: Jt 80° Un, Ro, clay <2mm, Fe St Ct 1.51-1.6m: Jt 60° Cv, Ro, FeO St 1.53-1.55m: Jt 15° Pl, Ro, FeO St 1.58-1.61m: Jt 40° Pl, Ro, FeO St 1.61-1.74m: Sz 1.74-1.8m: Jt 30° Pl, Ro, FeO St 1.82-1.93m: Jt 60° Pl, Ro, FeO St 1.83-1.89m: Jt 60° Pl, Ro, FeO St	1 - 1.45m: Recovered as gravel
2			(0)				MW			2.13-2.19m: Jt 60° Un, Ro, FeO St 2.17-2.2m: Jt 30° Pl, Ro, FeO St 2.17-2.23m: Jt 50° Un, Ro, FeO St 2.2-2.39m: Jt 60° Un, Ro, FeO St	1.93 - 2m: Handling breaks 2 - 2.13m: Drilling induced breaks, core recovered as gravel
	306.8				**QUARTZITE:** pale brown, fine to medium grained, distinctly laminated to thiny bedded at 60 degrees, iron staining along discontinuities, moderately to slightly weathered, slightly to moderately fractured, high to very high strength					2.26-2.33m: Jt 50° Pl, Ro, FeO St 2.38-2.48m: Jt 65° Un, Ro, clay Vn 2.39-2.4m: Jt 20° Un, Ro, FeO St 2.4-2.47m: Sz 2.47-2.51m: Jt 50° Pl, Ro, clay Vn 2.51-2.56m: Jt 70° Ir, Ro, FeO St 2.52-2.65m: Jt 70° Un, Ro, clay Vn	
			87								
			(0)				SW			2.8-2.96m: Jt 70° Pl, Ro, FeO St	
3			100							2.81-2.9m: Pt 65° Pl, Ro, clay Vn 2.87-2.97m: Pt 65° Pl, Ro, Cl 2.94-3m: Jt 60° Pl, Ro, clay Vn 3-3.08m: Sz 3.08-3.13m: Jt 45° Pl, Ro, clay Vn 3.11-3.15m: Jt 60° Un, Ro, clay Vn 3.12-3.17m: Jt 80° Pl, Ro, FeO St 3.15-3.2m: Jt 35° Pl, Ro, Cl 3.27-3.3m: Jt 40° Un, Ro, FeO St 3.28-3.4m: Jt 60° Pl, Ro, clay Vn	
			(0)							3.3-3.34m: Jt 60° Pl, Ro, clay Vn 3.32-3.41m: Jt 80° Un, Ro, clay Vn 3.34-3.35m: Jt 10° Pl, Ro, clay Vn	3.4 - 3.5m: Handling breaks 3.5 - 3.7m: Drilling induced breaks, core recovered as gravel
			100								
			(0)							3.71-3.76m: Jt 60° Pl, Ro, FeO St 3.76-3.83m: Jt 65° Un, Ro, clay Vn 3.78-3.86m: Jt 70° Cv, Ro, Cl	
4										3.91-3.98m: Jt 60° Pl, Ro, clay Vn 4.12-4.17m: Jt 60° Pl, Ro, FeO St	3.87 - 3.91m: Drilling induced breaks, core recovered as gravel
			100							4.27-4.37m: Jt 70° Pl, Ro, clay Vn 4.31-4.39m: Jt 65° Un, Ro, clay Vn: FeO st 4.36-4.46m: Jt 65° Un, Ro, clay Vn: FeO st 4.39-4.47m: Jt 65° Un, Ro, clay Vn: FeO st 4.44-4.5m: Jt 80° Un, Ro, clay Vn: FeO st 4.47-4.53m: Jt 70° Un, Ro, clay Vn: FeO st 4.61-4.63m: Jt 20° Un, Cl 4.64-4.68m: Jt 40° Un, Cl 4.67-4.75m: Jt 40° Un, Ro, clay Vn 4.77-4.82m: Jt 45° Un, Ro, clay Vn 4.84-4.89m: Jt 50° Pl, clay Vn: FeO st 4.86-4.93m: Jt 50° Pl, Ro, clay Vn 4.91-5m: Jt 70° Pl, Ro, clay Vn: FeO st	
5		HQ3	(38)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_12

Sheet: **2** of: **4**

Project:	**TSF3 GI Support**	Easting:	**328202 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819729 m**	Date commenced:	**27/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.1 m**	Date completed:	**29/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**15.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5								Vl 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · Vh 3 / 60 · Eh 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000	5.03-5.04m: Jt 20° Pl, Ro, clay Vn 5.04-5.12m: Jt 60° Un, Ro, clay Vn 5.06-5.14m: Jt 40° Un, clay Vn 5.12-5.16m: Jt 20° Un, FeO St 5.19-5.21m: Jt 20° Un, Ro, Cl 5.21-5.33m: Jt 65° Pl, Ro, clay Ct: 2mm 5.21-5.25m: Jt 60° Pl, clay Vn 2mm 5.21-5.3m: Pt 65° Un, Cl 5.28-5.35m: Pt 60° Pl, Ro, clay Vn 5.4-5.44m: Jt 55° Un, FeO St 5.44-5.48m: Pt 40° Pl, Ro, clay Vn 5.45-5.5m: Pt 60° Pl, Ro, clay Vn: FeO st 5.47-5.55m: Jt 55° Un, Ro, clay Vn 5.57-5.64m: Jt 60° Pl, FeO St 5.61-5.69m: Jt 65° Un, FeO St: clay Vn 5.63-5.69m: Jt 45° Pl, FeO St 5.69-5.73m: Jt 40° Pl, Ro, FeO St: clay Vn 5.73-5.8m: Jt 50° Un, FeO St	
			100							5.89-5.99m: Jt 60° Un, clay Vn: FeO st	
6										5.91-5.95m: Jt 70° Un, clay Vn 3mm: FeO st 6.05-6.15m: Jt 50° Pl, Ro, clay Ct: 3mm 6.05-6.09m: Jt 50° Un, Ro, FeO St 6.06-6.17m: Jt 50° Un, clay Vn 6.14-6.23m: Jt 60° Un, FeO St 6.15-6.25m: Jt 65° Un, FeO St 6.18-6.2m: Jt 35° Pl, FeO St 6.24-6.25m: Jt 20° Un, FeO St 2mm 6.27-6.34m: Jt 30° Pl, clay Vn 6.27-6.37m: Pt 60° Pl, clay Ct 2mm 6.38-6.41m: Jt 40° Un, clay Vn 6.4-6.45m: Jt 50° Un, clay Vn 6.56-6.59m: Jt 35° Pl, FeO St 6.57-6.65m: Pt 60° Pl, Ro, clay Vn 6.63-6.66m: Jt 30° Pl, Ro, clay Vn 6.69-6.73m: Jt 25° Un, Ro, clay Vn: FeO st 6.71-6.77m: Jt 60° Un, Ro, clay Vn	
			(67)								
7										6.89-6.99m: Pt 60° Pl, Ro, Cl 7.01-7.02m: Jt 25° Un, Cl 7.02-7.03m: Jt 20° Un, Cl 7.05-7.12m: Jt 50° Pl, clay Vn: FeO st	
		HQ3	100							7.18-7.23m: Jt 40° Pl, Ro, clay Vn 7.19-7.23m: Jt 30° Pl, Ro, FeO St 7.24-7.33m: Jt 55° Un, FeO St 7.34-7.36m: Pt 60° Pl, clay Vn: FeO st 7.34-7.38m: Pt 60° Un, Ro, clay Vn: FeO st 7.38-7.45m: Pt 60° Pl, clay Vn: FeO st 7.41-7.46m: Jt 35° Un, clay Vn: FeO st 7.48-7.51m: Jt 45° Un, Ro, clay Vn: FeO st	
8			**(90)**							7.51-7.75m: Jt 30° Un, Ro, clay Vn 7.51-7.59m: Jt 50° Pl, Ro, clay Vn 7.58-7.67m: Jt 60° Un, FeO St 7.6-7.65m: Pt 50° Pl, clay Vn 7.72-7.79m: Pt 45° Pl, clay Vn 7.87-7.91m: Jt 85° Un, clay Vn 7.91-7.96m: Jt 50° Un, Ro, clay Vn: FeO st 8.05-8.17m: Jt 70° Un, FeO St	
			100							8.1-8.19m: Pt 60° Pl, Ro, clay Ct: <2mm 8.14-8.23m: Pt 60° Pl, clay Vn 8.25-8.26m: Jt 20° Pl, clay Vn 8.28-8.31m: Pt 40° Pl, Ro, clay Vn 8.31-8.34m: Pt 40° Pl, clay Vn 8.34-8.51m: Jt 50° Un, Ro, clay Vn 8.39-8.4m: Jt 10° Pl, Ro, clay Vn 8.5-8.54m: Pt 40° Pl, Ro, clay Vn: FeO st 8.55-8.86m: Jt 80° Un, clay Vn: FeO st	
9										8.7-8.75m: Pt 40° Pl, Ro, clay Vn 8.86-9m: Jt 80° Un, FeO St 9-9.06m: Pt 60° Pl, Ro, clay Vn: FeO st 9.07-9.22m: Jt 70° Un, FeO St 9.18-9.24m: Pt 60° Pl, Ro, clay Vn 9.23-9.41m: Jt 80° Un, Ro, clay Vn	
			(84)							9.36-9.4m: Jt 30° Un, Ro, Cl 1.5mm 9.63-9.74m: Pt 60° Pl, clay Vn: FeO st	9.4 - 9.5m: Handling breaks
10											

ENGENY

Cored Borehole Log

TSF_BH_12

Sheet: 3 of: 4

Project:	**TSF3 GI Support**	Easting:	**328202 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819729 m**	Date commenced:	**27/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.1 m**	Date completed:	**29/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**15.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03/0.6, L 0.1/2, M 0.3/6, H 1/20, VH 3/60, EH 10/200	Average Defect Spacing (mm): <20, 20-60, 60-200, 200-600, 600-2000, >2000	Discontinuity Description	Field Records / Remarks
10			100							10.25-10.34m: Pt 60° Un, Ro, clay Ct: FeO st, <2mm, ripple mark 10.54-10.64m: Jt 55° Un, Ro, clay Vn 10.81-10.92m: Jt 60° Un, Ro, clay Vn: FeO st 10.81-10.83m: Jt 20° Pl, Ro, Cl 10.85-10.86m: Jt 20° Pl, Ro, clay Vn 10.89-10.91m: Jt 20° Un, Ro, clay Vn 1.5mm: FeO st	
11			(93)							11.29-11.33m: Jt 40° Un, FeO St 11.54-11.62m: Pt 50° Pl, Ro, clay Ct: <2mm, FeO st 11.68-11.78m: V 50° Pl, quartz In: <1mm 11.9-12m: Jt 60° Pl, Ro, clay Vn: FeO st 11.93-11.96m: Jt 30° Pl, Ro, Cl	
12			100							12.1-12.18m: Pt 60° Pl, Cl 12.2-12.21m: Jt 10° Pl, Ro, Cl 12.2-12.24m: Jt 60° Pl, clay Vn 12.2-12.3m: Jt 60° Un, Ro, clay Vn 12.29-12.4m: Pt 55° Un, Ro, clay Vn 12.38-12.45m: Jt 70° Pl, clay Vn: FeO st 12.43-12.5m: Pt 60° Pl, Ro, clay Vn 12.52-12.77m: Jt 80° Un, clay Vn	
13			(100)							12.63-12.64m: Jt 20° Un, Ro, clay Vn 12.66-12.69m: Jt 35° Un, clay Vn 12.71-12.72m: Jt 35° Un, clay Vn 12.76-12.77m: Jt 20° Un, clay Vn 12.77-13m: Jt 70° Un, Ro, clay Vn 12.81-13m: Jt 90° Un, Ro, clay Vn 12.83-12.84m: Jt 20° Un, Ro, Cl 13-13.08m: Jt 55° Un, Ro, clay Vn 13.08-13.55m: Jt 80° Un, Ro, clay Vn: FeO st	
14			100							13.13-13.16m: Jt 30° Pl, clay Vn 13.24-13.34m: Jt 60° Un, Cl 13.27-13.33m: Jt 40° Un, clay Vn 13.39-13.4m: Jt 20° Pl, Cl 13.46-13.55m: Pt 60° Pl, Ro, clay Vn: FeO st 13.46-13.61m: Jt 80° Un, clay Vn 13.52-13.62m: Jt 80° Un, clay Vn 13.56-14m: Jt 80° Un, clay Vn	
15			(48)							13.63-13.69m: Pt 60° Un, clay Vn 13.66-13.75m: Jt 80° Un, clay Vn 14.03-14.12m: Jt 80° Un, clay Vn 14.04-14.09m: Pt 60° Pl, Cl 14.09-14.12m: Pt 60° Pl, Cl 14.13-14.14m: Jt 0° Pl, clay Vn 14.14-14.25m: Jt 80° Un, clay Vn 14.14-14.15m: Jt 20° Un, clay Vn 14.15-14.16m: Jt 20° Un, Ro, clay Vn 14.16-14.31m: Pt 55° Un, Ro, clay Vn 14.18-14.19m: Jt 20° Un, clay Vn 14.3-14.49m: Jt 70° Un, Ro, clay Vn 14.49-15m: Jt 80° Un, Ro, clay Ct: <2mm	

ENGENY

Cored Borehole Log

TSF_BH_12

Sheet: **4** of: **4**

Project:	**TSF3 GI Support**	Easting:	**328202 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819729 m**	Date commenced:	**27/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.1 m**	Date completed:	**29/4/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**15.2 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15	293.9		(46)						VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000	14.69-14.7m: Jt 20˚ Pl, Ro, Cl 14.76-14.8m: Jt 45˚ Un, Ro, clay Vn 14.8-14.81m: Jt 10˚ Un, Ro, clay Vn: FeO st 14.81-15m: Jt 90˚ Un, clay Vn 15.11-15.18m: Jt 50˚ Un, Ro, clay Vn	

ENGENY

Cored Borehole Log

TSF_BH_13

Sheet: **1** of: **7**

Project:	**TSF3 GI Support**	Easting:	**328276 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819716 m**	Date commenced:	**5/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.8 m**	Date completed:	**10/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**32.6 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**Gravelly SAND:** dark red brown, medium to coarse grained sand, fine to medium, angular to sub-angular weathered quartzite and siltstone clasts, trace clay	M	SW	L			
1	307.8				**Sandy GRAVEL:** pale brown, medium to coarse, angular to sub-angular quartzite clasts, medium to coarse grained sand, trace cobbles, trace silt		GP				
			100								
2											
3			(0)								
4			100								
5		Sonic									

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_13

Sheet: **2** of: **7**

Project:	**TSF3 GI Support**	Easting:	**328276 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819716 m**	Date commenced:	**5/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.8 m**	Date completed:	**10/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**32.6 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5								VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
6			(0)								
7			100								
8											
9		Sonic	(0)		Quartzite cobbles						
10											

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Cored Borehole Log

TSF_BH_13

Sheet: **3** of: **7**

Project:	**TSF3 GI Support**	Easting:	**328276 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819716 m**	Date commenced:	**5/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.8 m**	Date completed:	**10/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**32.6 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10			83					VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
11											
12			(0)								
13			100								
14											
15			(0)								

ENGENY

Cored Borehole Log

TSF_BH_13

Sheet: **4** of: **7**

Project:	**TSF3 GI Support**	Easting:	**328276 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819716 m**	Date commenced:	**5/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.8 m**	Date completed:	**10/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**32.6 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15											
16	292.8				**Clayey SAND:** pale grey, medium to coarse grained sand, medium plasticity clay, trace gravel fine to medium, sub-angular to sub-rounded quartz clasts		SC				
			100								
17	291.8				**Sandy GRAVEL:** red-brown, medium to coarse, angular to sub-angular quartzite clasts, medium to coarse grained sand, trace cobbles, trace silt		GP				
18			(0) / 200 / (0)								
	290.7				**QUARTZITE:** pale brown, medium to coarse grained, thinly laminated to thinly bedded at 50-60 degrees, iron staining along discontinuities, slightly weathered, very high strength, slightly fractured		SW				
			100								
			(100)							18.4-18.53m: Jt 70° Pl, Ro, FeO St	
										18.51-18.54m: Jt 40° Pl, Ro, FeO St	
										18.69-18.72m: Jt 40° Pl, Ro, Cl	
19											
			100							19.38-19.42m: Jt 30° Pl, Ro, FeO St	
										19.61-19.68m: Jt 55° Un, Ro, FeO St	
										19.69-19.73m: Jt 35° Pl, Ro, Cl	
										19.73-19.92m: Jt 75° Un, Ro, clay Ct: 1mm, FeO st	
20		HQ3	(67)							19.85-19.86m: Jt 10° Un, Ro, FeO St	

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Cored Borehole Log

TSF_BH_13

Sheet: **5** of: **7**

Project:	**TSF3 GI Support**	Easting:	**328276 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819716 m**	Date commenced:	**5/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.8 m**	Date completed:	**10/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**32.6 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20									Vl 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
			100 (100)								20.08-20.22m: Jt 70° Pl, Ro, FeO St	
			100								20.63-20.72m: Jt 50° Pl, Ro, FeO St 20.68-20.78m: Jt 65° Un, Ro, FeO St 20.72-20.77m: Jt 80° Un, Ro, FeO St	
21			(75)								20.79-21m: Jt 80° Un, FeO St	
			100 (91)								21.25-21.31m: Pt 45° Un, Ro, clay Ct: 1mm, FeO st 21.29-21.38m: Pt 45° Pl, Ro, FeO St 2mm	
											21.78-21.81m: Jt 35° Pl, Ro, clay Vn 21.8-21.9m: Jt 55° Un, Ro, clay Ct 2mm: 2mm, FeO st	
22											22-22.08m: Jt 55° Pl, FeO St	
			100								22.05-22.11m: Jt 55° Un, Ro, clay Ct: 2mm 22.09-22.11m: Jt 10° Cv, Ro, Cl 22.13-22.22m: Jt 50° Pl, Cl 22.15-22.27m: Jt 70° Un, Cl 22.2-22.25m: Jt 70° Un, Cl 22.35-22.4m: Jt 40° Pl, Cl 22.42-22.43m: Jt 20° Pl, Cl 22.43-22.53m: Jt 60° Pl, Cl 22.45-22.56m: Jt 70° Un, Cl 22.53-22.6m: Jt 50° Un, Cl 22.57-22.66m: Jt 60° Un, Cl 2mm	
											22.81-22.89m: Jt 55° Pl, Cl	
23			(86)								23.03-23.07m: Vn 50° Un, Qz 3mm: 2mm 23.04-23.15m: Jt 65° Un, 2mm	
											23.08-23.36m: Vn 70° Un, Qz: 2-3mm	
											23.18-23.23m: Vn 35° Qz 2mm: 1-2mm 23.29-23.32m: Jt 30° Pl, Ro, FeO St 23.3-23.42m: Vn 80° Qz: 2mm 23.47-23.5m: Jt 25° Un, Ro, Cl 23.49-23.51m: Jt 10° Un, Ro, FeO St 23.51-23.57m: Jt 35° Pl, FeO St	
			100								23.83-23.84m: Jt 10° Un, Ro, FeO St 4mm 23.84-23.88m: Jt 40° Un, Ro, clay Ct 1mm: 1mm, FeO st	
24											24-24.1m: Vn 55° Qz 2mm: 2-4mm	
											24.09-24.18m: Vn 55° Qz: 1mm	
											24.17-24.2m: Jt 25° Un, Ro, clay Ct 2mm: 2mm, FeO st	
			(79)								24.32-24.53m: Jt 70° Un, clay Vn	
											24.47-24.59m: Vn 60° Qz: 2mm	
25												

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Cored Borehole Log

TSF_BH_13

Sheet: **6** of: **7**

Project:	**TSF3 GI Support**	Easting:	**328276 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819716 m**	Date commenced:	**5/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.8 m**	Date completed:	**10/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**32.6 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
25		HQ3	100						VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000	24.56-26.49m: Jt 70° Un, Ro, clay Vn	
			(83)									
26			100									26 - 26.54m: Drilling induced breaks
			(0)									
			100								24.62-24.64m: Jt 20° Un, Ro, Cl 24.62-24.68m: Jt 60° Pl, FeO St 25-25.08m: Jt 55° Un, clay Vn 25.11-25.24m: Jt 85° Un, clay Vn 2mm 25.12-25.34m: Jt 80° Un, clay Vn 25.29-25.43m: Vn 75° Qz: 2mm 25.42-25.52m: Jt 80° Un, FeO St 25.52-25.54m: Jt 20° Un, clay Vn 25.57-25.67m: Jt 80° Un, FeO St 25.77-25.86m: Jt 50° Un, clay Vn 26.36-26.42m: Jt 45° Pl, FeO St 26.37-26.44m: Jt 50° Pl, Ro, FeO St 1mm 26.58-26.61m: Jt 20° Un, FeO St 26.7-26.74m: Vn 35° Pl, Qz: 1mm 26.77-26.79m: Jt 25° Pl, 26.77-26.86m: Jt 60° Pl, FeO St 26.85-26.92m: Vn 50° Pl, Qz 27.06-27.07m: Jt 20° Un, Ro, Qz Vn 27.07-27.12m: Jt 50° Un, FeO St 27.18-27.35m: Jt 75° Un, Cl	
27											27.24-27.34m: Jt 70° Un, Ro, Cl	27.32 - 27.5m: Drilling induced breaks
			(96)								27.57-27.73m: Jt 75° Un, Cl	
											27.63-27.64m: Jt 10° Pl, Ro, Cl 27.64-27.65m: Jt 20° Pl, Ro, Cl	
												27.85 - 28.1m: Drilling induced breaks
28			100								28.04-28.11m: Jt 50° Un, Ro, FeO St 28.09-28.16m: Jt 70° Pl, Cl 28.1-28.21m: Jt 60° Pl, Cl	
											28.22-28.32m: Jt 65° Pl, Cl	
											28.34-28.52m: Jt 60° Pl, Ro, clay Vn	
											28.43-28.56m: Jt 70° Pl, FeO St 28.55-28.58m: Jt 20° Pl, Ro, clay Vn	
											28.68-28.73m: Jt 40° Pl, Ro, clay Vn	28.67 - 29.02m: Drilling induced breaks
			(60)									
29											29.06-29.09m: Jt 30° Pl, Cl 29.09-29.1m: Jt 10° Un, Ro, Cl 29.11-29.17m: Jt 70° Pl, Cl	
											29.24-29.29m: Jt 35° Un, Ro, FeO St	
											29.31-29.32m: Jt 10° Cv, Ro, Cl	
											29.38-29.42m: Jt 40° Un, FeO St	
											29.45-29.58m: Jt 30° Un,	
			100								29.46-29.47m: Jt 10° Un, 29.5-29.62m: Jt 75° Un, Cl 29.55-29.56m: Jt 25° Un, Ro, Cl 29.67-29.68m: Jt 15° Pl, Ro, Cl 29.7-29.73m: Jt 20° Pl, Ro, Cl 29.71-29.76m: Jt 70° Pl, FeO St 29.72-29.74m: Jt 30° Un, Cl 29.74-29.75m: Jt 10° Un, Cl 29.78-29.79m: Jt 0° Pl, Ro, Cl 29.79-29.83m: Jt 30° Un, Cl	
30												

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Cored Borehole Log

TSF_BH_13

Sheet: **7** of: **7**

Project:	**TSF3 GI Support**	Easting:	**328276 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819716 m**	Date commenced:	**5/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.8 m**	Date completed:	**10/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**32.6 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
30									Vl 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 Vh 3 / 60 Eh 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000	29.84-29.88m: Jt 35˚ Pl, Cl 29.85-29.96m: Jt 65˚ Pl, Cl 29.88-29.9m: Jt 25˚ Un, Ro, Cl 30-30.24m: Jt 70˚ Un, Ro, FeO St 30.11-30.14m: Jt 35˚ Un, FeO St 1mm 30.3-30.4m: Jt 60˚ Un, clay Vn 30.34-30.41m: Jt 50˚ Un, Ro, clay Ct: 1mm 30.36-30.45m: Jt 75˚ Un, clay Vn 30.38-30.49m: Jt 80˚ Un, clay Vn 30.49-30.54m: Jt 25˚ Un, Ro, FeO St 30.52-30.63m: Jt 60˚ Un, Ro, clay Vn 30.58-30.62m: Pt 55˚ Pl, Ro, clay Vn 0.5mm 30.61-30.7m: Jt 65˚ Pl, clay Vn 30.78-30.91m: Vn 90˚ Qz 2mm: <1mm	
			(50)									
31			100								31-31.07m: Pt 45˚ Un, Ro, clay Vn 3mm 31.09-31.13m: Jt 50˚ Un, Ro, clay Ct: 2mm 31.12-31.19m: Jt 45˚ Pl, Ro, clay In: 2-3mm 31.34-31.38m: Jt 30˚ Un, Ro, Cl 31.59-31.6m: Jt 10˚ Un, Ro, clay Vn 31.7-31.74m: Jt 30˚ Cv, Ro, clay Vn 0.5mm	31.07 - 31.09m: Drilling induced breaks
			(73)									
32			59								31.89-32m: Jt 80˚ Un, clay Vn 32.15-32.2m: Vn 50˚ Qz: <1mm	
	276.2		**(41)**									

ENGENY

Cored Borehole Log

TSF_BH_14

Sheet: **1** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328321 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819715 m**	Date commenced:	**3/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.6 m**	Date completed:	**4/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**22.5 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0	308.2				**SAND with clay:** dark red brown, medium to coarse grained sand, medium plasticity clay, trace fine to medium, angular to sub-angular quartzite clasts	M	SW	L			
1	307.3				**Sandy GRAVEL:** grey brown, fine to medium grained, sub-angular to sub-rounded clasts of quartzite, sand is fine to coarse grained, trace cobbles		GP				
2			43		**CORE LOSS:**						1.3 - 3m: Loss from the top of the hole due to loose gravel and cobbles
3	305.6		(0)		**Sandy Gravel:** pale brown, medium to coarse grained, angular to sub-angular quartzite clasts, trace clay, sand is fine to coarse grained, trace cobbles	M	GP	L			
4			100								
5		Sonic									

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_14

Sheet: **2** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328321 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819715 m**	Date commenced:	**3/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.6 m**	Date completed:	**4/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**22.5 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5								VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		
6			(0)								
7	301.2	Sonic	47		**CORE LOSS:**						
8											
9	299.6		(0)		**Sandy GRAVEL:** pale brown, medium to coarse grained, angular to sub-angular quartzite clasts, medium to course grained sand, trace clay, trace cobbles	M	GP	L			
10	298.6										

ENGENY

Cored Borehole Log

TSF_BH_14

Sheet: **3** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328321 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819715 m**	Date commenced:	**3/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.6 m**	Date completed:	**4/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**22.5 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10			33		**CORE LOSS:**						
11											
12	296.6		(0)								
					Sandy GRAVEL: dark red brown, medium to coarse grained, angular to sub-angular quartzite clasts, medium to course grained sand, trace clay, trace cobbles	M	GP	L			
13			100								
14											
15	293.6		(0)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6; L 0.1 / 2; M 0.3 / 6; H 1 / 20; VH 3 / 60; EH 10 / 200

Average Defect Spacing (mm): < 20; 20 - 60; 60 - 200; 200 - 600; 600 - 2000; > 2000

ENGENY

Cored Borehole Log

TSF_BH_14

Sheet: **4** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328321 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819715 m**	Date commenced:	**3/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.6 m**	Date completed:	**4/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**22.5 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15					**Gravelly SAND:** pale grey, medum to coarse grained sand, fine to medium, angular to sub-angular quartzite clasts, trace clay		SW	D			
16			40								
17										17.4-17.04m: Jt 50° Pl, Ro, Cl	
	292.6										
			(0)		**QUARTZITE:** pale brown, medium to coarse grained, laminated to thinly bedded at 70 degrees, iron staining along discontinuities, slightly weathered, very high strength, slightly to highly fractured		SW			17.53-17.54m: Jt 20° Pl, Ro, FeO St 17.54-17.59m: Jt 55° Pl, Ro, FeO St 17.58-17.64m: Jt 55° Pl, Ro, clay Vn	
18			100							17.84-17.9m: Pt 60° Un, Ro, Cl 17.88-17.93m: Jt 50° Un, Ro, Cl 17.95-18.03m: Jt 60° Pl, Ro, Cl 18-18.08m: Jt 60° Pl, FeO St 18.05-18.13m: Pt 55° Un, Ro, FeO St 18.15-18.19m: Jt 50° Pl, Ro, Cl 18.31-18.77m: Jt 80° Un, Ro, FeO St	
			(85)								
19			87							18.66-18.72m: Jt 70° Pl, FeO St 18.75-18.98m: Jt 80° Pl, Ro, FeO St 18.85-18.86m: Jt 20° Un, Ro, FeO St 18.85-18.96m: Jt 40° Pl, Ro, FeO St 18.88-18.95m: Jt 50° Un, Ro, Cl 18.95-19m: Jt 45° Pl, Ro, FeO St 19-19.11m: Jt 70° Un, FeO St 19.09-19.13m: Jt 20° Pl, Ro, FeO St 19.25-19.29m: Jt 30° Un, Ro, FeO St 19.33-19.72m: Jt 75° Un, Ro, FeO St: clay Vn 19.45-19.8m: Jt 80° Un, FeO St 19.56-19.58m: Jt 15° Un, FeO St 19.61-19.66m: Jt 45° Un, FeO St	
20		HQ3	(55)								

Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS): VL 0.03 / 0.6 | L 0.1 / 2 | M 0.3 / 6 | H 1 / 20 | VH 3 / 60 | EH 10 / 200

Average Defect Spacing (mm): < 20 | 20 - 60 | 60 - 200 | 200 - 600 | 600 - 2000 | > 2000

ENGENY

Cored Borehole Log

TSF_BH_14

Sheet: **5** of: **5**

Project:	**TSF3 GI Support**	Easting:	**328321 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819715 m**	Date commenced:	**3/5/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 308.6 m**	Date completed:	**4/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**22.5 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
20		HQ3					SW	VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000		20 - 20.21m: Drilling induced breaks
										20.22-20.24m: Jt 20° Un, Ro, FeO St	
										20.27-20.38m: Jt 50° Un, Ro, FeO St	
										20.34-20.41m: Jt 65° Un, Ro, Cl	
										20.44-20.47m: Jt 35° Un, Cl	
			100							20.7-20.72m: Jt 30° Un, Ro, Cl	
										20.79-20.85m: Jt 40° Un, Ro, FeO St	
21										21.01-21.07m: Jt 50° Un, Ro, FeO St	
										21.09-21.16m: Jt 60° Pl, Ro, Cl	
										21.11-21.23m: Jt 60° Pl, Ro, clay Vn	
										21.26-21.27m: Jt 10° Un, Ro, Cl	
										21.28-21.34m: Jt 60° Un, FeO St	
										21.38-21.39m: Jt 20° Un, Ro, FeO St	
			(47)							21.39-21.48m: Jt 65° Un, FeO St	
										21.45-21.47m: Jt 35° Un, Ro, Cl	
										21.47-21.52m: Jt 40° Pl, FeO St	
										21.54-21.57m: Jt 90° Un, FeO St	
										21.57-21.66m: Jt 70° Un, Ro, Cl	
										21.62-21.7m: Jt 50° Pl, FeO St	
										21.79-21.83m: Jt 50° Un, FeO St	
										21.82-21.89m: Jt 55° Un, FeO St	
22			100							21.94-21.97m: Jt 10° Un, FeO St	
										21.98-22m: Jt 10° Un, Ro, FeO St	
										21.99-22.06m: Jt 70° Pl, FeO St	
										21.99-22.13m: Jt 40° Un, FeO St	
										22.12-22.24m: Jt 70° Un, Ro, FeO St	
										22.16-22.2m: Jt 50° Un, Ro, Cl	
										22.22-22.29m: Jt 60° Un, Ro, FeO St	
										22.3-22.36m: Jt 90° Un, Ro, Cl	
										22.35-33.39m: Jt 30° Un, Ro, FeO St	
	286.1		**(43)**							22.37-22.49m: Jt 60° Un, Ro, Cl	
										22.38-22.44m: Jt 70° Un, Cl	
										22.48-22.5m: Jt 75° Pl, FeO St	

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Cored Borehole Log

TSF_BH_15A Sheet: 1 of: 4

Project:	**TSF3 GI Support**	Easting:	**328357 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819725 m**	Date commenced:	**30/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.0 m**	Date completed:	**2/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**20.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
0					**QUARTZITE:** pale brown, medium to coarse grained, distinctly laminated to thinly bedded at 50 degrees, iron staining along discontinuities, moderate to slightly weathered, medium strength		MW	VL 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000		0 - 0.2m: Drilling induced breaks
										0.29-0.31m: Jt 30° Un, Ro, FeO St 0.32-0.33m: Jt 20° Pl, Ro, FeO St	
										0.37-0.45m: Jt 45° Un, Ro, FeO St	
										0.47-0.48m: Jt 20° Un, Ro, FeO St	
										0.51-0.59m: Jt 65° Un, FeO St	
										0.6-0.61m: Jt 15° Pl, Ro, FeO St	
			93							0.7-0.75m: Jt 80° Un, Cl	
										0.81-1.07m: Jt 70° Un, Ro, FeO St	
1										0.82-0.84m: Jt 25° Un, Ro, FeO St 0.83-0.86m: Jt 30° Un, Ro, FeO St 0.87-0.9m: Jt 45° Un, Ro, FeO St 1.05-1.2m: Jt 60° Un, Ro, clay Vn: FeO st 1.1-1.15m: Jt 35° Un, Ro, FeO St 1.19-1.26m: Jt 60° Pl, Ro, clay Vn	1.26 - 1.4m: Handlng and drilling induced breaks. Core stuck in Drill bit
	307.6										
	307.5		(21)		**CORE LOSS:**						
					QUARTZITE: pale brown, medium to coarse grained, distinctly laminated to thinly bedded at 55 degrees, iron staining along discontinuities, slightly fractured, medium strength, moderately weathered		MW				1.5 - 1.55m: Drilling induced breaks
										1.58-1.62m: Pt 45° Un, Ro, FeO St	
			100							1.63-1.71m: Jt 50° Pl, Ro, clay Ct: <2mm	
										1.63-1.7m: Jt 70° Un, Ro, FeO St 1.63-1.66m: Sz 1.66-1.67m: Jt 10° Un, Ro, FeO St 1.67-1.68m: Jt 20° Pl, Ro, FeO St 1.69-1.78m: Jt 80° Un, Ro, FeO St: clay Vn	1.82 - 1.9m: Drilling and handling breaks
			(0)								
2										1.96-1.98m: Jt 35° Pl, Cl	
										2.14-2.15m: Jt 20° Un, Ro, FeO St 2.17-2.22m: Jt 30° Un, Ro, FeO St 2.2-2.21m: Jt 10° Un, Ro, FeO St 2mm	
										2.32-2.35m: Jt 70° Un, Ro, FeO St: clay Vn 2.32-2.39m: Pt 50° Pl, Ro, clay Ct: 2mm, FeO st	
			100								
										2.37-3.39m: Jt 25° Pl, Ro, FeO St	
3											
			(43)								
			100							2.42-2.5m: Jt 45° Un, Ro, clay Vn 2.53-2.59m: Jt 70° Pl, Ro, Cl 2.56-2.62m: Jt 40° Un, Ro, FeO St 2.68-2.79m: Jt 80° Un, clay Vn 2.75-2.77m: Jt 25° Pl, FeO St 2.75-2.84m: Jt 50° Pl, FeO St 2.77-2.84m: Jt 55° Un, Cl 2.85-2.86m: Jt 20° Un, Ro, FeO St 2.86-2.89m: Jt 40° Pl, Ro, FeO St 2.87-3m: Jt 80° Pl, Ro, clay Vn 2.9-2.94m: Jt 60° Pl, Ro, clay Vn 2.93-2.94m: Jt 20° Un, Ro, clay Vn 2.94-2.95m: Jt 10° Pl, Ro, clay Vn 2.96-3.04m: Jt 25° Un, Ro, clay Vn 3-3.13m: Jt 70° Pl, Ro, FeO St 3.06-3.07m: Jt 0° Pl, Ro, Cl 3.06-3.09m: Jt 40° Pl, Ro, Cl 3.09-3.19m: Jt 80° Un, Ro, clay Vn 3.11-3.16m: Jt 45° Un, Ro, clay Vn 3.17-3.2m: Jt 40° Pl, Ro, clay Vn 3.17-3.23m: Jt 50° Un, Ro, clay Vn 3.26-3.33m: Jt 50° Un, Ro, FeO St 3.27-3.34m: Jt 55° Un, Ro, FeO St 3.34-3.38m: Jt 40° Un, Ro, FeO St: clay Vn 3.43-3.53m: Pt 65° Un, Ro, Cl 3.63-3.85m: Jt 70° Pl, Ro, clay Vn 3.72-3.76m: Jt 35° Pl, Ro, clay Vn 3.87-3.88m: Jt 10° Pl, clay Vn 3.89-3.91m: Jt 20° Ir, Ro, clay Vn 4.01-4.15m: Jt 75° Pl, clay Vn 4.11-4.15m: Jt 10° Ir, Ro, clay Vn: FeO st 4.34-4.4m: Jt 75° Pl, Cl 4.56-4.61m: Pt 40° Pl, Ro, clay Vn 4.65-4.7m: Pt 40° Pl, Ro, clay Vn	
			(100)								
4											
			92								
	304.2									4.78-4.8m: Jt 40° Un, Ro, clay Vn	
	304.1		(77)		**CORE LOSS:**						
5							MW			4.9-4.94m: Xwsm : PP: 1.0 kg/cm2 4.94-4.98m: Jt 50° Pl, Ro, clay Vn	

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Cored Borehole Log

TSF_BH_15A Sheet: 2 of: 4

Project:	**TSF3 GI Support**	Easting:	**328357 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819725 m**	Date commenced:	**30/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.0 m**	Date completed:	**2/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**20.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
5					**QUARTZITE:** pale brown, medium to coarse grained, distinctly laminated to thinly bedded at 55 degrees, iron staining along discontinuities, slightly fractured, medium strength, moderately weathered				Vl 0.03 / 0.6 L 0.1 / 2 M 0.3 / 6 H 1 / 20 VH 3 / 60 EH 10 / 200	< 20 20 - 60 60 - 200 200 - 600 600 - 2000 > 2000	5.06-5.09m: Jt 30° Pl, Cl 5.14-5.18m: Jt 20° Pl, clay Vn 5.33-5.25m: Jt 25° Pl, Ro, FeO St 5.29-5.35m: Jt 60° Un, Ro, FeO St 5.37-5.39m: Jt 25° Pl, Ro, FeO St 5.5-5.52m: Jt 25° Pl, Ro, FeO St 5.52-5.63m: Jt 70° Un, clay Vn	
			100								5.58-5.63m: Jt 80° Un, clay Vn 5.63-5.64m: Jt 20° Un, Ro, FeO St 3mm 5.64-5.72m: Jt 60° Pl, clay Vn 5.72-5.73m: Jt 20° Pl, Ro, clay Ct: 3mm, FeO st 5.74-6.03m: Jt 75° Un, clay Vn: FeO st	
6											5.92-5.93m: Jt 10° Un, clay Vn 2mm: FeO st 5.93-6m: Jt 65° Un, clay Vn 2mm: FeO st 6-6.07m: Jt 60° Un, clay Ct 2mm 6.06-6.14m: Jt 75° Un, clay Ct 2mm 6.14-6.17m: Jt 30° Pl, clay Ct 2mm 6.18-6.22m: Jt 55° Pl, FeO St 6.21-6.24m: Jt 30° Un, Ro, FeO St 6.26-6.31m: Jt 70° Pl, clay Vn 6.31-6.4m: Jt 80° Un, clay Vn	
			(95)								6.4-6.43m: Jt 35° Un, Ro, FeO St 6.45-6.67m: Jt 20° Un, Ro, FeO St	
7			97								6.47-6.65m: Jt 70° Un, clay Vn 6.47-6.51m: Jt 90° Un, clay Vn 6.5-6.51m: Jt 20° Un, Ro, FeO St 6.52-6.62m: Jt 55° Un, clay Vn 6.61-6.62m: Jt 20° Un, FeO St 3mm 6.69-6.71m: Jt 30° Pl, FeO St 6.76-6.77m: Jt 10° Pl, Ro, clay Ct: 3mm, FeO st 6.83-6.85m: Jt 25° Pl, clay Vn: FeO st 6.83-6.95m: Jt 75° Un, clay Vn 6.91-6.98m: Jt 35° Pl, clay Vn: FeO st 7.08-7.11m: Jt 30° Pl, Ro, clay Vn: FeO st 7.11-7.19m: Jt 60° Un, Ro, FeO St 7.14-7.23m: Jt 80° Un, clay Vn 7.21-7.29m: Jt 65° Un, clay Vn 7.27-7.82m: Jt 30° Un, clay Vn: FeO st	
			(64)								7.32-7.36m: Jt 40° Un, FeO St 7.38-7.4m: Jt 20° Pl, FeO St 10mm 7.55-7.57m: Jt 20° Pl, Ro, FeO St 7.62-7.64m: Jt 10° Pl, Ro, clay In: 10mm, PP: 1.0 kg/cm2 7.68-7.69m: Jt 10° Un, FeO St 7.7-7.72m: Jt 20° Pl, Ro, FeO St 7.72-7.94m: Jt 70° Pl, FeO St 7.75-7.78m: Jt 30° Pl, Ro, FeO St 7.83-7.86m: Jt 35° Pl, Ro, FeO St 7.83-7.84m: Jt 20° Cv, FeO St 7.86-7.91m: Jt 35° Pl, Ro, FeO St 7.94-7.95m: Jt 10° Pl, Ro, FeO St 8.1-8.13m: Jt 30° Pl, Ro, FeO St 8.12-8.14m: Jt 30° Pl, Ro, FeO St 10mm 8.18-8.26m: Jt 60° Un, FeO St 8.27-8.28m: Jt 10° Pl, Ro, clay In 2mm: 10mm, PP: 4.4 kg/cm2 8.3-8.48m: Jt 80° Pl, FeO St: clay Vn 8.49-8.5m: Jt 10° Pl, Ro, clay Ct: 2mm 8.53-8.55m: Jt 20° Pl, FeO St: clay Vn 8.65-8.66m: Jt 25° Pl, FeO St 8.69-8.7m: Jt 10° Un, Ro, clay Vn 8.7-8.78m: Jt 70° Pl, clay Vn: FeO st 8.77-8.84m: Jt 60° Un, FeO St 8.78-8.97m: Jt 70° Pl, Ro, FeO St	
8			103									
9			(60)								8.85-8.87m: Jt 20° Un, Ro, clay Vn: FeO st 8.9-9m: Jt 80° Un, Ro, clay Vn 8.93-9m: Jt 50° Cv, Ro, clay Vn 9.02-9.07m: Jt 80° Un, clay Vn 5mm 9.03-9.11m: Jt 75° Un, clay Vn 9.04-9.11m: Jt 70° Un, clay Vn 9.07-9.24m: Jt 60° Un, Ro, clay In: 5mm 9.13-9.96m: Sz : clay and rock fragments	
10		HQ3									9.18-9.26m: Pt 60° Pl, Ro, FeO St	

ENGENY

Cored Borehole Log

TSF_BH_15A Sheet: 3 of: 4

Project:	**TSF3 GI Support**	Easting:	**328357 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819725 m**	Date commenced:	**30/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.0 m**	Date completed:	**2/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**20.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS / Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
10		HQ3	94					VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000	9.21-9.26m: Jt 50° Pl, FeO St 9.26-9.27m: Jt 20° Pl, Ro, Cl 9.27-9.34m: Jt 60° Pl, Ro, clay Vn 9.29-9.37m: Jt 70° Un, Ro, clay Vn 9.34-9.4m: Jt 90° Un, Ro, FeO St 9.45-9.52m: Jt 55° Pl, FeO St 9.5-9.56m: Jt 55° Cv, Ro, FeO St 9.52-9.59m: Jt 55° Pl, Ro, clay Vn 9.55-9.62m: Pt 50° Pl, Ro, clay Vn 9.63-9.69m: Jt 45° Pl, Ro, clay Vn 9.64-9.66m: Pt 55° Pl, Ro, clay Vn 9.67-9.79m: Jt 80° Un, Ro, clay Vn 9.77-9.81m: Jt 45° Pl, Ro, clay Vn 9.92-9.94m: Jt 20° Pl, Ro, clay Vn 5mm 10.07-10.12m: Pt 50° Pl, Ro, FeO St 10.11-10.12m: Jt 0° Pl, Ro, clay In 10mm: 5mm PP: 0 10.14-10.16m: Jt 20° un, Ro, FeO St 10.26-10.32m: Jt 50° Un, clay In 10mm: PP: No penetration 10.37-10.42m: pt 45° Pl, Ro, FeO St 10.54-10.58m: Jt 40° Pl, Ro, clay Vn 10.58-10.82m: Sz	
11			(50)							11.03-11.11m: Jt 70° Pl, Ro, FeO St 11.24-11.25m: Jt 20° Pl, Ro, clay Vn 11.26-11.27m: Jt 20° Pl, Ro, clay Vn 11.41-11.49m: pt 50° Pl, Ro, clay Vn	
12			107							11.82-11.84m: Jt 20° Pl, Ro, clay Vn 11.97-12.03m: Pt 30° Pl, Ro, clay Vn 12.1-12.17m: Jt 60° Un, Cl	
13			(100)							12.44-12.5m: Pt 55° Pl, Ro, clay Vn 12.51-12.71m: Vn 80° Un, quartz 12.77-12.83m: Xwsm 30° Un, Ro, 12.94-12.97m: Jt 25° Un, Ro, clay Vn 13-13.01m: Jt 10° Pl, Ro, Cl 13.08-13.09m: Jt 10° Pl, Cl 13.09-13.1m: Jt 10° Pl, Cl 13.12-13.13m: Jt 10° Un, Cl 13.14-13.15m: Jt 20° Un, Cl 13.15-13.17m: Jt 30° Cv, Ro, Cl 13.29-13.32m: Jt 20° pl, Ro, Cl 13.31-13.32m: Jt 10° Pl, Ro, FeO St 13.34-13.38m: Jt 40° Pl, Ro, clay Vn	
	295.4		100		**QUARTZITE:** pale brown, medium to coarse grained, distinctly laminated to thinly bedded at 55 degrees, iron staining along discontinuities, slightly fractured, medium strength, moderately weathered		SW			13.54-13.87m: Jt 80° Un, FeO St 13.8-14.02m: Jt 80° Un, Ro, FeO St	
14			(67)							13.87-13.88m: Jt 10° Pl, Ro, FeO St 13.91-13.94m: Jt 40° Pl, Ro, FeO St 13.92-14m: Jt 80° Un, FeO St 13.97-14.05m: Pt 40° Un, Ro, FeO St: Ripple mark 14-14.34m: Jt 90° Un, FeO St 14.09-14.12m: Jt 40° Un, FeO St 14.11-14.24m: Jt 65° Pl, FeO St: clay Vn 14.18-14.24m: Jt 60° Pl, clay Vn 14.21-14.72m: Jt 90° Un, FeO St: clay Vn	
15			100							14.31-14.62m: Jt 80° Un, FeO St 14.39-14.4m: Jt 10° Un, FeO St 14.4-14.9m: Jt 75° Un, FeO St 14.46-14.47m: Jt 10° Un, FeO St 14.86-14.95m: Pt 55° Pl, Ro, clay Vn	

ENGENY

Cored Borehole Log

TSF_BH_15A Sheet: 4 of: 4

Project:	**TSF3 GI Support**	Easting:	**328357 m**	Driller:	**GROUNDWAVE**
Client:	**29 Metals**	Northing:	**7819725 m**	Date commenced:	**30/4/2024**
Location:	**Proposed TSF3 Site / Borrow**	Ground elevation:	**RL 309.0 m**	Date completed:	**2/5/2024**
Job number:	**QC1022_018**	Dip: **-90°** Azimuth:	**-°**	Logged by:	**CM**
		Drill depth:	**20.0 m bgl**	Checked by:	**AL**

Horizontal coordinates to GDA94 MGAz54. Vertical levels to AHD.

Depth (m)	Elevation (RL m)	Method	Core Rec % / RQD (%)	Graphic Log	Material Description	Soil Moisture / Water Loss (%)	USCS	Weathering	Consistency Density / Inferred Rock Strength MPa (IS_{50}/UCS)	Average Defect Spacing (mm)	Discontinuity Description	Field Records / Remarks
15									VL 0.03 / 0.6 · L 0.1 / 2 · M 0.3 / 6 · H 1 / 20 · VH 3 / 60 · EH 10 / 200	< 20 · 20 - 60 · 60 - 200 · 200 - 600 · 600 - 2000 · > 2000	15.09-15.13m: Jt 30° Un, Ro, FeO St 2mm 15.14-15.24m: Jt 70° Pl, clay Vn 15.24-15.36m: Jt 65° Un, Ro, clay Ct: 2mm 15.24-15.32m: Jt 70° Un, clay Vn 15.3-15.34m: Jt 70° Un, FeO St 15.35-15.37m: Jt 30° Pl, Ro, FeO St 15.38-15.43m: Jt 30° Un, Ro, FeO St 15.43-15.61m: Jt 80° Pl, FeO St 15.52-15.54m: Jt 20° Pl, Ro, FeO St 15.57-15.64m: Jt 50° Un, FeO St 15.6-15.71m: Jt 70° Pl, FeO St 15.7-15.76m: Jt 40° Pl, FeO St 15.73-15.87m: Jt 80° Un, Ro, FeO St	
			(69)									
16											15.92-15.94m: Jt 20° Pl, Ro, FeO St 16.15-16.19m: Jt 40° Pl, FeO St 16.2-16.25m: Jt 55° Un, FeO St 16.25-16.3m: Jt 60° Un, FeO St 16.32-16.41m: Jt 50° Un, FeO St 16.34-16.42m: Jt 60° Un, FeO St 16.44-16.69m: Jt 70° Un, FeO St 16.61-16.62m: Jt 20° Un, FeO St 16.69-16.72m: Jt 50° Un, FeO St 16.7-16.81m: Jt 60° Pl, Ro, FeO St 16.78-16.92m: Jt 70° Un, Ro, FeO St	
			100									
17			(80)								16.8-16.82m: Jt 20° Un, Ro, FeO St 16.83-16.89m: Jt 60° Un, Ro, FeO St 16.89-16.97m: Jt 70° Un, Ro, clay Vn 16.98-17.1m: Jt 80° Un, Ro, FeO St 17-17.13m: Jt 80° Un, Ro, FeO St 17.12-17.2m: Jt 75° Un, FeO St 17.14-17.2m: Jt 70° Pl, Ro, FeO St 17.21-17.28m: Jt 70° Pl, FeO St 17.25-17.27m: Jt 75° Un, FeO St 17.25-17.3m: Jt 80° Un, FeO St 17.3-17.39m: Jt 60° Un, FeO St 17.32-17.56m: Jt 70° Pl, Ro, FeO St	
			100								17.41-17.42m: Jt 10° Un, Ro, FeO St 17.49-17.55m: Jt 40° Un, FeO St 17.53-17.69m: Jt 80° Un, FeO St 17.57-17.59m: Jt 10° Un, FeO St 17.69-17.7m: Jt 10° Un, Ro, FeO St 17.74-17.77m: Jt 55° Un, FeO St 17.77-17.78m: Jt 10° Un, Ro, clay Vn 17.78-17.85m: Jt 60° Un, FeO St 17.86-17.89m: Jt 30° Pl, FeO St	
18											17.94-18.34m: Jt 80° Pl, Ro, FeO St	
			(69)								18.08-18.09m: Jt 10° Pl, Ro, FeO St 18.12-18.19m: Jt 60° Pl, FeO St 18.17-18.2m: Jt 40° Un, clay Vn 18.23-18.32m: Jt 60° Un, Cl 18.32-18.42m: Jt 50° Pl, Ro, clay Vn 18.5-18.59m: Jt 70° Pl, Ro, clay Vn 18.59-18.6m: Jt 30° Pl, Ro, clay Vn 18.6-18.67m: Jt 70° Pl, Ro, clay Vn 18.63-18.79m: Jt 70° Pl, Ro, clay Vn	18.47 - 18.52m: Drilling and handling breaks
19											18.65-18.79m: Jt 80° Un, clay Vn 18.73-18.85m: Jt 70° Un, Ro, clay Vn 18.78-18.9m: Jt 65° Un, FeO St 18.84-18.9m: Jt 70° Un, FeO St 18.89-18.94m: Jt 50° Un, FeO St 18.9-18.97m: Jt 50° Un, Ro, clay Vn 19-19.14m: Jt 80° Un, Ro, clay Vn: FeO st	18.92 - 20m: Drilling and handling breaks
			100								19.04-19.07m: Jt 30° Un, Ro, clay Vn 19.14-19.15m: Jt 10° Pl, clay Vn: FeO st 19.14-19.21m: Jt 55° Pl, FeO St 19.22-19.31m: Jt 70° Un, Ro, clay Vn 19.25-19.32m: Jt 55° Un, Ro, clay Vn 19.3-19.4m: Jt 50° Un, clay Vn: FeO st 19.41-19.53m: Jt 60° Un, FeO St 19.42-19.5m: Jt 80° Un, FeO St 19.5-19.56m: Jt 50° Pl, FeO St 19.63-19.7m: Pt 50° Pl, Ro, Cl 19.75-19.83m: Jt 70° Pl, FeO St 19.75-19.86m: Jt 70° Pl, FeO St 19.8-19.82m: Jt 25° Un, Ro, FeO St 19.86-19.92m: Jt 30° Pl, Ro, FeO St	
20	289		(58)									

Test Pit Log

TSF_TP_02

Sheet: **1** of: **1**

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327562 m**	Contractor:	**STEELCON**
		Northing:	**7820183 m**	Date commenced:	**29/03/2023**
Client:	**29 Metals**	Ground elevation:	**RL 265.6 m**	Date completed:	**29/03/2023**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**CM**
Job number:	**QC1022_018**	Hole depth:	**0.7 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
30t Excavator 600mm Toothed Bucket			0		GW	**Sandy GRAVEL:** red-brown, fine to medium grained, angular to sub-angular siltstone and quartzite clasts, medium to coarse grained sand, trace silt, trace angualar to sub-angular boulders	M	D	QUATERNARY ALLUVIUM	D
			0.1							
			0.2							
			0.3							
			0.4					VD		D
			0.5							
			0.6							
		264.9	0.7							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_06 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327537 m**	Contractor:	**STEELCON**
		Northing:	**7820087 m**	Date commenced:	**28/03/2024**
Client:	**29 Metals**	Ground elevation:	**RL 273.5 m**	Date completed:	**28/03/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**CM**
Job number:	**QC1022_018**	Hole depth:	**1.6 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
30t Excavator 600mm Toothed Bucket		273.2	0 – 0.3		GW	**Sandy GRAVEL:** red-brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, with silt	M	MD	QUATERNARY ALLUVIUM	D
			0.3 – 1.4			**Sandy GRAVEL:** red-brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, trace silt		D		D
		272.1	1.4 – 1.6		GP	**GRAVEL with sand:** pale brown, medium to coarse grained, angular clasts of dolomitic siltstone, medium to coarse grained sand	D	VD	PARADISE CREEK FORMATION	D
		271.9								

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_08 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327524 m**	Contractor:	**STEELCON**
		Northing:	**7820036 m**	Date commenced:	**29/03/2023**
Client:	**29 Metals**	Ground elevation:	**RL 272.6 m**	Date completed:	**29/03/2023**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**CM**
Job number:	**QC1022_018**	Hole depth:	**1.3 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
30t Excavator 600mm Toothed Bucket			0		GP	**Sandy GRAVEL:** red-brown, fine to medium grained, angular to sub-angular siltstone and quartzite clasts, medium to coarse grained sand, with silt		MD	QUATERNARY ALLUVIUM	
			0.1							
			0.2							
			0.3							D
			0.4							
			0.5				M			
			0.6					D		
		271.9	0.7		GC	**Sandy GRAVEL with clay:** mottled orange-brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, low plasticity clay, trace boulders				D
			0.8							
			0.9							
		271.6	1			**Sandy GRAVEL with clay:** red-brown, medium to coarse grained, angular clasts of quartzite, medium to coarse grained sand, medium plasticity clay, trace boulders				
			1.1				D	VD		D
			1.2							
		271.3	1.3							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_10 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327519 m**
		Northing:	**7819979 m**
Client:	**29 Metals**	Ground elevation:	**RL 270 m**
Location:	**Proposed TSF3 Site / Borrow**		
Job number:	**QC1022_018**	Hole depth:	**3 m bgl**

Contractor:	**STEELCON**
Date commenced:	**29/03/2023**
Date completed:	**29/03/2024**
Logged by:	**CM**
Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
30t Excavator 600mm Toothed Bucket		269.4	0 – 0.6		GP	**Sandy GRAVEL with silt:** red-brown, medium to coarse grained, angular to sub-angular quartzite clasts, medium to coarse grained sand, with silt			QUATERNARY ALLUVIUM	D
			0.6 – 2.7			**Sandy GRAVEL with clay:** red-brown, fine to medium grained, angular to sub-angular quartzite and siltstone clasts, medium to coarse grained sand, medium plasticity clay	M	D		D
		267.3	2.7 – 2.9		CL	**CLAY with sand:** low plasticity, red-brown, medium to course grained sand, trace fine to medium grained gravel, angular clasts of dolomitic siltstone and quartzite	w<PL	H		D
		267								

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_11 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327606 m**	Contractor:	**STEELCON**
		Northing:	**7819876 m**	Date commenced:	**22/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 271.7 m**	Date completed:	**22/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**1.3 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket		271.5	0		ML	**Gravelly SILT:** Brown, low plasticity, gravel is fine to coarse, subangular siltstone gravel, organics	w<PL	F	RESIDUAL	
			0.1							
		271.1	0.2		GM	**Silty GRAVEL:** brown, fine to coarse grained, angular to subangular, weathered siltstone gravel, low plasticity silt	D	L		D, D, B, D
			0.3							
			0.4							
			0.5							
		270.7	0.6			**SILTSTONE:** Red brown, thinly laminated at 40 degrees, highly weathered, low strength, fine grain, excavated in block sizes 5-50mm	D	L	PARADISE CREEK FORMATION	B, D, D
			0.7							
			0.8							
			0.9							
		270.4	1			**SILTSTONE:** Pale red and grey, laminated at 85 degrees, moderately weathered, medium strength, fine grain, excavated in block sizes 60-200mm, iron staining on some parting defects, planar parting defects, lenses of clayey gravel 100mm thick, low plasticity, red brown	D	M		PL Index 1.912
			1.1							
			1.2							
			1.3							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_12 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327473 m**	Contractor:	**STEELCON**
		Northing:	**7819870 m**	Date commenced:	**29/03/2023**
Client:	**29 Metals**	Ground elevation:	**RL 269.1 m**	Date completed:	**29/03/2023**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**CM**
Job number:	**QC1022_018**	Hole depth:	**2.5 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
30t Excavator 600mm Toothed Bucket		268.5	0 – 0.6		GP	**Sandy GRAVEL with clay:** dark brown, fine to medium grained, angular to sub-angular siltstone and quartzite clasts, medium to coarse grained sand, medium plasticity clay, trace rootlets		L	QUATERNARY ALLUVIUM	D
		267.5	0.6 – 1.6			**Sandy GRAVEL with clay:** red-brown, fine to medium grained, angular to sub-angular siltstone and quartzite clasts, medium to coarse grained sand, medium plasticity clay	M	MD		D
		266.6	1.6 – 2.5		CI	**Gravelly CLAY with sand:** medium plasticity, mottled orange-brown, gravel is medium to coarse grained, angular to sub-angular clasts of siltstone, medium to coarse grained sand	w<PL	ST / VST		D

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_13 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327628 m**	Contractor:	**STEELCON**
		Northing:	**7819835 m**	Date commenced:	**23/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 277.3 m**	Date completed:	**23/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**2.6 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket		277	0		GP	**GRAVEL with sand:** Fine to medium grained, angular siltstone gravel, pale brown, sand is coarse grained, trace low plasticity silt	D	L	RESIDUAL	
			0.3			**SILTSTONE:** pale brown to white, laminated at 85 degrees, moderately weathered, medium strength, fine grain, excavated in block sizes 60-200mm, iron staining on some parting defects, planar parting defects, lenses of clayey gravel 100mm thick, low plasticity clay, red brown		M	PARADISE CREEK FORMATION	D, D, B, D, PL Index 0.585
		275.3	2			**SILTSTONE:** red and white,laminated to thinly bedded at 85 degrees, moderately to slightly weathered, high strength, excavated in block sizes 60-200mm, iron staining along planar parting defects		H		PL Index 1.79
		274.7	2.5							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_14 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327595 m**	Contractor:	**STEELCON**
		Northing:	**7819790 m**	Date commenced:	**22/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 281.6 m**	Date completed:	**22/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**0.3 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket			0		GP	**GRAVEL with sand:** Fine to medium grained, angular siltstone gravel, pale brown, sand is coarse grained, trace low plasticity silt	D	L	RESIDUAL	D, D, B, PL Index 2.185
		281.4	0.1							
			0.2			**SILTSTONE:** red and white,laminated to thinly bedded at 85 degrees, moderately to slightly weathered, high strength, excavated in block sizes 60-200mm, iron staining along planar parting defects		H	PARADISE CREEK FORMATION	
		281.3								

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_15 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327455 m**	Contractor:	**STEELCON**
		Northing:	**7819794 m**	Date commenced:	**29/03/2023**
Client:	**29 Metals**	Ground elevation:	**RL 266.6 m**	Date completed:	**29/03/2023**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**CM**
Job number:	**QC1022_018**	Hole depth:	**1.3 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
30t Excavator 600mm Toothed Bucket		265.6	0		GC	**Sandy GRAVEL with clay:** red-brown, fine to medium grained, angular to sub-angular siltstone and quartzite clasts, medium to coarse grained sand, medium plasticity, trace rootlets	M	MD	QUATERNARY ALLUVIUM	D
			1		GP	**Sandy GRAVEL:** red-brown, fine to medium grained, angular to sub-angular siltstone and quartzite clasts, medium to coarse grained sand, trace clay, medium plasticity				D
		265.3	2					VD		D

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_16 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327574 m**	Contractor:	**STEELCON**
		Northing:	**7819773 m**	Date commenced:	**23/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 284.5 m**	Date completed:	**23/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**0.5 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket		284.5	0		GM	**Silty GRAVEL:** brown, fine to coarse grained, angular to subangular, weathered siltstone gravel, low plasticity silt	D	L	RESIDUAL	D,B,D
		284.3	0.1							
			0.2			**SILTSTONE:** Dark grey, laminated, moderately weathered, high strength, fine grained, excavated in block sizes 60-200mm, iron staining along defects, laminated at 70 degrees			PARADISE CREEK FORMATION	
			0.3				D	H		PL
		284	0.4							
			0.5							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_17 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327586 m**	Contractor:	**STEELCON**
		Northing:	**7819711 m**	Date commenced:	**22/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 280.2 m**	Date completed:	**22/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**1.1 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket			0			**SILTSTONE:** pale brown to white, Thinly bedded at 85 degrees, moderately weathered, medium strength, fine grain, excavated in block sizes 60-200mm, iron staining on some parting defects, planar parting defects, lenses of clayey gravel, low plasticity, red brown	D	M	PARADISE CREEK FORMATION	D, D, B, D, PL Index 0.431
			0.1							
			0.2							
			0.3							
			0.4							
			0.5							
			0.6							
			0.7							
		279.4	0.8			**SILTSTONE:** red brown, thinly bedded at 85 degrees, moderately to slightly weathered, high strength, excavated in block sizes 60-200mm		H		
			0.9							
			1							
		279.1	1.1							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_18 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327530 m**	Contractor:	**STEELCON**
		Northing:	**7819625 m**	Date commenced:	**22/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 268.7 m**	Date completed:	**22/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**2.7 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket		268.3	0 – 0.4		GM	**Silty GRAVEL:** brown, Fine to coarse grained, angular to subangular, weathered siltstone gravel, low plasticity silt		L	RESIDUAL	
			0.4 – 1.3			**SILTSTONE:** red brown and pale brown to white, very thinly to thinly bedded at 40 degrees, highly weathered, medium strength, fine grain, excavated in block sizes 20-100mm		M	PARADISE CREEK FORMATION	PL Index 0.890
		267.4	1.3 – 2.3		GC	**Clayey GRAVEL:** red brown, Fine to medium, angular, highly weathered, moderate strength siltstone gravel, clay is low plasticity, trace medium grained sand	D	M		D, B, D, D
		266.4	2.3 – 2.7			**SILTSTONE:** pale brown to white, Thinly bedded at 20 degrees, moderately weathered, medium strength, fine grain, excavated in block sizes 60-200mm, clean, planar parting defects		M		
		266	2.7							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_19 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327440 m**	Contractor:	**STEELCON**
		Northing:	**7819577 m**	Date commenced:	**22/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 265.7 m**	Date completed:	**22/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**1.2 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 600mm Toothed Bucket		265.1	0		GC	**Clayey GRAVEL:** Fine to coarse grained, weathered siltstone clasts, red brown, clay is low plasticity, some angular , highly weathered siltsone cobbles and boulders.	D	L	RESIDUAL	D, D, B
		264.5	0.6			**SILTSTONE:** moderately to highly weathered, pale brown, moderate strength, laminated at 20 degrees, iron staining along discontinuities		M	PARADISE CREEK FORMATION	

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_21 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327406 m**	Contractor:	**STEELCON**
		Northing:	**7819491 m**	Date commenced:	**22/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 266.5 m**	Date completed:	**22/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**1.3 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 600mm Toothed Bucket		265.9	0		GC	**Clayey GRAVEL:** brown, fine to coarse grained subangular to angular siltstone clasts		L	FILL	D, D, B, D
			0.6			**SILTSTONE:** grey, laminated to thinly bedded at 45 degrees, quartz veins at 50 degrees, excavated in 200mm angular blocks, High strength	D	H	PARADISE CREEK FORMATION	
		265.2	1.3							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_23

Sheet: **1** of: **1**

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327347 m**	Contractor:	**STEELCON**
		Northing:	**7819422 m**	Date commenced:	**22/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 268 m**	Date completed:	**22/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**1.3 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance (1 2 3 4 5)	Elevation (AHD)	Depth (m)	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket		267.9	0		SM	**Silty SAND with gravel:** brown, fine to medium grained, low plasticity silt, gravel is fine to coarse, subanglular, trace organics			TOPSOIL	
			0.1		GM	**Silty GRAVEL:** brown, fine to coarse grained, angular to subangular, weathered siltstone gravel, low plasticity silt			RESIDUAL	D
			0.2							
			0.3							
			0.4							
			0.5							
			0.6				D	L		D, D, B, D
			0.7							
			0.8							
			0.9							
			1							
		266.9	1.1			**COBBLES AND BOULDERS with sand:** high strength, moderately weathered, subangular siltsone cobbles and boulders, coarse grained sand			PARADISE CREEK FORMATION	
			1.2							
		266.7	1.3							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_24 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**327349 m**	Contractor:	**STEELCON**
		Northing:	**7819362 m**	Date commenced:	**22/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 270.1 m**	Date completed:	**22/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**0.45 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket		270.1	0			**SILTSTONE:** pale brown to dark brown, thinly laminated at 70 degrees, highly weathered, very low strength, fine grained, excavated as silty gravel, fine to coarse angular, silt is low plasticity, dark brown, trace organics	D	VL	PARADISE CREEK FORMATION	D, D, D, B, PL Index 1.509
			0.1							
		269.9	0.2			**SILTSTONE:** pale brown, laminated at 70 degrees, moderately weathered, medium strength, fine grain, excavated in block sizes 20-60mm		M		
		269.8	0.3			**SILTSTONE:** grey with iron staining along parting defects, thinly bedded at 70 degrees, slightly weathered, high strength, fine grained, excavated in block sizes 100mm to 300mm.		H		PL Index 5.324
		269.7	0.4							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_25 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**328206 m**	Contractor:	**STEELCON**
		Northing:	**7822236 m**	Date commenced:	**28/03/2024**
Client:	**29 Metals**	Ground elevation:	**RL 229.5 m**	Date completed:	**28/03/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**CM**
Job number:	**QC1022_018**	Hole depth:	**0.9 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
30t Excavator 600mm Toothed Bucket			0		GW	**Sandy GRAVEL with clay:** red-brown, fine to medium grained, angular to sub-angular siltstone clasts, medium to coarse grained sand, low plasticity clay		L	QUATERNARY ALLUVIUM	D
			0.1							
			0.2				M	MD		D
			0.3							
			0.4							
		229.1				**GRAVEL with sand:** pale brown, fine to medium grained, angular dolomitic silstone clasts, medium to coarse grained sand				
			0.5							D
			0.6				D			
			0.7							
			0.8							
		228.6	0.9							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_WRD1 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**328026 m**
		Northing:	**7820540 m**
Client:	**29 Metals**	Ground elevation:	**RL 313 m**
Location:	**Proposed TSF3 Site / Borrow**		
Job number:	**QC1022_018**	Hole depth:	**3.5 m bgl**

Contractor:	**STEELCON**
Date commenced:	**24/05/2024**
Date completed:	**24/05/2024**
Logged by:	**TM**
Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket		312.2	0 – 0.8		GW	**Sandy GRAVEL:** dark grey, fine to coarse grained, angular to sub-angular , high strength, moderately weathered siltstone clasts, medium to coarse grained sand, trace silt, trace cobbles			FILL	B
		311.5	0.8 – 1.5			**Sandy GRAVEL:** dark red, fine to coarse grained, angular to sub-angular , moderate strength, highly weathered quartzite clasts, medium to coarse grained sand, trace silt				B
		309.5	1.5 – 3.5			**Sandy GRAVEL:** dark grey, fine to coarse grained, angular to sub-angular , high strength, moderately weathered siltstone clasts, medium to coarse grained sand, trace silt, trace cobbles and boulders lenses of medium plasticity, dark grey clay, trace concrete cobbles	D	L		B

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Test Pit Log

TSF_TP_WRD2 | Sheet: 1 of: 1

ENGENY

Project:	**TSF3 GI Support**	Easting:	**328048 m**	Contractor:	**STEELCON**
		Northing:	**7820499 m**	Date commenced:	**24/05/2024**
Client:	**29 Metals**	Ground elevation:	**RL 296.2 m**	Date completed:	**24/05/2024**
Location:	**Proposed TSF3 Site / Borrow**			Logged by:	**TM**
Job number:	**QC1022_018**	Hole depth:	**1.1 m bgl**	Checked by:	**AL**

EXCAVATION				Material Type			Condition		Observations	Testing
Method	Penetration Resistance 1 2 3 4 5	Elevation AHD	Depth m	Graphic Log	Classification Symbol	Soil Type *Colour, Plasticity/Grain Size, Minor Components*	Moisture Condition	Consistency / Strength	Soil Origin, Structure, etc.	Samples
45t Komatsu Excavator 1200mm Toothed Bucket		295.9	0		GP	**Sandy GRAVEL:** red brown, subangular, moderately to highly weathered siltstone gravel, coarse sand, trace low plasticity silt	D	L	FILL	B, B
			0.1							
			0.2							
			0.3			**Sandy GRAVEL:** dark grey, coarse grained, angular, fresh, high strength siltstone cobbles, fine to coarse grained sand, trace cobbles and boulders				
			0.4							
			0.5							
			0.6							
			0.7							
			0.8							
			0.9							
			1							
		295.1	1.1							

Site Notes / Termination Remark: Refusal

HORIZONTAL DATUM: GDA94 MGA ZONE 55
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

APPENDIX C: IN-SITU TESTING

PROJECT: TSF3 Geotechnical Investigation
CLIENT: 29 Metals
LOCATION: Capricorn Copper Mine
SUBJECT: Point Load Test Results
Tested By: TM
Date Tested: 24.05.24
Equipment Used: PLT Model 6500
Equipment Type: Electronic / Load Cell Hydraulic / Pressure Gauge

DATE:	18/09/2024
JOB NO	QC1022_018
FILE	

Moisture Content Field (insitu) / ~~Saturated / Air Dried~~

According to AS 4133.4.1 - 1993 **Y**
According to ISRM Suggest Methods

Sample Location	Depth (Top)	Depth (Base)	Test Type and Dir	L/W = 0.3 to 1.0 AXIAL (A) Platen Sep. (or Length) D	L/W = 0.3 to 1.0 AXIAL (A) Width (or core diam.) W	L/D > 1.0 DIAMETRAL (D) Platen Sep. (or core diam) D	L/D > 1.0 DIAMETRAL (D) Dist to End L	L= 0.5 D IRREGULAR (I) Width (if irregular lump W = $W_1+W_2+W_3/3$) W	Platen Sep at Failure D'	Load at Failure P	Equivalent Core Diameter De	Equivalent Core Diameter De^2	Point Load Strength Is	Point Load Strength Index Is(50)	Rock Strength Class	F -Failed through rock fabric BB - Bad break along preexisting failure plane B - Broke along bedding
	(m)	(m)	A/D/I	E	(mm)	(mm)	(mm)	(mm)	(mm)	(kN)	(mm^2)	(mm^2)	(MPa)	(MPa)		
TSF3_BH_03	17.5	17.6	D			63	100		62	5.59	62	3844	1.454	1.602	H	BB
TSF3_BH_03	19.15	19.29	D			63	140		62	20.95	62	3844	5.450	6.004	VH	F
TSF3_BH_03	12.87	13	D			63	130		62	0.54	62	3844	0.140	0.155	L	B
TSF3_BH_03	14.24	14.3	A	60	63				62	3.36	71	4973	0.676	0.789	M	F
TSF3_BH_03	8.78	8.9	D			63	120		62	6.48	62	3844	1.686	1.857	H	F
TSF3_BH_03	8.85	8.9	A	50	63				50	7.24	63	4011	1.805	2.008	H	F
TSF3_BH_03	5.35	5.42	D			63	70		62	12.51	62	3844	3.254	3.585	VH	F
TSF3_BH_03	5.35	5.39	A	40	63				40	9.68	57	3209	3.017	3.191	VH	F
TSF3_BH_03	2.3	2.46	D			63	160		62	5.93	62	3844	1.543	1.699	H	F
TSF3_BH_03	2.2	2.24	A	40	63				40	6.94	57	3209	2.163	2.288	H	F
TSF3_BH_12	6.74	6.9	D			63	160		62	18	62	3844	4.683	5.159	VH	NA - EXCEEDED PLT CAPACITY
TSF3_BH_12	7.95	8	A	50	63				50	18	63	4011	4.488	4.992	VH	NA - EXCEEDED PLT CAPACITY
TSF3_BH_12	3.92	4	D			63	80		62	6.68	62	3844	1.738	1.914	H	BB
TSF3_BH_12	14.12	14.23	D			63	110		62	18	62	3844	4.683	5.159	VH	NA - EXCEEDED PLT CAPACITY
TSF3_BH_12	10	10.2	D				200		62	18	62	3844	4.683	5.159	VH	NA - EXCEEDED PLT CAPACITY
TSF3_BH_12	10.82	10.85	A	30	63				30	18	49	2406	7.480	7.416	VH	NA - EXCEEDED PLT CAPACITY
TSF3_BH_08	13.37	13.47	D			63	100		62	18	62	3844	4.683	5.159	VH	NA - EXCEEDED PLT CAPACITY
TSF3_BH_08	15.85	15.9	A	50	63				50	18	63	4011	4.488	4.992	VH	NA - EXCEEDED PLT CAPACITY
TSF3_BH_14	22	22.1	D			63	100		62	18	62	3844	4.683	5.159	VH	NA - EXCEEDED PLT CAPACITY
TSF3_BH_14	19.1	19.21	D			63	110		62	18	62	3844	4.683	5.159	VH	NA - EXCEEDED PLT CAPACITY
TSF3_BH_15A	12.9	12.95	A	50	63				50	0.59	63	4011	0.147	0.164	L	BB
TSF3_BH_15A	12.7	12.9	D			63	200		62	5.54	62	3844	1.441	1.588	H	F
TSF3_BH_15A	12.7	12.75	A	50	63				50	7.14	63	4011	1.780	1.980	H	F
TSF3_BH_03	4.15	4.25	D			63	100		62	5.22	62	3844	1.358	1.496	H	F
TSF3_BH_03	5.72	5.81	D			63	110		62	8.35	62	3844	2.172	2.393	H	F
TSF3_BH_03	6.71	6.8	D			63	90		62	11.94	62	3844	3.106	3.422	VH	F
TSF3_BH_03	7.5	7.58	D			63	80		60	3.42	60	3600	0.950	1.031	H	F
TSF3_BH_03	9	9.15	D			63	150		62	4.81	62	3844	1.251	1.378	H	F
TSF3_BH_03	9.2	9.35	D			63	150		61	5.5	61	3721	1.478	1.616	H	F
TSF3_BH_03	12.54	12.64	D			63	100		55	4.54	55	3025	1.501	1.567	H	F
TSF3_BH_03	13.65	13.75	D			63	100		48	3.86	48	2304	1.675	1.645	H	BB
TSF3_BH_03	14.12	14.24	D			63	120		59	5.46	59	3481	1.569	1.690	H	F
TSF3_BH_03	16.56	16.66	D			63	100		61	5.6	61	3721	1.505	1.646	H	F
TSF3_BH_03	17.48	17.55	D			63	70		62	0.1	62	3844	0.026	0.029	EL	BB
TSF3_BH_03	17.5	17.6	D			63	100		62	5.59	62	3844	1.454	1.602	H	F
TSF3_BH_03	18.58	18.68	D			63	100		62	13.91	62	3844	3.619	3.986	VH	F
TSF3_BH_03	19	19.1	D			63	100		62	14.8	62	3844	3.850	4.241	VH	NA - EXCEEDED PLT CAPACITY

$De^2 = D'^{*2}$ (diametrial tests)

$De^2 = {}^{4xWxD'}/_{Pi}$ (axial, block and lump tests)

$De = (De^2)^{*0.5}$

$Is = {}^{(Px1000)}/_{De^2}$

P in kN, De^2 in mm

$Is_{(50)} = F \times Is$

$F = (De/50)^{*0.45}$

PROJECT: TSF3 Geotechnical Investigation
CLIENT: 29 Metals
LOCATION: Capricorn Copper Mine
SUBJECT: Point Load Test Results
Tested By: TM
Date Tested: 24.05.24
Equipment Used: PLT Model 6500
Equipment Type: Electronic / Load Cell Hydraulic / Pressure Gauge

DATE:	18/09/2024
JOB NO	QC1022_018
FILE	

Moisture Content Field (insitu) / ~~Saturated / Air Dried~~

According to AS 4133.4.1 - 1993 **Y**
According to ISRM Suggest Methods

Sample Location	Depth (Top)	Depth (Base)	Test Type and Dir	L/W = 0.3 to 1.0 AXIAL (A) Platen Sep. (or Length) D	L/W = 0.3 to 1.0 AXIAL (A) Width (or core diam.) W	L/D > 1.0 DIAMETRAL (D) Platen Sep. (or core diam) D	L/D > 1.0 DIAMETRAL (D) Dist to End L	L= 0.5 D IRREGULAR (I) Width (if irregular lump W = $W_1+W_2+W_3/3$) W	Platen Sep at Failure D'	Load at Failure P	Equivalent Core Diameter De	Equivalent Core Diameter De^2	Point Load Strength Is	Point Load Strength Index Is(50)	Rock Strength Class	F -Failed through rock fabric BB - Bad break along preexisting failure plane B - Broke along bedding
	(m)	(m)	A/D/I	E	(mm)	(mm)	(mm)	(mm)	(mm)	(kN)	(mm^2)	(mm^2)	(MPa)	(MPa)		
TSF3_BH_05	50.36	50.5	D			63	140		62	4.68	**62**	**3844**	**1.217**	**1.341**	**H**	F
TSF3_BH_05	51.56	51.66	A	60	63				60	6.01	**69**	**4813**	**1.249**	**1.447**	**H**	F
TSF3_BH_05	52.08	52.18	D			63	100		62	14.85	**62**	**3844**	**3.863**	**4.256**	**VH**	F
TSF3_BH_05	53.27	53.36	D			63	90		61	2.94	**61**	**3721**	**0.790**	**0.864**	**M**	BB
TSF3_BH_05	55	55.1	D			63	100		61	2.61	**61**	**3721**	**0.701**	**0.767**	**M**	BB
TSF3_BH_05	55.8	55.86	A	60	63				60	2.72	**69**	**4813**	**0.565**	**0.655**	**M**	BB
TSF3_BH_05	56.16	56.21	D			36	70		34	1.65	**34**	**1156**	**1.427**	**1.200**	**H**	F
TSF3_BH_05	58.58	58.65	D			63	70		62	5.67	**62**	**3844**	**1.475**	**1.625**	**H**	F
TSF3_BH_05	58.65	58.73	D			63	80		62	0.09	**62**	**3844**	**0.023**	**0.026**	**EL**	F
TSF3_BH_05	59	59.09	D			63	90		60	5.38	**60**	**3600**	**1.494**	**1.622**	**H**	F
TSF3_BH_05	60.15	60.25	D			63	100		59	6.96	**59**	**3481**	**1.999**	**2.154**	**H**	F
TSF3_BH_06	41.75	41.85	D			63	100		62	7	**62**	**3844**	**1.821**	**2.006**	**H**	F
TSF3_BH_06	43.6	43.68	D			63	80		62	7.37	**62**	**3844**	**1.917**	**2.112**	**H**	F
TSF3_BH_06	44	44.07	D			63	70		62	4.57	**62**	**3844**	**1.189**	**1.310**	**H**	F
TSF3_BH_06	45.45	45.5	A	50	63				49	2.14	**63**	**3930**	**0.544**	**0.603**	**M**	F
TSF3_BH_06	45.5	45.6	D			63	100		60	4.06	**60**	**3600**	**1.128**	**1.224**	**H**	F
TSF3_BH_06	47.3	48.4	D			63	100		63	14.7	**63**	**3969**	**3.704**	**4.110**	**VH**	F
TSF3_BH_07	4.12	4.22	D			63	100		62	9.49	**62**	**3844**	**2.469**	**2.720**	**H**	F
TSF3_BH_07	5.22	5.3	D			63	80		62	4.24	**62**	**3844**	**1.103**	**1.215**	**H**	F
TSF3_BH_07	9.51	9.6	D			63	90		62	3.31	**62**	**3844**	**0.861**	**0.949**	**M**	F
TSF3_BH_07	10.5	10.65	D			63	150		63	16.65	**63**	**3969**	**4.195**	**4.655**	**VH**	**NA - EXCEEDED PLT CAPACITY**
TSF3_BH_07	14.51	14.6	D			63	90		63	7.71	**63**	**3969**	**1.943**	**2.155**	**H**	F
TSF3_BH_07	15.07	15.14	D			63	70		61	1.35	**61**	**3721**	**0.363**	**0.397**	**M**	F
TSF3_BH_07	17.7	17.8	D			63	100		63	17.55	**63**	**3969**	**4.422**	**4.906**	**VH**	**NA - EXCEEDED PLT CAPACITY**
TSF3_BH_07	18.28	18.4	D			63	120		62	18.13	**62**	**3844**	**4.716**	**5.196**	**VH**	**NA - EXCEEDED PLT CAPACITY**
TSF3_BH_08	6.2	6.28	D			62	80		62	3.17	**62**	**3844**	**0.825**	**0.908**	**M**	F
TSF3_BH_08	6.75	6.86	D			63	110		59	8	**59**	**3481**	**2.298**	**2.476**	**H**	F
TSF3_BH_08	8	8.1	D						62	13.99	**62**	**3844**	**3.639**	**4.009**	**VH**	BB
TSF3_BH_08	15	15.05	A	55	63				55	5.35	**66**	**4412**	**1.213**	**1.378**	**H**	F
TSF3_BH_08	15.85	19.9	A	50	63				50	18.55	**63**	**4011**	**4.625**	**5.144**	**VH**	**NA - EXCEEDED PLT CAPACITY**
TSF3_BH_10A	3.92	4	D			63	80		59	11.58	**59**	**3481**	**3.327**	**3.584**	**VH**	F/BB
TSF3_BH_10A	9.28	9.38	D			63	100		62	17.51	**62**	**3844**	**4.555**	**5.018**	**VH**	BB
TSF3_BH_10A	13.52	13.6	D			63	140		63	18.32	**63**	**3969**	**4.616**	**5.122**	**VH**	BB
TSF3_BH_10A	17.5	17.55	A	50	63				49	8.71	**63**	**3930**	**2.216**	**2.453**	**H**	BB
TSF3_BH_13	23.1	23.22	D			63	120		63	18	**63**	**3969**	**4.535**	**5.032**	**VH**	**NA - EXCEEDED PLT CAPACITY**
TSF3_BH_13	19.9	20	D			63	100		63	18.6	**63**	**3969**	**4.686**	**5.200**	**VH**	**NA - EXCEEDED PLT CAPACITY**
TSF3_BH_13	27.5	28.5	D						63	18.67	**63**	**3969**	**4.704**	**5.220**	**VH**	**NA - EXCEEDED PLT CAPACITY**

$De^2 = D'^{\wedge 2}$ (diametrial tests)

$De^2 = {}^{4xWxD'}/_{Pi}$ (axial, block and lump tests)

$De = (De^2)^{\wedge 0.5}$

$Is = {}^{(Px1000)}/_{De^2}$

P in kN, De^2 in mm

$Is_{(50)} = F \times Is$

$F = (De/50)^{\wedge 0.45}$

PROJECT: TSF3 Geotechnical Investigation
CLIENT: 29 Metals
LOCATION: Capricorn Copper Mine
SUBJECT: Point Load Test Results
Tested By: TM
Date Tested: 24.05.24
Equipment Used: PLT Model 6500
Equipment Type: Electronic / Load Cell Hydraulic / Pressure Gauge

DATE:	**18/09/2024**
JOB NO	**QC1022_018**
FILE	

Moisture Content Field (insitu) / ~~Saturated / Air Dried~~

According to AS 4133.4.1 - 1993 **Y**
According to ISRM Suggest Methods

Sample Location	Depth (Top)	Depth (Base)	Test Type and Dir	L/W = 0.3 to 1.0 AXIAL (A) Platen Sep. (or Length) D	L/W = 0.3 to 1.0 AXIAL (A) Width (or core diam.) W	L/D > 1.0 DIAMETRAL (D) Platen Sep. (or core diam) D	L/D > 1.0 DIAMETRAL (D) Dist to End L	L= 0.5 D IRREGULAR (I) Width (if irregular lump W = $W_1+W_2+W_3/3$) W	Platen Sep at Failure D'	Load at Failure P	Equivalent Core Diameter De	Equivalent Core Diameter De^2	Point Load Strength Is	Point Load Strength Index Is(50)	Rock Strength Class	F -Failed through rock fabric BB - Bad break along preexisting failure plane B - Broke along bedding
	(m)	(m)	A/D/I	E	(mm)	(mm)	(mm)	(mm)	(mm)	(kN)	(mm^2)	(mm^2)	(MPa)	(MPa)		
TSF3_BH_13	31.9	32	D			63	100		63	18	**63**	**3969**	**4.535**	**5.032**	**VH**	**NA - EXCEEDED PLT CAPACITY**
TSF3_BH_15A	2	2.1	D			63	100		63	18.39	**63**	**3969**	**4.633**	**5.141**	**VH**	F
TSF3_BH_15A	2	2.05	A	50	63				49	12.19	**63**	**3930**	**3.101**	**3.434**	**VH**	F
TSF3_BH_15A	5.33	5.38	A	50	63				50	10.66	**63**	**4011**	**2.658**	**2.956**	**H**	F
TSF3_BH_15A	10.4	10.5	D			63	100		62	11.59	**62**	**3844**	**3.015**	**3.322**	**VH**	F
TSF3_BH_15A	18.55	18.6	A	50	63				62	14	**71**	**4973**	**2.815**	**3.286**	**VH**	**NA - EXCEEDED PLT CAPACITY**
TSF3_BH_15A	19.7	19.8	D			63	100		60	17	**60**	**3600**	**4.722**	**5.126**	**VH**	**NA - EXCEEDED PLT CAPACITY**
TSF3_TP_13	2	2.6	I					67	55	7.29	**68**	**4692**	**1.554**	**1.790**	**H**	F
TSF3_TP_13	0.3	2	I					67	65	2.71	**74**	**5545**	**0.489**	**0.585**	**M**	F
TSF3_TP_24	0	0.45	I					75	43	5.54	**64**	**4106**	**1.349**	**1.509**	**H**	F
TSF3_TP_24	0	0.45	I					58	44	16.31	**57**	**3249**	**5.019**	**5.324**	**VH**	F
TSF3_TP_18	0.4	2.7	I					69	67	4.32	**77**	**5886**	**0.734**	**0.890**	**M**	F
TSF3_TP_17	0	0.8	I					68	67	2.07	**76**	**5801**	**0.357**	**0.431**	**M**	F
TSF3_TP_23	1.1	1.3	I					53	51	20.94	**59**	**3442**	**6.084**	**6.538**	**VH**	F
TSF3_TP_14	0	0.3	I					78	77	12.99	**87**	**7647**	**1.699**	**2.185**	**H**	F
TSF3_TP_11	1	1.3	I					60	58	7.45	**67**	**4431**	**1.681**	**1.912**	**H**	F
TSF3_TP_16	0	0.5	I					52	51	11.88	**58**	**3377**	**3.518**	**3.764**	**VH**	F

$De^2 = D'^{*2}$ (diametrial tests)

$De^2 = {}^{4xWxD'}/_{Pi}$ (axial, block and lump tests)

$De = (De^2)^{*0.5}$

$Is = {}^{(Px1000)}/_{De^2}$

P in kN, De^2 in mm

$Is_{(50)} = F \times Is$

$F = (De/50)^{*0.45}$

Is (50)

0	EL	Extremely Low
0.03	VL	Very low
0.1	L	Low
0.3	M	Medium
1	H	High
3	VH	Very High
10	EH	Extremely High

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	UEDD
Job No.:	QC1022_018
Packer Model:	Straddle
Pump Model	3.5kW Flexi,
Gauge Model:	,

Tested By:	CM
Test Date:	Tuesday, 30 April 2024
Calculation By:	CM
Checked By:	AL

Borehole:	**TSF_BH_12**
Drilling Rig:	Boart Longyear
Driller:	Nigel

Elevation

Ground Level AHD: 0.00 m

Test Section

Hole Inclination (Angle):	90 degrees	
From: (Corrected/Actual)	6.00	6.00 m
To: (Corrected/Actual)	11.00	11.00 m
Centre:	8.50 m	
Length of Test Section:	5.00 m	

Gauge

Gauge Height above ground:	1.00 m
Height of Water Column at GL:	8.50 m

Groundwater

Depth Below Ground Level:	0.00	0.00 m
Applied Groundwater Level:	0.00 m	
Height Above Test Mid Section:	8.50 m	

Pipe

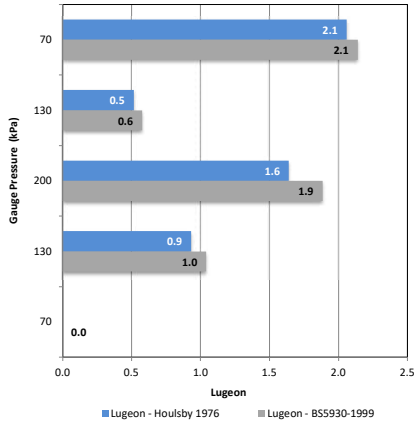
Pipe Radius:	0.025 m
Pipe Length:	7.00 m
Radius of Borehole:	0.048 m

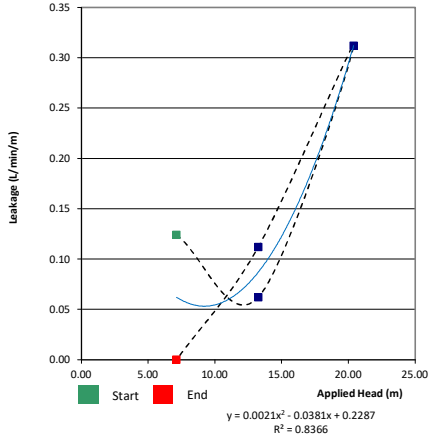
Calculations

Internal Surface Area:	1.10 m^2	
Pipe Orifice Area:	0.0020 m^2	
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07 m/s	
Flow Type:	Dilation	Houlsby

Jacking/Dilation Check

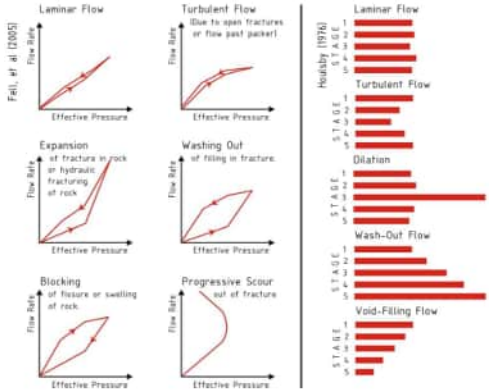
Density of Overburden	25 kg/m^3	
Overburden Load - Dry	0.25 kPa	
Overburden Load - Wet	-9.56 kPa	





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
70	10	6.2	0.01	1.03E-05	0.12	1.14E-04	7.14	2.14E-07	2.1	2.1
130	10	3.1	0.00	5.17E-06	0.06	3.17E-05	13.26	5.76E-08	0.6	0.5
200	10	15.6	0.01	2.60E-05	0.31	6.30E-04	20.39	1.88E-07	1.9	1.6
130	10	5.6	0.00	9.33E-06	0.11	9.47E-05	13.26	1.04E-07	1.0	0.9
70	10	0.0	0.00	0.00E+00	0.00	0.00E+00	7.14	0.00E+00	0.0	0.0

Stage	1	2	3	4	5
Test Pressure (kPa)	70	130	200	130	70
Jacking/Dilation Possible	Yes	Yes	Yes	Yes	Yes
Equivalent Thickness of Rock - Dry (m)	559.52	804.25	1089.77	804.25	559.52
Equivalent Thickness of Rock - Wet (m)	-14.35	-20.62	-27.94	-20.62	-14.35

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
1.25E-07	**m/s**
Houlsby Flow Type **Dilation**	
Calculated Lugeon Values	
0.9	BS5930:1999 Accounts For GW
0.9	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	UEDD
Job No.:	QC1022_018
Packer Model:	Single
Pump Model	Beam pump,
Gauge Model:	,

Tested By:	CM
Test Date:	Friday, 3 May 2024
Calculation By:	CM
Checked By:	AL

Borehole:	**TSF_BH_15A**
Drilling Rig:	Boart Longyear
Driller:	Adrian Wheatley

Elevation

Ground Level AHD:	0.00	m

Test Section

Hole Inclination (Angle):	90		degrees
From: (Corrected/Actual)	6.00	6.00	m
To: (Corrected/Actual)	12.00	12.00	m
Centre:	9.00		m
Length of Test Section:	6.00		m

Gauge

Gauge Height above ground:	1.00	m
Height of Water Column at GL:	9.00	m

Groundwater

Depth Below Ground Level:	12.00	12.00	m
Applied Groundwater Level:	12.00		m
Height Above Test Mid Section:	-3.00		m

Pipe

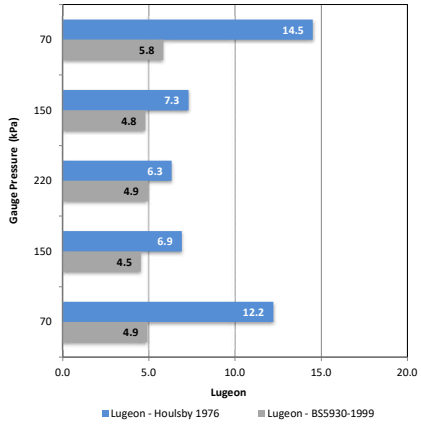
Pipe Radius:	0.025	m
Pipe Length:	7.00	m
Radius of Borehole:	0.048	m

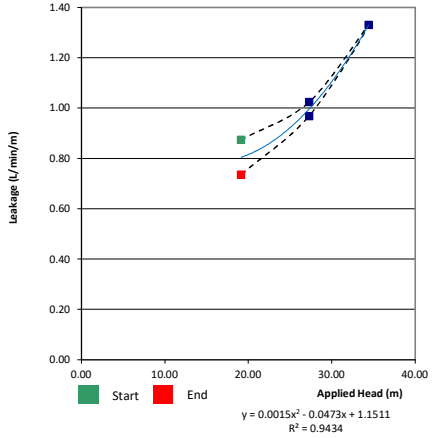
Calculations

Internal Surface Area:	1.10	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Turbulent	Houlsby

Jacking/Dilation Check

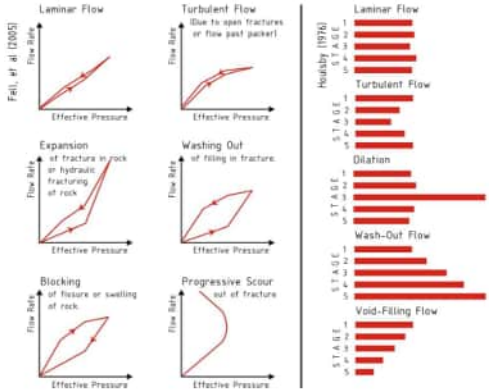
Density of Overburden	25	kg/m^3
Overburden Load - Dry	0.25	kPa
Overburden Load - Wet	-9.56	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
70	10	52.4	0.04	8.73E-05	0.87	5.93E-03	19.14	5.84E-07	5.8	14.5
150	10	61.4	0.05	1.02E-04	1.02	7.95E-03	27.29	4.80E-07	4.8	7.3
220	10	79.8	0.07	1.33E-04	1.33	1.29E-02	34.43	4.95E-07	4.9	6.3
150	10	58.1	0.05	9.68E-05	0.97	7.17E-03	27.30	4.54E-07	4.5	6.9
70	10	44.1	0.04	7.35E-05	0.74	4.31E-03	19.14	4.92E-07	4.9	12.2

Stage	1	2	3	4	5
Test Pressure (kPa)	70	150	220	150	70
Jacking/Dilation Possible	Yes	Yes	Yes	Yes	Yes
Equivalent Thickness of Rock - Dry (m)	559.52	885.83	1171.35	885.83	559.52
Equivalent Thickness of Rock - Wet (m)	-14.35	-22.71	-30.03	-22.71	-14.35

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
4.99E-07	**m/s**
Houlsby Flow Type **Turbulent**	
Calculated Lugeon Values	
4.9	BS5930:1999 Accounts For GW
6.3	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	UEDD
Job No.:	QC1022_018
Packer Model:	Double
Pump Model	Beam pump,
Gauge Model:	,

Tested By:	CM
Test Date:	Friday, 3 May 2024
Calculation By:	CM
Checked By:	0

Borehole:	**TSF_BH_15A**
Drilling Rig:	Boart Longyear
Driller:	Adrain Wheatley

Elevation

Ground Level AHD:	0.00	m

Test Section

Hole Inclination (Angle):	90	degrees	
From: (Corrected/Actual)	53.00	15.00	m
To: (Corrected/Actual)	20.00	20.00	m
Centre:	36.50	m	
Length of Test Section:	33.00	m	

Gauge

Gauge Height above ground:	1.05	m
Height of Water Column at GL:	36.50	m

Groundwater

Depth Below Ground Level:	0.00	0.00	m
Applied Groundwater Level:	0.00	m	
Height Above Test Mid Section:	36.50	m	

Pipe

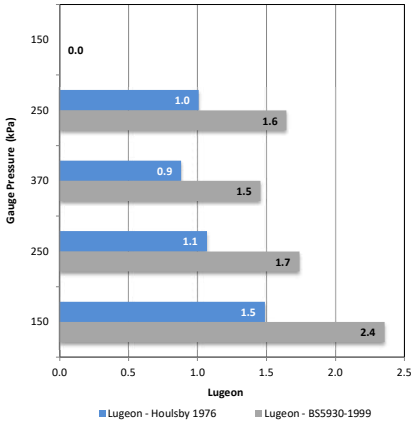
Pipe Radius:	0.025	m
Pipe Length:	54.05	m
Radius of Borehole:	0.048	m

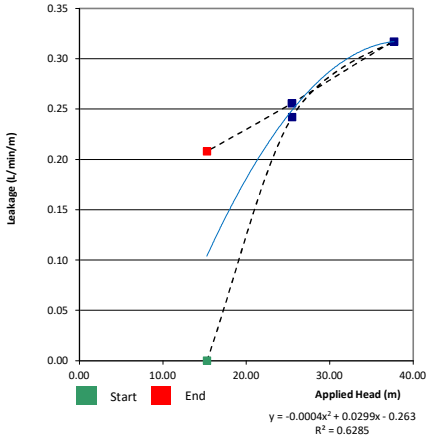
Calculations

Internal Surface Area:	8.49	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Turbulent	Houlsby

Jacking/Dilation Check

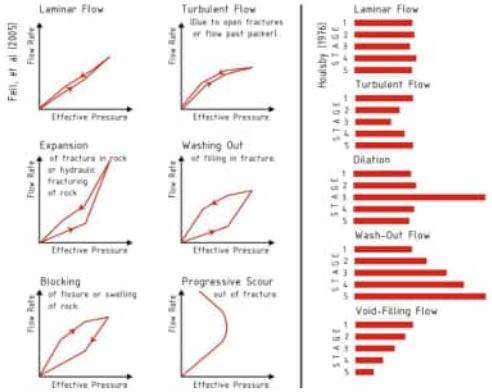
Density of Overburden	25	kg/m^3
Overburden Load - Dry	0.25	kPa
Overburden Load - Wet	-9.56	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
150	10	0.0	0.00	0.00E+00	0.00	0.00E+00	15.30	0.00E+00	0.0	0.0
250	10	79.8	0.07	1.33E-04	0.24	9.96E-02	25.48	1.64E-07	1.6	1.0
370	10	104.6	0.09	1.74E-04	0.32	1.64E-01	37.71	1.46E-07	1.5	0.9
250	10	84.4	0.07	1.41E-04	0.26	1.11E-01	25.48	1.74E-07	1.7	1.1
150	10	68.6	0.06	1.14E-04	0.21	7.53E-02	15.29	2.36E-07	2.4	1.5

Stage	1	2	3	4	5
Test Pressure (kPa)	150	250	370	250	150
Jacking/Dilation Possible	Yes	Yes	Yes	Yes	Yes
Equivalent Thickness of Rock - Dry (m)	2720.83	3128.72	3618.18	3128.72	2720.83
Equivalent Thickness of Rock - Wet (m)	-69.76	-80.22	-92.77	-80.22	-69.76

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
1.77E-07	**m/s**
Houlsby Flow Type **Turbulent**	
Calculated Lugeon Values	
1.5	BS5930:1999 Accounts For GW
0.9	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	WRD
Job No.:	QC1022_018
Packer Model:	Single
Pump Model	Groundwave - Adrian
Gauge Model:	Boart Longyear

Tested By:	Groundwave - Adrian
Test Date:	Monday, 13 May 2024
Calculation By:	TM
Checked By:	AL

Borehole:	**TSF_BH_07**
Drilling Rig:	Boart Longyear
Driller:	Groundwave - Adrian

Elevation

Ground Level AHD:	0.00	m

Test Section

Hole Inclination (Angle):	60	degrees	
From: (Corrected/Actual)	15.59	18.00	m
To: (Corrected/Actual)	21.22	24.50	m
Centre:	18.40	m	
Length of Test Section:	5.63	m	

Gauge

Gauge Height above ground:	0.40	m
Height of Water Column at GL:	18.40	m

Groundwater

Depth Below Ground Level:		m
Applied Groundwater Level:		m
Height Above Test Mid Section:	18.40	m

Pipe

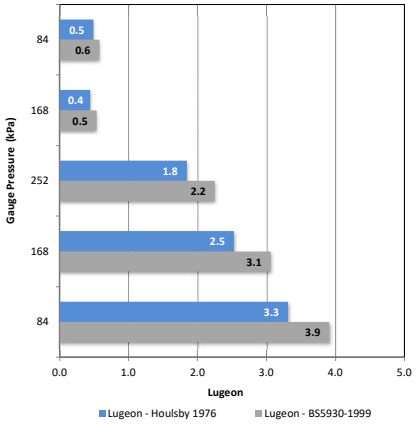
Pipe Radius:	0.025	m
Pipe Length:	15.99	m
Radius of Borehole:	0.048	m

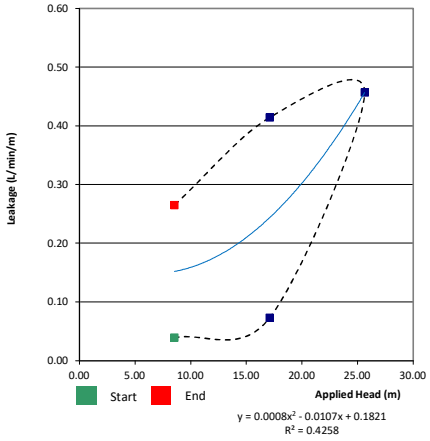
Calculations

Internal Surface Area:	2.51	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Wash-Out	Houlsby

Jacking/Dilation Check

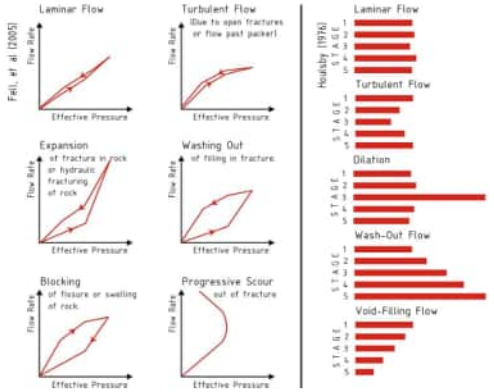
Density of Overburden	2430	kg/m^3
Overburden Load - Dry	23.83	kPa
Overburden Load - Wet	14.02	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
84	10	2.2	0.00	3.67E-06	0.04	3.84E-05	8.55	5.78E-08	0.6	0.5
168	10	4.1	0.00	6.83E-06	0.07	1.21E-04	17.10	5.38E-08	0.5	0.4
252	10	25.7	0.02	4.28E-05	0.46	3.62E-03	25.65	2.25E-07	2.2	1.8
168	10	23.3	0.02	3.88E-05	0.41	3.02E-03	17.10	3.06E-07	3.1	2.5
84	10	14.9	0.01	2.48E-05	0.26	1.32E-03	8.55	3.91E-07	3.9	3.3

Stage	1	2	3	4	5
Test Pressure (kPa)	84	168	252	168	84
Jacking/Dilation Possible	No	No	Yes	No	No
Equivalent Thickness of Rock - Dry (m)	-	-	1.55	-	-
Equivalent Thickness of Rock - Wet (m)	-	-	2.63	-	-

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
1.53E-07	**m/s**
Houlsby Flow Type **Wash-Out**	
Calculated Lugeon Values	
3.9	BS5930:1999 Accounts For GW
3.3	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	WRD
Job No.:	QC1022_018
Packer Model:	Single
Pump Model	Groundwave - Adrian
Gauge Model:	Boart Longyear

Tested By:	Groundwave - Adrian
Test Date:	Friday, 17 May 2024
Calculation By:	TM
Checked By:	AL

Borehole:	**TSF_BH_08**
Drilling Rig:	Boart Longyear
Driller:	Groundwave - Adrian

Elevation

Ground Level AHD: 0.00 m

Test Section

Hole Inclination (Angle):	60		degrees
From: (Corrected/Actual)	11.26	13.00	m
To: (Corrected/Actual)	15.59	18.00	m
Centre:	13.42		m
Length of Test Section:	4.33		m

Gauge

Gauge Height above ground:	0.40	m
Height of Water Column at GL:	13.42	m

Groundwater

Depth Below Ground Level:		m
Applied Groundwater Level:		m
Height Above Test Mid Section:	13.42	m

Pipe

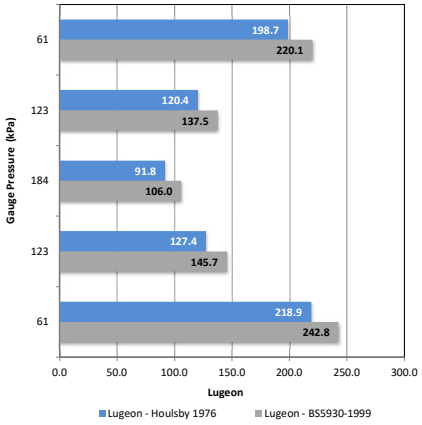
Pipe Radius:	0.025	m
Pipe Length:	11.66	m
Radius of Borehole:	0.048	m

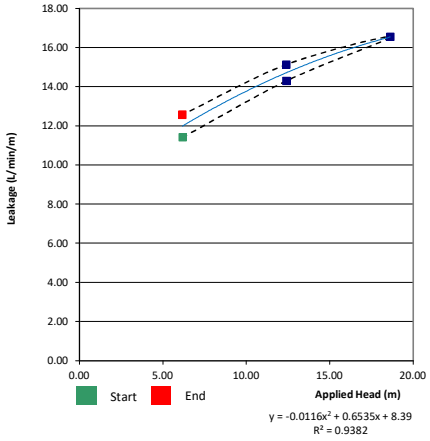
Calculations

Internal Surface Area:	1.83	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Turbulent	Houlsby

Jacking/Dilation Check

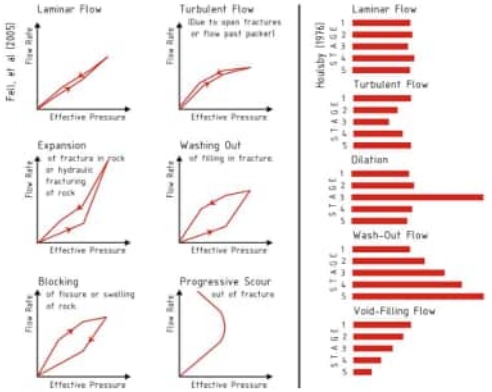
Density of Overburden	2422	kg/m^3
Overburden Load - Dry	23.76	kPa
Overburden Load - Wet	13.95	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
61	10	494.0	0.42	8.23E-04	11.41	6.27E-01	6.19	2.20E-05	220.1	198.7
123	10	619.0	0.53	1.03E-03	14.30	9.51E-01	12.41	1.38E-05	137.5	120.4
184	10	716.0	0.61	1.19E-03	16.54	1.24E+00	18.63	1.06E-05	106.0	91.8
123	10	655.0	0.56	1.09E-03	15.13	1.06E+00	12.40	1.46E-05	145.7	127.4
61	10	544.0	0.46	9.07E-04	12.56	7.49E-01	6.18	2.43E-05	242.8	218.9

Stage	1	2	3	4	5
Test Pressure (kPa)	61	123	184	123	61
Jacking/Dilation Possible	No	No	Yes	No	No
Equivalent Thickness of Rock - Dry (m)	-	-	1.30	-	-
Equivalent Thickness of Rock - Wet (m)	-	-	2.21	-	-

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
1.63E-05	**m/s**
Houlsby Flow Type **Turbulent**	
Calculated Lugeon Values	
106.0	BS5930:1999 Accounts For GW
91.8	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	WRD
Job No.:	QC1022_018
Packer Model:	Single
Pump Model	Groundwave - Adrian
Gauge Model:	Boart Longyear

Tested By:	Groundwave - Adrian
Test Date:	Friday, 17 May 2024
Calculation By:	TM
Checked By:	AL

Borehole:	**TSF_BH_08**
Drilling Rig:	Boart Longyear
Driller:	Groundwave - Adrian

Elevation

Ground Level AHD:	0.00	m

Test Section

Hole Inclination (Angle):	60		degrees
From: (Corrected/Actual)	15.59	18.00	m
To: (Corrected/Actual)	21.04	24.30	m
Centre:	18.32		m
Length of Test Section:	5.46		m

Gauge

Gauge Height above ground:	0.40	m
Height of Water Column at GL:	18.32	m

Groundwater

Depth Below Ground Level:		m
Applied Groundwater Level:		m
Height Above Test Mid Section:	18.32	m

Pipe

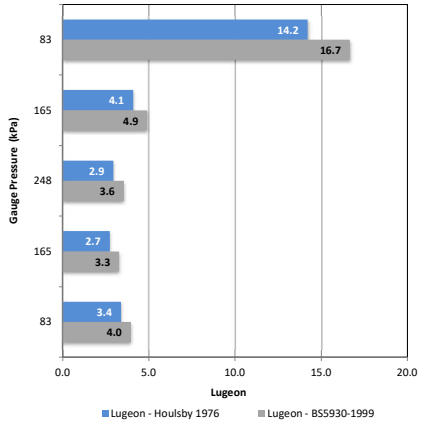
Pipe Radius:	0.025	m
Pipe Length:	15.99	m
Radius of Borehole:	0.048	m

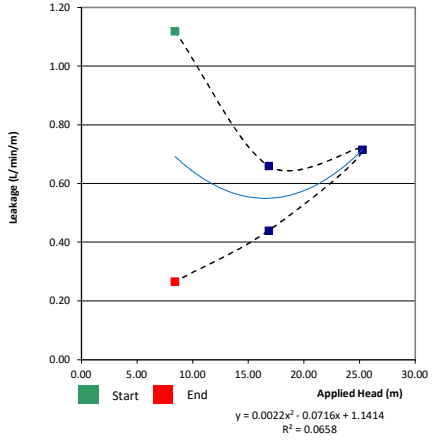
Calculations

Internal Surface Area:	2.51	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Turbulent	Houlsby

Jacking/Dilation Check

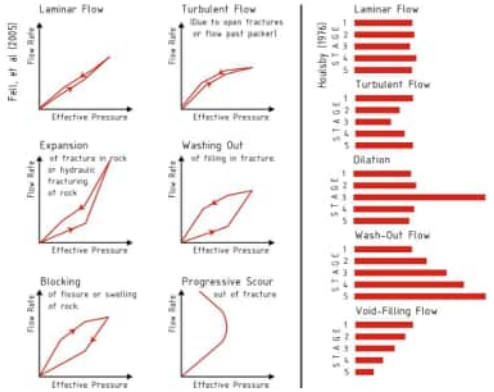
Density of Overburden	2422	kg/m^3
Overburden Load - Dry	23.76	kPa
Overburden Load - Wet	13.95	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
83	10	61.0	0.05	1.02E-04	1.12	1.79E-02	8.42	1.67E-06	16.7	14.2
165	10	36.0	0.03	6.00E-05	0.66	6.76E-03	16.84	4.92E-07	4.9	4.1
248	10	39.0	0.03	6.50E-05	0.71	7.84E-03	25.26	3.55E-07	3.6	2.9
165	10	24.0	0.02	4.00E-05	0.44	3.19E-03	16.84	3.28E-07	3.3	2.7
83	10	14.5	0.01	2.42E-05	0.27	1.26E-03	8.42	3.96E-07	4.0	3.4

Stage	1	2	3	4	5
Test Pressure (kPa)	83	165	248	165	83
Jacking/Dilation Possible	No	No	Yes	No	No
Equivalent Thickness of Rock - Dry (m)	-	-	1.44	-	-
Equivalent Thickness of Rock - Wet (m)	-	-	2.45	-	-

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
5.19E-07	**m/s**
Houlsby Flow Type **Turbulent**	
Calculated Lugeon Values	
3.6	BS5930:1999 Accounts For GW
2.9	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	WRD
Job No.:	QC1022_018
Packer Model:	Single
Pump Model	Groundwave - Adrian
Gauge Model:	Boart Longyear

Tested By:	Groundwave - Adrian
Test Date:	Monday, 20 May 2024
Calculation By:	TM
Checked By:	AL

Borehole:	**TSF_BH_10A**
Drilling Rig:	Boart Longyear
Driller:	Groundwave - Adrian

Elevation

Ground Level AHD: 0.00 m

Test Section

Hole Inclination (Angle):	60	degrees	
From: (Corrected/Actual)	16.45	19.00	m
To: (Corrected/Actual)	20.65	23.85	m
Centre:	18.55	m	
Length of Test Section:	4.20	m	

Gauge

Gauge Height above ground:	0.40	m
Height of Water Column at GL:	18.55	m

Groundwater

Depth Below Ground Level:		m
Applied Groundwater Level:		m
Height Above Test Mid Section:	18.55	m

Pipe

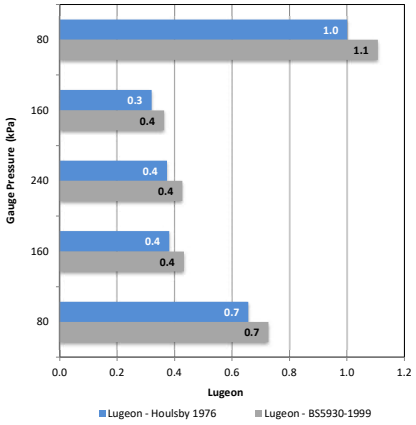
Pipe Radius:	0.025	m
Pipe Length:	16.85	m
Radius of Borehole:	0.048	m

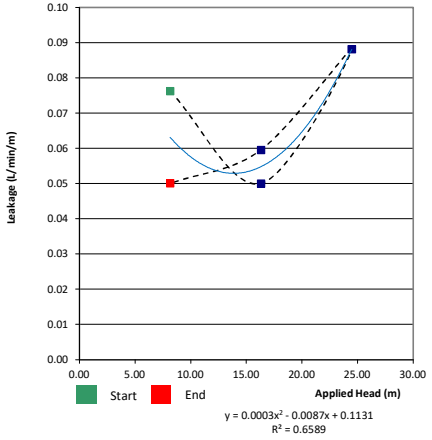
Calculations

Internal Surface Area:	2.65	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Turbulent	Houlsby

Jacking/Dilation Check

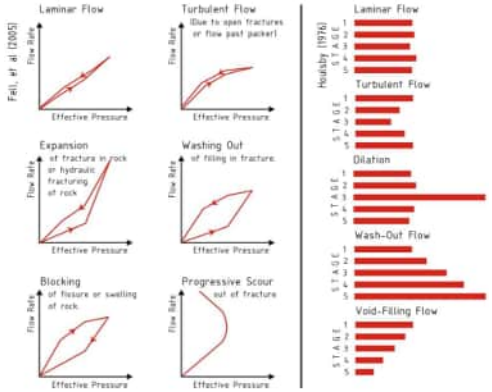
Density of Overburden	2434	kg/m^3
Overburden Load - Dry	23.87	kPa
Overburden Load - Wet	14.07	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
80	10	3.2	0.00	5.33E-06	0.08	8.09E-05	8.16	1.11E-07	1.1	1.0
160	10	2.1	0.00	3.50E-06	0.05	3.71E-05	16.32	3.63E-08	0.4	0.3
240	10	3.7	0.00	6.17E-06	0.09	1.06E-04	24.48	4.27E-08	0.4	0.4
160	10	2.5	0.00	4.17E-06	0.06	5.13E-05	16.32	4.33E-08	0.4	0.4
80	10	2.1	0.00	3.50E-06	0.05	3.71E-05	8.16	7.27E-08	0.7	0.7

Stage	1	2	3	4	5
Test Pressure (kPa)	80	160	240	160	80
Jacking/Dilation Possible	No	No	Yes	No	No
Equivalent Thickness of Rock - Dry (m)	-	-	0.52	-	-
Equivalent Thickness of Rock - Wet (m)	-	-	0.89	-	-

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
5.58E-08	**m/s**
Houlsby Flow Type **Turbulent**	
Calculated Lugeon Values	
0.4	BS5930:1999 Accounts For GW
0.4	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	UEDD
Job No.:	QC1022_018
Packer Model:	Double
Pump Model	Groundwave - Adrian
Gauge Model:	Boart Longyear

Tested By:	Groundwave - Adrian
Test Date:	Saturday, 11 May 2024
Calculation By:	CM
Checked By:	0

Borehole:	**TSF_BH_13**
Drilling Rig:	Boart Longyear
Driller:	Groundwave - Adrian

Elevation

Ground Level AHD:	0.00	m

Test Section

Hole Inclination (Angle):	90		degrees
From: (Corrected/Actual)	20.00	20.00	m
To: (Corrected/Actual)	26.00	26.00	m
Centre:	23.00		m
Length of Test Section:	6.00		m

Gauge

Gauge Height above ground:	0.40	m
Height of Water Column at GL:	23.00	m

Groundwater

Depth Below Ground Level:	0.00	0.00	m
Applied Groundwater Level:	0.00		m
Height Above Test Mid Section:	23.00		m

Pipe

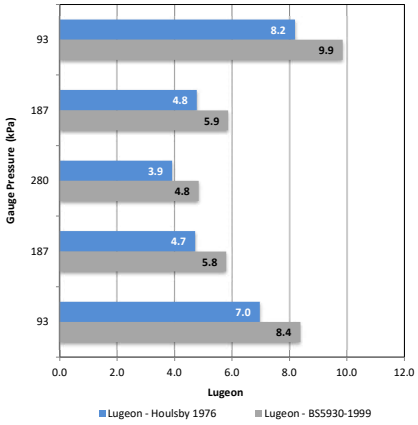
Pipe Radius:	0.025	m
Pipe Length:	20.40	m
Radius of Borehole:	0.048	m

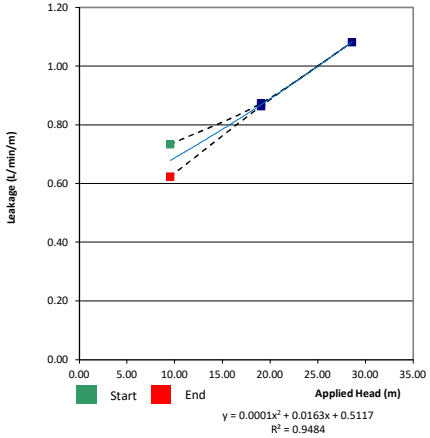
Calculations

Internal Surface Area:	3.20	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Turbulent	Houlsby

Jacking/Dilation Check

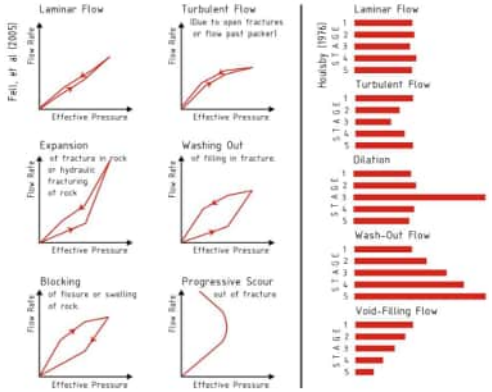
Density of Overburden	2321	kg/m^3
Overburden Load - Dry	22.76	kPa
Overburden Load - Wet	12.95	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
93	10	44.0	0.04	7.33E-05	0.73	1.25E-02	9.53	9.85E-07	9.9	8.2
187	10	52.4	0.04	8.73E-05	0.87	1.73E-02	19.06	5.87E-07	5.9	4.8
280	10	64.9	0.06	1.08E-04	1.08	2.57E-02	28.59	4.84E-07	4.8	3.9
187	10	51.8	0.04	8.63E-05	0.86	1.69E-02	19.06	5.80E-07	5.8	4.7
93	10	37.4	0.03	6.23E-05	0.62	9.25E-03	9.53	8.38E-07	8.4	7.0

Stage	1	2	3	4	5
Test Pressure (kPa)	93	187	280	187	93
Jacking/Dilation Possible	No	No	Yes	No	No
Equivalent Thickness of Rock - Dry (m)	-	-	1.11	-	-
Equivalent Thickness of Rock - Wet (m)	-	-	1.95	-	-

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
6.71E-07	**m/s**
Houlsby Flow Type **Turbulent**	
Calculated Lugeon Values	
4.8	BS5930:1999 Accounts For GW
3.9	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	UEDD
Job No.:	QC1022_018
Packer Model:	Single
Pump Model	Groundwave - Adrian
Gauge Model:	Boart Longyear

Tested By:	Groundwave - Adrian
Test Date:	Saturday, 11 May 2024
Calculation By:	CM
Checked By:	0

Borehole:	**TSF_BH_13**
Drilling Rig:	Boart Longyear
Driller:	Groundwave - Adrian

Elevation

Ground Level AHD:	0.00	m

Test Section

Hole Inclination (Angle):	90		degrees
From: (Corrected/Actual)	26.60	26.60	m
To: (Corrected/Actual)	32.60	32.60	m
Centre:	29.60		m
Length of Test Section:	6.00		m

Gauge

Gauge Height above ground:	0.40	m
Height of Water Column at GL:	29.60	m

Groundwater

Depth Below Ground Level:	0.00	0.00	m
Applied Groundwater Level:	0.00		m
Height Above Test Mid Section:	29.60		m

Pipe

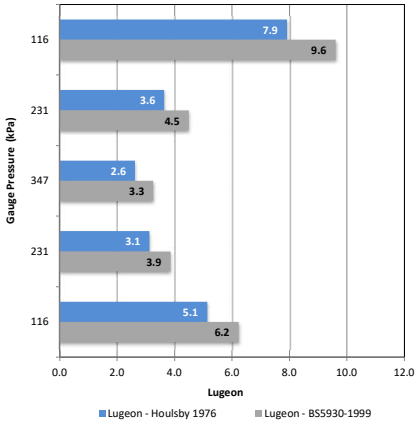
Pipe Radius:	0.025	m
Pipe Length:	27.00	m
Radius of Borehole:	0.048	m

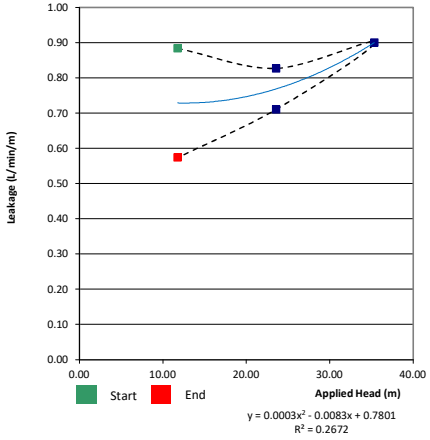
Calculations

Internal Surface Area:	4.24	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Turbulent	Houlsby

Jacking/Dilation Check

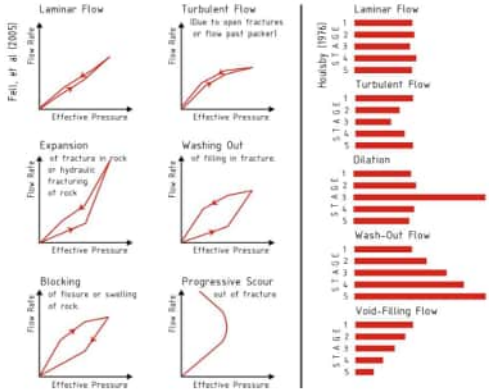
Density of Overburden	2321	kg/m^3
Overburden Load - Dry	22.76	kPa
Overburden Load - Wet	12.95	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
116	10	53.0	0.04	8.83E-05	0.88	2.33E-02	11.78	9.60E-07	9.6	7.9
231	10	49.6	0.04	8.27E-05	0.83	2.06E-02	23.57	4.49E-07	4.5	3.6
347	10	54.0	0.05	9.00E-05	0.90	2.42E-02	35.35	3.26E-07	3.3	2.6
231	10	42.6	0.04	7.10E-05	0.71	1.56E-02	23.57	3.86E-07	3.9	3.1
116	10	34.4	0.03	5.73E-05	0.57	1.05E-02	11.78	6.23E-07	6.2	5.1

Stage	1	2	3	4	5
Test Pressure (kPa)	116	231	347	231	116
Jacking/Dilation Possible	No	No	Yes	No	No
Equivalent Thickness of Rock - Dry (m)	-	-	0.27	-	-
Equivalent Thickness of Rock - Wet (m)	-	-	0.47	-	-

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
5.08E-07	**m/s**
Houlsby Flow Type **Turbulent**	
Calculated Lugeon Values	
3.3	BS5930:1999 Accounts For GW
2.6	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	0
Job No.:	QC1022_018
Packer Model:	Double
Pump Model	Groundwave - Adrian
Gauge Model:	Boart Longyear

Tested By:	Groundwave - Adrian
Test Date:	Monday, 13 May 2024
Calculation By:	CM
Checked By:	0

Borehole:	**TSF_BH_7**
Drilling Rig:	Boart Longyear
Driller:	Groundwave - Adrian

Elevation

Ground Level AHD:	0.00	m

Test Section

Hole Inclination (Angle):	90		degrees
From: (Corrected/Actual)	20.00	20.00	m
To: (Corrected/Actual)	26.00	26.00	m
Centre:	23.00		m
Length of Test Section:	6.00		m

Gauge

Gauge Height above ground:	0.40	m
Height of Water Column at GL:	23.00	m

Groundwater

Depth Below Ground Level:	0.00	0.00	m
Applied Groundwater Level:	0.00		m
Height Above Test Mid Section:	23.00		m

Pipe

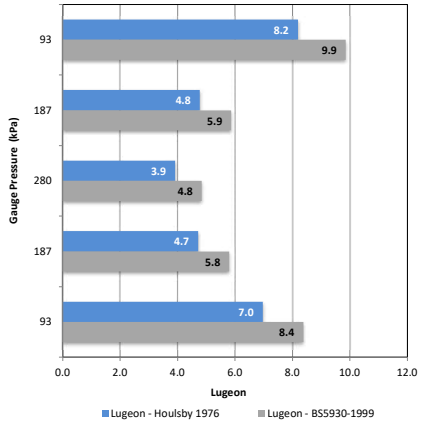
Pipe Radius:	0.025	m
Pipe Length:	20.40	m
Radius of Borehole:	0.048	m

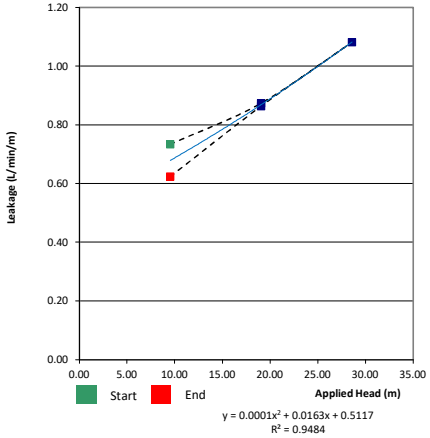
Calculations

Internal Surface Area:	3.20	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Turbulent	Houlsby

Jacking/Dilation Check

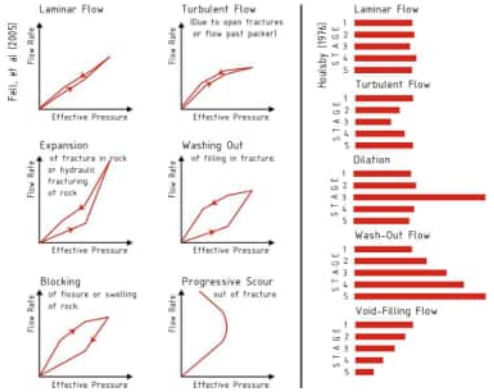
Density of Overburden	2321	kg/m^3
Overburden Load - Dry	22.76	kPa
Overburden Load - Wet	12.95	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
93	10	44.0	0.04	7.33E-05	0.73	1.25E-02	9.53	9.85E-07	9.9	8.2
187	10	52.4	0.04	8.73E-05	0.87	1.73E-02	19.06	5.87E-07	5.9	4.8
280	10	64.9	0.06	1.08E-04	1.08	2.57E-02	28.59	4.84E-07	4.8	3.9
187	10	51.8	0.04	8.63E-05	0.86	1.69E-02	19.06	5.80E-07	5.8	4.7
93	10	37.4	0.03	6.23E-05	0.62	9.25E-03	9.53	8.38E-07	8.4	7.0

Stage	1	2	3	4	5
Test Pressure (kPa)	93	187	280	187	93
Jacking/Dilation Possible	No	No	Yes	No	No
Equivalent Thickness of Rock - Dry (m)	-	-	1.11	-	-
Equivalent Thickness of Rock - Wet (m)	-	-	1.95	-	-

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
6.71E-07	**m/s**
Houlsby Flow Type **Turbulent**	
Calculated Lugeon Values	
4.8	BS5930:1999 Accounts For GW
3.9	Houlsby Excludes GW

Water Pressure (Packer) Test - Calculations

Client:	29 Metals
Project:	TSF3
Location:	UEDD
Job No.:	QC1022_018
Packer Model:	Single
Pump Model	3.5kW Flexi,
Gauge Model:	,

Tested By:	CM
Test Date:	Monday, 29 April 2024
Calculation By:	CM
Checked By:	0

Borehole:	**TSF_BH_12**
Drilling Rig:	Boart Longyear
Driller:	Nigel

Elevation

Ground Level AHD:	0.00	m

Test Section

Hole Inclination (Angle):	90		degrees
From: (Corrected/Actual)	53.00	9.00	m
To: (Corrected/Actual)	15.20	15.20	m
Centre:	34.10		m
Length of Test Section:	37.80		m

Gauge

Gauge Height above ground:	1.00	m
Height of Water Column at GL:	34.10	m

Groundwater

Depth Below Ground Level:	0.00	0.00	m
Applied Groundwater Level:	0.00		m
Height Above Test Mid Section:	34.10		m

Pipe

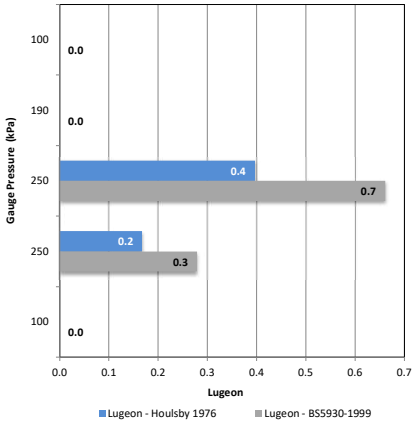
Pipe Radius:	0.025	m
Pipe Length:	54.00	m
Radius of Borehole:	0.048	m

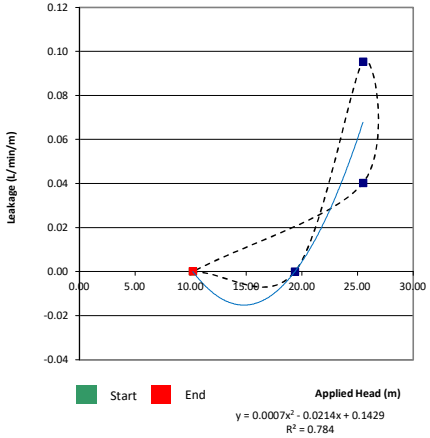
Calculations

Internal Surface Area:	8.48	m^2
Pipe Orifice Area:	0.0020	m^2
C:	130	Constant
Conversion Method:	BS5930	Reference
Lugeon Equivalent:	1.00E-07	m/s
Flow Type:	Turbulent	Houlsby

Jacking/Dilation Check

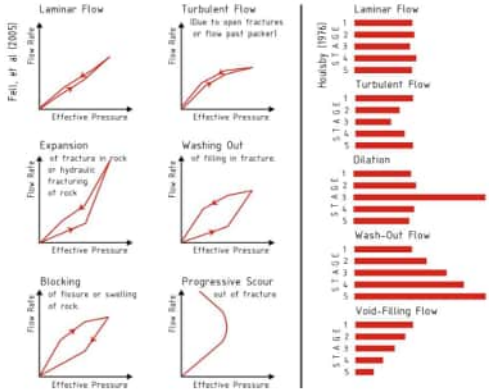
Density of Overburden	25	kg/m^3
Overburden Load - Dry	0.25	kPa
Overburden Load - Wet	-9.56	kPa





Theoretical Flow Patterns (Lugeons)

Fell et al (2005) **Houlsby (1976)**



Gauge Pressure (kPa)	Test duration (min)	Water Loss (litres)	Flow Velocity (m/s)	Flow (Q) (m^3/sec)	Leakage (L/min/m)	Friction Loss (kPa) Hazen-Williams	Total Applied Head (H_T)	Permeability (k) BS5930:1999	Lugeons BS5930:1999	Lugeons Houlsby (1976)
100	10	0.0	0.00	0.00E+00	0.00	0.00E+00	10.20	0.00E+00	0.0	0.0
190	10	0.0	0.00	0.00E+00	0.00	0.00E+00	19.37	0.00E+00	0.0	0.0
250	10	36.0	0.03	6.00E-05	0.10	2.28E-02	25.49	6.61E-08	0.7	0.4
250	10	15.2	0.01	2.53E-05	0.04	4.63E-03	25.49	2.79E-08	0.3	0.2
100	10	0.0	0.00	0.00E+00	0.00	0.00E+00	10.20	0.00E+00	0.0	0.0

Stage	1	2	3	4	5
Test Pressure (kPa)	100	190	250	250	100
Jacking/Dilation Possible	Yes	Yes	Yes	Yes	Yes
Equivalent Thickness of Rock - Dry (m)	2514.89	2881.98	3126.72	3126.72	2514.89
Equivalent Thickness of Rock - Wet (m)	-64.48	-73.90	-80.17	-80.17	-64.48

Permeability Results

Rock Mass Permeability (BS5930:1999) (Geometric Mean)	
#NUM!	**m/s**
Houlsby Flow Type **Turbulent**	
Calculated Lugeon Values	
0.7	BS5930:1999 Accounts For GW
0.4	Houlsby Excludes GW

APPENDIX D: GEOPHYSICAL LOGS

BOREHOLE ATV REPORT

BOREHOLE NO. TSF_BH_07

CONSULTANT:	**GROUNDWAVE**	DATE COMMENCED:	**13/05/24**
CLIENT:	**29 METALS**	DATE COMPLETED:	**14/05/24**
PROJECT:	**TSF3 GI SUPPORT**	RECORDED BY:	
LOCATION:	**PROPOSED TSF3 SITE**	LOG CHECKED BY:	
PROJECT NUMBER:	**QC1022_018**		

COORDINATES:	**E 327, 995 N 7, 820, 385**	DEPTH OF TEST (m):	**3.52**
REDUCED LEVEL (mAHD):	**279.76**	DEPTH OF BOREHOLE (m):	**24.5**
INCLINATION:	**60**	DIAMETER OF BOREHOLE (mm):	**96**
		TYPE OF CASING (mm):	
		GROUNDWATER LEVEL (m):	

LITHOLOGY

CORE LOSS | QUARTZITE | FILL

STRUCTURES

BEDDING / BANDING / FOLIATION

MAJOR OPEN JOINT / FRACTURE

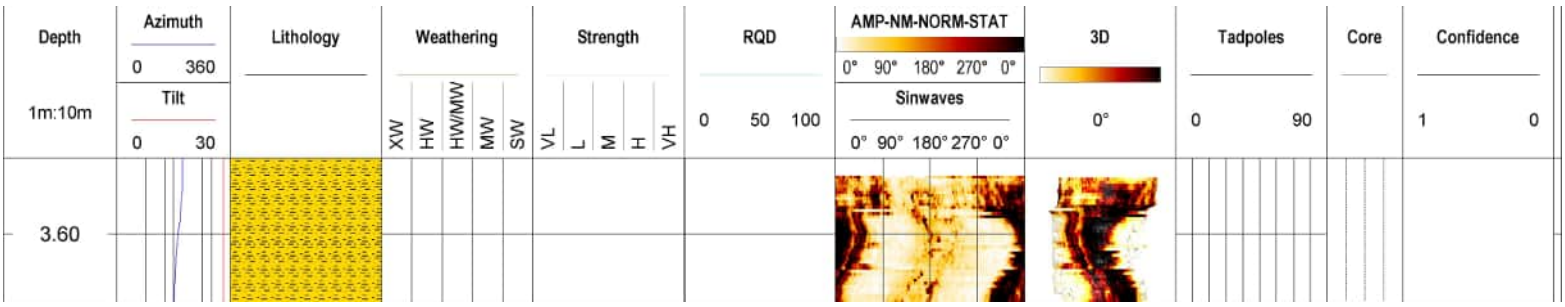
MINOR OPEN JOINT / FRACTURE

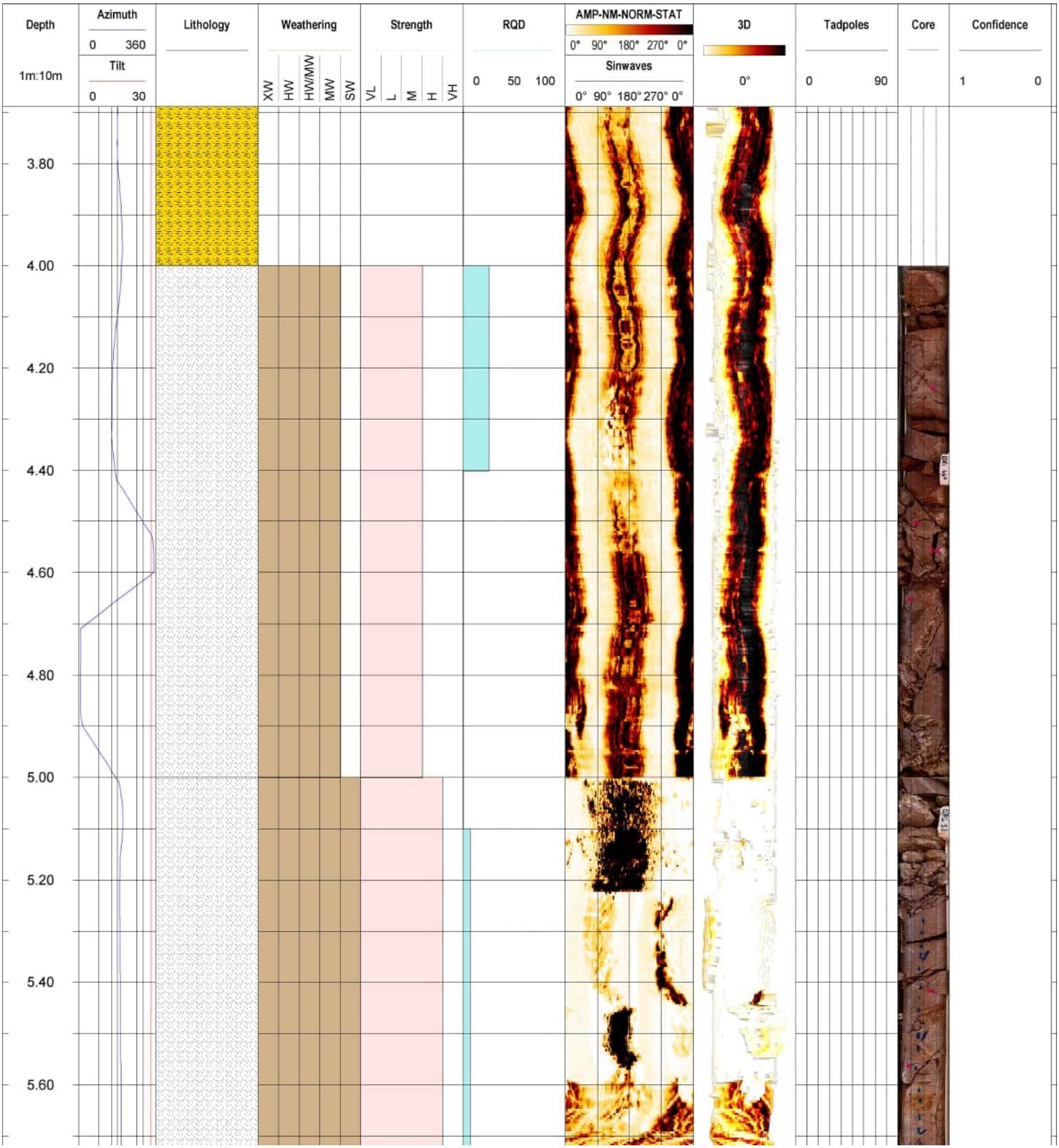
TIGHT JOINT

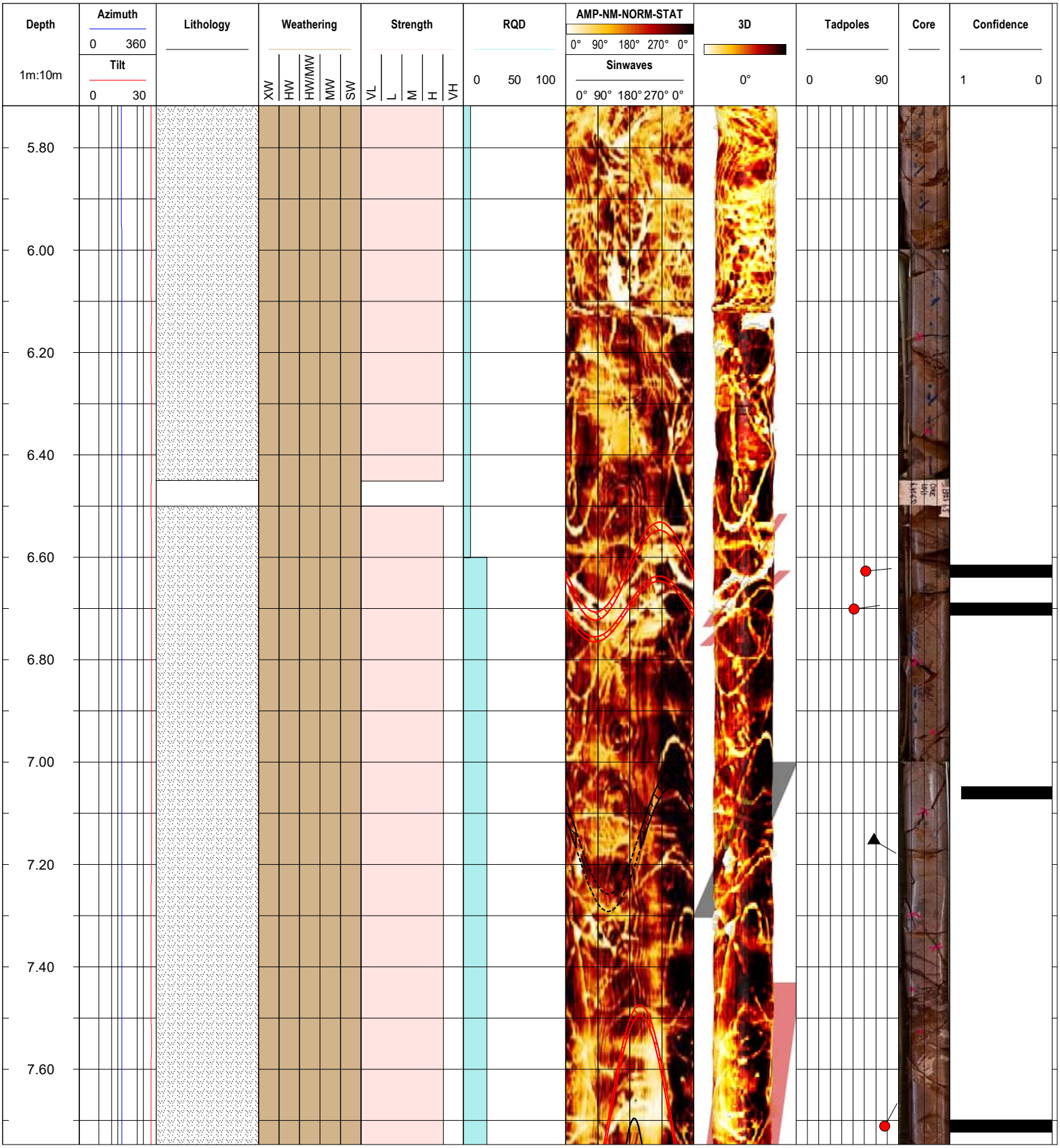
TIGHT JOINT (POTENTIALLY INCIPIENT AT OUTCROP)

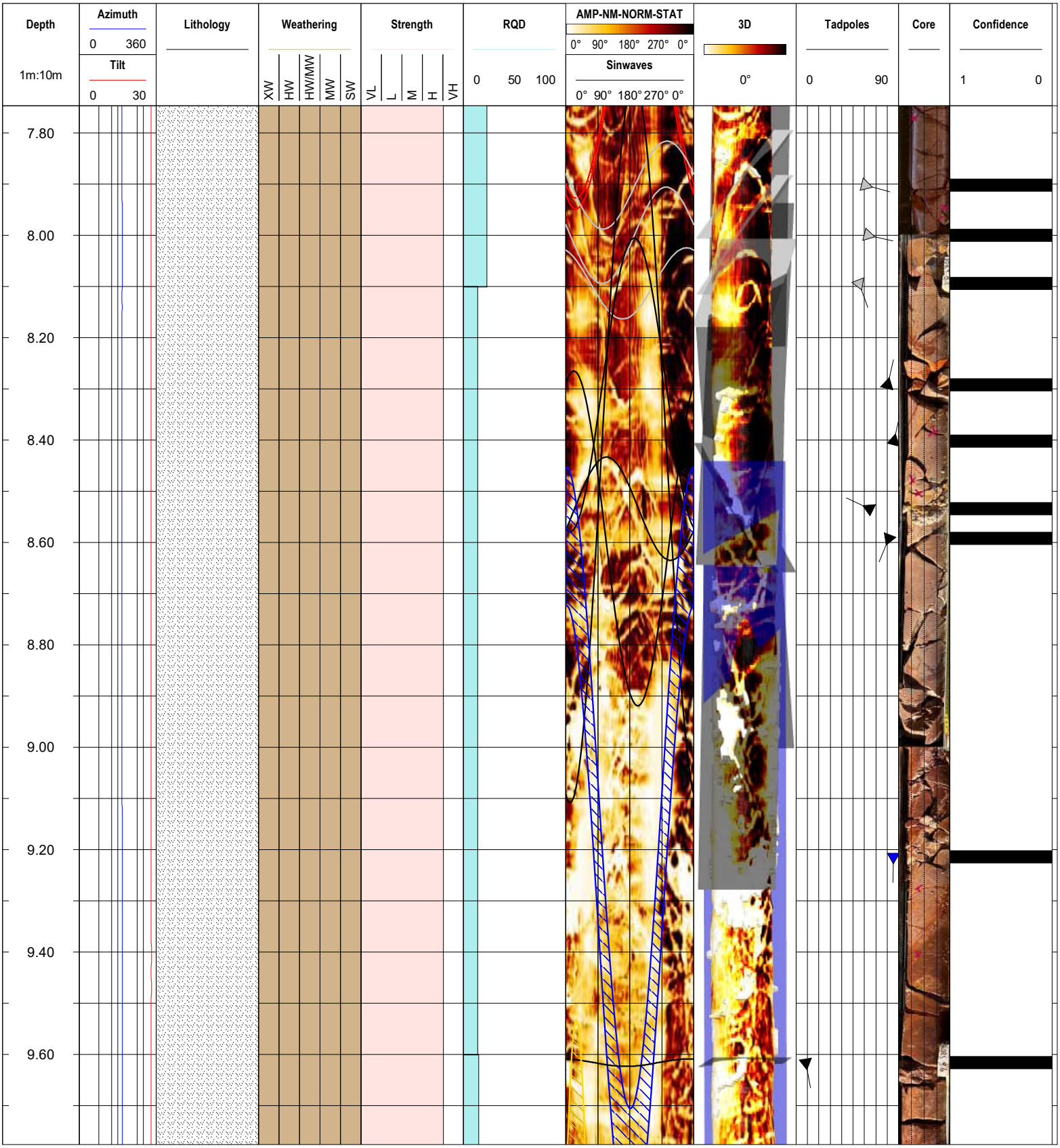
VEIN

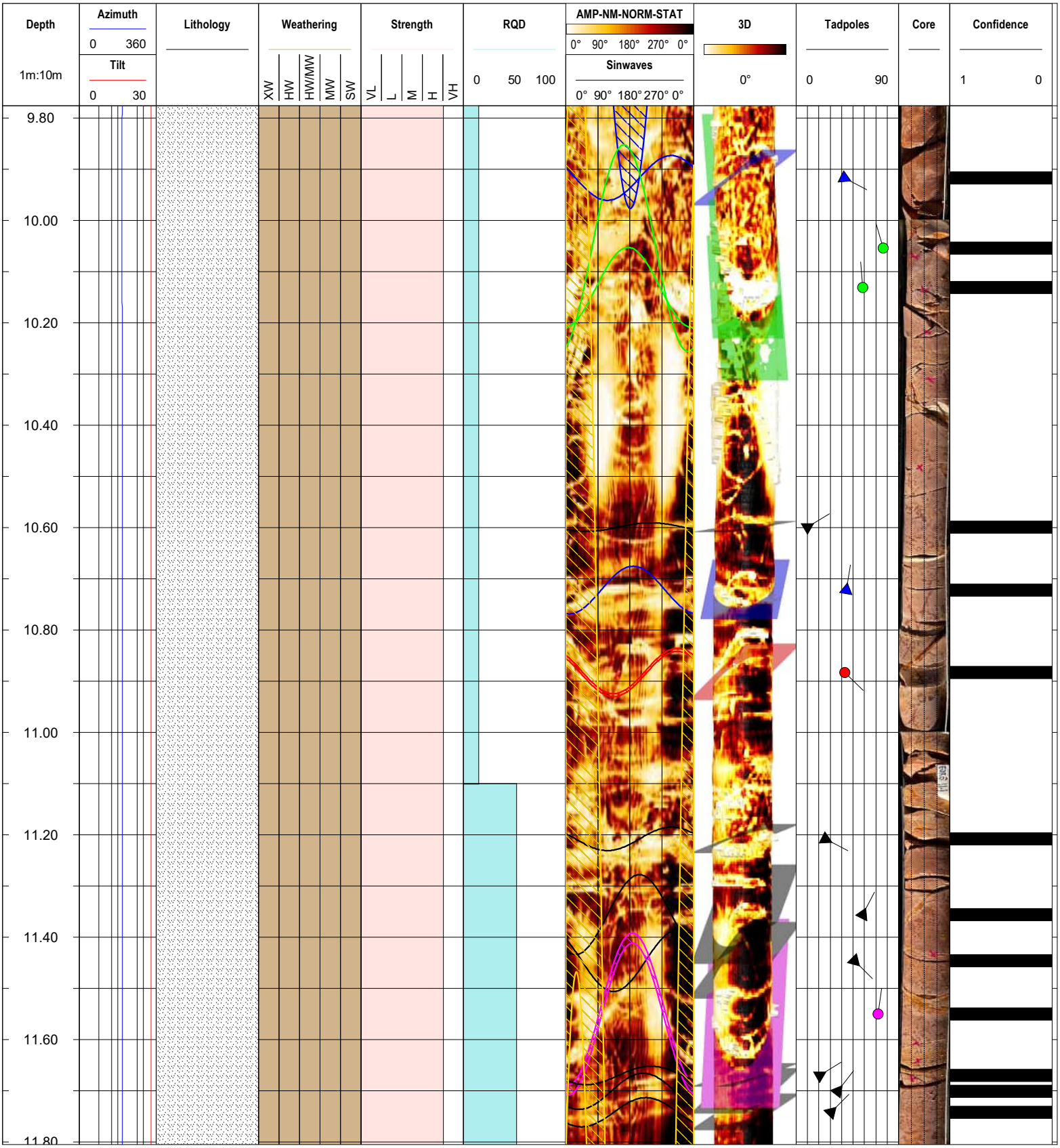
SHEAR ZONE

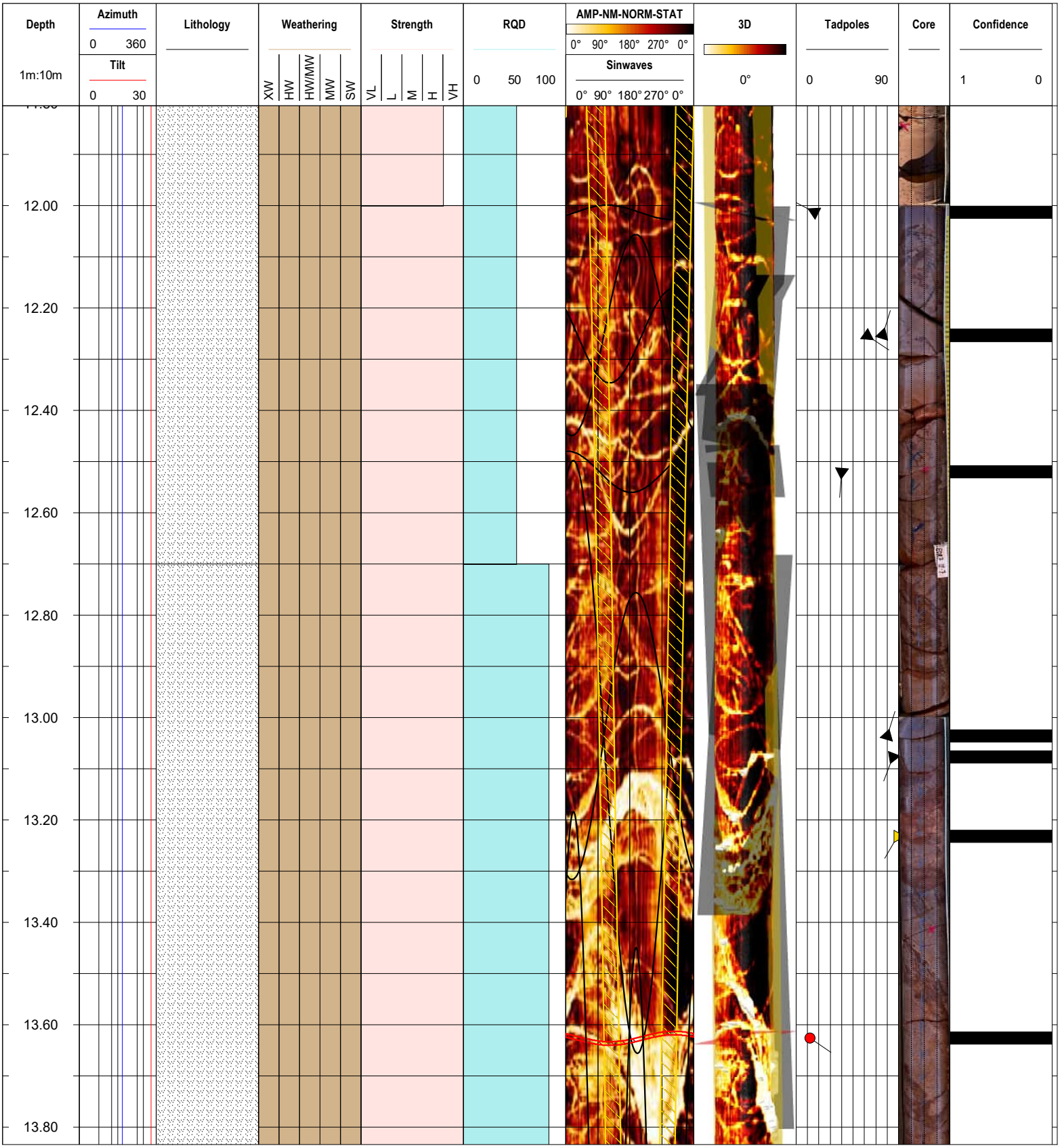


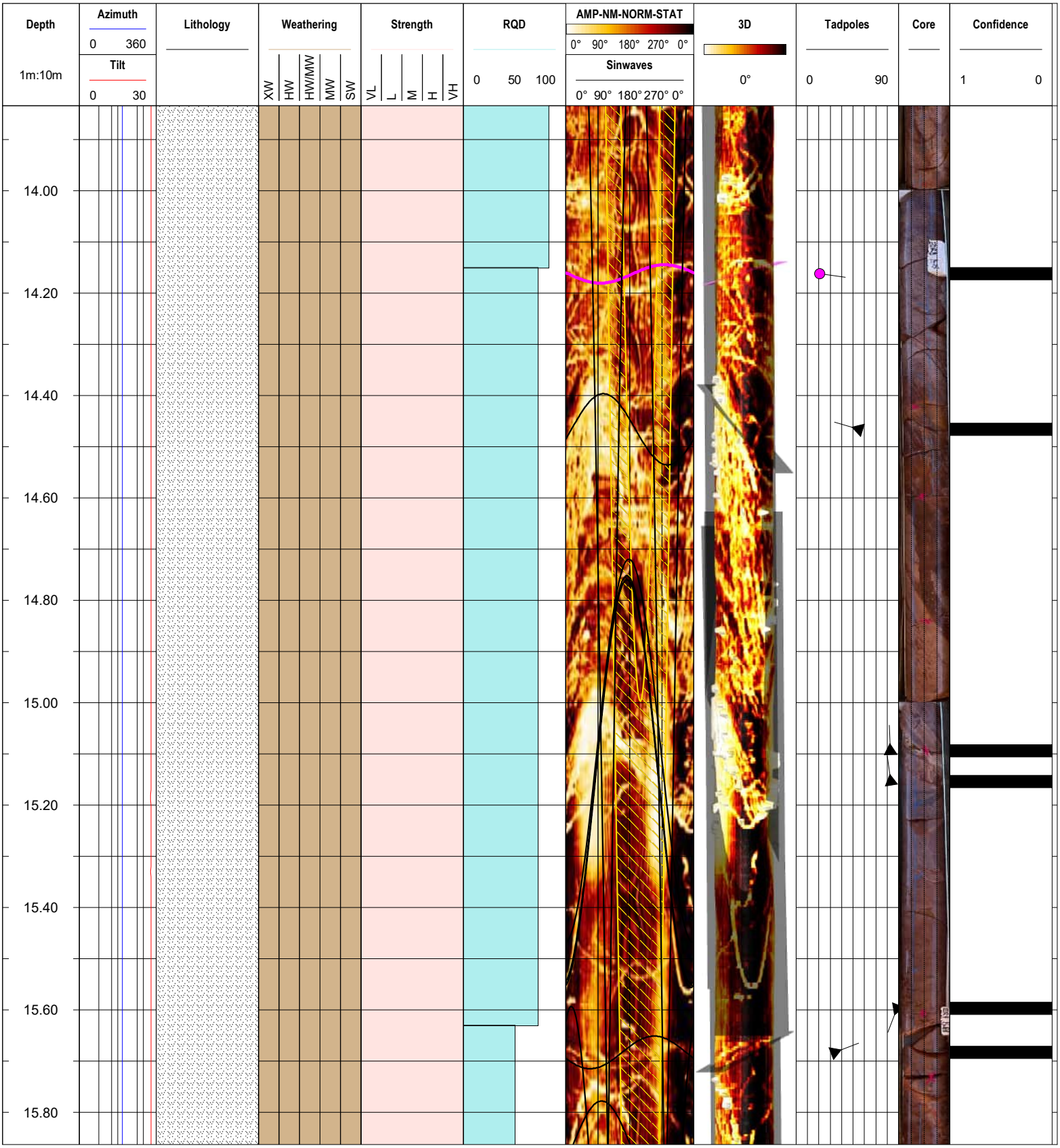

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Azimuth
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Tilt
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Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
H
VH
RQD
0 50 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
0°
Tadpoles
0 90
Core
Confidence
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4.80
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5.60

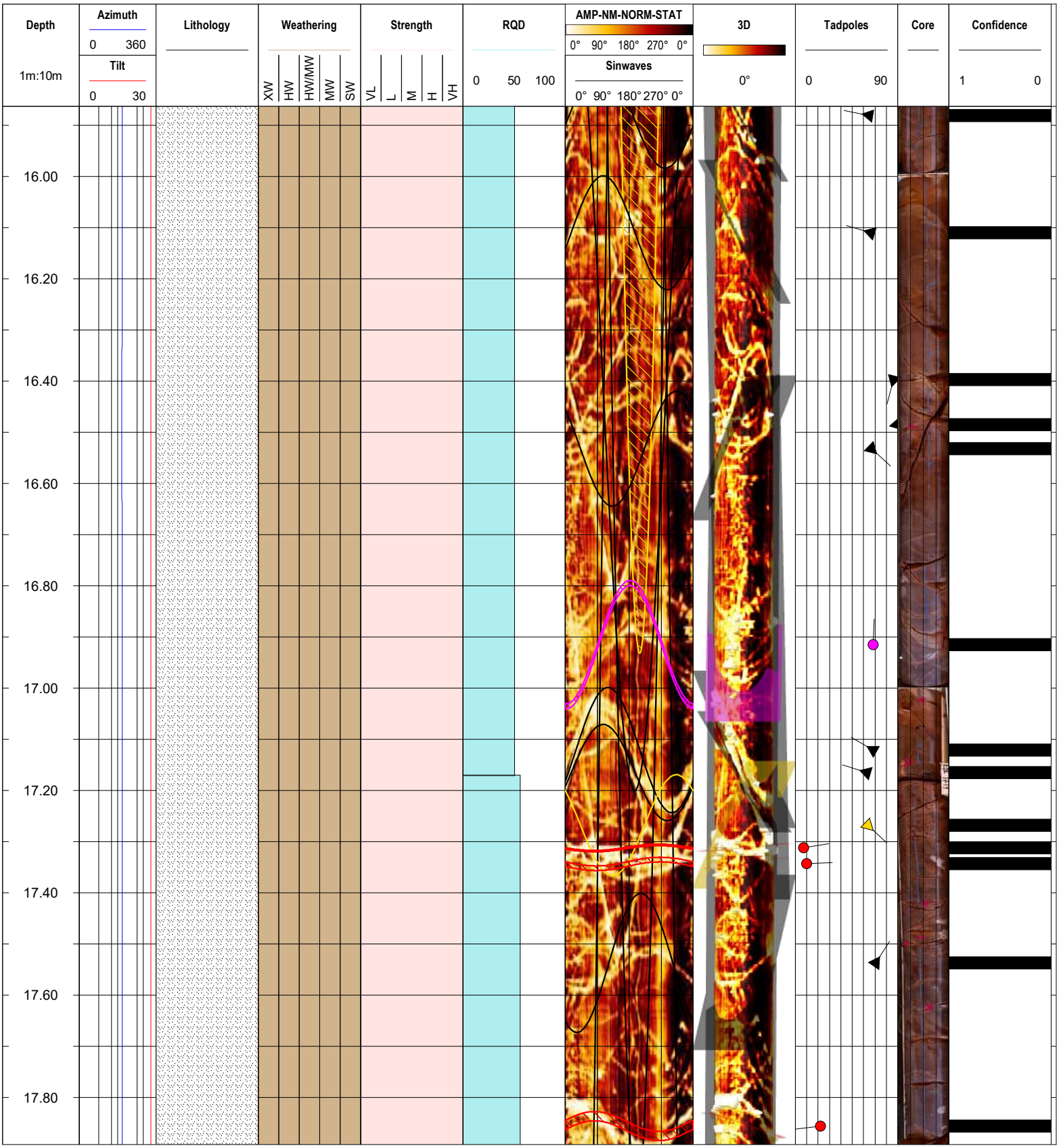

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Tilt
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Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
H
VH
RQD
0
50
100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
0°
Tadpoles
0
90
Core
Confidence
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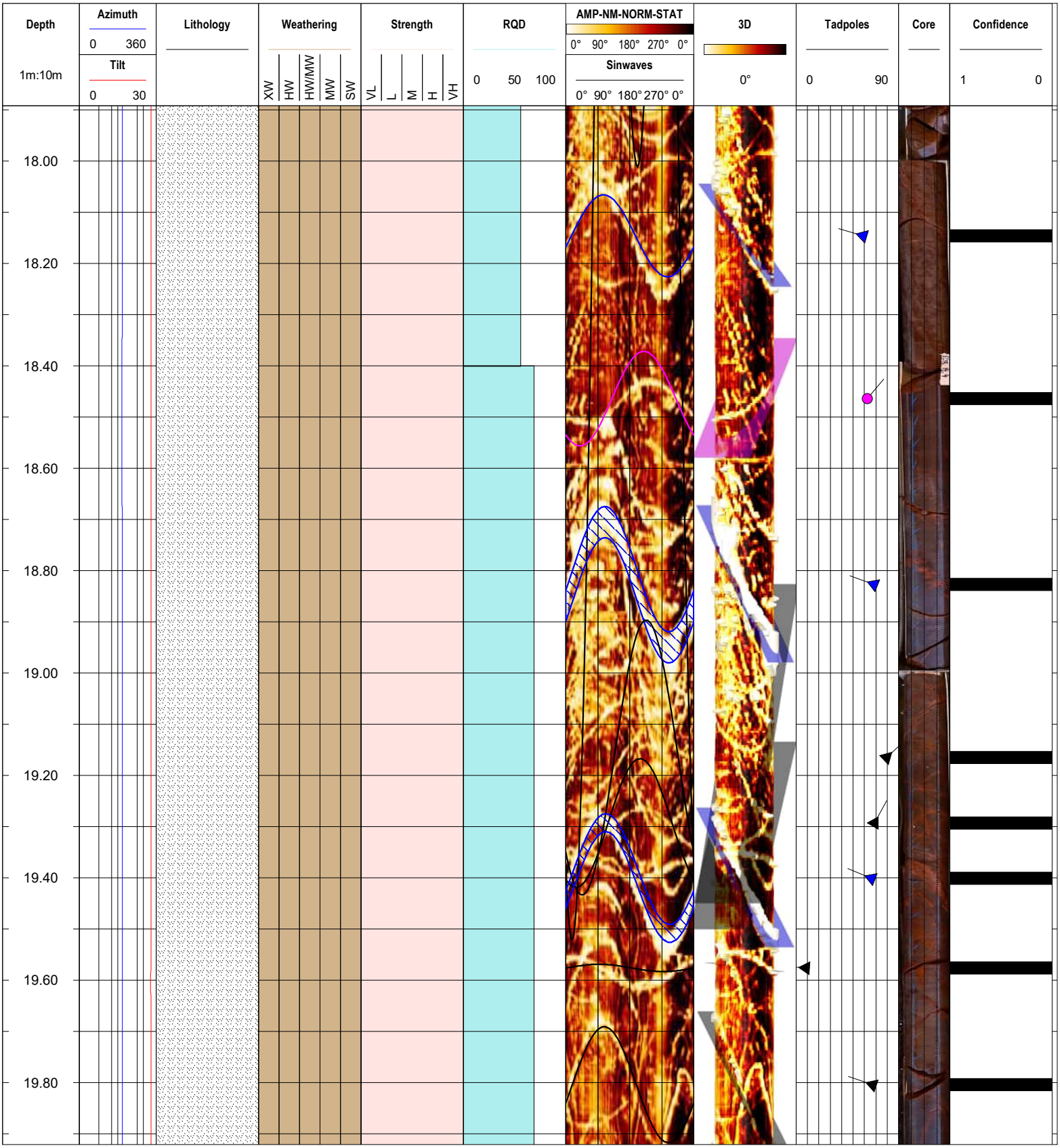

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Azimuth
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Tilt
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Lithology
Weathering
XW HW HW/MW MW SW
Strength
VL L M H VH
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0 50 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
0°
Tadpoles
0 90
Core
Confidence
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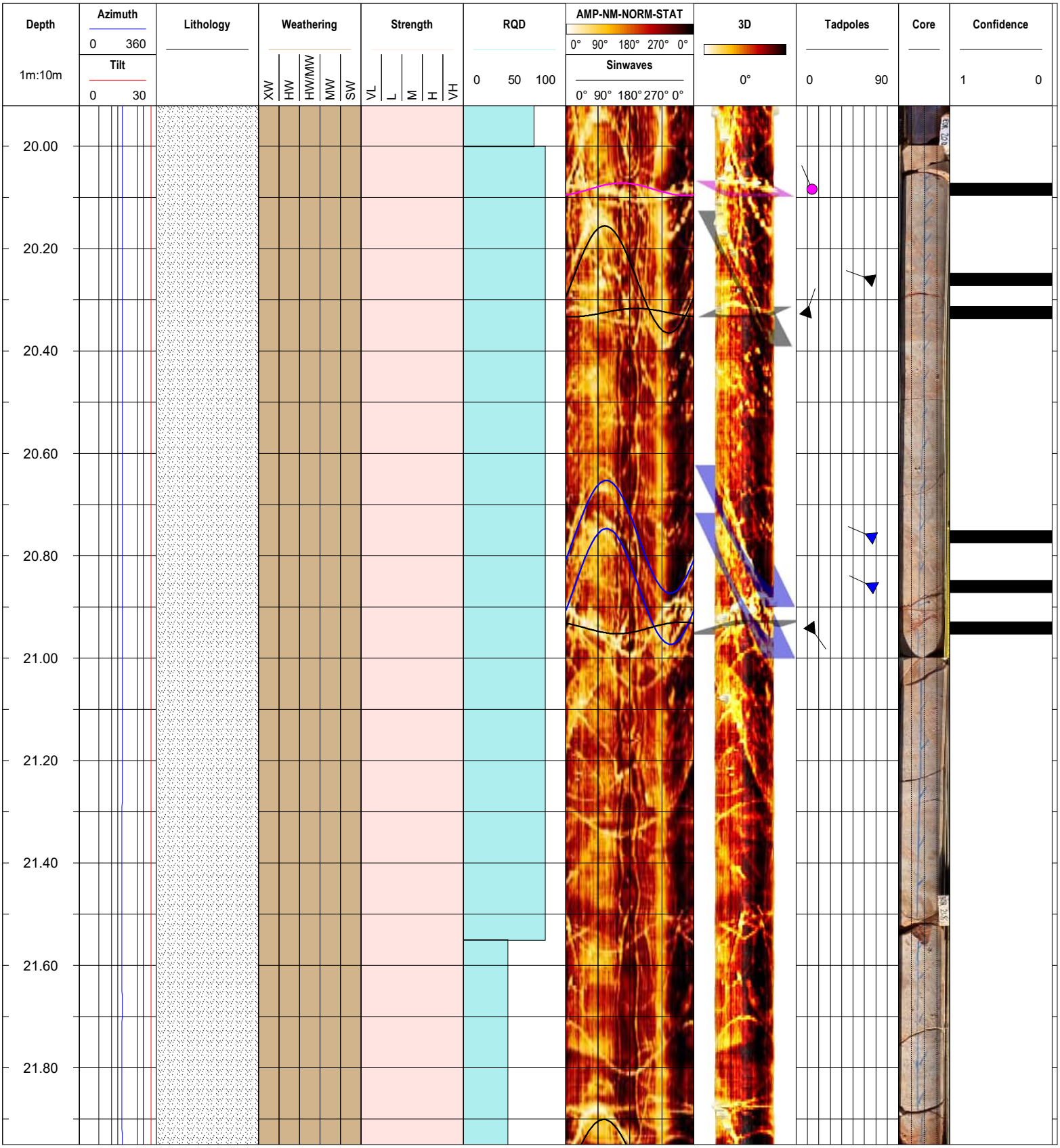

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Strength
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M
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VH
RQD
0 50 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
0°
Tadpoles
0 90
Core
Confidence
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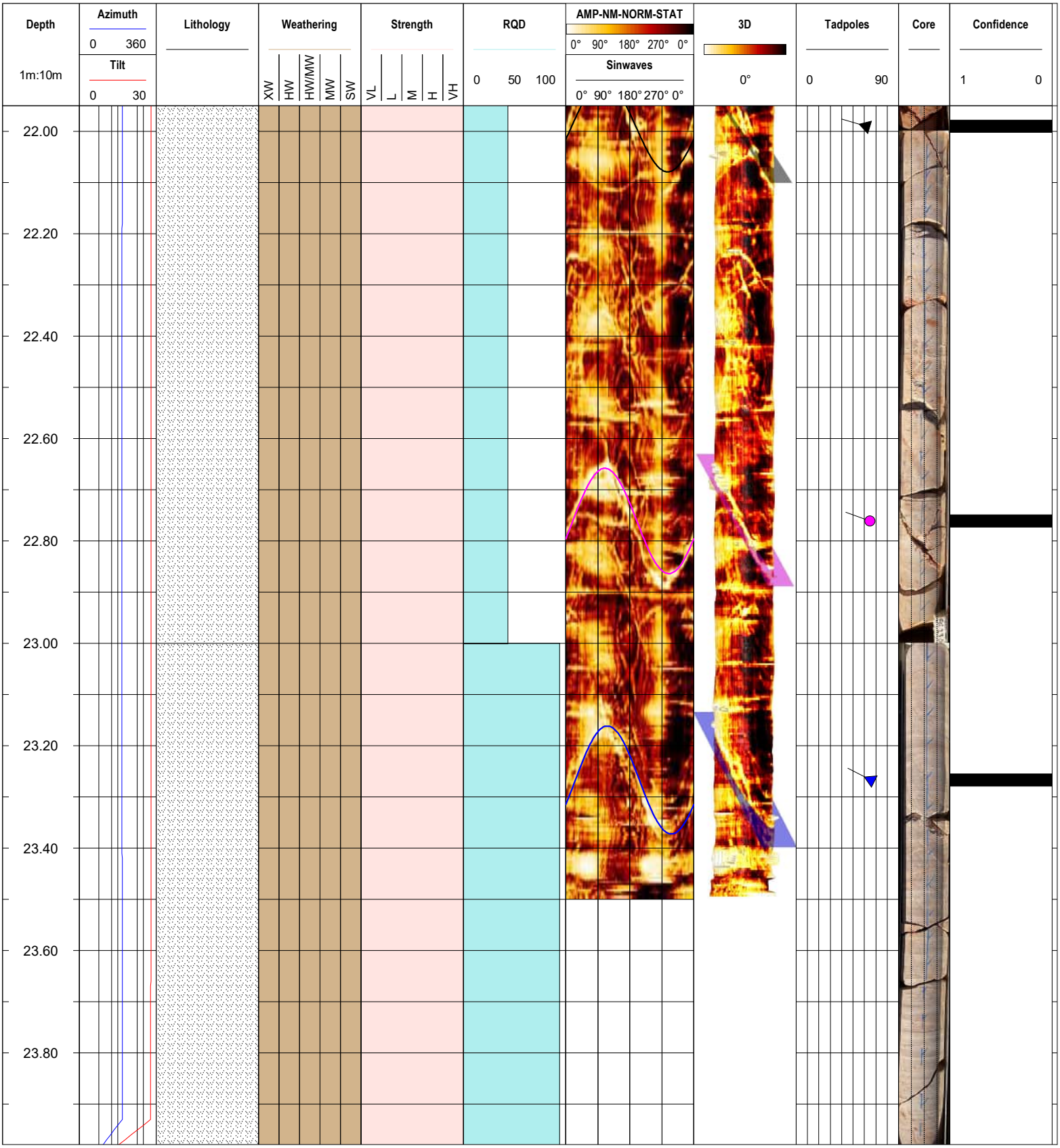

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Weathering
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HW/MW
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VL
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M
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VH
RQD
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AMP-NM-NORM-STAT
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Sinwaves
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3D
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Tadpoles
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90
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13.80

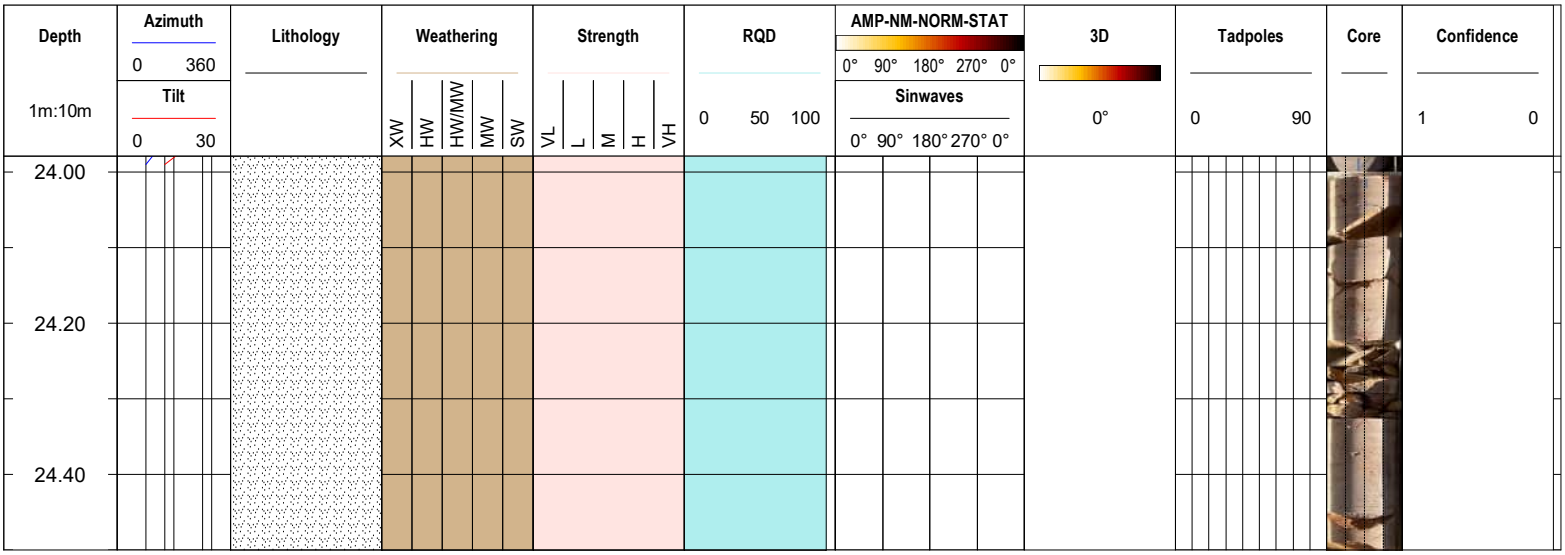

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Azimuth
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Tilt
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Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
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L
M
H
VH
RQD
0 50 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
0°
Tadpoles
0 90
Core
Confidence
1 0
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14.60
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15.00
15.20
15.40
15.60
15.80


Depth
1m:10m
Azimuth
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360
Tilt
0
30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
H
VH
RQD
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100
AMP-NM-NORM-STAT
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Sinwaves
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3D
0°
Tadpoles
0
90
Core
Confidence
1
0
16.00
16.20
16.40
16.60
16.80
17.00
17.20
17.40
17.60
17.80


Depth
1m:10m
Azimuth
0 360
Tilt
0 30
Lithology
Weathering
XW HW HW/MW MW SW
Strength
VL L M H VH
RQD
0 50 100
AMP-NM-NORM-STAT
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Sinwaves
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3D
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Tadpoles
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Core
Confidence
1 0
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18.20
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19.00
19.20
19.40
19.60
19.80


Depth
1m:10m
Azimuth
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Tilt
0 30
Lithology
Weathering
XW HW HW/MW MW SW
Strength
VL L M H VH
RQD
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AMP-NM-NORM-STAT
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Sinwaves
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3D
0°
Tadpoles
0 90
Core
Confidence
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21.00
21.20
21.40
21.60
21.80


Depth
1m:10m
Azimuth
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Tilt
0 30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
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VH
RQD
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AMP-NM-NORM-STAT
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3D
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Tadpoles
0 90
Core
Confidence
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22.20
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23.00
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23.40
23.60
23.80


Depth
1m:10m
Azimuth
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360
Tilt
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30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
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VH
RQD
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100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
0°
Tadpoles
0
90
Core
Confidence
1
0
24.00
24.20
24.40

BOREHOLE ATV REPORT

BOREHOLE NO. TSF_BH_08

CONSULTANT:	**GROUNDWAVE**	DATE COMMENCED:	**16/05/24**
CLIENT:	**29 METALS**	DATE COMPLETED:	**18/05/24**
PROJECT:	**TSF3 GI SUPPORT**	RECORDED BY:	
LOCATION:	**PROPOSED TSF3 SITE**	LOG CHECKED BY:	
PROJECT NUMBER:	**QC1022_018**		

COORDINATES:	**E 328, 032 N 7, 820, 370**	DEPTH OF TEST (m):	**5.04**
REDUCED LEVEL (mAHD):	**268.45**	DEPTH OF BOREHOLE (m):	**23.8**
INCLINATION:	**60**	DIAMETER OF BOREHOLE (mm):	**96**
		TYPE OF CASING (mm):	
		GROUNDWATER LEVEL (m):	

LITHOLOGY

QUARTZITE FILL

STRUCTURES

BEDDING / BANDING / FOLIATION

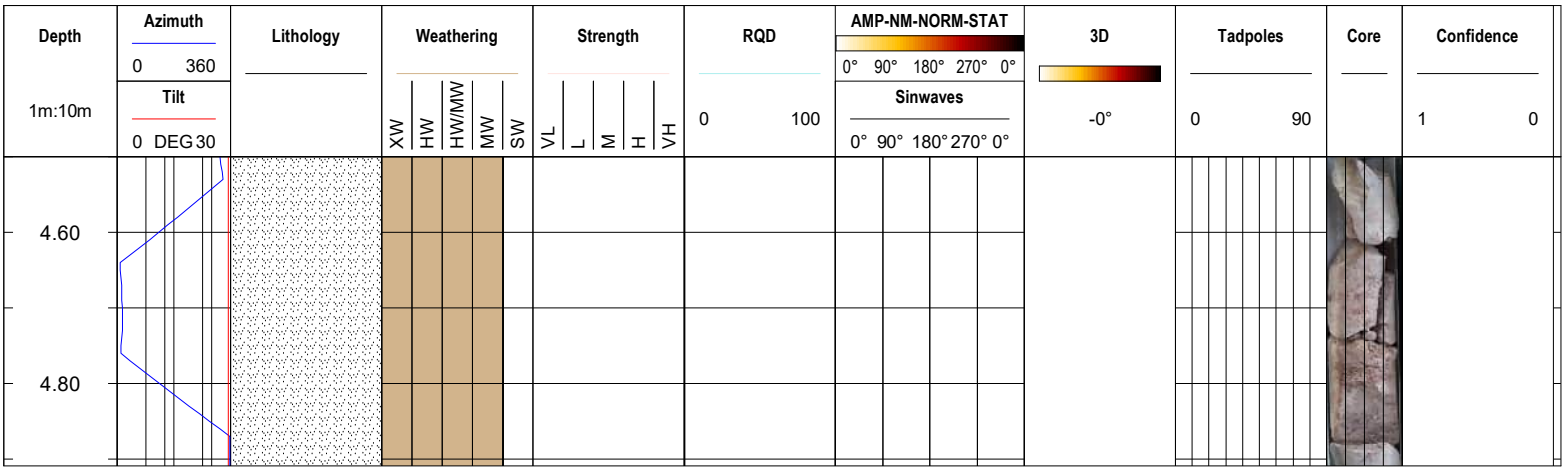
MAJOR OPEN JOINT / FRACTURE

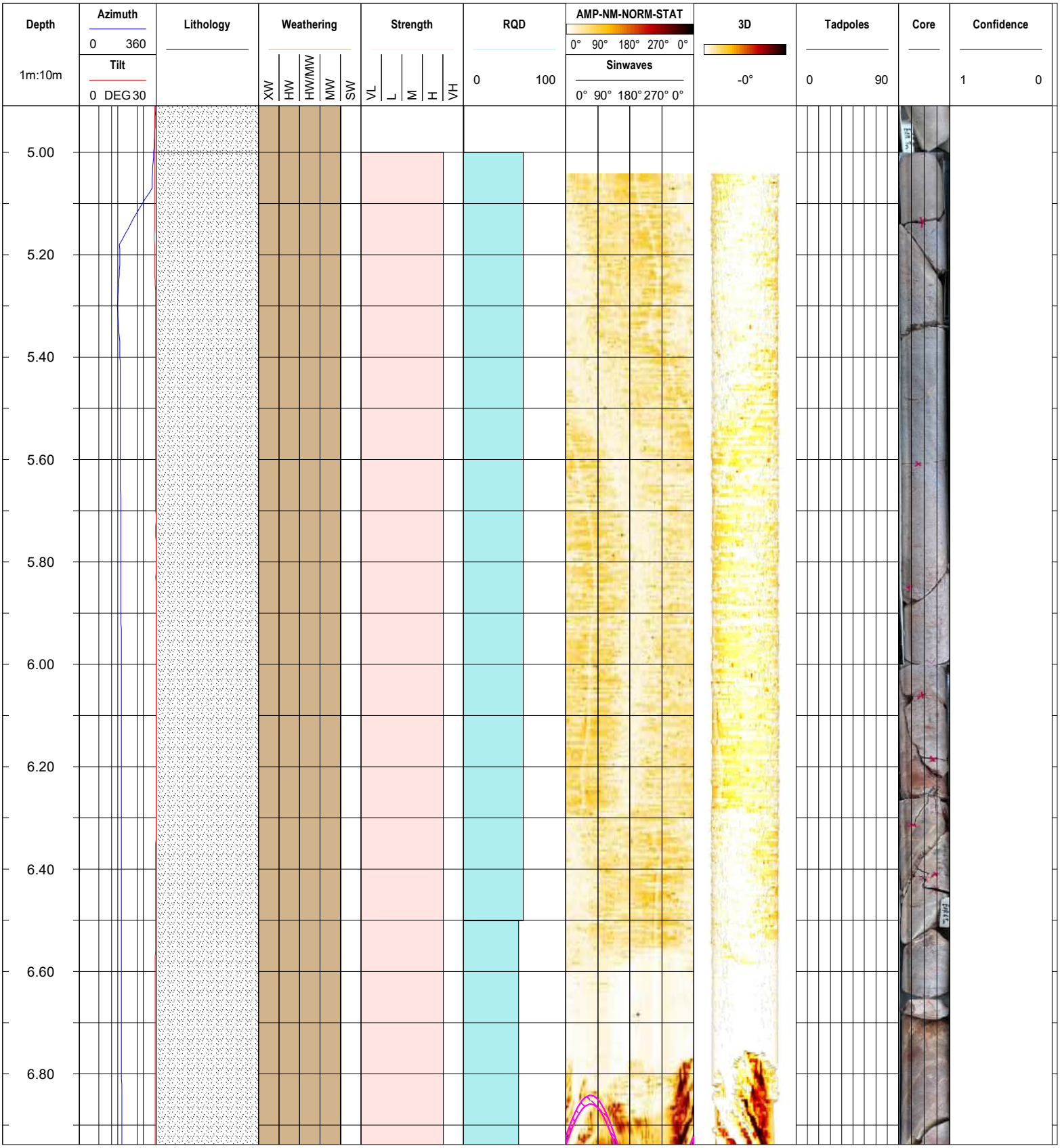
MINOR OPEN JOINT / FRACTURE

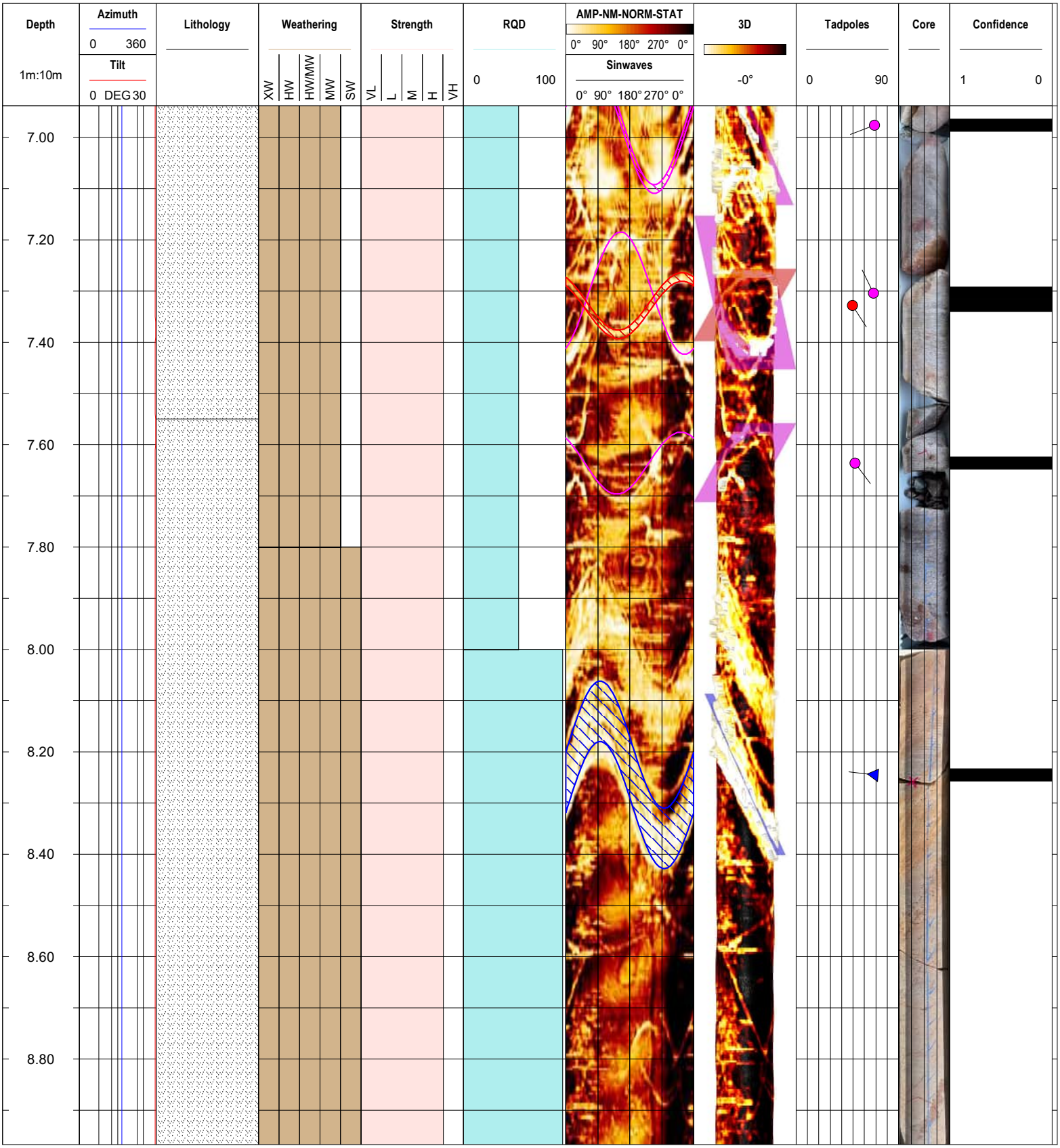
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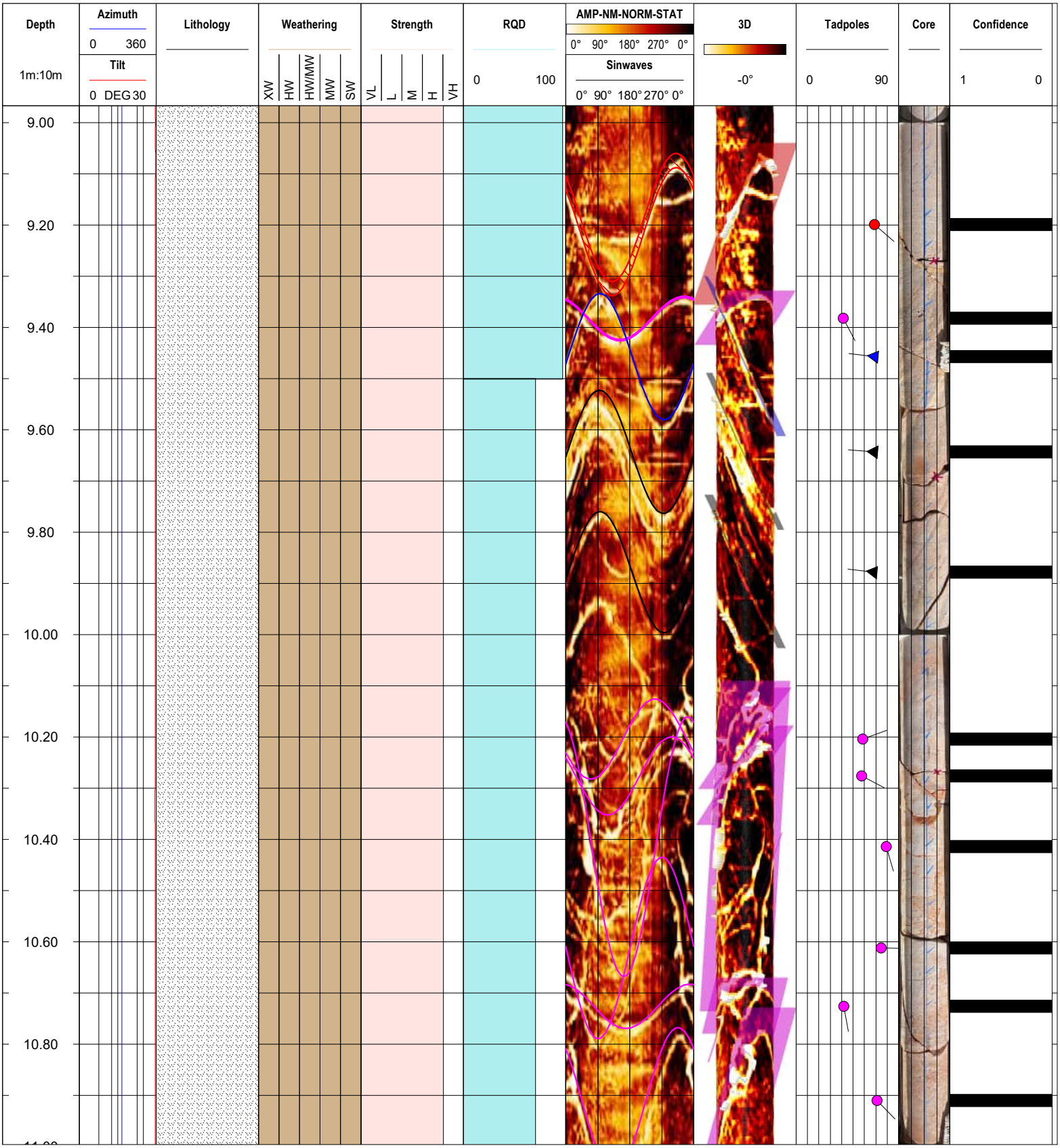
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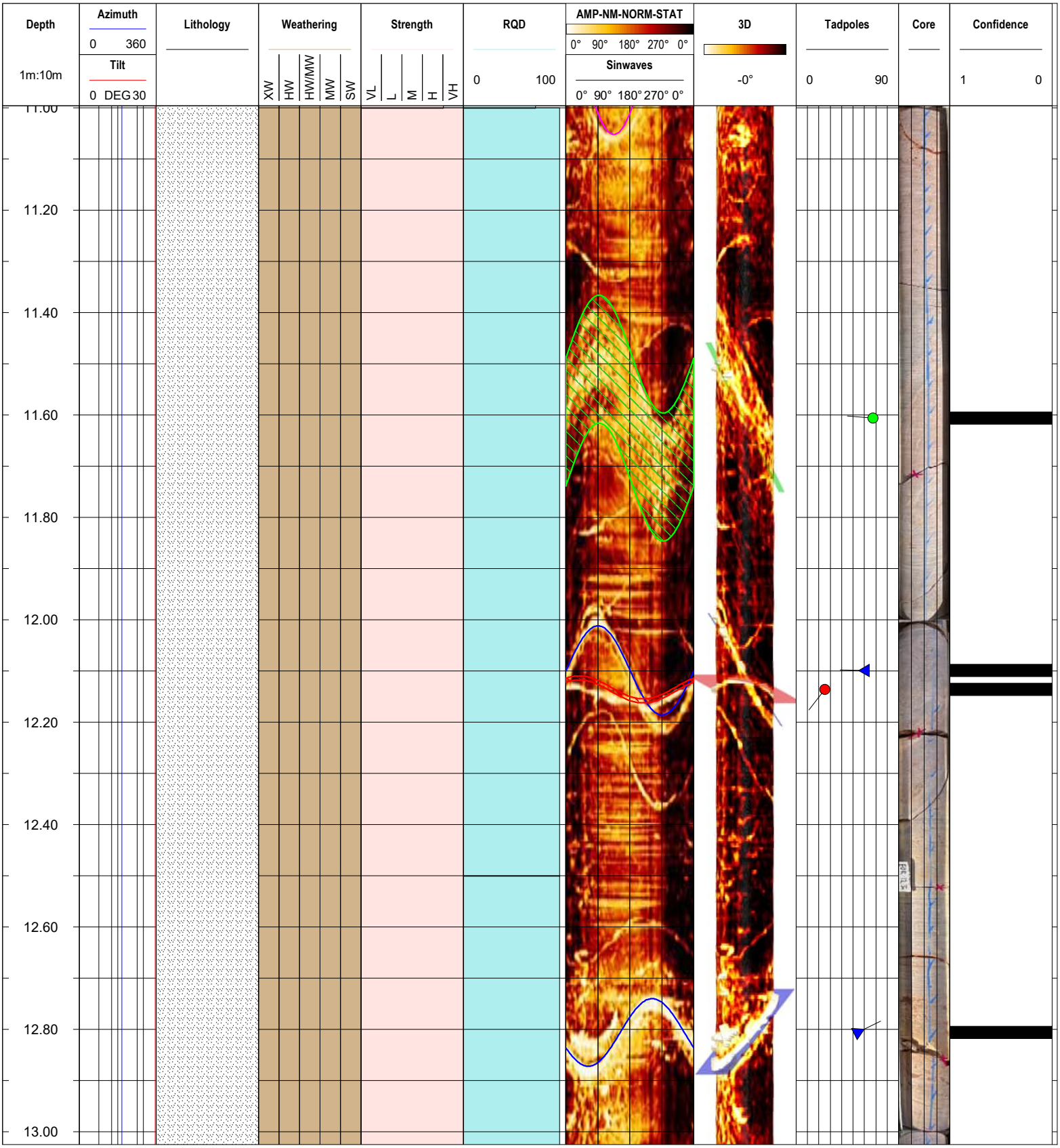
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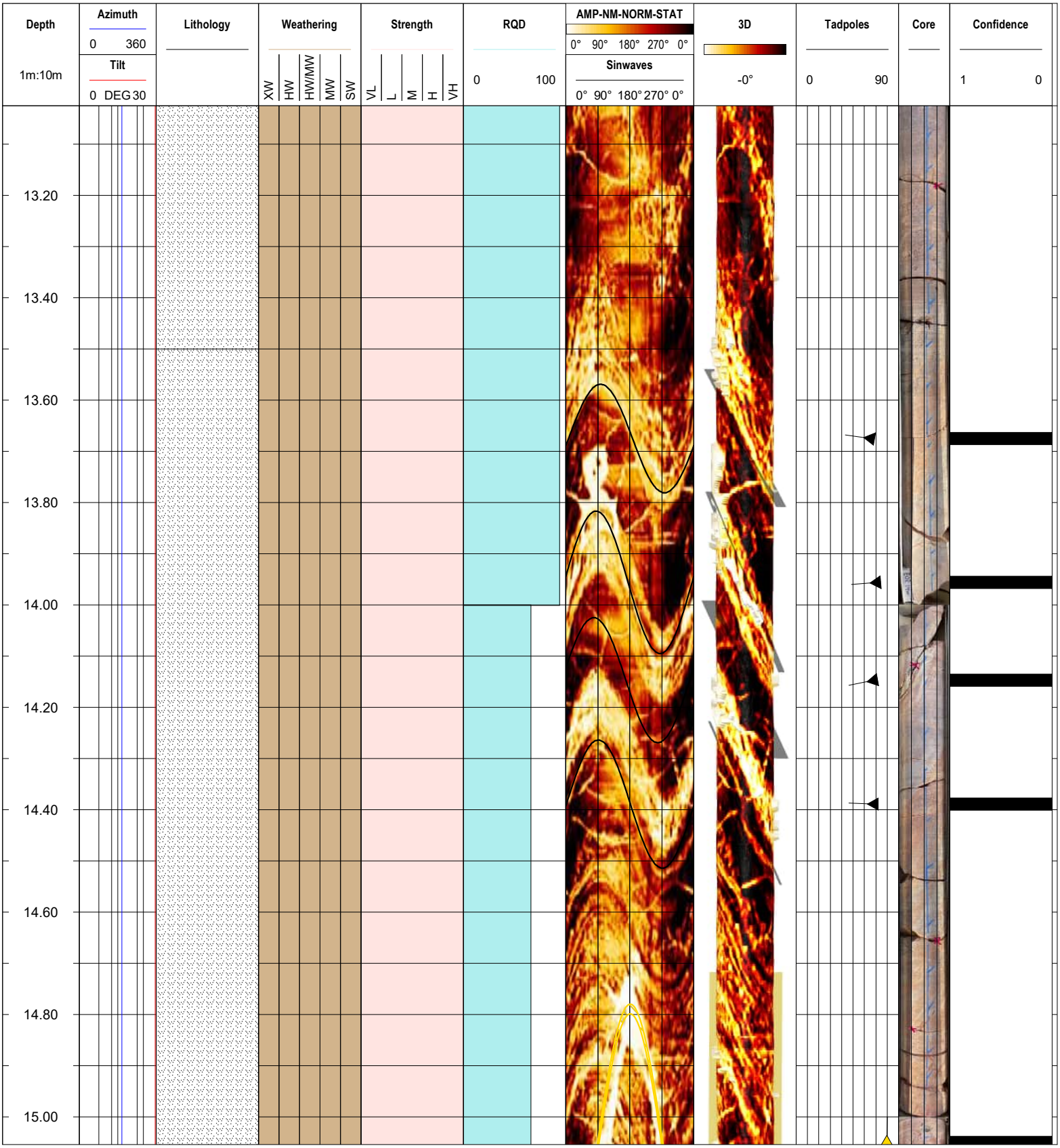


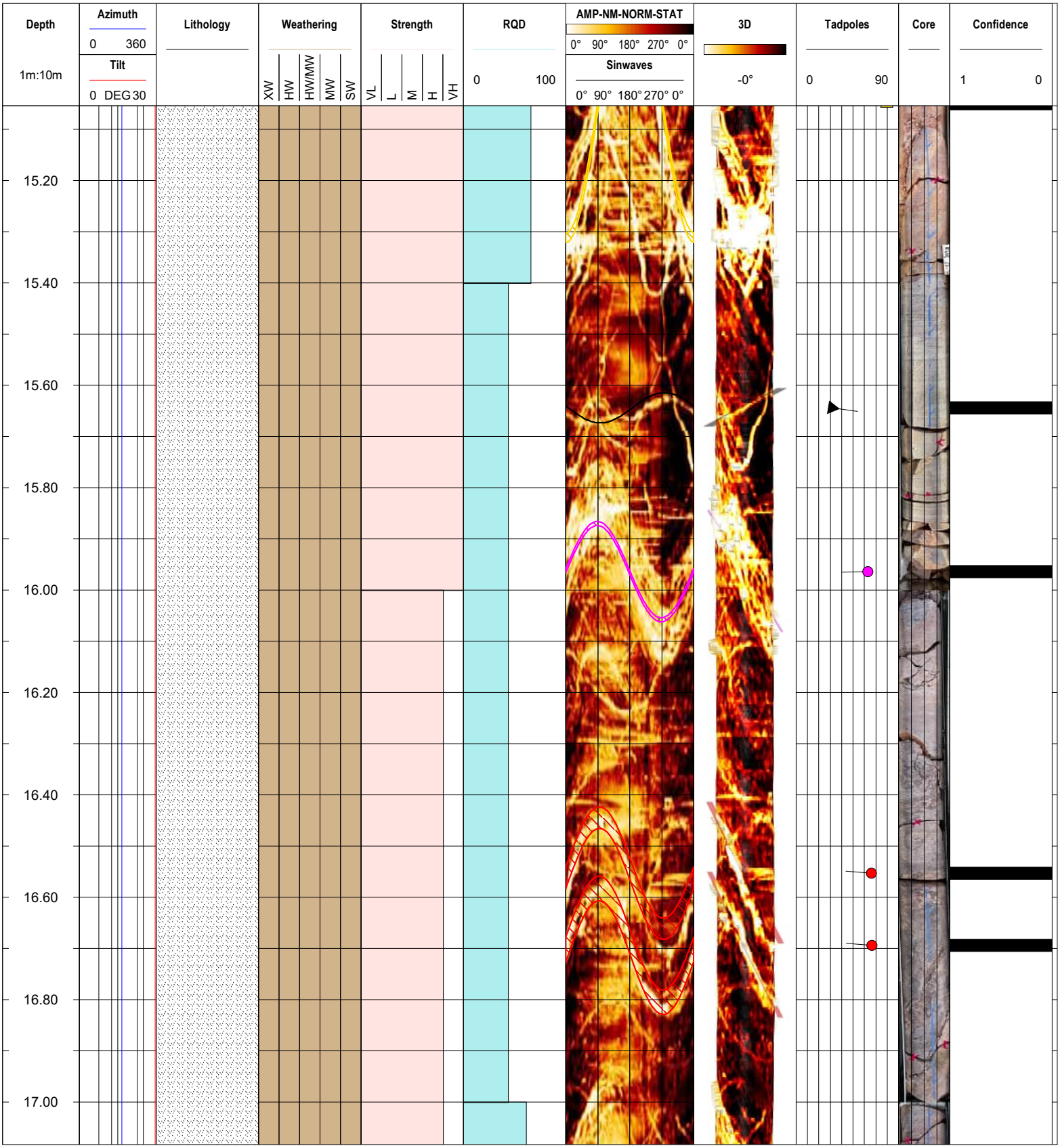

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1m:10m
Azimuth
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Tilt
0 DEG 30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
H
VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
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6.00
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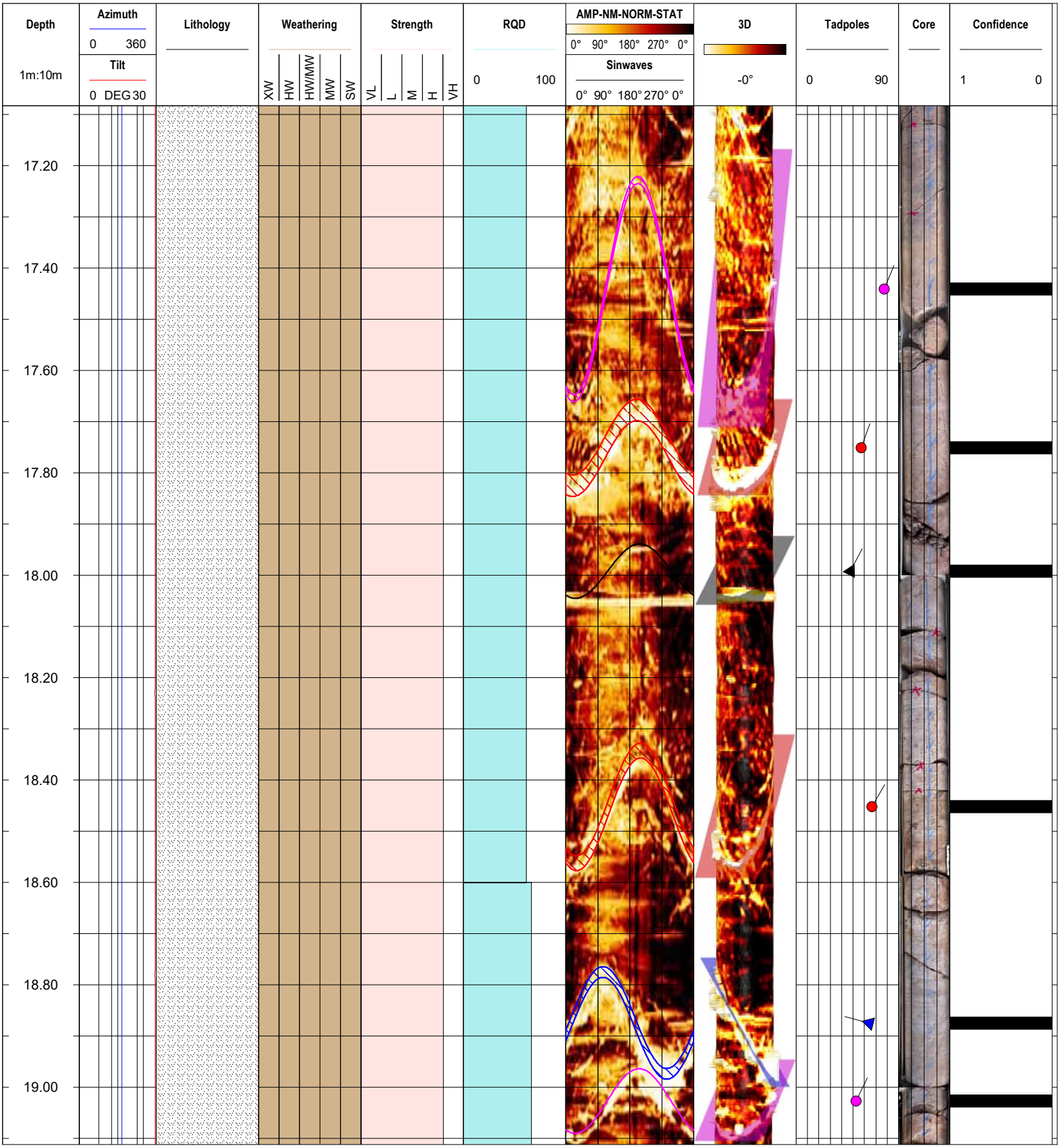

Depth
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Weathering
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HW/MW
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Strength
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L
M
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VH
RQD
0 100
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Tadpoles
0 90
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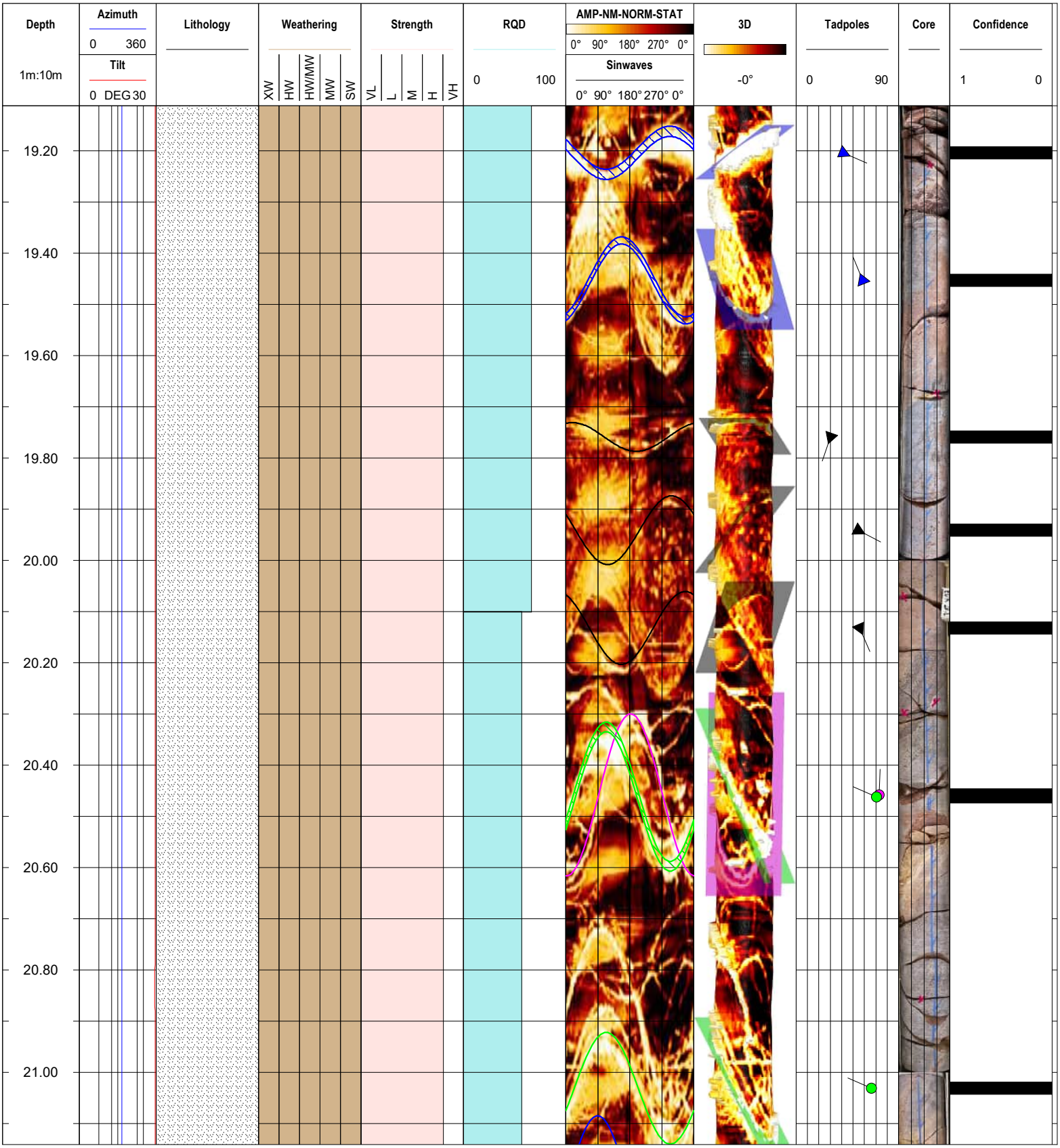

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Weathering
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VH
RQD
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AMP-NM-NORM-STAT
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3D
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Tadpoles
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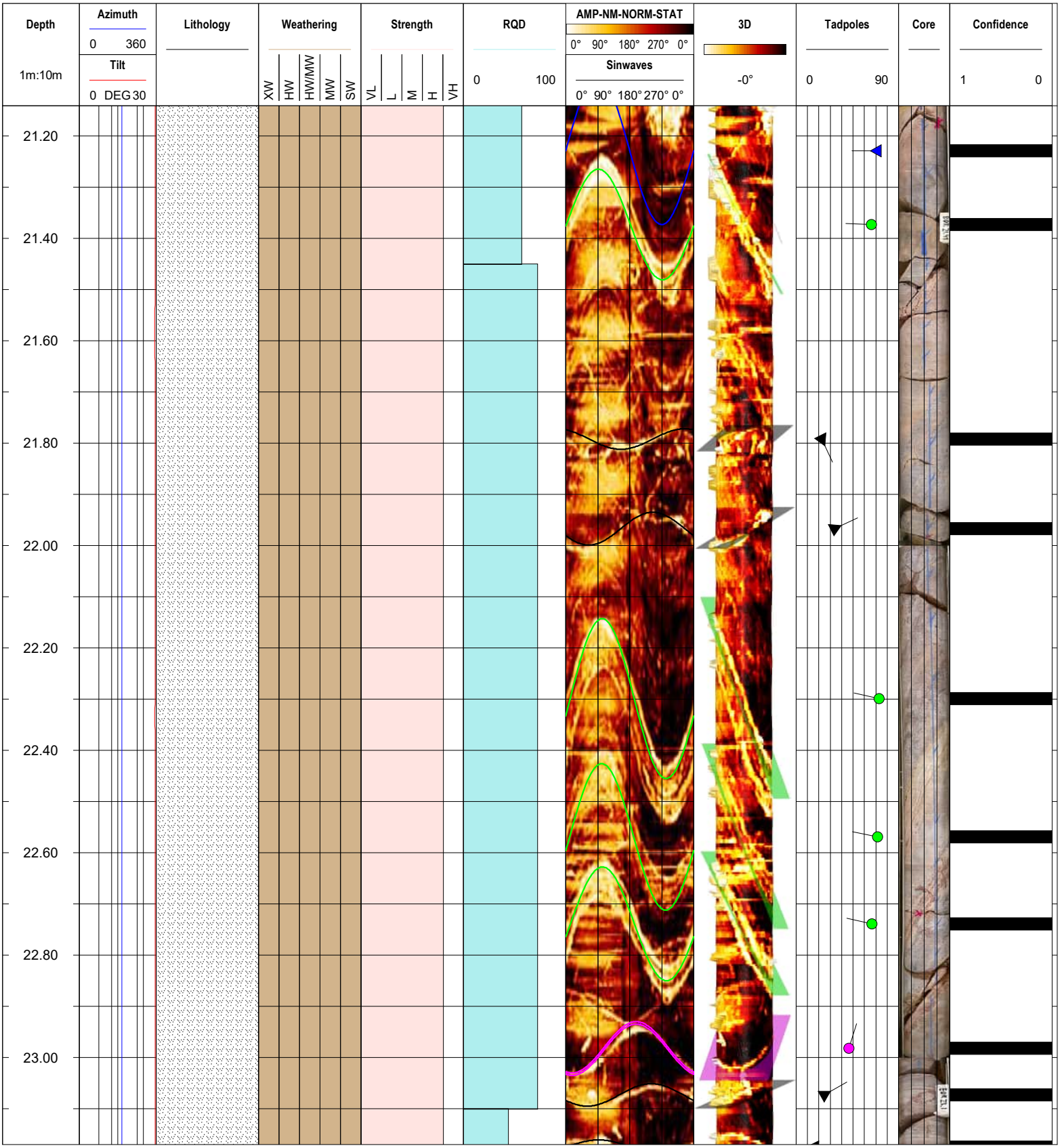

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Azimuth
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Tilt
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Lithology
Weathering
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HW/MW
MW
SW
Strength
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L
M
H
VH
RQD
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AMP-NM-NORM-STAT
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3D
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Tadpoles
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Core
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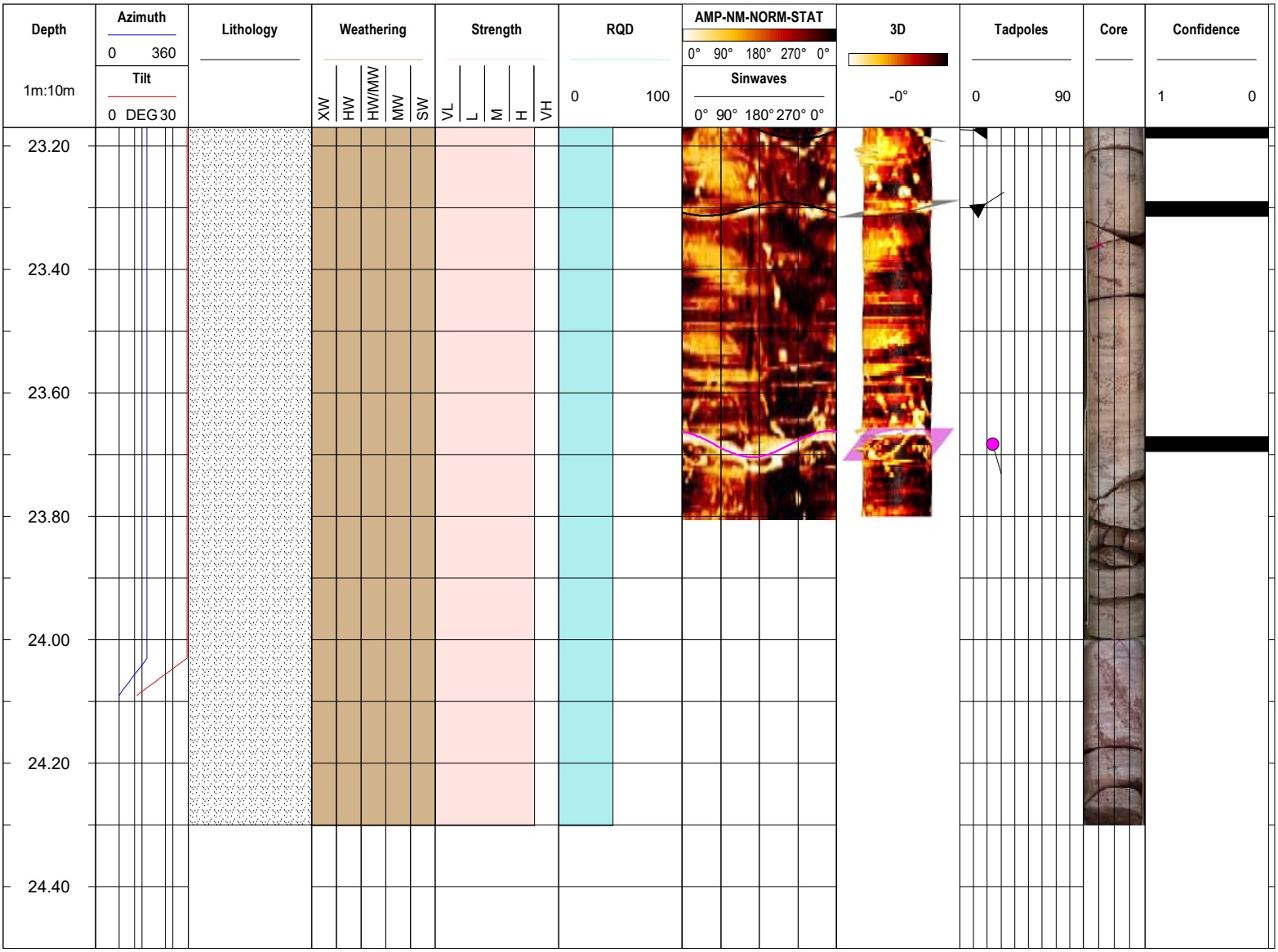

Depth
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Azimuth
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Tilt
0 DEG 30
Lithology
Weathering
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HW
HW/MW
MW
SW
Strength
VL
L
M
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VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
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Tadpoles
0 90
Core
Confidence
1 0
13.20
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14.00
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15.00


Depth
1m:10m
Azimuth
0 360
Tilt
0 DEG 30
Lithology
Weathering
XW
HW
HW/MW
MW
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Strength
VL
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VH
RQD
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3D
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Tadpoles
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Core
Confidence
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17.00


Depth
1m:10m
Azimuth
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Tilt
0 DEG 30
Lithology
Weathering
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HW
HW/MW
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SW
Strength
VL
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VH
RQD
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Tadpoles
0 90
Core
Confidence
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19.00


Depth
1m:10m
Azimuth
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Tilt
0 DEG 30
Lithology
Weathering
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HW
HW/MW
MW
SW
Strength
VL
L
M
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Sinwaves
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3D
-0°
Tadpoles
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Core
Confidence
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19.80
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20.40
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21.00


Depth
1m:10m
Azimuth
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Tilt
0 DEG 30
Lithology
Weathering
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HW
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Strength
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Sinwaves
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Tadpoles
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Core
Confidence
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23.00


Depth
1m:10m
Azimuth
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Strength
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VH
RQD
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Sinwaves
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3D
-0°
Tadpoles
0 90
Core
Confidence
1 0
23.20
23.40
23.60
23.80
24.00
24.20
24.40

BOREHOLE ATV REPORT

BOREHOLE NO. TSF_BH10A

CONSULTANT:	**GROUNDWAVE**	DATE COMMENCED:	**18/05/24**
CLIENT:	**29 METALS**	DATE COMPLETED:	**21/05/24**
PROJECT:	**TSF3 GI SUPPORT**	RECORDED BY:	
LOCATION:	**PROPOSED TSF3 SITE**	LOG CHECKED BY:	
PROJECT NUMBER:	**QC1022_018**		

COORDINATES:	**E 328, 331 N 7, 820, 474**	DEPTH OF TEST (m):	**3.39**
REDUCED LEVEL (mAHD):	**282.14**	DEPTH OF BOREHOLE (m):	**23.85**
INCLINATION:	**60**	DIAMETER OF BOREHOLE (mm):	**96**
		TYPE OF CASING (mm):	
		GROUNDWATER LEVEL (m):	

LITHOLOGY

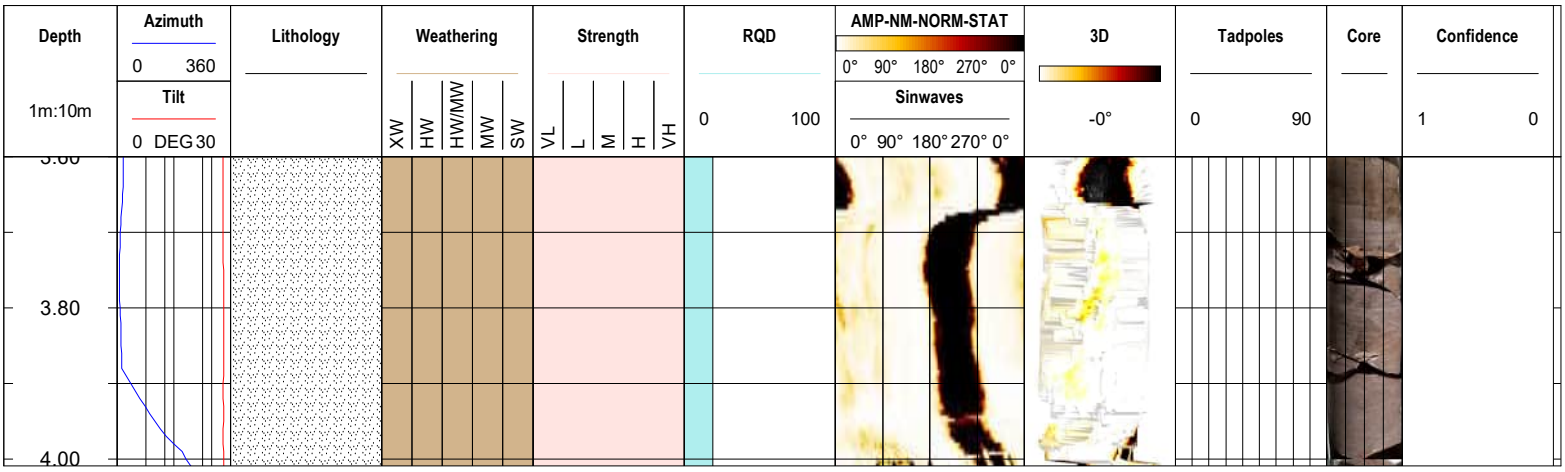
QUARTZITE FILL

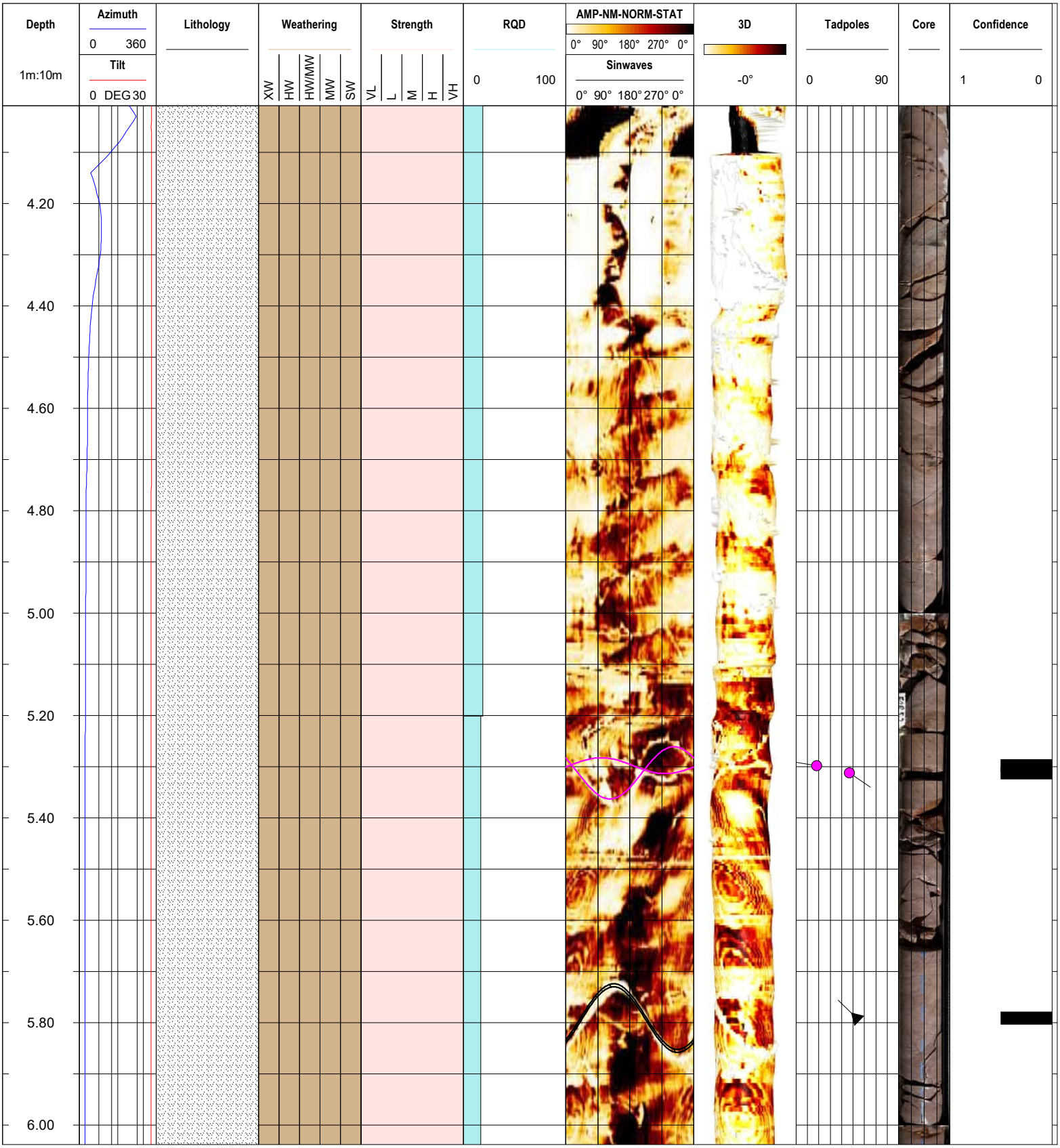
STRUCTURES

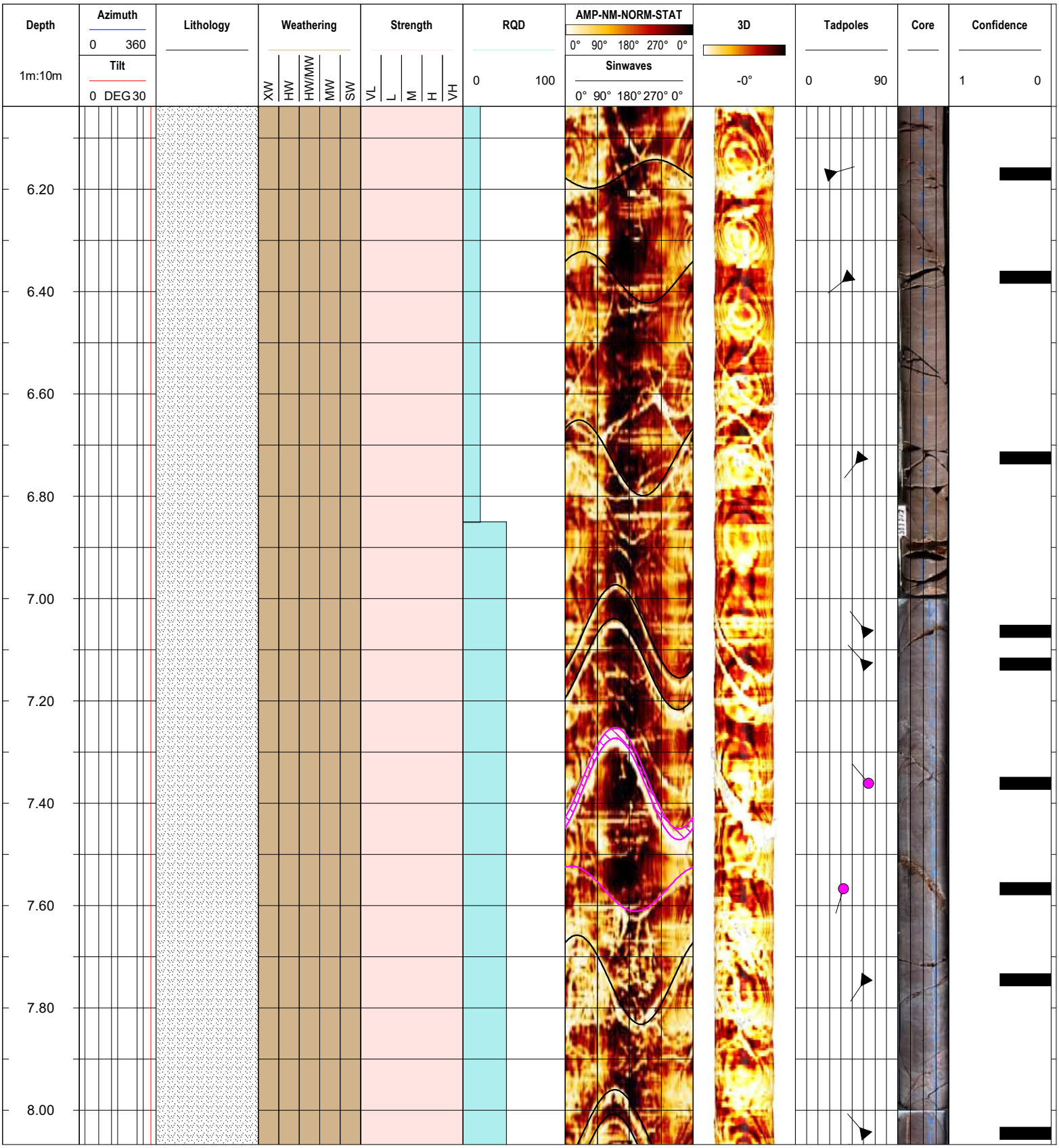
MINOR OPEN JOINT / FRACTURE

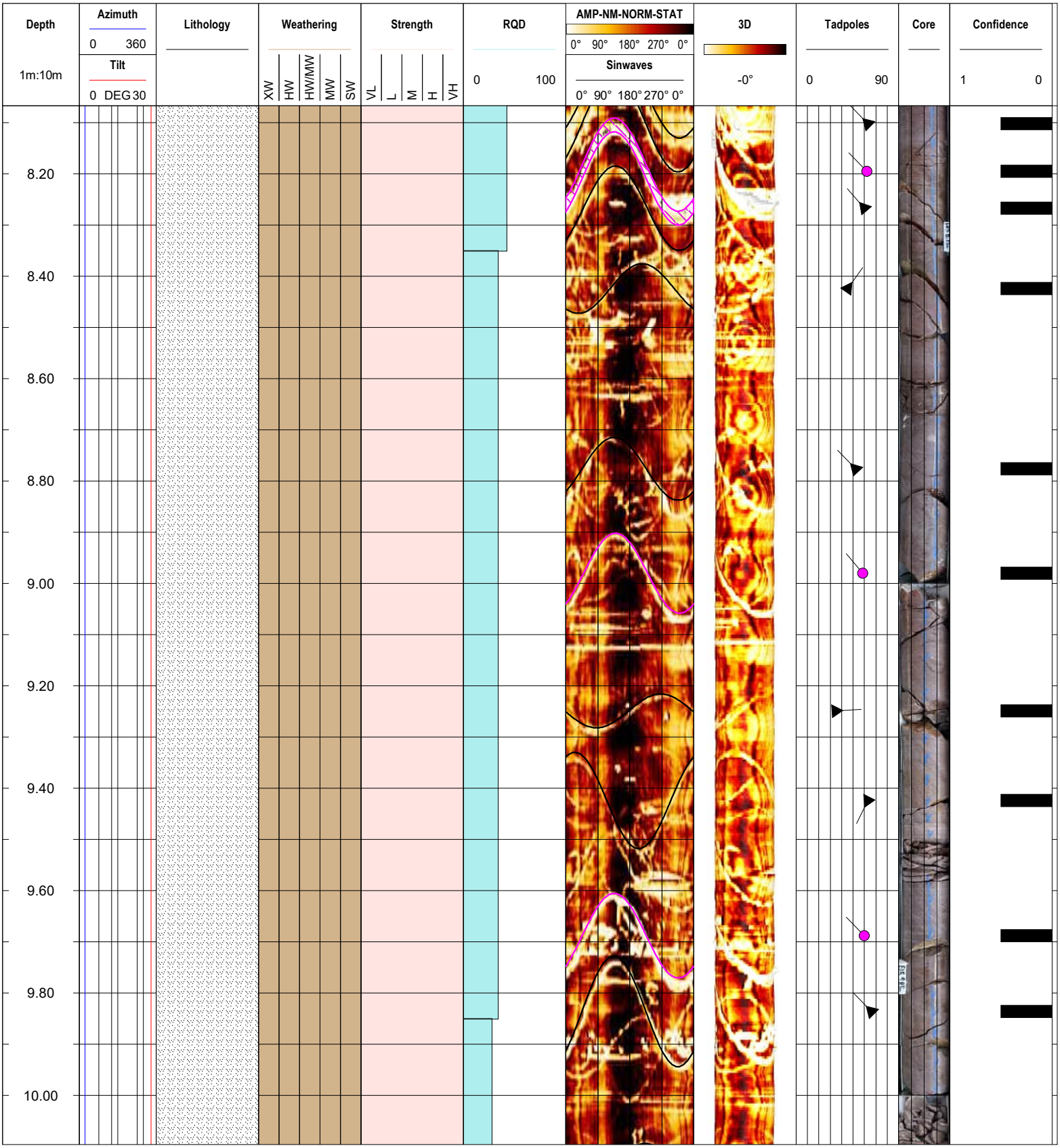
TIGHT JOINT

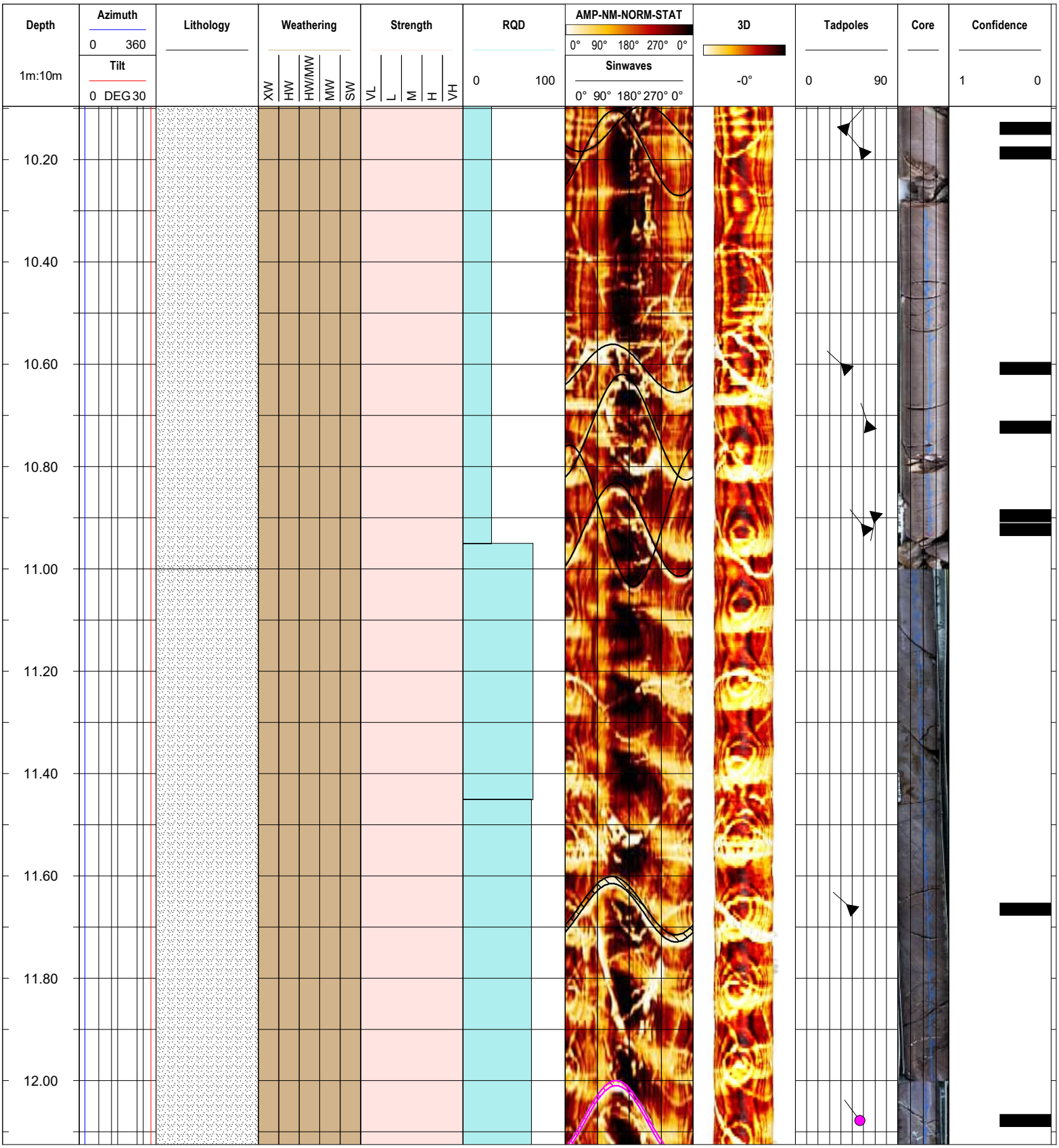
TIGHT JOINT (POTENTIALLY INCIPIENT AT OUTCROP)

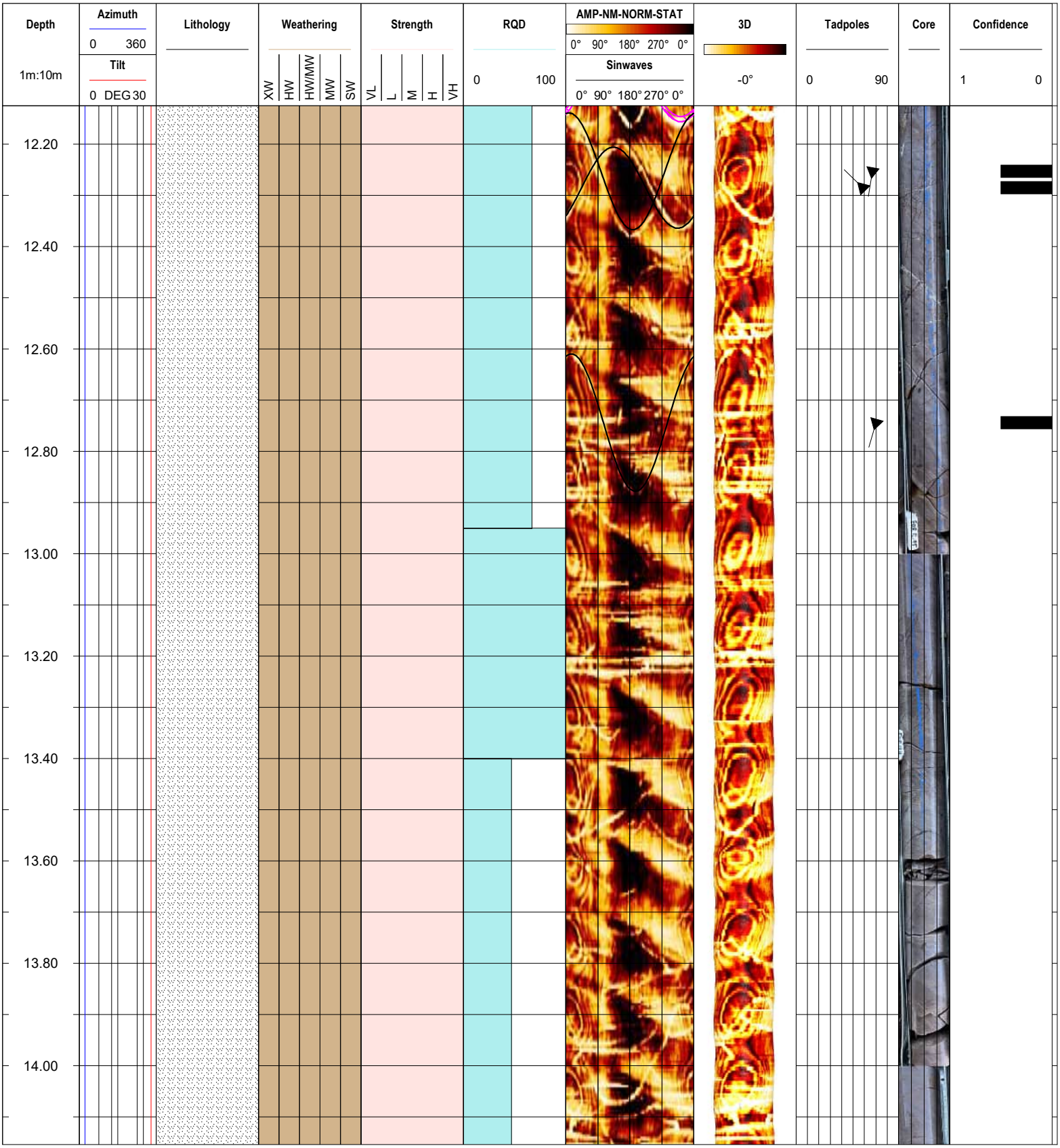


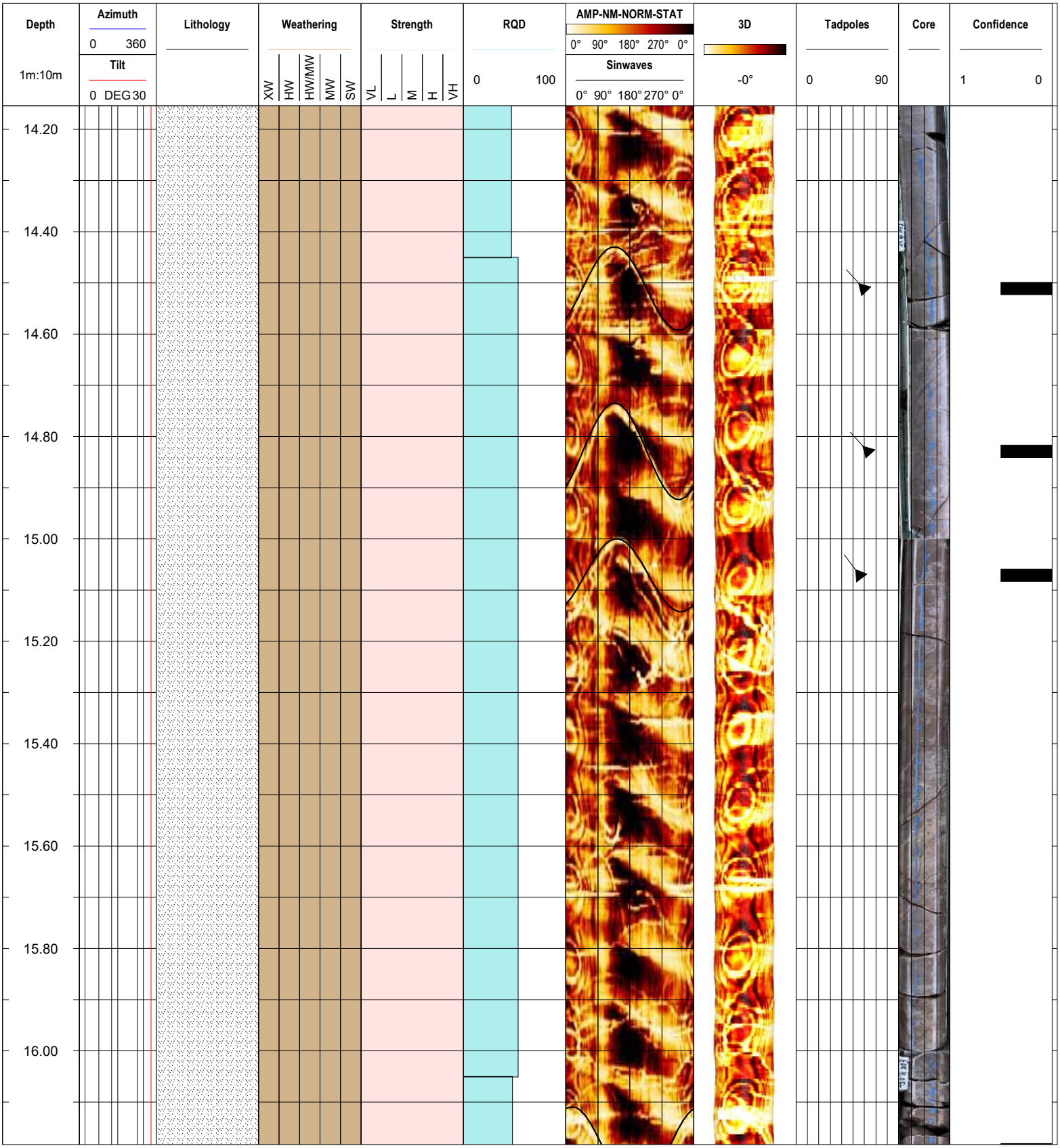

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Tilt
0 DEG 30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
H
VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
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4.20
4.40
4.60
4.80
5.00
5.20
5.40
5.60
5.80
6.00

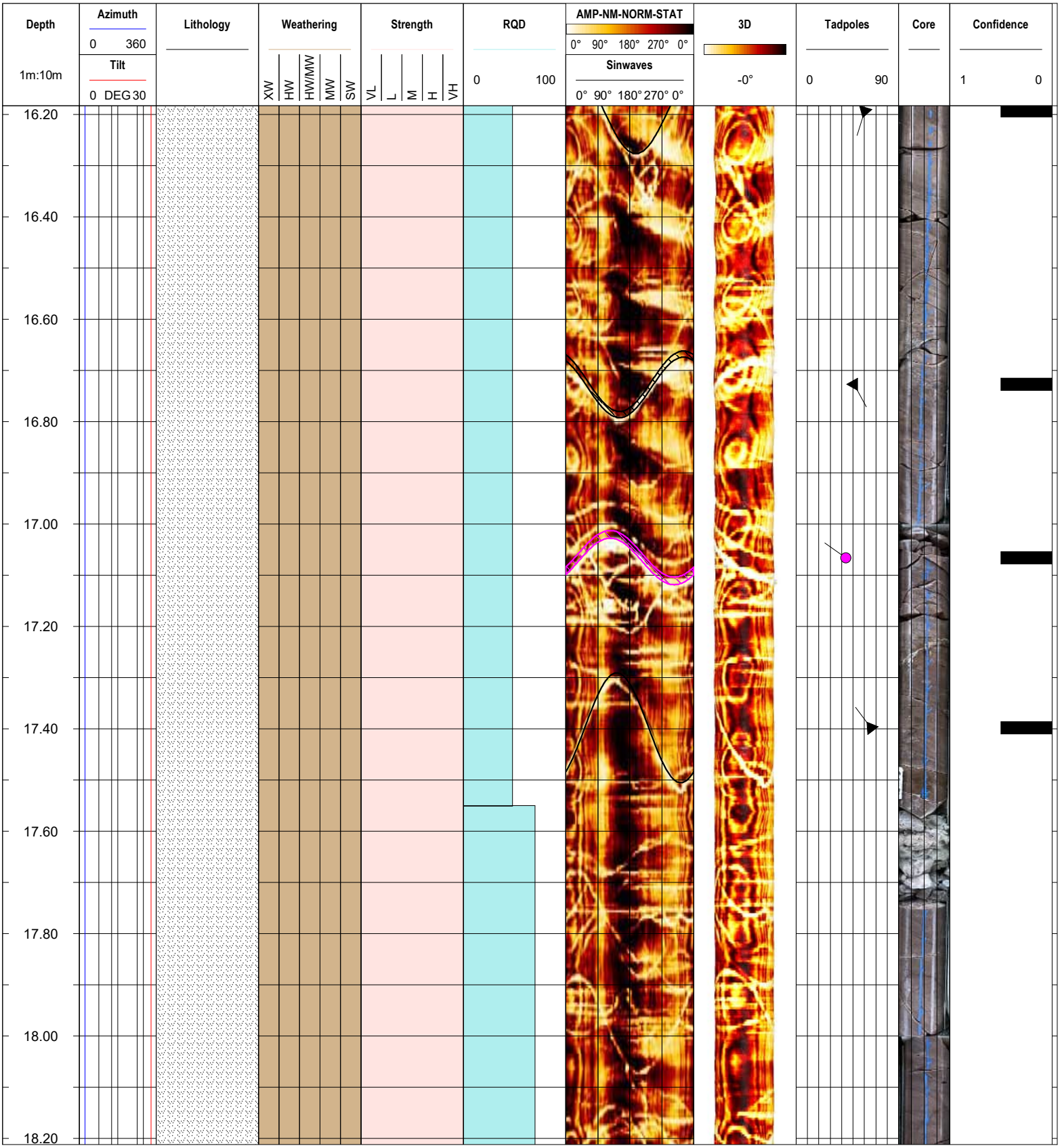

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Azimuth
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Tilt
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Lithology
Weathering
XW
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HW/MW
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Strength
VL
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VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
1 0
6.20
6.40
6.60
6.80
7.00
7.20
7.40
7.60
7.80
8.00

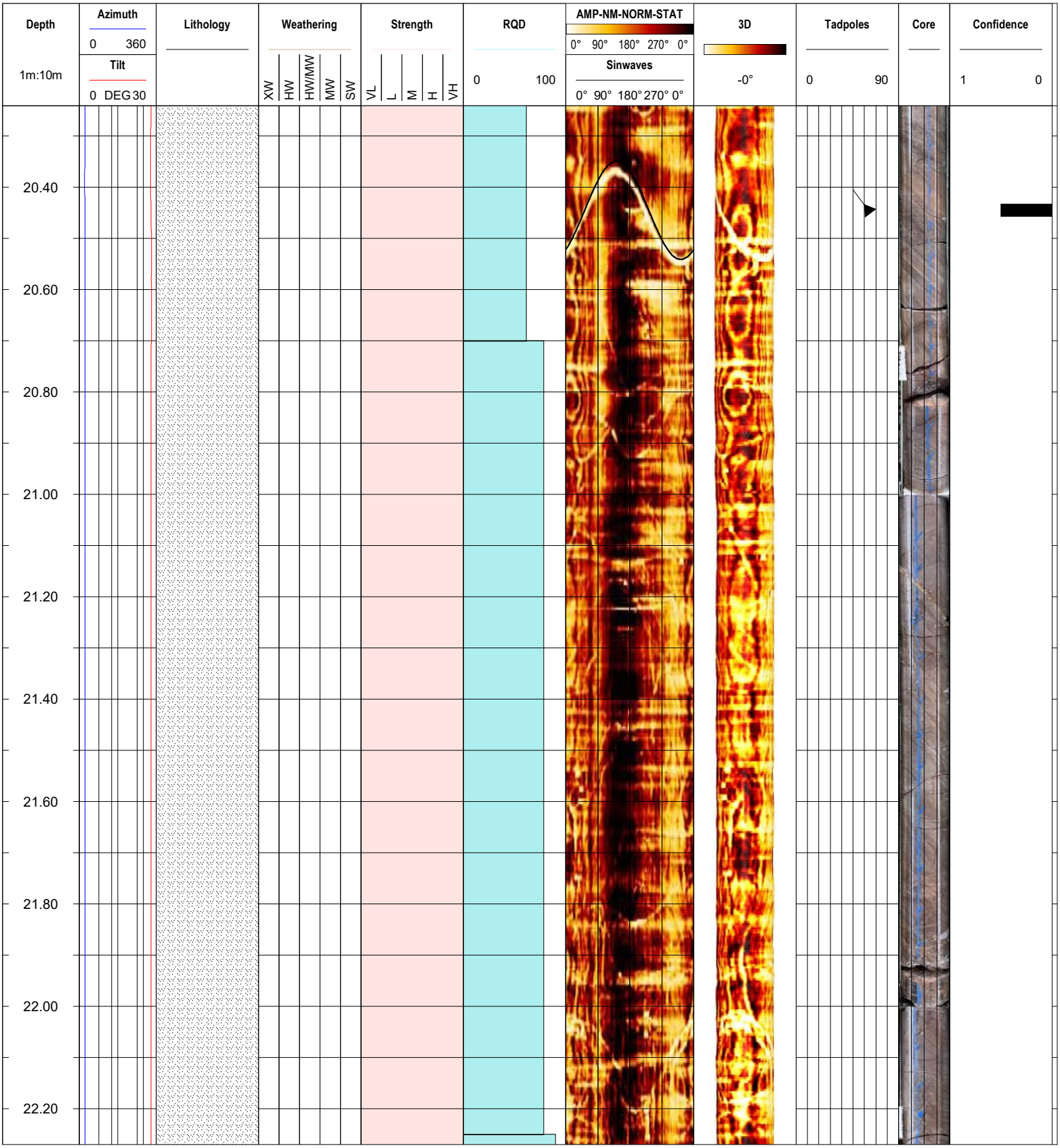

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Azimuth
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Tilt
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Lithology
Weathering
XW
HW
HW/MW
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SW
Strength
VL
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M
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VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
1 0
8.20
8.40
8.60
8.80
9.00
9.20
9.40
9.60
9.80
10.00

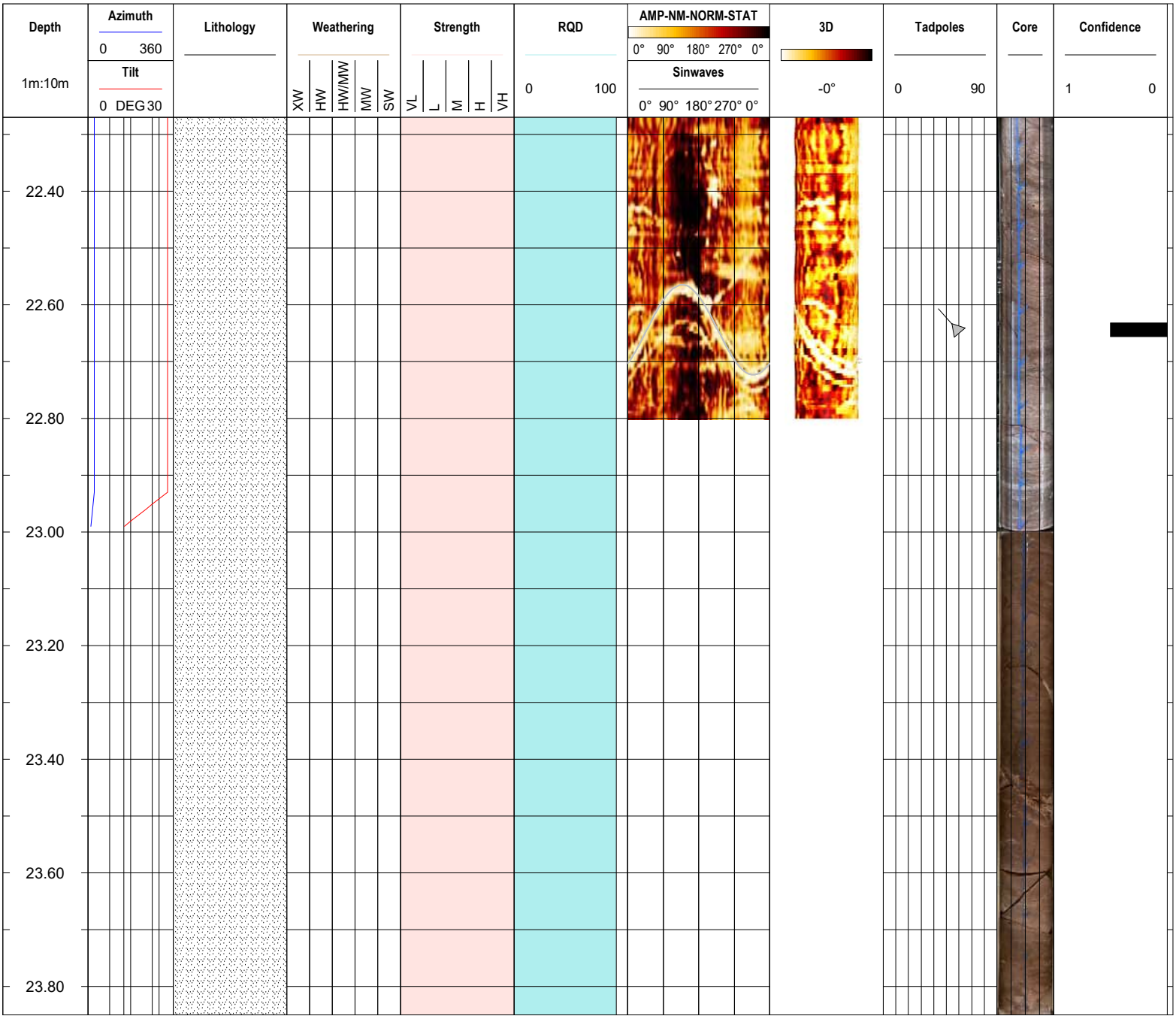

Depth
1m:10m
Azimuth
0 360
Tilt
0 DEG 30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
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M
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VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
1 0
10.20
10.40
10.60
10.80
11.00
11.20
11.40
11.60
11.80
12.00


Depth
1m:10m
Azimuth
0 360
Tilt
0 DEG 30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
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VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
1 0
12.20
12.40
12.60
12.80
13.00
13.20
13.40
13.60
13.80
14.00


Depth
1m:10m
Azimuth
0 360
Tilt
0 DEG 30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
H
VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
1 0
14.20
14.40
14.60
14.80
15.00
15.20
15.40
15.60
15.80
16.00


Depth
1m:10m
Azimuth
0 360
Tilt
0 DEG 30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
H
VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
1 0
16.20
16.40
16.60
16.80
17.00
17.20
17.40
17.60
17.80
18.00
18.20


Depth
1m:10m
Azimuth
0 360
Tilt
0 DEG 30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
H
VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
1 0
20.40
20.60
20.80
21.00
21.20
21.40
21.60
21.80
22.00
22.20


Depth
1m:10m
Azimuth
0 360
Tilt
0 DEG 30
Lithology
Weathering
XW
HW
HW/MW
MW
SW
Strength
VL
L
M
H
VH
RQD
0 100
AMP-NM-NORM-STAT
0° 90° 180° 270° 0°
Sinwaves
0° 90° 180° 270° 0°
3D
-0°
Tadpoles
0 90
Core
Confidence
1 0
22.40
22.60
22.80
23.00
23.20
23.40
23.60
23.80

APPENDIX E: STANDPIPE PIEZOMETER INSTALLATION

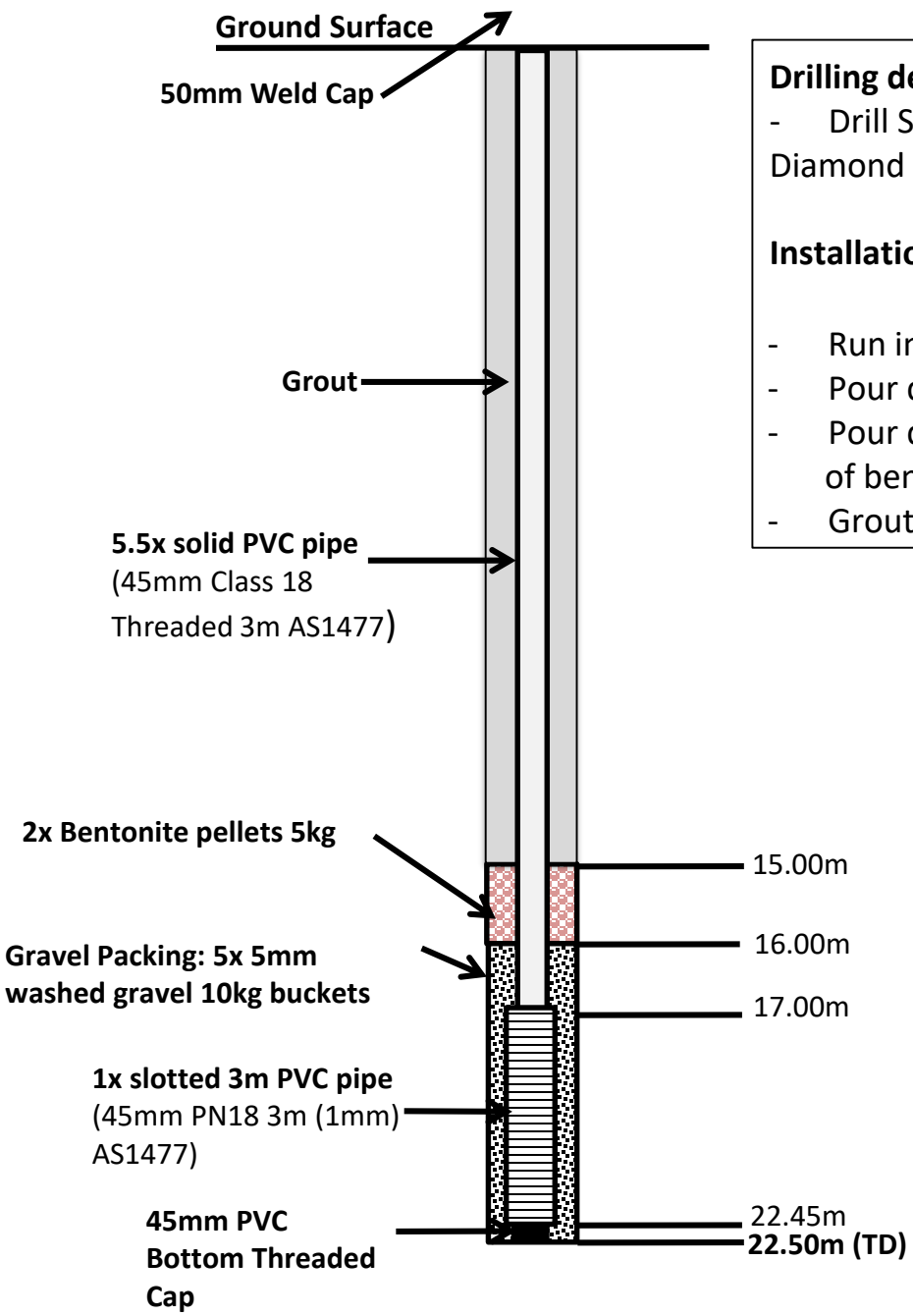
TSF_BH_14 / UEDD STANDPIPE CONSTRUCTION DETAILS

Hole ID: TSF_BH_14 **Driller:** Adrian Wheatley **Geo:** Cec Martin

Company: Groundwave **Rig No:** 2 & 6

Date commenced: 3/05/2024 **Date completed:** 5/05/2024

Easting (GDA94): 328321 **Northing (GDA94):** 7819715



Drilling details:

- Drill Sonic 7” to 17.4m and Diamond HQ3 22.5m

Installation:

- Run in 45mm standpipe
- Pour down 5x 10kg buckets of gravel
- Pour down 2x 5kg buckets of bentonite
- Grout hole. 8x 20kg bags of cement

APPENDIX F: LABORATORY TEST CERTIFICATES

CERTIFICATE OF ANALYSIS

Work Order	: **EB2412108**	Page	: 1 of 12
Client	: **ENGENY AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALEX LEOTTA	Contact	: Customer Services EB
Address	: Level 1, 500 Queen Street Brisbane 4000	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: QC1022_018	Date Samples Received	: 11-Apr-2024 13:10
Order number	: QC1022_018	Date Analysis Commenced	: 12-Apr-2024
C-O-C number	: ----	Issue Date	: 24-Apr-2024 15:19
Sampler	: Cecelia Martin		
Site	: Capricorn Copper Mine		
Quote number	: EB24ENGENY0002		
No. of samples received	: 28		
No. of samples analysed	: 17		

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*
Beatriz Llarinas	Senior Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Soil Preparation, 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 Contract 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.

- Particular samples have been crushed prior to preparation and analysis as per client request on the Chain of Custody. Please refer to SRN for further details.
- EG005T (Total Metals by ICP-AES): TSF3_BH_01 (clip seal bag sample) (EB2412108-011) shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- It is recognised that ED040T (Total Major Anions by ICP-AES) is less than ED040S (Soluble Major Anions by ICP-AES) for some samples. However, the difference is within experimental variation of the methods.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.
- ASS: EA003 (NATA Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme

Analytical Results

Sub-Matrix: ROCK
(Matrix: SOIL)

				Sample ID	TSF3_BH_05 (clip seal bag sample) 10-10.1m	----	----	----	----
				Sampling date / time	01-Apr-2024 11:05	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2412108-003	--------	--------	--------	--------
					Result	----	----	----	----
EA003 :pH (field/fox)									
pH (F)	----	0.1	pH Unit		**6.7**	----	----	----	----
pH (Fox)	----	0.1	pH Unit		**6.2**	----	----	----	----
Reaction Rate	----	1	Reaction Unit		**2**	----	----	----	----
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-15.6**	----	----	----	----
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		**8.1**	----	----	----	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	----	----	----	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t		<0.1	----	----	----	----
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**28.1**	----	----	----	----
ANC as CaCO3	----	0.1	% CaCO3		**2.9**	----	----	----	----
Fizz Rating	----	0	Fizz Unit		**1**	----	----	----	----
ED040S: Soluble Major Anions									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		**3880**	----	----	----	----
Sulfur as S	63705-05-5	10	mg/kg		**1290**	----	----	----	----
ED040T : Total Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		**3540**	----	----	----	----
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.41**	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		**31**	----	----	----	----
Barium	7440-39-3	10	mg/kg		**30**	----	----	----	----
Beryllium	7440-41-7	1	mg/kg		<1	----	----	----	----
Boron	7440-42-8	50	mg/kg		<50	----	----	----	----
Cadmium	7440-43-9	1	mg/kg		<1	----	----	----	----

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)				Sample ID	TSF3_BH_05 (clip seal bag sample) 10-10.1m	----	----	----	----
				Sampling date / time	01-Apr-2024 11:05	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2412108-003	--------	--------	--------	--------
					Result	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Chromium	7440-47-3	2	mg/kg		**4**	----	----	----	----
Cobalt	7440-48-4	2	mg/kg		**43**	----	----	----	----
Copper	7440-50-8	5	mg/kg		**153**	----	----	----	----
Lead	7439-92-1	5	mg/kg		<5	----	----	----	----
Manganese	7439-96-5	5	mg/kg		**5650**	----	----	----	----
Nickel	7440-02-0	2	mg/kg		**16**	----	----	----	----
Selenium	7782-49-2	5	mg/kg		<5	----	----	----	----
Vanadium	7440-62-2	5	mg/kg		<5	----	----	----	----
Zinc	7440-66-6	5	mg/kg		**24**	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	----	----	----	----
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		**0.29**	----	----	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.42**	----	----	----	----
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		**1.97**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_02 (clip seal bag sample) 5-5.1m	TSF3_BH_05 (clip seal bag sample) 5.4-5.5m	TSF3_BH_05 (clip seal bag sample) 19.1-19.2m	TSF3_BH_05 (clip seal bag sample) 19.9-20m	TSF3_BH_01 (clip seal bag sample) 0-0.1m
				Sampling date / time	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	31-Mar-2024 11:05
					EB2412108-001	EB2412108-002	EB2412108-004	EB2412108-005	EB2412108-006
					Result	Result	Result	Result	Result
EA003 :pH (field/fox)									
pH (F)	----	0.1	pH Unit		5.5	5.0	3.8	3.7	3.3
pH (Fox)	----	0.1	pH Unit		4.0	3.2	2.5	2.9	2.2
Reaction Rate	----	1	Reaction Unit		2	2	4	4	4
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-0.2	-10.7	102	94.2	195
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		6.7	8.4	2.9	3.0	2.2
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	18.1	20.9	84.2
NAG (pH 7.0)	----	0.1	kg H2SO4/t		0.4	<0.1	30.4	46.1	110
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		3.3	29.1	<0.5	<0.5	<0.5
ANC as CaCO3	----	0.1	% CaCO3		0.3	3.0	<0.1	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit		0	1	0	0	0
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		7.9	9.6	9.2	19.8	9.3
ED040S: Soluble Major Anions									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		850	9720	34000	49200	76000
Sulfur as S	63705-05-5	10	mg/kg		280	3240	11400	16400	25300
ED040T : Total Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		840	12400	58000	43000	95500
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.10	0.60	3.32	3.08	6.38
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		102	89	437	78	422
Barium	7440-39-3	10	mg/kg		<10	30	30	<10	10
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	TSF3_BH_02 (clip seal bag sample) 5-5.1m	TSF3_BH_05 (clip seal bag sample) 5.4-5.5m	TSF3_BH_05 (clip seal bag sample) 19.1-19.2m	TSF3_BH_05 (clip seal bag sample) 19.9-20m	TSF3_BH_01 (clip seal bag sample) 0-0.1m
				Sampling date / time	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	31-Mar-2024 11:05
Compound	CAS Number	LOR	Unit		EB2412108-001	EB2412108-002	EB2412108-004	EB2412108-005	EB2412108-006
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		**6**	**3**	**13**	<2	**7**
Cobalt	7440-48-4	2	mg/kg		**51**	**7**	**105**	**113**	**149**
Copper	7440-50-8	5	mg/kg		**244**	**331**	**2530**	**8880**	**2700**
Lead	7439-92-1	5	mg/kg		**71**	**9**	**148**	**20**	**181**
Manganese	7439-96-5	5	mg/kg		**192**	**100**	**483**	**304**	**68**
Nickel	7440-02-0	2	mg/kg		**6**	**9**	**37**	**34**	**69**
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		<5	**5**	**8**	<5	**9**
Zinc	7440-66-6	5	mg/kg		**18**	<5	**47**	**25**	**28**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		**0.1**	<0.1	**0.2**	**0.2**	**0.4**
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		**0.07**	**0.19**	**1.39**	**1.65**	**3.20**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.11**	**1.58**	**0.45**	**0.39**	**0.92**
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		<0.02	**0.35**	**0.37**	<0.02	<0.02

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_01 (clip seal bag sample) 0.2-0.4m	TSF3_BH_01 (clip seal bag sample) 1-1.1m	TSF3_BH_01 (clip seal bag sample) 1.9-2m	TSF3_BH_01 (clip seal bag sample) 2.9-3m	TSF3_BH_01 (clip seal bag sample) 3.6-3.7m
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
					EB2412108-007	EB2412108-008	EB2412108-009	EB2412108-010	EB2412108-011
					Result	Result	Result	Result	Result
EA003 :pH (field/fox)									
pH (F)	----	0.1	pH Unit		3.1	3.0	3.7	3.8	3.4
pH (Fox)	----	0.1	pH Unit		2.1	2.1	2.5	2.5	2.4
Reaction Rate	----	1	Reaction Unit		4	4	4	4	4
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		334	477	52.9	35.8	91.5
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		1.9	2.0	2.6	4.5	3.3
NAG (pH 4.5)	----	0.1	kg H2SO4/t		174	120	25.0	<0.1	4.4
NAG (pH 7.0)	----	0.1	kg H2SO4/t		209	204	36.7	12.2	14.4
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		<0.5	<0.5	<0.5	<0.5	<0.5
ANC as CaCO3	----	0.1	% CaCO3		<0.1	<0.1	<0.1	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit		0	0	0	0	0
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		12.0	10.0	8.8	14.5	12.2
ED040S: Soluble Major Anions									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		102000	80800	27000	24700	38800
Sulfur as S	63705-05-5	10	mg/kg		34000	26900	8990	8240	12900
ED040T : Total Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		122000	80000	37000	32900	37000
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		10.9	15.6	1.73	1.17	2.99
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		701	919	504	30	48
Barium	7440-39-3	10	mg/kg		<10	10	<10	<10	<10
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	TSF3_BH_01 (clip seal bag sample) 0.2-0.4m	TSF3_BH_01 (clip seal bag sample) 1-1.1m	TSF3_BH_01 (clip seal bag sample) 1.9-2m	TSF3_BH_01 (clip seal bag sample) 2.9-3m	TSF3_BH_01 (clip seal bag sample) 3.6-3.7m
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
Compound	CAS Number	LOR	Unit		EB2412108-007	EB2412108-008	EB2412108-009	EB2412108-010	EB2412108-011
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		3	2	4	<1	<1
Chromium	7440-47-3	2	mg/kg		6	12	16	2	2
Cobalt	7440-48-4	2	mg/kg		130	118	82	300	304
Copper	7440-50-8	5	mg/kg		657	1380	1240	3910	3730
Lead	7439-92-1	5	mg/kg		583	296	63	<5	7
Manganese	7439-96-5	5	mg/kg		44	89	410	840	953
Nickel	7440-02-0	2	mg/kg		51	41	23	92	52
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		5	9	29	<5	<5
Zinc	7440-66-6	5	mg/kg		44	42	139	136	84
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		0.6	0.4	0.1	<0.1	<0.1
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		6.83	12.9	0.50	0.07	1.76
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		0.85	0.84	1.30	0.24	0.49
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		<0.02	<0.02	<0.02	4.51	0.43

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_01 (clip seal bag sample) 4.8-4.9m	TSF3_BH01 (clip seal bag sample) 11.9-12m	TSF3_BH_01 (clip seal bag sample) 16.9-17m	TSF3_BH_01 (clip seal bag sample) A 18-18.45m	TSF3_BH_01 (clip seal bag sample) 21.9-22m
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
					EB2412108-012	EB2412108-013	EB2412108-014	EB2412108-015	EB2412108-016
					Result	Result	Result	Result	Result
EA003 :pH (field/fox)									
pH (F)	----	0.1	pH Unit		3.6	4.0	5.1	4.2	4.1
pH (Fox)	----	0.1	pH Unit		2.3	2.4	2.4	2.3	2.4
Reaction Rate	----	1	Reaction Unit		4	4	4	4	4
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		93.3	55.7	277	125	27.8
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		2.7	2.9	2.3	2.5	3.0
NAG (pH 4.5)	----	0.1	kg H2SO4/t		25.3	10.1	83.3	50.6	7.9
NAG (pH 7.0)	----	0.1	kg H2SO4/t		40.1	17.4	103	68.1	10.8
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		<0.5	<0.5	35.0	13.2	5.5
ANC as CaCO3	----	0.1	% CaCO3		<0.1	<0.1	3.6	1.4	0.6
Fizz Rating	----	0	Fizz Unit		0	0	1	1	1
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		11.5	10.4	6.9	24.7	20.9
ED040S: Soluble Major Anions									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		38600	27400	13200	7530	22900
Sulfur as S	63705-05-5	10	mg/kg		12800	9130	4400	2510	7620
ED040T : Total Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		38700	25800	11800	11300	26600
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		3.05	1.82	10.2	4.52	1.09
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		145	136	838	862	321
Barium	7440-39-3	10	mg/kg		<10	<10	<10	<10	<10
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	TSF3_BH_01 (clip seal bag sample) 4.8-4.9m	TSF3_BH01 (clip seal bag sample) 11.9-12m	TSF3_BH_01 (clip seal bag sample) 16.9-17m	TSF3_BH_01 (clip seal bag sample) A 18-18.45m	TSF3_BH_01 (clip seal bag sample) 21.9-22m
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
Compound	CAS Number	LOR	Unit		EB2412108-012	EB2412108-013	EB2412108-014	EB2412108-015	EB2412108-016
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	**4**	<1	<1
Chromium	7440-47-3	2	mg/kg		**25**	**26**	**14**	**33**	**8**
Cobalt	7440-48-4	2	mg/kg		**319**	**279**	**670**	**441**	**332**
Copper	7440-50-8	5	mg/kg		**1290**	**654**	**4720**	**2110**	**1030**
Lead	7439-92-1	5	mg/kg		**17**	<5	**133**	**124**	**36**
Manganese	7439-96-5	5	mg/kg		**1010**	**1190**	**1450**	**1210**	**700**
Nickel	7440-02-0	2	mg/kg		**46**	**33**	**168**	**109**	**46**
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		**9**	**16**	**24**	**15**	**9**
Zinc	7440-66-6	5	mg/kg		**70**	**89**	**269**	**257**	**41**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	**0.3**	**0.2**	<0.1
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		**1.76**	**0.96**	**9.81**	**4.14**	**0.20**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.37**	**0.06**	**0.97**	**0.44**	**0.11**
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		**0.29**	**0.27**	**0.49**	**0.52**	<0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	TSF3_BH_01 (clip seal bag sample) B 18-15.45m	----	----	----	----
			Sampling date / time	31-Mar-2024 11:05	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2412108-017	--------	--------	--------	--------
				Result	----	----	----	----
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**4.3**	----	----	----	----
pH (Fox)	----	0.1	pH Unit	**2.1**	----	----	----	----
Reaction Rate	----	1	Reaction Unit	**4**	----	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**201**	----	----	----	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**2.3**	----	----	----	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	**85.0**	----	----	----	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	**98.5**	----	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**12.7**	----	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	**1.3**	----	----	----	----
Fizz Rating	----	0	Fizz Unit	**1**	----	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**8.2**	----	----	----	----
ED040S: Soluble Major Anions								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**5130**	----	----	----	----
Sulfur as S	63705-05-5	10	mg/kg	**1710**	----	----	----	----
ED040T : Total Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	**6640**	----	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**6.99**	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**2000**	----	----	----	----
Barium	7440-39-3	10	mg/kg	<10	----	----	----	----
Beryllium	7440-41-7	1	mg/kg	<1	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	TSF3_BH_01 (clip seal bag sample) B 18-15.45m	----	----	----	----
				Sampling date / time	31-Mar-2024 11:05	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2412108-017	--------	--------	--------	--------
					Result	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Boron	7440-42-8	50	mg/kg		<50	----	----	----	----
Cadmium	7440-43-9	1	mg/kg		**2**	----	----	----	----
Chromium	7440-47-3	2	mg/kg		**40**	----	----	----	----
Cobalt	7440-48-4	2	mg/kg		**886**	----	----	----	----
Copper	7440-50-8	5	mg/kg		**3130**	----	----	----	----
Lead	7439-92-1	5	mg/kg		**144**	----	----	----	----
Manganese	7439-96-5	5	mg/kg		**1060**	----	----	----	----
Nickel	7440-02-0	2	mg/kg		**172**	----	----	----	----
Selenium	7782-49-2	5	mg/kg		<5	----	----	----	----
Vanadium	7440-62-2	5	mg/kg		**18**	----	----	----	----
Zinc	7440-66-6	5	mg/kg		**235**	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		**0.3**	----	----	----	----
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		**6.77**	----	----	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**1.36**	----	----	----	----
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		**0.06**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2415139**	Page	: 1 of 17
Client	: **ENGENY AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALEX LEOTTA	Contact	: Customer Services EB
Address	: Level 1, 500 Queen Street Brisbane 4000	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: QC1022_018	Date Samples Received	: 07-May-2024 09:54
Order number	: ----	Date Analysis Commenced	: 08-May-2024
C-O-C number	: ----	Issue Date	: 15-May-2024 09:02
Sampler	: Cecelia Martin		
Site	: Capricorn Copper Mine		
Quote number	: EB24ENGENY0002		
No. of samples received	: 34		
No. of samples analysed	: 34		

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*
Vincent Muller	Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD
Vincent Muller	Chemist - Inorganics	Brisbane Soil Preparation, 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 Contract 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.

- EG005C (Leachable Metals by ICP-AES): Limit of reporting raised for TSF3_BH_01 (clip seal bag sample) (EB2415139-009) due to matrix interference.

Analytical Results

Sub-Matrix: **ASLP LEACHATE**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_02 (clip seal bag sample) 5-5.1m	TSF3_BH_05 (clip seal bag sample) 5.4-5.5m	TSF3_BH_05 (clip seal bag sample) 10-10.1m	TSF3_BH_05 (clip seal bag sample) 19.1-19.2m	TSF3_BH_05 (clip seal bag sample) 19.9-20m
				Sampling date / time	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05
					EB2415139-001	EB2415139-002	EB2415139-003	EB2415139-004	EB2415139-005
					Result	Result	Result	Result	Result
EG005(ED093)C: Leachable Metals by ICPAES									
Arsenic	7440-38-2	0.1	mg/L		<0.1	<0.1	<0.1	**0.1**	**0.1**
Cobalt	7440-48-4	0.1	mg/L		<0.1	<0.1	<0.1	**3.0**	**6.1**
Copper	7440-50-8	0.1	mg/L		<0.1	**0.1**	<0.1	**10.6**	**228**
Lead	7439-92-1	0.1	mg/L		**----**	**----**	**----**	<0.1	**----**
Manganese	7439-96-5	0.1	mg/L		**0.4**	**0.5**	**4.0**	**10.6**	**17.3**

Analytical Results

Sub-Matrix: **ASLP LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_01 (clip seal bag sample) 0-0.1m	TSF3_BH_01 (clip seal bag sample) 0.2-0.4m	TSF3_BH_01 (clip seal bag sample) 1-1.1m	TSF3_BH_01 (clip seal bag sample) 1.9-2m	TSF3_BH_01 (clip seal bag sample) 2.9-3m
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
					EB2415139-006	EB2415139-007	EB2415139-008	EB2415139-009	EB2415139-010
					Result	Result	Result	Result	Result
EG005(ED093)C: Leachable Metals by ICPAES									
Arsenic	7440-38-2	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.05	mg/L		----	----	----	<0.05	----
Cobalt	7440-48-4	0.1	mg/L		**4.4**	**6.6**	**1.2**	**0.6**	**5.3**
Copper	7440-50-8	0.1	mg/L		**40.9**	**14.8**	**4.3**	**0.2**	**23.7**
Lead	7439-92-1	0.1	mg/L		<0.1	<0.1	<0.1	----	----
Manganese	7439-96-5	0.1	mg/L		**2.5**	**4.5**	**1.4**	**5.4**	**22.4**
Zinc	7440-66-6	0.1	mg/L		----	----	----	<0.5	**2.5**
EG035C: Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0010	mg/L		----	<0.0010	<0.0010	----	----

Analytical Results

Sub-Matrix: **ASLP LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_01 (clip seal bag sample) 3.6-3.7m	TSF3_BH_01 (clip seal bag sample) 4.8-4.9m	TSF3_BH01 (clip seal bag sample) 11.9-12m	TSF3_BH_01 (clip seal bag sample) 16.9-17m	TSF3_BH_01 (clip seal bag sample) A 18-18.45m
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
					EB2415139-011	EB2415139-012	EB2415139-013	EB2415139-014	EB2415139-015
					Result	Result	Result	Result	Result
EG005(ED093)C: Leachable Metals by ICPAES									
Arsenic	7440-38-2	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.05	mg/L		----	----	----	<0.05	----
Cobalt	7440-48-4	0.1	mg/L		**11.7**	**10.5**	**7.2**	**2.3**	**2.4**
Copper	7440-50-8	0.1	mg/L		**41.0**	**15.3**	**2.1**	**0.4**	**2.0**
Lead	7439-92-1	0.1	mg/L		----	----	----	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/L		**36.1**	**35.3**	**41.4**	**3.2**	**8.1**
Nickel	7440-02-0	0.1	mg/L		----	----	----	**0.4**	**0.4**
Zinc	7440-66-6	0.1	mg/L		----	----	----	**0.4**	**4.6**

Analytical Results

Sub-Matrix: **ASLP LEACHATE**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_01 (clip seal bag sample) 21.9-22m	TSF3_BH_01 (clip seal bag sample) B 18-15.45m	TSF3_BH_02 (clip seal bag sample) 5-5.1m ASLP leachate pH 5	TSF3_BH_05 (clip seal bag sample) 5.4-5.5m ASLP leachate pH 5	TSF3_BH_05 (clip seal bag sample) 10-10.1m ASLP leachate pH 5
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05
					EB2415139-016	EB2415139-017	EB2415139-018	EB2415139-019	EB2415139-020
					Result	Result	Result	Result	Result
EG005(ED093)C: Leachable Metals by ICPAES									
Arsenic	7440-38-2	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/L		**3.5**	<0.1	**0.6**	<0.1	**0.1**
Copper	7440-50-8	0.1	mg/L		**1.3**	<0.1	**1.5**	**3.9**	**0.2**
Lead	7439-92-1	0.1	mg/L		**----**	<0.1	**----**	**----**	**----**
Manganese	7439-96-5	0.1	mg/L		**11.5**	<0.1	**2.3**	**1.2**	**19.1**
Nickel	7440-02-0	0.1	mg/L		**----**	<0.1	**----**	**----**	**----**
Zinc	7440-66-6	0.1	mg/L		**----**	<0.1	**----**	**----**	**----**

Analytical Results

Sub-Matrix: **ASLP LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_05 (clip seal bag sample) 19.1-19.2m ASLP leachate pH 5	TSF3_BH_05 (clip seal bag sample) 19.9-20m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 0-0.1m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 0.2-0.4m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 1-1.1m ASLP leachate pH 5
				Sampling date / time	01-Apr-2024 11:05	01-Apr-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
				EB2415139-021	EB2415139-022	EB2415139-023	EB2415139-024	EB2415139-025	
				Result	Result	Result	Result	Result	
EG005(ED093)C: Leachable Metals by ICPAES									
Arsenic	7440-38-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	
Cobalt	7440-48-4	0.1	mg/L	**3.2**	**5.9**	**6.9**	**6.0**	**1.6**	
Copper	7440-50-8	0.1	mg/L	**31.6**	**263**	**82.1**	**19.5**	**14.2**	
Lead	7439-92-1	0.1	mg/L	<0.1	----	<0.1	<0.1	<0.1	
Manganese	7439-96-5	0.1	mg/L	**9.7**	**16.8**	**3.1**	**4.2**	**1.8**	
EG035C: Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0010	mg/L	----	----	----	<0.0010	<0.0010	

Analytical Results

Sub-Matrix: **ASLP LEACHATE**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_01 (clip seal bag sample) 1.9-2m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 2.9-3m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 3.6-3.7m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 4.8-4.9m ASLP leachate pH 5	TSF3_BH01 (clip seal bag sample) 11.9-12m ASLP leachate pH 5
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
					EB2415139-026	EB2415139-027	EB2415139-028	EB2415139-029	EB2415139-030
					Result	Result	Result	Result	Result
EG005(ED093)C: Leachable Metals by ICPAES									
Arsenic	7440-38-2	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.05	mg/L		<0.05	----	----	----	----
Cobalt	7440-48-4	0.1	mg/L		**1.2**	**5.6**	**10.6**	**8.7**	**7.2**
Copper	7440-50-8	0.1	mg/L		**2.2**	**32.8**	**56.4**	**14.2**	**7.0**
Manganese	7439-96-5	0.1	mg/L		**5.4**	**21.6**	**33.2**	**27.6**	**40.5**
Zinc	7440-66-6	0.1	mg/L		**1.8**	**3.6**	----	----	----

Analytical Results

Sub-Matrix: **ASLP LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_01 (clip seal bag sample) 16.9-17m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) A 18-18.45m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 21.9-22m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) B 18-15.45m ASLP leachate pH 5	----
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	----
					EB2415139-031	EB2415139-032	EB2415139-033	EB2415139-034	--------
					Result	Result	Result	Result	----
EG005(ED093)C: Leachable Metals by ICPAES									
Arsenic	7440-38-2	0.1	mg/L		<0.1	<0.1	<0.1	**0.2**	**----**
Cadmium	7440-43-9	0.05	mg/L		<0.05	**----**	**----**	**----**	**----**
Cobalt	7440-48-4	0.1	mg/L		**3.8**	**2.4**	**4.6**	**2.8**	**----**
Copper	7440-50-8	0.1	mg/L		**22.7**	**17.4**	**4.6**	**17.5**	**----**
Lead	7439-92-1	0.1	mg/L		<0.1	<0.1	**----**	<0.1	**----**
Manganese	7439-96-5	0.1	mg/L		**4.9**	**8.0**	**13.3**	**4.9**	**----**
Nickel	7440-02-0	0.1	mg/L		**0.5**	**0.4**	**----**	**0.6**	**----**
Zinc	7440-66-6	0.1	mg/L		**1.0**	**8.8**	**----**	**3.1**	**----**

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	TSF3_BH_05 (clip seal bag sample) 10-10.1m	TSF3_BH_05 (clip seal bag sample) 10-10.1m ASLP leachate pH 5	----	----	----
			Sampling date / time	01-Apr-2024 11:05	01-Apr-2024 11:05	----	----	----
Compound	CAS Number	LOR	Unit	EB2415139-003	EB2415139-020	--------	--------	--------
				Result	Result	----	----	----
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Extraction Fluid pH	----	0.1	pH Unit	**7.0**	**5.0**	**----**	**----**	**----**
Final pH	----	0.1	pH Unit	**8.0**	**5.2**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	TSF3_BH_02 (clip seal bag sample) 5-5.1m	TSF3_BH_05 (clip seal bag sample) 5.4-5.5m	TSF3_BH_05 (clip seal bag sample) 19.1-19.2m	TSF3_BH_05 (clip seal bag sample) 19.9-20m	TSF3_BH_01 (clip seal bag sample) 0-0.1m
			Sampling date / time	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	31-Mar-2024 11:05
Compound	CAS Number	LOR	Unit	EB2415139-001	EB2415139-002	EB2415139-004	EB2415139-005	EB2415139-006
				Result	Result	Result	Result	Result
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Extraction Fluid pH	----	0.1	pH Unit	**7.0**	**7.0**	**7.0**	**7.0**	**7.0**
Final pH	----	0.1	pH Unit	**6.9**	**7.1**	**7.8**	**5.5**	**5.3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	TSF3_BH_01 (clip seal bag sample) 0.2-0.4m	TSF3_BH_01 (clip seal bag sample) 1-1.1m	TSF3_BH_01 (clip seal bag sample) 1.9-2m	TSF3_BH_01 (clip seal bag sample) 2.9-3m	TSF3_BH_01 (clip seal bag sample) 3.6-3.7m
			Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
Compound	CAS Number	LOR	Unit	EB2415139-007	EB2415139-008	EB2415139-009	EB2415139-010	EB2415139-011
				Result	Result	Result	Result	Result
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Extraction Fluid pH	----	0.1	pH Unit	**7.0**	**7.0**	**7.0**	**7.0**	**7.0**
Final pH	----	0.1	pH Unit	**4.7**	**5.6**	**5.7**	**5.3**	**5.2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	TSF3_BH_01 (clip seal bag sample) 4.8-4.9m	TSF3_BH01 (clip seal bag sample) 11.9-12m	TSF3_BH_01 (clip seal bag sample) 16.9-17m	TSF3_BH_01 (clip seal bag sample) A 18-18.45m	TSF3_BH_01 (clip seal bag sample) 21.9-22m
			Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
Compound	CAS Number	LOR	Unit	EB2415139-012	EB2415139-013	EB2415139-014	EB2415139-015	EB2415139-016
				Result	Result	Result	Result	Result
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Extraction Fluid pH	----	0.1	pH Unit	**7.0**	**7.0**	**7.0**	**7.0**	**7.0**
Final pH	----	0.1	pH Unit	**5.2**	**5.4**	**6.6**	**6.2**	**6.0**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	TSF3_BH_01 (clip seal bag sample) B 18-15.45m	TSF3_BH_02 (clip seal bag sample) 5-5.1m ASLP leachate pH 5	TSF3_BH_05 (clip seal bag sample) 5.4-5.5m ASLP leachate pH 5	TSF3_BH_05 (clip seal bag sample) 19.1-19.2m ASLP leachate pH 5	TSF3_BH_05 (clip seal bag sample) 19.9-20m ASLP leachate pH 5
			Sampling date / time	31-Mar-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05	01-Apr-2024 11:05
Compound	CAS Number	LOR	Unit	EB2415139-017	EB2415139-018	EB2415139-019	EB2415139-021	EB2415139-022
				Result	Result	Result	Result	Result
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Extraction Fluid pH	----	0.1	pH Unit	**7.0**	**5.0**	**5.0**	**5.0**	**5.0**
Final pH	----	0.1	pH Unit	**6.2**	**5.1**	**5.1**	**4.8**	**4.6**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_01 (clip seal bag sample) 0-0.1m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 0.2-0.4m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 1-1.1m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 1.9-2m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 2.9-3m ASLP leachate pH 5
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
				EB2415139-023	EB2415139-024	EB2415139-025	EB2415139-026	EB2415139-027	
				Result	Result	Result	Result	Result	
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)									
Extraction Fluid pH	----	0.1	pH Unit	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	
Final pH	----	0.1	pH Unit	**4.3**	**4.6**	**4.8**	**4.8**	**4.8**	

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	TSF3_BH_01 (clip seal bag sample) 3.6-3.7m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 4.8-4.9m ASLP leachate pH 5	TSF3_BH01 (clip seal bag sample) 11.9-12m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) 16.9-17m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) A 18-18.45m ASLP leachate pH 5
				Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05	31-Mar-2024 11:05
				EB2415139-028	EB2415139-029	EB2415139-030	EB2415139-031	EB2415139-032	
				Result	Result	Result	Result	Result	
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)									
Extraction Fluid pH	----	0.1	pH Unit		**5.0**	**5.0**	**5.0**	**5.0**	**5.0**
Final pH	----	0.1	pH Unit		**4.8**	**4.8**	**5.1**	**5.1**	**5.0**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	TSF3_BH_01 (clip seal bag sample) 21.9-22m ASLP leachate pH 5	TSF3_BH_01 (clip seal bag sample) B 18-15.45m ASLP leachate pH 5	----	----	----
			Sampling date / time	31-Mar-2024 11:05	31-Mar-2024 11:05	----	----	----
Compound	CAS Number	LOR	Unit	EB2415139-033	EB2415139-034	--------	--------	--------
				Result	Result	----	----	----
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Extraction Fluid pH	----	0.1	pH Unit	**5.0**	**5.0**	**----**	**----**	**----**
Final pH	----	0.1	pH Unit	**5.0**	**4.0**	**----**	**----**	**----**

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Particle Size Distribution Report

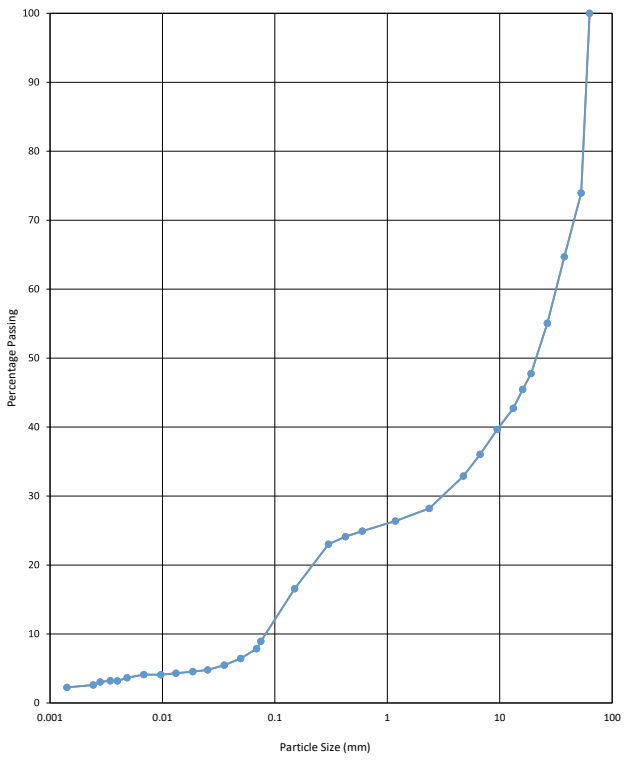
Client :	Engeny Australia	Report Number :	SR/PTP/00143 - 1/1
Client Address :	Level 1/500 Queen Street, Brisbane, 4000, QLD	Report Date :	19/08/2024
Project Name :	QC1022_018	Test Request :	-
Project Number :	PTP/00143	Page 1 of 1	
Location :	Brisbane City		

Test Methods :	AS1289.3.6.3,AS1289.3.6.1, AS1289.2.1.1
Material Description	silty GRAVEL - brown

Sample Number :	S/00927	Sampling Method :	As Received
Date Tested :	12/08/2024	Time :	00:00
Material Source :	-	Location 1 :	TSF_BH_14
For Use As :	-	Location 2 :	13.00-13.50m
Lot Number :	-	Location 3 :	-
PSD Specification Number :	N/A	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :
75.0	
63.0	100
53.0	74
37.5	65
26.5	55
19.0	48
16	45
13.2	43
9.5	40
6.7	36
4.75	33
2.36	28
1.18	26
0.600	25
0.425	24
0.300	23
0.150	17
0.075	9
0.0689	8
0.0496	6
0.0355	5
0.0253	5
0.0186	5
0.0132	4
0.0097	4
0.0068	4
0.0048	4
0.0040	3
0.0034	3
0.0028	3
0.0024	3
0.0014	2

Particle Size Distribution Graph



Soil Particle Density (t/m3) 2.62	Sample Preparation : Oven dried at 105-110oC	Method of Dispersion :	Mechanical	Type of Hydrometer : ASTM 152H
Remarks :				

Note: The results contained in this report relate only to the item/s that were tested/sampled
Accredited for Compliance with ISO/ IEC 17025 - Testing
Precision Geotechnical Services Accreditation Number - 21250
Base Laboratory Site Number - 25576 - Brisbane

Base Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

APPROVED SIGNATORY

Chris Channon - Signatory

Precision Geotechnical Services
ABN: 18 667 147 917
www.pgservices.com.au

Particle Size Distribution Report

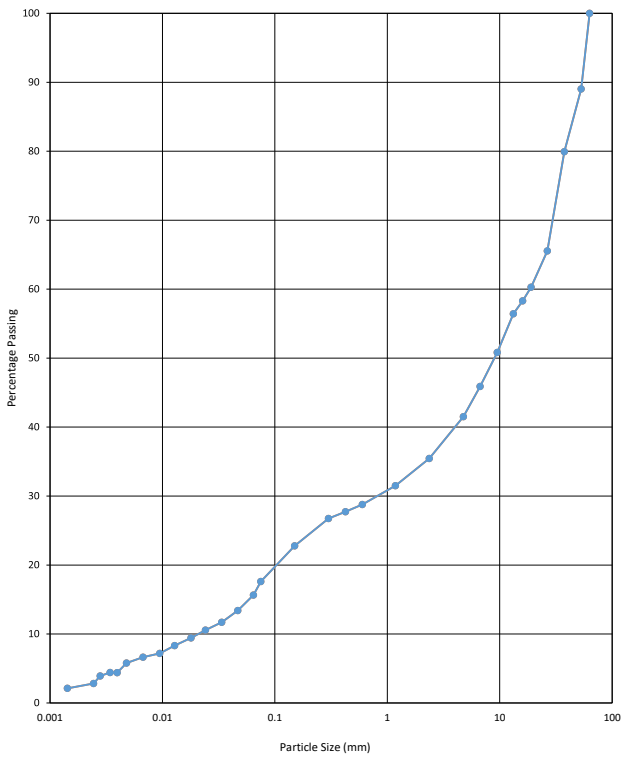
Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 2/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**19/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.3,AS1289.3.6.1, AS1289.2.1.1**
Material Description	**silty GRAVEL - brown**

Sample Number :	**S/00928**	Sampling Method :	**As Received**
Date Tested :	**12/08/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_BH_14**
For Use As :	-	Location 2 :	**15.50-16.00m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :
75.0	
63.0	**100**
53.0	**89**
37.5	**80**
26.5	**66**
19.0	**60**
16	**58**
13.2	**56**
9.5	**51**
6.7	**46**
4.75	**42**
2.36	**35**
1.18	**32**
0.600	**29**
0.425	**28**
0.300	**27**
0.150	**23**
0.075	**18**
0.0644	**16**
0.0468	**13**
0.0337	**12**
0.0241	**11**
0.0180	**9**
0.0128	**8**
0.0095	**7**
0.0067	**7**
0.0048	**6**
0.0040	**4**
0.0034	**4**
0.0028	**4**
0.0024	**3**
0.0014	**2**

Particle Size Distribution Graph



Soil Particle Density (t/m3) 2.61	Sample Preparation : Oven dried at 105-110oC	Method of Dispersion :	Mechanical	Type of Hydrometer : ASTM 152H
Remarks :				

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Precision Geotechnical Services Accreditation Number - 21250

Base Laboratory Site Number - 25576 - Brisbane

Base Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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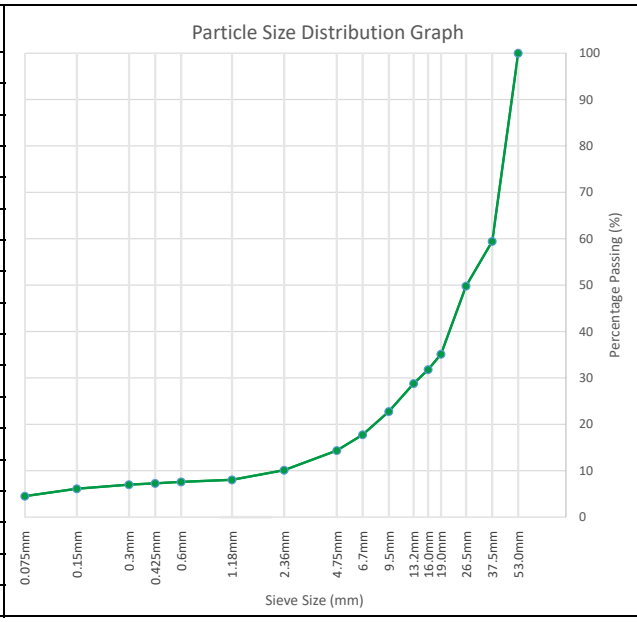
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 3/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**silty GRAVEL - brown**

Sample Number :	**S/00926**	Sampling Method :	**As Received**
Date Tested :	**12/08/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_BH_14**
For Use As :	-	Location 2 :	**3.50-4.00m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0	**100**	
37.5	**59**	
26.5	**50**	
19.0	**35**	
16	**32**	
13.2	**29**	
9.5	**23**	
6.7	**18**	
4.75	**14**	
2.36	**10**	
1.18	**8**	
0.600	**8**	
0.425	**7**	
0.300	**7**	
0.150	**6**	
0.075	**5**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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Atterberg Limits Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 4/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**silty GRAVEL - brown**

Sample Number :	**S/00926**	Sampling Method :	**As Received**
Date Tested :	**16/08/2024**	Time :	**00:00**
Material Source :	**-**	Location 1 :	**TSF_BH_14**
For use as :	**-**	Location 2 :	**3.50-4.00m**
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Oven Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**150**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**21**	**15**	**6**	**1.5**
Specifications :				

Remarks :	

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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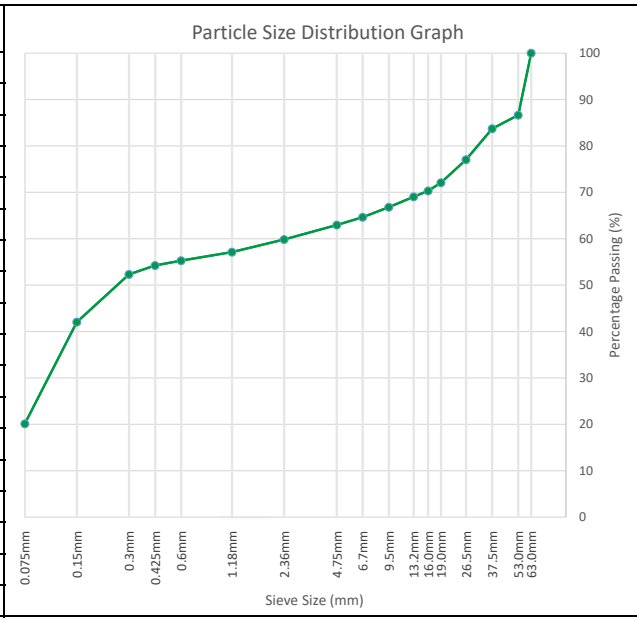
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 5/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**silty GRAVEL - brown**

Sample Number :	**S/00929**	Sampling Method :	**As Received**
Date Tested :	**12/08/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_BH_13**
For Use As :	-	Location 2 :	**0.00-1.00m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**87**	
37.5	**84**	
26.5	**77**	
19.0	**72**	
16	**70**	
13.2	**69**	
9.5	**67**	
6.7	**65**	
4.75	**63**	
2.36	**60**	
1.18	**57**	
0.600	**55**	
0.425	**54**	
0.300	**52**	
0.150	**42**	
0.075	**20**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

APPROVED SIGNATORY

Chris Channon - Signatory

Precision Geotechnical Services
ABN: 18 667 147 917
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Atterberg Limits Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 6/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**silty GRAVEL - brown**

Sample Number :	**S/00927**	Sampling Method :	**As Received**
Date Tested :	**16/08/2024**	Time :	**00:00**
Material Source :	**-**	Location 1 :	**TSF_BH_14**
For use as :	**-**	Location 2 :	**13.00-13.50m**
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Oven Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**150**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**Non Plastic**	**Non Plastic**	**Non Plastic**	**0.0**
Specifications :				

Remarks :	

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

APPROVED SIGNATORY

Chris Channon - Signatory

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Atterberg Limits Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 7/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**silty GRAVEL - brown**

Sample Number :	**S/00928**	Sampling Method :	**As Received**
Date Tested :	**16/08/2024**	Time :	**00:00**
Material Source :	**-**	Location 1 :	**TSF_BH_14**
For use as :	**-**	Location 2 :	**15.50-16.00m**
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Oven Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**150**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**14**	**13**	**1**	**0.5**
Specifications :				

Remarks :	

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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Atterberg Limits Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 8/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**silty GRAVEL - brown**

Sample Number :	**S/00929**	Sampling Method :	**As Received**
Date Tested :	**16/08/2024**	Time :	**00:00**
Material Source :	**-**	Location 1 :	**TSF_BH_13**
For use as :	**-**	Location 2 :	**0.00-1.00m**
Lot Number :	**-**	Location 3 :	**-**
ATT Specification Number :	**N/A**	Location 4 :	**-**

History of Sample :	**Oven Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**150**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**Non Plastic**	**Non Plastic**	**Non Plastic**	**0.0**
Specifications :				

Remarks :	

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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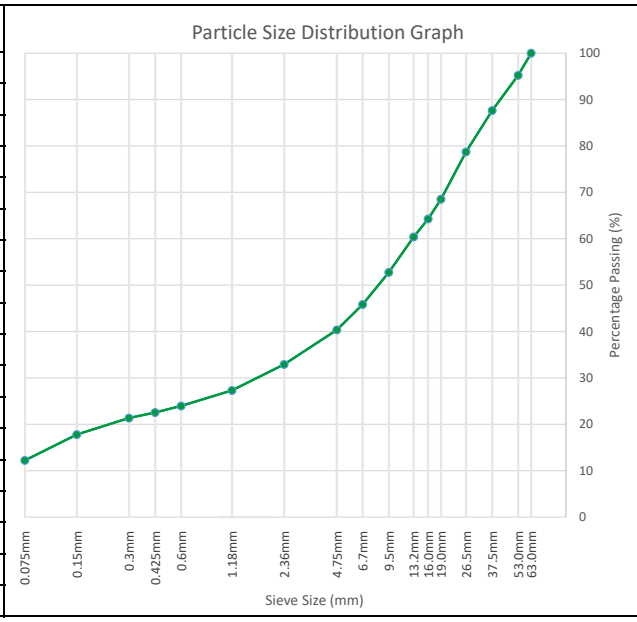
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 9/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**silty GRAVEL - brown**

Sample Number :	**S/00930**	Sampling Method :	**As Received**
Date Tested :	**12/08/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_BH_13**
For Use As :	-	Location 2 :	**6.00-7.00m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**95**	
37.5	**88**	
26.5	**79**	
19.0	**69**	
16	**64**	
13.2	**60**	
9.5	**53**	
6.7	**46**	
4.75	**40**	
2.36	**33**	
1.18	**27**	
0.600	**24**	
0.425	**23**	
0.300	**21**	
0.150	**18**	
0.075	**12**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Atterberg Limits Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 10/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**silty GRAVEL - brown**

Sample Number :	**S/00930**	Sampling Method :	**As Received**
Date Tested :	**16/08/2024**	Time :	**00:00**
Material Source :	**-**	Location 1 :	**TSF_BH_13**
For use as :	**-**	Location 2 :	**6.00-7.00m**
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Oven Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**150**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**19**	**15**	**4**	**2.0**
Specifications :				

Remarks :	

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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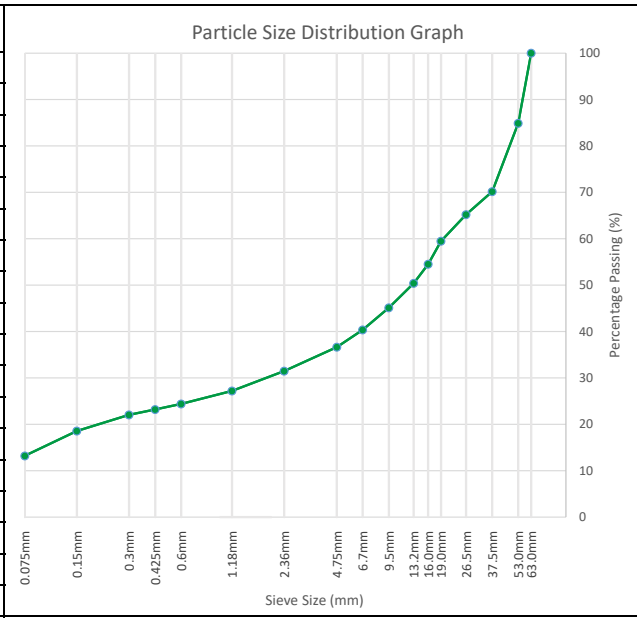
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 11/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**silty GRAVEL - brown**

Sample Number :	**S/00931**	Sampling Method :	**As Received**
Date Tested :	**12/08/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_BH_13**
For Use As :	-	Location 2 :	**12.00-13.00m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**85**	
37.5	**70**	
26.5	**65**	
19.0	**59**	
16	**55**	
13.2	**50**	
9.5	**45**	
6.7	**40**	
4.75	**37**	
2.36	**31**	
1.18	**27**	
0.600	**24**	
0.425	**23**	
0.300	**22**	
0.150	**19**	
0.075	**13**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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Atterberg Limits Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 12/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**silty GRAVEL - brown**

Sample Number :	**S/00931**	Sampling Method :	**As Received**
Date Tested :	**16/08/2024**	Time :	**00:00**
Material Source :	**-**	Location 1 :	**TSF_BH_13**
For use as :	**-**	Location 2 :	**12.00-13.00m**
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Oven Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**150**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**16**	**14**	**2**	**1.5**
Specifications :				

Remarks :	

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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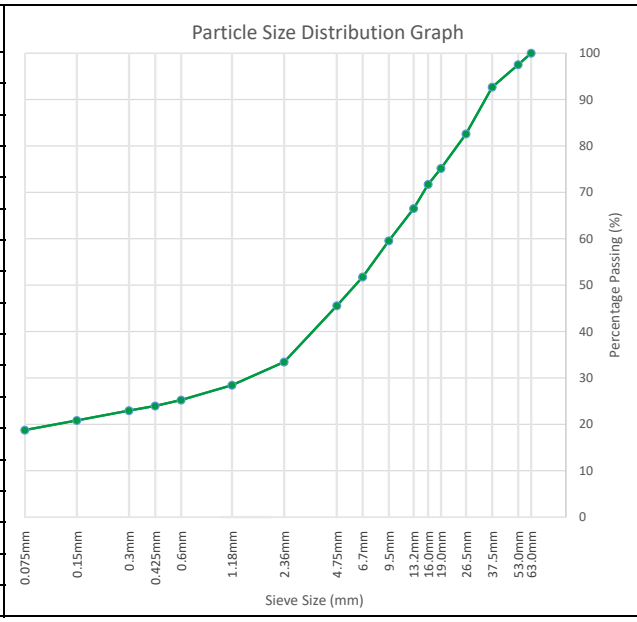
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 13/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**clayey GRAVEL - red brown**

Sample Number :	**S/00933**	Sampling Method :	**As Received**
Date Tested :		Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_19**
For Use As :	-	Location 2 :	**0.0-0.60m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**98**	
37.5	**93**	
26.5	**83**	
19.0	**75**	
16	**72**	
13.2	**67**	
9.5	**60**	
6.7	**52**	
4.75	**46**	
2.36	**33**	
1.18	**28**	
0.600	**25**	
0.425	**24**	
0.300	**23**	
0.150	**21**	
0.075	**19**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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Atterberg Limits Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 14/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**clayey GRAVEL - red brown**

Sample Number :	**S/00933**	Sampling Method :	**As Received**
Date Tested :	**16/08/2024**	Time :	**00:00**
Material Source :	**-**	Location 1 :	**TSF_TP_19**
For use as :	**-**	Location 2 :	**0.0-0.60m**
Lot Number :	**-**	Location 3 :	**-**
ATT Specification Number :	**N/A**	Location 4 :	**-**

History of Sample :	**Oven Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**150**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**32**	**17**	**15**	**7.0**
Specifications :				

Remarks :	

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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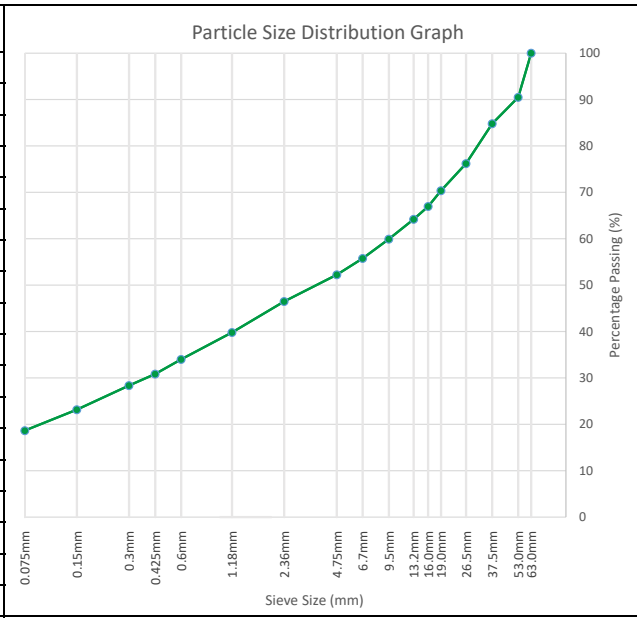
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 16/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**silty GRAVEL- brown**

Sample Number :	**S/00934**	Sampling Method :	**As Received**
Date Tested :	**16/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_23**
For Use As :	-	Location 2 :	**0.50-1.10m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**91**	
37.5	**85**	
26.5	**76**	
19.0	**70**	
16	**67**	
13.2	**64**	
9.5	**60**	
6.7	**56**	
4.75	**52**	
2.36	**46**	
1.18	**40**	
0.600	**34**	
0.425	**31**	
0.300	**28**	
0.150	**23**	
0.075	**19**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Atterberg Limits Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 17/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**silty GRAVEL- brown**

Sample Number :	**S/00934**	Sampling Method :	**As Received**
Date Tested :	**16/08/2024**	Time :	**00:00**
Material Source :	**-**	Location 1 :	**TSF_TP_23**
For use as :	**-**	Location 2 :	**0.50-1.10m**
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Oven Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**150**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**24**	**17**	**7**	**5.0**
Specifications :				

Remarks :	

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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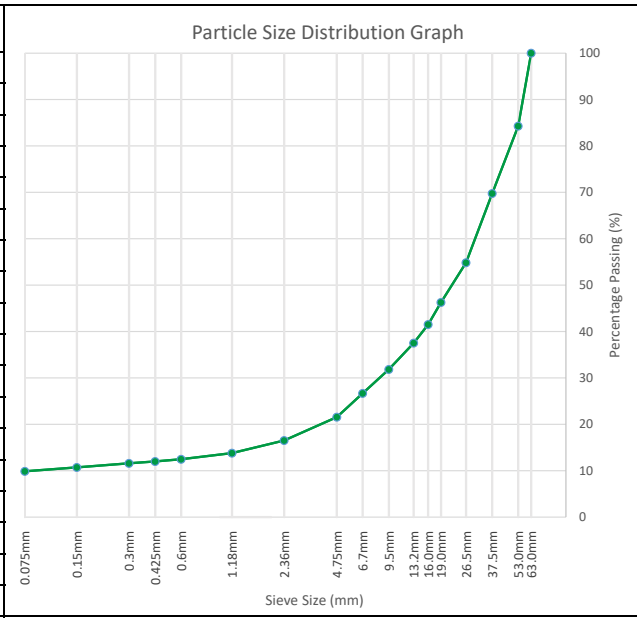
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 18/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**silty GRAVEL - brown**

Sample Number :	**S/00935**	Sampling Method :	**As Received**
Date Tested :	**16/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_11**
For Use As :	-	Location 2 :	**0.60-1.00m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**84**	
37.5	**70**	
26.5	**55**	
19.0	**46**	
16	**42**	
13.2	**38**	
9.5	**32**	
6.7	**27**	
4.75	**22**	
2.36	**17**	
1.18	**14**	
0.600	**12**	
0.425	**12**	
0.300	**12**	
0.150	**11**	
0.075	**10**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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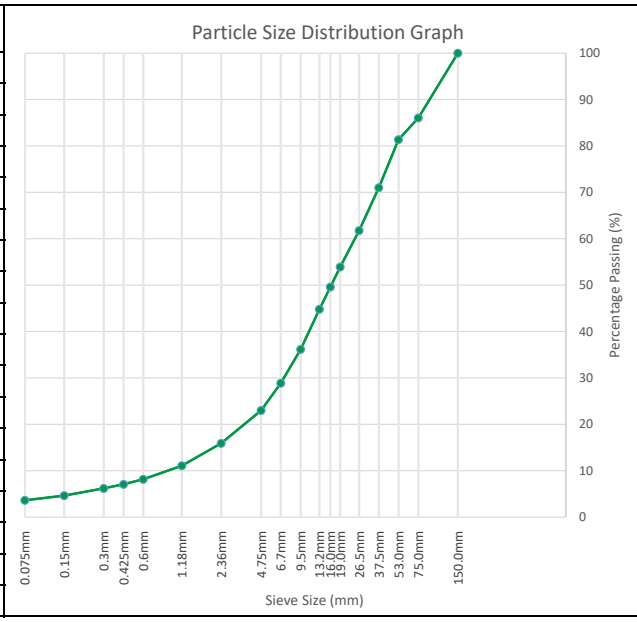
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 19/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**silty GRAVEL - brown**

Sample Number :	**S/00936**	Sampling Method :	**As Received**
Date Tested :	**31/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_WRD1**
For Use As :	-	Location 2 :	**0.80-1.50m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
150.0	**100**	
75.0	**86**	
53.0	**81**	
37.5	**71**	
26.5	**62**	
19.0	**54**	
16	**50**	
13.2	**45**	
9.5	**36**	
6.7	**29**	
4.75	**23**	
2.36	**16**	
1.18	**11**	
0.600	**8**	
0.425	**7**	
0.300	**6**	
0.150	**5**	
0.075	**4**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing
Precision Geotechnical Services Accreditation Number - 21250
Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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Chris Channon - Signatory

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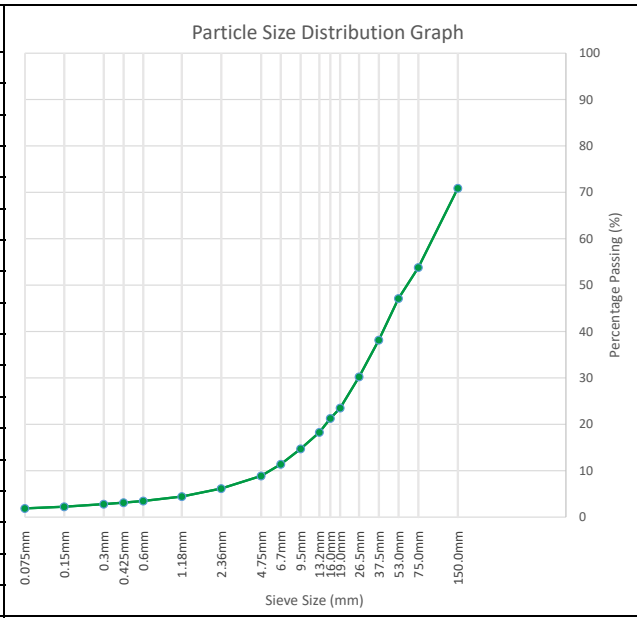
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 20/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**GRAVEL - grey brown**

Sample Number :	**S/00937**	Sampling Method :	**As Received**
Date Tested :	**1/08/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_WRD2**
For Use As :	-	Location 2 :	**0.00-1.10m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
150.0	**71**	
75.0	**54**	
53.0	**47**	
37.5	**38**	
26.5	**30**	
19.0	**24**	
16	**21**	
13.2	**18**	
9.5	**15**	
6.7	**11**	
4.75	**9**	
2.36	**6**	
1.18	**4**	
0.600	**3**	
0.425	**3**	
0.300	**3**	
0.150	**2**	
0.075	**2**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Precision Geotechnical Services Accreditation Number - 21250
Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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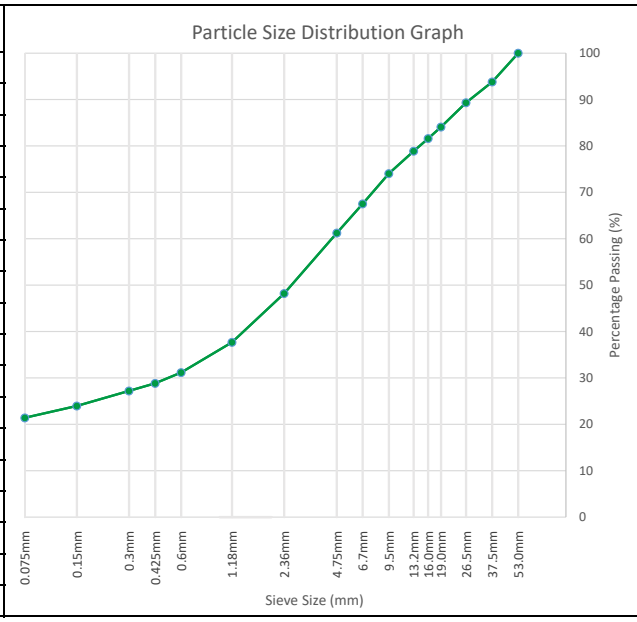
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Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 21/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		
Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**		
Material Description	**clayey silty GRAVEL - red brown**		
Sample Number :	**S/00938**	Sampling Method :	**As Received**
Date Tested :	**30/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_25**
For Use As :	-	Location 2 :	**0.15-0.45m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0	**100**	
37.5	**94**	
26.5	**89**	
19.0	**84**	
16	**82**	
13.2	**79**	
9.5	**74**	
6.7	**68**	
4.75	**61**	
2.36	**48**	
1.18	**38**	
0.600	**31**	
0.425	**29**	
0.300	**27**	
0.150	**24**	
0.075	**21**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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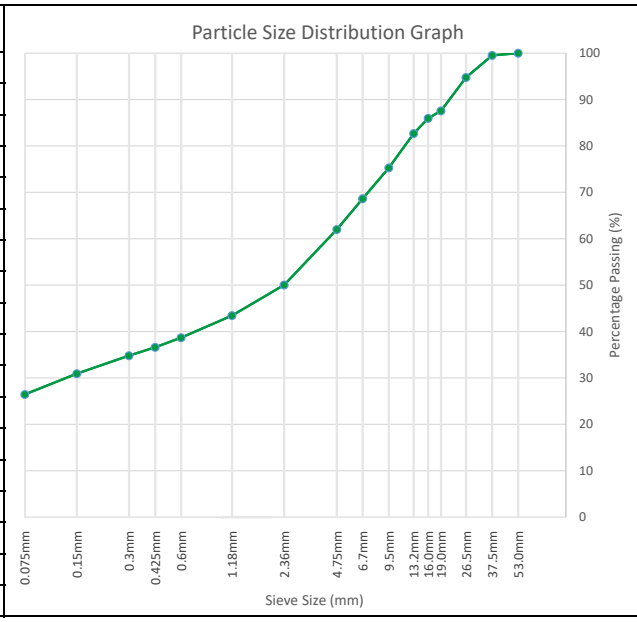
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 22/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**clayey GRAVEL- brown**

Sample Number :	**S/00939**	Sampling Method :	**As Received**
Date Tested :	**30/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_06**
For Use As :	-	Location 2 :	**0.0-0.70m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0	**100**	
37.5	**100**	
26.5	**95**	
19.0	**88**	
16	**86**	
13.2	**83**	
9.5	**75**	
6.7	**69**	
4.75	**62**	
2.36	**50**	
1.18	**43**	
0.600	**39**	
0.425	**37**	
0.300	**35**	
0.150	**31**	
0.075	**26**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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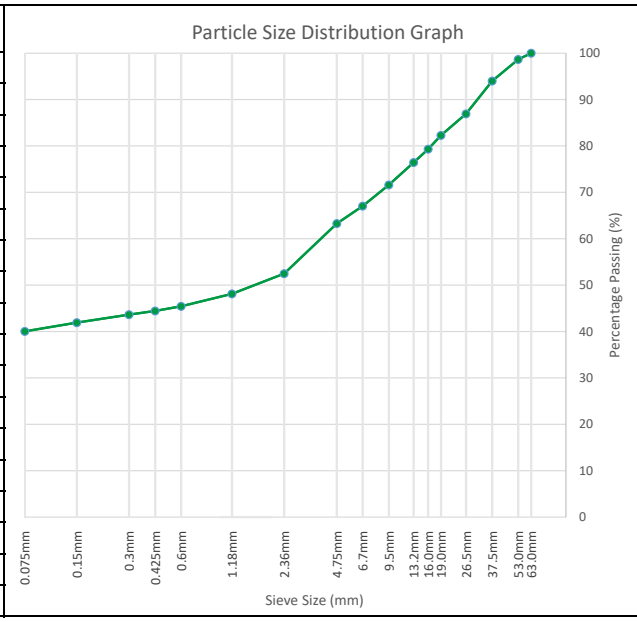
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Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 23/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		
Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**		
Material Description	**gravelly silty CLAY - red brown**		
Sample Number :	**S/00940**	Sampling Method :	**As Received**
Date Tested :	**30/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_06**
For Use As :	-	Location 2 :	**1.40-1.60m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**99**	
37.5	**94**	
26.5	**87**	
19.0	**82**	
16	**79**	
13.2	**76**	
9.5	**72**	
6.7	**67**	
4.75	**63**	
2.36	**52**	
1.18	**48**	
0.600	**45**	
0.425	**44**	
0.300	**44**	
0.150	**42**	
0.075	**40**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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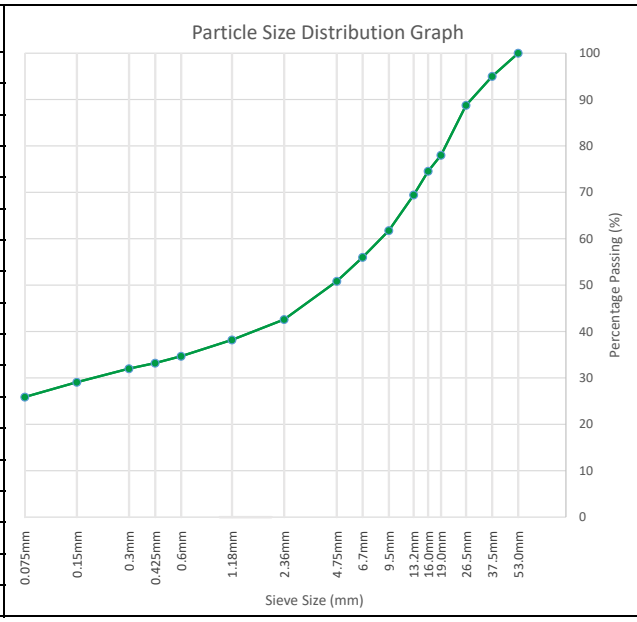
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 24/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**clayey GRAVEL- brown**

Sample Number :	**S/00941**	Sampling Method :	**As Received**
Date Tested :	**30/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_08**
For Use As :	-	Location 2 :	**0.0-0.70m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0	**100**	
37.5	**95**	
26.5	**89**	
19.0	**78**	
16	**75**	
13.2	**69**	
9.5	**62**	
6.7	**56**	
4.75	**51**	
2.36	**43**	
1.18	**38**	
0.600	**35**	
0.425	**33**	
0.300	**32**	
0.150	**29**	
0.075	**26**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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ABN: 18 667 147 917
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Atterberg Limits Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 25/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**clayey GRAVEL- brown**

Sample Number :	**S/00941**	Sampling Method :	**As Received**
Date Tested :	**16/08/2024**	Time :	**00:00**
Material Source :	**-**	Location 1 :	**TSF_TP_08**
For use as :	**-**	Location 2 :	**0.0-0.70m**
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Oven Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**149**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**27**	**16**	**11**	**6.0**
Specifications :				

Remarks :	

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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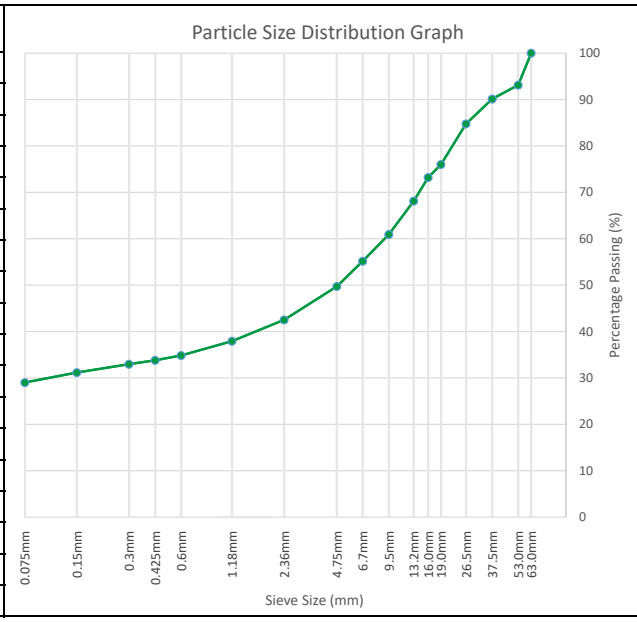
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 26/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**clayey silty GRAVEL - red brown**

Sample Number :	**S/00942**	Sampling Method :	**As Received**
Date Tested :	**31/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_08**
For Use As :	-	Location 2 :	**1.00-1.30m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**93**	
37.5	**90**	
26.5	**85**	
19.0	**76**	
16	**73**	
13.2	**68**	
9.5	**61**	
6.7	**55**	
4.75	**50**	
2.36	**43**	
1.18	**38**	
0.600	**35**	
0.425	**34**	
0.300	**33**	
0.150	**31**	
0.075	**29**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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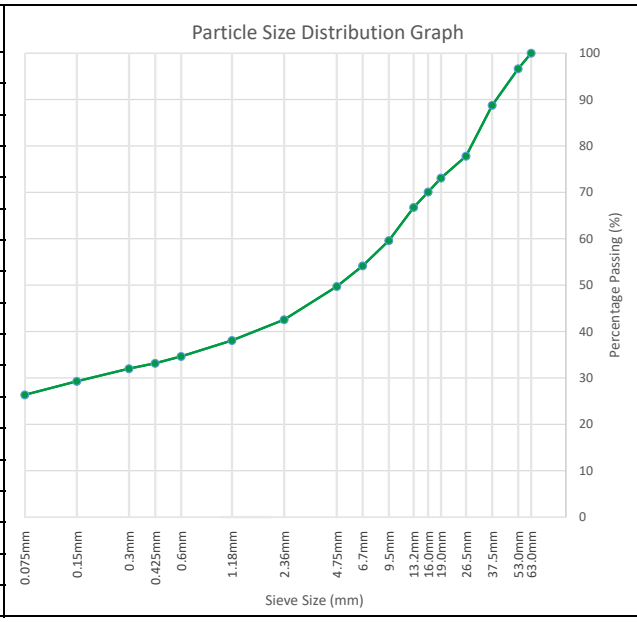
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 27/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**clayey GRAVEL - brown**

Sample Number :	**S/00943**	Sampling Method :	**As Received**
Date Tested :	**31/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_12**
For Use As :	-	Location 2 :	**0.60-1.60m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**97**	
37.5	**89**	
26.5	**78**	
19.0	**73**	
16	**70**	
13.2	**67**	
9.5	**60**	
6.7	**54**	
4.75	**50**	
2.36	**43**	
1.18	**38**	
0.600	**35**	
0.425	**33**	
0.300	**32**	
0.150	**29**	
0.075	**26**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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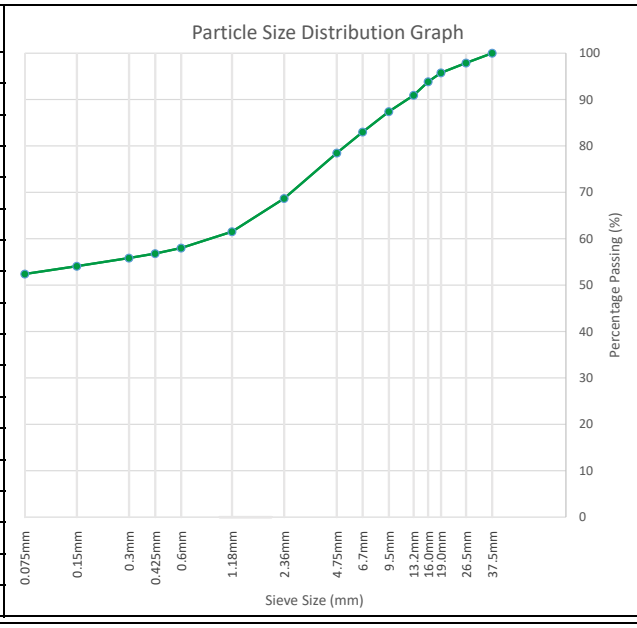
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 28/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**gravelly CLAY - red brown**

Sample Number :	**S/00944**	Sampling Method :	**As Received**
Date Tested :	**31/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_12**
For Use As :	-	Location 2 :	**1.60-2.50m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0		
37.5	**100**	
26.5	**98**	
19.0	**96**	
16	**94**	
13.2	**91**	
9.5	**87**	
6.7	**83**	
4.75	**78**	
2.36	**69**	
1.18	**62**	
0.600	**58**	
0.425	**57**	
0.300	**56**	
0.150	**54**	
0.075	**52**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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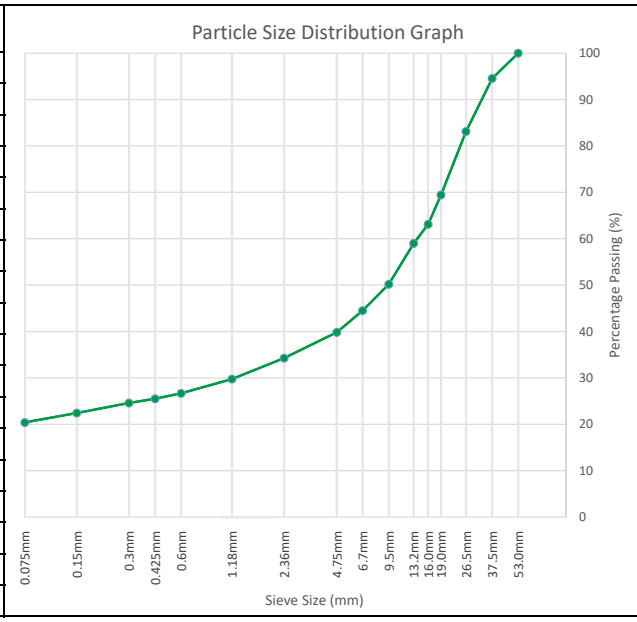
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 29/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**clayey GRAVEL - red brown**

Sample Number :	**S/00945**	Sampling Method :	**As Received**
Date Tested :	**31/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_15**
For Use As :	-	Location 2 :	**0.00-1.00m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0	**100**	
37.5	**95**	
26.5	**83**	
19.0	**69**	
16	**63**	
13.2	**59**	
9.5	**50**	
6.7	**45**	
4.75	**40**	
2.36	**34**	
1.18	**30**	
0.600	**27**	
0.425	**26**	
0.300	**25**	
0.150	**22**	
0.075	**20**	



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

APPROVED SIGNATORY

Chris Channon - Signatory

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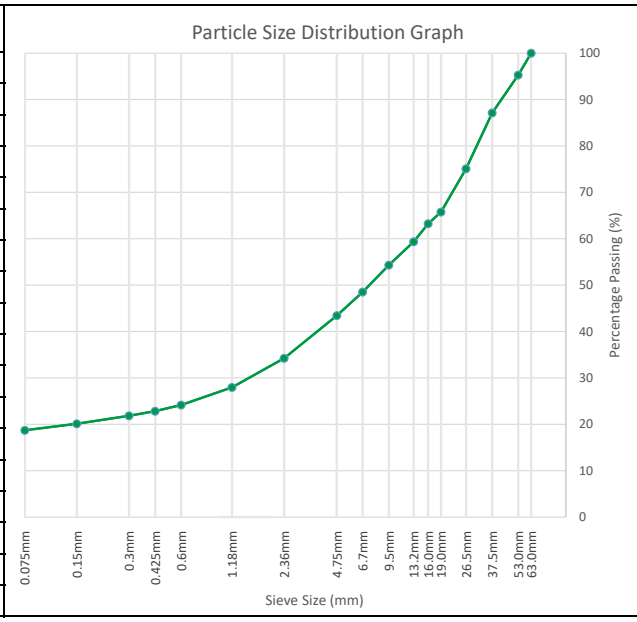
Particle Size Distribution Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 30/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1, AS1289.1.1**
Material Description	**clayey silty GRAVEL - red brown**

Sample Number :	**S/00946**	Sampling Method :	**As Received**
Date Tested :	**31/07/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_02**
For Use As :	-	Location 2 :	**0.40-0.70m**
Lot Number :	-	Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0	**100**	
53.0	**95**	
37.5	**87**	
26.5	**75**	
19.0	**66**	
16	**63**	
13.2	**59**	
9.5	**54**	
6.7	**49**	
4.75	**43**	
2.36	**34**	
1.18	**28**	
0.600	**24**	
0.425	**23**	
0.300	**22**	
0.150	**20**	
0.075	**19**	



Remarks :	-

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Emerson Class Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 32/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.8.1**

Sample Number :	S/00926	S/00927	S/00928	S/00929	S/00930	S/00931
Date Sampled :	12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Date Tested :	20/08/2024	20/08/2024	20/08/2024	20/08/2024	20/08/2024	20/08/2024
Material Source :	-	-	-	-	-	-
For Use As :	-	-	-	-	-	-
Sampling Method :	As Received	As Received	As Received	As Received	As Received	As Received
Time :	00:00	00:00	00:00	00:00	00:00	00:00
Lot Number :	-	-	-	-	-	-
Location 1 :	TSF_BH_14	TSF_BH_14	TSF_BH_14	TSF_BH_13	TSF_BH_13	TSF_BH_13
Location 2 :	3.50-4.00m	13.00-13.50m	15.50-16.00m	0.00-1.00m	6.00-7.00m	12.00-13.00m
Location 3 :	-	-	-	-	-	-
Location 4 :	-	-	-	-	-	-
Water Type :	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled
Soil Description :	silty GRAVEL - brown	silty GRAVEL - brown	silty GRAVEL - brown	silty GRAVEL - brown	silty GRAVEL - brown	silty GRAVEL - brown
Emerson Class Number :	**5**	**5**	**2**	**5**	**5**	**5**

Remarks :	**-**

Note: The results contained in this report relate only to the item/s that were tested/sampled

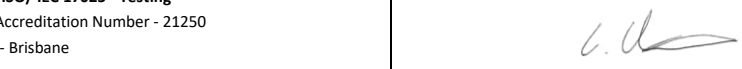
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Precision Geotechnical Services Accreditation Number - 21250

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Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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Emerson Class Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 33/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.8.1**

Sample Number :	S/00933	S/00938	S/00941	S/00942	S/00943	S/00944
Date Sampled :	12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Date Tested :	12/08/2024	12/08/2024	12/08/2024	12/08/2024	12/08/2024	12/08/2024
Material Source :	-	-	-	-	-	-
For Use As :	-	-	-	-	-	-
Sampling Method :	As Received	As Received	As Received	As Received	As Received	As Received
Time :	00:00	00:00	00:00	00:00	00:00	00:00
Lot Number :	-	-	-	-	-	-
Location 1 :	TSF_TP_19	TSF_TP_25	TSF_TP_08	TSF_TP_08	TSF_TP_12	TSF_TP_12
Location 2 :	0.0-0.60m	0.15-0.45m	0.0-0.70m	1.00-1.30m	0.60-1.60m	1.60-2.50m
Location 3 :	-	-	-	-	-	-
Location 4 :	-	-	-	-	-	-
Water Type :	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled
Soil Description :	clayey GRAVEL - red brown	clayey silty GRAVEL - red brown	clayey GRAVEL- brown	clayey silty GRAVEL - red brown	clayey GRAVEL - brown	gravelly CLAY - red brown
Emerson Class Number :	**4**	**5**	**4**	**4**	**4**	**6**

Remarks :	**-**

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Accredited for Compliance with ISO/ IEC 17025 - Testing

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APPROVED SIGNATORY

Chris Channon - Signatory

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Emerson Class Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 34/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**20/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.3.8.1**

Sample Number :	S/00945	S/00946				
Date Sampled :	12/07/2024	12/07/2024				
Date Tested :	12/08/2024	12/08/2024				
Material Source :	-	-				
For Use As :	-	-				
Sampling Method :	As Received	As Received				
Time :	00:00	00:00				
Lot Number :	-	-				
Location 1 :	TSF_TP_15	TSF_TP_02				
Location 2 :	0.00-1.00m	0.40-0.70m				
Location 3 :	-	-				
Location 4 :	-	-				
Water Type :	Distilled	Distilled				
Soil Description :	clayey GRAVEL - red brown	clayey silty GRAVEL - red brown				
Emerson Class Number :	**5**	**4**				

Remarks :	**-**

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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Chris Channon - Signatory

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Moisture Density Relationship Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 35/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**21/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

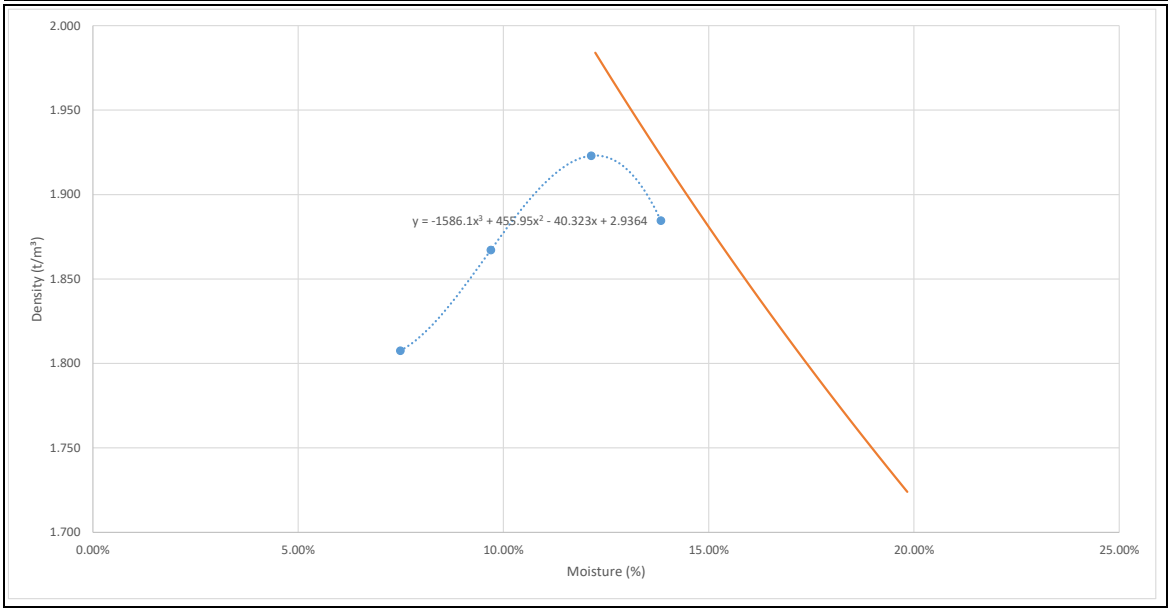
Test Methods :	**AS1289.5.1.1, AS1289.2.1.1**
Material Description :	**silty GRAVEL- brown**

Sample Number :	**S/00934**	Sampling Method :	**As Received**
Date Tested :	**13/08/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_23**
For Use As :	-	Location 2 :	**0.50-1.10m**
Lot Number :	-	Location 3 :	-
		Location 4 :	-

Test Fraction (mm) :	**< 19.00mm**	Liquid Limit Method :	**Tactile/Visual Assessment**
Oversize Wet :	-	Curing Time (hrs) :	**48**
Oversize Density - Wet (t/m³) :	-		
Field Moisture :	**6.9%**		

MDD (t/m³) : **1.92**

OMC : **12.0%**



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025

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Moisture Density Relationship Report

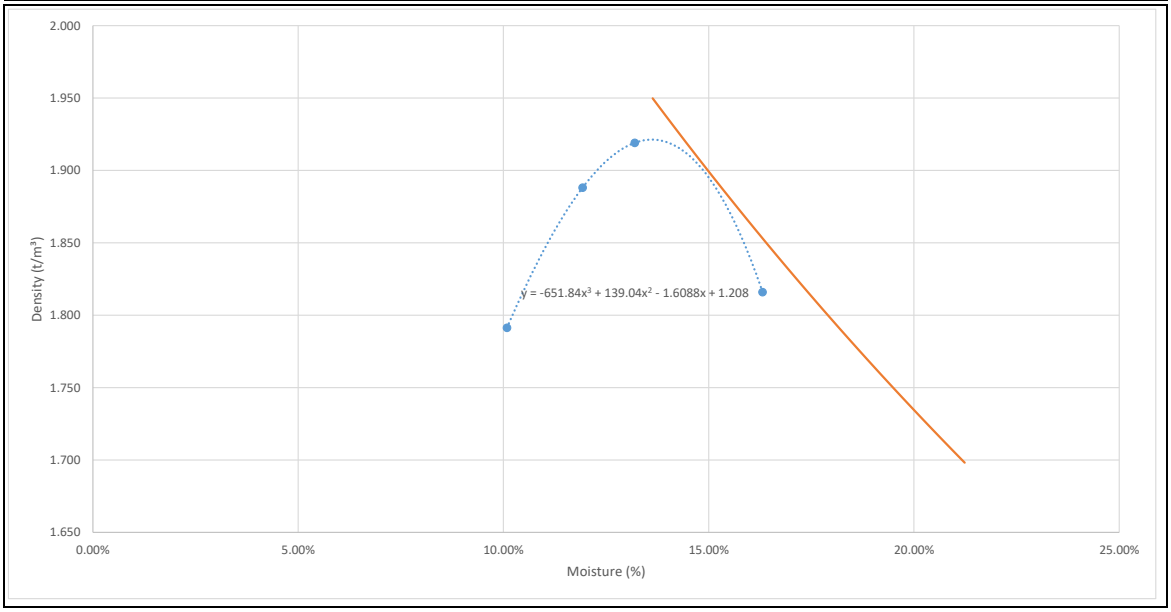
Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 36/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**21/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**		
Location :	**Brisbane City**	**Page 1 of 1**	

Test Methods :	**AS1289.5.1.1, AS1289.2.1.1**
Material Description :	**clayey GRAVEL - red brown**

Sample Number :	**S/00933**	Sampling Method :	**As Received**
Date Tested :	**13/08/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_19**
For Use As :	-	Location 2 :	**0.0-0.60m**
Lot Number :	-	Location 3 :	-
		Location 4 :	-

Test Fraction (mm) :	**< 19.00mm**	Liquid Limit Method :	**Tactile/Visual Assessment**
Oversize Wet :	-	Curing Time (hrs) :	**48**
Oversize Density - Wet (t/m³) :	-		
Field Moisture :	**9.6%**		

MDD (t/m³) :	**1.92**
OMC :	**13.5%**



Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025

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Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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Moisture Density Relationship Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 37/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**21/08/2024**
Project Name :	**QC1022_018**	Test Request :	-
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

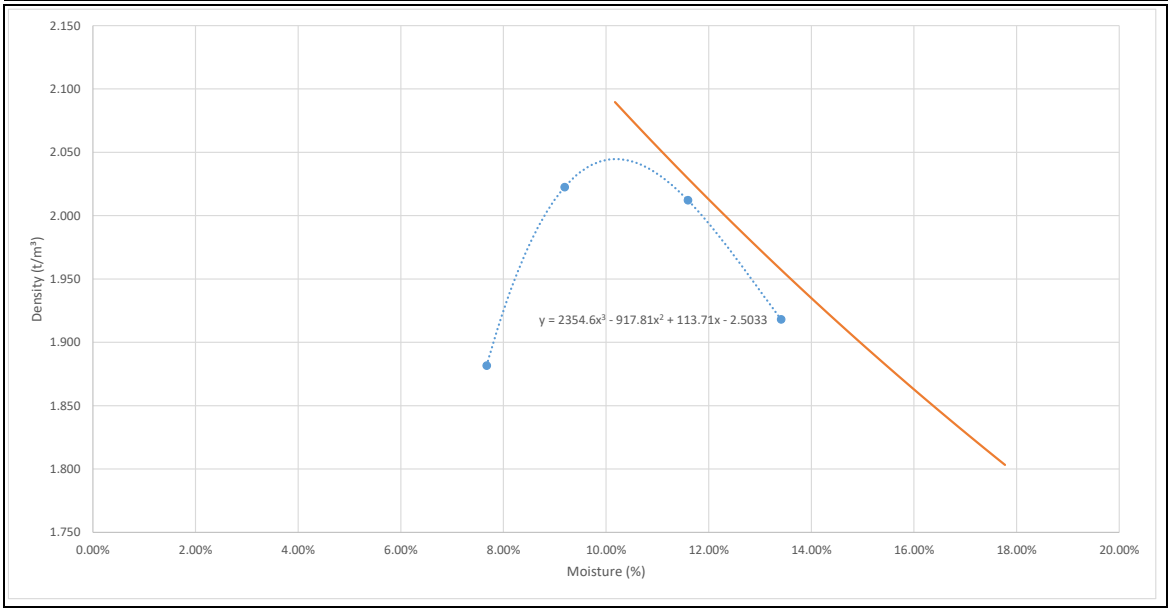
Test Methods :	**AS1289.5.1.1, AS1289.2.1.1**
Material Description :	**silty GRAVEL - brown**

Sample Number :	**S/00935**	Sampling Method :	**As Received**
Date Tested :	**13/08/2024**	Time :	**00:00**
Material Source :	-	Location 1 :	**TSF_TP_11**
For Use As :	-	Location 2 :	**0.60-1.00m**
Lot Number :	-	Location 3 :	-
		Location 4 :	-

Test Fraction (mm) :	**< 19.00mm**	Liquid Limit Method :	**Tactile/Visual Assessment**
Oversize Wet :	-	Curing Time (hrs) :	**48**
Oversize Density - Wet (t/m³) :	-		
Field Moisture :	**5.4%**		

MDD (t/m³) : **2.04**

OMC : **10.0%**



Remarks :	-

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Accredited for Compliance with ISO/ IEC 17025

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Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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Moisture Content Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 38/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**21/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.2.1.1**

Sample Number :	S/00926	S/00927	S/00928	S/00929	S/00930	S/00931
Date Tested :	12/08/2024	12/08/2024	12/08/2024	12/08/2024	12/08/2024	12/08/2024
Material Source :	-	-	-	-	-	-
For Use As :	-	-	-	-	-	-
Sampling Method :	As Received	As Received	As Received	As Received	As Received	As Received
Time :	00:00	00:00	00:00	00:00	00:00	00:00
Lot Number :	-	-	-	-	-	-
Location 1 :	TSF_BH_14	TSF_BH_14	TSF_BH_14	TSF_BH_13	TSF_BH_13	TSF_BH_13
Location 2 :	3.50-4.00m	13.00-13.50m	15.50-16.00m	0.00-1.00m	6.00-7.00m	12.00-13.00m
Location 3 :	-	-	-	-	-	-
Location 4 :	-	-	-	-	-	-
Moisture Content (%) :	**0.1**	**0.2**	**0.0**	**0.2**	**0.2**	**0.1**

Remarks :	**-**

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Accredited for Compliance with ISO/ IEC 17025 - Testing

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Chris Channon - Signatory

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Moisture Content Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 39/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**21/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.2.1.1**

Sample Number :	S/00933	S/00934	S/00935	S/00936	S/00937	S/00938
Date Tested :	16/07/2024	16/07/2024	16/07/2024	16/07/2024	16/07/2024	16/07/2024
Material Source :	-	-	-	-	-	-
For Use As :	-	-	-	-	-	-
Sampling Method :	As Received	As Received	As Received	As Received	As Received	As Received
Time :	00:00	00:00	00:00	00:00	00:00	00:00
Lot Number :	-	-	-	-	-	-
Location 1 :	TSF_TP_19	TSF_TP_23	TSF_TP_11	TSF_TP_WRD1	TSF_TP_WRD2	TSF_TP_25
Location 2 :	0.0-0.60m	0.50-1.10m	0.60-1.00m	0.80-1.50m	0.00-1.10m	0.15-0.45m
Location 3 :	-	-	-	-	-	-
Location 4 :	-	-	-	-	-	-
Moisture Content (%) :	**9.6**	**6.9**	**5.4**	**2.4**	**2.4**	**17.1**

Remarks :	**-**

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Accredited for Compliance with ISO/ IEC 17025 - Testing

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Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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Chris Channon - Signatory

Precision Geotechnical Services
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Moisture Content Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 40/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**21/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.2.1.1**

Sample Number :	S/00939	S/00940	S/00941	S/00942	S/00943	S/00944
Date Tested :	30/07/2024	30/07/2024	30/07/2024	30/07/2024	30/07/2024	30/07/2024
Material Source :	-	-	-	-	-	-
For Use As :	-	-	-	-	-	-
Sampling Method :	As Received	As Received	As Received	As Received	As Received	As Received
Time :	00:00	00:00	00:00	00:00	00:00	00:00
Lot Number :	-	-	-	-	-	-
Location 1 :	TSF_TP_06	TSF_TP_06	TSF_TP_08	TSF_TP_08	TSF_TP_12	TSF_TP_12
Location 2 :	0.0-0.70m	1.40-1.60m	0.0-0.70m	1.00-1.30m	0.60-1.60m	1.60-2.50m
Location 3 :	-	-	-	-	-	-
Location 4 :	-	-	-	-	-	-
Moisture Content (%) :	**12.6**	**8.9**	**14.6**	**14.6**	**16.5**	**23.1**

Remarks :	**-**

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

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Moisture Content Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 41/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**21/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.2.1.1**

Sample Number :	S/00944	S/00945				
Date Tested :	31/07/2024	31/07/2024				
Material Source :	-	-				
For Use As :	-	-				
Sampling Method :	As Received	As Received				
Time :	00:00	00:00				
Lot Number :	-	-				
Location 1 :	TSF_TP_12	TSF_TP_15				
Location 2 :	1.60-2.50m	0.00-1.00m				
Location 3 :	-	-				
Location 4 :	-	-				
Moisture Content (%) :	**16.0**	**15.6**				

Remarks :	**-**

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

APPROVED SIGNATORY

Chris Channon - Signatory

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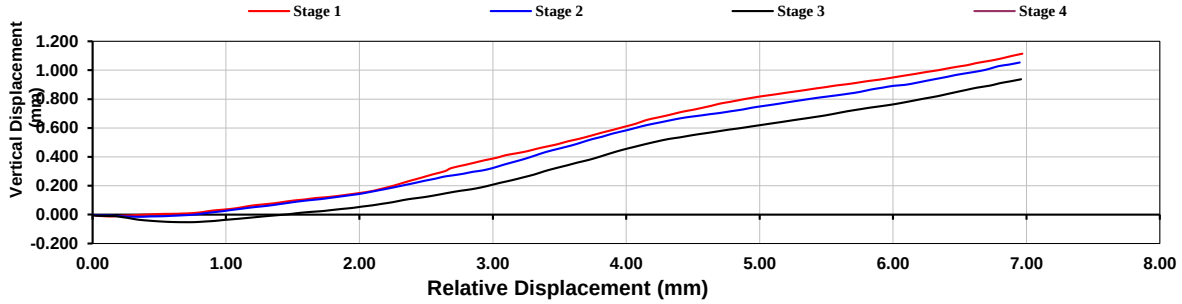
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

DIRECT SHEAR TEST REPORT

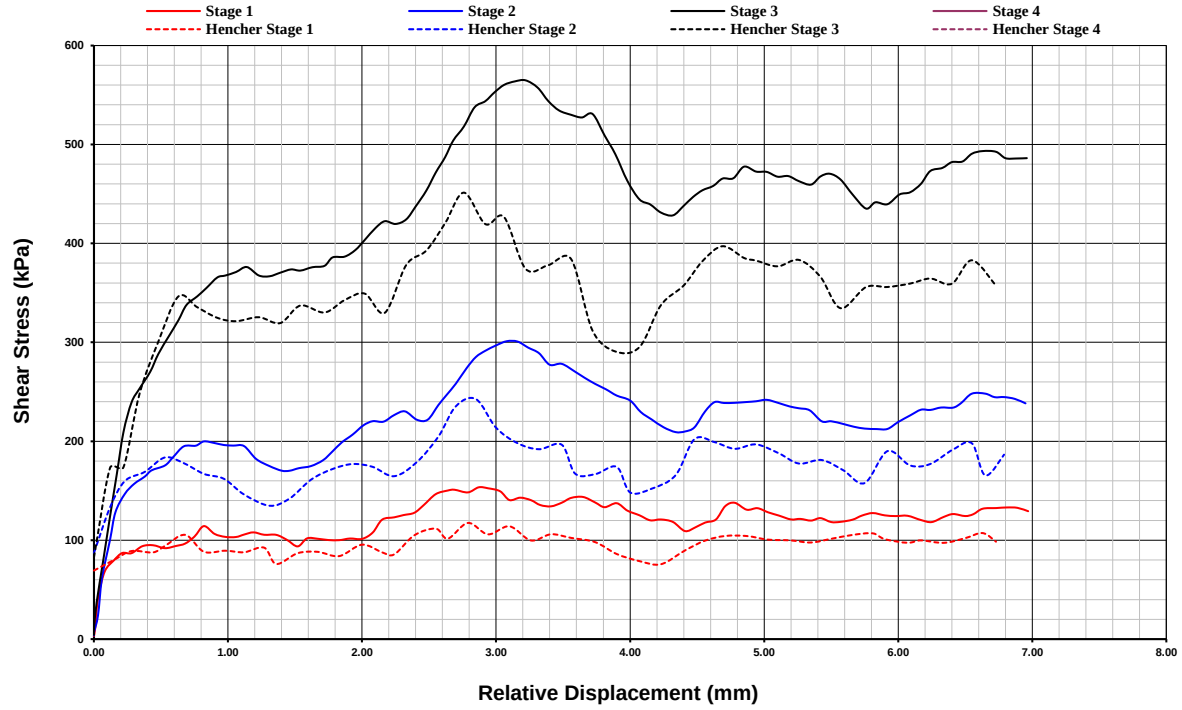
ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083091-MRDS
		Workorder No.	9919/T/611
Address	10 Hungerford Street Northgate QLD 4013	**Test Date**	26/08/2024
		Report Date	30/08/2024
Project	PTP/00143		
Client ID	S/00952	**Bore Hole**	TSF-BH-08
		Depth (m)	9.4 - 9.5
Description	Not Supplied	**Sample Type**	Single individual rock core specimen with existing defect.

Average Vertical Displacement/Relative Displacement Plot



Shear Stress/Displacement Plot



Notes/Remarks: Normal stress corrected for change in area as requested by the client

Note: Area correction based on square sample equation.

Sample/s supplied by the client Graph not to scale

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Approved Signatory

Joshua Rasmussen

Joshua Rasmussen

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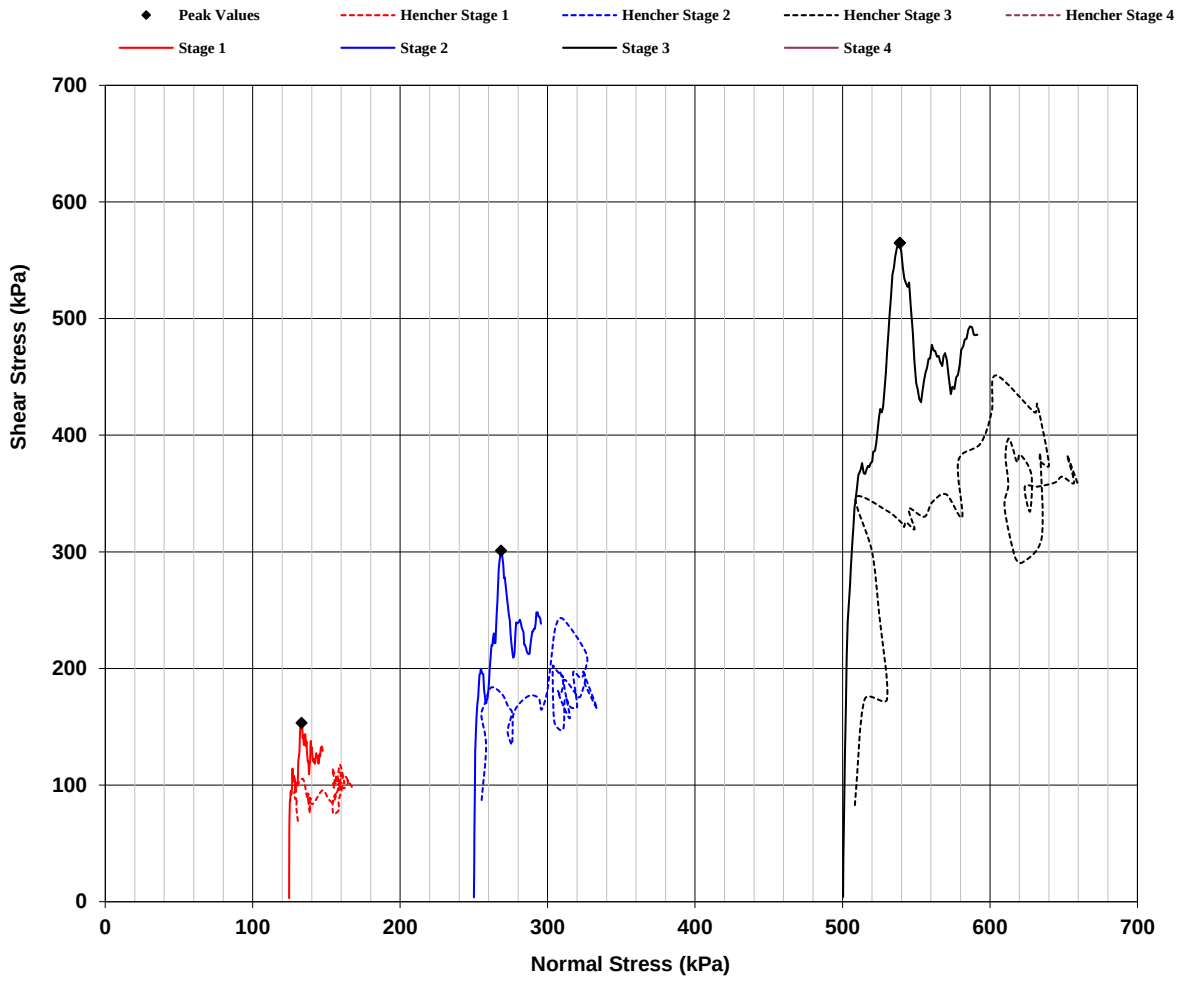
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DIRECT SHEAR TEST REPORT

ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083091-MRDS

Corrected Normal Stress vs Corrected Shear Stress



Shear Angle (°)	45.2	Cohesion (kPa)	24	R^2	1.000
Specimen Condition	As Received	Corrected Normal Stress (kPa)		Corrected Shear Stress (kPa)	
Specimen Dimensions (mm)	77.98 * 60.66	Stage 1	133.1		153.4
Rate of Strain (mm/min)	0.080	Stage 2	268.3		301.1
Initial Moisture Content (%)	1.0	Stage 3	538.8		564.8
Initial Wet Density(t/m^3)	2.50				

Notes/Remarks: Normal stress corrected for change in area as requested by the client
Note: Area correction based on square sample equation.

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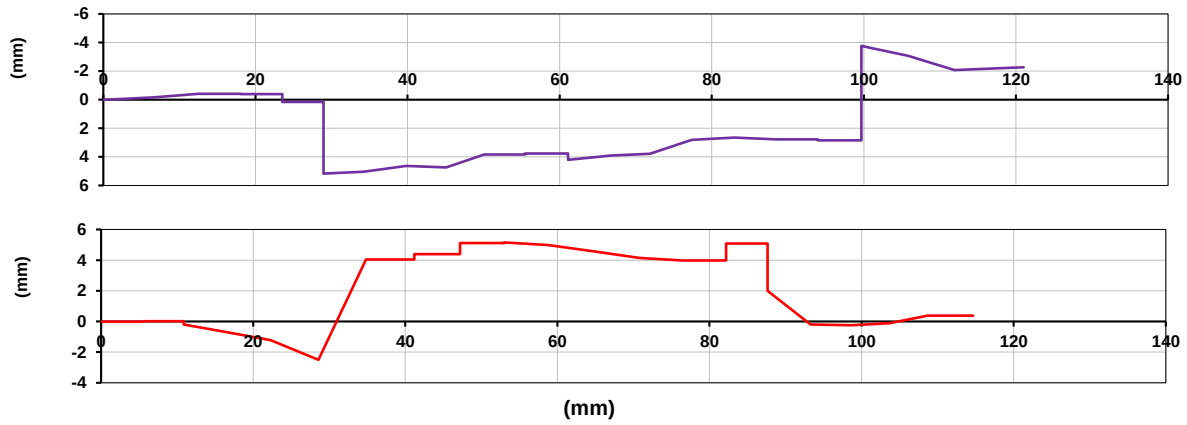
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DIRECT SHEAR TEST REPORT

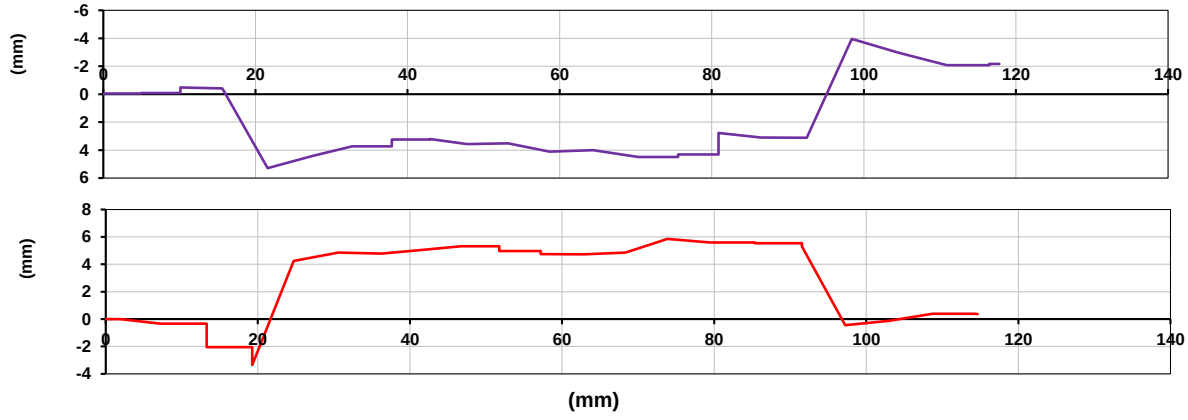
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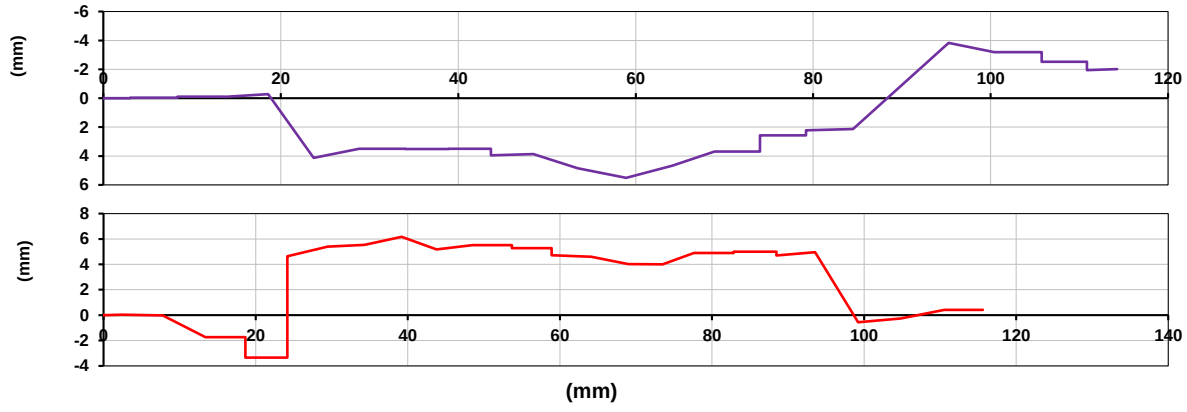
Top and Bottom Profile - Position 1 - Prior to Shearing



Top and Bottom Profile - Position 2 - Prior to Shearing



Top and Bottom Profile - Position 3 - Prior to Shearing



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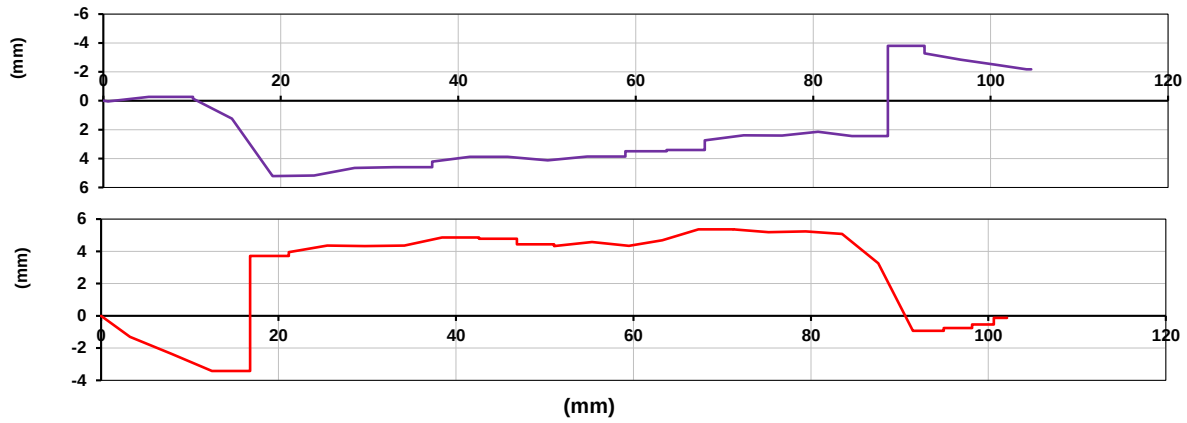
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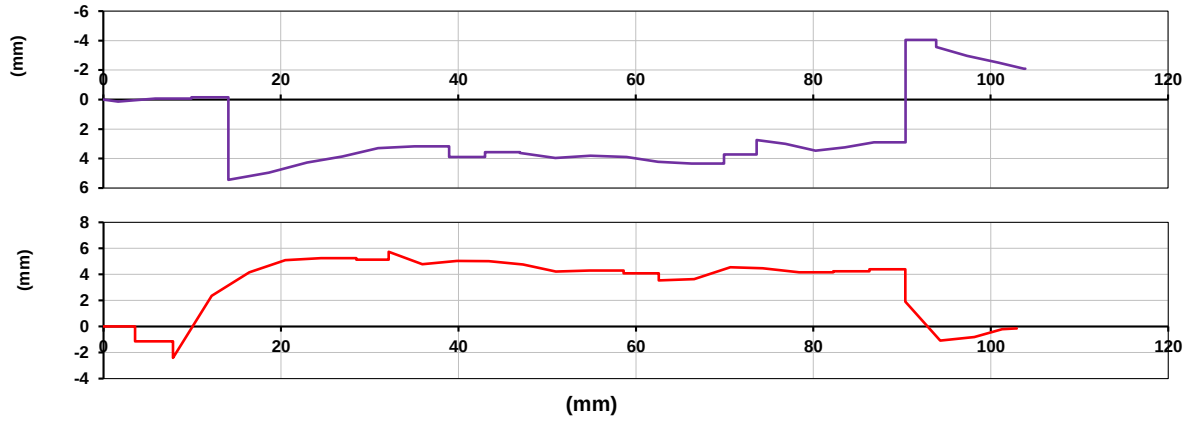
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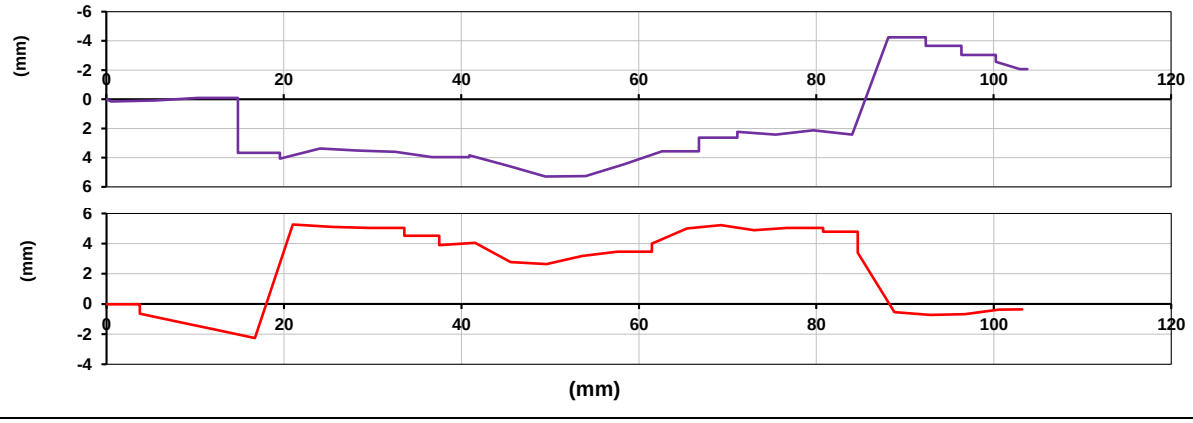
Top and Bottom Profile - Position 1 - After Shearing



Top and Bottom Profile - Position 2 - After Shearing



Top and Bottom Profile - Position 3 - After Shearing



Sample/s supplied by the client

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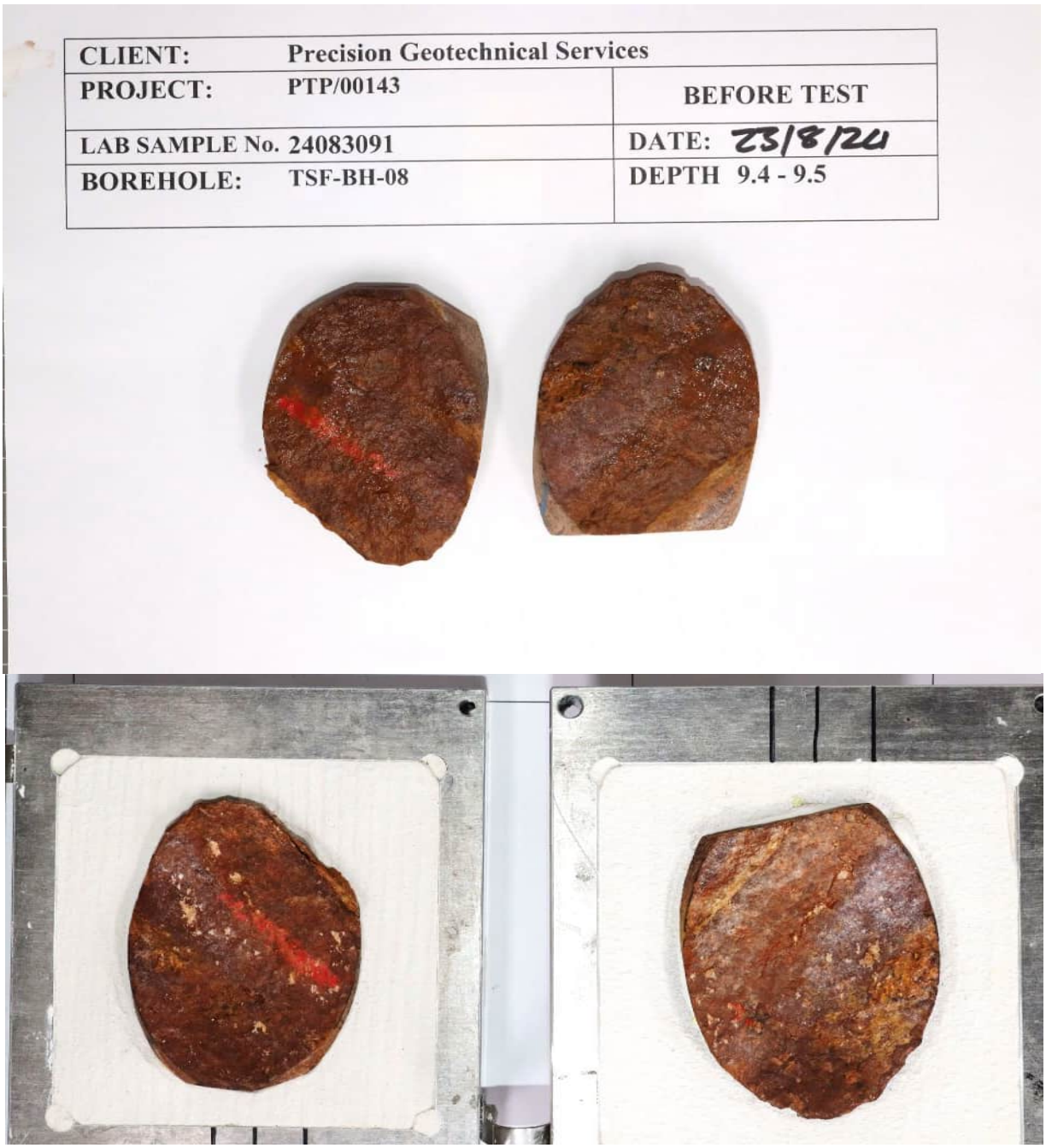
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Client	Precision Geotechnical Services	**Report No**	24083091-MRDS



Sample/s supplied by the client

Photo not to scale

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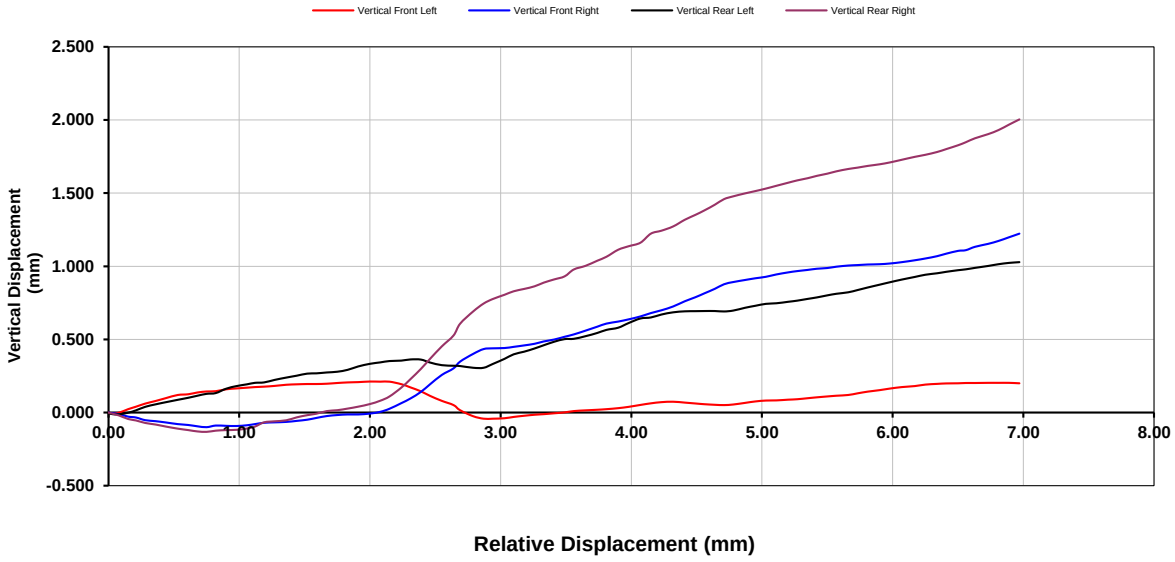
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DIRECT SHEAR TEST REPORT

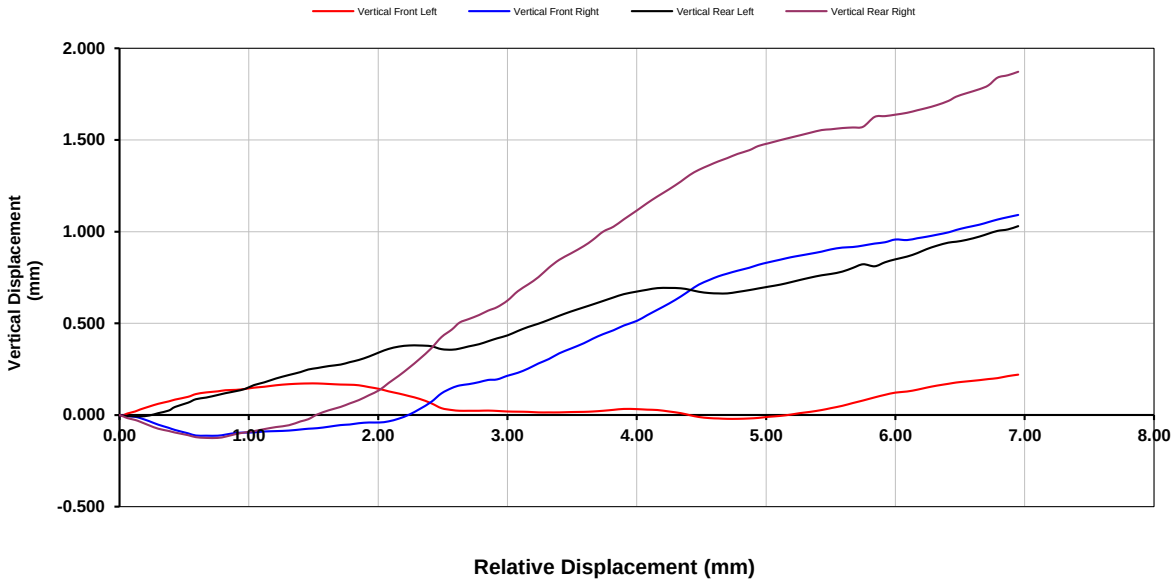
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Client	Precision Geotechnical Services	**Report No**	24083091-MRDS

Stage 1 Vertical Displacement/Relative Displacement Plot



Stage 2 Vertical Displacement/Relative Displacement Plot



Sample/s supplied by the client

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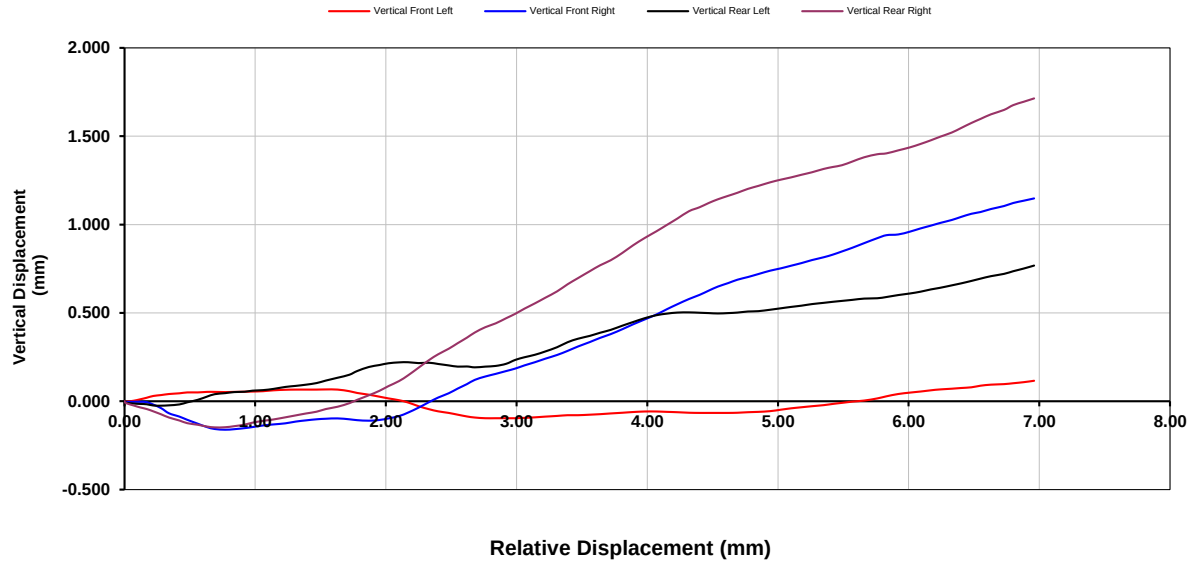
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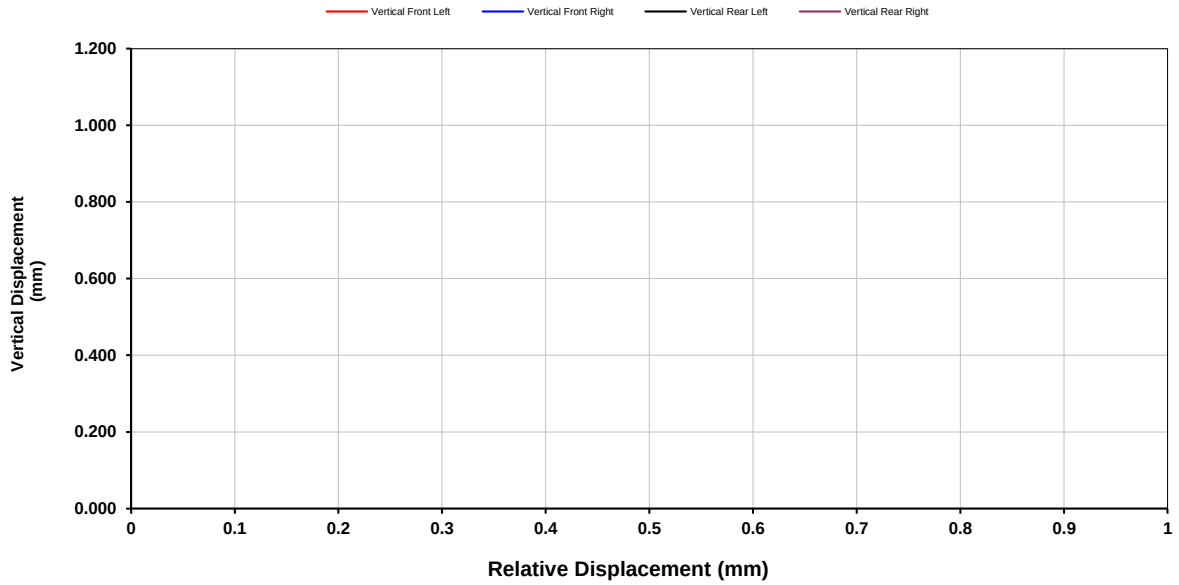
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Client	Precision Geotechnical Services	**Report No**	24083091-MRDS

Stage 3 Vertical Displacement/Relative Displacement Plot



Stage 4 Vertical Displacement/Relative Displacement Plot



Sample/s supplied by the client

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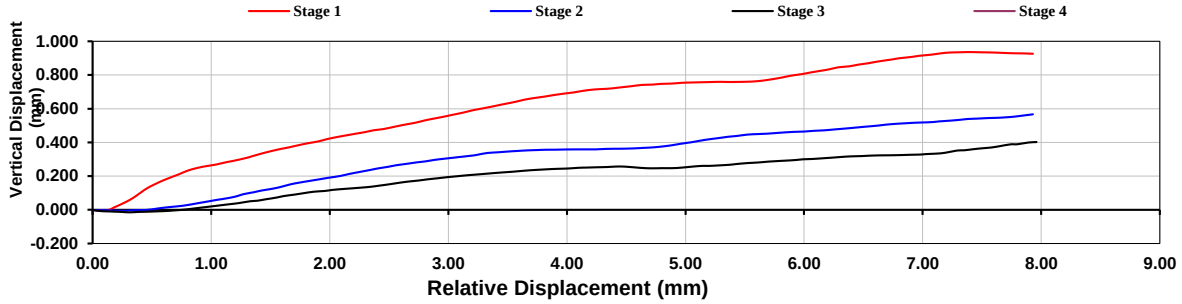
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DIRECT SHEAR TEST REPORT

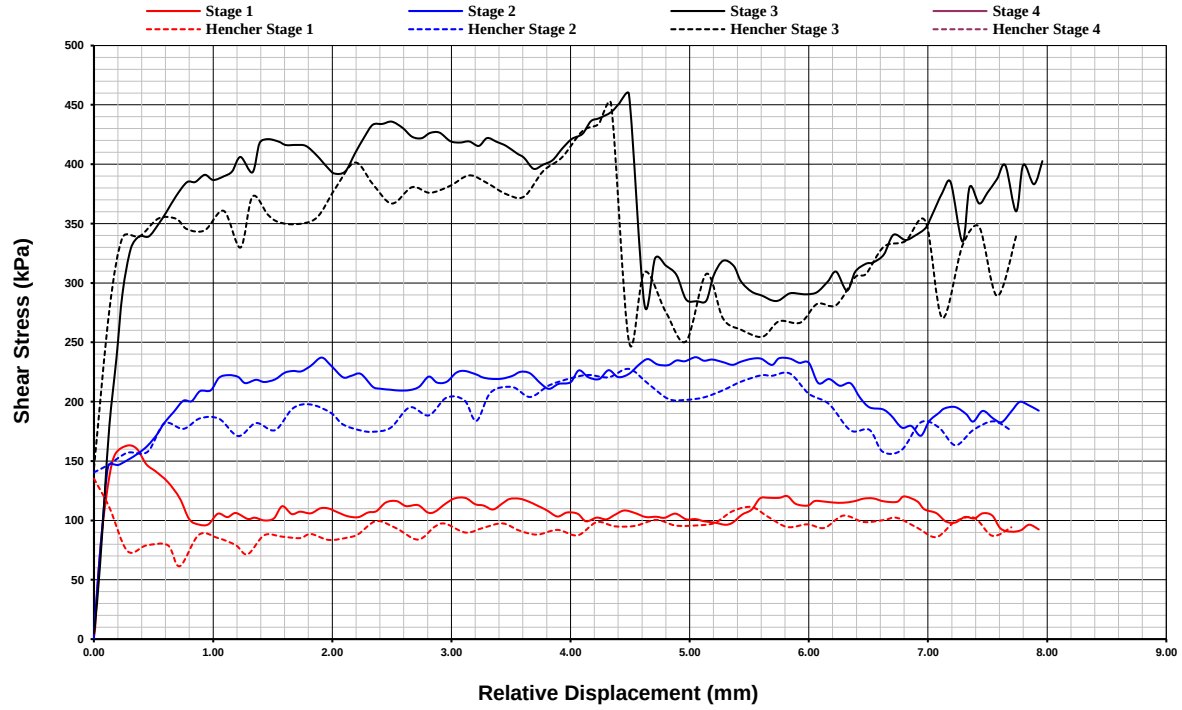
ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083092-MRDS
		Workorder No.	9919/T/611
Address	10 Hungerford Street Northgate QLD 4013	**Test Date**	26/08/2024
		Report Date	30/08/2024
Project	PTP/00143		
Client ID	S/00954	**Bore Hole**	TSF-BH-08
		Depth (m)	12.3 - 12.4
Description	Not Supplied	**Sample Type**	Single individual rock core specimen with existing defect.

Average Vertical Displacement/Relative Displacement Plot



Shear Stress/Displacement Plot



Notes/Remarks: Normal stress corrected for change in area as requested by the client

Note: Area correction based on square sample equation.

Sample/s supplied by the client Graph not to scale

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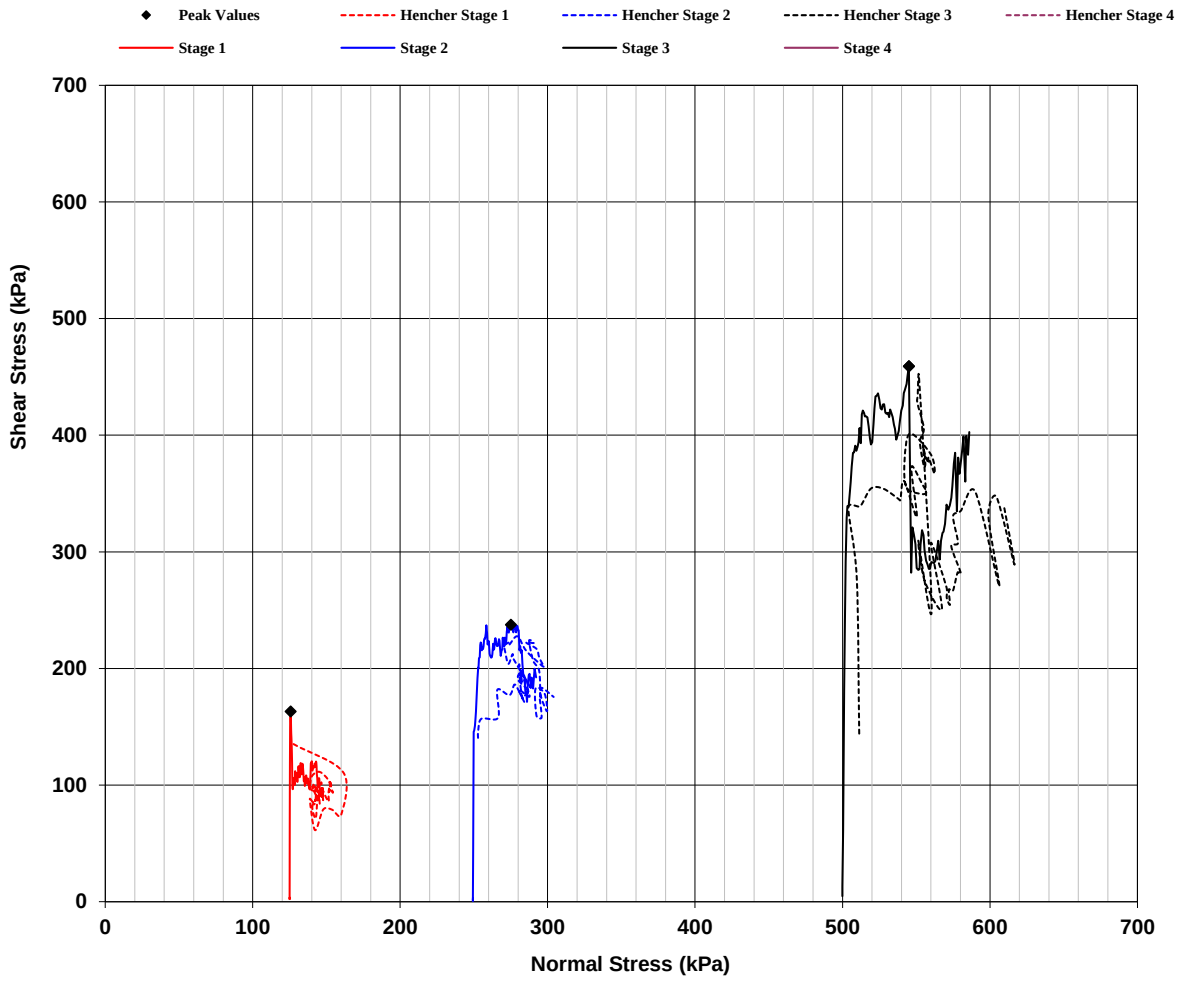
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DIRECT SHEAR TEST REPORT

ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083092-MRDS

Corrected Normal Stress vs Corrected Shear Stress



Shear Angle (°)	**35.8**	**Cohesion (kPa)**	**60**	**R^2**	**0.993**
Specimen Condition	As Received	Corrected Normal Stress (kPa)		Corrected Shear Stress (kPa)	
Specimen Dimensions (mm)	61.83 * 60.93	Stage 1	125.7		163.0
Rate of Strain (mm/min)	0.080	Stage 2	275.0		237.5
Initial Moisture Content (%)	0.3	Stage 3	545.1		459.2
Initial Wet Density(t/m^3)	2.62				

Notes/Remarks: Normal stress corrected for change in area as requested by the client
Note: Area correction based on square sample equation.

Sample/s supplied by the client Graph not to scale

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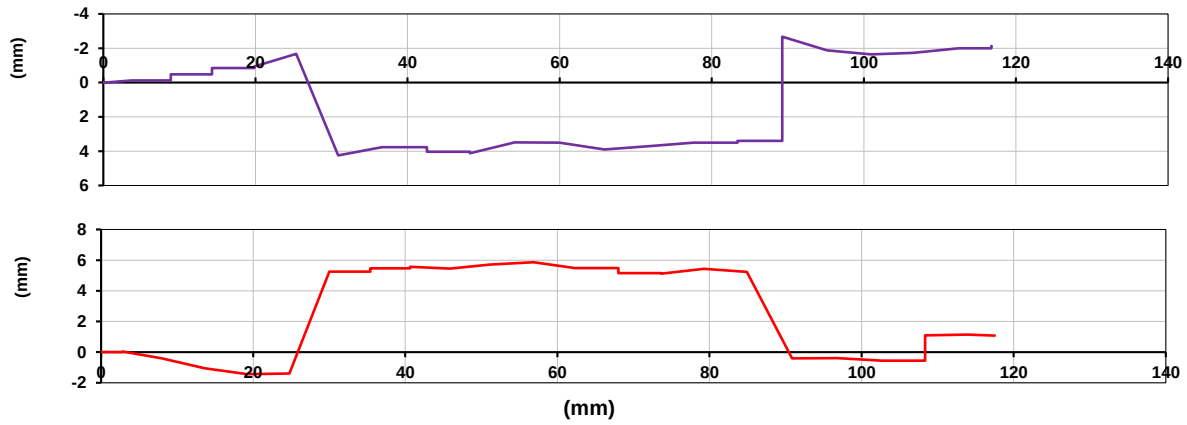
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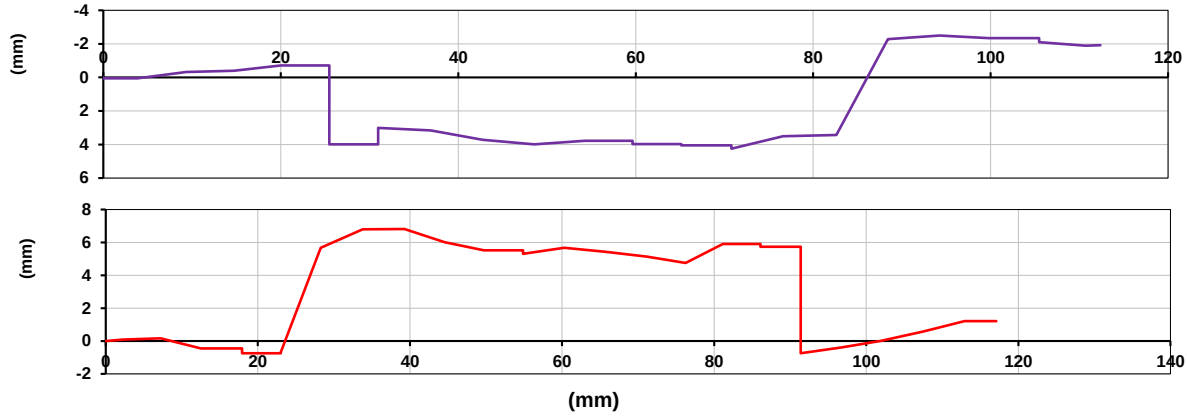
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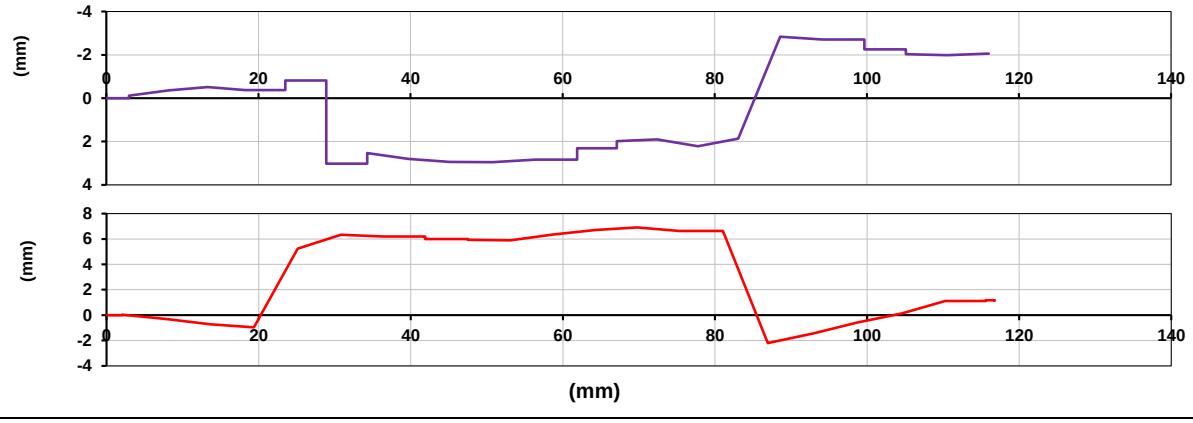
Top and Bottom Profile - Position 1 - Prior to Shearing



Top and Bottom Profile - Position 2 - Prior to Shearing



Top and Bottom Profile - Position 3 - Prior to Shearing



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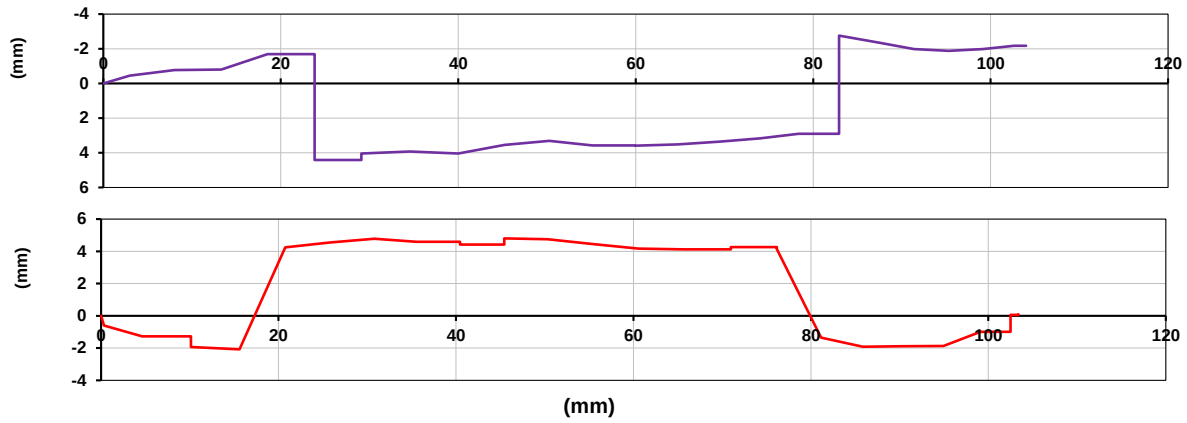
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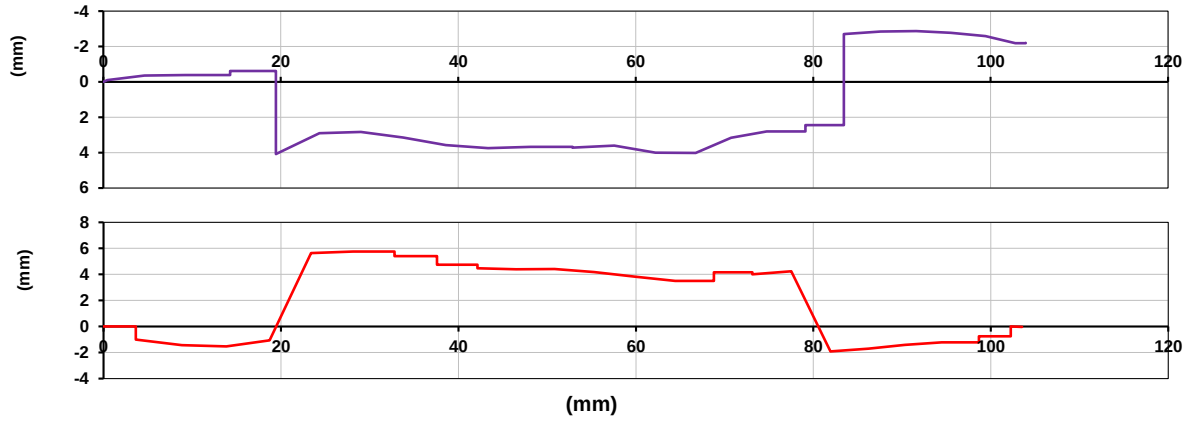
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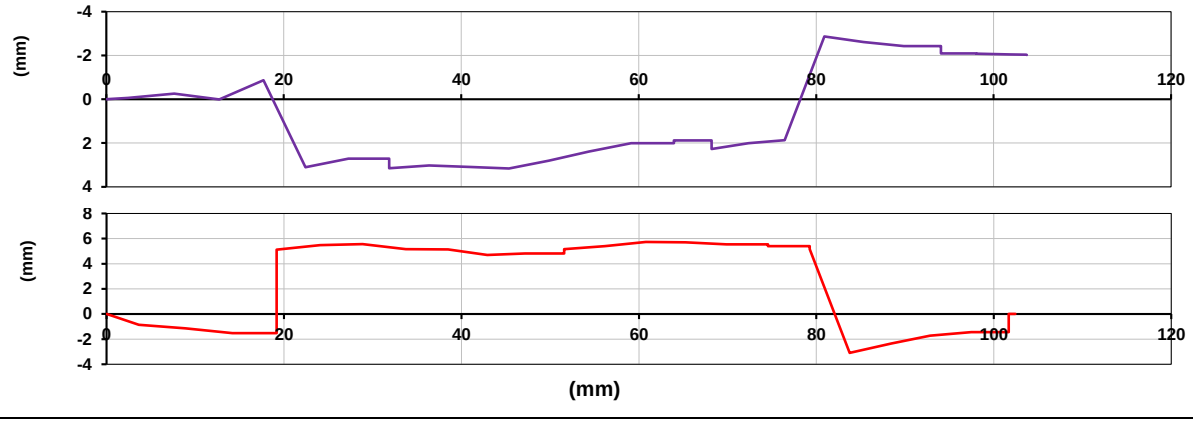
Top and Bottom Profile - Position 1 - After Shearing



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Top and Bottom Profile - Position 3 - After Shearing



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DIRECT SHEAR TEST REPORT

ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083092-MRDS

CLIENT:	Precision Geotechnical Services	
PROJECT:	PTP/00143	BEFORE TEST
LAB SAMPLE No.	24083092	DATE: 23/8/24
BOREHOLE:	TSF-BH-08	DEPTH 12.3 - 12.4





Sample/s supplied by the client

Photo not to scale

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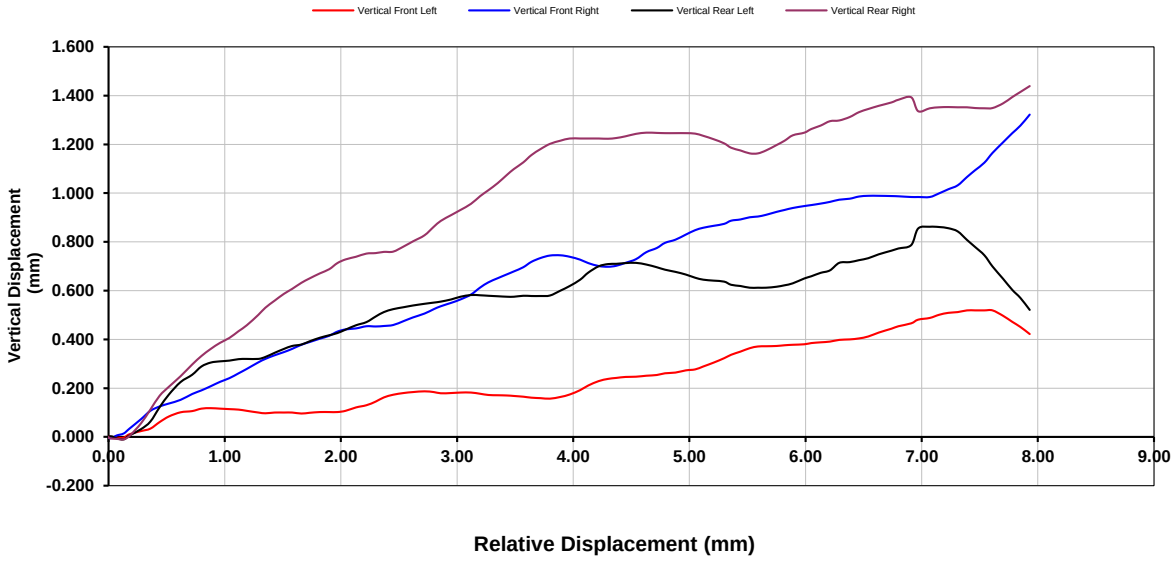
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DIRECT SHEAR TEST REPORT

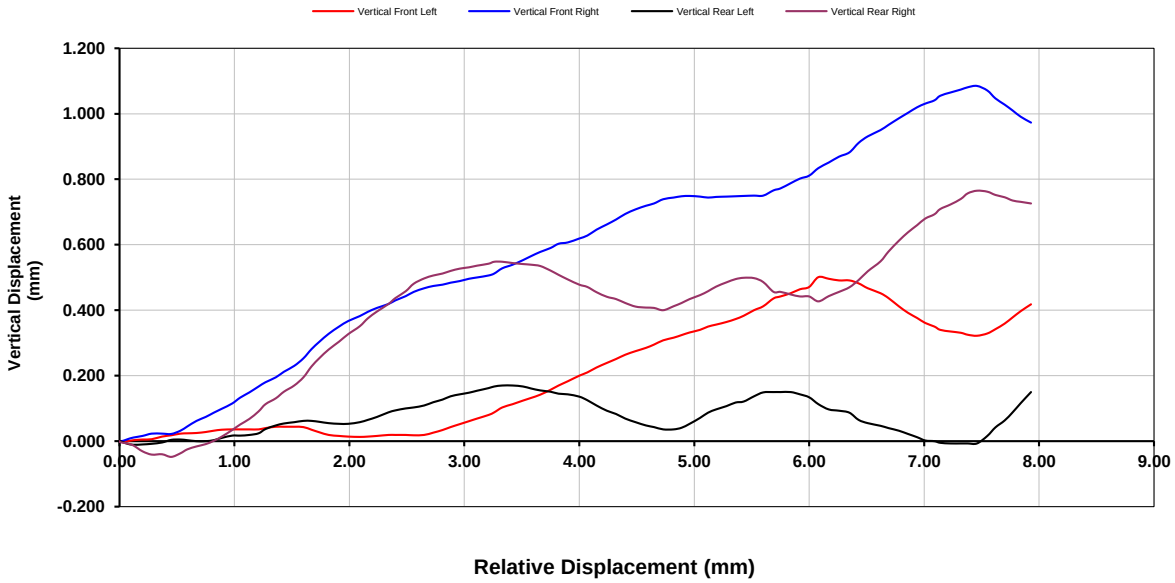
ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083092-MRDS

Stage 1 Vertical Displacement/Relative Displacement Plot



Stage 2 Vertical Displacement/Relative Displacement Plot



Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory

Approved Signatory

Joshua Rasmussen

Joshua Rasmussen

Laboratory No. 9926

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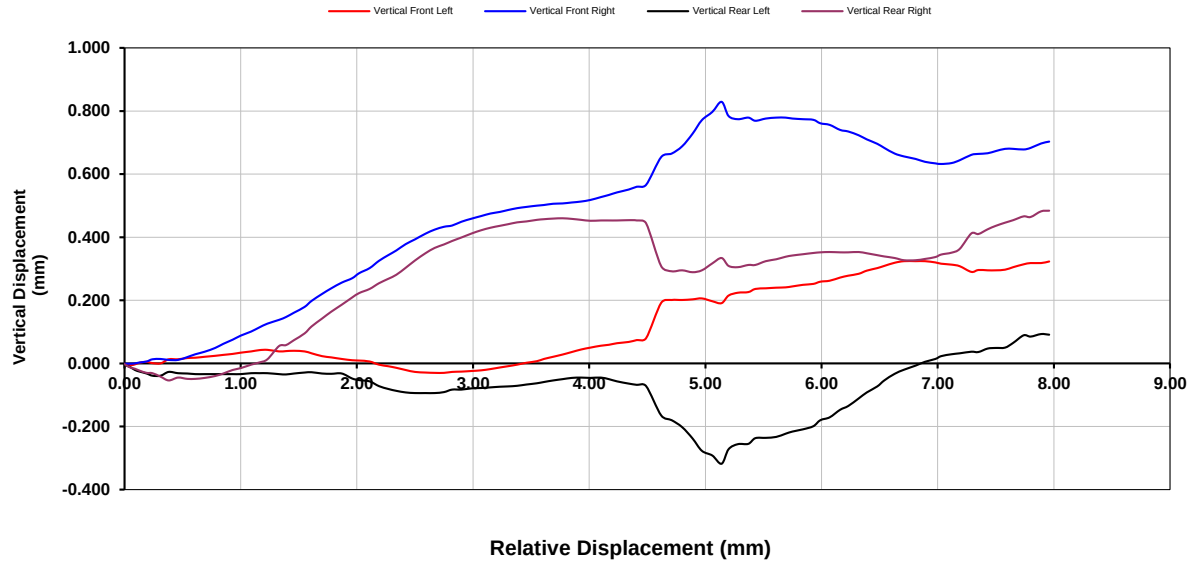
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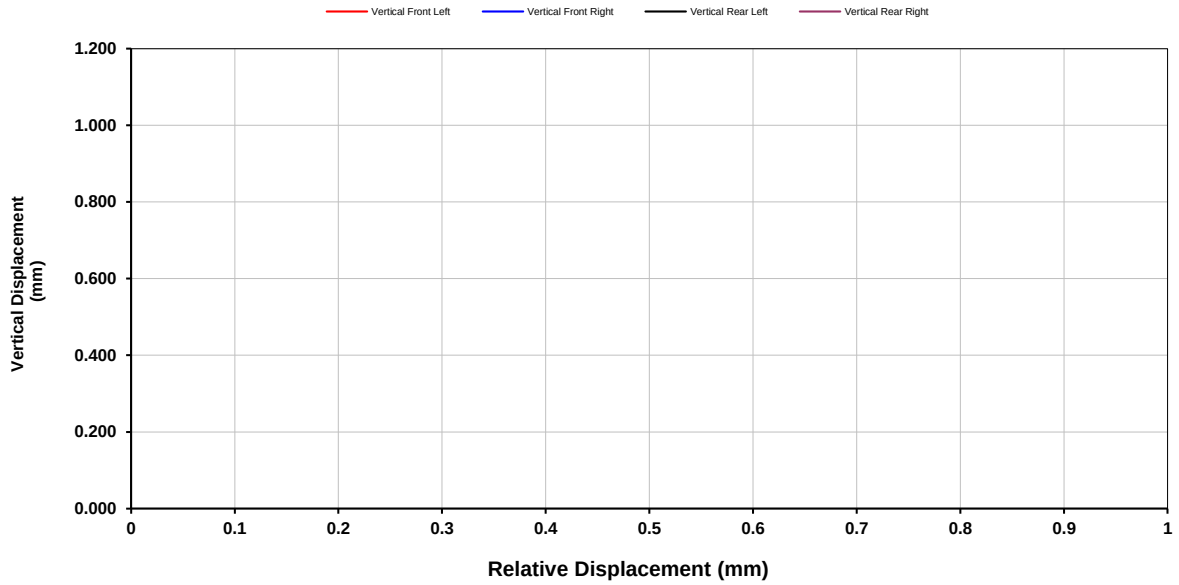
ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083092-MRDS

Stage 3 Vertical Displacement/Relative Displacement Plot



Stage 4 Vertical Displacement/Relative Displacement Plot



Sample/s supplied by the client

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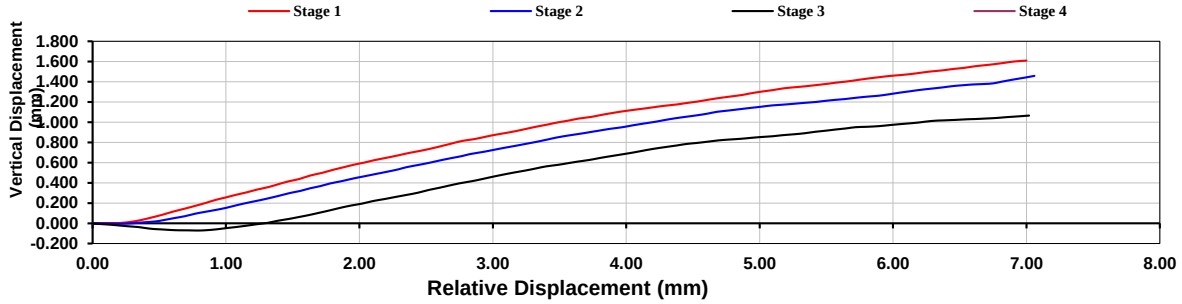
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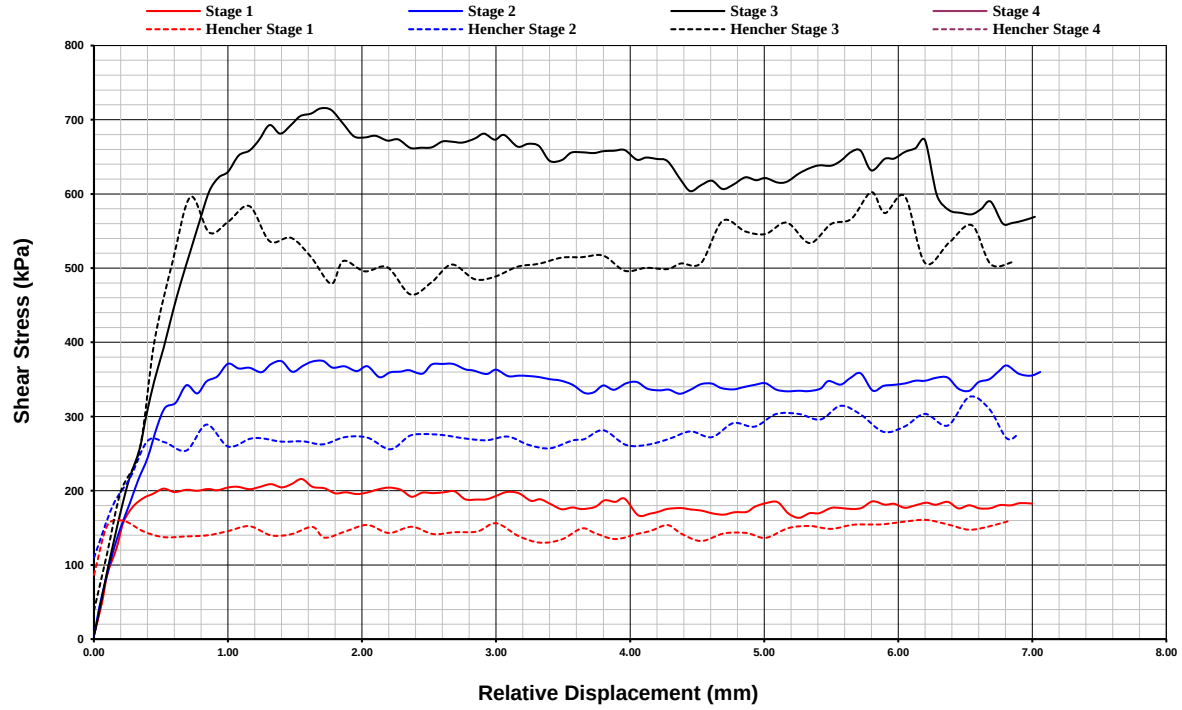
ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083093-MRDS
		Workorder No.	9919/T/611
Address	10 Hungerford Street Northgate QLD 4013	**Test Date**	26/08/2024
		Report Date	30/08/2024
Project	PTP/00143		
Client ID	S/00955	**Bore Hole**	TSF-BH-10A
		Depth (m)	8.3 - 8.35
Description	Not Supplied	**Sample Type**	Single individual rock core specimen with existing defect.

Average Vertical Displacement/Relative Displacement Plot



Shear Stress/Displacement Plot



Notes/Remarks: Normal stress corrected for change in area as requested by the client

Note: Area correction based on square sample equation.

Sample/s supplied by the client Graph not to scale

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Approved Signatory

Joshua Rasmussen

Joshua Rasmussen

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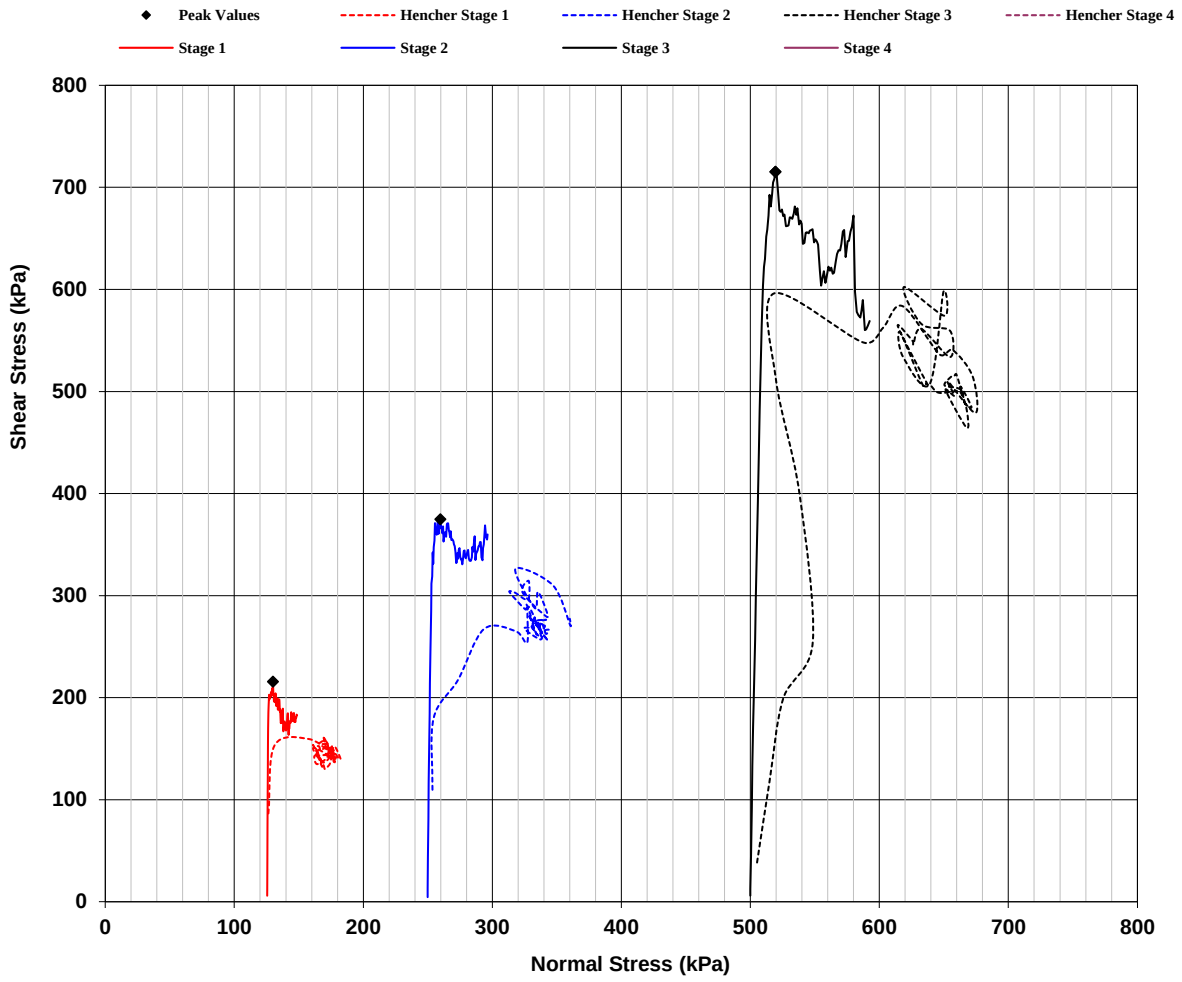
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DIRECT SHEAR TEST REPORT

ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083093-MRDS

Corrected Normal Stress vs Corrected Shear Stress



Shear Angle (°)	52.1	Cohesion (kPa)	45	R^2	1.000
Specimen Condition	As Received	Corrected Normal Stress (kPa)		Corrected Shear Stress (kPa)	
Specimen Dimensions (mm)	67.75 * 60.84	Stage 1	130.0		215.8
Rate of Strain (mm/min)	0.080	Stage 2	259.7		374.8
Initial Moisture Content (%)	0.3	Stage 3	519.5		715.2
Initial Wet Density(t/m^3)	2.61				

Notes/Remarks: Normal stress corrected for change in area as requested by the client
Note: Area correction based on square sample equation.

Sample/s supplied by the client Graph not to scale

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Approved Signatory

Joshua Rasmussen

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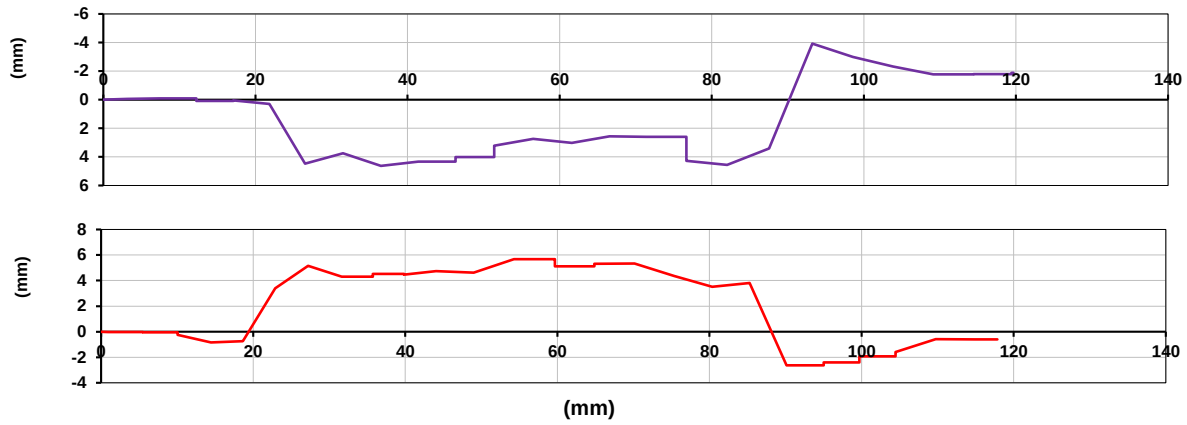
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DIRECT SHEAR TEST REPORT

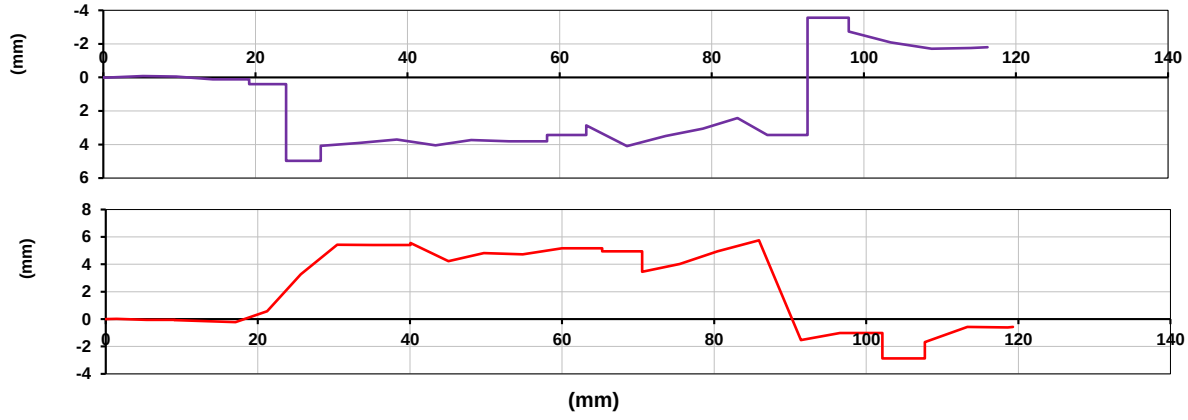
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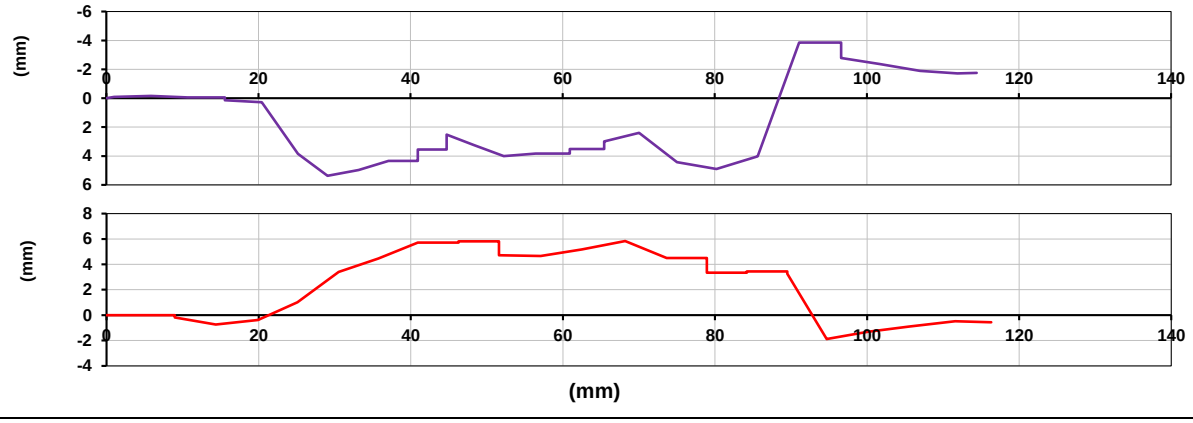
Top and Bottom Profile - Position 1 - Prior to Shearing



Top and Bottom Profile - Position 2 - Prior to Shearing



Top and Bottom Profile - Position 3 - Prior to Shearing



Sample/s supplied by the client

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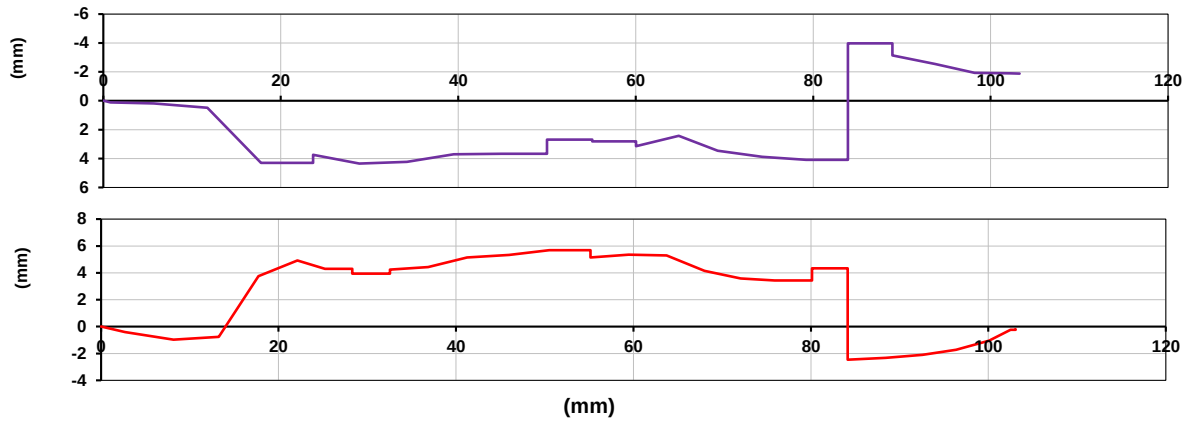
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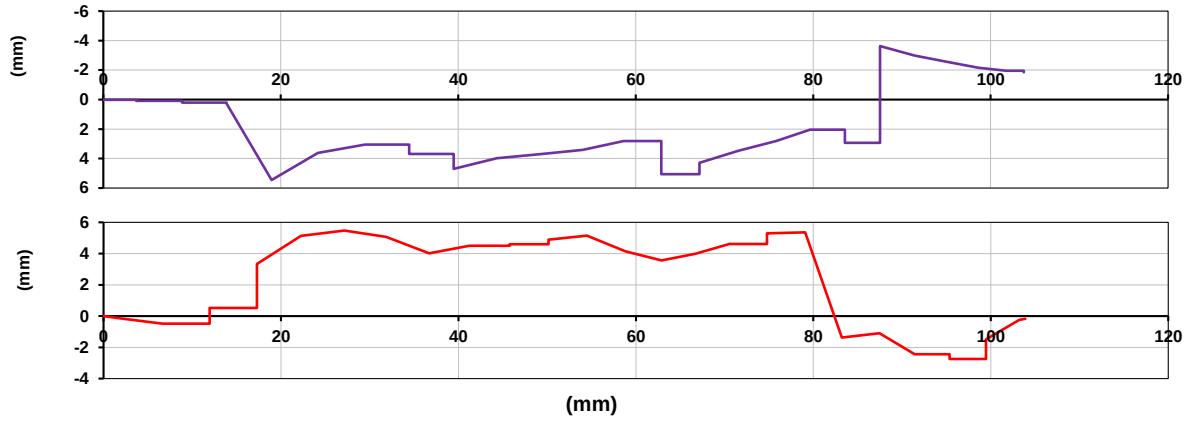
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Client	Precision Geotechnical Services	**Report No**	24083093-MRDS

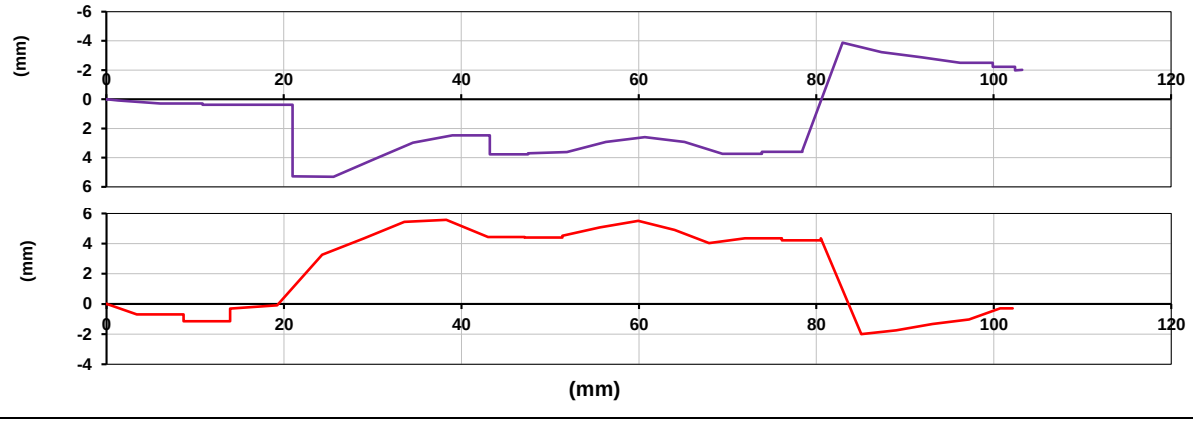
Top and Bottom Profile - Position 1 - After Shearing



Top and Bottom Profile - Position 2 - After Shearing



Top and Bottom Profile - Position 3 - After Shearing



Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083093-MRDS

CLIENT:	Precision Geotechnical Services	
PROJECT:	PTP/00143	BEFORE TEST
LAB SAMPLE No.	24083093	DATE: 23/8/24
BOREHOLE:	TSF-BH-10A	DEPTH 8.3 - 8.35









Sample/s supplied by the client

Photo not to scale

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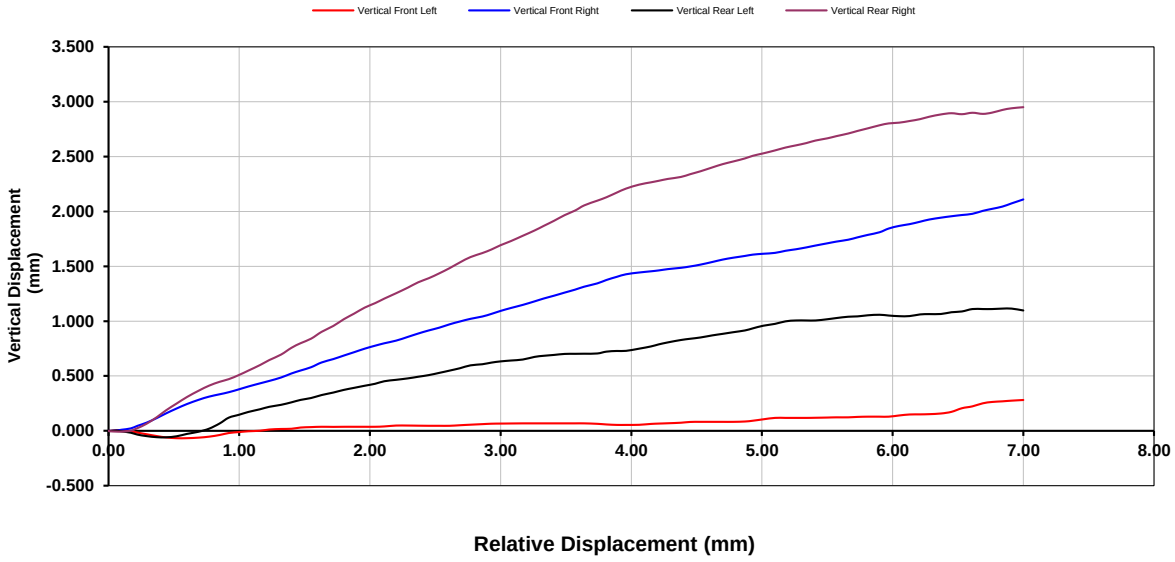
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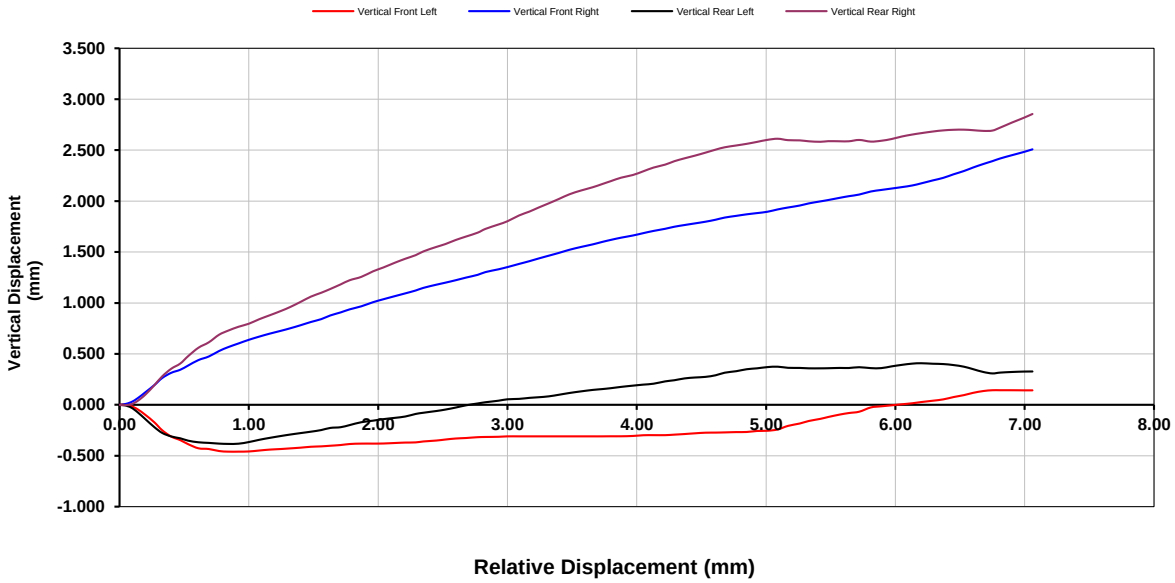
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Client	Precision Geotechnical Services	**Report No**	24083093-MRDS

Stage 1 Vertical Displacement/Relative Displacement Plot



Stage 2 Vertical Displacement/Relative Displacement Plot



Sample/s supplied by the client

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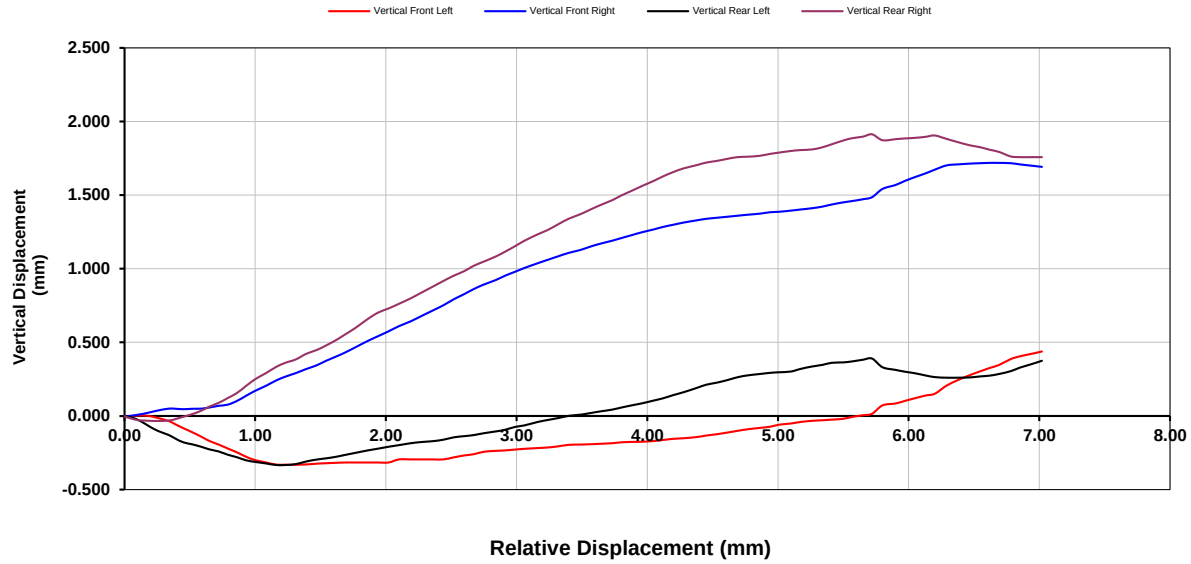
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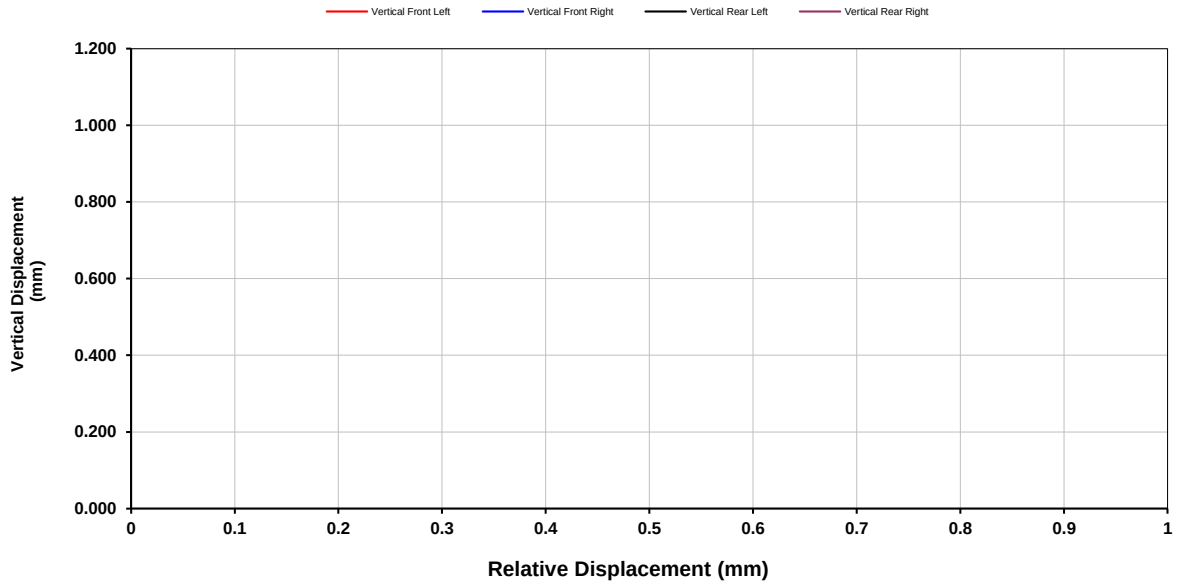
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Client	Precision Geotechnical Services	**Report No**	24083093-MRDS

Stage 3 Vertical Displacement/Relative Displacement Plot



Stage 4 Vertical Displacement/Relative Displacement Plot



Sample/s supplied by the client

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Material Test Report

Alliance Specialised Testing

Date Issued:	13/08/2024
Report Number:	P244301-1
Issue Number:	1
Reissue Reason:	N/A

Client:	Precision Geotechnical Services Pty Ltd
Client Address:	10 Hungerford Street,Northgate,QLD 4013
Client Contact:	Chris Channon <chris.channon@pgservices.com.au>
Client Project Number:	PTP/00143

Project Number:	P244301
Project Name:	QC1022_018
Project Location:	N/A

Page	Test Date	Sample Number	Sample Source	Test
2	12/08/2024	24-37726A	TSF_BH_07, Depth:13.70-13.90m	Rock Strength - AS 4133.4.2.1
3	12/08/2024	24-37726C	TSF_BH_10A, Depth:10.30-10.40m	Rock Strength - AS 4133.4.2.1

Work Request:	37726
Date Sampled:	12/07/2024
Sampling Method:	Sampled by Client
	The results apply to the sample as received
Specification:	-

Approved Signature:



Nicholas Botross
Lab Coordinator (SR Lab)

alliance Specialty Testing

Office & Laboratory 8-10 Welder Road, Seven Hills, NSW
Mailing Address PO Box 275, Seven Hills, NSW 1730
Phone 1800 288 188
Email ian@allgeo.com.au
Website allgeo.com.au

alliance

Specialised Testing - 1800 288 188

Uniaxial Compressive Strength of Rock Strength greater than 50MPa

Test Method: AS4133.4.2.1

Report Number:	P244301-1	Sample Date:	12/07/2024
Sample Number:	24-37726A	Test Date:	12/08/2024
Sample Source:	TSF_BH_07, Depth: 13.70-13.90m	Report Date:	13/08/2024

Project Name:	QC1022_018
Client:	Precision Geotechnical Services Pty Ltd
Identification:	Rock Core
Storage History, Curing and Environment:	Stored in laboratory at room temperature.

Specimen Details	
Diameter (mm)	61.1
Height (mm)	79.7
Length to Diameter Ratio	1.3
Moisture Content at Time of Test (%)	0.3
Dry Density (t/m^3)	2.43

Results	
Uniaxial Compressive Strength (MPa)	97
Rate of Displacement (mm/min)	0.10
Time to Failure (min)	7.1
Description of Failure	Mixed Mode
Pertinent Observations	Pre-existing fracture

Photos

Before Testing	After Testing
	

Comments

- Sample tested as-received condition.
-Sample L/D ratio less than 2.5, which is a deviation from AS4133.4.2.1
- Client reference: S/00956
-Before Test: Sample had pre-existing fractures

Approved Signature:

Nicholas Botross
SR Laboratory Coordinator

alliance

Specialised Testing - 1800 288 188

Uniaxial Compressive Strength of Rock Strength greater than 50MPa

Test Method: AS4133.4.2.1

Report Number:	P244301-1	Sample Date:	12/07/2024
Sample Number:	24-37726C	Test Date:	12/08/2024
Sample Source:	TSF_BH_10A, Depth:10.30-10.40m	Report Date:	13/08/2024

Project Name:	QC1022_018
Client:	Precision Geotechnical Services Pty Ltd
Identification:	Rock Core
Storage History, Curing and Environment:	Stored in laboratory at room temperature.

Specimen Details	
Diameter (mm)	60.9
Height (mm)	102.6
Length to Diameter Ratio	1.7
Moisture Content at Time of Test (%)	0.1
Dry Density (t/m^3)	2.59

Results	
Uniaxial Compressive Strength (MPa)	89
Rate of Displacement (mm/min)	0.10
Time to Failure (min)	6.4
Description of Failure	Mixed Mode
Pertinent Observations	Pre-existing fracture

Photos

Before Testing	After Testing
	

Comments

- Sample tested as-received condition.
-Sample L/D ratio less than 2.5, which is a deviation from AS4133.4.2.1
-Client Reference : S/00959
-Before Test: Sample had pre-existing fractures

Approved Signature:

Nicholas Botross
SR Laboratory Coordinator

Material Test Report

Alliance Specialised Testing

Date Issued:	13/08/2024
Report Number:	P244301-1
Issue Number:	1
Reissue Reason:	N/A

Client:	Precision Geotechnical Services Pty Ltd
Client Address:	10 Hungerford Street,Northgate,QLD 4013
Client Contact:	Chris Channon <chris.channon@pgservices.com.au>
Client Project Number:	PTP/00143

Project Number:	P244301
Project Name:	QC1022_018
Project Location:	N/A

Page	Test Date	Sample Number	Sample Source	Test
2	12/08/2024	24-37726B	TSF_BH_08, Depth 13.20-13.30m	Rock Strength - AS 4133.4.3.1

Work Request:	37726
Date Sampled:	12/07/2024
Sampling Method:	Sampled by Client
	The results apply to the sample as received
Specification:	-

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NATA Accredited Laboratory Number: 15100

Approved Signature:

Ian Goldschmidt
Specialised Testing Manager

alliance Specialty Testing

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Email ian@allgeo.com.au
Website allgeo.com.au

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Specialised Testing - 1800 288 188

Rock Strength and Deformability greater than 50MPa

Test Method: AS4133.4.3.1-2009

Report Number:	P244301-1	Sample Date:	12/07/2024
Sample Number:	24-37726B	Test Date:	12/08/2024
Project Number:	P244301	Report Date:	13/08/2024

Client:	Precision Geotechnical Services Pty Ltd
Project Name:	QC1022_018
Sample Description:	Rock Core
Sample Source:	TSF_BH_08, Depth 13.20-13.30m
Storage History, Curing and Environment:	Stored in laboratory at room temperature

Specimen Details	
Diameter (mm)	61.0
Height (mm)	158.0
Length to Diameter Ratio	2.6
Moisture Content (%)	1
Rate of Loading (MPa/s)	0.2

Results	
Uniaxial Compressive Strength (MPa)	62
Description of Failure	Mixed Mode
Test Duration (min)	5.2
Pertinent Observations	Pre-existing fracture

Method of Determination	*Tangent*	*Secant*
Young's Modulus (GPa)	25.5	22.0
Poisson's Ratio	0.098	0.12
Axial Stress Levels	From 28% to 63% of max UCS	From 0% to 52% of max UCS

Additional Comments and Observations

- Sample tested as-received condition.
- Extensometers were taken off before sample's failure to prevent it from being damaged by the violent failure of the rock.
- Client reference: S/00958
- Before Test: Sample had pre-existing fractures
- After Test: Sample failed through pre-existing fractures

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Number: 15100

Approved Signature:

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Specialised Testing - 1800 288 188

Rock Strength and Deformability greater than 50MPa

Test Method: AS4133.4.3.1-2009

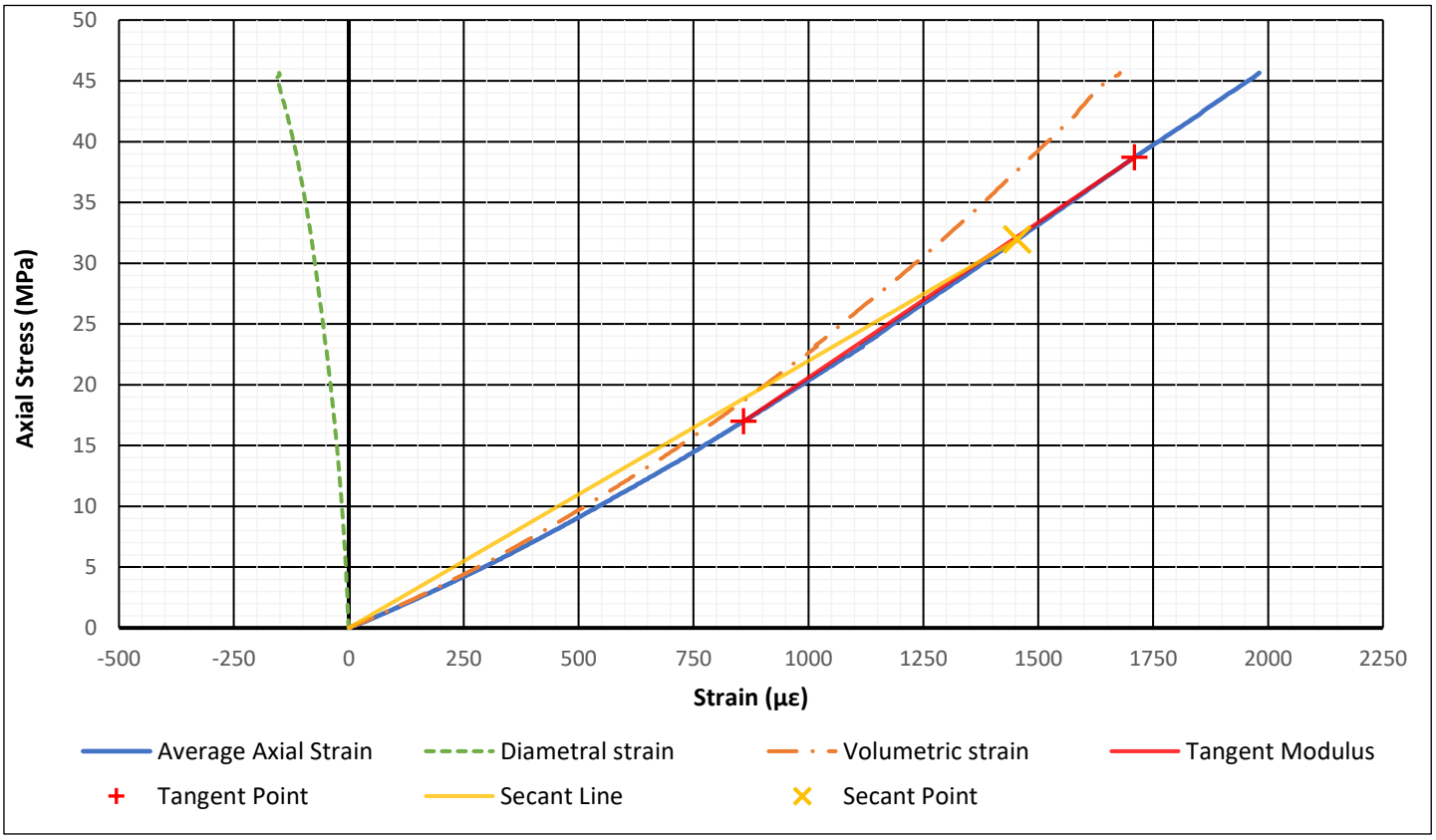


Figure 1 - Axial Stress vs Strain Graph

Photos

Before Testing	*After Failure*
	

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Accredited for compliance with
ISO/IEC 17025 - Testing
NATA Accredited Laboratory
Number: 15100

Approved Signature:

Ian Goldschmidt
Specialised Testing Manager

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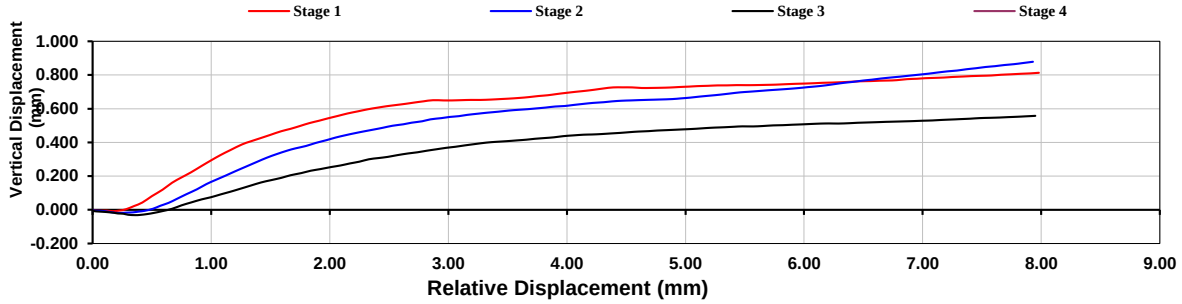
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DIRECT SHEAR TEST REPORT

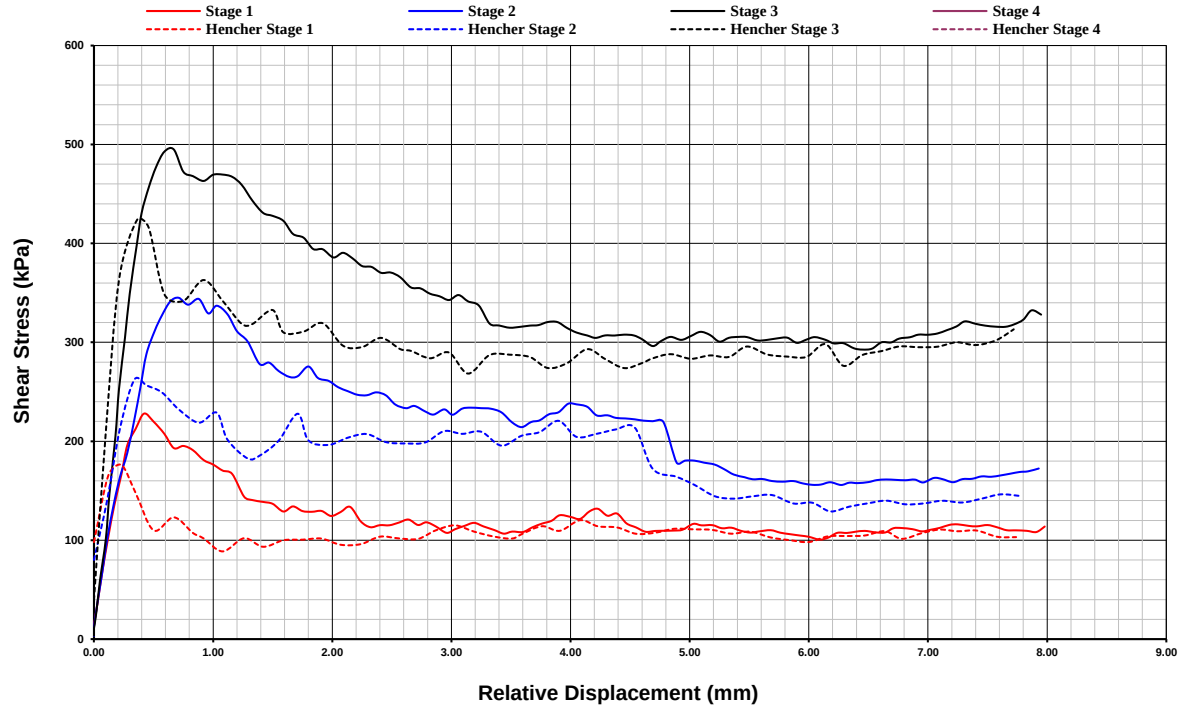
ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083090-MRDS
		Workorder No.	9919/T/611
Address	10 Hungerford Street Northgate QLD 4013	**Test Date**	26/08/2024
		Report Date	30/08/2024
Project	PTP/00143		
Client ID	S/00951	**Bore Hole**	TSF-BH-07
		Depth (m)	19.65 - 19.69
Description	Not Supplied	**Sample Type**	Single individual rock core specimen with existing defect.

Average Vertical Displacement/Relative Displacement Plot



Shear Stress/Displacement Plot



Notes/Remarks: Normal stress corrected for change in area as requested by the client
Note: Area correction based on square sample equation.

Sample/s supplied by the client — Graph not to scale

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Tested at Trilab Brisbane Laboratory

Approved Signatory

Joshua Rasmussen

Joshua Rasmussen

Laboratory No. 9926

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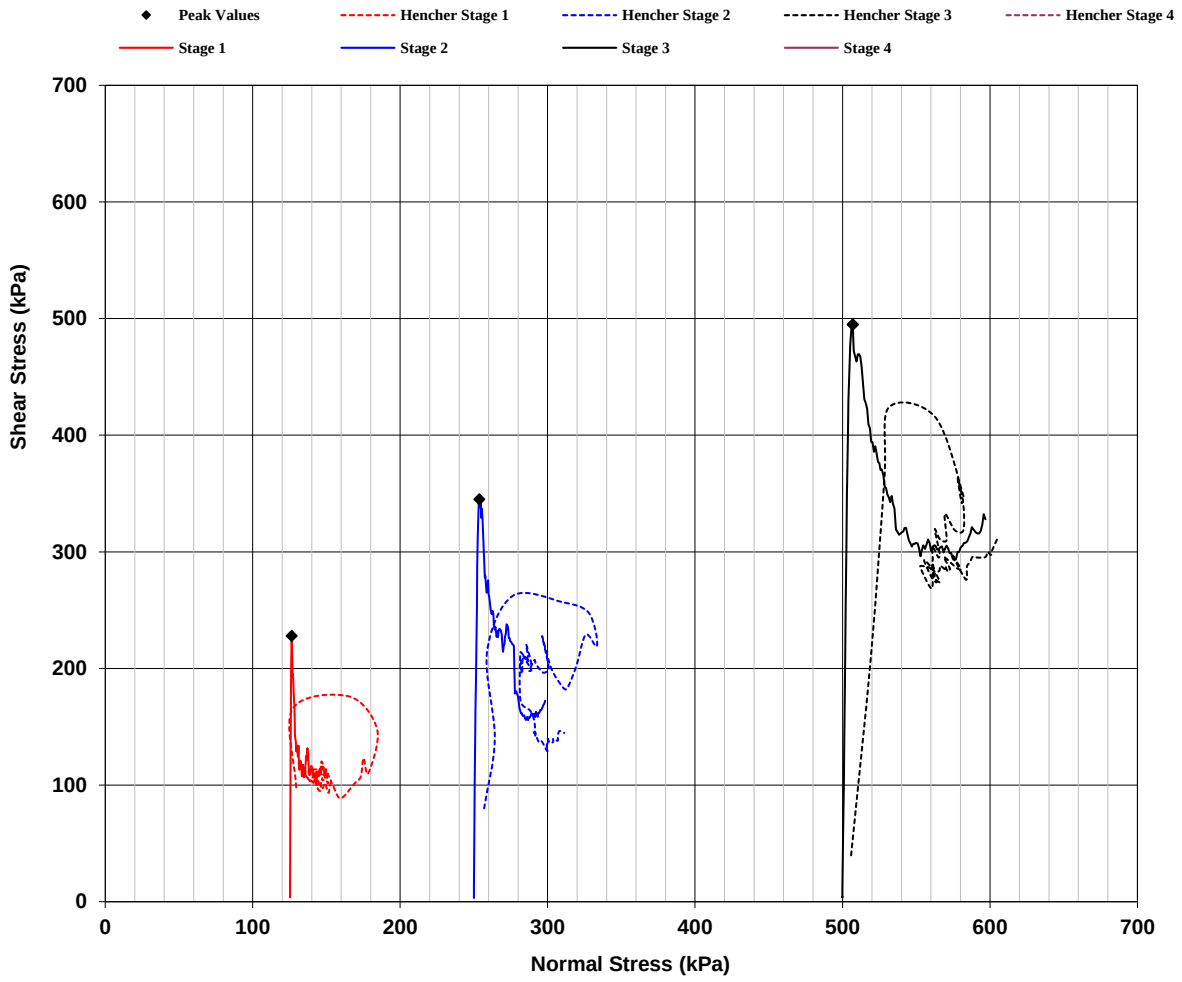
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DIRECT SHEAR TEST REPORT

ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083090-MRDS

Corrected Normal Stress vs Corrected Shear Stress



Shear Angle (°)	34.5	Cohesion (kPa)	153	R^2	0.993

		Corrected Normal Stress (kPa)		Corrected Shear Stress (kPa)
Specimen Condition	As Received			
Specimen Dimensions (mm)	68.50 * 61.19	Stage 1	126.4	228.0
Rate of Strain (mm/min)	0.080	Stage 2	253.7	345.1
Initial Moisture Content (%)	0.7	Stage 3	506.9	494.9
Initial Wet Density(t/m^3)	2.50			

Notes/Remarks: Normal stress corrected for change in area as requested by the client
Note: Area correction based on square sample equation.

Sample/s supplied by the client — Graph not to scale

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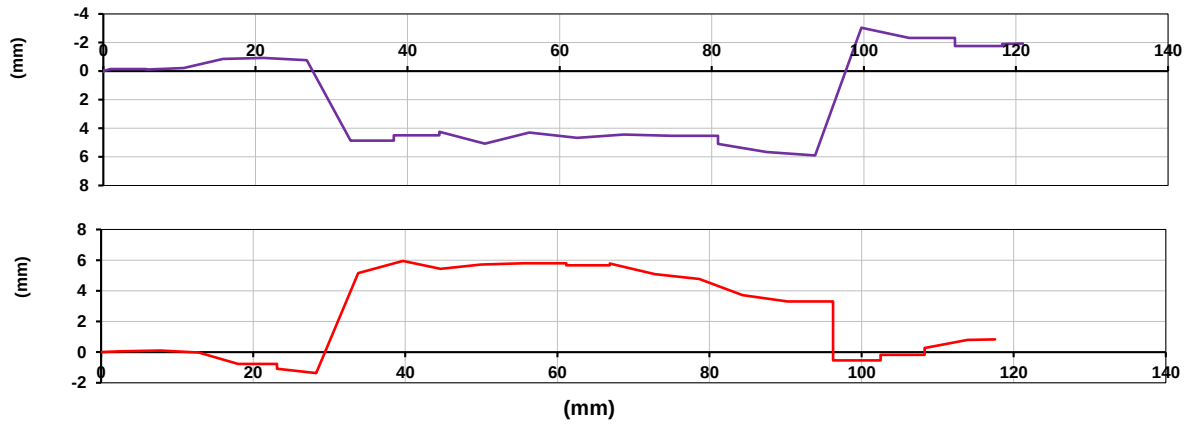
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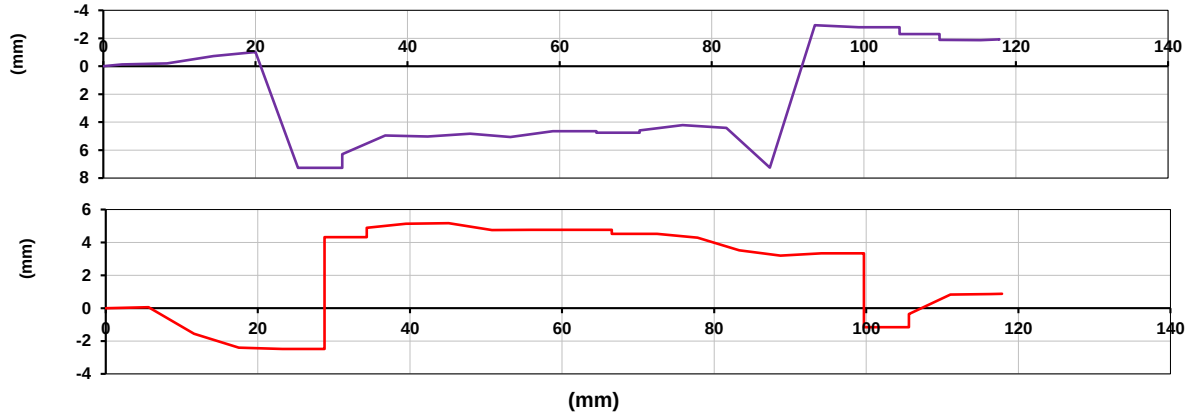
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Client	Precision Geotechnical Services	**Report No**	24083090-MRDS

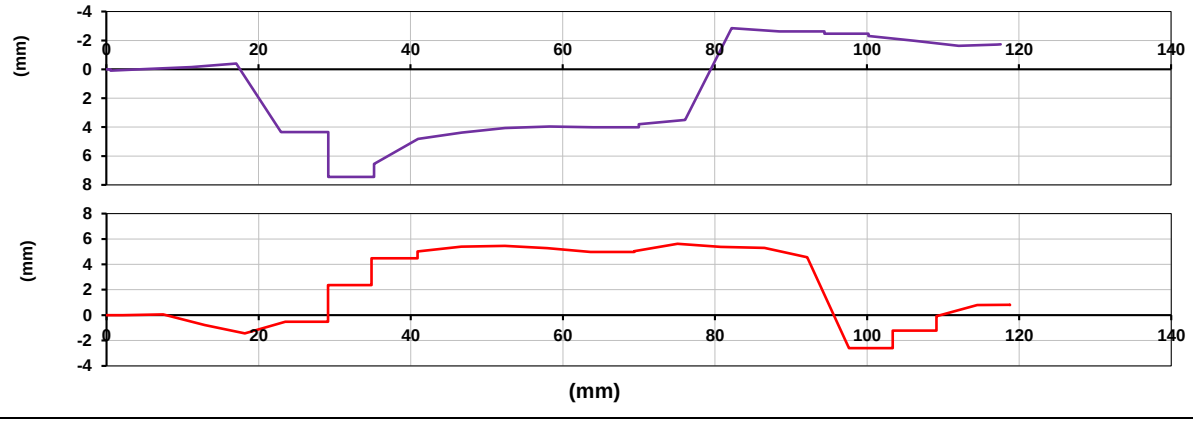
Top and Bottom Profile - Position 1 - Prior to Shearing



Top and Bottom Profile - Position 2 - Prior to Shearing



Top and Bottom Profile - Position 3 - Prior to Shearing



Sample/s supplied by the client

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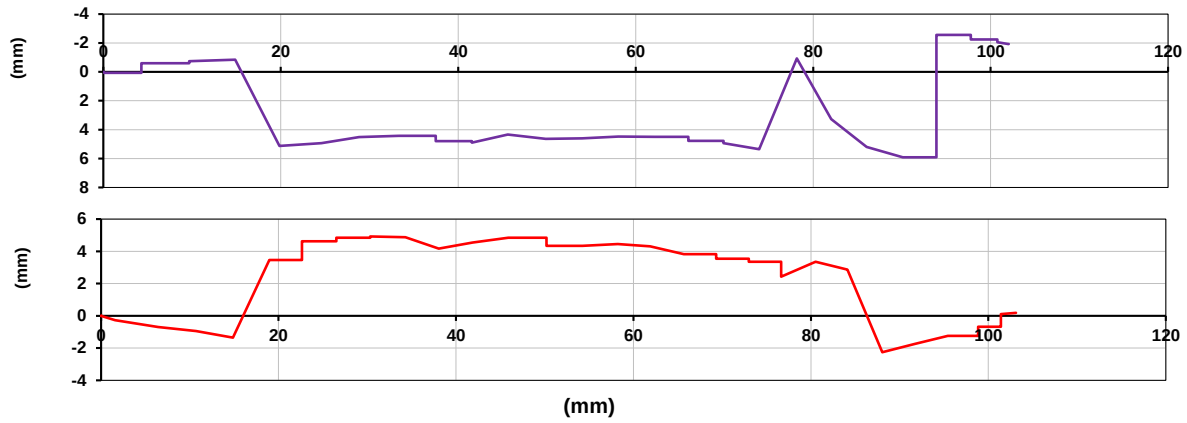
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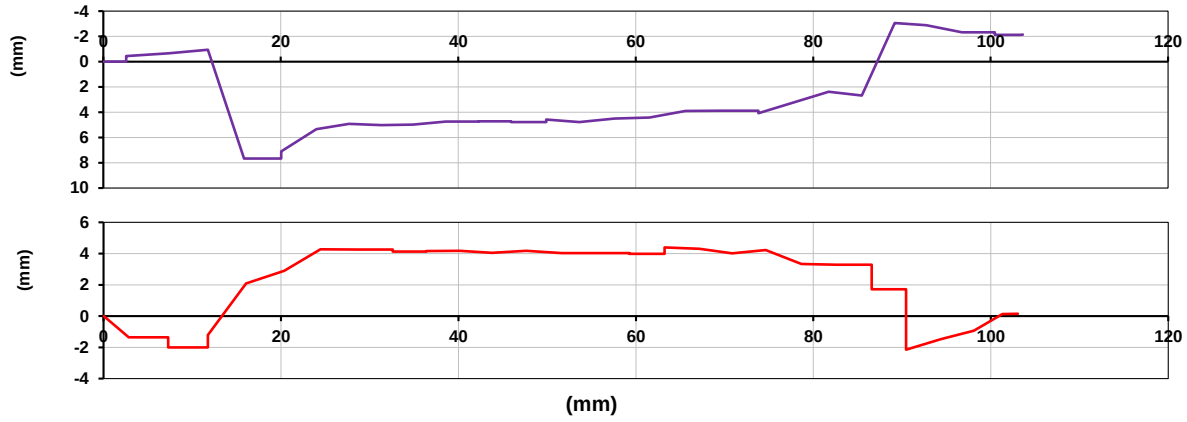
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Client	Precision Geotechnical Services	**Report No**	24083090-MRDS

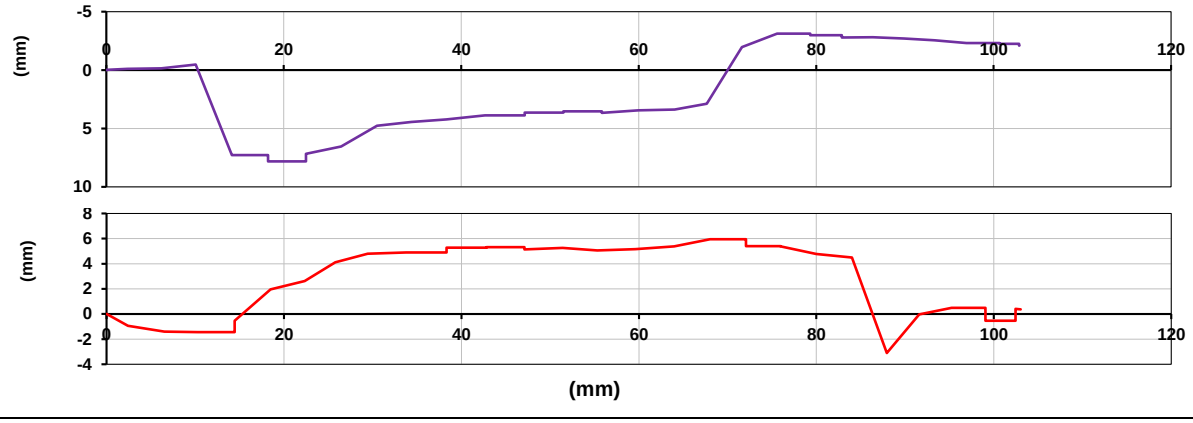
Top and Bottom Profile - Position 1 - After Shearing



Top and Bottom Profile - Position 2 - After Shearing



Top and Bottom Profile - Position 3 - After Shearing



Sample/s supplied by the client

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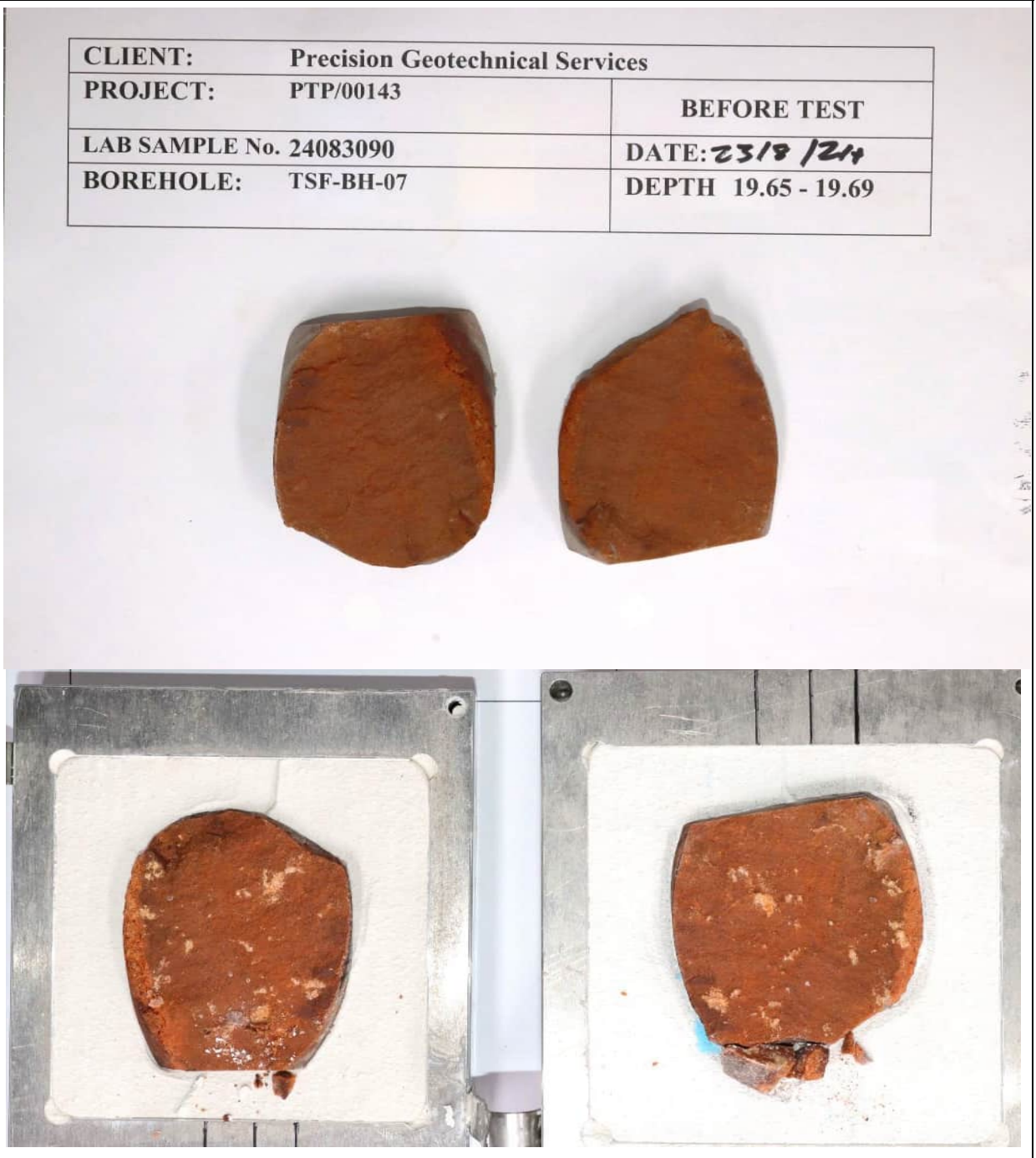
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DIRECT SHEAR TEST REPORT

ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083090-MRDS



Sample/s supplied by the client

Photo not to scale

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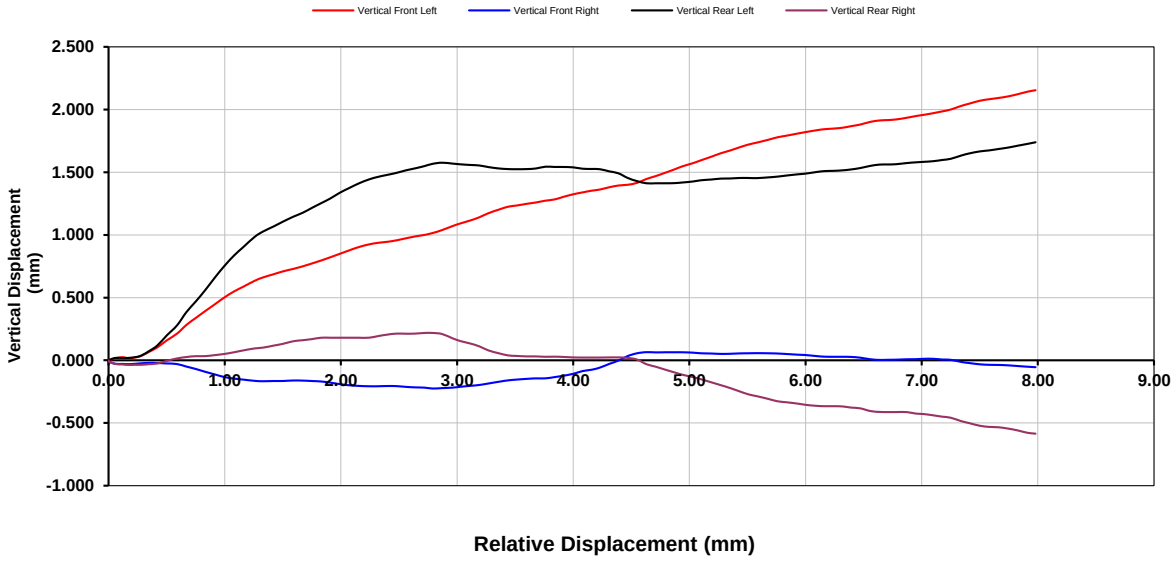
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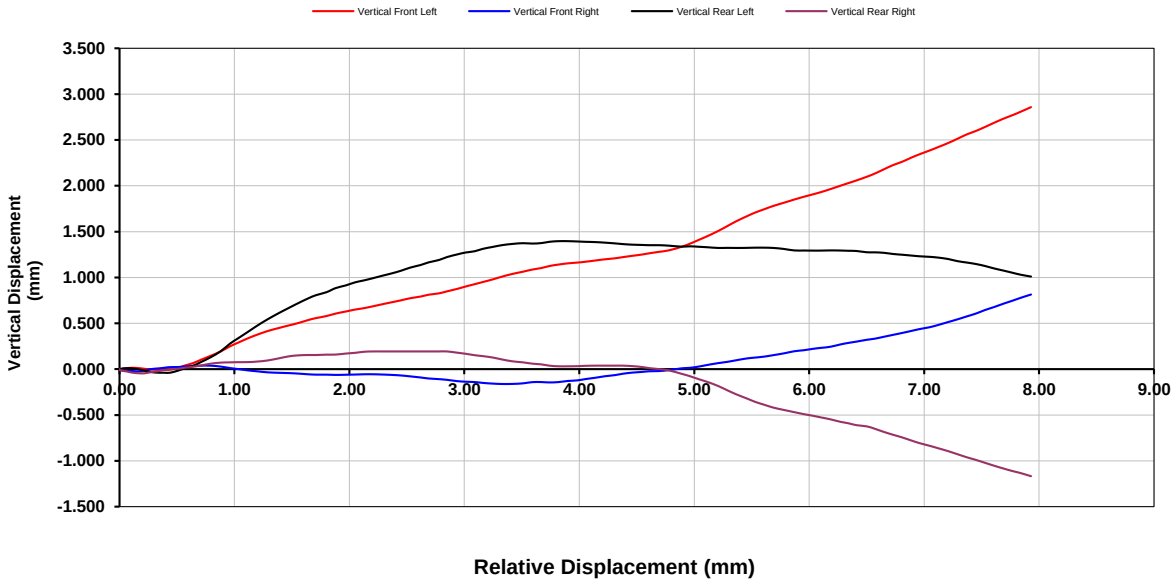
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Client	Precision Geotechnical Services	**Report No**	24083090-MRDS

Stage 1 Vertical Displacement/Relative Displacement Plot



Stage 2 Vertical Displacement/Relative Displacement Plot



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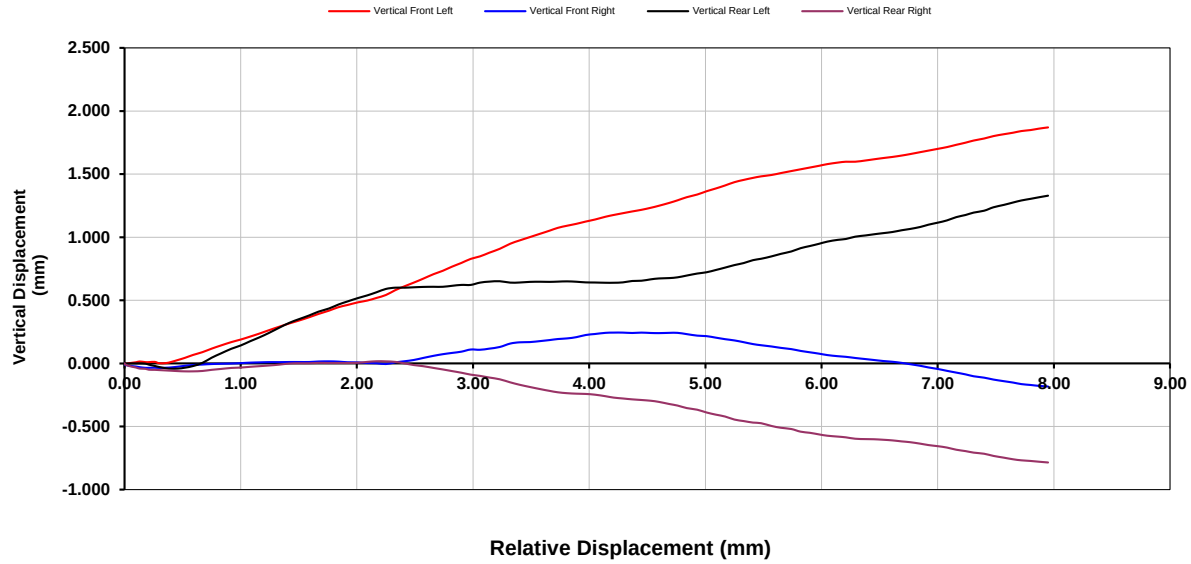
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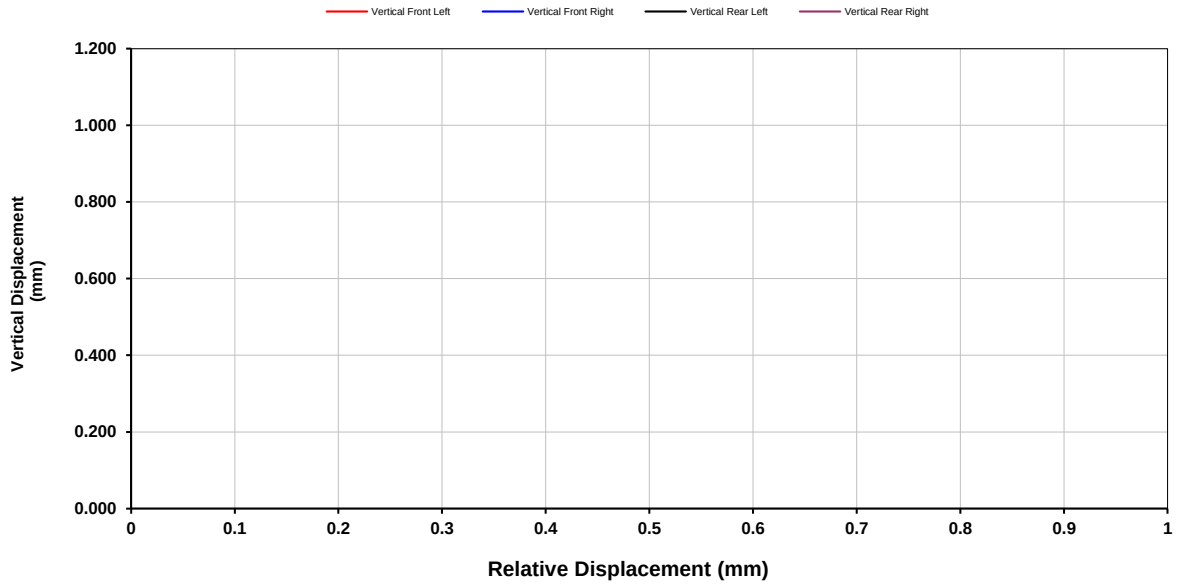
ASTM D5607 - Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

Client	Precision Geotechnical Services	**Report No**	24083090-MRDS

Stage 3 Vertical Displacement/Relative Displacement Plot



Stage 4 Vertical Displacement/Relative Displacement Plot



Sample/s supplied by the client

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Precision Geotechnical Services
ABN: 18 667 147 917
www.pgservices.com.au

Moisture Content Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 40/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**21/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.2.1.1**

Sample Number :	S/00939	S/00940	S/00941	S/00942	S/00943	S/00944
Date Tested :	30/07/2024	30/07/2024	30/07/2024	30/07/2024	30/07/2024	30/07/2024
Material Source :	-	-	-	-	-	-
For Use As :	-	-	-	-	-	-
Sampling Method :	As Received	As Received	As Received	As Received	As Received	As Received
Time :	00:00	00:00	00:00	00:00	00:00	00:00
Lot Number :	-	-	-	-	-	-
Location 1 :	TSF_TP_06	TSF_TP_06	TSF_TP_08	TSF_TP_08	TSF_TP_12	TSF_TP_12
Location 2 :	0.0-0.70m	1.40-1.60m	0.0-0.70m	1.00-1.30m	0.60-1.60m	1.60-2.50m
Location 3 :	-	-	-	-	-	-
Location 4 :	-	-	-	-	-	-
Moisture Content (%) :	**12.6**	**8.9**	**14.6**	**14.6**	**16.5**	**23.1**

Remarks :	**-**

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

APPROVED SIGNATORY

Chris Channon - Signatory

Precision Geotechnical Services
ABN: 18 667 147 917
www.pgservices.com.au

Moisture Content Report

Client :	**Engeny Australia**	Report Number :	**SR/PTP/00143 - 41/1**
Client Address :	**Level 1/500 Queen Street, Brisbane, 4000, QLD**	Report Date :	**21/08/2024**
Project Name :	**QC1022_018**	Test Request :	**-**
Project Number :	**PTP/00143**	**Page 1 of 1**	
Location :	**Brisbane City**		

Test Methods :	**AS1289.2.1.1**

Sample Number :	S/00944	S/00945				
Date Tested :	31/07/2024	31/07/2024				
Material Source :	-	-				
For Use As :	-	-				
Sampling Method :	As Received	As Received				
Time :	00:00	00:00				
Lot Number :	-	-				
Location 1 :	TSF_TP_12	TSF_TP_15				
Location 2 :	1.60-2.50m	0.00-1.00m				
Location 3 :	-	-				
Location 4 :	-	-				
Moisture Content (%) :	**16.0**	**15.6**				

Remarks :	**-**

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Precision Geotechnical Services Accreditation Number - 21250

Laboratory Site Number - 25576 - Brisbane

Laboratory Address - 10 Hungerford Street, Northgate, QLD 4013

APPROVED SIGNATORY

Chris Channon - Signatory

APPENDIX B: MULTI-CATERIA ASSESSMENT

Number	Criteria	Weighting	1. UE TSF3 (Phase 1)	2. Greenstone Ck	3. Diamond Ck	4. Epit RL 270m	5. Magazine Creek	6. UE TSF - South of UEDD (Phase 2)	7. E TSF Raise
1	**STORAGE CAPACITY** Target 10 years	5.00	3	5	5	3	5	2	1
			7.2 years	15.3 years	13.8 Years	8.9 years	11.5 years	5.7 years	2 years
2	**COST** Capex Opex Complexity	20.00	2	4	3	4	5	3	1
			$13.98/m3	$8.08/m3	$9.52/m3	$8.55/m3	$6.41/m3	$11.58/m3	$20/m3
3	**GEOTECHNICAL CONDITIONS** **Natural Topography** **Borrow Risk**	10.00	5	3	5	4	3	4	3
			Steep sided valley. Waste dump with good stability.	Flat area, multiple embankments.	Steep sided valley, Small embankment.	Enclosed pit wall with small embankment volume.	Natural valley. Large main embankment volume	Steep sided valleys. Multiple embankments.	Raise on existing facility. Buttressing likely.
4	**CONSEQUENCE OF FAILURE** Downstream consequence	10.00	4	3	3	3	3	5	4
			On-site PAR at ESS underground. Above E Pit and UEDD	Indirect PAR, creek and lake users Above Greenstone Ck and Lake W.	Indirect PAR, Road users Above Greenstone Ck and Public Road.	On-site PAR at Mammoth underground. Above MCD	Indirect PAR, Road and Lake users Above Gunpowder Ck and Lake W and Public Road.	No PAR. Above Upper Esperanza, Magazine Ck and Snakeskin Valley.	No PAR. Above Gunpowder Creek
5	**LAND DISTURBANCE** Flora/Fauna impact	10.00	4	2	3	5	3	3	5
			Medium area. Surveys complete. Possible threatened Species	Largest area. Unknown species	Large area. Unknown species	No new disturbance or flora/fauna impact	Large area. Previous distubance. Unknown species	Medium area. Unknown species	No new disturbance or flora/fauna impact
6	**SEEPAGE PATHWAY** Geology / Faults (Before any new controls)	10.00	3	3	3	2	2	4	4
			500m to E Pit with PAF Waste Dump in pathway.. Interceptions at MCD and NWRD. 1.6km to Gunpowder Ck.	On Greenstone Ck tributary.	On Greenstone Ck tributary.	1km to Gunpowder Ck. Known seepage above 222RL. Interceptions at MCD and NWRD.	On Magazine Ck. 600m to Lake, 1.2km to Gunpowder Ck.	1.2km to Magazine Ck. 2km to Gunpowder Ck.	400m to Gunpowder Creek. Existing seepage capture systems at NWRD and saddle dams.
7	**WATER MANAGEMENT** Surface Water Diversions Catchment area	10.00	4	4	3	1	4	2	5
			Diversion already in place. Medium catchment (80 ha)	No diversion expected. Large catchment (243 ha, low accuracy – ELVIS publicly available data).	Possible diversion, Large catchment (195 ha, low accuracy – ELVIS publicly available data).	Requires additional site MAW storage capacity. Large existing catchment. Catchment area may range from 38 ha (contained by large embankment) to 80 ha (inclusive of ETSF) to 180 (total inclusive of existing EPit catchment + ETSF).	Minor diversion works. Medium catchment (104 ha).	Major diversion works required. Large Catchment (189 ha).	No change to surface water management
8	**MINING TENURE** Timing for applications	5.00	4	1	1	4	2	2	5
			On existing tenure	No mining lease or agreement.	No mining lease or agreement	On existing tenure	Partially on and off tenure	Partially on and off tenure	Existing tailings storage
9	**LOCAL STAKEHOLDERS**	10.00	4	2	2	3	3	3	2
			Generally supportive	Desirable Agricultural land. Owner not supportive.	Agrigultural land. Owner not supportive.	Generally supportive. Only if water is managed.	Neutral	Neutral	Some misconceptions about seepage and stability.
10	**CLOSURE CONCEPT** Closure volumes Residual Risk	10.00	4	3	4	3	3	4	5
			Large capping volume. Includes waste dump closure	Largest capping volume Residual risk to Greenstone creek	Large capping volume	Small capping volume. Water shedding option required.	Large capping volume. Water management during rehab.	Large capping volume	Small capping volume
	Weighted Score	**100**	71.0	62.0	64.0	65.0	69.0	66.0	66.0

CCM
TSF MCA SUMMARY

Capricorn Copper Mine

Rev 3

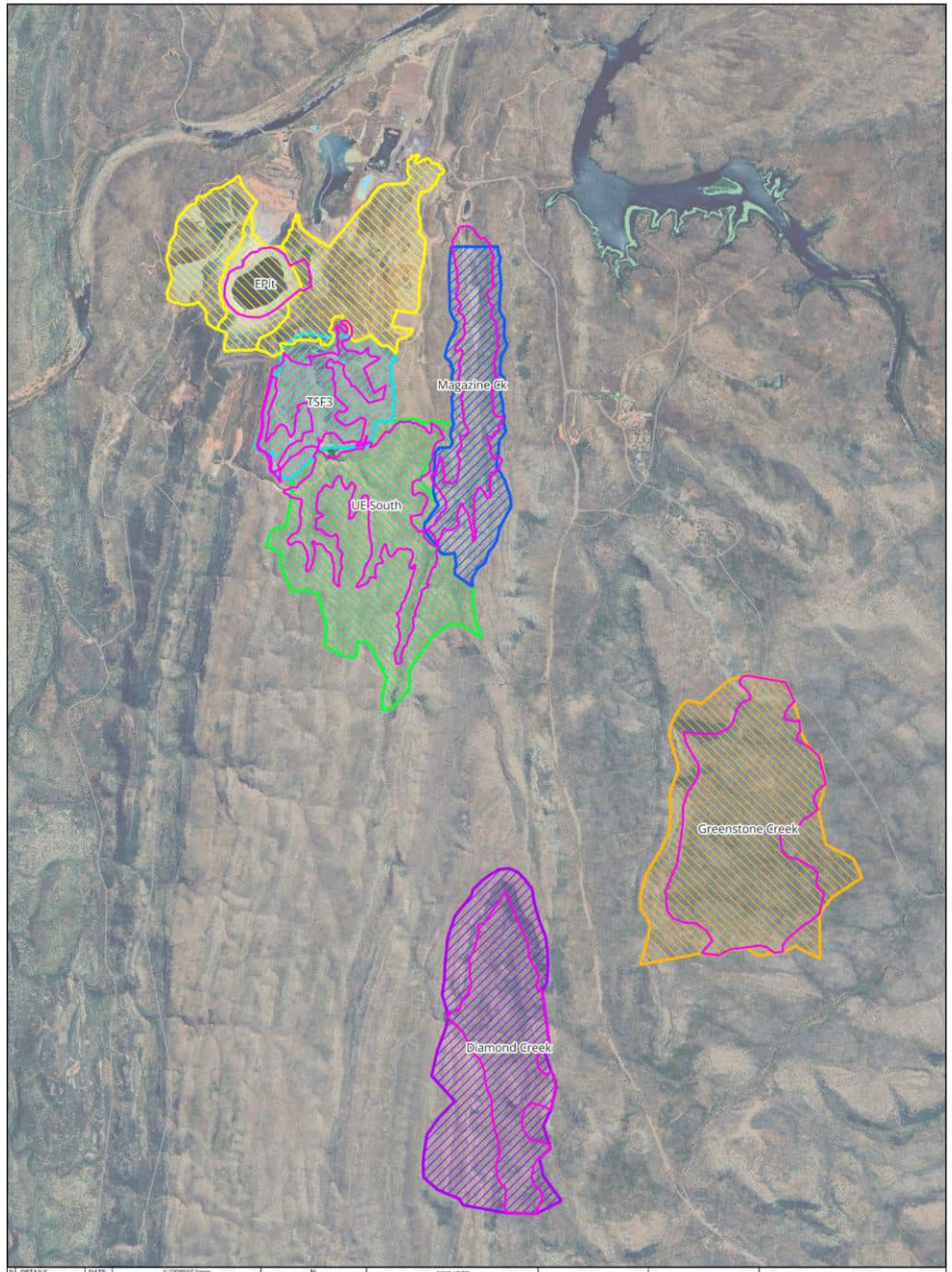
26 July 2024

ENGENY

Options

- Option 1 – TSF3 (Modelled)
- Option 2 – Greenstone Ck
- Option 3 – Diamond Ck
- Option 4 – EPit RL 270m (Embankments Modelled)
- Option 5 – Magazine Ck (Modelled)
- Option 6 – UE TSF South (Modelled)

ENGENY



- [x] [ ] **TSF Options - Approximate Footprints**
- [x] **Catchments for TSF Options**
  - [x] TSF3
  - [x] UE South
  - [x] Magazine ck
  - [x] Diamond Ck
  - [x] Greenstone Ck
  - [x] EPit (Inclusive of ETSF and Existing EPit Catchments)

ENGENY

R	DETAILS	DATE
D	For Information Only	25-07-2024

DRAWN MB CHECKED BW
APPROVED BW DATE 15-07-2024
NOTES:

SCALE @ A3 - 1:25,000
GDA94 / MGA zone 54

DISCLAIMER
Engeny has endeavoured to ensure accuracy and completeness of the data. Engeny assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DATA SOURCE
QLD Government Open Data Source

ENGENY

29 Metals

TSF MCA Option Locations
29 Metals - Capricorn Copper Pty Ltd
TSF MCA Summary

Dig Ref: Figure 1

Key Quantities and Costs Assumptions

- No new thickener for all options – 60% solids.
- Grout curtain drilling to 10m depth (assumed)
- Mean design life is based on the mean tailings deposition rate of 0.9 Mm^3/year
- OPEX Power/Mechanical costs of all options other than TSF3 are scaled for distance and design life with TSF3 as the base rate.
- CAPEX Mechanical costs of all options other than TSF3 are scaled for distance with TSF3 as the base rate.
- CAPEX Power costs of all options are based on approximate distance from plant to furthest tailings discharge point (TDP) at a rate of $5M/2.2km (past QLD project experience).
- Civil Works BOQ/CAPEX key assumptions:
  - Internal embankment toe has a concrete plinth / grout curtain and internal face has a liner system (as described for TSF3) for all embankments with water stored against them.
  - The following is not included for options other than TSF3:
    - Haul roads and access roads, and the associated safety bunds.
    - Haul roads culverts and the associated construction works.
    - Instrumentation – this quantity is unknown, and the depths of the instrumentation differ greatly between TSF options.
    - Dumped rock items – due to insufficient information of spillway design.
  - Assume 5% of the embankment fill is Select Fill and 95% is General Fill for all options other than TSF3.
- Closure costs not considered.

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Option Quantities and Costs Summary Details

Each option will have:

- Key assumptions for that particular option.
- General arrangement figure
- Typical cross-section of embankment with liner, plinth and grout curtain and which of the embankments are assumed to have these works
- Total embankments volume (including both Select Fill & General Fill)
- Grout curtain toe length / drilling length
- Tailings storage volume
- Design life
- Distance from plant (for rough route of tailings pipeline if not already provided)
- Total CAPEX $ and $/$m^3$ storage (inclusive of 30% contingency)
- Total OPEX $ and $/$m^3$ storage (not inclusive of contingency)
- Total CAPEX and OPEX per m^3 storage

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Other MCA Criteria Summary Details

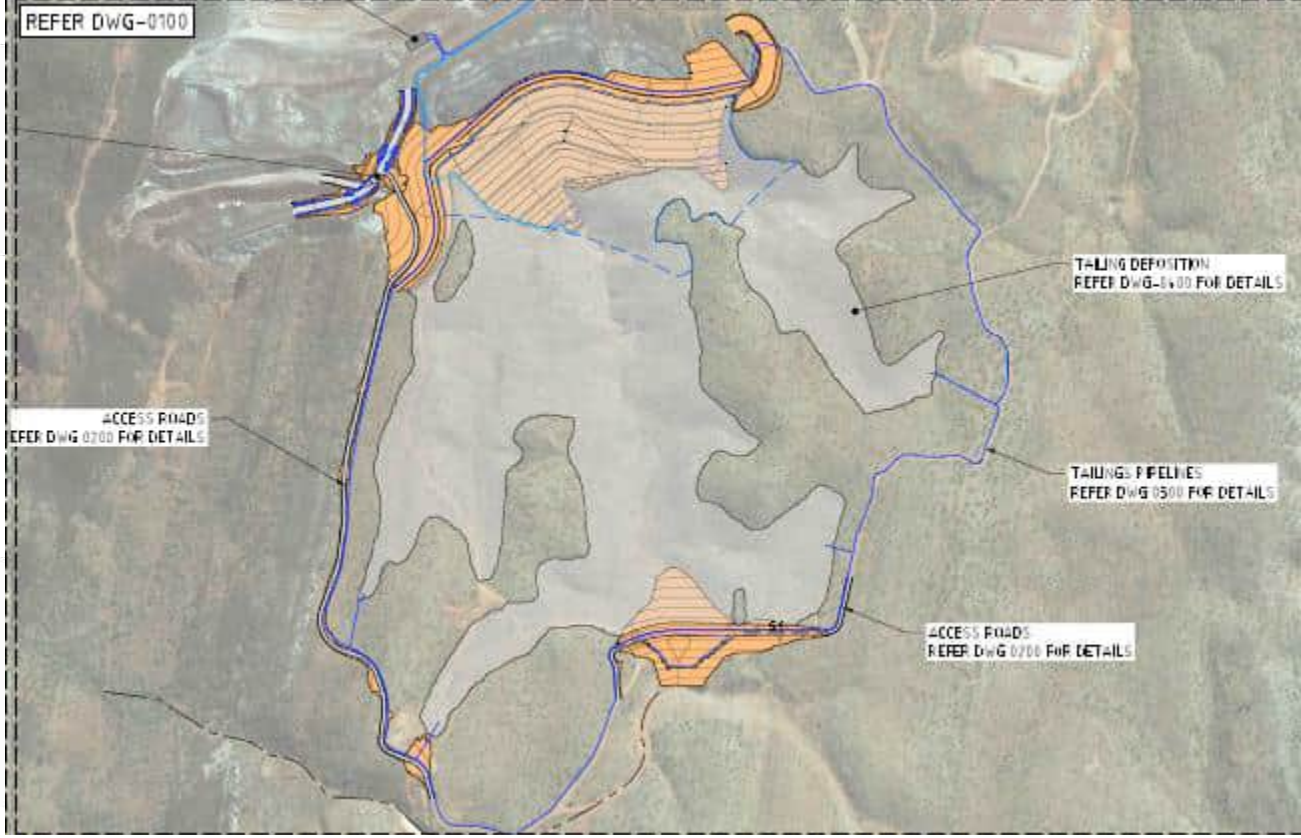
Each option will have the following criteria outcomes summarised:

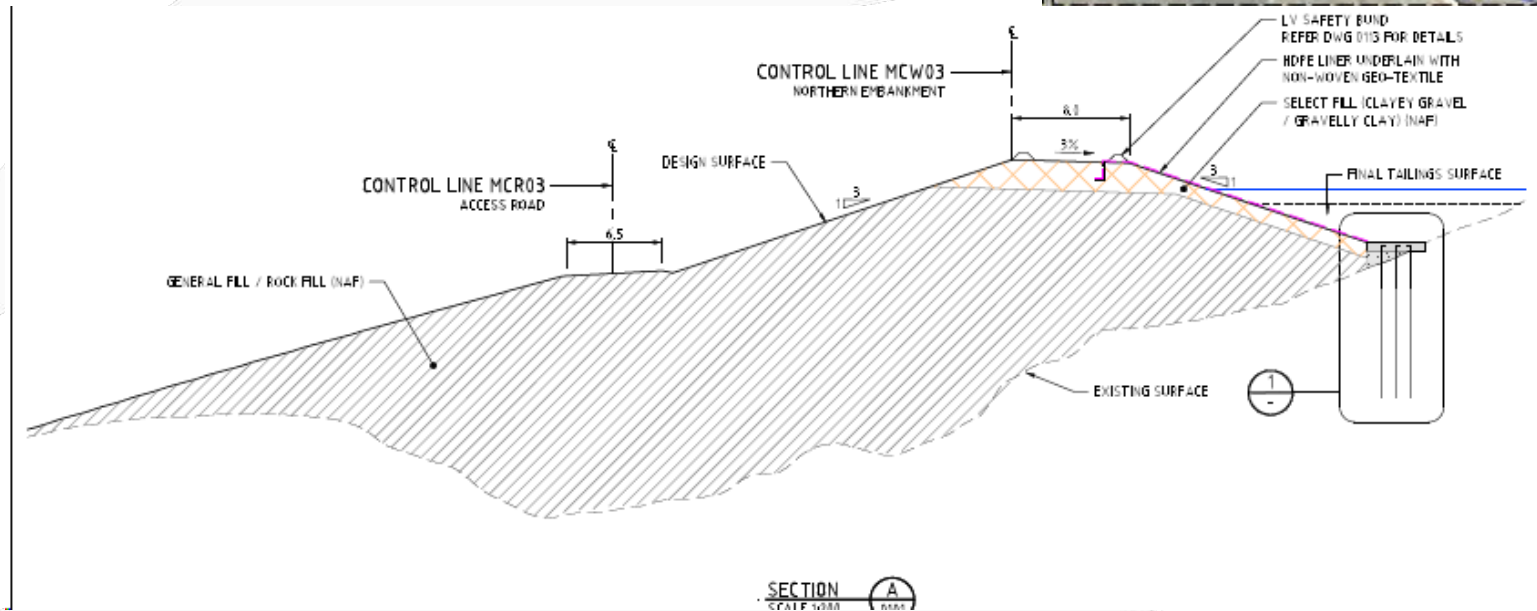
- Geotechnical conditions – Natural topography, borrow risk
- Consequence of failure – downstream consequence
- Land disturbance – flora / fauna impact
- Seepage Pathway – geology / faults (before any new controls)
- Water management – surface water diversions, catchment area
- Mining tenure – timing of applications
- Local stakeholders
- Closure concept – closure volumes, residual risk

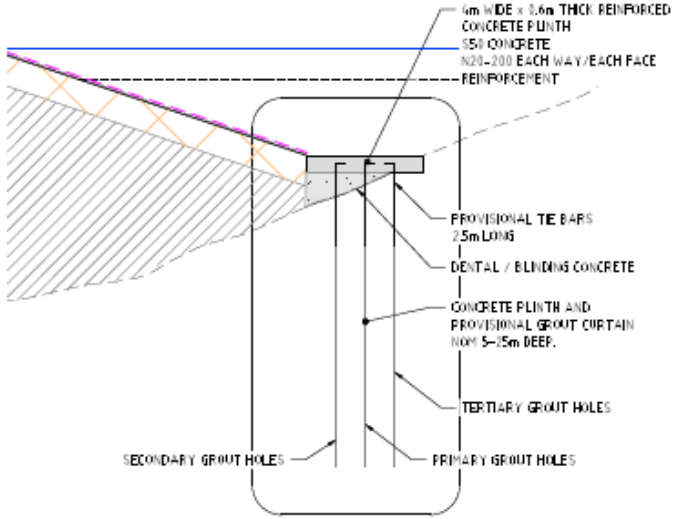
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Option 1 – TSF3

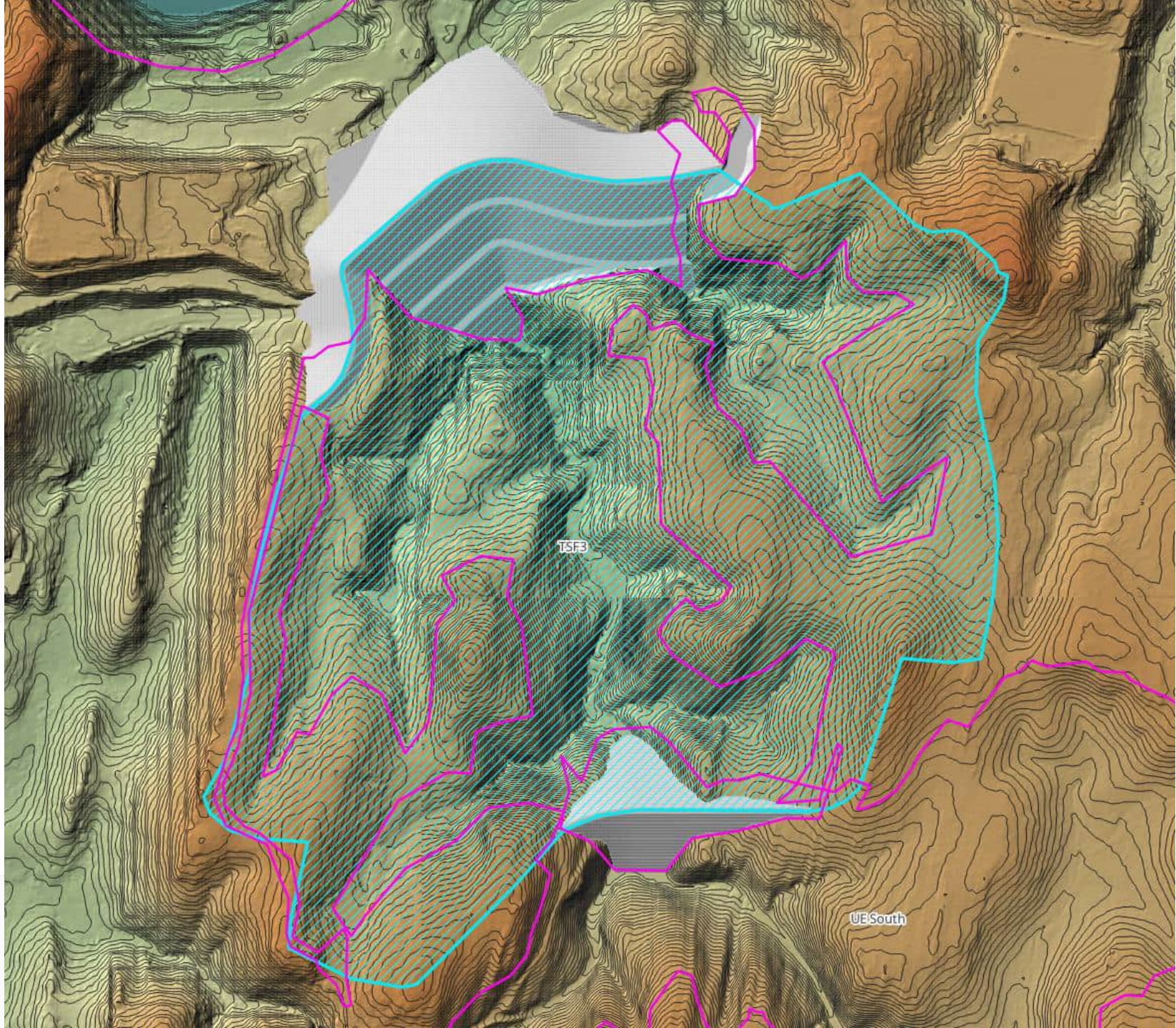
- CAPEX Civil costs inclusive of several items not detailed in the other options (HV & LV roads, bunds, signage, instrumentation, spillway & dumped rock.
- Only northern embankment upstream face will have a liner system and grout curtain at the toe.
- CAPEX priced for 10m Deep Grout Curtain







Option 1 – TSF3



Option 1 – TSF3

- Total embankment volume = 546,200 m^3
- Grout curtain toe length / drilling length = 1,050 m / 10,500 m
- Tailings storage volume = 6.5 Mm^3
- Mean design life = 7.2 years
- Distance from plant= 2.7 km
- Total CAPEX = \$85,644,000 = \$13.28/m^3 storage
- Total OPEX across design life = \$5,200,000 = \$0.80/m^3 storage
- Total CAPEX and OPEX per m^3 storage = \$13.98 /m^3

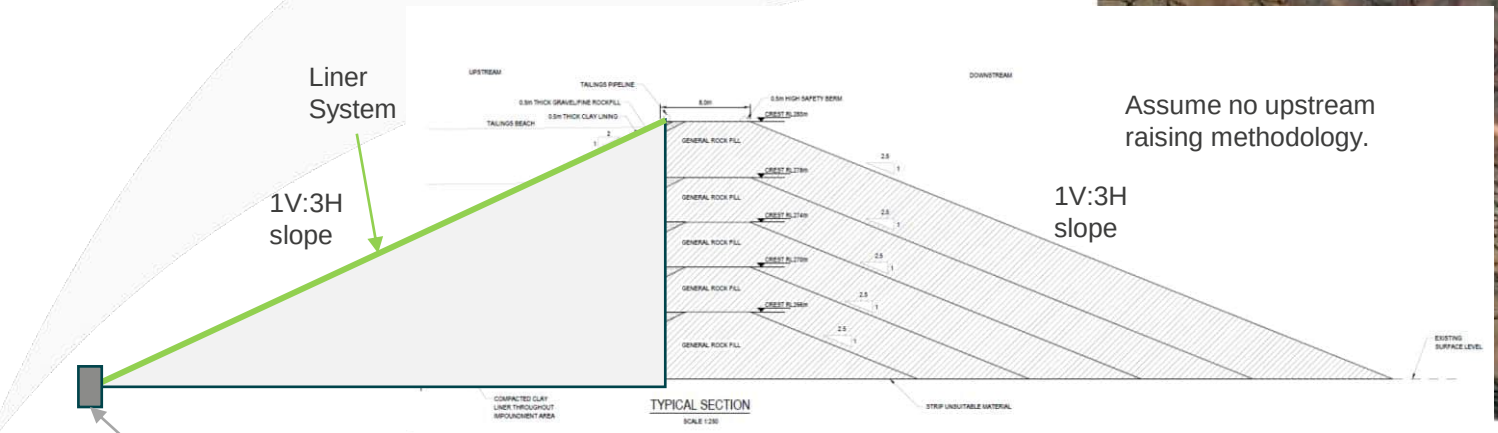
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Option 1 – TSF3

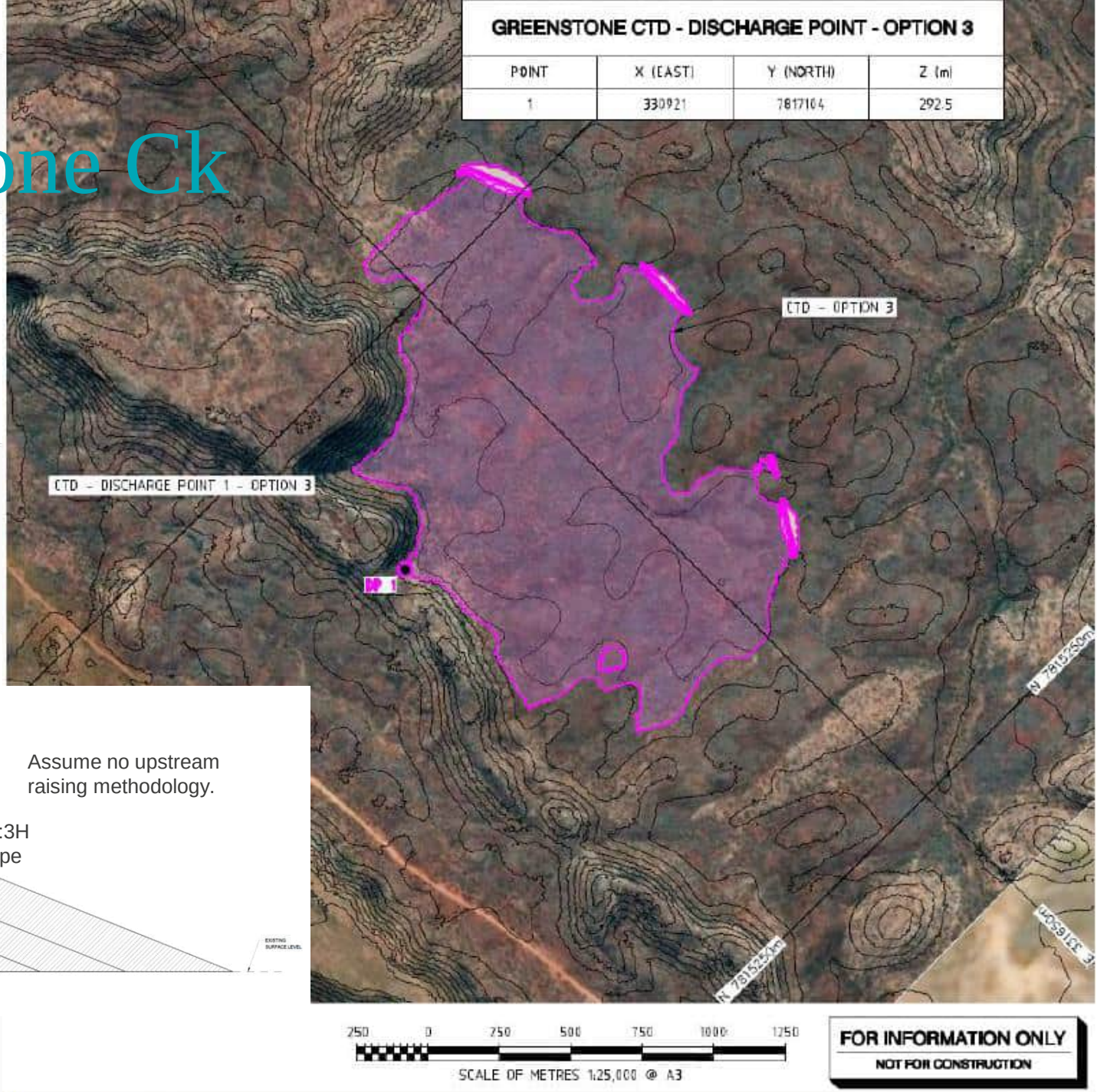
Criteria	Assessment Summary
Geotechnical conditions	Steep sided valley. WRD with good stability.
Consequence of failure	On-site PAR at ESS underground.
Land disturbance	Medium area. Surveys complete.
Seepage Pathway	500m to E Pit with PAF Waste Dump in pathway. Interceptions at MCD and NWRD. 1.6km to Gunpowder Ck.
Water management	Diversion already in place. Medium catchment (80 ha).
Mining tenure	On existing tenure.
Local stakeholders	Generally supportive.
Closure concept	Large capping volume. Includes WRD closure.

Option 2 – Greenstone Ck

- Assume all embankments upstream face will have a liner system and grout curtain at the toe.
- Sensitivity assessment - Assume 300 mm CCL / HDPE Liner over 80% of floor.



Grout Curtain and Concrete Plinth at toe



Option 2 – Greenstone



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Option 2A – Greenstone Ck – With Floor Liner

- Total embankment volume = 173,500 m^3 (Low accuracy)
- Grout curtain toe length / drilling length = 677 m / 6,770 m
- Tailings storage volume = 13.9 Mm^3 (Low accuracy)
- Mean design life = 15.4 years
- Distance from plant= 7.9 km
- Total floor liner base cost = $41,100,800 for an area of 135 ha
- Total CAPEX = $160,124,000 = $11.52/$m^3$ storage
- Total OPEX across design life = $32,696,000 = $2.35/$m^3$ storage
- Total CAPEX and OPEX per m^3 storage = $13.87/$m^3$

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Option 2B – Greenstone Ck – Without Floor Liner (Base Case for MCA Comparison)

- Total embankment volume = 173,500 m^3 (Low accuracy)
- Grout curtain toe length / drilling length = 677 m / 6,770 m
- Tailings storage volume = 13.9 Mm^3 (Low accuracy)
- Mean design life = 15.4 years
- Distance from plant= 7.9 km
- Total CAPEX = $79,566,000 = $5.72/$m^3$ storage
- Total OPEX across design life = $32,696,000 = $2.35/$m^3$ storage
- Total CAPEX and OPEX per m^3 storage = $8.08/$m^3$

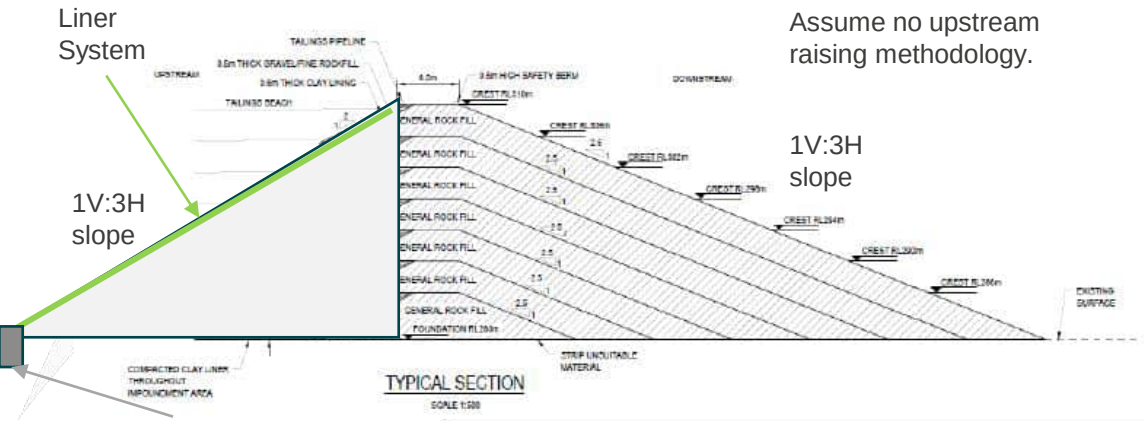
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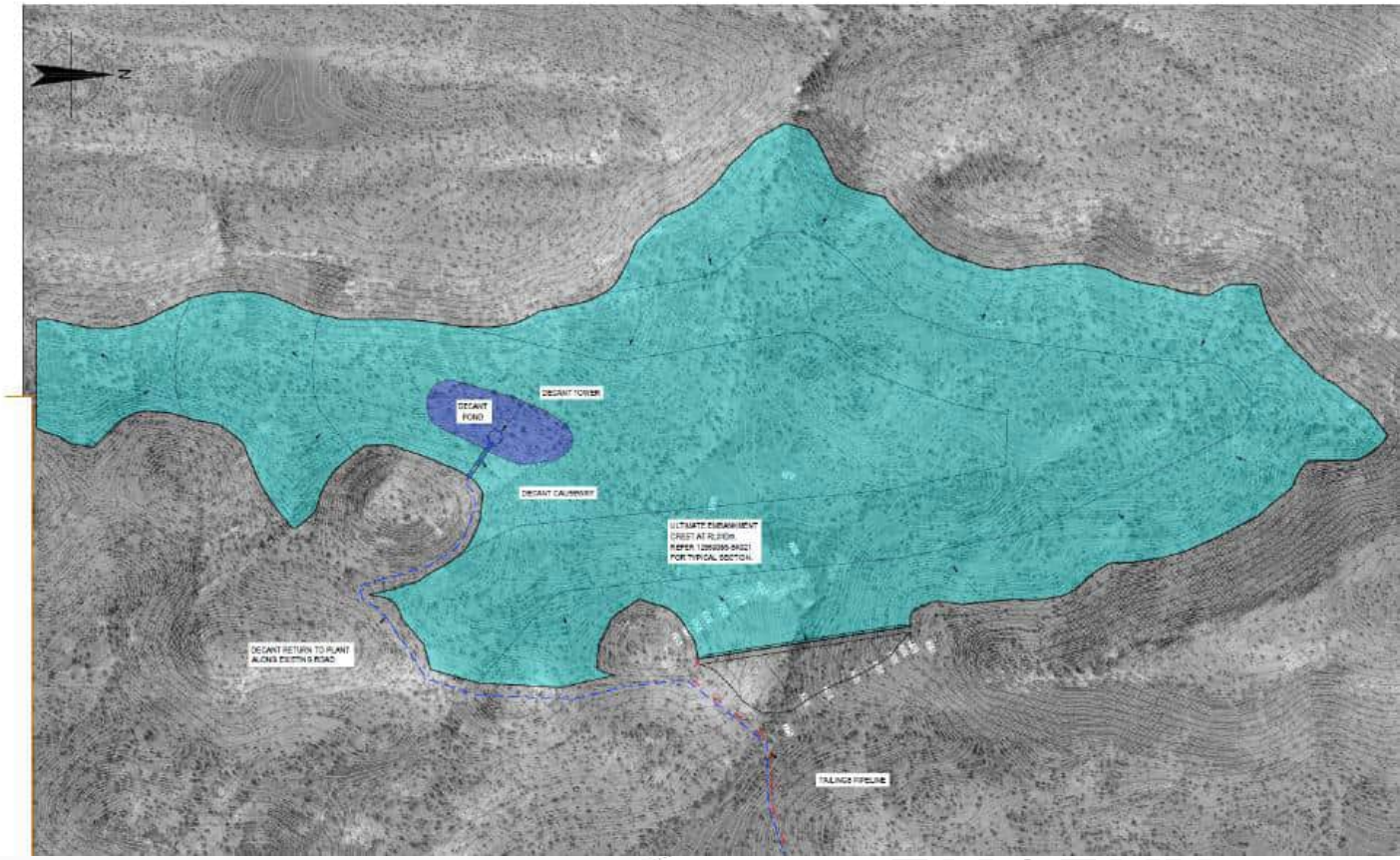
Option 2 – Greenstone Ck

Criteria	Assessment Summary
Geotechnical conditions	Flat area, multiple embankments.
Consequence of failure	Indirect PAR, creek and lake users. Above Greenstone Ck and Lake W.
Land disturbance	Largest area. Unknown species.
Seepage Pathway	On Greenstone Ck tributary.
Water management	No diversion expected. Large catchment (243 ha, low accuracy – ELVIS publicly available data).
Mining tenure	No mining lease or agreement.
Local stakeholders	Desirable Agricultural land. Owner not supportive.
Closure concept	Largest capping volume. Residual risk to Greenstone Creek.

Option 3 – Diamond Ck

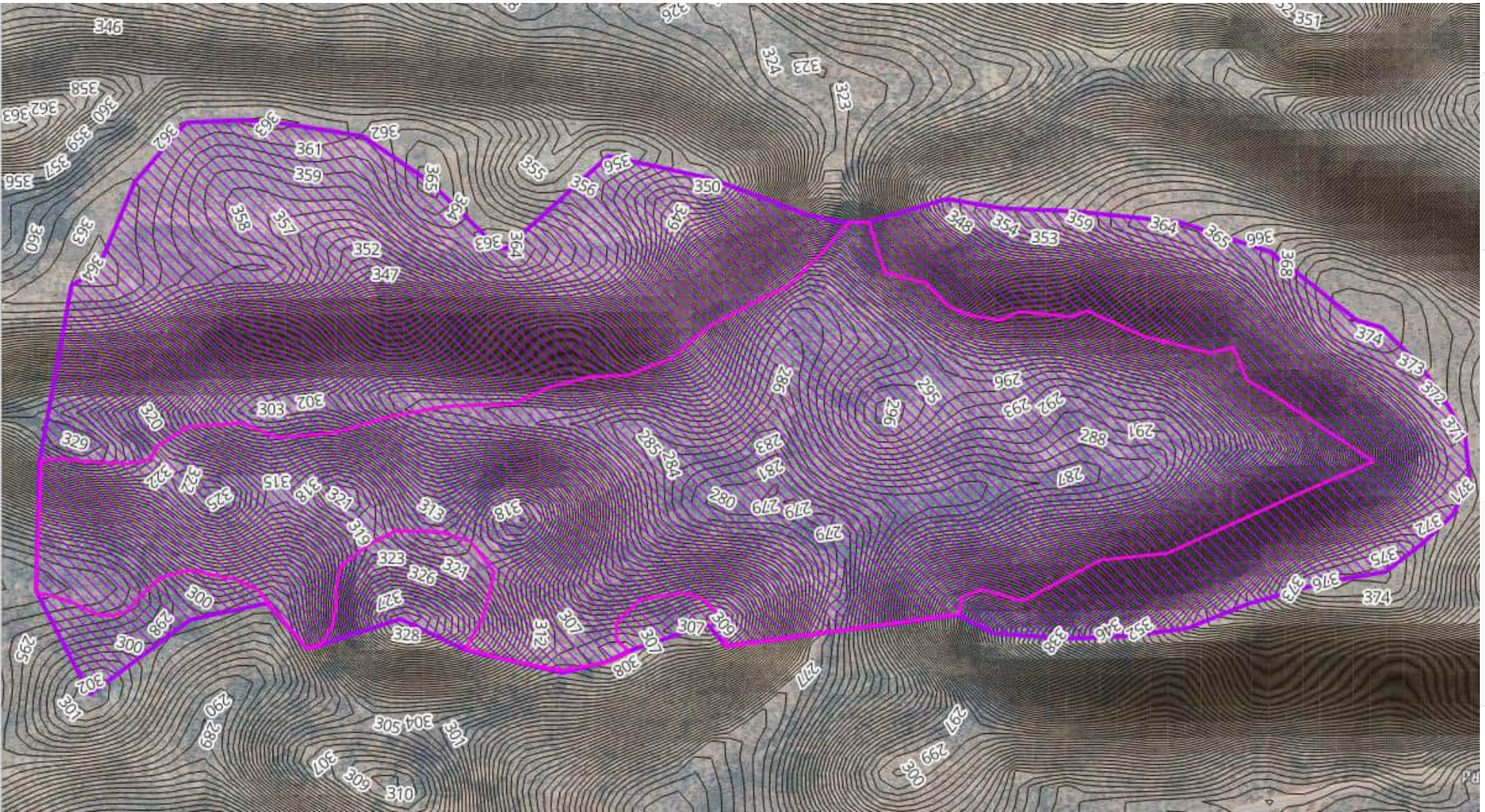
- Assume east embankment upstream face will have a liner system and grout curtain at the toe.





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Option 3 – Diamond Ck



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Option 3 – Diamond Ck

- Total embankment volume = 100,900 m^3 (Low accuracy)
- Grout curtain toe length / drilling length = 614 m / 6,140 m
- Tailings storage volume = 12.58 Mm^3 (Low accuracy)
- Mean design life = 13.87 years
- Distance from plant = 9.87 km
- Total CAPEX = $82,665,000 = $6.57/$m^3$ storage
- Total OPEX across design life = $37,074,000 = $2.95/$m^3$ storage
- Total CAPEX and OPEX per m^3 storage = $9.52/$m^3$

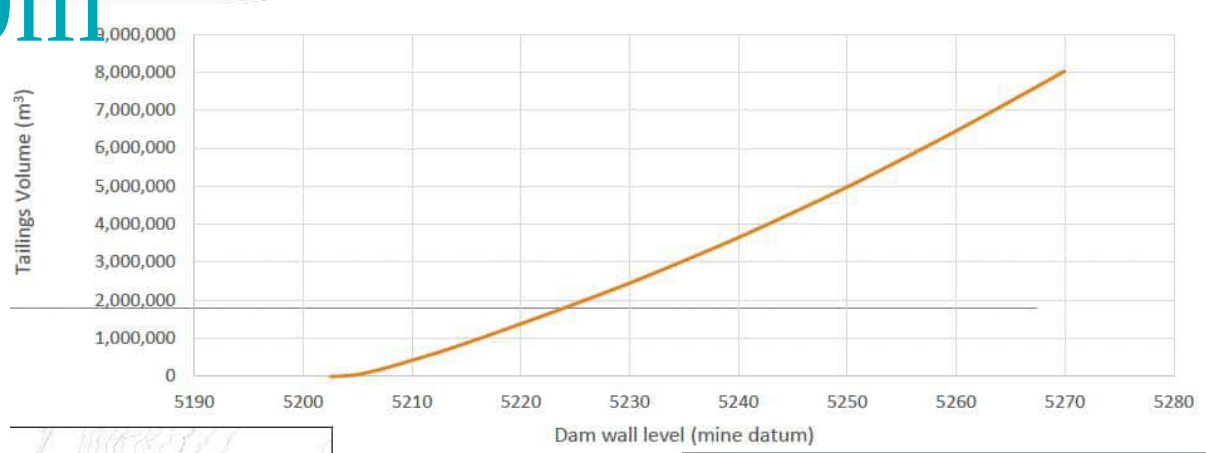
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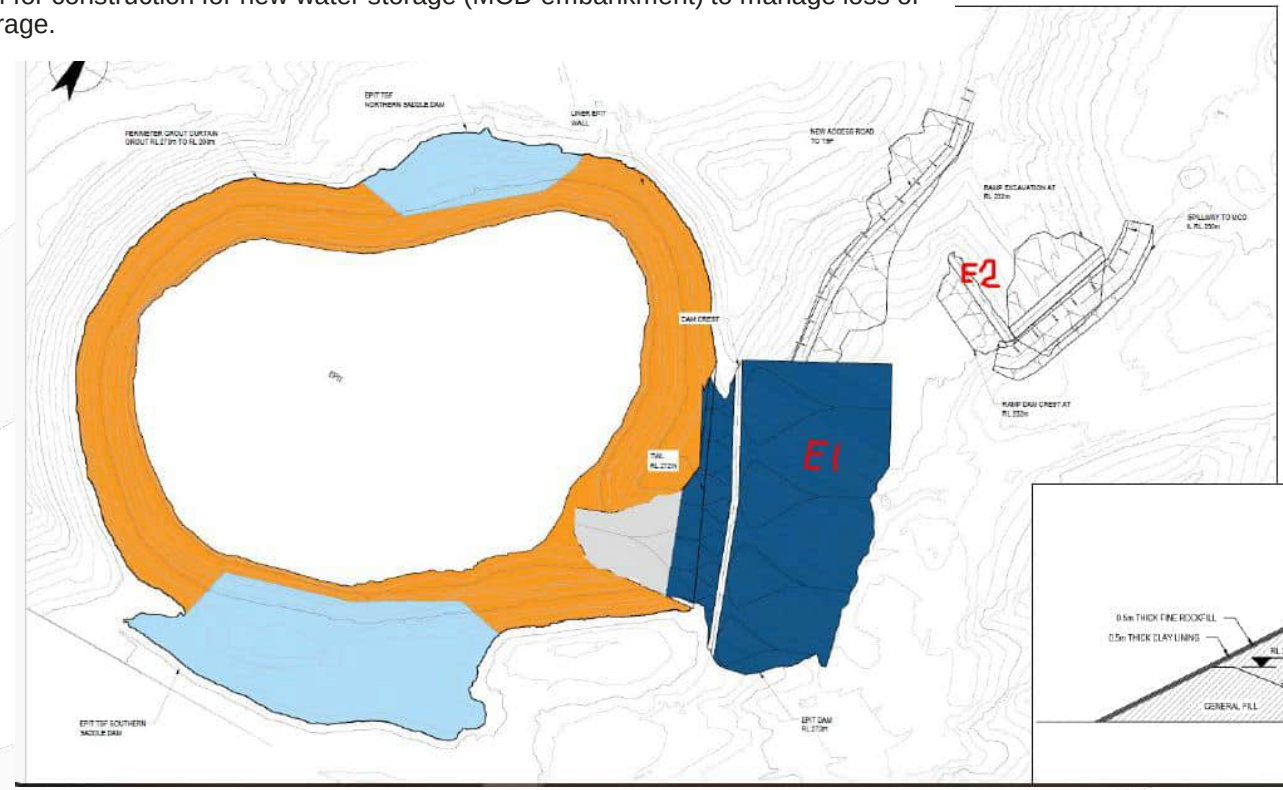
Option 3 – Diamond Ck

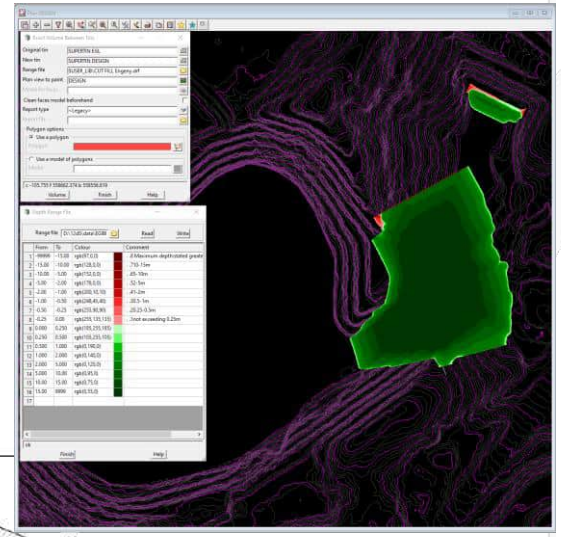
Criteria	Assessment Summary
Geotechnical conditions	Steep sided valley, Small embankment.
Consequence of failure	Indirect PAR, Road users. Above Greenstone Ck and Public Road.
Land disturbance	Large area. Unknown species.
Seepage Pathway	On Greenstone Ck tributary.
Water management	Possible diversion, Large catchment (195 ha, low accuracy – ELVIS publicly available data).
Mining tenure	No mining lease or agreement.
Local stakeholders	Agricultural land. Owner not supportive.
Closure concept	Large capping volume.

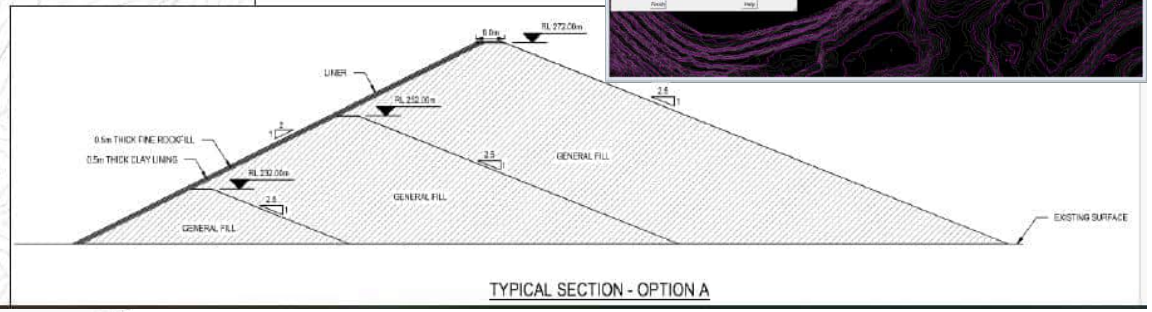
Option 4 – EPit RL 270m

- Assume embankment E2 upstream face will have a liner system and grout curtain at the toe.
- Assume no liner on pit walls and no northern and southern TSF embankments included in the cost estimate.
- Assume the new access road and spillway works are not included in the cost estimate.
- Assume no pit perimeter grout curtain works.
- Allowed $15M for paste plant relocation. (Alternate Water Storage).
- Allowed $10M for construction for new water storage (MCD embankment) to manage loss of site water storage.

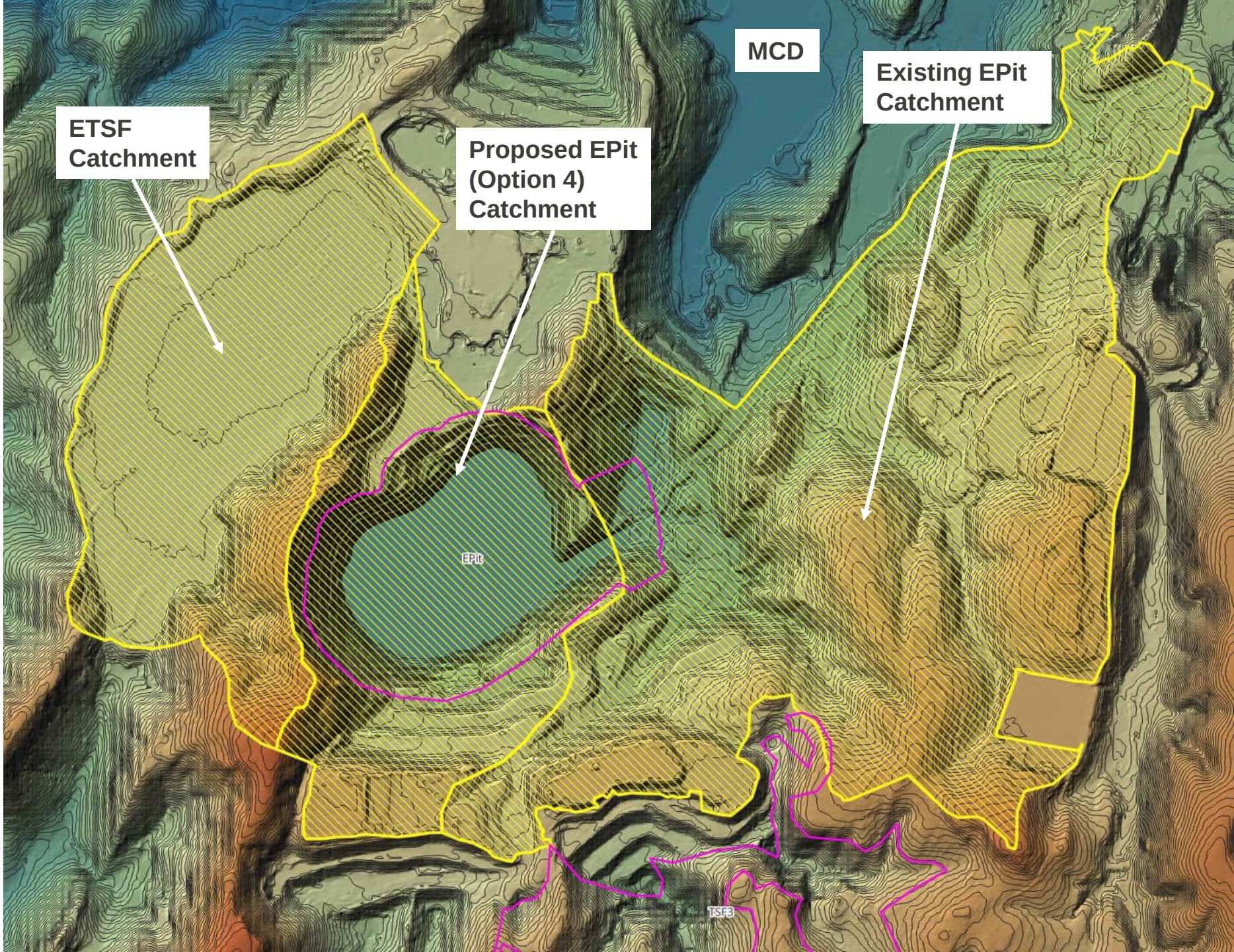








Option 4 – EPit RL 270m



Option 4 – EPit RL 270m

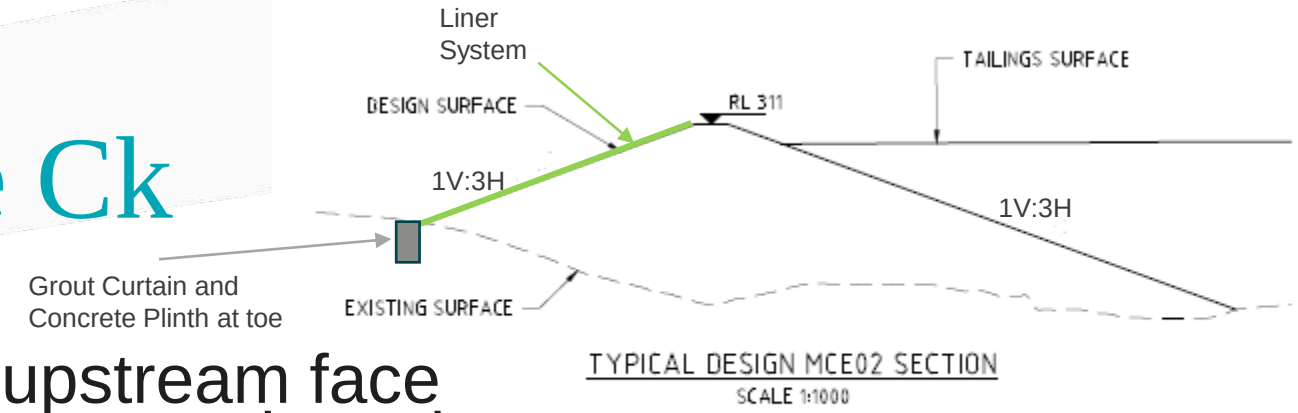
- Total embankment volume = 558,700 m^3 – max embankment crest height of 272m AHD (embankment height of ~47.5m)
- Grout curtain toe length / drilling length = 94 m / 940 m
- Tailings storage volume = 8.04 Mm^3
- Mean design life = 8.87 years
- Distance from plant= 1.08 km
- Total CAPEX = $66,178,000 = $8.23/$m^3$ storage
- Total OPEX across design life = $2,593,000 = $0.32/$m^3$ storage
- Total CAPEX and OPEX per m^3 storage = $8.55/$m^3$

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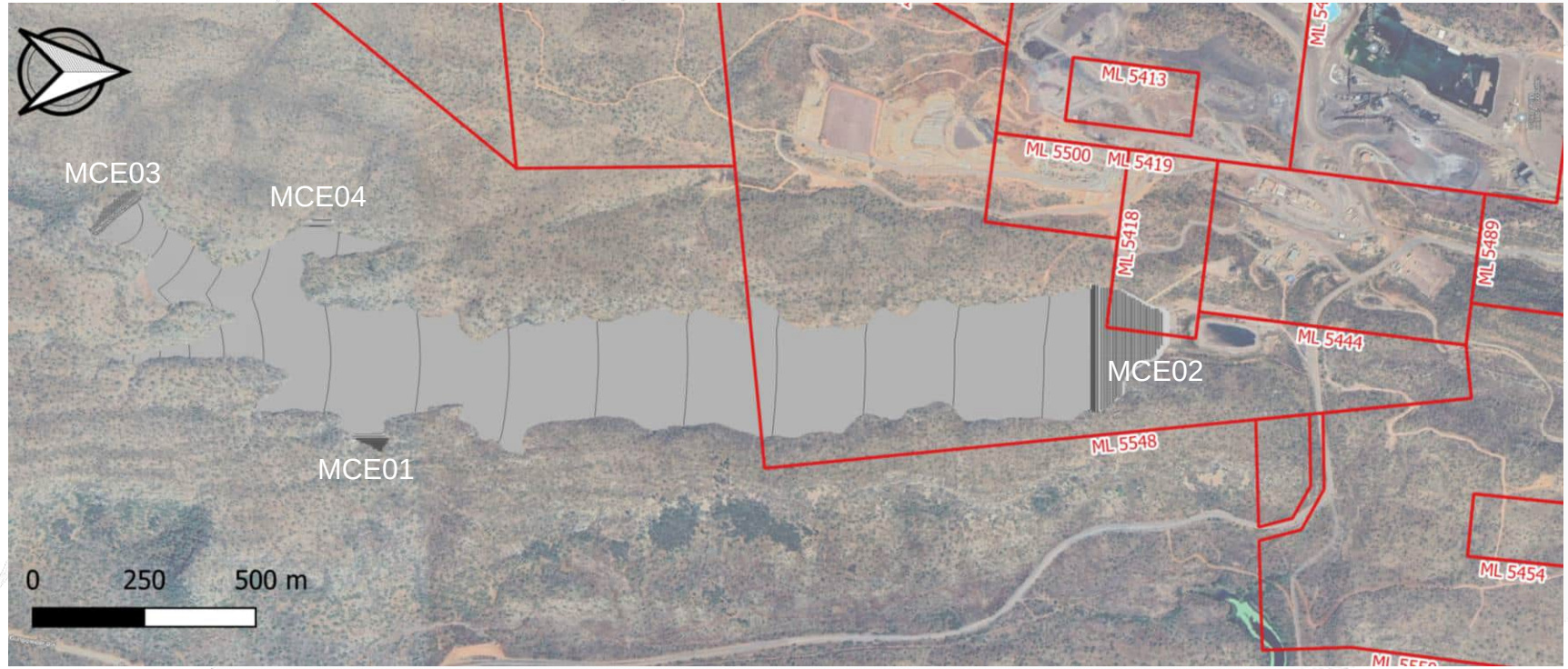
Option 4 – EPit RL 270m

Criteria	Assessment Summary
Geotechnical conditions	Enclosed pit wall with large embankment volume.
Consequence of failure	On-site PAR at Mammoth underground. Above MCD.
Land disturbance	No new disturbance or flora/fauna impact
Seepage Pathway	1km to Gunpowder Ck. Known seepage above 222RL. Interceptions at MCD and NWRD.
Water management	Requires additional site MAW storage capacity. Large existing catchment. Catchment area may range from 38 ha (contained by large embankment) to 80 ha (inclusive of ETSF) to 180 (total inclusive of existing EPit catchment + ETSF).
Mining tenure	On existing tenure.
Local stakeholders	Generally supportive. Only if water is managed.
Closure concept	Small capping volume. Water shedding option required.

Option 5 – Magazine Ck



- Assume MCE02 embankment upstream face will have a liner system and grout curtain at the toe.



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Option 5 – Magazine Ck



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Option 5 – Magazine Ck

- Total embankment volume = 1,163,200 m^3
- Grout curtain toe length / drilling length = 395 m / 3,950 m
- Tailings storage volume = 10.47 Mm^3
- Mean design life = 11.54 years
- Distance from plant= 3.19 km
- Total CAPEX = \$57,114,000 = \$5.46/m^3 storage
- Total OPEX across design life = \$9,968,000 = \$0.95/m^3 storage
- Total CAPEX and OPEX per m^3 storage = \$6.41/m^3

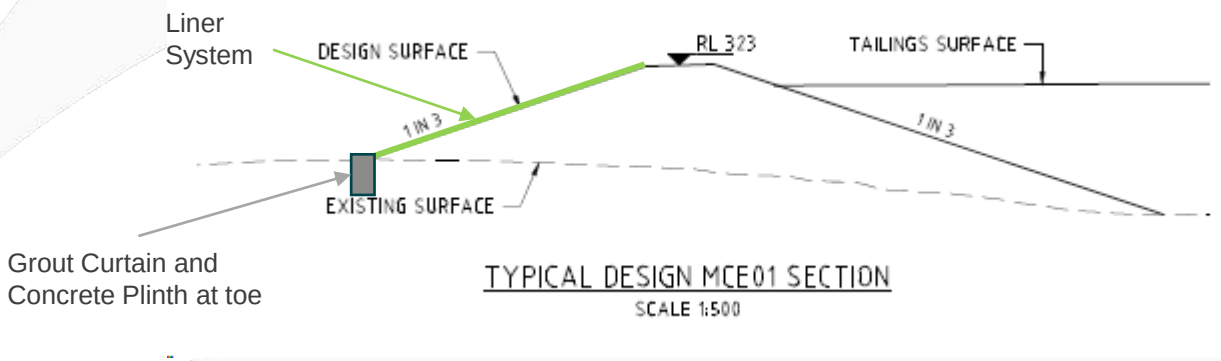
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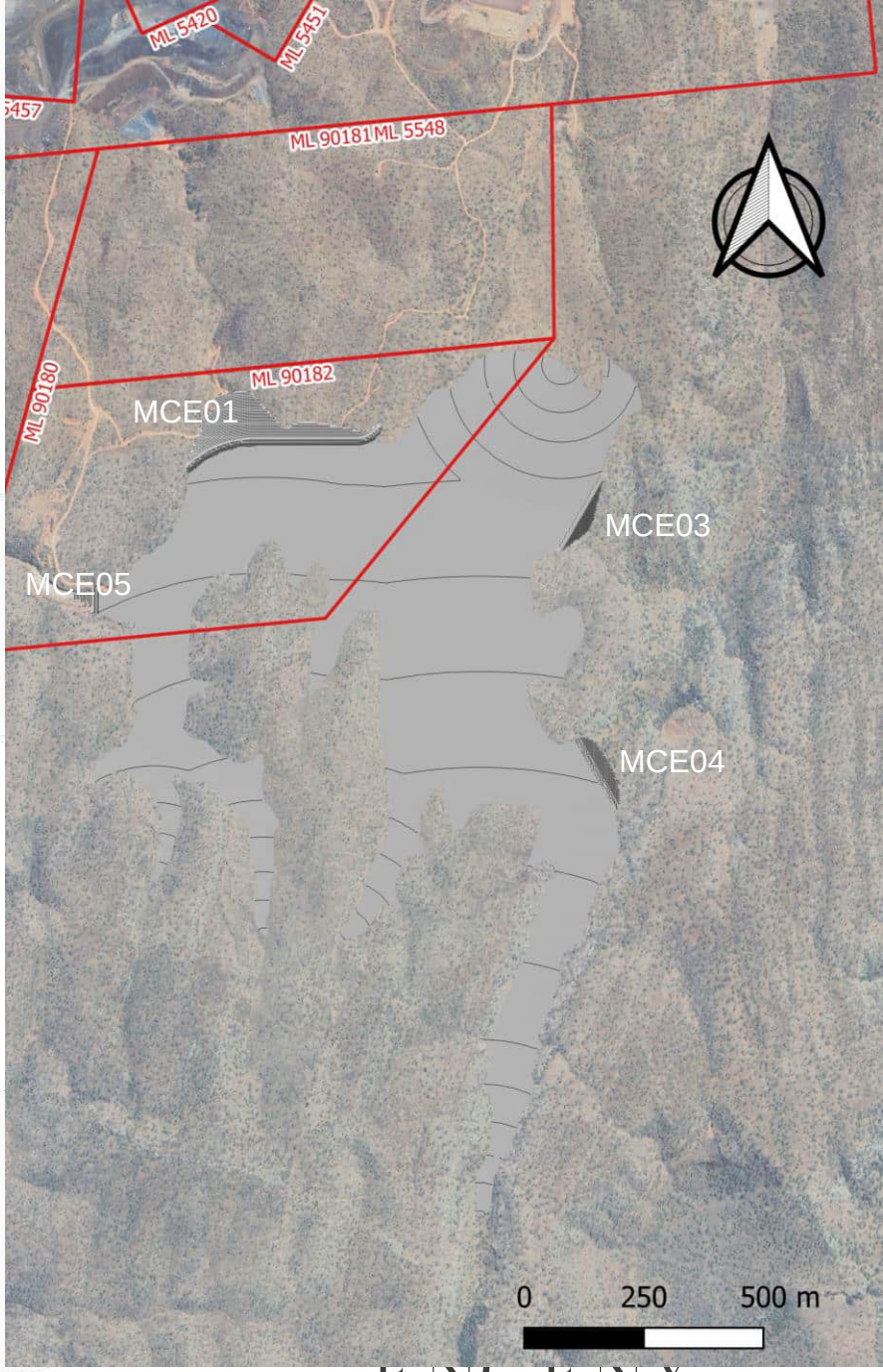
Option 5 – Magazine Ck

Criteria	Assessment Summary
Geotechnical conditions	Natural valley. Large main embankment volume.
Consequence of failure	Indirect PAR, Road and Lake users. Above Gunpowder Ck and Lake W and Public Road.
Land disturbance	Large area. Previous disturbance. Unknown species.
Seepage Pathway	On Magazine Ck. 600m to Lake, 1.2km to Gunpowder Ck.
Water management	Minor diversion works. Medium catchment (104 ha).
Mining tenure	Partially on and off tenure.
Local stakeholders	Neutral.
Closure concept	Large capping volume. Water management during rehab.

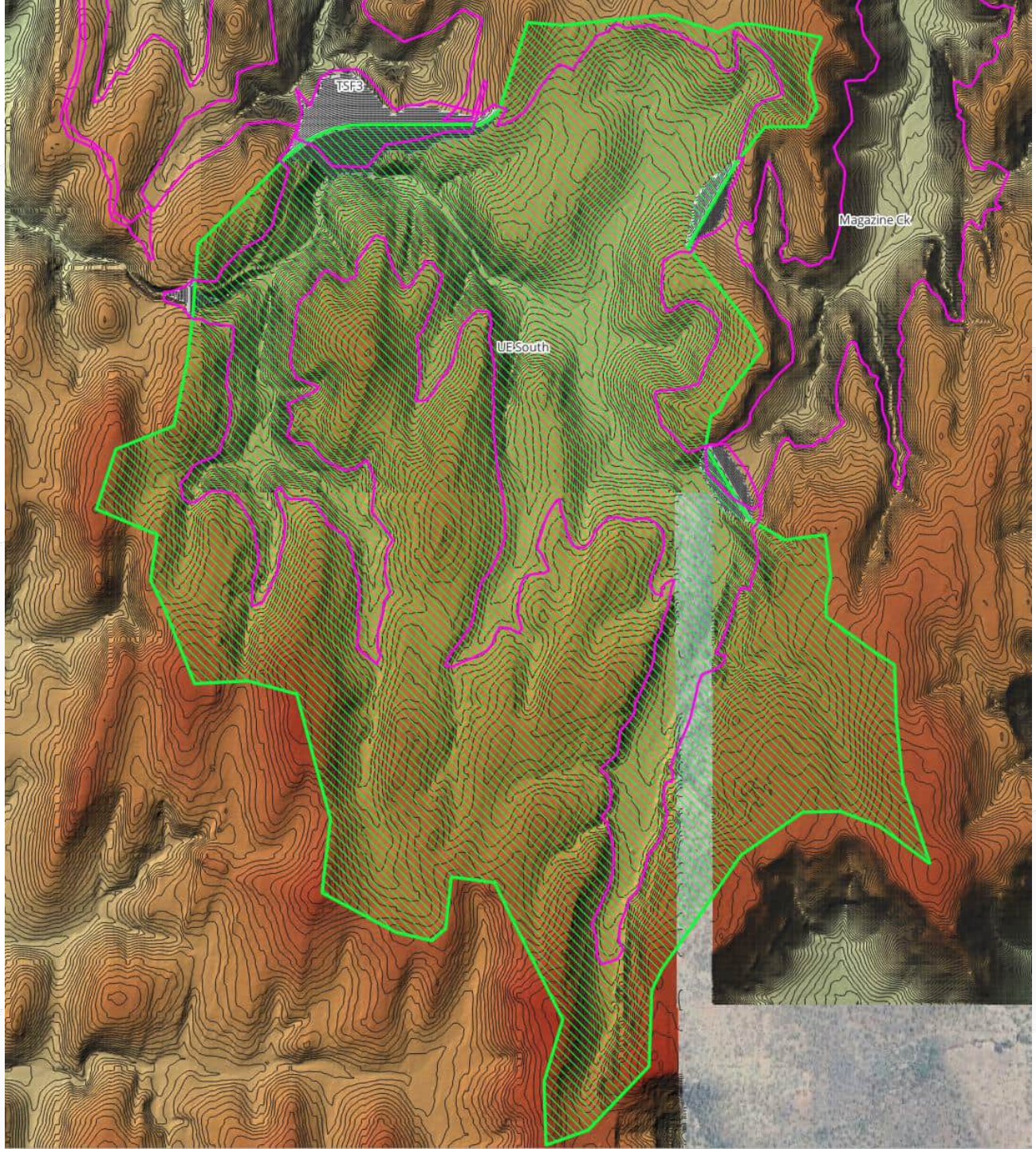
Option 6 – UE TSF South

- Assume MCE01 & MCE04 embankments upstream face will have a liner system and grout curtain at the toe.





Option 6 – UE TSF South



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Option 6 – UE TSF South

- Total embankment volume = 455,900 m^3
- Grout curtain toe length / drilling length = 656 m / 6,560 m
- Tailings storage volume = 5.21 Mm^3
- Mean design life = 5.75 years
- Distance from plant = 3.84 km
- Total CAPEX = \$54,406,000 = \$10.44/m^3 storage
- Total OPEX across design life = \$5,976,000 = \$1.15/m^3 storage
- Total CAPEX and OPEX per m^3 storage = \$11.58/m^3

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Option 6 – UE TSF South

Criteria	Assessment Summary
Geotechnical conditions	Steep sided valleys. Multiple embankments.
Consequence of failure	No PAR. Above Upper Esperanza, Magazine Ck and Snakeskin Valley.
Land disturbance	Medium area. Unknown species.
Seepage Pathway	1.2km to Magazine Ck. 2km to Gunpowder Ck.
Water management	Major diversion works required. Large Catchment (189 ha).
Mining tenure	Partially on and off tenure.
Local stakeholders	Neutral.
Closure concept	Large capping volume.

MCA Scores Summary (incl. ETSF Raise option)

Criteria	Weighting	1. UE TSF3 (Phase 1)	2. Greenstone Ck	3. Diamond Ck	4. Epit RL 270m	5. Magazine Creek	6. UE TSF - South of UEDD (Phase 2)	7. E TSF Raise
STORAGE CAPACITY	5	3	5	5	3	5	2	1
COST	20	2	4	3	4	5	3	1
GEOTECHNICAL CONDITIONS	10	5	3	5	4	3	4	3
CONSEQUENCE OF FAILURE	10	4	3	3	3	3	5	4
LAND DISTURBANCE	10	4	2	3	5	3	3	5
SEEPAGE PATHWAY	10	3	3	3	2	2	4	4
WATER MANAGEMENT	10	4	4	3	1	4	2	5
MINING TENURE	5	4	1	1	4	2	2	5
LOCAL STAKEHOLDERS	10	4	2	2	3	3	3	2
CLOSURE CONCEPT	10	4	3	4	3	3	4	5
Weighted Score	**100**	**71.0**	**62.0**	**64.0**	**65.0**	**69.0**	**66.0**	**66.0**

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Summary of Updated CAPEX and OPEX

Option	CAPEX $	CAPEX / m^3 storage	OPEX / m^3 storage	CAPEX + OPEX / m^3 storage
1. TSF3	$85,644,000	$13.18	$0.80	$13.98
2a. Greenstone Ck 2b. No floor liner	$160,124,000 $79,566,000	$11.52 $5.72	$2.35	$13.87 $8.08
3. Diamond Ck	$82,665,000	$6.57	$2.95	$9.52
4. EPit RL270m	$66,178,000	$8.23	$0.32	$8.55
5. Magazine Ck	$57,114,000	$5.46	$0.95	$6.41
6. UE TSF South	$54,406,000	$10.44	$1.15	$11.58

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MCA CAPEX and OPEX Ratings

5 (BEST MEETS CRITERIA) to 1 (LEAST MEETS CRITERA)

Option	CAPEX Rank	OPEX Rank	Rank for OPEX+CAPEX #
1. TSF3	1	4	2
2a. Greenstone Ck	2	2	2
2b. No floor liner	5	2	4
3. Diamond Ck	4	1	3
4. E-Pit RL270m	3*	5	4*
5. Magazine Ck	5	4	5
6. UE TSF South	2	3	3

* This rank is for the lower potential CAPEX cost as it assumes only the RL232m embankment (E2) has the liner, plinth and grout curtain and the pit wall works, access road works and spillway works are not included in the cost estimate.

Overall cost rankings consider ETSF total cost of $20/m3 (ranked 1)

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Sensitivity – Seepage Control Costs Removed

No seepage controls.
OPEX unchanged.

Option	CAPEX $	CAPEX / m^3 storage	CAPEX + OPEX / m^3 storage	Ranking
1. TSF3	$44,489,000	$6.84	$7.64	2
2. Greenstone Ck	$58,066,000	$4.18	$6.53	3
3. Diamond Ck	$60,883,000	$4.84	$7.78	2
4. EPit RL270m	$63,210,000	$7.86	$8.18	1
5. Magazine Ck	$43,069,000	$4.11	$5.07	5
6. UE TSF South	$32,556,000	$6.25	$7.39	2

Notes
– Does not consider reduction in EWRD Landform Earthworks for Option 1 – TSF3. CAPEX likely significantly overestimated.
– Costs revised for removal of upstream liners / concrete plinth / grout curtain.

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APPENDIX C: GEOLOGICAL MAPPING REPORT

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Capricorn Copper Mine

TSF3 Geological Mapping Report

QC1022_018-REP-001-1

12 MAY 2025

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	28/03/2024	Client Review	Alex Leotta	Deryk Forster / Brendan Wallace	Brendan Wallace	Brendan Wallace
1	12/05/2025	Client Issue	Deryk Forster	Brendan Wallace	Brendan Wallace	Brendan Wallace
Signatures:						

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1. INTRODUCTION

Capricorn Copper Pty Ltd (Capricorn Copper) have engaged Engeny to undertake a geological mapping program to support the detailed design of the proposed Tailings Storage Facility 3 (TSF3) including the assessment of potential seepage risks, the detailed design of required seepage controls, and the identification of potential borrow materials for the construction and closure of TSF3. TSF3 is proposed to be located between the existing Ezperanza Waste Rock Dump (ERWD) and Upper Ezperanza Diversion Dam (UEDD) at Capricorn Copper Mine (CCM) located around 130km north-west of Mount Isa, Queensland.

As part of the geological mapping program scope of works, a desktop review of previous geotechnical, geophysical, and hydrogeological investigation and assessment data / documentation and previous dam construction data was undertaken. The outcome of this review suggested the following:

- Available clayey borrow material for TSF3 embankments material may be limited.
- Faults identified through geophysical assessments have not been ground truthed. Additionally, any fault characteristics regarding dip orientation and physical characteristics regarding mineralogy, material weathering and strength are unknown.
- There is limited geotechnical drillhole data to inform the detailed design of TSF3 including required seepage controls, existing embankment conditions, and embankment founding conditions.

This report presents the objectives, scope, geological field mapping results and further works required to support geotechnical aspects of the TSF3 detailed design.

1.1 Objectives

The key objectives of the geological mapping program were to:

- Evaluate existing borrow pits and assess prospective areas/materials for future borrow pit production.
- Field reconnaissance of mapped lithological/stratigraphic units to better understand their typical geotechnical/geomechanical characteristics.
- Ground truth faults identified by desktop geophysical analyses and shown in the available 1:250,000 surface geological map.
- Identify any additional faults or deleterious materials which may impact the TSF3 design.
- Develop target areas for further geotechnical investigation required as part of detailed design.

1.2 Scope

The scope of the geotechnical mapping program include:

- Desktop review of existing geological data to inform mapping targets and prospective borrow areas.
- Delivery of a 3-day mapping program carried out by a Principal Engineering Geologist and Senior Engineering Geologist. The mapping consisted of the following:
  - Site walk over and measurement of geological structures.
  - Tactile assessment of prospective borrow materials.

1.3 Battery Limits

The geological mapping program targeted prospective borrow areas identified during desktop review and the TSF3 embankment footprint and tailings impoundment areas, particularly where intersecting faults were identified. These target areas are shown in Figure 1.1. Assessment of the existing Ezperanza Waste Rock Dump (EWRD) and Upper Esperanza Diversion Dam (UEDD) are outside the scope of this geological assessment.

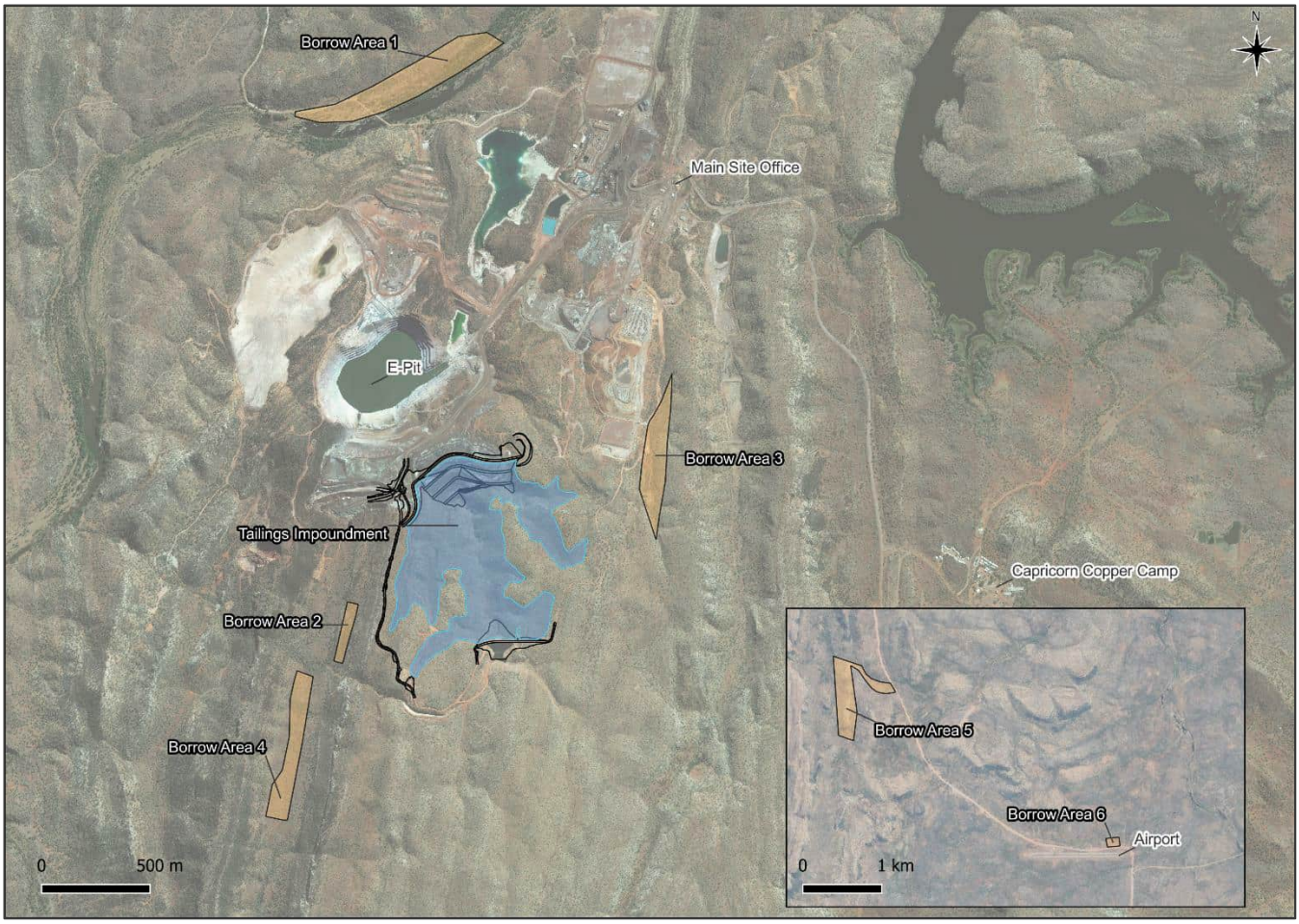


FIGURE 1.1: BATTERY LIMITS OF GEOLOGICAL MAPPING PROGRAM

1.4 Conventions

The following conventions apply to this report:

- All geometric measurements are metric.
- Coordinates are in metres and relative to GDA94 MGA Zone 55 horizontal datum and all Reduced Levels (RL) report to Australian Height Datum (AHD).
- All bearings (unless noted otherwise) are presented as degrees clockwise from grid (true) north and have been adjusted for site magnetic declination which, at the time of investigation, was 5.4° East. All inclination data is measured and noted in degrees relative to horizontal.
- All geological measurements regarding the geometry of surfaces present within the rock mass (unless noted otherwise) such as bedding, joints or other structural features provided in this report are presented as Dip Angle / Dip Direction (°).
- Where strike measurements have been calculated from dip-direction measurement, the American right-hand rule has been adopted.
- All stereonets[1] presented herein are lower hemisphere and equal area, with polar or equatorial overlays as appropriate.

1.5 Abbreviations

- E Pit – Esperanza Pit.
- EWRD – Esperanza Waste Rock Dump.

[1] A conceptual representation of geological structures illustrating the orientation of geological structures, such as bedding planes, fault lines and joints.

- UEV – Upper Esperanza Valley.
- UEDD – Upper Esperanza Diversion Dam.
- EF – Esperanza Fault.
- MF – Mammoth Fault.
- MEF – Mammoth Extended Fault.

2. BACKGROUND

Prior to the mapping program, a desktop study was conducted to understand site geology and identify mapping targets. The information available and summary of geological information is described in the following sections.

2.1 Available Information

Table 2.1 below outlines the information reviewed as part of the desktop study and field assessment.

TABLE 2.1: AVAILABLE DATA

Data Type	Date	Author	Title
Imagery	-	Microsoft Corporation	Bing Satellite
	1972	QImagery	QAP2255049.jpg
LiDAR	July 2020	Capricorn Copper	Gunpowder 20Jul2021 WV3 50cm DTM GDA94 MGA54 1m Extended.dem
Geological	1998	Richardson, S M and Moy, A D	Gunpowder Copper Deposits, in *Geology of Australian and Papua New Guinean Mineral Deposits,* pp743 -752.
	1975	Mitchell, J W and Moore, G. P	Mammoth Copper Deposit, in *Northwest Queensland Province,* pp 383-389.
	2008	Keys, D L	Mechanical localisation of copper deposits in the Mt Isa Inlier, North Queensland.
	2022	GSQ	1:100,000 geology dataset GSQ, STRUCTURAL AND DETAILED
Design Reports	Oct-06	GHD Pty Ltd	Mill Creek Dam
	Oct-06	GHD Pty Ltd	Mill Creek Dam Drawing Set
	Nov-19	GHD Pty Ltd	Esperanza Spillway Raise
	Jan-22	GHD Pty Ltd	Esperanza Tailings Storage Facility raise to RL284
	Jul-22	GHD Pty Ltd	Esperanza Tailings Storage Facility raise to RL287.7
	Jul-23	ATC Williams Pty Ltd	Capricorn copper, temporary water storage options assessment.
Geotechnical Reports	Jan-19	GHD Pty Ltd	Borrow Area Investigations
	Sep-20	GHD Pty Ltd	Esperanza Pit Factual Geotechnical Investigation
	Apr-23	ATC Williams Pty Ltd	Esperanza TSF Conceptual Model and Seepage Assessment Report

Notes: the 1:250,000 scale state geophysical data (RTP 1DV, RTP) were reviewed, however, were not used owing to the relevance (insufficient level of detail).

2.2 Site Description

2.2.1 General

The proposed TSF3 embankments (EWRD and UEDD) are located around 1.8 and 2.5km south of the main site offices respectively and are accessed via the mine access tracks and haul roads shown in Figure 2.2.

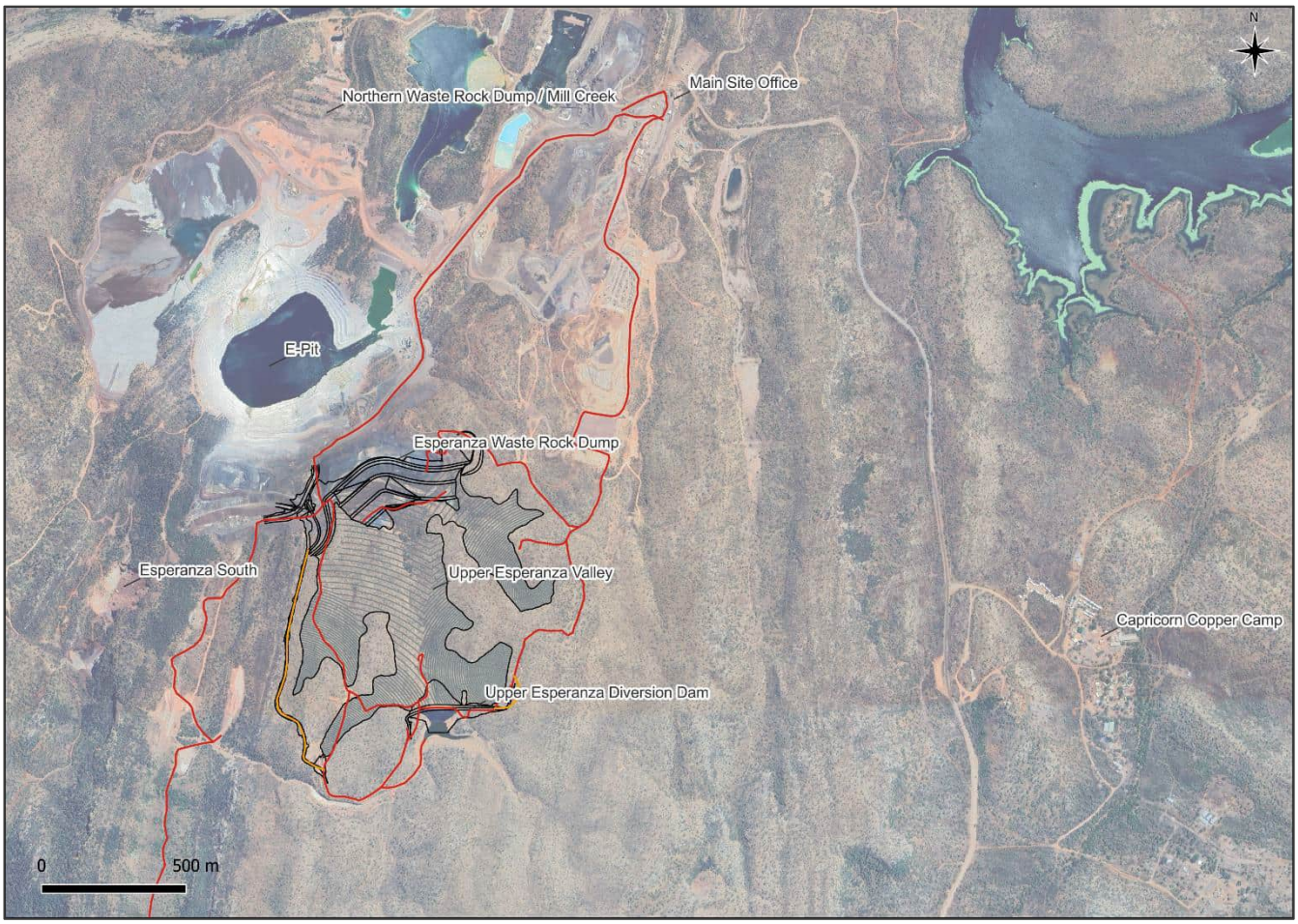


FIGURE 2.1: GENERAL ARRANGEMENT (ACCESS TRACKS/HAUL ROADS SHOWN IN RED, PROPOSED TRACKS SHOWN IN YELLOW)

The site topography consists of roughly north-south striking undulating ridges which are incised by a main drainage line which forms the Upper Esperanza Valley (UEV) and is bound by the EWRD in the north and by the UEDD in the south . TSF3 is proposed to be located between the EWRD and UEDD and bound by the surrounding ridges.

The UEV runs roughly south-east / north-west and drains waters to the north toward the E-Pit. The base of the UEV beneath the Upper UEDD exists at approximately RL 287 mAHD and drops to RL 249 mAHD beneath the EWRD, falling at a grade of approximately 5%. Valley sides which form the abutments of the TSF3 and UEDD rise at approximately 37% and 20% [grade] respectively. Figure 2.3 below illustrates the main topographic features within the study area.

Valley sides in the tributary lines either side of the UEV (denoted by blue arrows in Figure 2.2) have similar properties to the UEV. The topography in the UEV and adjacent valleys present difficulty for LV access and the ability to build access tracks.

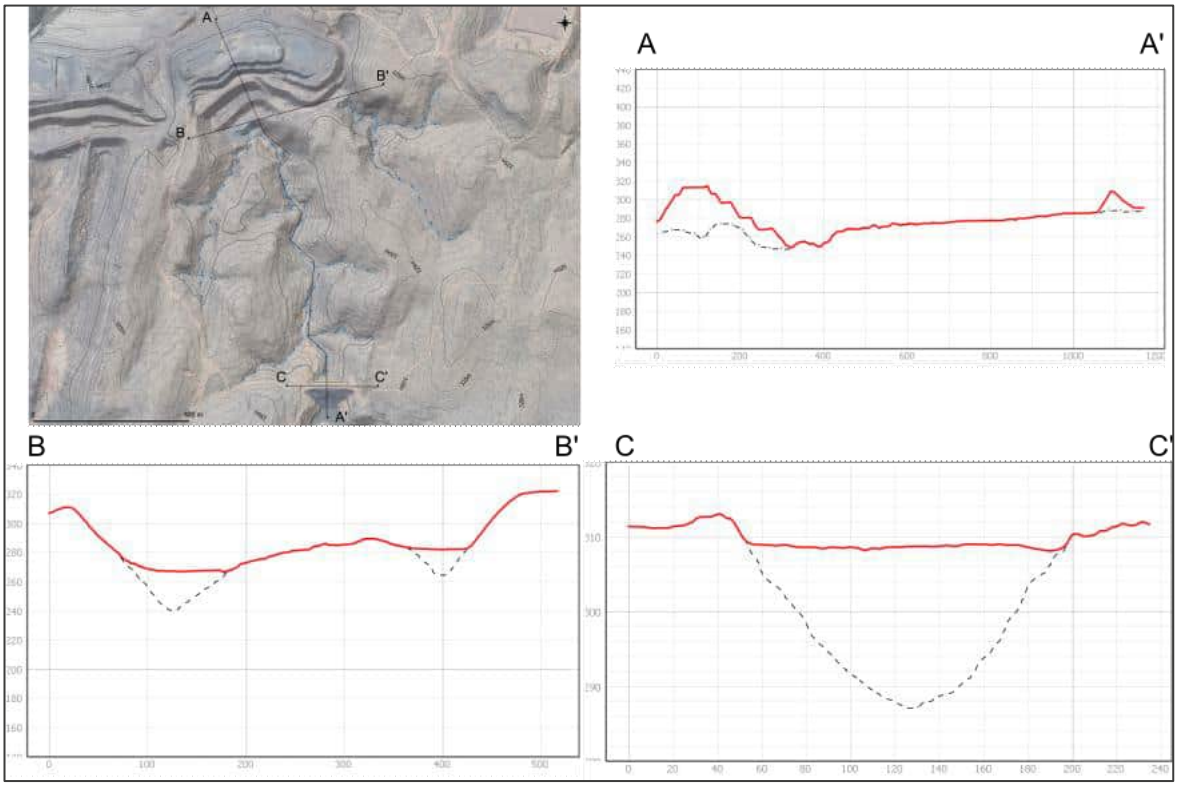


FIGURE 2.2: TOPOGRAPHICAL SECTIONS THROUGH THE UEV. NOTE: INFERRED GROUND SURFACE BENEATH THE EMBANKMENTS BASED ON HISTORICAL IMAGERY ARE SHOWN IN DASHED BLACK ABOVE.

2.2.2 Waste Rock Dump and Dam Development

Construction of the EWRD occurred sometime after the commencement of mining at Esperanza Pit (E-Pit) circa 1997. The EWRD appears to have infilled existing drainage lines which drain waters to the north (refer Figure 2.3). Subsequent to the field mapping program, a historic survey of the area prior to the development of the EWRD was located. This survey confirms the interpretation shown in Figure 2.3.

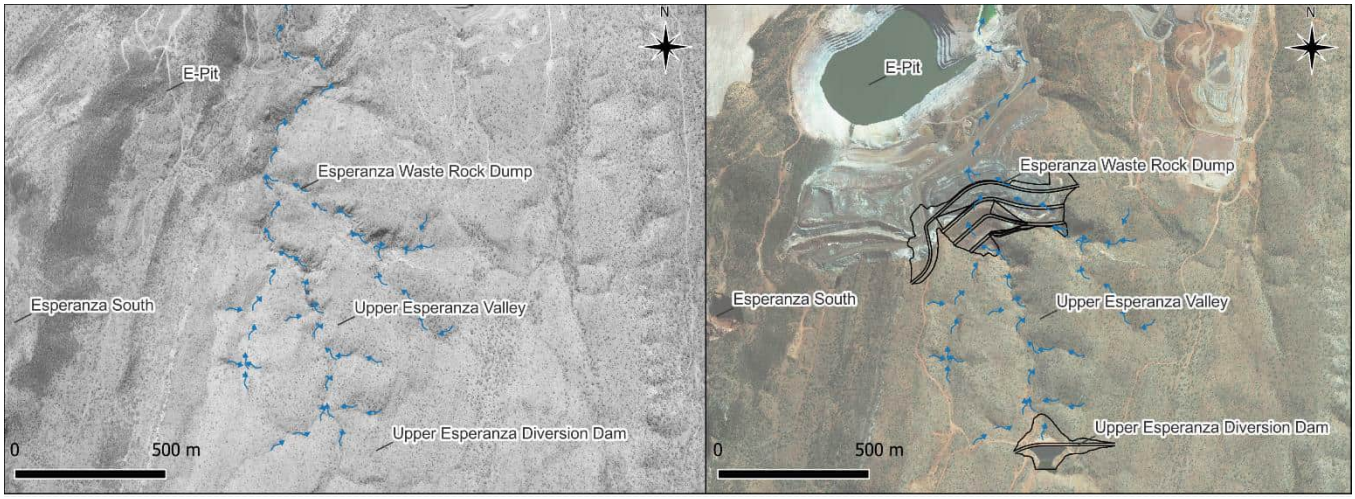


FIGURE 2.3: IMAGERY 1972, PRE E-PIT DEVELOPMENT COMPARED TO CURRENT ARRANGEMENT OF E-PIT.

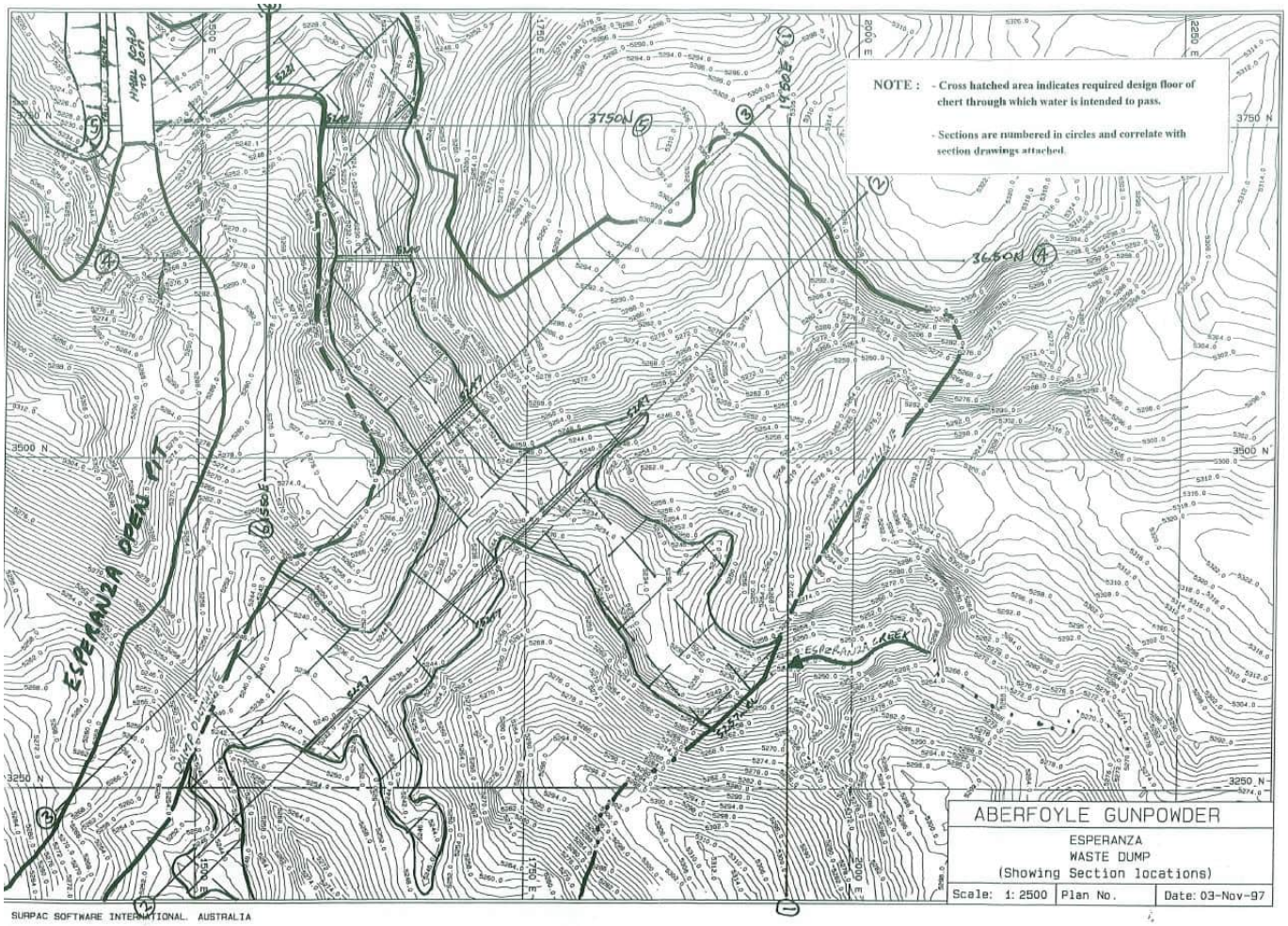


FIGURE 2.4: HISTORICAL SURVEY, PRE E-PIT DEVELOPMENT (GOLDER, 1997)

2.3 Geological Setting

2.3.1 Regional Geology

CCM sits within the Western Fold Belt of the Mount Isa Inlier (refer Figure 2.5). Mineralisation in the area is associated with faults relating to the Mount Gordan Fault Zone (outcrops to the west of CCM), which generally separates gently folded McNamara Group rocks of the Lawn Hill Platform to the west from older tightly folded rocks of the Haslingden Group to the east. Mineralisation at CCM is hosted by Proterozoic units at various stratigraphic levels, ranging from Haslington Group rocks at the Mammoth deposit (at E-Pit), to McNamara Group units at Esperanza (refer Figure 2.6).

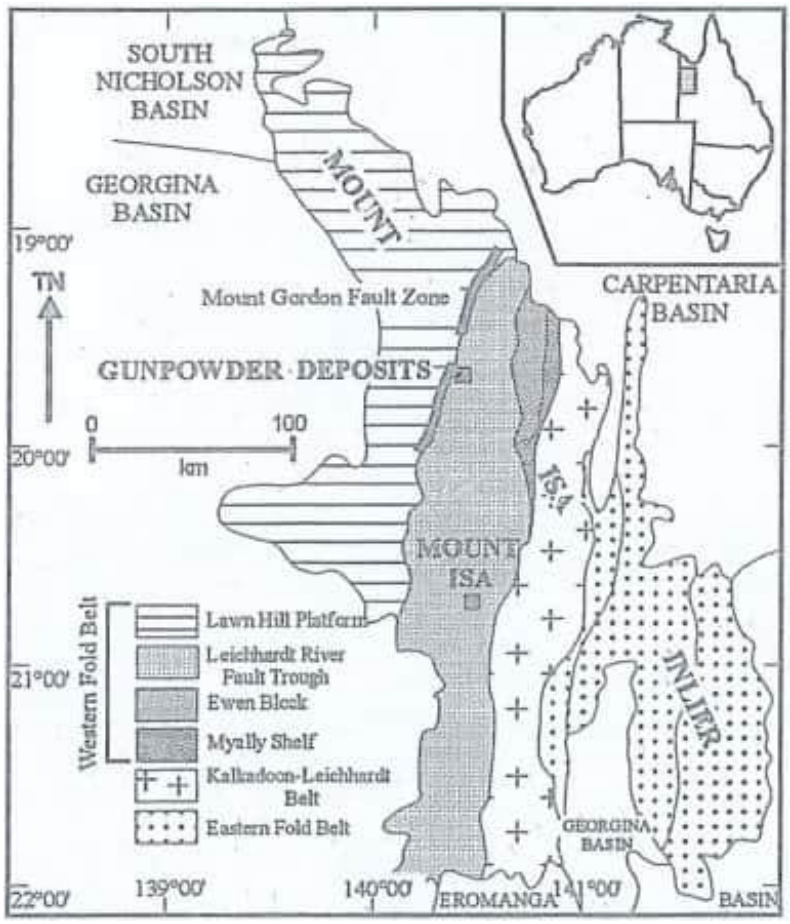


FIGURE 2.5: LOCATION OF CAPCOPPER MINE AFTER BLAKE ET AL. (1990)

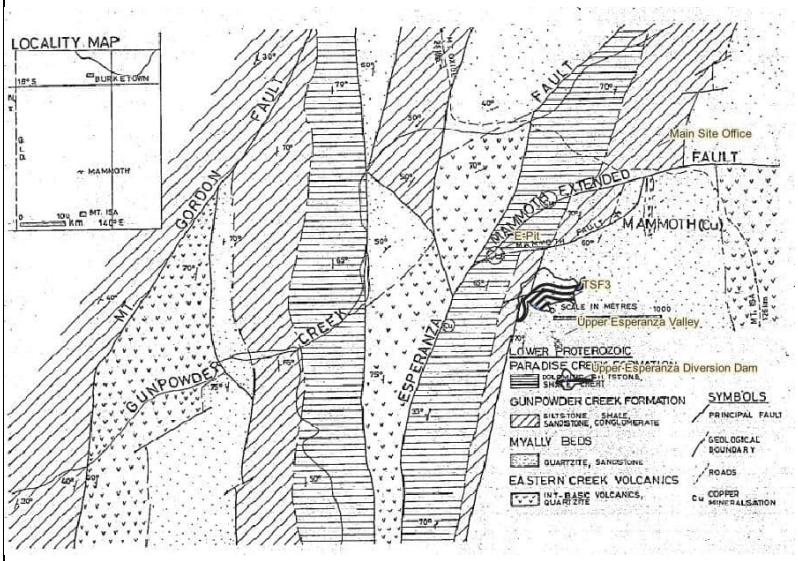


FIGURE 2.6: LOCATION OF MAIN GEOLOGICAL UNITS AND STRUCTURAL FEATURES

All stratigraphic relationships such as lithology age, formation groups and bedding relationships for all the regional geological units (i.e., Lawn Hill Platform, Haslingden Group, McNamara Group, etc.) are presented on the Figure 2.7. These stratigraphic relationships help verify any future investigations and measurement taken at CCM.

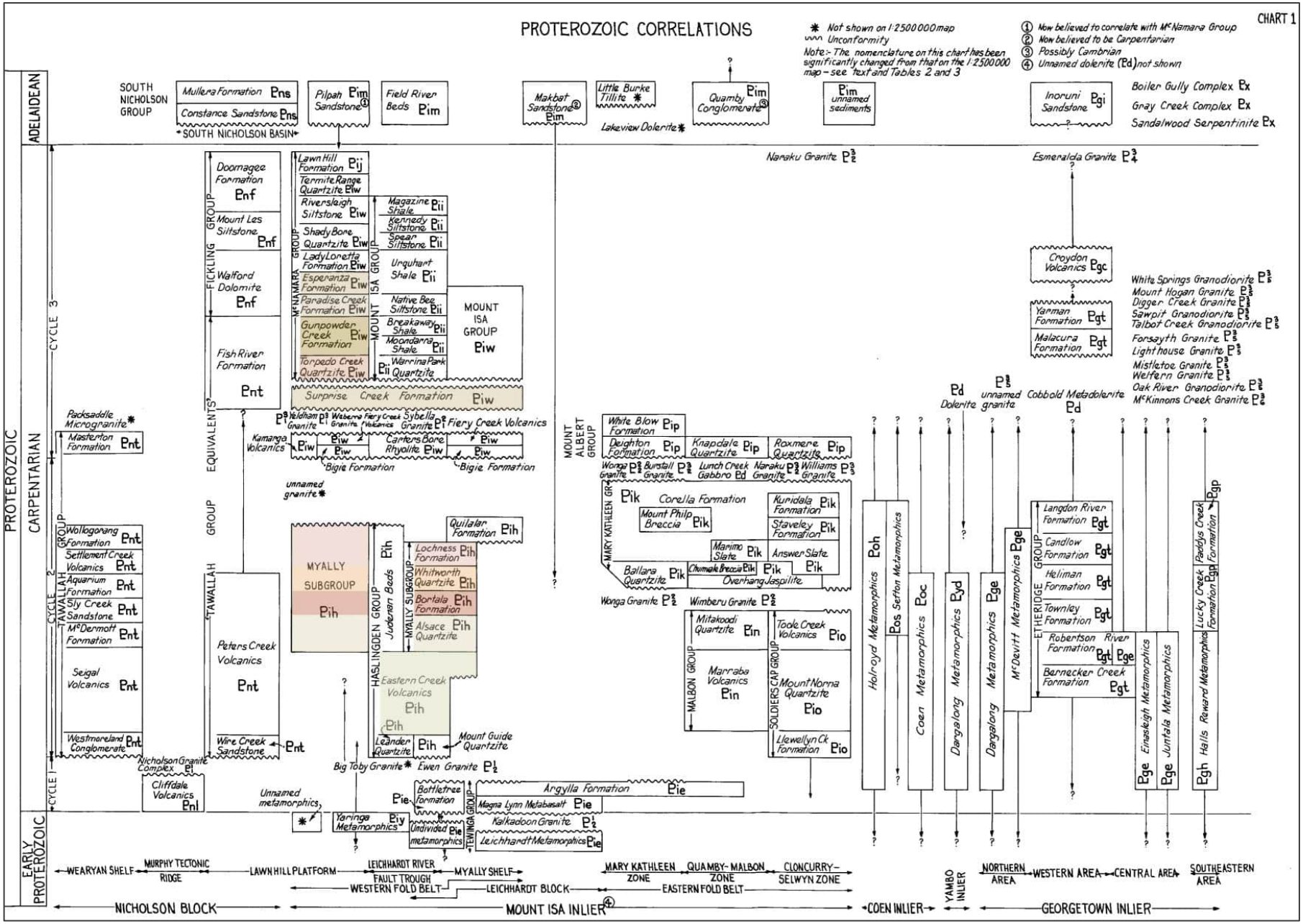


FIGURE 2.7: MOUNT ISA INLIER STRATIGRAPHIC SECTION AND STRATIGRAPHIC CORRELATIONS. ALL SHADED UNITS ARE OUTCROPPING AT THE TSF3 PROJECT AREA, (GEOLOGICAL SURVEY OF QUEENSLAND, 1983)

2.3.2 Structure

Deformation at CCM is related to four phases (D_1-D_4) of the 1620 to 1550 million-year (Ma) Isan Orogeny (Blake, 1990) . At the site, D_1 is reflected as an east-trending lineation. Regional and mesoscopic, upright, north-trending folds and greenschist facies metamorphism relate to deformation during D_2. Major faulting (including the faults noted at CCM) are generally thought to have occurred during D_3. D_4 is expressed as a number of mutual overprinting fracture cleavages. (Blake, 1990)

Faults associated with the Regional Mount Gordan Fault Zone outcrop at CCM as the NNE striking Esperanza Fault (EF) and the ENE-trending cross faults including the Mammoth and Mammoth Extended Faults (MF and MEF). Descriptions of each of these main faults is described below after (Mitchell, 1975) and (Richardson, 1998).

Esperanza Fault (EF)

The EF is a NNE-trending regional structure dipping around 55-70° west. The MEF and MF splay off the EF in a poorly understood area just south of the orebody. Movement along the EF is interpreted to be dextral reverse.

Mammoth Extended Fault (MEF)

The MEF is a normal fault with displacement of the north block eastwards approximately 600-700m. It strikes north-east and dips steeply south-east but swings to a north-north-east strike with westerly dip immediately north-east of the mine.

The MEF is the main structure controlling mineralisation at the Esperanza deposit. At surface, the MEF is expressed by strong shearing of ferruginous siltstone for several metres from the Esperanza chert boundary.

Mammoth Fault (MF)

The ENE-trending MF is mapped at surface striking into the Esperanza area, however its location and the nature of its termination are poorly constrained. Dip of the MF varies by location, though is noted to be dipping roughly 70° toward south at Mammoth (E Pit location) and is inferred as sub-vertical dipping north where the MF meets the MEF. It's understood the area between the MF and MEF represents a single broad zone of fault breccia. Exposures of the MEF and MF are sparse in outcrop, however the MF is interpreted to be a sinistral reverse fault.

2.3.3 Stratigraphy

Available stratigraphic geological descriptions of the site have been previously detailed by (Keyser, 1958), (Carter, 1961) and (Keys, 2008). The stratigraphic column is shown in Figure 2.8 and detailed surface mapping of all units is shown in Figure 2.9; which displays the Geological Survey of Queensland 1:100,000 dataset, which expands on previous geological units shown in Figure 2.6.

Relevant units are described in detail in the following sections from oldest to newest, which trend from east to west over the site.

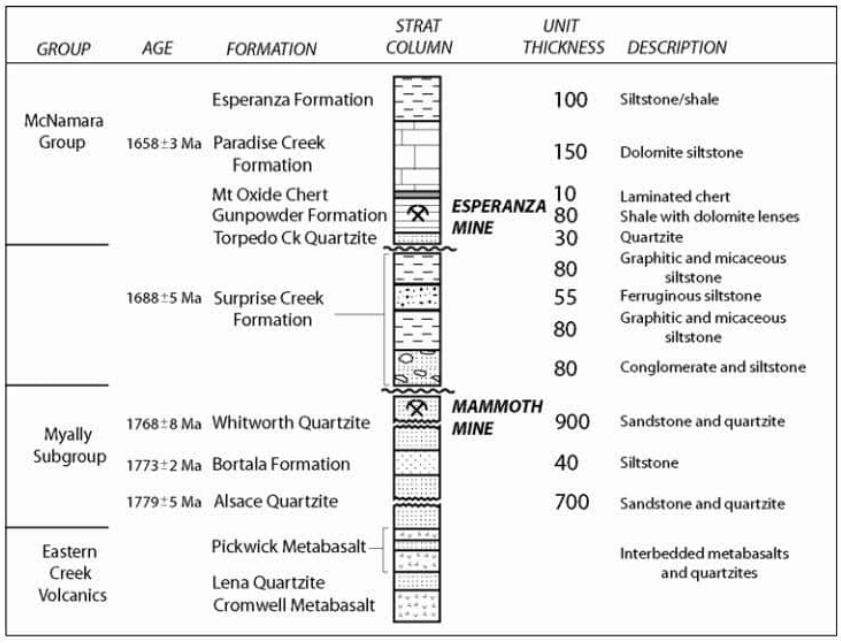


FIGURE 2.8: STRATIGRAPHIC COLUMNS AFTER (KEYS, 2008)

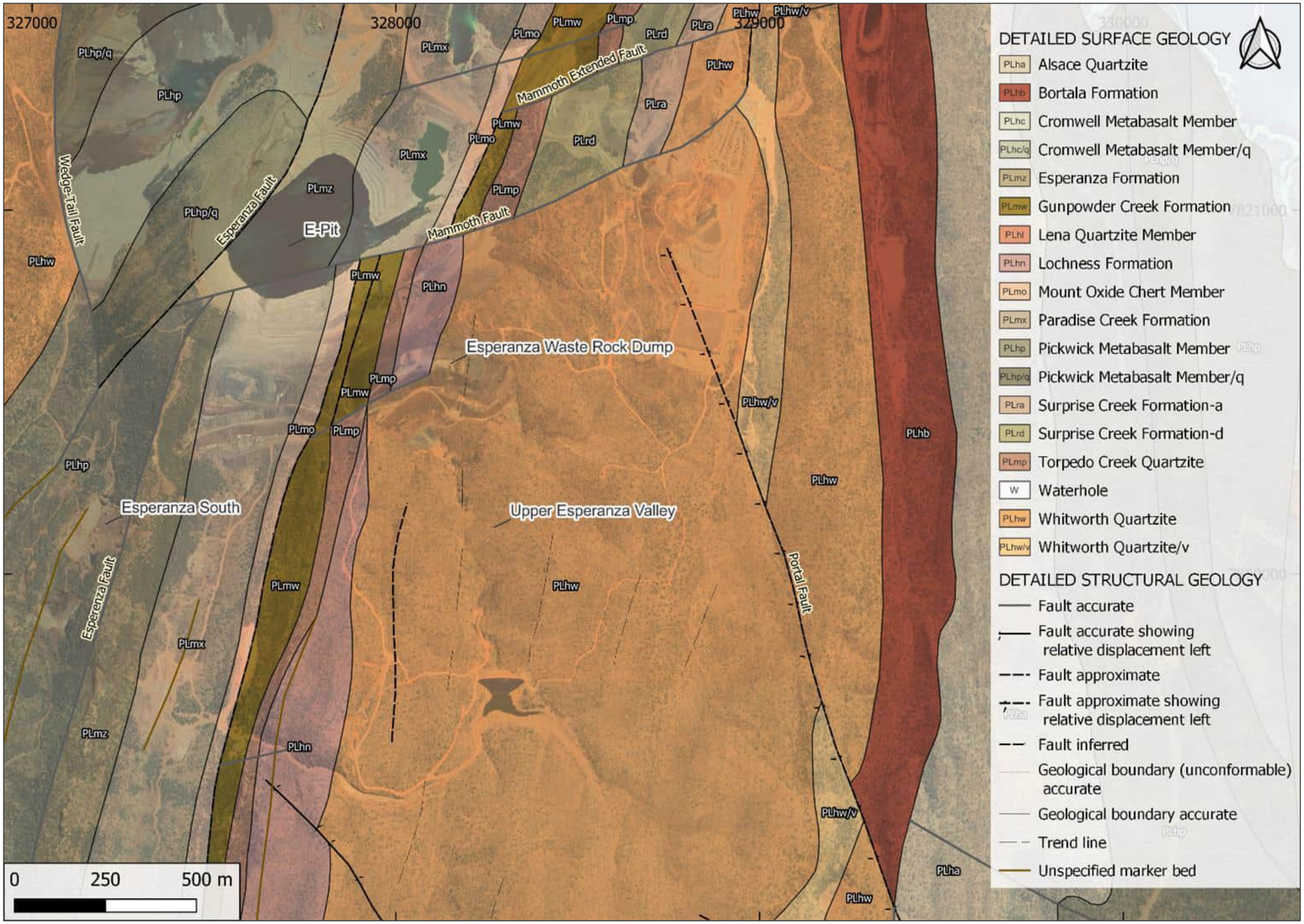


FIGURE 2.9: DETAILED GEOLOGICAL MAPPING

Eastern Creek Volcanics (ECV)

Outcrop extends over an extensive area south-east of CCM and includes the Cromwell Metabasalt, Lena Quartzite, and Pickwick Metabasalt. Generally, these are fine to medium grained meta-basalts and meta-andesites with porphyritic and amygdaloidal structures. Interbeds of quartzites and minor grey fissile shales occur throughout these units. Towards the top of the unit, the sediment to volcanic ratio increases and the volcanics contain a considerable amount of andesites and trachytes, indicating a change in magmatic chemistry. The upper limit of the ECV is taken as the last volcanic flow before transitioning to the Myally Subgroup.

Myally Subgroup

Conformably overlying the ECV are the Myally subgroup. The dominant rock is the Whitworth Quartzite which is a massive, poorly bedded, homogenous quartzite formed by regional metamorphism of the original arenite rock. Composition is variable and rocks can range from lithic, to arkosic, and chloritic arenites. Arenites with high clay content are largely unmetamorphosed (interpreted here as the Lochness Formation) and occurs toward the top of the sequence. The important feature of these being the lithic sandstone at the top of the formation which is the host rock for the mineralisation at the Mammoth deposit. Metamorphism appears to be limited to silicification of the more silica rich elements of the unit, with original sedimentary textures and bedding clearly recognisable, with ripples, cross beds, and trough cross beds abundant in outcrop.

The Whitworth Quartzite dips to the west between 60° and 80°, striking roughly north-south in the mine area. Lensing, load casts, ripple marks and mud cracks and intraformational brecciation have been recorded within the Whitworth quartzite. The most significant mineralisation is hosted by several discrete orebodies in dilational veins and breccias (Keys, 2008). The mineralisation is comprised of a range of copper species, dominantly chalcopyrite, bornite and chalcocite.

McNamara Group

The Whitworth Quartzite is unconformably overlain by the McNamara Group sediments including Torpedo Creek Quartzite, Gunpowder Creek, Paradise Creek Formation, and Esperanza Formation, all of which outcrop directly west of the TSF3 embankment. The unconformity strikes approximately north-south but dips at approximately 50° to the west giving an angular separation of 20° to 30° between the units above and below (Keys, 2008).

There are no detailed descriptions available for the Torpedo Creek formation as the formation was previously grouped with Gunpowder Creek formations. Lithological descriptions for Gunpowder Creek are noted as being divisible into three lithological sequences including:

- Upper sequence of micaceous siltstone-shale with dolomite lenses.
- Central siltstone-ferruginous sandstone-quartzite sequence.
- Lower conglomerate-siltstone-sandstone sequence.

These sequences are unlikely to outcrop within the project area as the formation thins south of the MEF and MF.

The Paradise Creek Formation consists of a basal chert marker bed and a finely bedded white siltstone, followed [upward] by a sequence of finely bedded, brown, dolomitic siltstones, and cherts. The formation sediments strike roughly north-south and dip at 60°-70°. Ripple marks and other sedimentary structures indicate a shallow water, restricted environment. These are overlain by a sequence of ferruginous siltstones and shales which are graphitic at depth. The top of the sequence in the area is the stromatolitic chert which is silicified and contains both columnar and laminae types of stromatolite.

2.4 Existing Site Information

2.4.1 Geophysical Assessments

Interpretation of airborne geophysical datasets was completed by Southern Geotechnical Consultants (SGC) in 2023 to identify structural settings, domains, and fault distribution. SGC used freely available [open source and State Government] aeromagnetic (AMAG), radiometric (RAD), and airborne EM (AEM) surveys to inform the geophysical interpretations against existing or known faults derived from the Geological Survey of Queensland (GSQ) 1:250,000 scale Camooweal and 1:100,000 scale Mammoth geology maps.

The SGC assessment identified four characteristic fault types which are summarised in Table 2.2.

TABLE 2.2: FAULT DESCRIPTION SUMMARY

Fault Type	Description
Major faults	Structures observed through the whole Area of Investigation (AOI) and beyond. Mostly interpreted to be related to major tectonic events such as super basin developments or Mt Isa orogeny.
Major faults - inferred	Same definition as major faults but associated with more subtle magnetic features and therefore assigned a lower degree of confidence.
Minor faults	Structures with shorter extents, less displacement, splays from larger faults and fractures.
Minor faults - inferred	Less clear / lower confidence minor faults.

All faults identified by SGC consultants are presented in Figure 2.10 below. SGC noted that their structural interpretation of the magnetic data improves the understanding of the geological structures in the area, refines the geometry of certain known faults and potentially identifies local, subtle faults that may not have been previously recognised.

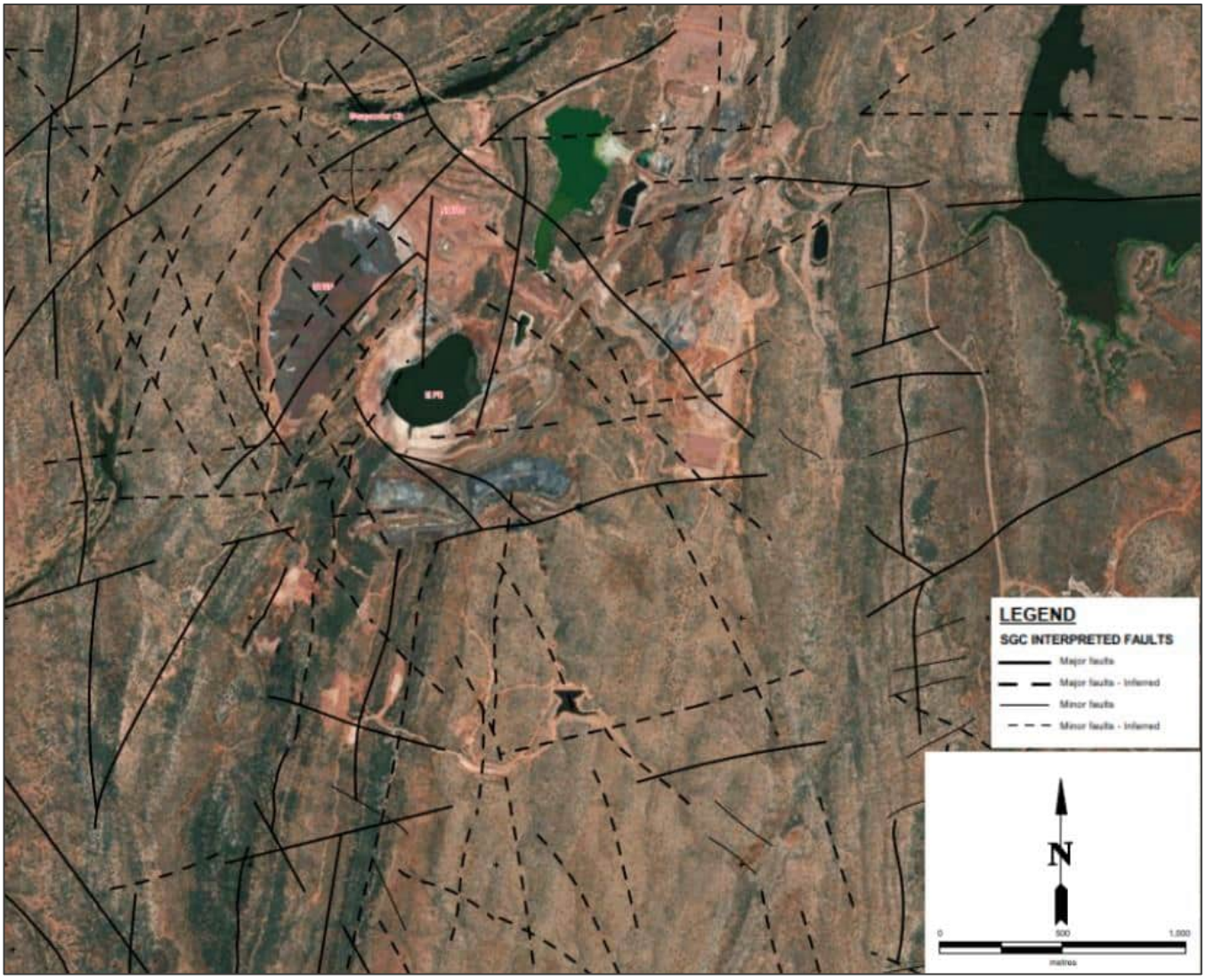


FIGURE 2.10: SGC GEOPHYSICAL INTERPRETATION

2.4.2 Existing Site Investigations

Previous investigations assessed as part of the geological mapping program desktop review are limited to the GHD 2019 field investigations which were completed to evaluate potential growth medium and low permeability clay borrow areas at CCM. The field investigations consisted of 51 test pits across five sites excavated with a 20-tonne excavator and progressed to a maximum depth of 4.3 m. All investigations are shown on Figure 2.11 and a summary of the investigation findings are presented in Table 2.3:.

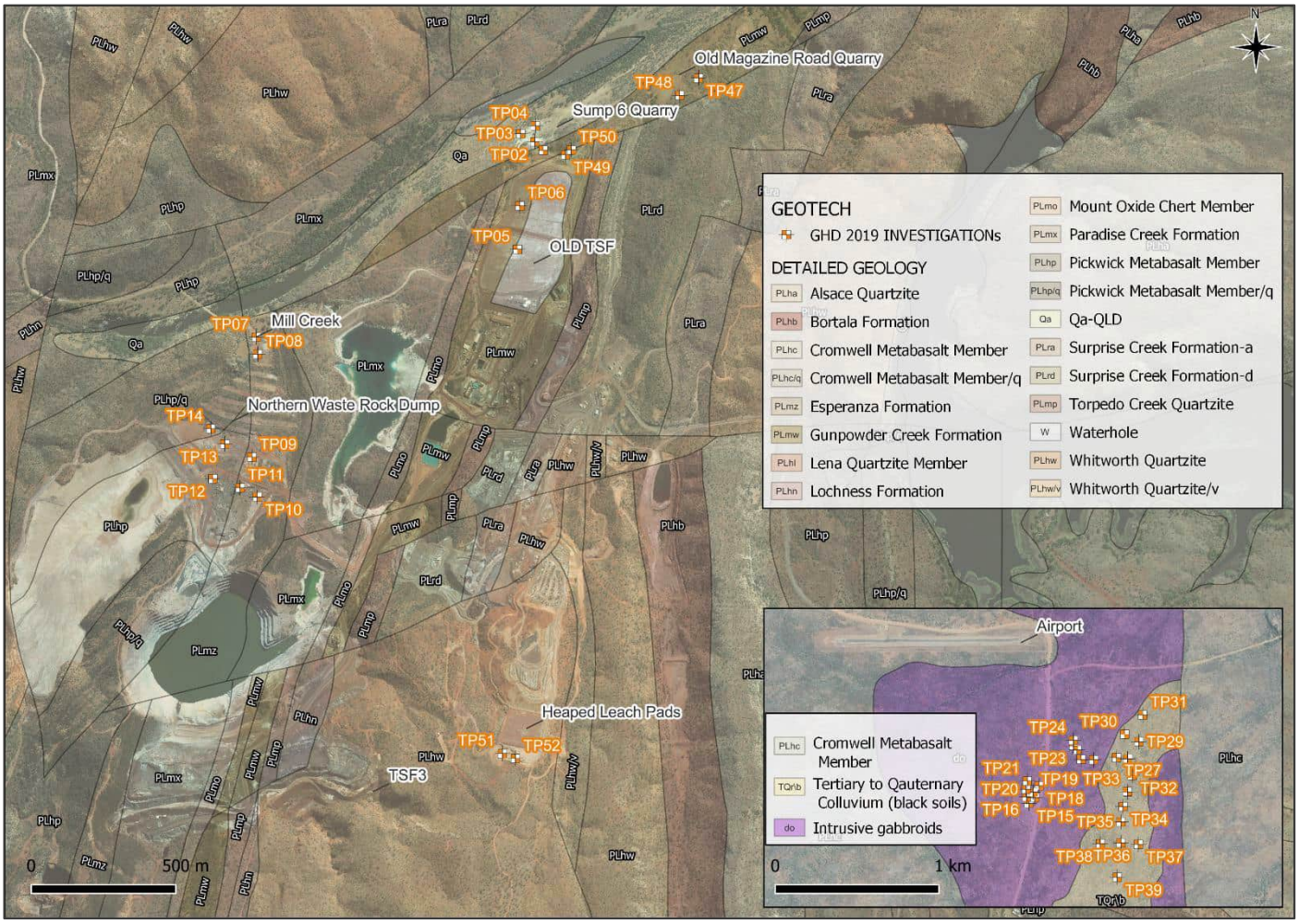


FIGURE 2.11: GHD BORROW AREAS PRESENTED AGAINST DETAILED SURFACE MAPPING

TABLE 2.3: GHD 2019 BORROW AREA RESULTS

Borrow Type	Borrow Area	Geological Formation	Available Test Pits	Viable Borrow Area Y/N	Comments	Indicative Volume Available
Growth Medium Borrow	Old Magazine Road	Gunpowder Creek Formation	TP47, TP48	Y	The samples collected from the test pits indicated Silt with gravel and Silty GRAVEL. Geochemical testing indicated that the material is NAF and suitable for use as a cover material.	Based on the limited testing, it is estimated that there is approximately **40,000 m³** of material suitable for use as a growth medium, as estimated by GHD 2019.
	Sump 6 Borrow	Alluvium, Gunpowder Creek Formation	TP01,TP02,TP03, TP04, TP49,TP50	N	The material in the face of the existing borrow indicated in-situ Sandy SILT and Gravelly SILT. Geochemical testing of the samples indicated low capacity potentially acid forming material, indicating that the borrow would not be suitable for use in a closure cover.	N/A
	North Rock Quarry/Mill Creek	Esperanza Formation	TP07,TP08	N	The test pits indicated that there is a shallow layer of Gravel with silt overlying bed rock at the toe of the quarry. Visual assessments of the quarry face indicated that there is likely to be rock at very shallow depths higher in the quarry. Based on the test pits and visual observation it is unlikely that there is significant volume of suitable material for construction.	N/A
	North Waste Rock Dump	Fill	TP09,TP10,TP11,TP12, TP13,TP14	Y	The North Waste Rock Dump (NWRD) comprises waste rock mined from the Esperanza Pit, generally the material is inert. A total of six test pits were excavated in the NWRD area, typically the material was relatively consistent, comprising of Gravelly SILT and Gravelly CLAY with Sand. During the excavation of the test pits the material appeared to have a high gravel content, during laboratory testing this was found to be cemented clay, which broke down during testing. The material from the NWRD would be suitable for growth medium	An approximate area of **75,000 m²** is available for borrowing. This results in a total volume of growth medium of **350,000 m³**, as reported by GHD 2019. Should a capillary break layer be required, material could be screened from the NWRD.
Clay Borrow	Airport Borrow	Cromwell Metabasalt	TP15,TP16,TP17, TP18,TP19,TP20,TP21, TP22,TP23,TP24,TP25,TP26	Unknown	No assessment was made by GHD specifically on the Cromwell Metabasalt.	Unknown
		Colluvium	TP27,TP28,TP29,TP30, TP31,TP32,TP33,TP34,TP3, TP36,TP37,TP38,TP39	Y	It is interpreted the area identified to the east of Gunpowder road with clay typically 1 m deep, overlying dolerite was the mapped colluvium geology.	The area investigated was approximately **210,000 m²**, resulting in approximately **210,000 m³** of clay material, as estimated by GHD 2019.

2.5 Target Mapping Areas

The primary goal of this program was to validate the interpretation of airborne geophysical data, which had identified a series of possible faults that traversed the proposed TSF3 storage area and its abutments. These structures, and those mapped by the Geological Survey of Queensland (which includes faults mapped as part of the exploration of the leases since discovery of the original orebody), were located in the field and observed to determine their characteristics, allowing their potential to act as a seepage path to be considered.

Mapping, for the purposes of engineering of the proposed embankment or seepage control measures, was not completed as part of this assessment as this mapping is of a higher resolution and requires the foundation footprint to be more clearly defined. As such, this mapping will occur as part of the detailed design phase.

2.5.1 TSF3 Potential Seepage Pathways

To assess for potential seepage pathways beneath the TSF3 embankments and through the TSF3 impoundment, geological faults (and inferred geological faults) identified in Sections 2.3.2 and 2.4.1 above have been plotted against the boundary of the proposed TSF3 maximum tailings deposition extents. The intersection of these faults with the maximum tailings deposition extents were used to inform the basis for mapping targets as these faults represent the most likely foundation seepage pathways through potentially broken or weathered rock. It is possible that further faults are present, and detailed geological mapping will be required prior to construction to identify any additional risk zones. It is, however, most likely that the faults of sufficient size to be discernible on geophysical imagery, are expected to present the greatest risk.

Eight (8) target mapping areas were identified for this mapping program based on access constraints and fault type and are presented in Figure 2.11 below.

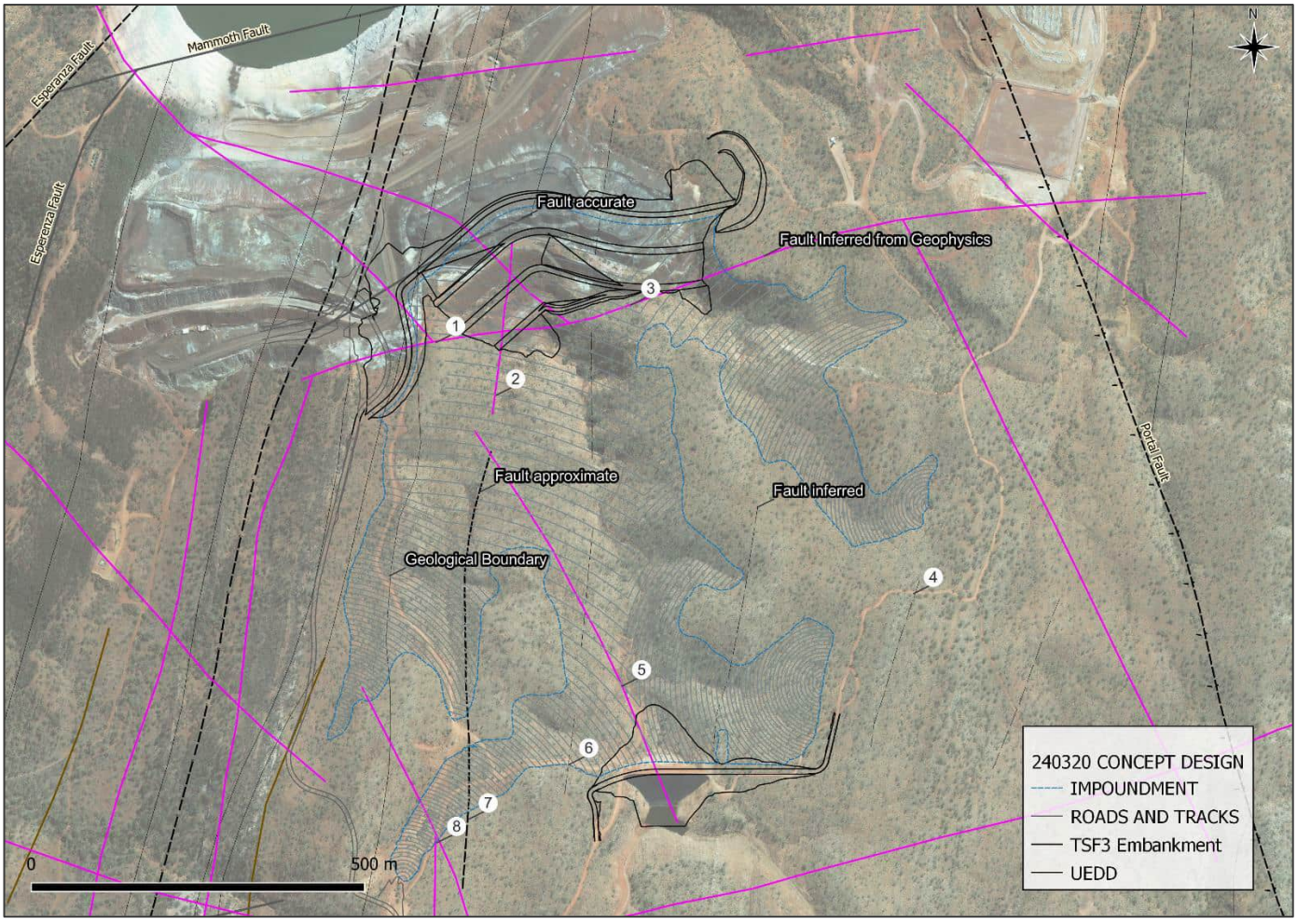


FIGURE 2.12: TSF3 TARGET MAPPING AREAS IDENTIFIED BY NUMBER

2.5.2 Natural Abutments

The proposed storage area is bounded to the east and west by natural rock ridges. To the east, the abutment comprises silicified arenite/quartzite of the Whitworth Quartzite, with the western bank and abutment consisting of a combination of Whitworth Quartzite, directly underlying the proposed tailings to the top of the ridge, unconformably bounded to the west by the Lochness formation, the Torpedo Creek Quartzite, the Gunpowder Creek formation, the Mount Oxide Chert Member, and the Paradise Creek formation to the west. The base of the Esperanza formation is marked by a stromatolitic chert layer, which serves as a local marker bed.

The quartzites of the Whitworth and Alsace are reported to be hydraulically tight, with increased permeability in the [surficial] weathered zone to approximately 30 m below ground level, with the clays and silts generally washed from the joint surfaces over time. As depth increases, the defects decrease in aperture and the hydraulic conductivity decreases significantly. Further, the quartzites contain quartz blows, dominated by milky quartz, that persist along a northwest trending strike. The fluids responsible for the emplacement of these milky quartz features post dates the silicification of the broader rock mass. The quartzites, likely due to their higher initial permeability [being arenites] have undergone significant silicification, to report very high strength rocks that are highly resistant to weathering across the majority of the proposed impoundment and eastern abutment.

The western abutment is underlain by the Whitworth Quartzite, which dips westerly. As mentioned, the rocks of the McNamara Group, which also dip steeply to the west. These rocks are generally fine grained and unlike the Whitworth Quartzite, lack silicification across the majority of the unit. Those sub-units containing arenaceous rocks, have undergone silicification, however the pelitic rocks are typically non-silicic, dominated by dolomitic and calcareous carbonates, the former being dominant. The fine-grained nature of these units, in addition to the lack of silica, allow these rocks to behave more plastically, allowing shearing and local deformation, which results in some re-healing of the rock mass along faults and shears. The primary permeability of the unit is expected to be low, with flow likely to pass along open defects and geological structures. The presence of dolomitic and calcareous horizons presents a small risk of increased permeability, however karstic terrain is not anticipated in the TSF3 area.

During later phases of design, the natural abutments, and the opposing hillslopes, will require geological mapping to confirm those structures, interpreted to be faults or shears, from existing mapping and geophysical interpretation. The section below (Figure 2.13) provides an indication of mapping areas for future phases.

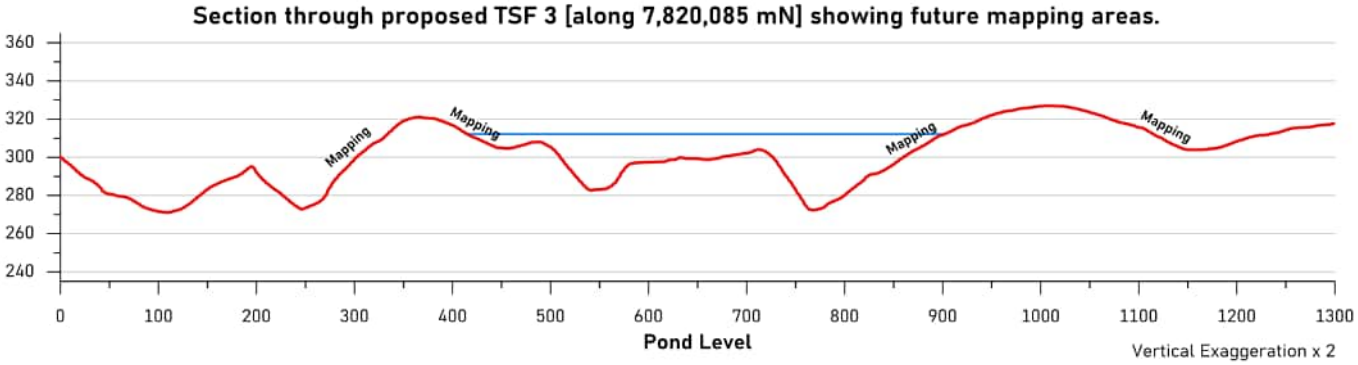


FIGURE 2.13: INDICATIVE FUTURE MAPPING AREAS

2.5.3 Borrow Area Investigations

To assess for potential borrow areas the following was considered:

- Quaternary soil deposits noted from detailed 1:100,000 surface geology datasets.
- Locations of mafic[2] rock types (which typically weather more readily into clayey or silty soils) noted from detailed 1:100,000 surface geology datasets.
- Potential soil deposits adjacent to low velocity flow areas along drainage systems.
- Existing quarries or borrow pits on/off site.

[2] Mafic rocks include basalts and ECV rock types.

Six (6) potential borrow sites (including the TSF3 impoundment area) were identified for further investigation and are shown previously in Figure 2.14.

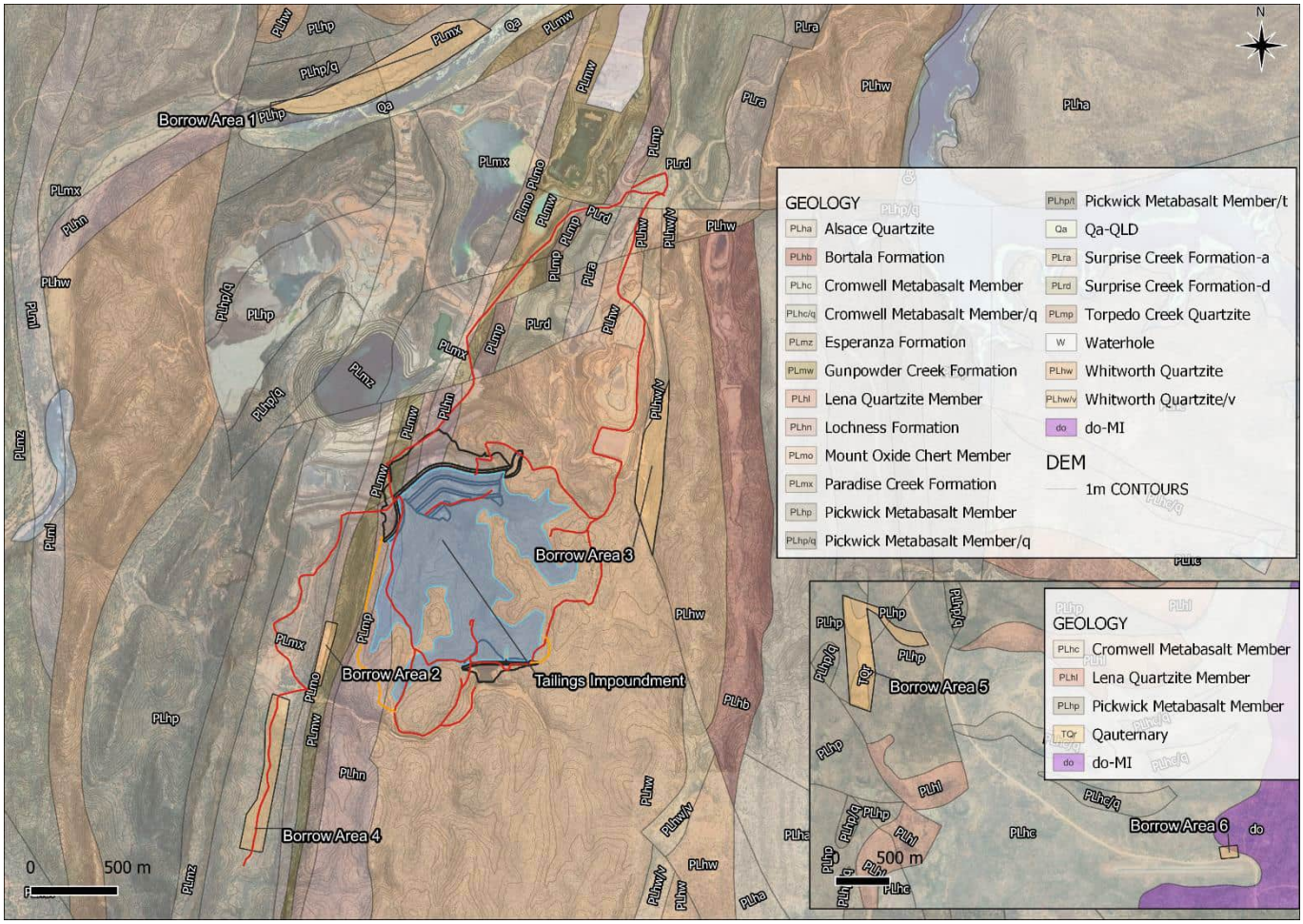


FIGURE 2.14: TARGET BORROW AREA SUMMARY

3. GEOLOGICAL MAPPING RESULTS

3.1 General

The geological mapping program was completed at CCM between 05 – 07 January 2024 by Deryk Forster (Principal Engineering Geologist) and Alex Leotta (Senior Engineering Geologist). The mapping program was completed under client escort. All measurements were taken with a Brunton Geological Compass [relative to Magnetic North] and mapping tracks were recorded with Garmin eTrex SE hand held GPS using all available constellations, relative to GDA2020 Z54. All mapping tracks and lithological units are displayed within Appendix A and detailed lithological descriptions are provided in the following sections.

3.2 Lithology

All lithological descriptions are presented in Table 3.1.

TABLE 3.1: LITHOLOGY SUMMARY

Lithology Group	**Formation**	**Site Area /** Borrow Area Designation **(refer** Figure 2.14 **)**	**Lithological Descriptions/Comments**	Weathering and Strength
Eastern Creek Volcanics	**Cromwell Metabasalt**	Borrow Area 6	Typical profiles consisted of a thin cover of low plasticity Silty CLAY (< 0.5 – 1.0 m) generally underlain by gabbro which typically outcropped as massive, with phaneritic pyroxene, plagioclase and minor amphibole. Minor andesite was observed west of the access road, and south of the airport runway and was slightly to moderately weathered and high strength, aphanitic to phaneritic amphiboles and plagioclase.	**Gabbro:** Very high strength, fresh. **Andesite:** Slightly to moderately weathered and high strength.
	Pickwick Metabasalt	East of Borrow Area 4.	Little to no soil generation was observed at ground surface. Dominant rock type consisted of basalt which was dark grey, aphanitic.	Moderately weathered and at high strength.
Myally Group	**Whitworth Quartzite**	TSF Impoundment Area	No soil cover. Unit consisted of poorly to well bedded well cemented fine grained and medium grained quartz-arenites and quartzites. Bedding ranged from 200mm to 2m spacing with trough cross bedding and ripples commonly observed throughout the impoundment area.	Slightly weathered to fresh and high to very high strength.

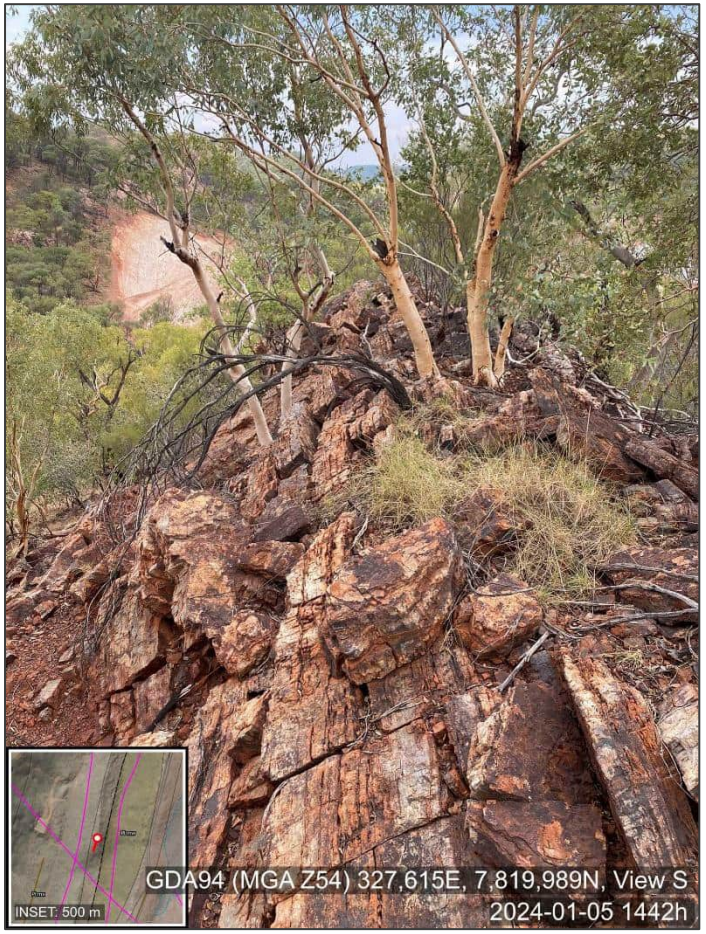
Lithology Group	Formation	Site Area / Borrow Area Designation (refer Figure 2.14)	Lithological Descriptions/Comments	Weathering and Strength
	Lochness Formation	Immediately east of TSF3 Impoundment	Little to no soil cover. Dominant rock type was a feldspathic arenite. Minor interbedded siltstone was observed.	Moderately weathered, low to moderate strength. Slightly weathered, high strength
McNamara Group	**Torpedo Creek Quartzite**	Immediately east of TSF3 Impoundment	Punctuates the ridge line directly to the west of the proposed TSF3 embankment and forms the eastern margin of Borrow Area 2. Dominant rock type was fine to medium grained, well cemented Quartzite with jointing at typically 400-600mm spacings.	Slightly weathered to fresh, high to very high strength.
	Gunpowder Creek Formation	Immediately east of TSF3 Impoundment	No geological mapping was conducted along the gunpowder creek formation.	N/A
	Mt Oxide Chert Member	Eastern border of Borrow Area 2.	Pale grey to white, cryptocrystalline chert. Forms the western border of Borrow Area 2.	Slightly weathered to fresh, high to very high strength.
	Paradise Creek Formation	Borrow Area 2	Dominant rock type is a yellow, fine to medium grained arenite with lesser dolomitic siltstone and is bound by a siliceous stromatolite marker bed in the west. Faults outcropping in the Paradise Creek formation are marked by low fracture spacing (10-20mm) and precipitation of native copper and manganese along the fault surface, refer to Section 3.4.	**Arenite:** Moderately weathered, high strength. **Dolomitic Siltstone:** Moderate to highly weathered, moderate strength. **Stromatolite marker bed:** high strength, slightly weathered to fresh.

3.3 Bedding and Jointing

3.3.1 General

Lithology Group	Formation	Bedding / Jointing (Dip / Dip Direction)	Typical Site Photo
Eastern Creek Volcanics	**Cromwell Metabasalt**	**Gabbro:** Joint orientations not recorded, joint spacing 200 mm – 600 mm at surface. **Andesite/Basalt:** No joint orientations recorded, however, rock mass encountered at surface is blocky with defect spacing between 60 – 200 mm.	 Photo Description: Andesite/Basalt pictured adjacent the airport.
	Pickwick Metabasalt	No joint orientations recorded, however, rock mass encountered at surface is blocky with defect spacing between 60 – 200 mm.	**No photo available**

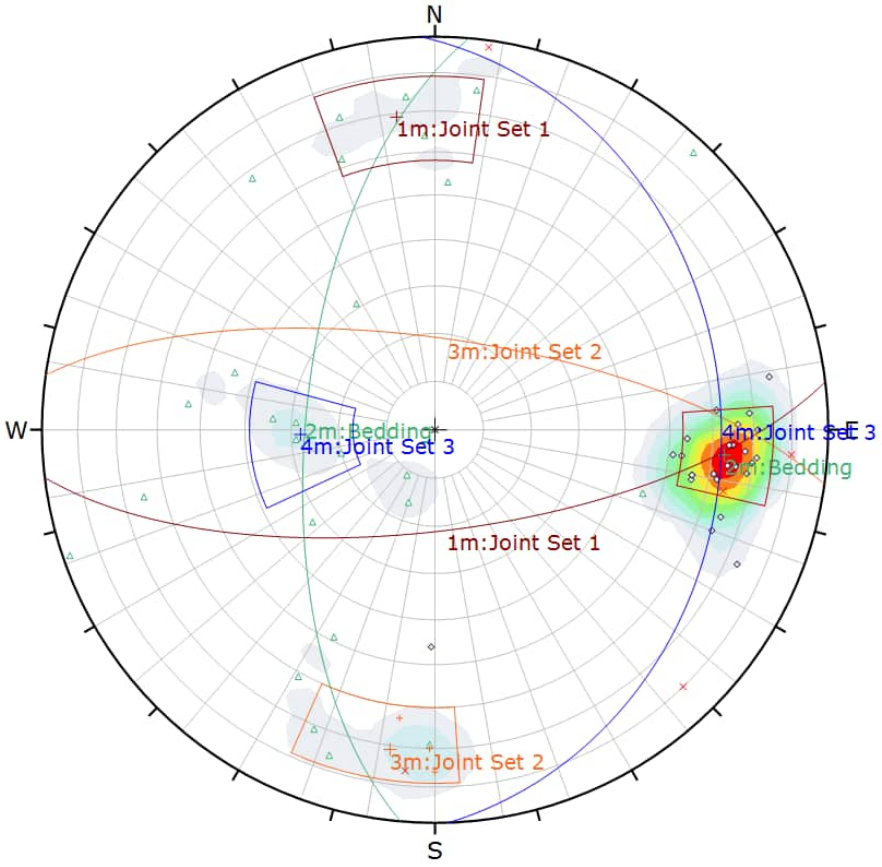
Lithology Group	Formation	Bedding / Jointing (Dip / Dip Direction)	Typical Site Photo
Myally Group	**Whitworth Quartzite**	**Bedding:** ~73° / ~294 **Jointing:** Typically 3 main joint sets present 1) 69° / 173 2) 71° / 008 3) 28° / 088 Joints typically spaced ~300 mm apart, tight with manganese staining.	 Photo taken near UEDD.
	Lochness Formation	**Bedding:** 54° / ~272 **Jointing:** Insufficient outcrop mapped to determine joint sets. Although likely similar to Whitworth Quartzite.	**No photo available**
McNamara Group	**Torpedo Creek Quartzite**	**Bedding:** ~60° / ~274	**No photo available**
	Gunpowder Creek Formation	N/A	N/A

Lithology Group	Formation	Bedding / Jointing (Dip / Dip Direction)	Typical Site Photo
	Mt Oxide Chert Member	**Bedding:** 69° / ~274 **Jointing:** No measurements taken, however, one steep joint set dipping north (or orthogonal to bedding) is present.	 Photo taken on the eastern boundary of the existing southern borrow pit.

Lithology Group	Formation	Bedding / Jointing (Dip / Dip Direction)	Typical Site Photo
	Paradise Creek Formation	**Bedding:** 54° / ~272 **Jointing:** Two joint sets measured 61° / 029 72° / 163 Joint spacing varied throughout the unit and was typically related to the proximity of fault structures for the arenite. Where it was adjacent to faulting the joints appeared to be open and spacing is typically 60 – 200 mm. Outside of faulting fractures are 200 – 600 mm spacing and tight. Within dolomitic siltstone (as observed within the southern borrow) displays well developed fissility, however, joint sets were not identified during the site visit.	 **Arenite** (taken 200 m south of the EWRD adjacent the LV access road)  **Dolomitic Siltstone** Photo taken from existing southern borrow pit.

3.3.2 Stereoplots

All field measurements were analysed in Rocscience's Dips [Version 8] software to confirm joint populations plotting all measurements against an equal area lower hemisphere stereoplot. This was progressed to confirm orientations acquired remotely from existing and proposed boreholes, and to ensure any proposed intrusive investigations were correctly aligned so as to provide un- or less-biased data; as discussed in Section 4. The field measurements are presented in Figure 3.1.



Symbol	TYPE	Quantity
◇	Bedding	25
×	Fault	5
△	Joint	26
+	Vein	3

Color	Density Concentrations
	0.00 - 2.20
	2.20 - 4.40
	4.40 - 6.60
	6.60 - 8.80
	8.80 - 11.00
	11.00 - 13.20
	13.20 - 15.40
	15.40 - 17.60
	17.60 - 19.80
	19.80 - 22.00

Contour Data	Pole Vectors
Maximum Density	21.22%
Contour Distribution	Fisher
Counting Circle Size	1.0%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		69	173	Joint Set 1
2m		63	275	Bedding
3m		71	8	Joint Set 2
4m		28	88	Joint Set 3

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Hemisphere	Lower
Projection	Equal Area

Figure 3.1: Summary of Measured Structures

3.4 Fault Structures

The mapping program specifically focused on the mapping targets identified in Section 2.5, as well as three (3) additional fault structures identified during the mapping program (Refer to Figure 3.2). Shaded areas in Figure 3.2 indicate areas covered during the field mapping program.

Geological mapping was completed in these areas to identify structures evidence by the following observations in outcrop:

- Offset bedding strike;
- Weathered or weak material;
- Increased jointing; and
- Brecciated material.

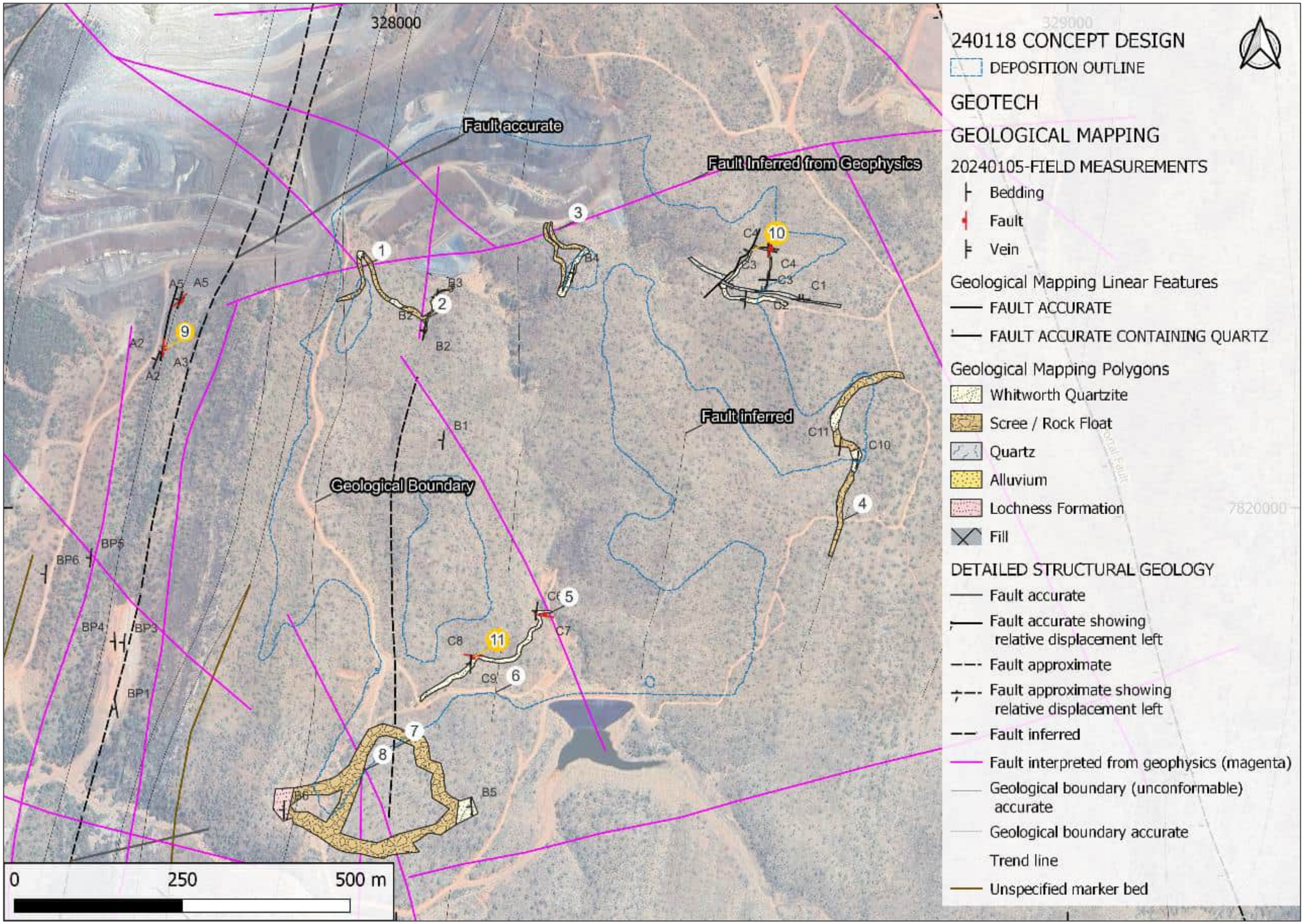


FIGURE 3.2: COMPLETED GEOLOGICAL MAPPING AREAS

TABLE 3.2: FAULT MAPPING RESULTS

Target No.	Original Structure Identification Method	Surface Expression (Y/N)	Comments / Description	Seepage Risk /Potential Treatment (low/medium/ high)	Typical Site Photo
1	Geophysics	N	Very little outcropping rock, mostly scree. Where rock does outcrop, joint spacing averages ~300 mm and is tight.	**Low** – no treatment expected.	 Taken 100m upstream of the TSF3 embankment within the Upper Esperanza Valley.
2	Geophysics	N			
3	Geophysics	N			
4	1:100,000 Detailed Mapping	N	Very little outcropping rock, mostly scree. No obvious fault indicators.	**Low** – no treatment expected.	N/A

Target No.	Original Structure Identification Method	Surface Expression (Y/N)	Comments / Description	Seepage Risk /Potential Treatment (low/medium/ high)	Typical Site Photo
5	Geophysics	N	No continuous seams. Some discontinuous breccia zones observed (striking roughly ~90° and extend for around 5m), however, no other information that would indicate large continuous geological structures. High to Very High Strength, slightly weathered to fresh.	**Low** – no treatment expected, breccia outside dam embankment and contained within tailings impoundment.	 Photo taken around 50m south of the downstream toe of the UEDD.
6	1:100,000 Detailed Mapping	N	Very little outcropping rock, mostly scree. No obvious fault indicators. Where outcrop occurred, dominated by quartzite with clear bedsets and strikelines.	**Low** – no treatment expected.	**N/A**
7	1:100,000 Detailed Mapping	N			
8	Geophysics	N			
Additional Features Identified During Mapping Program					

Target No.	Original Structure Identification Method	Surface Expression (Y/N)	Comments / Description	Seepage Risk /Potential Treatment (low/medium/ high)	Typical Site Photo
9	Identified during mapping	Y	Fault observed in Paradise Creek Formation. Rock either side of the fault surface shows fracture habit and spacing roughly 10-20 mm orthogonal to bedding. The fault material itself is characterised by thick (~ 10 mm) manganese oxide along fault surface with granular gouge material and native copper(?).	N/A – Outside of dam impoundment area, for reference only.	 Photo taken at mapping target 9, as shown on Figure 3.2
10	Identified during mapping	Y	Identified by strike separation (totalling 30 m) of quartz veins striking parallel to bedding. Quartz veins are around 1 m thick and the fault surface was identified by en-echelon veining along the strike of the fault. Fault material was completely healed, very high strength and fresh. Any jointing observed in the vicinity appears tight.	**Low** – no treatment expected.	 Photo taken at mapping target 10, as shown on Figure 3.2

Target No.	Original Structure Identification Method	Surface Expression (Y/N)	Comments / Description	Seepage Risk /Potential Treatment (low/medium/ high)	Typical Site Photo
11	Identified during mapping	Y	Fault breccia 600 mm thick, striking ~275°, re-healed, high to very high strength, slightly weathered to fresh, competent material.	**Low** – no treatment expected.	

Photo taken at mapping target 11, as shown on Figure 3.2

3.5 Borrow Areas

The target borrow areas mapped were limited to the battery limits displayed previously in Figure 2.14. The mapping program focused on finding material of lower permeability for use in embankment construction and closure capping.

Results of the borrow area assessment are presented in Table 3.3 below.

TABLE 3.3: BORROW AREA ASSESSMENT SUMMARY

Target No.	Target Lithology	Viable Borrow Source (Y/N)	Comments / Description
Borrow Area 1	Gunpowder Creek Alluvium	N	Mostly consisted of gravels and sand with oversize (cobbles and boulders) dominating the area.
Borrow Area 2	Existing Southern Borrow / Paradise Creek Formation	Y	Viable borrow source for a small amount of clay and potential crushed aggregate or bedding material through pallid siltstones and dolomitic siltstones. Rock aggregate sizes and breaking habit of rocks to be confirmed by follow up test pitting program.
Borrow Area 3	Residual Soils and XW ECV	N	Little to no residual soil development.
Borrow Area 4	Future Diversion Drain Cut / Paradise Creek Formation	Y	Viable borrow source for a small amount of clay and potential crushed aggregate or bedding material. Rock aggregate sizes and breaking habit of rocks to be confirmed by follow up test pitting program.
Borrow Area 5	Quaternary Alluvium/Colluvium	N	Soils dominated by sands, silts and gravels.
Borrow Area 6	Airport, residual and XW ECV	Y	Clayey soils noted just north-west airstrip adjacent the access road, this could be opened together with the previously identified borrow area located nearby by GHD in 2019.
Tailings Impoundment Area	Whitworth Quartzite	N	Little to no residual soil development.

4. CONCLUSIONS & RECOMMENDATIONS

4.1 Conclusions

The following conclusions may be drawn from the desktop assessment and geological mapping program completed to date.

General:

- Access to the TSF3 impoundment area is limited due to high strength rock at surface and undulating terrain, which dictates the requirement for advanced planning for future access tracks to potential borehole drilling locations and placement of LV tracks around the proposed TSF3 impoundment extents.
- Review of historic aerial imagery from 1972 shows the waste rock dump to be constructed over and infilled an old drainage line which connects to the UEV. It is unclear what preparation was completed to remove unfavourable materials (alluvium, organise detritus, etc) prior to the placement of waste rock.

Lithology, Structures and Seepage Pathways (Rock):

- The upstream extents of the proposed TSF3 embankments and the TSF3 impoundment area is contained within Quartzite, quartzose sandstones and chert lithologies (belonging to the Whitworth Quartzite, Lochness Formation and Torpedo Creek Quartzite respectively). These rock units appear to be well cemented, have low porosity, are high strength and with tight or healed discontinuities (joints and faults). This indicates an overall low permeability (defect controlled or similar) and likely presents a low risk to seepage.
- Defined joint sets are noted within the Whitworth Quartzite are summarised as follows:
  - Bedding: 73° / 294.
  - Joint Set 1: 69° / 173.
  - Joint Set 2: 71° / 008.
  - Joint Set 3: 28° / 088.
- Geological structures (investigated through mapping targets 1-9) intersecting the TSF3 impoundment showed to have no surface expression and the discontinuities (joints and bedding) in these areas appear to remain unchanged from the typical descriptions described here-in. Generally, structures such as shear zones and faults would generally need to exhibit open jointing, a halo of weak and weathered material to allow for high hydraulic conductivity, which is not consistent with what was found during the mapping program.
- Some discrete areas of Breccia (at additional mapping target 11) were noted, however, were not wide-spread and appeared to be discontinuous in nature and do not present a material risk of seepage.
- The geological mapping program was expanded on site to areas outside of the TSF3 embankment and impoundment area (at additional mapping target 9) to better understand adjacent geological conditions in the Paradise Creek Formation. In general, these appears to be less favourable for the TSF3 location for the following reasons:
  - Higher degree of weathering and lower strength was noted, i.e. less competent materials.
  - Highly brecciated material and open fractures noted adjacent identified fault areas, (which is different to the TSF3 areas which showed no surface expression).
- Further mapping of this unit will be required during subsequent phases of design to confirm the hydrogeological characteristics of the materials at depth. Near surface weathering processes are likely to result in a more permeable horizon, which should improve (i.e. become less permeable with depth). A baseline (sentinel) monitoring bore will be required in this unit, ideally drilled along, and through, one of the priority faults mapped as extending from the proposed TSF3 reservoir to the west.

Borrow Areas (low permeability soils)

- Borrow areas 1, 3, 5 and 6 showed little to no soil development at surface and does not present viable options for low permeability borrow sources.

- Borrow areas 2 and 4 appear to be a viable borrow source for a small amount of clay and potential crushed aggregate or bedding material. The volume of clay available, rock aggregate sizes and breaking habit of rocks will need to be confirmed by a follow up test pitting program. The test pitting program should follow the bedding strike of the Paradise Creek Formation, which is the source rock.
- Areas immediately north-east of the access road adjacent the airstrip appear to have the highest available quantities of low permeability clay, along with previous areas identified by the GHD investigation in 2019.

4.2 Recommendations

Based on the outcomes of the desktop assessment and field geological mapping program, recommendations and actions are provided in Table 4.1.

TABLE 4.1: RECOMMENDATIONS

Consideration	Recommendation	Action Needed
Access for subsequent investigations.	All follow up investigations shall be scheduled in areas that provide reasonable access, i.e., utilise existing access tracks, accessible benches of the waste rock dump, etc. Thought should be given during preliminary design for the design and placement of future access tracks where existing access tracks are inundated by the TSF3 extents.	**Yes**, currently being completed as part of preliminary and detailed design.
Waste Rock Dump Geometry	Confirmatory boreholes are recommended to constrain the geometry of the waste rock dump and confirm ground conditions beneath the dump through the old drainage lines identified through aerial imagery.	**Yes**. Additional boreholes are detailed in the geotechnical brief *QC1022_018-SOW-001-0-Geotechnical Investigation Brief.pdf* dated 9 February 2024.
Sub-surface lithology and fracture properties below dam embankment	Although seepage through fractures and low strength rock has been identified through geological mapping as being low risk, confirmatory boreholes are recommended. Boreholes shall be inclined and directed such that each hole intersects high angle interbeds and joint sets as much as possible. Optimal borehole dip and azimuth of 60°/210 has been identified via stereographic review (refer Figure 3.1).	**Yes**. Additional boreholes are detailed in the geotechnical brief *QC1022_018-SOW-001-0-Geotechnical Investigation Brief.pdf* dated 9 February 2024.
Borrow Area Investigations (at Borrow areas 2 and 4).	These areas require confirmatory test pitting to assess the suitability and volume of clay and potential crushed aggregate for bedding material.	**Yes**. Additional test pits are detailed in the geotechnical brief *QC1022_018-SOW-001-0-Geotechnical Investigation Brief.pdf* dated 9 February 2024.
Borrow Area Investigations – Airport Quaternary Colluvium borrow source.	GHD have previously identified the Airport Quaternary Colluvium borrow source as having ~210,000m^3 of low permeability clay. Follow up survey is required to confirm volumes.	**Yes,** CapCopper to complete follow up survey.

5. REFERENCES

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6. QUALIFICATIONS

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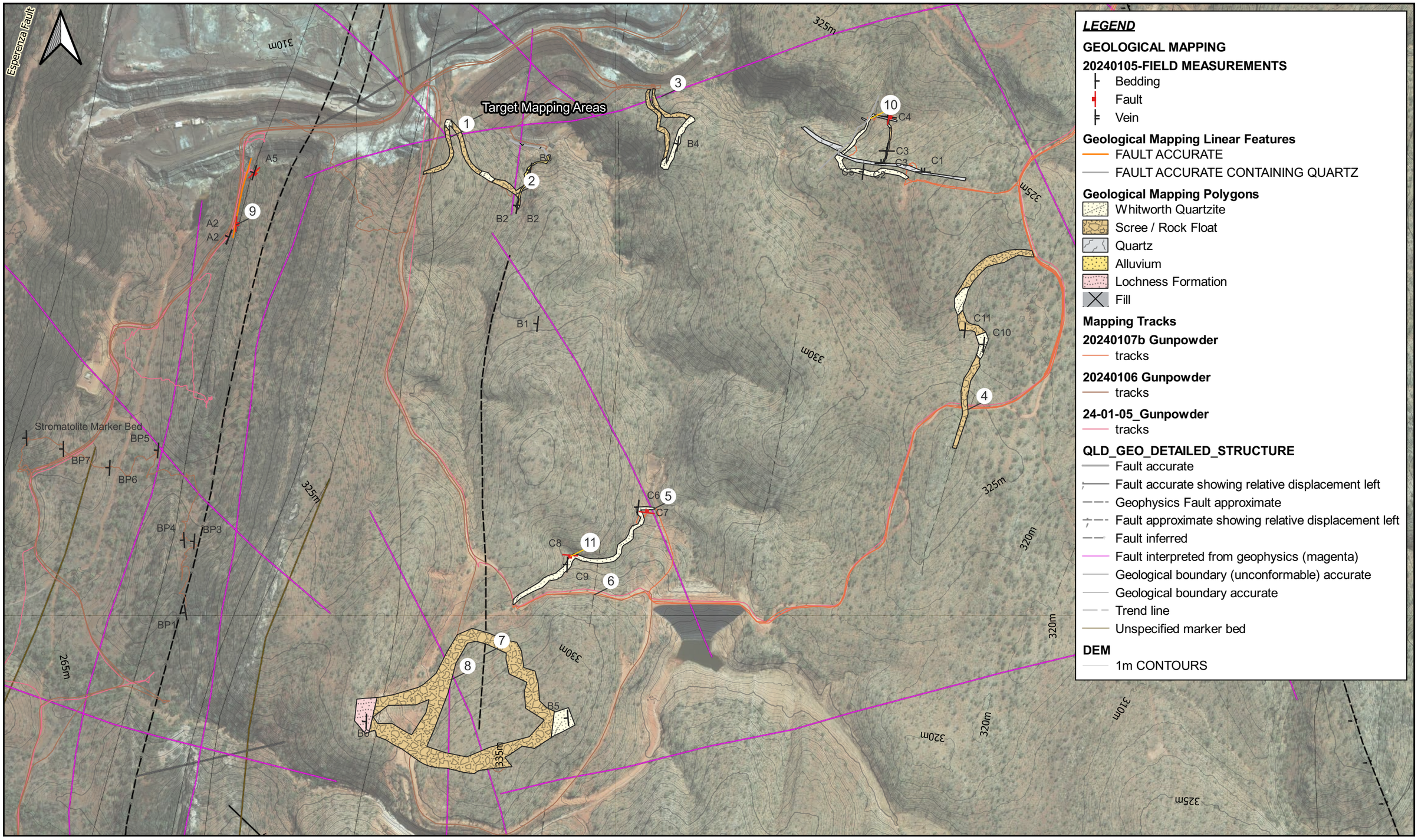
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APPENDIX A: GEOLOGICAL MAPPING FIGURE



LEGEND

GEOLOGICAL MAPPING

20240105-FIELD MEASUREMENTS
- Bedding
- Fault
- Vein

Geological Mapping Linear Features
- FAULT ACCURATE
- FAULT ACCURATE CONTAINING QUARTZ

Geological Mapping Polygons
- Whitworth Quartzite
- Scree / Rock Float
- Quartz
- Alluvium
- Lochness Formation
- Fill

Mapping Tracks

20240107b Gunpowder
- tracks

20240106 Gunpowder
- tracks

24-01-05_Gunpowder
- tracks

QLD_GEO_DETAILED_STRUCTURE
- Fault accurate
- Fault accurate showing relative displacement left
- Geophysics Fault approximate
- Fault approximate showing relative displacement left
- Fault inferred
- Fault interpreted from geophysics (magenta)
- Geological boundary (unconformable) accurate
- Geological boundary accurate
- Trend line
- Unspecified marker bed

DEM
- 1m CONTOURS

SCALE: 1:5,000
HORIZONTAL DATUM: GDA94 MGA ZONE 54
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

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No.	BY	DATE	REVISION	APPD
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DOC NUMBER	DOCUMENT TITLE
REFERENCE DOCUMENTS	

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DRAWN	AL	CHECKED	BW
APPROVED	BW	DATE	21/03/24
RPEQ	-	RPEQ No.	-

CAPRICORN COPPER PTY LTD

GEOLOGICAL MAPPING
CAPRICORN COPPER MINE - TSF3
SHEET 1 OF 1

Original size	Drg No.	Rev.
A3	QC1022-018-SKE-0004	0

APPENDIX B: MAPPING NOTES

TSF3 Geological Mapping Notes

Capircorn Copper Mine

Project:	TSF3 Preliminary Design
Date:	5/01/2024 to 7/01/2024
Revision:	0
Work By:	AL
Reviewed:	DJF

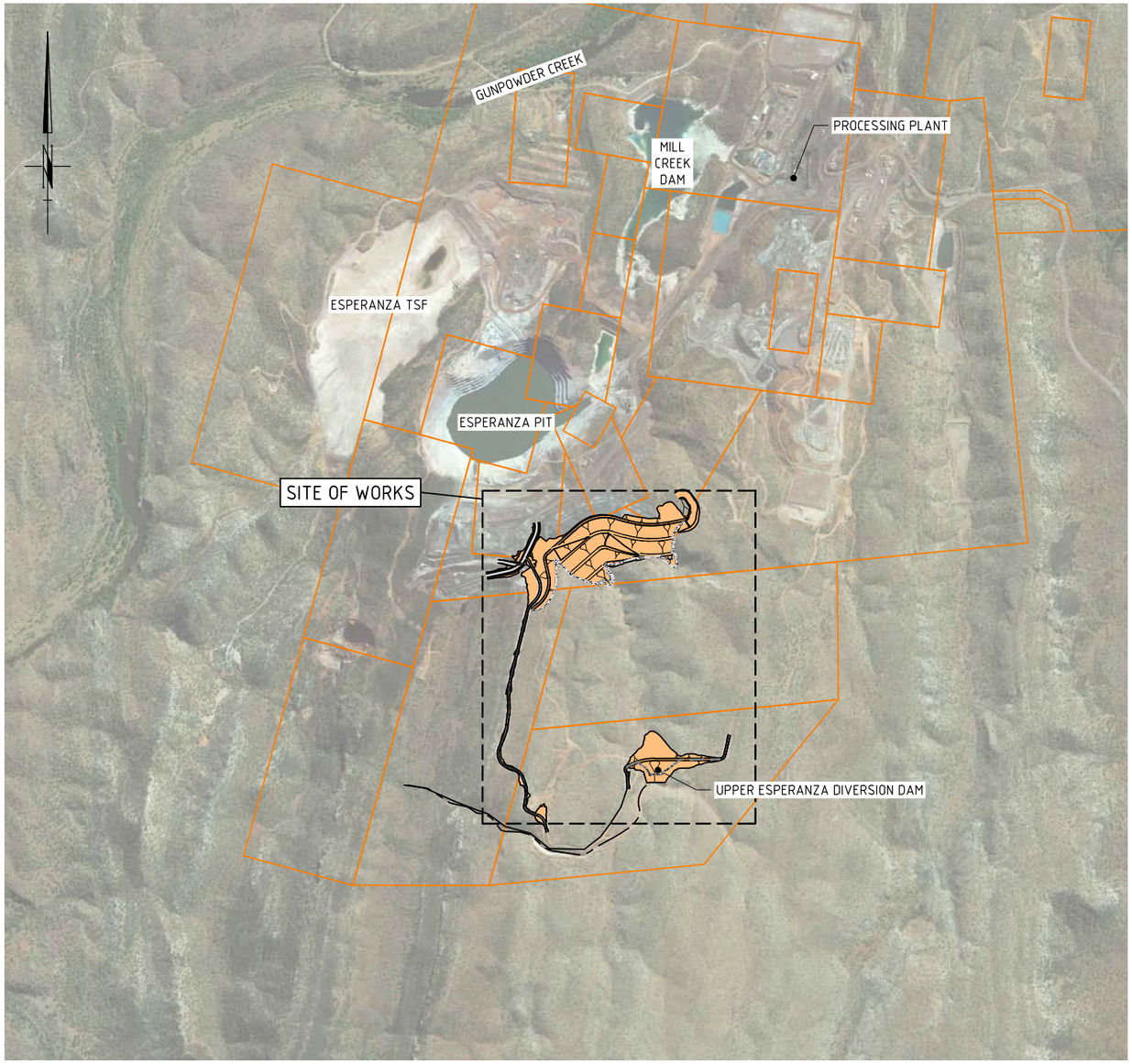
ENGENY

Site ID	Time Stamp	Date	Obs. ID	Easting	Northing	Type	Dip	Direction	Description
A1	14:04	5/01/2024	1	327,616.00	7,820,000.00				Paradise Creek Formation, chert, grey, dull, earth interbeds and stromatilitic, subvertical bedding.
A2	14:57	5/01/2024	1	327,643.00	7,820,220.00	Bedding	73	294	Boundary between competent and highly fractured (fault affected material). Fracture habit and spacing roughly 10-20 mm orthogonal to bedding.
A2	14:57	5/01/2024	2	327,643.00	7,820,220.00	Joint	61	029	Boundary between competent and highly fractured (fault affected material). Fracture habit and spacing roughly 10-20 mm orthogonal to bedding.
A2	14:57	5/01/2024	3	327,643.00	7,820,220.00	Joint	72	163	Boundary between competent and highly fractured (fault affected material). Fracture habit and spacing roughly 10-20 mm orthogonal to bedding.
A2	14:57	5/01/2024	4	327,643.00	7,820,220.00	Bedding	64	290	Boundary between competent and highly fractured (fault affected material). Fracture habit and spacing roughly 10-20 mm orthogonal to bedding.
A3	15:05	5/01/2024	1	327,653.00	7,820,238.00	Fault	80	274	Fault material characterised by thick (~ 10 mm) manganese oxide along fault surface with granular gouge material and ¿native copper.
A4	15:15	5/01/2024	1	327,671.00	7,820,310.00				Accommodation fault, 300 mm spacing separating C-structures
A5	15:21	5/01/2024	1	327,678.00	7,820,309.00	Fault	80	316	Fault surface, striated surface, highly fractured, though rehealed, rock structure to ~ 10 m either side of fault.
A5	15:21	5/01/2024	2	327,678.00	7,820,309.00	Bedding	65	287	Fault surface, striated surface, highly fractured, though rehealed, rock structure to ~ 10 m either side of fault.
BP		5/01/2024	1	327,583.00	7,819,701.00	Bedding	75	261	Siltstone, off white to purplish pink to red, chalky (¿dolomitic), highly weathered, thinly laminated, low to medium, slatey cleavage, fissile.
BP		5/01/2024	2	327,583.00	7,819,701.00				Possible sulfide casts, ¿pyrite. Appearance similar to Zebra Stone, grades upward from pale, chalky, leached, to iron oxide rich, red to dark red + MnO on defects.
BP		5/01/2024	1	327,595.00	7,819,799.00	Bedding	68	274	Pale Siltstone
BP		5/01/2024	1	327,581.00	7,819,801.00	Bedding	69	267	Red Siltstone
BP		5/01/2024	1	327,545.00	7,819,925.00	Bedding	71	275	Yellow Arenite
BP		5/01/2024	1	327,478.00	7,819,901.00	Bedding	65	273	Dolomitic + Stromatolitic Siltstone
BP		5/01/2024	1	327,414.00	7,819,927.00	Bedding	71	270	Change to arenite to west from dolomitic siltstone to east
Stromatolite Marker Bed		5/01/2024	1	327,363.00	7,819,942.00	Bedding	66	269	Stromatolite marker bed, siliceous, grey, high strength, SW-Fr
B1	10:07	6/01/2024	1	328,070.00	7,820,100.00	Bedding	70	276	Whitworth Sandstone
B2	10:17	6/01/2024	1	328,042.00	7,820,263.00	Bedding	56	281	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	2	328,042.00	7,820,263.00	Joint	29	086	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	3	328,042.00	7,820,263.00	Joint	69	001	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	4	328,042.00	7,820,263.00	Joint	29	093	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	5	328,042.00	7,820,263.00	Joint	16	020	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	6	328,042.00	7,820,263.00	Joint	31	148	Whitworth Sandstone (West of Creek)
B2	10:17	6/01/2024	7	328,042.00	7,820,263.00	Bedding	56	280	Whitworth Sandstone (West of Creek)
B3	10:32	6/01/2024	1	328,060.00	7,820,312.00	Bedding	62	280	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	2	328,060.00	7,820,312.00	Joint	76	018	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	3	328,060.00	7,820,312.00	Joint	53	096	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	4	328,060.00	7,820,312.00	Joint	32	053	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	5	328,060.00	7,820,312.00	Joint	74	175	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	6	328,060.00	7,820,312.00	Joint	88	071	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	7	328,060.00	7,820,312.00	Joint	65	077	Joint spacing averages ~ 300 mm, tight with manganese staining.

B4	12:17	6/01/2024	1	328,264.00	7,820,349.00	Bedding	61	279	Slope break, natural bench. Fine grained, dominantly quartz, minor feldspar or oxidised sulfide providing pinkish hue.
B4	12:17	6/01/2024	2	328,264.00	7,820,349.00	Joint	34	094	Slope break, natural bench. Fine grained, dominantly quartz, minor feldspar or oxidised sulfide providing pinkish hue.
B4	12:17	6/01/2024	3	328,264.00	7,820,349.00	Joint	62	161	Slope break, natural bench. Fine grained, dominantly quartz, minor feldspar or oxidised sulfide providing pinkish hue.
B4	12:17	6/01/2024	4	328,264.00	7,820,349.00	Joint	76	187	Slope break, natural bench. Fine grained, dominantly quartz, minor feldspar or oxidised sulfide providing pinkish hue.
B5	14:19	6/01/2024	1	328,112.00	7,819,555.00	Bedding	61	266	Sandstone
B6	13:56	6/01/2024	1	327,833.00	7,819,550.00	Bedding	54	272	Feldspathic sandstone and siltstone, medium strength, highly weathered. Lochness Formation.
C1	11:21	7/01/2024	1	328,603.00	7,820,310.00	Vein	70	001	Fine grained, white multiphase stockwork quartz blow bordering Lochness Formation.
C2	11:30	7/01/2024	1	328,547.00	7,820,322.00	Vein	76	000	Quartz Blow
C3	11:30	7/01/2024	1	328,553.00	7,820,339.00	Bedding	69	278	Lochness
C3	11:30	7/01/2024	2	328,553.00	7,820,339.00	Bedding	46	001	Quartz Blow
C4	11:48	7/01/2024	1	328,556.00	7,820,386.00	Vein	63	007	Quartz Vein
C4	11:48	7/01/2024	2	328,556.00	7,820,386.00	Bedding	56	280	Whitworth
C4	11:48	7/01/2024	3	328,556.00	7,820,386.00	Fault	64	282	Whitworth
C5	12:10	7/01/2024	1	328,520.00	7,820,310.00	Joint	64	178	
C5	12:10	7/01/2024	2	328,520.00	7,820,310.00	Joint	49	026	
C5	12:10	7/01/2024	3	328,520.00	7,820,310.00	Bedding	53	276	
C6	12:26	7/01/2024	1	328,209.00	7,819,846.00	Joint	71	022	200-300mm spacing, 2m+ trace length, tight.
C6	12:26	7/01/2024	2	328,209.00	7,819,846.00	Joint	11	032	200-300mm spacing, 2m+ trace length, tight.
C6	12:26	7/01/2024	3	328,209.00	7,819,846.00	Joint	86	223	200-300mm spacing, 2m+ trace length, tight.
C6	12:26	7/01/2024	4	328,209.00	7,819,846.00	Bedding	64	277	Whitworth
C7	12:45	7/01/2024	1	328,221.00	7,819,839.00	Fault	88	188	Fault breccia, starts as fracture zone and progresses into clast supported, semi-healed high strength Breccia. Individual clasts can be plucked with force or hammer blow. Some loose gravel from the breccia observed.
C8	12:50	7/01/2024	1	328,115.00	7,819,780.00	Fault	76	005	Fault breccia 600mm thick, totally healed.
C9	12:53	7/01/2024	1	328,111.00	7,819,767.00	Joint	44	106	
C9	12:53	7/01/2024	2	328,111.00	7,819,767.00	Joint	68	144	
C9	12:53	7/01/2024	3	328,111.00	7,819,767.00	Bedding	64	273	
C9	12:53	7/01/2024	4	328,111.00	7,819,767.00	Joint	20	076	
C10	13:20	7/01/2024	1	328,687.00	7,820,071.00	Joint	46	287	
C10	13:20	7/01/2024	2	328,687.00	7,820,071.00	Bedding	66	277	
C11	13:26	7/01/2024	1	328,661.00	7,820,091.00	Bedding	51	276	
C11	13:26	7/01/2024	2	328,661.00	7,820,091.00	Joint	53	183	

APPENDIX D: PRELIMINARY DESIGN DRAWINGS

CAPRICORN COPPER
TSF3 PRELIMINARY DESIGN



LOCALITY PLAN
SCALE 1:10000 m

DRAWING INDEX		
DRAWING No.	DRAWING TITLE	REVISION
QC1022-018-DWG-0001	LOCALITY PLAN AND DRAWING INDEX	C
QC1022-018-DWG-0002	LEGEND AND GENERAL NOTES	C
QC1022-018-DWG-0010	KEY PLAN	C
QC1022-018-DWG-0100	EARTHWORKS - GENERAL ARRANGEMENT PLAN	C
QC1022-018-DWG-0101	NORTHERN EMBANKMENT - GENERAL ARRANGEMENT PLAN	C
QC1022-018-DWG-0102	SOUTHERN EMBANKMENT - GENERAL ARRANGEMENT PLAN	C
QC1022-018-DWG-0110	TYPICAL SECTIONS AND DETAILS - SHEET 1 OF 4	D
QC1022-018-DWG-0111	TYPICAL SECTIONS AND DETAILS - SHEET 2 OF 4	D
QC1022-018-DWG-0112	TYPICAL SECTIONS AND DETAILS - SHEET 3 OF 4	D
QC1022-018-DWG-0113	TYPICAL SECTIONS AND DETAILS - SHEET 4 OF 4	D
QC1022-018-DWG-0120	LONGITUDINAL SECTIONS - SHEET 1 OF 3	A
QC1022-018-DWG-0121	LONGITUDINAL SECTIONS - SHEET 2 OF 3	A
QC1022-018-DWG-0122	LONGITUDINAL SECTIONS - SHEET 3 OF 3	A
QC1022-018-DWG-0200	ROADS - GENERAL ARRANGEMENT PLAN	C
QC1022-018-DWG-0210	ROADS - TYPICAL SECTIONS AND DETAILS	A
QC1022-018-DWG-0220	LONGITUDINAL SECTIONS - SHEET 1 OF 3	A
QC1022-018-DWG-0221	LONGITUDINAL SECTIONS - SHEET 2 OF 3	A
QC1022-018-DWG-0222	LONGITUDINAL SECTIONS - SHEET 3 OF 3	A
QC1022-018-DWG-0300	TAILINGS & DECANT PIPELINES - GENERAL ARRANGEMENT PLAN	C
QC1022-018-DWG-0310	TAILINGS & DECANT PIPELINES - TYPICAL SECTIONS AND DETAILS	A
QC1022-018-DWG-0410	DEPOSITION - TYPICAL SECTIONS AND DETAILS	A
QC1022-018-DWG-0500	INSTRUMENTATION - GENERAL ARRANGEMENT PLAN - SHEET 1 OF 2	B
QC1022-018-DWG-0501	INSTRUMENTATION - GENERAL ARRANGEMENT PLAN - SHEET 2 OF 2	B
QC1022-018-DWG-0510	INSTRUMENTATION - TYPICAL SECTIONS AND DETAILS	A
QC1022-018-DWG-0600	CUT/FILL HEAT MAP - GENERAL ARRANGEMENT PLAN	A
QC1022-018-DWG-0601	DISTURBANCE BOUNDARY - GENERAL ARRANGEMENT PLAN	A
QC1022-018-DWG-0602	BORROW AREAS - GENERAL ARRANGEMENT PLAN	A
QC1022-018-DWG-0603	CONSTRUCTION HAUL ROUTES - GENERAL ARRANGEMENT PLAN	A
QC1022-018-DWG-0700	CLOSURE - GENERAL ARRANGEMENT PLAN	B
QC1022-018-DWG-0710	CLOSURE - TYPICAL SECTIONS AND DETAILS	A

0 100 200 300 400 500m
SCALE 1:10,000 (A1)
SCALE BEFORE REDUCTION

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REV	BY	DATE	REVISION DESCRIPTION	PM APPD
C	ON	02.05.25	ISSUED FOR REVIEW	BW
B	ST	29.11.24	ISSUED FOR REVIEW	BW
A	ST	10.05.24	ISSUED FOR REVIEW	BW

DOC. NUMBER	DOCUMENT TITLE
REFERENCE DOCUMENTS	

29 Metals

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PM APPD.	BW	PD APPD.	TW	
RPEQ		RPEQ No.		

CAPRICORN COPPER

TSF3 PRELIMINARY DESIGN
LOCALITY PLAN AND DRAWING INDEX

ORIGINAL SIZE A1 | DWG NO. QC1022-018-DWG-0001 | REV. C

LAST MODIFIED: 9/5/2025 11:59 AM
CAD REF: Q:\PROJECTS\QC1022-2\METALS\QC1022-018 "TSF 3 DESIGN & STUDIES\05 DESIGN\AUTOCAD\DRAWINGS\QC1022-018-DWG-0001.DWG

LEGEND – EXISTING FEATURES

- 240 240 CONTOUR LABEL
- CONTOUR MAJOR
- CONTOUR MINOR
- MINE LEASE BOUNDARY
- EXISTING HDPE LINER
- WATERWAY
- CONCRETE PLINTH

LEGEND – PROPOSED SERVICES

- TAILINGS DELIVERY PIPELINE
- RETURN WATER PIPELINE

LEGEND – PROPOSED FEATURES

- 240 240 FINISHED CONTOUR MAJOR
- FINISHED CONTOUR MINOR
- 240 240 FINISHED CONTOUR CLOSURE SURFACE
- CIVIL WORKS EXTENT
- CONCRETE EXTENT
- LV/HV ROAD EXTENT
- SELECT FILL (CLAYEY GRAVEL / GRAVELLY CLAY) (NAF)
- GENERAL FILL / ROCK FILL (PAF/NAF)
- GENERAL FILL / ROCK FILL (NAF)
- CONCRETE PLINTH
- FULL SUPPLY LEVEL
- TOPSOIL
- ROCK COVER
- COMPACTED CLAY
- CAPILLARY BREAK
- WASTE ROCK
- WORKING COVER
- TOPSOIL & VEGETATION
- INDICATIVE CLOSURE SURFACE EXTENT
- DECANT POND EXTENT
- FINAL TAILINGS DEPOSITION
- 2YR TAILINGS DEPOSITION
- 4YR TAILINGS DEPOSITION
- 6YR TAILINGS DEPOSITION
- FULL SUPPLY LEVEL
- BATTER SLOPE INDICATORS
- CONTROL LINE
- ROAD INVERT DRAIN

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS NOTED OTHERWISE. ALL ELEVATIONS ARE IN METRES (m). ALL CO-ORDINATES ARE IN METRES (m).
2. VERTICAL DATUM IS AUSTRALIAN HEIGHT DATUM (A.H.D.)
3. HORIZONTAL DATUM IS IN ACCORDANCE WITH GDA94 MGA ZONE 54.
4. THE COMPANY'S REPRESENTATIVE SHALL ESTABLISH SURVEY BASELINES AND BENCHMARKS. PRIOR TO THE COMMENCEMENT OF WORK THE CONTRACTOR SHALL VERIFY THE EXISTING SURVEY LEVELS AND AGREE WITH THE COMPANY'S REPRESENTATIVE ANY VARIATION FROM THE LEVELS SHOWN ON THE DRAWINGS.
5. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE TECHNICAL SPECIFICATION (XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX).
6. REFER TECHNICAL SPECIFICATION FOR COMPACTION REQUIREMENTS AND MATERIAL STANDARDS.
7. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH RELEVANT SAA CODES, BY-LAWS AND ORDINANCES OF RELEVANT STATUTORY AUTHORITIES.
8. SECTION NUMBERS REFER TO THE LAST FOUR NUMBERS OF THE DRAWING NUMBER. IE. REFER DRAWING 0201
9. SETTING OUT DIMENSIONS SHOWN ON THE DRAWINGS SHALL BE VERIFIED BY THE SITE CONTRACTOR. REFER ANY DISCREPANCY TO THE COMPANY'S REPRESENTATIVE BEFORE PROCEEDING WITH WORK.
10. ALL REINFORCEMENT, CONCRETE, CONCRETE MATERIALS AND CONSTRUCTION TO BE IN ACCORDANCE WITH AS3600.
11. REFER ALL DISCREPANCIES TO THE COMPANY'S REPRESENTATIVE BEFORE PROCEEDING WITH THE WORKS.
12. DESIGN BASED ON LiDAR SURVEY DATED 20/07/2021 SUPPLIED BY THE PRINCIPAL. ENGENY TAKES NO RESPONSIBILITY FOR INACCURACIES ASSOCIATED WITH THE PRINCIPAL SUPPLIED LiDAR SURVEY AND DISCREPANCIES WITH EXISTING GROUND LEVELS.
13. EXISTING SERVICE LOCATIONS ARE INDICATIVE ONLY.
14. LOCATION OF ALL EXISTING SERVICES TO BE CONFIRMED PRIOR TO CONSTRUCTION AND TREATMENT APPROVED BY COMPANY'S REPRESENTATIVE.
15. TSF3 STORAGE ESTIMATES AND FILLING RATES SHOWN IN THE DRAWINGS ARE APPROXIMATE ONLY FOR THE NO HIGH DENSITY THICKENER OPTION. DIVERSION OF A PROPORTION OF THE TAILINGS STREAM TO PASTE BACKFILL OPERATIONS IS EXCLUDED. REDUCTION IN STORAGE CAPACITY DUE TO WATER TREATMENT PLANT SLUDGE DEPOSITION IN TSF3 EXCLUDED.

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REV	BY	DATE	REVISION DESCRIPTION	PM APPD.
C	ON	02.05.25	ISSUED FOR REVIEW	BW
B	TD	15.04.25	ISSUED FOR REVIEW	BW
A	ST	10.05.24	ISSUED FOR REVIEW	BW

DOC. NUMBER	DOCUMENT TITLE
REFERENCE DOCUMENTS	

29 Metals

ENGENY

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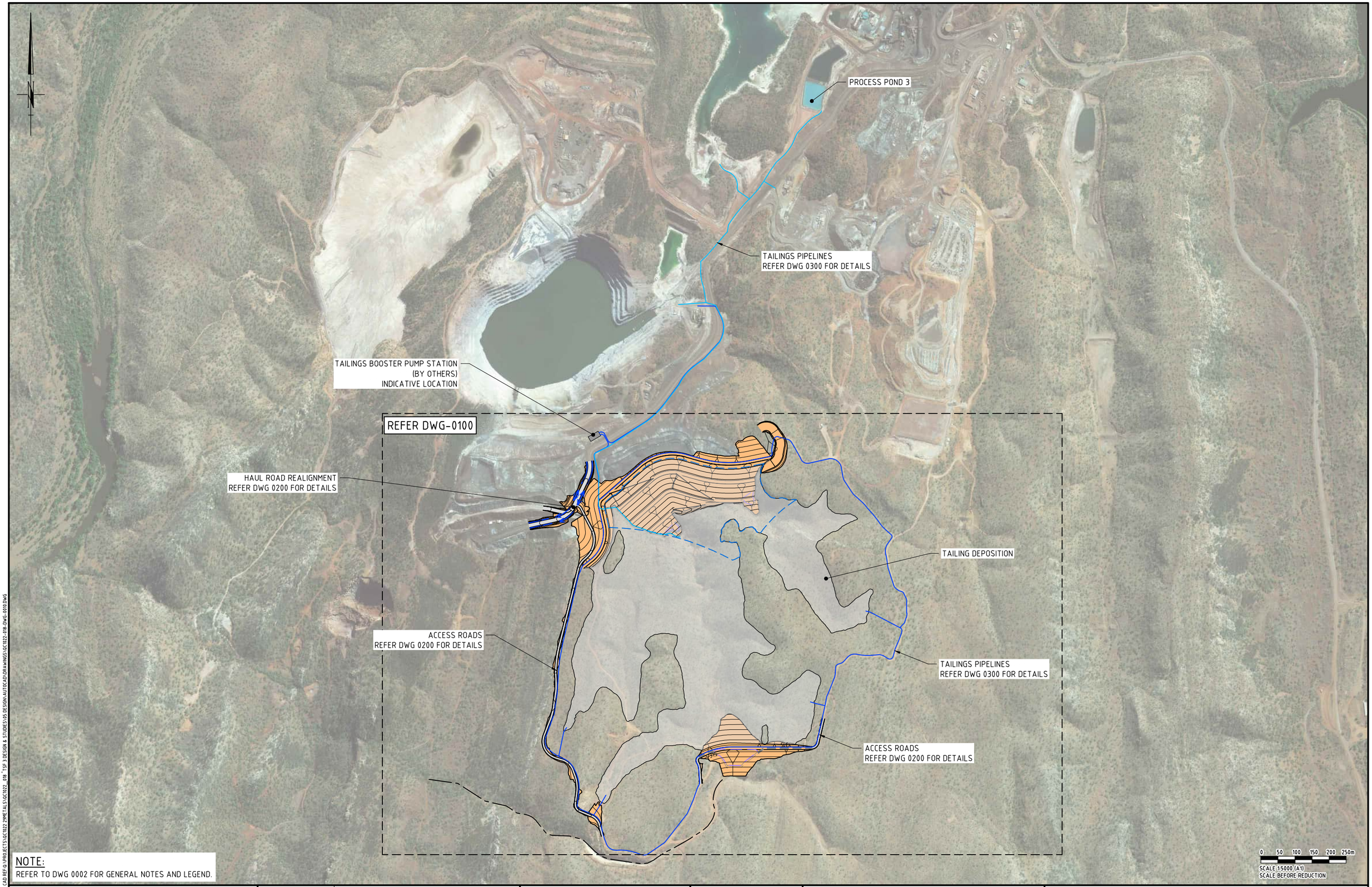
DESIGNED	MT	CHECKED	BW	
DRAWN	ST	CHECKED	BW	
PM APPD.	BW	PD APPD.	TW	
RPEQ		RPEQ No.		

CAPRICORN COPPER

TSF3 PRELIMINARY DESIGN
LEGEND AND GENERAL NOTES

ORIGINAL SIZE: A1
DWG NO.: QC1022-018-DWG-0002
REV.: C

LAST MODIFIED:25/9/2025 2:37 PM
CAD REF:Q:\PROJECTS\QC1022_29METALS\QC1022_018 TSF 3 DESIGN & STUDIES\05 DESIGN\AUTOCAD\DRAWINGS\QC1022-018-DWG-0002.DWG



NOTE:
REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

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C	ON	02.05.25	ISSUED FOR REVIEW	BW
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A	ST	10.05.24	ISSUED FOR REVIEW	BW

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DRAWN	ST	CHECKED	BW
PM APPD.	BW	PD APPD.	TW
RPEQ		RPEQ No.	

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TSF3 PRELIMINARY DESIGN
KEY PLAN

ORIGINAL SIZE A1 | DWG NO. QC1022-018-DWG-0010 | REV. C

LAST MODIFIED: 23/4/2025 4:27 PM
CAD REF: G:\PROJECTS\QC1022 29METALS\QC1022_018 "TSF 3 DESIGN & STUDIES\05 DESIGN\AUTOCAD\DRAWINGS\QC1022-018-DWG-0010.DWG

REFER DWG-0101

TAILINGS BOOSTER PUMP STATION
(BY OTHERS)
INDICATIVE LOCATION

HAUL ROAD
REFER DWG 0200 FOR DETAILS

DECANT POND OPERATING EXTENT

ACCESS ROADS
REFER DWG 0200 FOR DETAILS

TAILING DEPOSITION

REFER DWG-0102

NOTE:
REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

0 25 50 75 100 125m
SCALE 1:2500 (A1)
SCALE BEFORE REDUCTION

CAD REF:G:\PROJECTS\QC1022 29METALS\QC1022_018 - TSF 3 DESIGN & STUDIES\05 DESIGN\AUTOCAD\DRAWINGS\QC1022-018-DWG-0100.DWG

LAST MODIFIED:5/5/2025 3:03 PM

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REV	BY	DATE	REVISION DESCRIPTION	PM APPD.
C	ON	02.05.25	ISSUED FOR REVIEW	BW
B	ST	29.11.24	ISSUED FOR REVIEW	BW
A	ST	10.05.24	ISSUED FOR REVIEW	BW

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DRAWN	ST	CHECKED	BW	
PM APPD.	BW	PD APPD.	TW	
RPEQ		RPEQ No.		

CAPRICORN COPPER

TSF3 PRELIMINARY DESIGN
EARTHWORKS
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE A1
DWG NO. QC1022-018-DWG-0100
REV. C

HOLD: SPILLWAY EROSION PROTECTION DETAILS TO BE CONFIRMED DURING DETAILED DESIGN (PROVISIONALLY WASTE ROCK DUMP TOE TO BE PROTECTED FROM EROSION BY DUMPED ROCK / CONCRETE LINING)

HOLD: SPILLWAY ARRANGEMENT AND DETAILS TO BE CONFIRMED DURING DETAILED DESIGN

TAILINGS PIPELINES
REFER DWG 0300 FOR DETAILS

TAILINGS BOOSTER PUMP STATION
(BY OTHERS)
INDICATIVE LOCATION

CONTROL LINE MCW03
NORTHERN EMBANKMENT

CONTROL LINE MCR07
ACCESS RAMP

CONCRETE SILL
REFER DWG 0112 FOR DETAILS

CONTROL LINE MCS01
SPILLWAY

HAUL ROAD REALIGNMENT
REFER DWG 0200 FOR DETAILS

EXISTING HDPE LINER EXTENTS
INDICATIVE LOCATION

EXISTING CONCRETE PLINTH
INDICATIVE LOCATION

CONTROL LINE MCR08
ACCESS RAMP

CONTROL LINE MCR06
ACCESS RAMP

EXISTING HDPE LINER EXTENTS
INDICATIVE LOCATION

EXISTING CONCRETE PLINTH
INDICATIVE LOCATION

CONCRETE PLINTH AND PROVISION GROUT CURTAIN
REFER DWG 0110 FOR DETAILS. REFER NOTE 2.

EXISTING PLUNGE POOL

CONTROL LINE MCX01
CONCRETE PLINTH

ACCESS TRACK
REFER DWG 0200 FOR DETAILS

NOTE:
1. REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.
2. THE NEED FOR, EXTENTS, AND DETAILS OF THE CONCRETE PLINTH AND GROUT CURTAIN MAY BE REVISED DURING DETAILED DESIGN BASED ON THE OUTCOMES OF THE SITE WIDE TRANSIENT GROUNDWATER MODEL AND ASSOCIATED GROUNDWATER IMPACT ASSESSMENT.

SCALE 1:1000 (A1)
SCALE BEFORE REDUCTION

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B	ST	29.11.24	ISSUED FOR REVIEW	BW
A	ST	10.05.24	ISSUED FOR REVIEW	BW

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DRAWN	ST	CHECKED	BW	
PM APPD.	BW	PD APPD.	TW	
RPEQ		RPEQ No.		

CAPRICORN COPPER

TSF3 PRELIMINARY DESIGN
NORTHERN EMBANKMENT
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE	DWG NO.	REV.
A1	QC1022-018-DWG-0101	C

LAST MODIFIED: 2/5/2025 2:37 PM
CAD REF: A:\PROJECTS\QC1022 20METALS\QC1022_018 - TSF 3 DESIGN & STUDIES\05 DESIGN\AUTOCAD\DRAWINGS\QC1022-018-DWG-0101.DWG

F
0113

ACCESS TRACK REALIGNMENT
REFER DWG 0200 FOR DETAILS

EXTENSION OF EXISTING
CONCRETE PLINTH AND
GROUT CURTAIN. REFER
NOTE 2.

CONTROL LINE MCW06
SOUTHERN EMBANKMENT

EXISTING HDPE LINER EXTENTS

EXISTING GROUT CURTAIN

UPPER ESPERANZA DIVERSION DAM

ACCESS TRACK REALIGNMENT
REFER DWG 0200 FOR DETAILS

TAILINGS DELIVERY PIPELINE
REFER DWG 0300 FOR DETAILS

R 200.0
R 70.0
R 50.0
R 20.0
87.995
0.000
100
200
300
333.886
315
310
305
295

NOTE:

1. REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.
2. THE NEED FOR, EXTENTS, AND DETAILS OF THE CONCRETE PLINTH AND GROUT CURTAIN MAY BE REVISED DURING DETAILED DESIGN BASED ON THE OUTCOMES OF THE SITE WIDE TRANSIENT GROUNDWATER MODEL AND ASSOCIATED GROUNDWATER IMPACT ASSESSMENT.

0 25 50 75 100 125m
SCALE 1:2500 (A1)
SCALE BEFORE REDUCTION

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C	ON	02.05.25	ISSUED FOR REVIEW	BW
B	TD	15.04.25	ISSUED FOR REVIEW	BW
A	ST	10.05.24	ISSUED FOR REVIEW	BW

DOC. NUMBER	DOCUMENT TITLE
REFERENCE DOCUMENTS	

29 Metals

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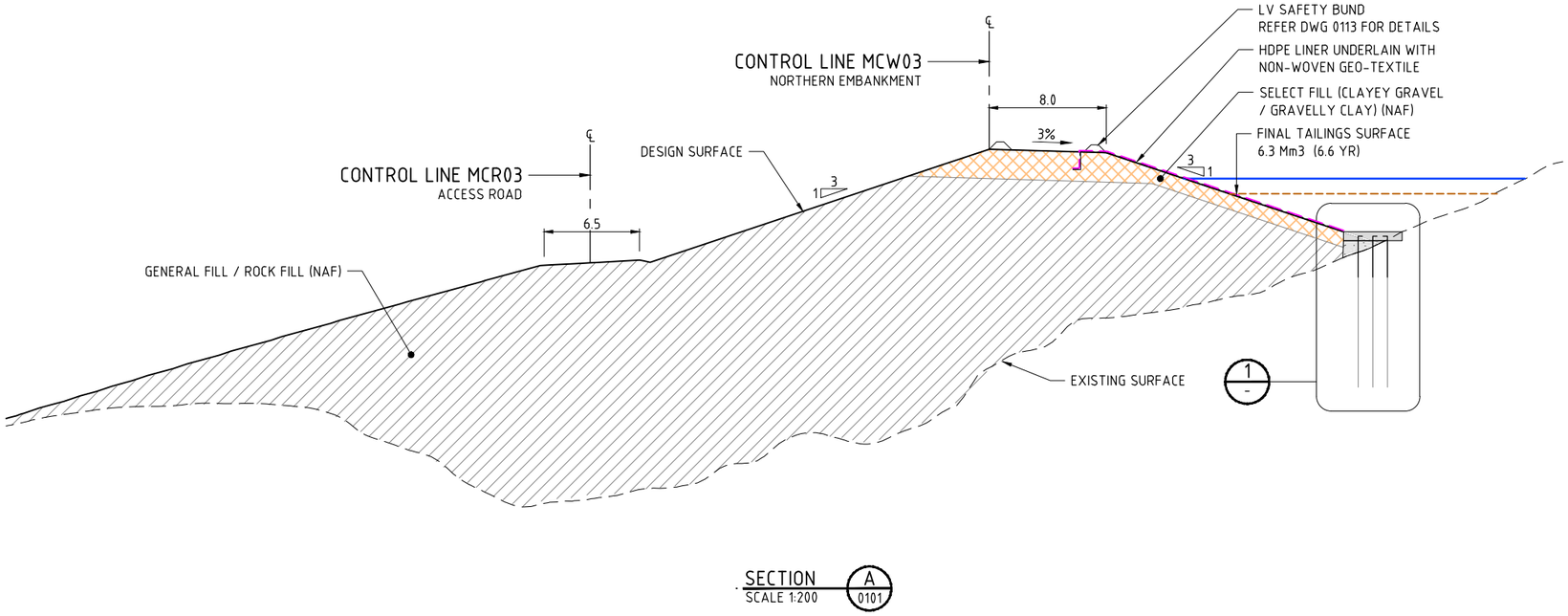
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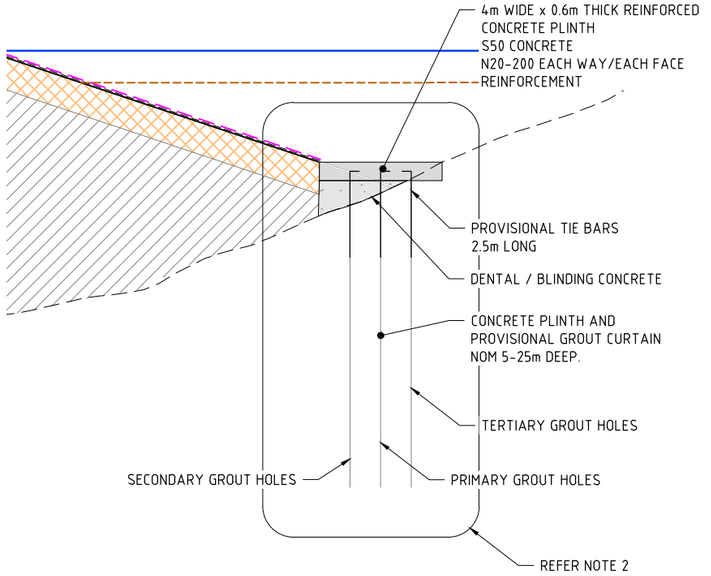
TSF3 PRELIMINARY DESIGN
SOUTHERN EMBANKMENT
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE A1
DWG NO. QC1022-018-DWG-0102
REV. C

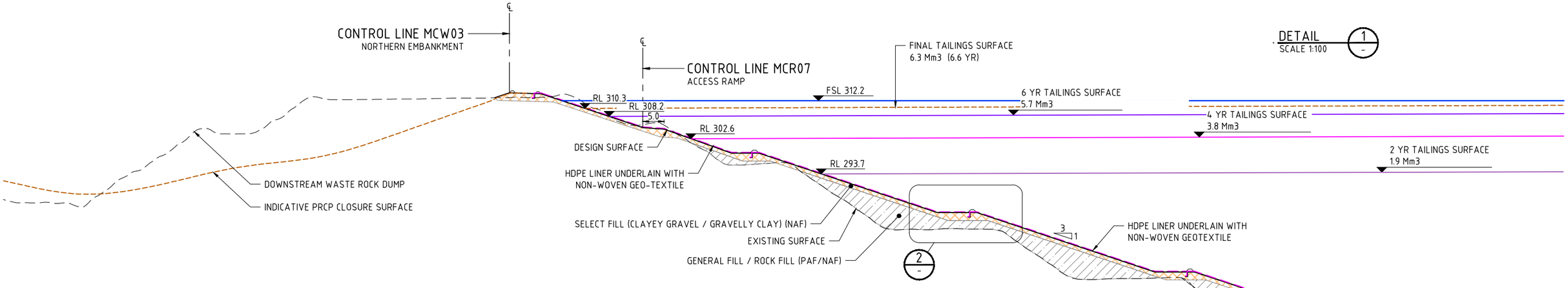
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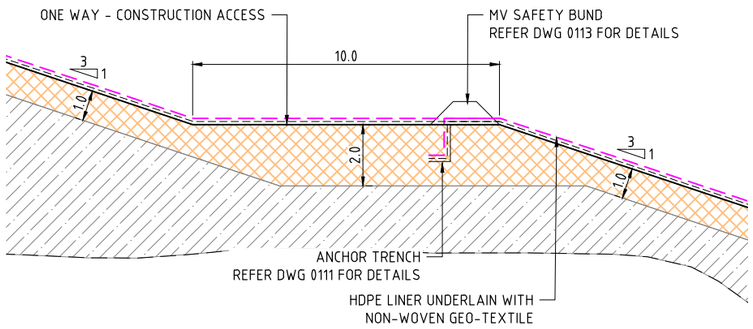
SECTION A
SCALE 1:200
0101



DETAIL 1
SCALE 1:100



SECTION B
SCALE 1:500
0101



DETAIL 2
SCALE 1:100

LEGEND

- EXISTING SURFACE
- DESIGN SURFACE
- FINAL TAILING DEPOSITION

NOTE:

1. REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.
2. THE NEED FOR, EXTENTS, AND DETAILS OF THE CONCRETE PLINTH AND GROUT CURTAIN MAY BE REVISED DURING DETAILED DESIGN BASED ON THE OUTCOMES OF THE SITE WIDE TRANSIENT GROUNDWATER MODEL AND ASSOCIATED GROUNDWATER IMPACT ASSESSMENT.

0 1 2 3 4 5m
SCALE 1:100 (A1)
SCALE BEFORE REDUCTION

0 2 4 6 8 10m
SCALE 1:200 (A1)
SCALE BEFORE REDUCTION

0 5 10 15 20 25m
SCALE 1:500 (A1)
SCALE BEFORE REDUCTION

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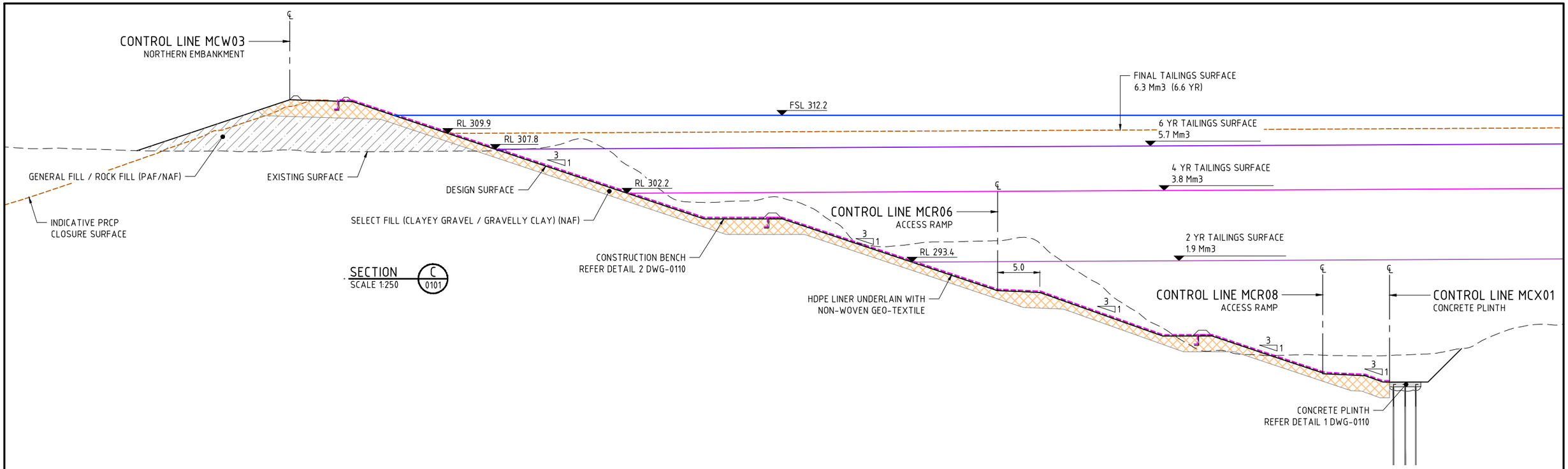
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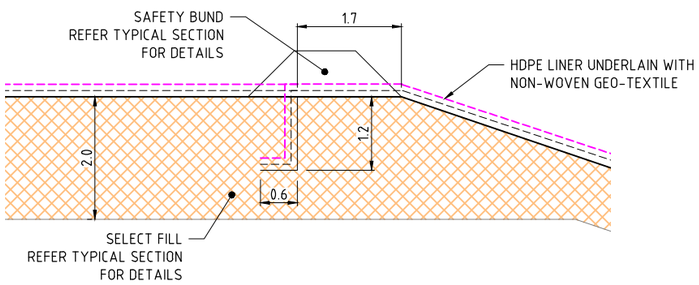
TSF3 PRELIMINARY DESIGN
TYPICAL SECTIONS AND DETAILS
SHEET 1 OF 4

ORIGINAL SIZE A1
DWG NO. QC1022-018-DWG-0110
REV. D

LAST MODIFIED: 9/5/2025 10:51 AM
CAD REF: G:\PROJECTS\QC1022-29ME TAILS\QC1022_018 "TSF 3 DESIGN & STUDIES\05 DESIGN\AUTOCAD\DRAWINGS\QC1022-018-DWG-0110.DWG



SECTION C
SCALE 1:250 0101



ANCHOR TRENCH TYPICAL DETAIL
SCALE 1:50

LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

SCALE 1:100 (A1) SCALE BEFORE REDUCTION

SCALE 1:250 (A1) SCALE BEFORE REDUCTION

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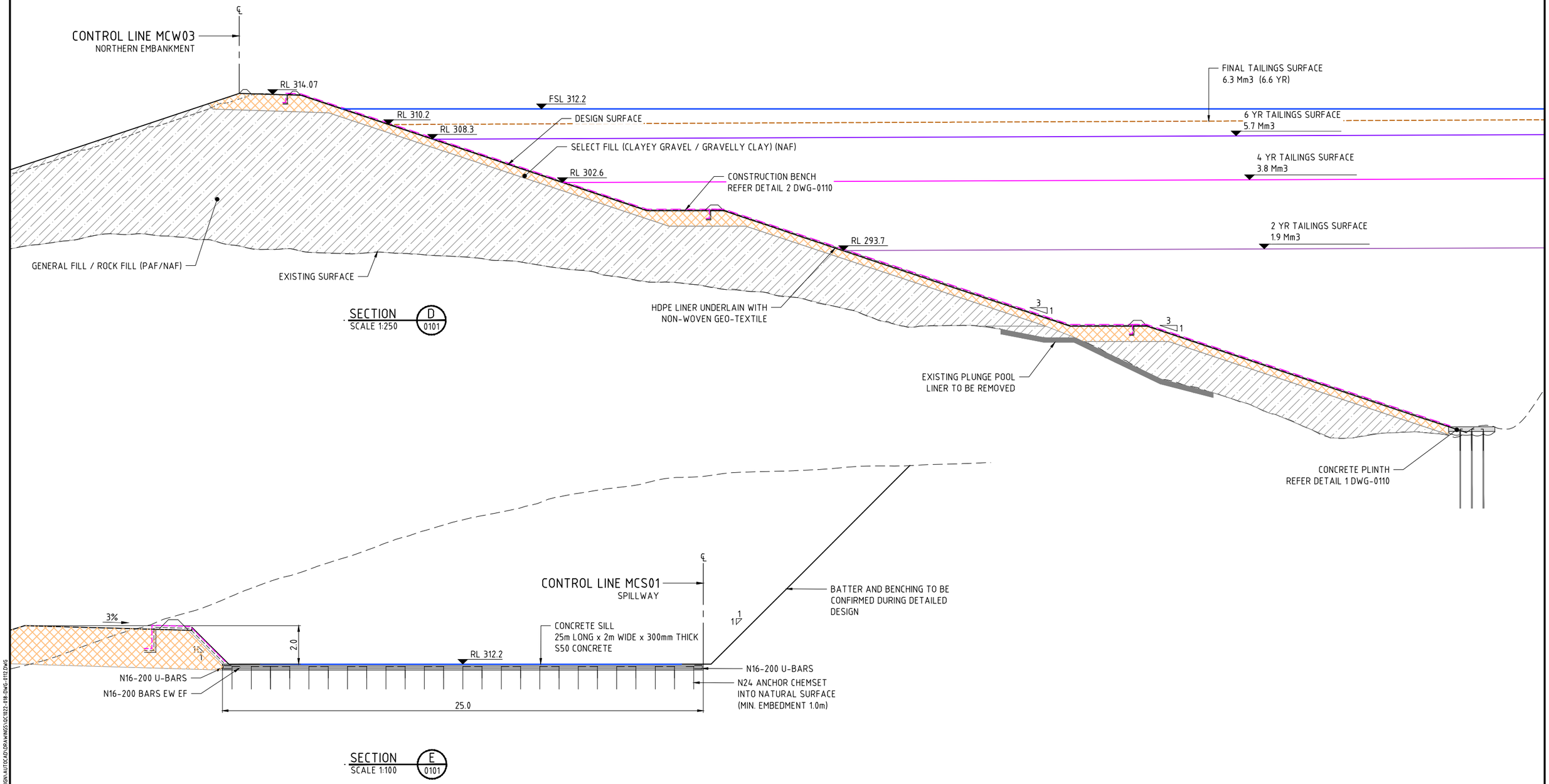
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TSF3 PRELIMINARY DESIGN
TYPICAL SECTIONS AND DETAILS
SHEET 2 OF 4

ORIGINAL SIZE A1 | DWG NO. QC1022-018-DWG-0111 | REV. D

LAST MODIFIED:9/5/2025 11:51 AM
CAD REF:G:\PROJECTS\QC1022_29METALS\QC1022_018_TSF 3 DESIGN & STUDIES\05 DESIGN\AUTOCAD\DRAWINGS\QC1022-018-DWG-0111.DWG



LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

SCALE 1:100 (A1)
SCALE BEFORE REDUCTION

0 1 2 3 4 5m

SCALE 1:250 (A1)
SCALE BEFORE REDUCTION

0 2.5 5.0 7.5 10.0 12.5m

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LAST MODIFIED:9/5/2025 10:51 AM

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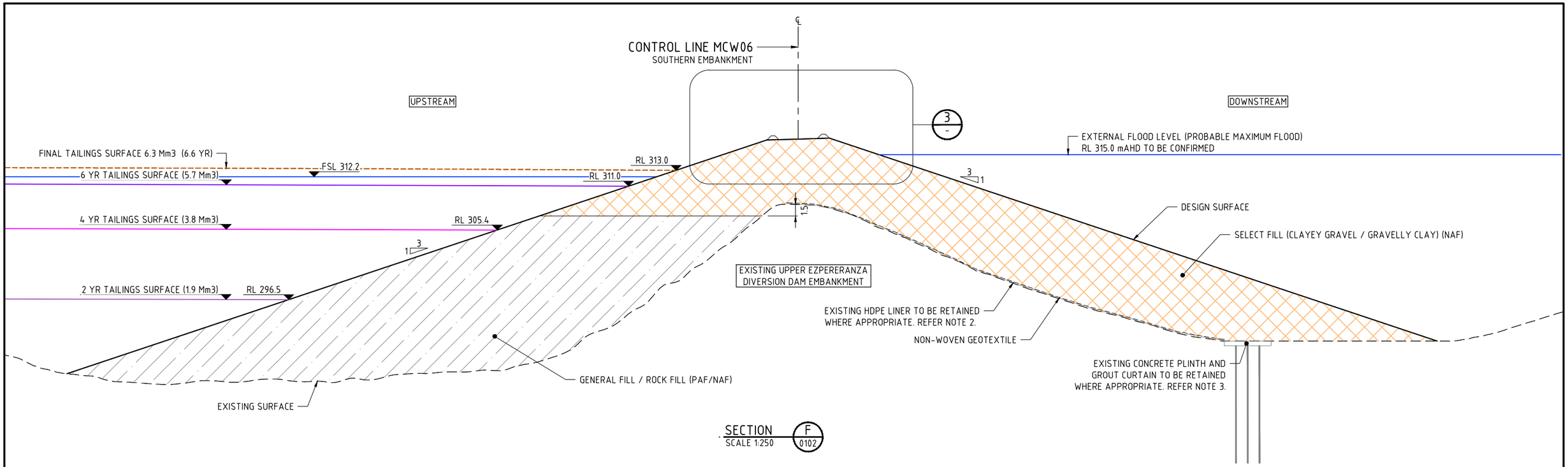
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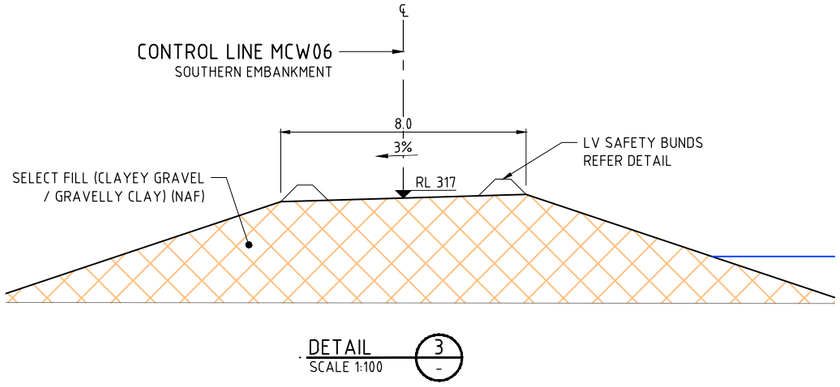
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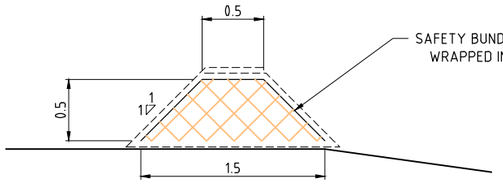
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TSF3 PRELIMINARY DESIGN
TYPICAL SECTIONS AND DETAILS
SHEET 3 OF 4

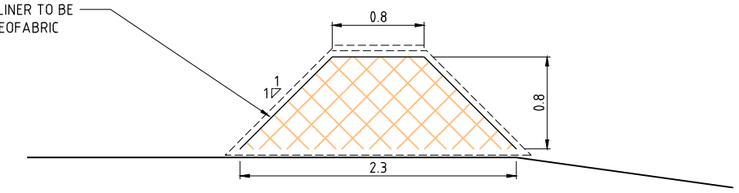
ORIGINAL SIZE A1
DWG NO. QC1022-018-DWG-0112
REV. D







LIGHT VEHICLE (LV) SAFETY BUND DETAIL
SCALE 1:25



MEDIUM VEHICLE (MV) SAFETY BUND DETAIL
SCALE 1:25

LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

1. REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.
2. EXISTING HDPE LINER TO BE RETAINED WHERE APPROPRIATE BASED ON INTEGRITY VERITIFCATION (INSPECTION AND TESTING). WHERE UNSUITABLE, LINER SYSTEM TO BE REMOVED AND REPLACED.
3. EXISTING CONCRETE PLINTH AND GROUT CURTAIN TO BE RETAINED WHERE APPROPRIATE BASED ON INTEGRITY VERITIFCATION INSPECTION AND TESTING (E.G VERIFICATION GROUTING.)

0 0.25 0.5 0.75 1.0 1.25m
SCALE 1:25 (A1)
SCALE BEFORE REDUCTION

0 1 2 3 4 5m
SCALE 1:100 (A1)
SCALE BEFORE REDUCTION

0 2.5 5.0 7.5 10.0 12.5m
SCALE 1:250 (A1)
SCALE BEFORE REDUCTION

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TSF3 PRELIMINARY DESIGN
TYPICAL SECTIONS AND DETAILS
SHEET 4 OF 4

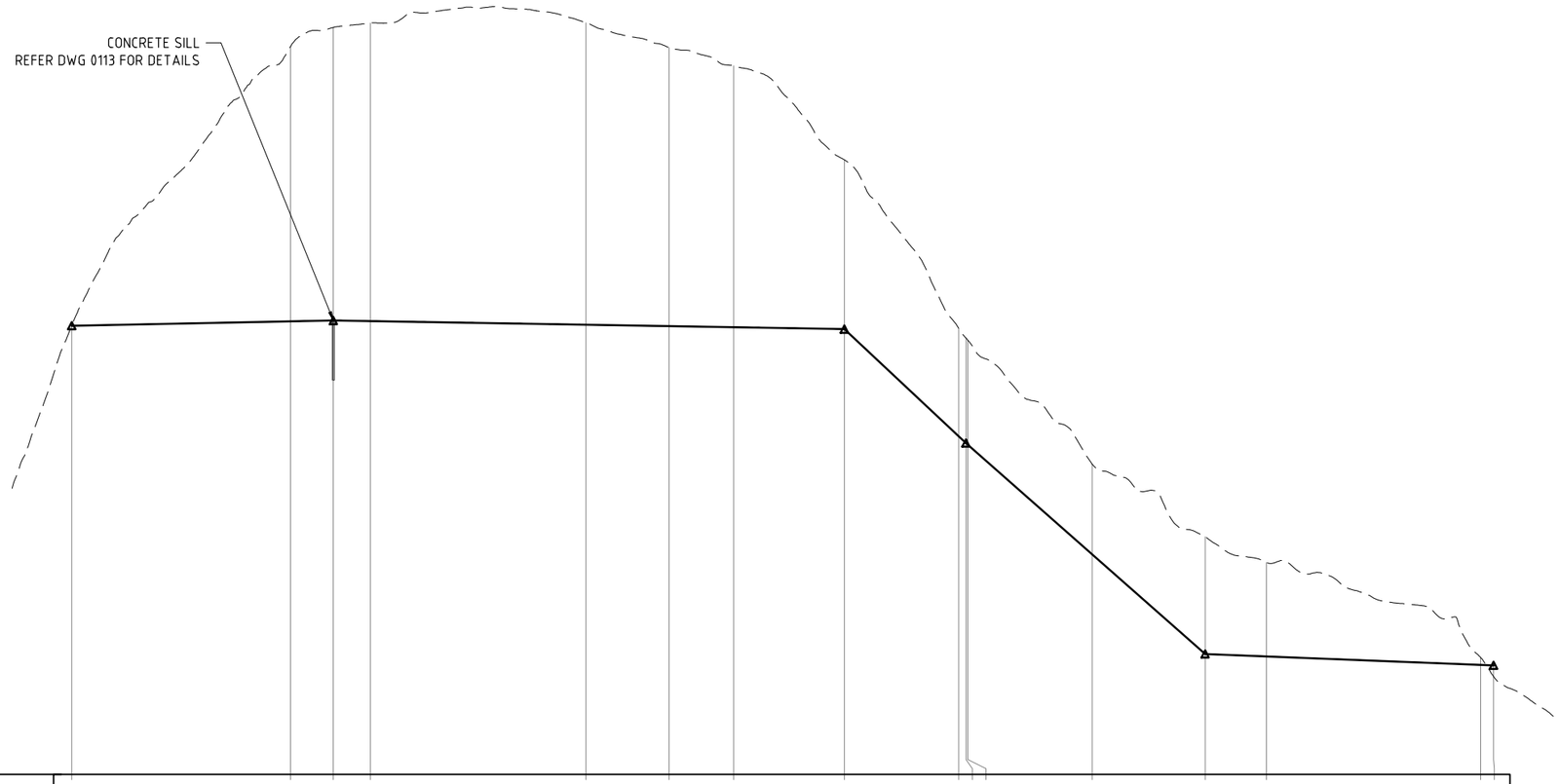
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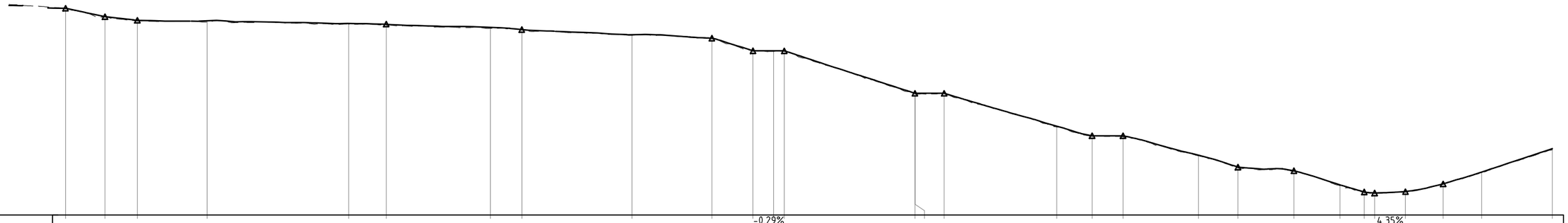
DATUM 288.0

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DATUM 297.0

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DATUM 241.0

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REFER DWG-0210

TIE INTO EXISTING HV ROAD

CONTROL LINE MCR02
ACCESS ROAD
REFER TYPICAL DETAIL DWG 0210

TIE INTO EXISTING LV ROAD

TIE INTO EXISTING HV ROAD

CONTROL LINE MCR01
HAUL ROAD REALIGNMENT

NORTHERN EMBANKMENT
REFER DWG 0101 FOR DETAILS

TAILING DEPOSITION (FINAL SURFACE)
REFER DWG-0400 FOR DETAILS

CONTROL LINE MCR03
ACCESS ROAD
REFER TYPICAL DETAIL DWG 0210

CONSTRUCTION ACCESS ROUTE
(INDICATIVE LOCATION)
BY OTHERS

TIE INTO EXISTING LV ROAD

CONTROL LINE MCR05
ACCESS ROAD
REFER TYPICAL DETAIL DWG 0210

SOUTHERN EMBANKMENT
REFER DWG 0102 FOR DETAILS

CONTROL LINE MCR04
ACCESS ROAD
REFER TYPICAL DETAIL DWG 0210

TIE INTO EXISTING LV ROAD

TIE INTO EXISTING LV ROAD

NOTE:
REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

0 25 50 75 100 125m
SCALE 1:2500 (A1)
SCALE BEFORE REDUCTION

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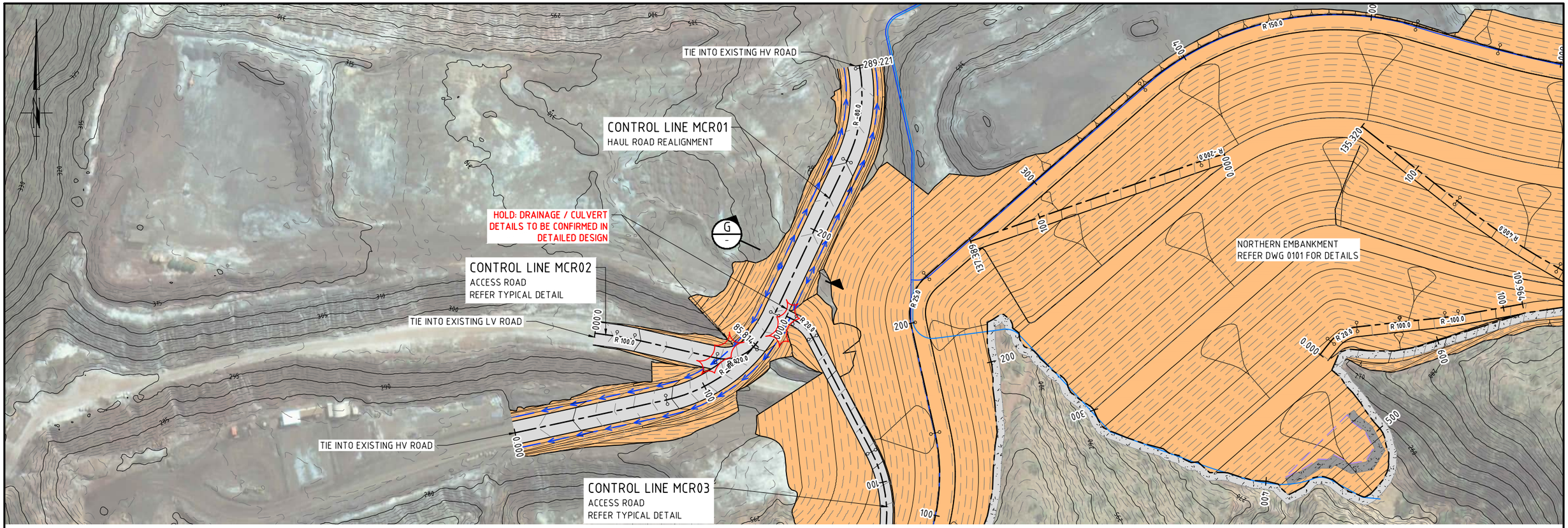
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TSF3 PRELIMINARY DESIGN
ROADS
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE A1
DWG NO. QC1022-018-DWG-0200
REV. C

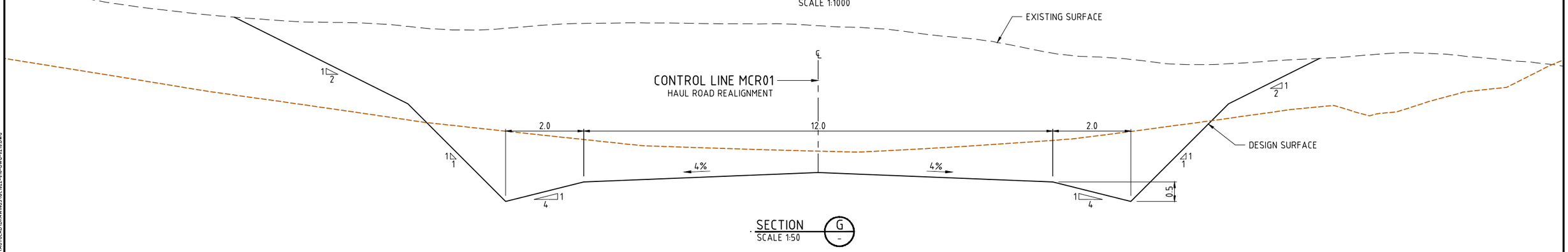
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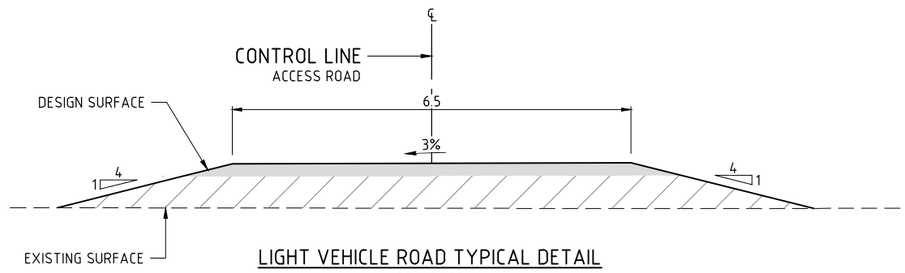
HAUL ROAD GENERAL ARRANGEMENT

SCALE 1:1000



SECTION G

SCALE 1:50



LIGHT VEHICLE ROAD TYPICAL DETAIL

SCALE 1:50

LEGEND

- EXISTING SURFACE
- DESIGN SURFACE

NOTE:

REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

SCALE 1:50 (A1) SCALE BEFORE REDUCTION: 0 0.5 1.0 1.5 2.0 2.5m

SCALE 1:1000 (A1) SCALE BEFORE REDUCTION: 0 10 20 30 40 50m

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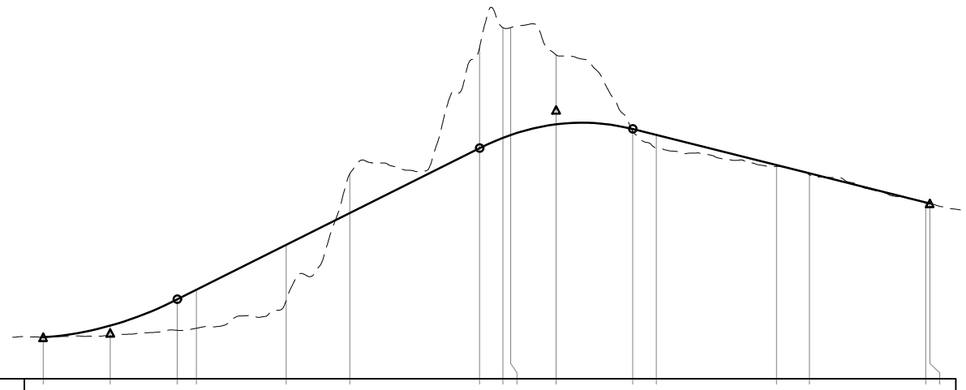
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TSF3 PRELIMINARY DESIGN
ROADS
TYPICAL SECTIONS AND DETAILS

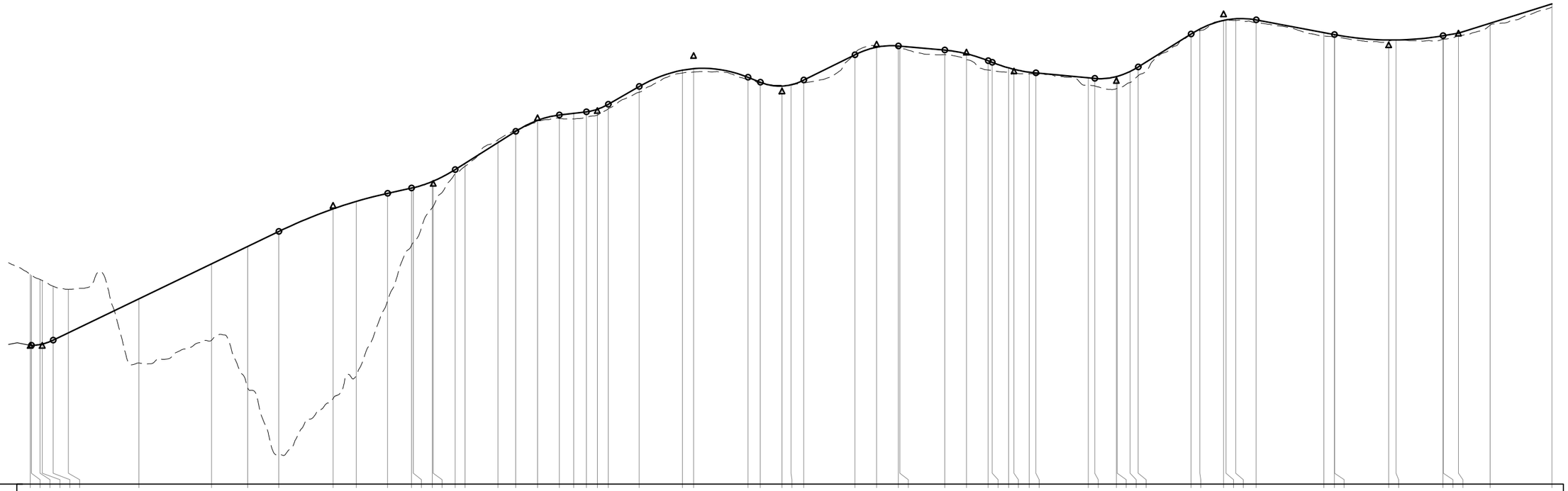
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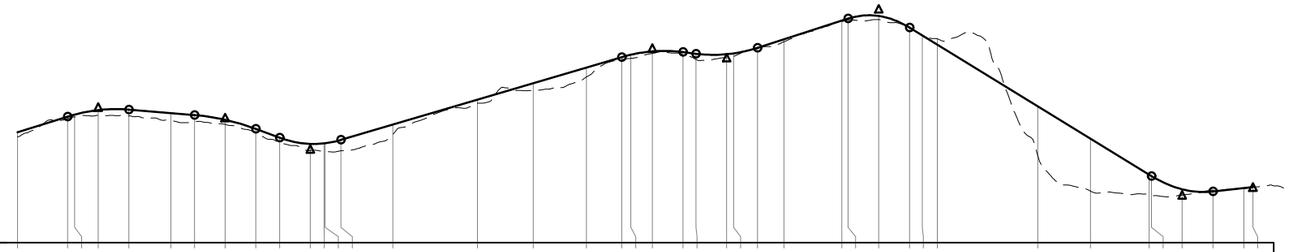
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DATUM 284.0

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DATUM 321.0

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NOTE:
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TSF3 PRELIMINARY DESIGN
TAILINGS & DECANT PIPELINES
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE A1 | DWG NO. QC1022-018-DWG-0300 | REV. C

LAST MODIFIED: 23/5/2025 2:37 PM
CAD REF: G:\PROJECTS\QC1022 29METALS\QC1022_018 "TSF 3 DESIGN & STUDIES\03 DESIGN\AUTOCAD\DRAWINGS\QC1022-018-DWG-0300.DWG

HOLD: DETAILS TO BE CONFIRMED DURING DETAILED DESIGN

LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

SCALE 1:100 (A1)
SCALE BEFORE REDUCTION

SCALE 1:200 (A1)
SCALE BEFORE REDUCTION

SCALE 1:500 (A1)
SCALE BEFORE REDUCTION

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RPEQ		RPEQ No.	

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TSF3 PRELIMINARY DESIGN
TAILINGS & DECANT PIPELINES
TYPICAL SECTIONS AND DETAILS

ORIGINAL SIZE: A1

DWG NO.: QC1022-018-DWG-0310

REV.: A

LAST MODIFIED:25/7/2025 2:37 PM
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HOLD: DETAILS TO BE CONFIRMED DURING DETAILED DESIGN

LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

0 5 10 15 20 25m

SCALE 1:500 (A1)
SCALE BEFORE REDUCTION

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TSF3 PRELIMINARY DESIGN
DEPOSITION
TYPICAL SECTIONS AND DETAILS

ORIGINAL SIZE	DWG NO.	REV.
A1	QC1022-018-DWG-0410	A

HOLD: DOWNSTREAM INSTRUMENTATION TO BE CONFIRMED FOLLOWING CONFIRMATION OF LOM WRD DESIGN

NORTHERN EMBANKMENT
REFER DWG-0101 FOR DETAILS

VWP1 S_N1
VWP2 S_N2
VWP3 S_N3
VWP4 S_N4
VWP5 S_N5
VWP6 S_N6
VWP7 S_N7
VWP8 S_N8
BS_1
BS_2

SURVEY MONUMENTS & BASE STATION SETOUT POINTS

POINT No.	COORDINATES	
	EASTING	NORTHING
BS 1	327833.657	7820233.836
S N1	327884.204	7820273.345
S N2	327912.796	7820345.762
S N3	327909.520	7820447.923
S N4	328000.111	7820548.223
S N5	328055.267	7820578.041
S N6	328130.635	7820572.616
S N7	328211.262	7820551.341
S N8	328324.592	7820557.845
BS 2	328395.389	7820486.718

VIBRATING WIRE PIEZOMETER SETOUT POINTS

POINT No.	COORDINATES	
	EASTING	NORTHING
VWP1	327886.381	7820275.673
VWP2	327912.867	7820347.282
VWP3	327911.432	7820449.833
VWP4	328002.417	7820550.254
VWP5	328058.517	7820578.949
VWP6	328132.869	7820571.908
VWP7	328214.202	7820550.746
VWP8	328326.163	7820557.931

NOTES:
1. REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.
2. REFER TO DWG 0510 FOR SURVEY MONUMENT AND VIBRATING WIRE PIEZOMETER TYPICAL DETAILS
3. TYPE AND LOCATIONS OF MONITORING INSTRUMENTATION TO BE CONFIRMED DURING DETAILED DESIGN

NORTHERN EMBANKMENT INSTRUMENTATION PLAN
SCALE 1:1000

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SCALE 1:1000 (A1)
SCALE BEFORE REDUCTION

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INSTRUMENTATION
GENERAL ARRANGEMENT PLAN - SHEET 1 OF 2

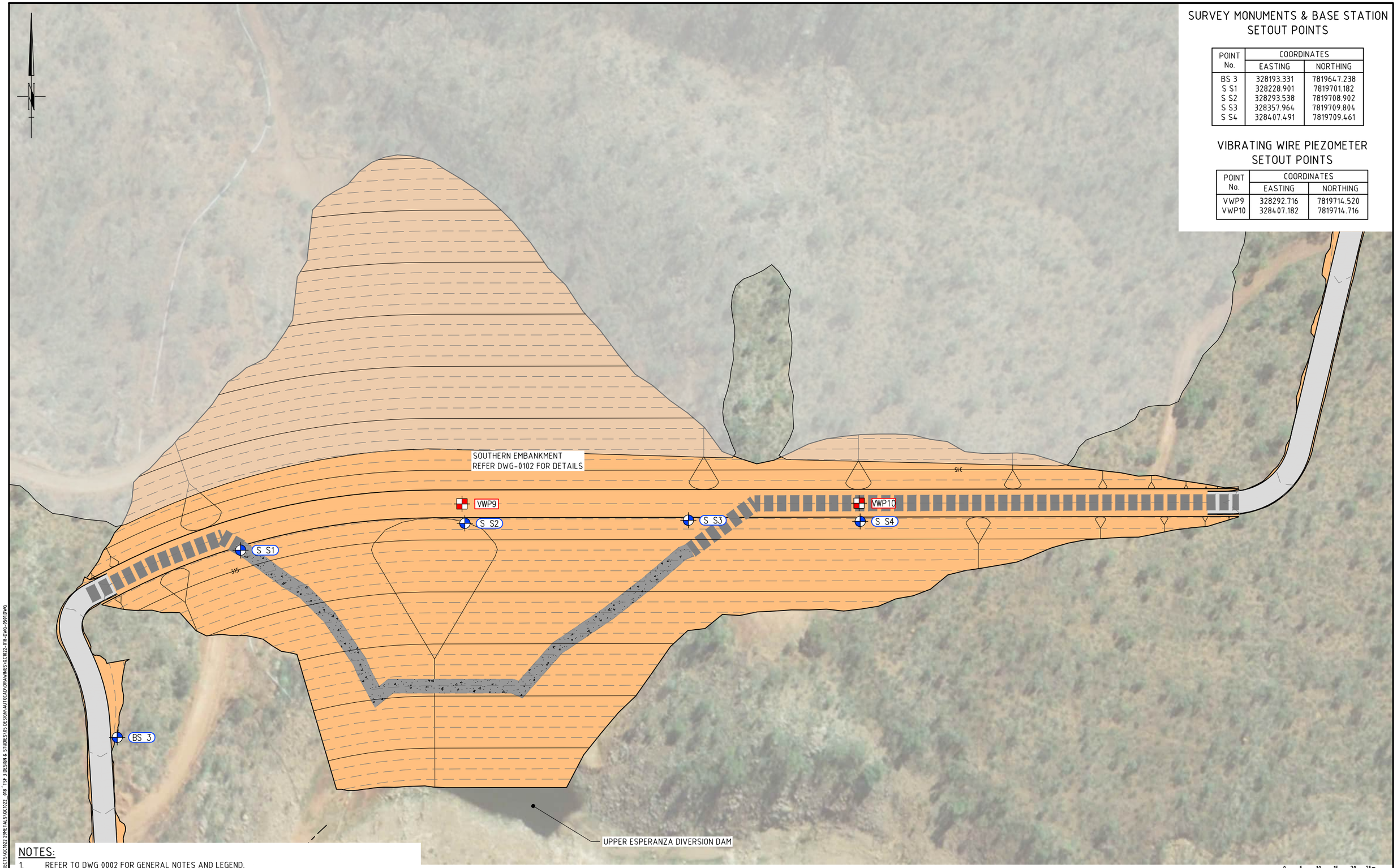
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A1	QC1022-018-DWG-0500	B

SURVEY MONUMENTS & BASE STATION SETOUT POINTS

POINT No.	COORDINATES	
	EASTING	NORTHING
BS 3	328193.331	7819647.238
S S1	328228.901	7819701.182
S S2	328293.538	7819708.902
S S3	328357.964	7819709.804
S S4	328407.491	7819709.461

VIBRATING WIRE PIEZOMETER SETOUT POINTS

POINT No.	COORDINATES	
	EASTING	NORTHING
VWP9	328292.716	7819714.520
VWP10	328407.182	7819714.716



NOTES:

1. REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.
2. REFER TO DWG 0510 FOR SURVEY MONUMENT AND VIBRATING WIRE PIEZOMETER TYPICAL DETAILS.
3. TYPE AND LOCATIONS OF MONITORING INSTRUMENTATION TO BE CONFIRMED DURING DETAILED DESIGN.

SOUTHERN EMBANKMENT INSTRUMENTATION PLAN

SCALE 1:1000

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SCALE 1:500 (A1)
SCALE BEFORE REDUCTION

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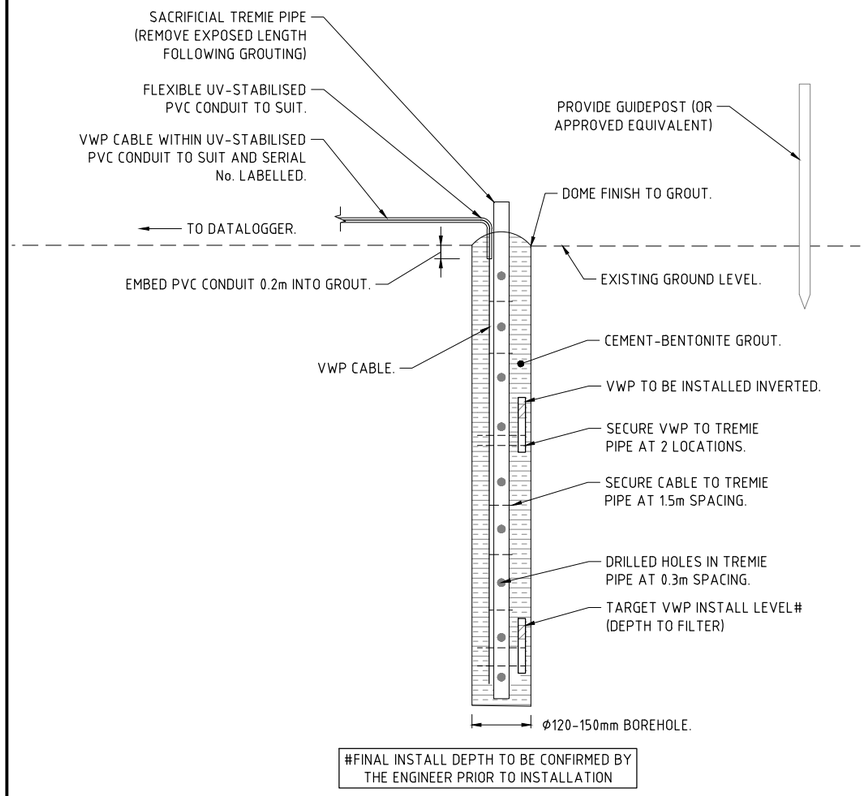
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TSF3 PRELIMINARY DESIGN
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GENERAL ARRANGEMENT PLAN - SHEET 2 OF 2

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REV.: B

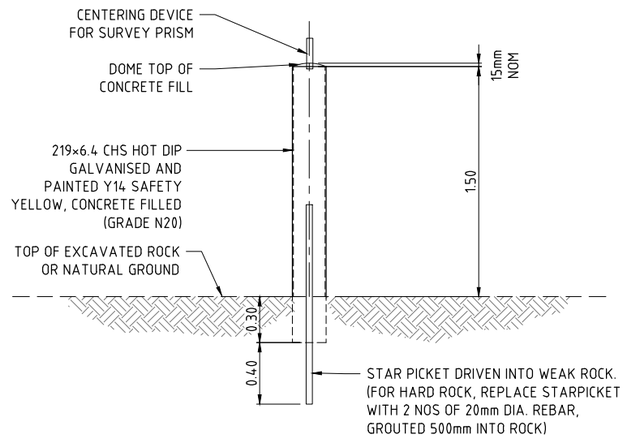
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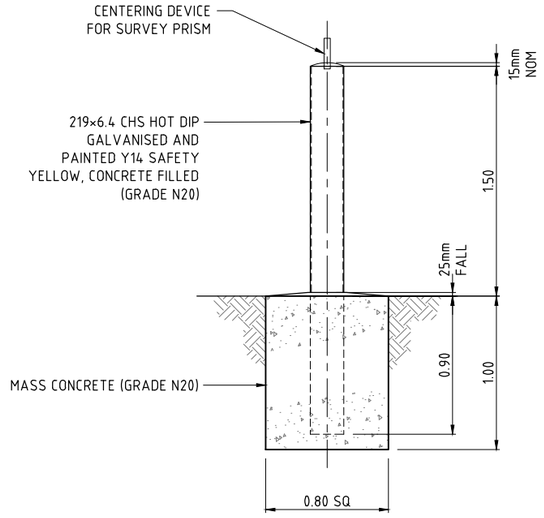
#FINAL INSTALL DEPTH TO BE CONFIRMED BY THE ENGINEER PRIOR TO INSTALLATION

TYPICAL 'VWP' VIBRATING WIRE PIEZOMETER INSTALLATION



SURVEY MONUMENT (BASE STATION) TYPICAL DETAIL

SCALE 1:10



SURVEY MONUMENT (IN FILL) TYPICAL DETAIL

SCALE 1:20

LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

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SCALE 1:200 (A1) SCALE BEFORE REDUCTION

SCALE 1:500 (A1) SCALE BEFORE REDUCTION

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TSF3 PRELIMINARY DESIGN
INSTRUMENTATION
TYPICAL SECTIONS AND DETAILS

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TAILINGS BOOSTER PUMP STATION
(BY OTHERS)
INDICATIVE LOCATION

HAUL ROAD REALIGNMENT
REFER DWG 0200 FOR DETAILS

NORTHERN EMBANKMENT
REFER DWG-0101 FOR DETAILS

ACCESS ROAD
REFER DWG 0200 FOR DETAILS

SOUTHERN EMBANKMENT
REFER DWG-0102 FOR DETAILS

UPPER ESPERANZA DIVERSION DAM

DEPTH RANGE LEGEND - 5.0m		
FROM	TO	COLOUR
-9999	-15.0	
-15.0	-10.0	
-10.0	-5..0	
-5.0	0	
0	5.0	
5.0	10.0	
10.0	15.0	
15.0	20.0	
20.0	25.0	
25.0	9999	

0 25 50 75 100 125m
SCALE 1:2500 (A1)
SCALE BEFORE REDUCTION

NOTE:
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TSF3 PRELIMINARY DESIGN
CUT/FILL HEAT MAP
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE A1
DWG NO. QC1022-018-DWG-0600
REV. A

LAST MODIFIED: 24/5/2025 2:37 PM
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HOLD: DETAILS TO BE CONFIRMED DURING DETAILED DESIGN

LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

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SCALE BEFORE REDUCTION

SCALE 1:200 (A1)
SCALE BEFORE REDUCTION

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TSF3 PRELIMINARY DESIGN
DISTURBANCE BOUNDARY
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE	DWG NO.	REV.
A1	QC1022-018-DWG-0601	A

LAST MODIFIED: 25/2/2025 2:37 PM
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HOLD: DETAILS TO BE CONFIRMED DURING DETAILED DESIGN

LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

REFER TO DWG 0002 FOR GENERAL NOTES AND LEGEND.

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TSF3 PRELIMINARY DESIGN
BORROW AREAS
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE	DWG NO.	REV.
A1	QC1022-018-DWG-0602	A

HOLD: DETAILS TO BE CONFIRMED DURING DETAILED DESIGN

LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

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0 5 10 15 20 25m

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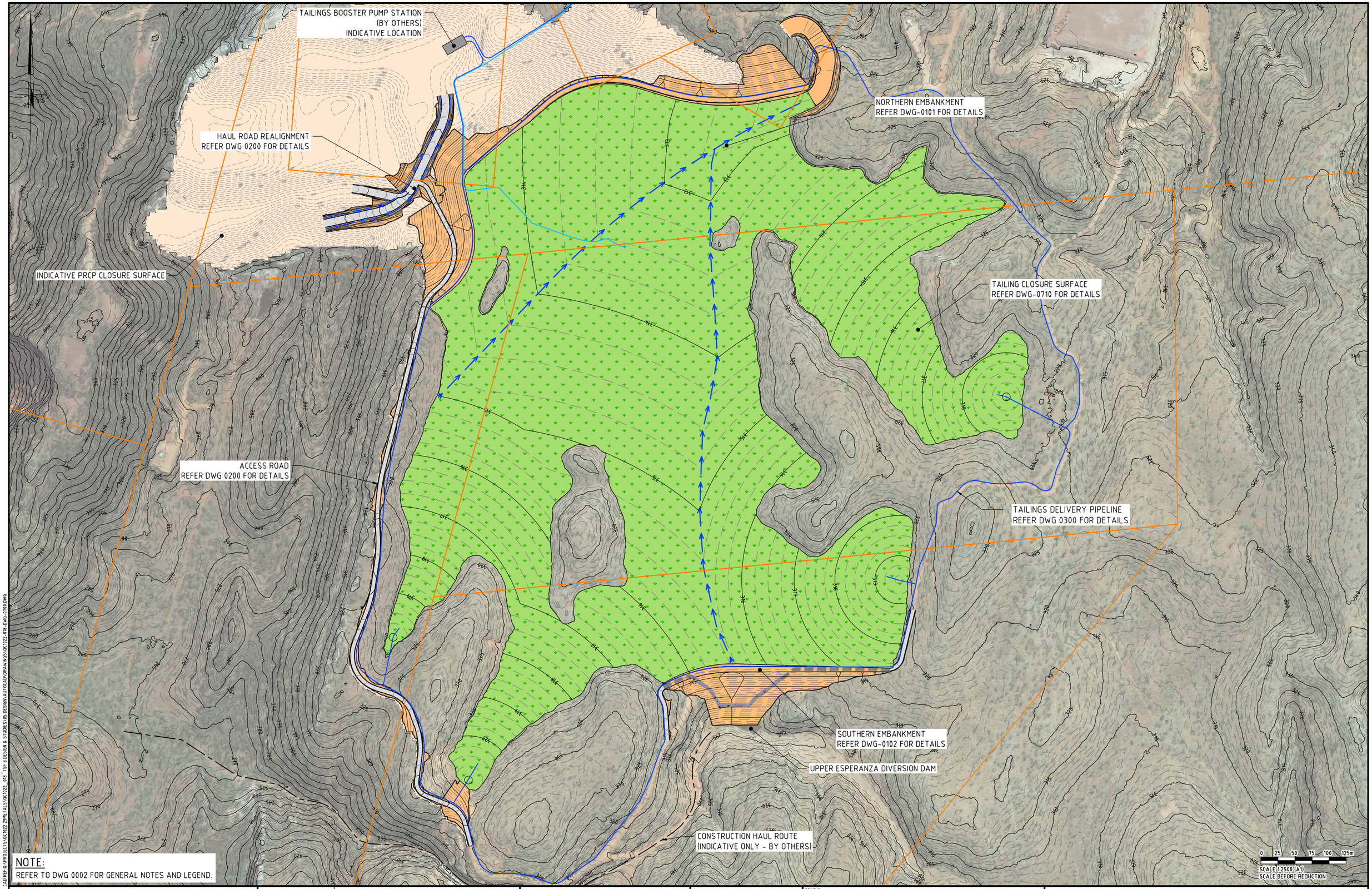
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TSF3 PRELIMINARY DESIGN
CONSTRUCTION HAUL ROUTES
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE	DWG NO.	REV.
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NOTE:
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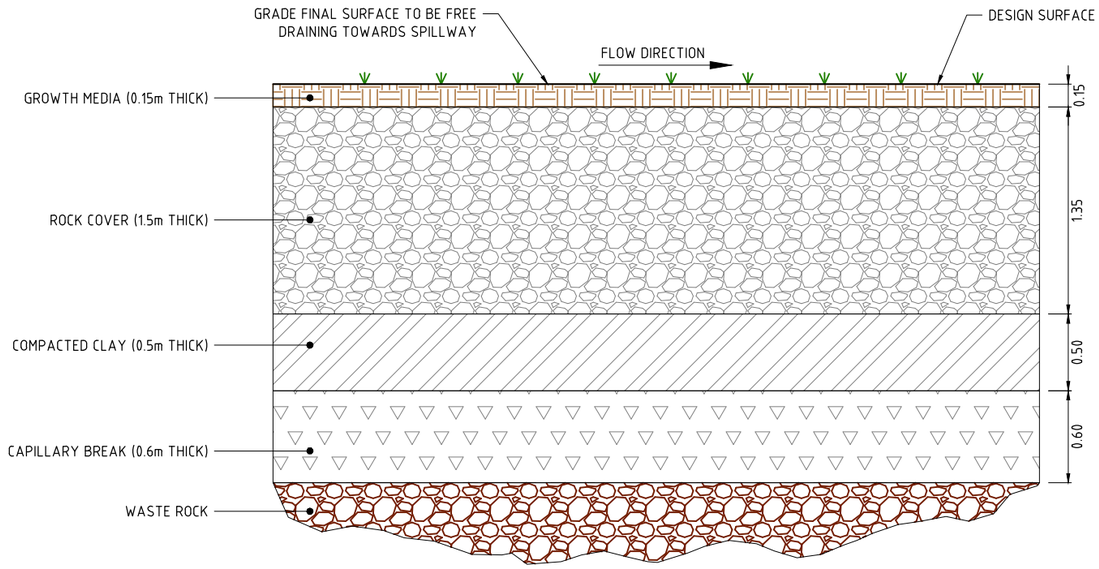
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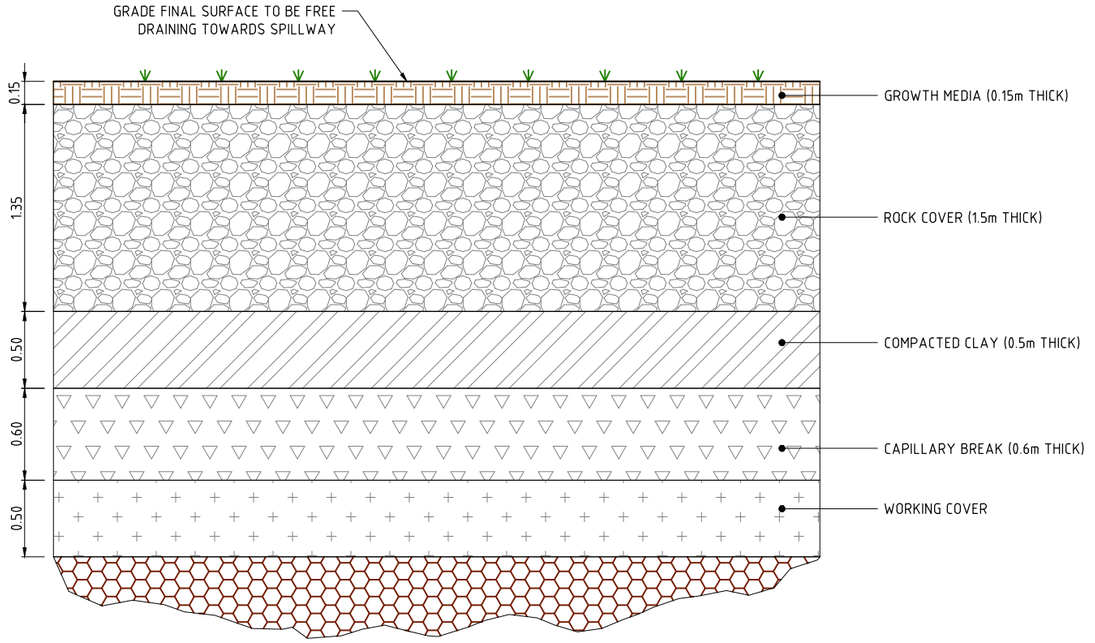
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TSF3 PRELIMINARY DESIGN
CLOSURE
GENERAL ARRANGEMENT PLAN

ORIGINAL SIZE	DWG NO.	REV.
A1	QC1022-018-DWG-0700	B



WASTE ROCK DUMP



TAILINGS STORAGE FACILITY

TYPICAL CLOSURE DETAIL

SCALE 1:20

LEGEND

EXISTING SURFACE

DESIGN SURFACE

NOTE:

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0 0.2 0.4 0.6 0.8 1.0m

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TSF3 PRELIMINARY DESIGN
CLOSURE
TYPICAL SECTIONS AND DETAILS

ORIGINAL SIZE	DWG NO.	REV.
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APPENDIX E: PRELIMINARY CONSEQUENCE CATEGORY ASSESSMENTS

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CAPRICORN COPPER PTY LTD

Capricorn Copper Mine

TSF3 Preliminary Consequence Category Assessment

BBNE00006_0022-REP-006-0

18 JULY 2025

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	18/07/2023	Client Issue	Meggan Brown	Brendan Wallace	Brendan Wallace	Travis Warren
Signatures:						

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1. INTRODUCTION

1.1 General

Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29Metals Limited, owns and operates the Capricorn Copper Mine (CCM) located in Gunpowder, North Queensland. CCM is operated under the approval of Environmental Authority EPML00911413 (EA) (dated 23 May 2025) managed by the Department of Environment, Tourism, Science, Science and Innovation (DETSI).

The site manages copper tailings as a waste product from mining activities through the use of tailings storage facilities (TSFs). CCPL propose to construct a new TSF, known as TSF3, at CCM between the Esperanza waste rock dump (WRD) and Upper Esperanza Diversion Dam (UEDD), which act as the northern and southern embankments respectively. CCM have requested the Department of Tourism, Science and Innovation (DETSI) preliminary consequence category assessment (CCA), which categorised TSF3 as a regulated structure of overall 'High' consequence category, be progressed to a certified assessment by Engeny as part of the revised preliminary design of TSF3.

This report details the DETSI CCA of TSF3, which has been undertaken in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures Version 5.03* (DETSI, 2024) herein referred to as 'the Manual'. RPEQ Certification of the CCA in accordance with the requirements of the EA and the Manual is provided in Appendix A.

This preliminary consequence category is required to be reviewed and revised if required based on the outcomes of more detailed assessments during the detailed design phase to quantify impacts.

A general arrangement showing the location of TSF3 relative to other features of CCM is shown in Figure 1.1.

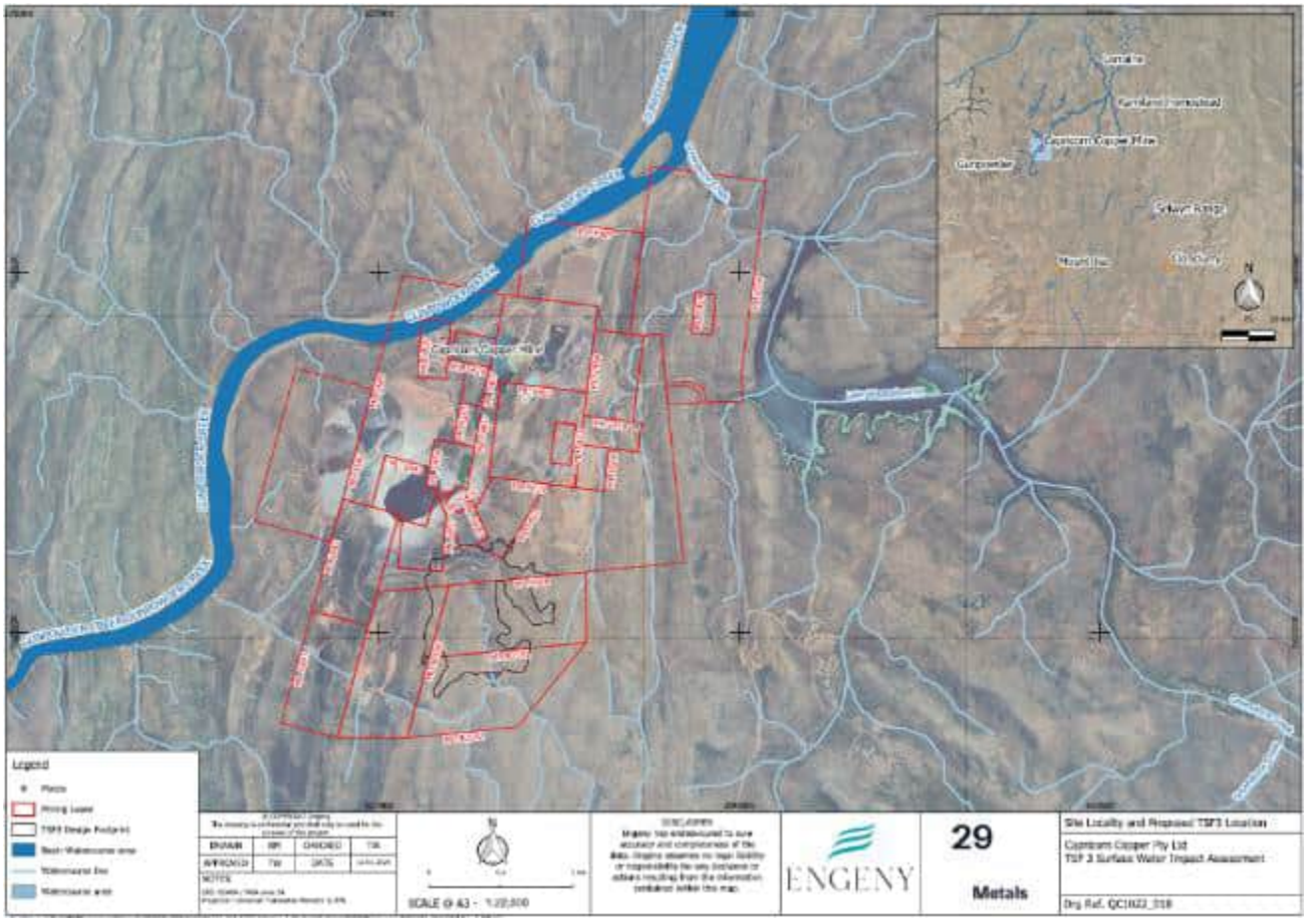


Figure 1.1: Site Locality and TSF3 Location

1.2 DES / Environmental Authority Requirements

The requirements for consequence category assessment of structures at the CCM are defined in Conditions G1-1 to G1-3 of the *EPML00911413* (dated 23 May 2025).

(G1-1) 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.

(G1-2) 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.

(G1-3) 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).

2. TSF3 DETAILS

2.1 Overview

Key features of TSF3 are provided in Table 2.1 below, with the general arrangement plan shown in Figure 2.1.

TABLE 2.1: TSF3 KEY FEATURES

Feature	Value
	General
Name of Structure	Tailings Storage Facility 3 (TSF3)
Location	Capricorn Copper Mine
Nearest Town	Mount Isa
Owner	Capricorn Copper Mine Pty Ltd (subsidiary of 29 Metals Limited)
Operator	Capricorn Copper Mine Pty Ltd
Purpose	Tailings storage
Configuration	Located in a topographic valley with two zoned earth and rockfill embankments: Esperanza WRD (Northern Embankment) and UEDD (Southern Embankment)
	Esperanza WRD Northern Embankment
Type	Zoned Rockfill / Earthfill
Liner	Geomembrane (Type to be confirmed during Detailed Design) Option 1 – HDPE on Non-woven Geotextile Option 2 – LLDPE on Non-woven Geotextile Options 3 – Bituminous Geomembrane Liner (BGM). Integrated into foundation / abutments with concrete plinth / grout curtain.
Maximum Embankment Height	65 m
Embankment Crest Level	RL 314.2 mAHD
Embankment Crest Length	780 m
Embankment Crest Width	8 m
Embankment Batter Slopes	1V:3H

Feature	Value
Embankment Intermediate Bench Width	10 m
UEDD Southern Embankment	
Type	Zoned Rockfill / Earthfill
Liner	Retain existing geosynthetic clay liner (GCL) and geomembrane liner / grout cut-off wall.
Maximum Embankment Height	32 m
Embankment Crest Level	RL 317.0 m AHD
Embankment Crest Length	334 m
Embankment Crest Width	8 m
Embankment Batter Slopes	1V:3H
Hydraulic / Hydrology / Storage	
Full Supply Level (Spillway Level)	RL 312.2 mAHD
Full Supply Volume (Spillway Level)	6.6 GL
Spillway Depth	2 m
Stored Contents	Fine metalliferous tailings, lime sludge (from proposed water treatment plant) plus decant pond (water) on top of tailings beach
Tailings Storage Capacity Total	6.3 Mm^3 (no new high-density thickener – settled density = 1.65 t/m^3)
Decant Pond Depth	Nominally 1 m maximum operating decant depth
Catchment area	79 ha
Spillway	Provisional bywash spillway (insitu rock cut with concrete sill)

Feature	Value
Spillway Design Capacity	1:100,000 AEP plus 1:10 AEP Wind Wave Run-up or Probable Maximum Flood (PMF)
Environmental Containment	ESS - Integrated Containment System, TSF3 ESS 1:10 AEP, 72 hr Design Rainfall Event (171.4 ML) DSA -Integrated Containment System - Combined 1:20 AEP (95th percentile or 5% AEP) wet season inventory increase in Epit, ETSF, MCS and TSF3.
Inflows and Outflows	
Inflows	• Direct rainfall and catchment runoff • Tailings slurry from the Processing Plant
Outflows	• Evaporation and seepage losses • Overflow to Esperanza Pit (EPit) via the spillway • Pumped flows from decant pond to EPit, Mill Creek Dam (MCD), or the proposed new Water Treatment Plant (WTP), with the decant water destination dependent of the water quality and site water storage inventories.

The general arrangement of TSF3 is shown in Figure 2.1. Key elements of the design relevant to the CCA include:

- Raising and reprofiling of the existing EWRD to form the northern extent (embankment) of the storage. An upstream geomembrane liner, concrete plinth and/or grout curtain have been incorporated into the design for seepage control.
- Centreline raising of the existing UEDD embankment to form the southern extent of the storage including retaining the existing geosynthetic clay liner, geomembrane liner and grout curtain centrally within the centreline raise to provide bi-directional seepage control. As part of the works, the adequacy of the existing geomembrane liner and grout curtain will be verified through inspection and testing and where required, repaired or replaced. The existing grout curtain will also be extended to facilitate the raise of the UEDD embankment, tying into low permeability Select Fill.
- The UEDD raise also provides flood ingress protection to TSF3 from external flooding to the same design hydraulic performance standard as the TSF3 emergency spillway. The existing flood ingress protection prior to raising of the UEDD is the 1:1,000 AEP design event.
- Following the construction of supporting tailings infrastructure, tailings will be deposited in a down valley discharge manner along the southern extents of TSF3 via a new tailings delivery ring pipeline to four discharge spigots. Tailings will beach in a northern direction (varying beach slopes) with the decant pond formed against the EWRD.
- Under normal operating conditions the decant pond will be maintained in a minimum condition (nominally 1m maximum normal operating depth), with decant water pumped to either EPit, MCD, Pond 3, or the proposed new Water Treatment Plant (WTP) with the decant water destination dependent of the water quality and site water storage inventories.
- An emergency overflow spillway is located near the eastern side of the of the northern embankment. The spillway alignment and design are provisional, however are intended to reduce the risks of embankment instability and erosion. The spillway is proposed to also form part of the closure design of TSF3 to convey surface flows from the TSF3 capped surface. During the operational phase, in the unlikely event spillway overflows should occur they will report to EPit. Based on water balance modelling undertaken, with the incorporation of TSF3, no overflows from the terminal dam of the CCM *integrated containment system* (Hoover Dam) to Gunpowder creek were seen. (Engeny, 2025b)
- The maximum tailings surface has been limited to allow containment of the nominal decant pond operating depth and the extreme storm storage (ESS) event based on site wide operational simulation water balance modelling undertaken as part of the preliminary design process. It is intended that the decant return pump and pipeline will be sized to enable a dewatering capacity of approximately 200 L/s to return elevated TSF3 water levels from the ESS event back to normal operating levels within 10 days.

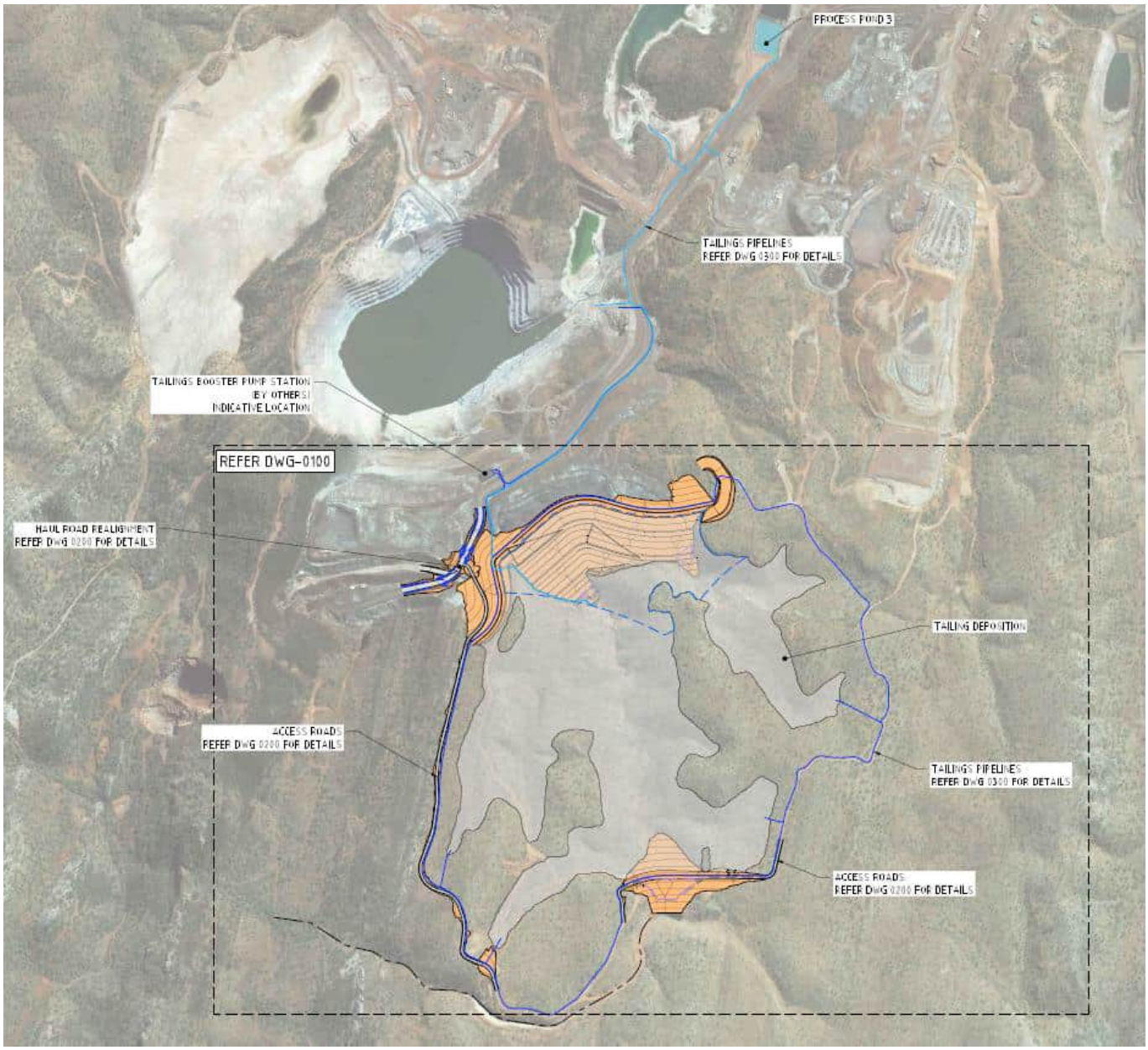


Figure 2.1: TSF3 Preliminary Design General Arrangement Plan (Extract from Drawing QC1022-018-DWG-0010)

2.2 Water Quality Data

TSF3 is a planned structure and as such, does not have water quality data. However, for the purpose of this assessment, historical (2014 to 2023) water quality monitoring data for the EPit, MCD and ETSF has been used as a substitute. This data is summarised below in Table 2.2 and for comparison purposes, the water quality monitoring data is presented alongside the following:

- Receiving Waters Contaminant Trigger Levels in the EA (Schedule C – Table 4 of EA).
- Stock watering (lower) limits from the ANZECC water quality guidelines (ANZECC, 2000).
- Background historical water quality data from the following upstream and downstream monitoring points (displayed in Figure 2.2)[1]:
  - Upstream monitoring points:
    - GPU1
    - GPU2
    - GPU3
    - Gunpowder Creek Reference Site
    - Gunpowder Creek EPO
    - SS1
    - SW44
  - Downstream monitoring points
    - GPD1
    - GPD2
    - GPD3
    - GPD5
    - SW45
    - WC04

The water quality monitoring data is also presented alongside the groundwater contaminant trigger levels in the EA (Schedule C – Table 6) in Table 2.3. For the purpose of this assessment, non-detect values for analytes are reported as zero (due to the data provided containing data presented as zero concentrations).

The water quality parameters and analytes of the MCD, EPit and ETSF generally exceed trigger limits, contaminant limits and stock watering limits. This indicates that the water stored on site is of poor quality and has potential to negatively impact waterways and the environment downstream of the mine in the event of release to the environment. Water stored within TSF3 is expected to be of similar quality (i.e. poor quality) with the potential to negatively impact waterways and downstream environments in the event of a release to the environment.

[1] Data displayed in Tables 2.2 and 2.3 for this CCA is extracted from the Surface Water Quality Impact Assessment and Groundwater Impact Assessment undertaken by Engeny (Engeny, 2023a & Engeny & Pendragon, 2023), as well as client supplied water quality data.



Figure 2.2: Monitoring Locations

Table 2.2: Water Quality (WQ) Monitoring Data vs Receiving Water Trigger Levels

Contaminant	Water Quality Monitoring Data 2014 - 2023														
	EPit	Compliance (×/✓)			ETSF	Compliance (×/✓)			MCD	Compliance (×/✓)			Surface Water Upstream Monitoring Points	Surface Water Downstream Monitoring Points	Trigger Level (TL) (µg/L) unless otherwise specified)	Contaminant Limit (CL) (µg /L unless otherwise specified)	Stock Water (SW) Trigger Level (ANZECC, 2000) (µg /L unless otherwise specified)
		TL	CL	SW		TL	CL	SW		TL	CL	SW					
pH (pH units)	2.78 - 8.18 Average - 4.42	×	×	×	2.5 - 8.85 Average - 4.67	×	×	×	3.05 - 8.3 Average - 4.08	×	×	×	5.1 – 10.0 Average – 7.57	4.54 – 9.69 Average – 7.64		6.0 - 8.5	6.5 – 9.0
EC (uS/fcm)	2840 - 8110 Average - 4622.78	×	-	×	2640 - 9340 Average - 4557.78	×	-	×	1620 - 7400 Average - 5463.33	×	-	×	56.00 – 2024.00 Average – 192.08	151 - 1390 Average – 691.19	435 uS/fcm	-	2000 uS/fcm
Sulphate (mg/l)	1780 - 7450 Average - 3961.18	×	×	-	1310 - 22000 Average - 6898.38	×	×	-	894 - 10900 Average - 5390.8	×	×	-	1 – 3156 Average – 19.46	0 – 5281 Average – 251.07	250 mg/L	1000 mg/l	-
Fluoride (mg/l)	0.1 - 6.4 Average - 1.29	-	✓	✓	0.1 - 13.5 Average - 2.48	-	×	×	0.1 - 17.2 Average - 2.22	-	×	×	-	-	-	2 mg/l	2 mg/l
Aluminum (µg/L)	10 - 252000 Average - 37662.3	×	×	×	30 - 1700000 Average - 226338.62	×	×	×	10200 - 150000 Average - 66525.42	×	×	×	-	-	55	5000	5000
Arsenic (µg/L)	1 - 2260 Average - 42.64	×	✓	✓	1 - 229000 Average - 13773.06	×	×	×	2 - 11 Average - 4.18	✓	✓	✓	-	-	13	500	500
Boron (µg/L)	50 - 140 Average - 84.8	✓	✓	✓	50 - 400 Average - 140.45	✓	✓	✓	50 - 210 Average - 93.18	✓	✓	✓	-	-	370	5,000	5,000
Cadmium (µg/L)	0.1 - 3.3 Average - 0.99	×	✓	✓	0.1 - 3.8 Average - 1.81	×	✓	✓	0.1 - 3.8 Average - 1.58	×	✓	✓	-	-	0.2	10	10
Chromium (µg/L)	1 - 129 Average - 21.77	×	✓	✓	1 - 4050 Average - 526.08	×	✓	✓	1 - 12 Average - 4.08	×	✓	✓	-	-	1	1,000	1,000
Cobalt (mg/l)	0.055 - 34.5 Average - 5.44	-	×	×	0.005 - 36.5 Average - 13.03	-	×	×	0.023 - 28.7 Average - 12.1	-	×	×	-	-	-	1 mg/L	1 mg/L
Copper (µg/L)	14 - 298000 Average - 45965.21	×	×	×	11 - 798000 Average - 146918.03	×	×	×	2 - 219000 Average - 89873.82	×	×	×	0.01– 0.114 Average – 0.01	0.002 – 20.9 Average – 0.14	1.4	1,000	40
Lead (µg/L)	1 - 8 Average - 2.5	✓	✓	✓	1 - 12 Average - 4.44	×	✓	✓	1 - 3 Average - 1.66	✓	✓	✓	-	-	3.4	10	10
Manganese (µg/L)	282 - 108000 Average - 17822.72	×	-	-	51 - 176000 Average - 56736.1	×	-	-	111 - 109000 Average - 43305.92	×	-	-	-	-	1900	-	Not sufficiently toxic
Nickel (µg/L)	24 - 7000 Average - 1340.57	×	×	×	2 - 14700 Average - 4183.73	×	×	×	5 - 5620 Average - 2699.34	×	×	×	-	-	11	1,000	1000
Uranium (mg/l)	0.001 - 0.13 Average - 0.02	-	✓	✓	0.001 - 0.177 Average - 0.07	-	✓	✓	0.008 - 0.103 Average - 0.04	-	✓	✓	-	-	-	0.2 mg/l	0.2 mg/l
Zinc (µg/L)	6 - 6200 Average - 1165.94	✓	✓	✓	6 - 7740 Average - 2580.24	×	✓	✓	15 - 6610 Average - 2687.71	×	✓	✓	-	-	8	20,000	20,000

✓ *– Complies*

× *– Exceeds*

TABLE 2.3: WATER QUALITY (WQ) MONITORING DATA VS GROUNDWATER CONTAMINANT TRIGGER LEVELS

Contaminant	Water Quality Monitoring Data 2014 - 2023														
	EPit	Compliance (×▮M▮)			ETSF	Compliance (×▮M▮)			MCD	Compliance (×▮M▮)			Groundwater Upstream Monitoring Points	Groundwater Downstream Monitoring Points	Groundwater Trigger Level (TL) (µg/L) unless otherwise specified)	Groundwater Contaminant (CL) Limit (µg /L unless otherwise specified)	Stock Water (SW) Trigger Level (ANZECC, 2000) (µg /L unless otherwise specified)
		TL	CL	SW		TL	CL	SW		TL	CL	SW					
pH (pH units)	2.78 - 8.18 Average - 4.42	×	×	×	2.5 - 8.85 Average - 4.67	×	×	×	3.05 - 8.3 Average - 4.08	×	×	×	5.1 – 10.0 Average – 7.57	4.54 – 9.69 Average – 7.64	6.0 - 8.5		6.5 – 9.0
EC (uS/fcm)	2840 - 8110 Average - 4622.78	×	-	×	2640 - 9340 Average - 4557.78	×	-	×	1620 - 7400 Average - 5463.33	×	-	×	56.00 – 2024.00 Average – 192.08	151 - 1390 Average – 691.19	435 uS/fcm	1000 uS/fcm	2000 uS/fcm
Sulphate (mg/l)	1780 - 7450 Average - 3961.18	×	×	-	1310 - 22000 Average - 6898.38	×	×	-	894 - 10900 Average - 5390.8	×	×	-	1 – 3156 Average – 19.46	0 – 5281 Average – 251.07	250 mg/L	1000 mg/l	-
Fluoride (mg/l)	0.1 - 6.4 Average - 1.29	-	✓	✓	0.1 - 13.5 Average - 2.48	-	×	×	0.1 - 17.2 Average - 2.22	-	×	×	-	-	-	2 mg/l	2 mg/l
Aluminum (µg/L)	10 - 252000 Average - 37662.3	×	×	×	30 - 1700000 Average - 226338.62	×	×	×	10200 - 150000 Average - 66525.42	×	×	×	-	-	55	5000	5000
Arsenic (µg/L)	1 - 2260 Average - 42.64	×	✓	✓	1 - 229000 Average - 13773.06	×	×	×	2 - 11 Average - 4.18	✓	✓	✓	-	-	13	500	500
Boron (µg/L)	50 - 140 Average - 84.8	✓	✓	✓	50 - 400 Average - 140.45	✓	✓	✓	50 - 210 Average - 93.18	✓	✓	✓	-	-	370	5,000	5,000
Cadmium (µg/L)	0.1 - 3.3 Average - 0.99	×	✓	✓	0.1 - 3.8 Average - 1.81	×	✓	✓	0.1 - 3.8 Average - 1.58	×	✓	✓	-	-	0.2	10	10
Chromium (µg/L)	1 - 129 Average - 21.77	×	✓	✓	1 - 4050 Average - 526.08	×	✓	✓	1 - 12 Average - 4.08	×	✓	✓	-	-	1	1,000	1,000
Cobalt (mg/l)	0.055 - 34.5 Average - 5.44	-	×	×	0.005 - 36.5 Average - 13.03	-	×	×	0.023 - 28.7 Average - 12.1	-	×	×	-	-	-	1 mg/L	1 mg/L
Copper (µg/L)	14 - 298000 Average - 45965.21	×	×	×	11 - 798000 Average - 146918.03	×	×	×	2 - 219000 Average - 89873.82	×	×	×	0.01– 0.114 Average – 0.01	0.002 – 20.9 Average – 0.14	1.4	1,000	40
Lead (µg/L)	1 - 8 Average - 2.5	✓	✓	✓	1 - 12 Average - 4.44	×	✓	✓	1 - 3 Average - 1.66	✓	✓	✓	-	-	3.4	10	10
Manganese (µg/L)	282 - 108000 Average - 17822.72	×	-	-	51 - 176000 Average - 56736.1	×	-	-	111 - 109000 Average - 43305.92	×	-	-	-	-	1900	-	Not sufficiently toxic
Nickel (µg/L)	24 - 7000 Average - 1340.57	×	×	×	2 - 14700 Average - 4183.73	×	×	×	5 - 5620 Average - 2699.34	×	×	×	-	-	11	1,000	1000
Uranium (mg/l)	0.001 - 0.13 Average - 0.02	-	✓	✓	0.001 - 0.177 Average - 0.07	-	✓	✓	0.008 - 0.103 Average - 0.04	-	✓	✓	-	-	-	0.2 mg/l	0.2 mg/l
Zinc (µg/L)	6 - 6200 Average - 1165.94	✓	✓	✓	6 - 7740 Average - 2580.24	×	✓	✓	15 - 6610 Average - 2687.71	×	✓	✓	-	-	8	20,000	20,000

✓ – *Complies*

× – *Exceeds*

3. DESCRIPTION OF RECEIVING ENVIRONMENT

3.1 Surface Waters

CCM is located in the Leichhardt River drainage sub-basin area in the Leichhardt Drainage Basin. The Leichhardt Drainage Basin has a total catchment area of 32,882 km^2.

The Leichhardt River rises in the Selwyn Ranges, 40 kilometres southeast of Mount Isa. It flows in a northerly direction, through the city of Mount Isa and Lake Moondarra, before passing through Julius Dam. It is joined by its major tributary, Gunpowder Creek, 15 kilometres downstream of Kamilaroi homestead. Another major tributary, Fiery Creek, joins the river 70 kilometres downstream of Lorraine. The Alexandra River enters the river from the east, just below Floraville, before the Leichhardt River finally passes through a vast coastal plain and enters the Gulf of Carpentaria 30 kilometres northeast of Burketown.

CCM is located directly east of Gunpowder Creek, which is an ephemeral system in the upstream reaches that receives licensed releases of mine-affected water that enters the creek system at the EA-nominated release point. At CCM, dam break (northern embankment) and spillway flows from TSF3 report to the EPit which flows into MCD. Any overflows from MCD report to Hoover Dam then to Gunpowder Creek and toward Leichardt River. A dam break of the southern embankment of TSF3 reports to Snakeskin Gully. If the Snakeskin Gully Diversion Dam (SSD) overtops, flows report to Gunpowder Creek and then toward Leichardt River.

Magazine Creek flows into Greenstone Creek, which flows into Gunpowder Creek downstream of the mining activities.

Gunpowder Creek flows into Leichhardt River, approximately 100 km north-east of CCM.

Receiving waterways downstream of CCM are shown in Figure 3.1.

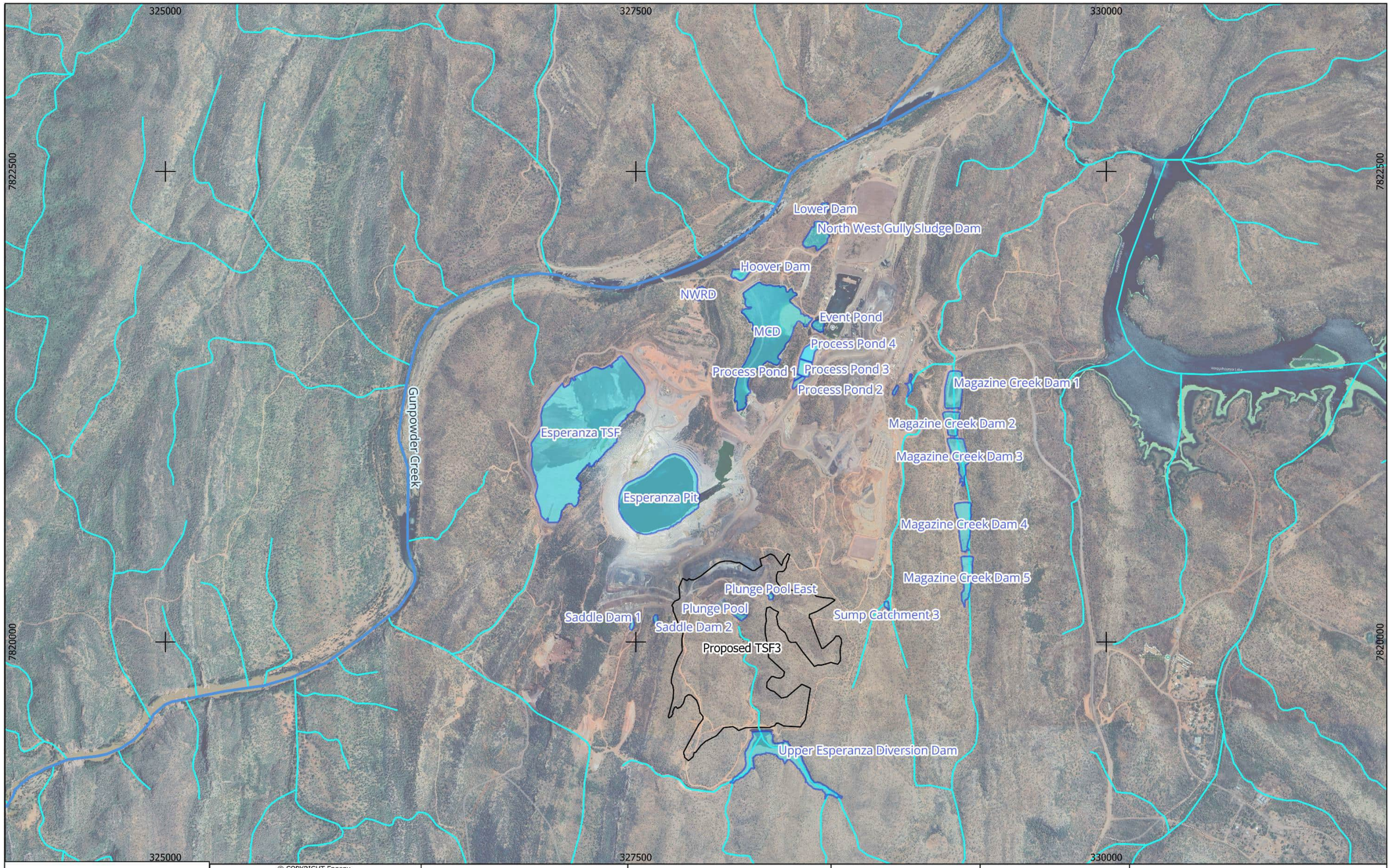


Figure 3.1: CCM Receiving Waterways

3.2 Groundwater

Based on published data (Queensland Government, 2025), it is understood there are multiple bores within a 5 km radius of CCM. CCM maintains approx. 35 monitoring bores on site.

Mapping indicates bores within a 5 – 10 km are not listed as extraction bores for drinking purposes. It is understood that Lake Waggaboonya (the source of potable water for CCM) is not currently impacted by CCM operations.

Water bores located within 10 km of CCM is displayed in Figure 3.2 below.

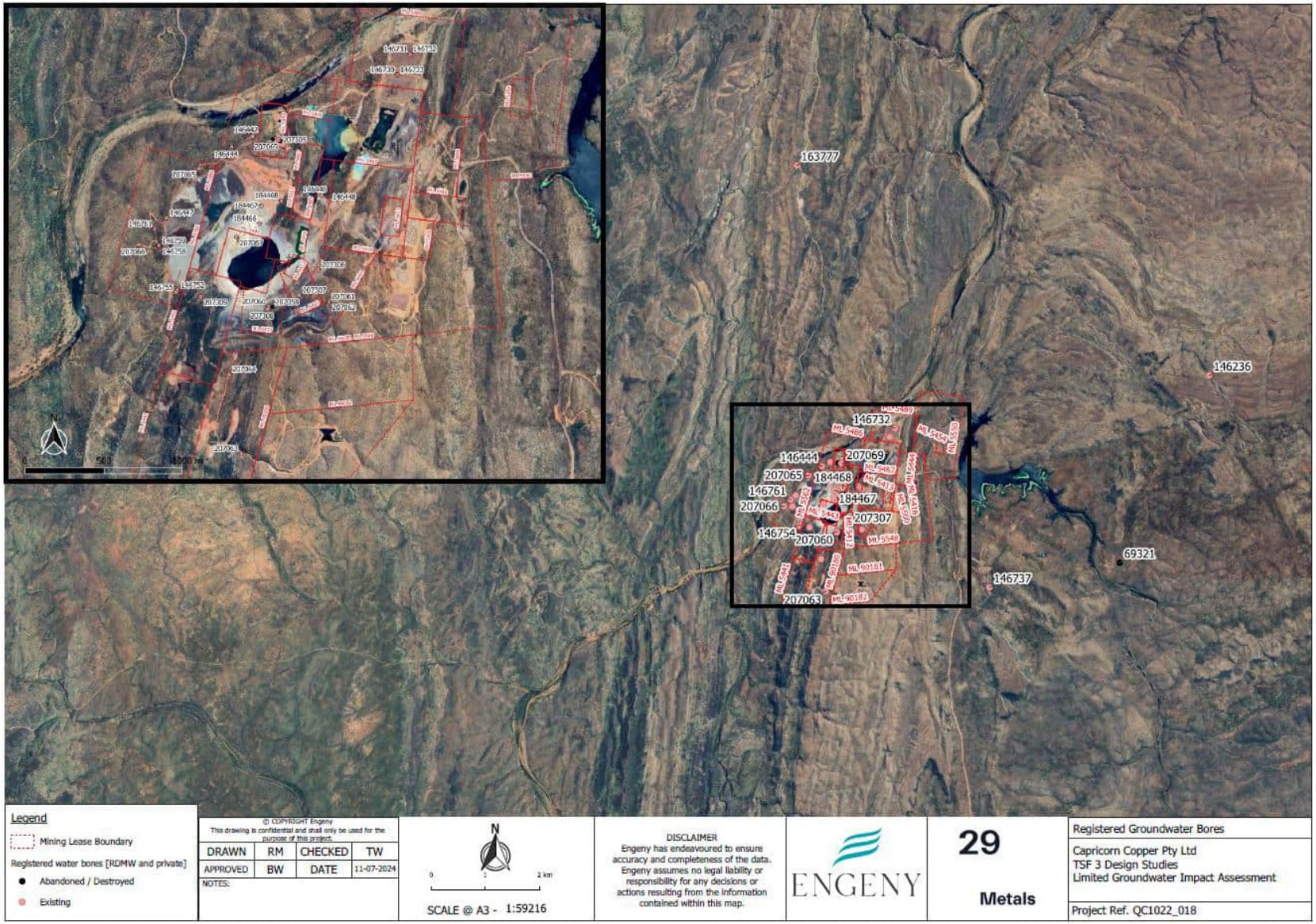


Figure 3.2: Ground Water Bores Located within a 10km radius to CCM (Queensland Government, 2025)

The groundwater monitoring network at CCM is presented in Figure 3.3. Five (5) groundwater monitoring bores were recently installed in the area surrounding the proposed TSF3 footprint (GWMB78, GWMB79, GWMB80, GWMB81 and GWMB82).

Figure 3.3 also presents inferred groundwater contours calculated from the average standing water levels obtained across the site between 23 February 2023 and 1 May 2024, inclusive of the newly installed bores. The direction of flow of groundwater is generally to the north. Groundwater levels mostly mimic a subdued version of the surface elevation. Elevated groundwater is noted surrounding GWMB21 and GWMB22 and at GWMB75.

Groundwater contours generated in the absence of groundwater observation data from the TSF3 footprint and using surface topography suggests that groundwater may flow to the west from TSF3. This is currently being tested with the development of the transient groundwater model and may require additional groundwater monitoring locations to be installed and monitored to confirm.

The groundwater impact assessment (GWIA) report developed for the TSF3 preliminary design discusses the hydrogeological behaviour at the site in more detail (Engeny, 2025a).

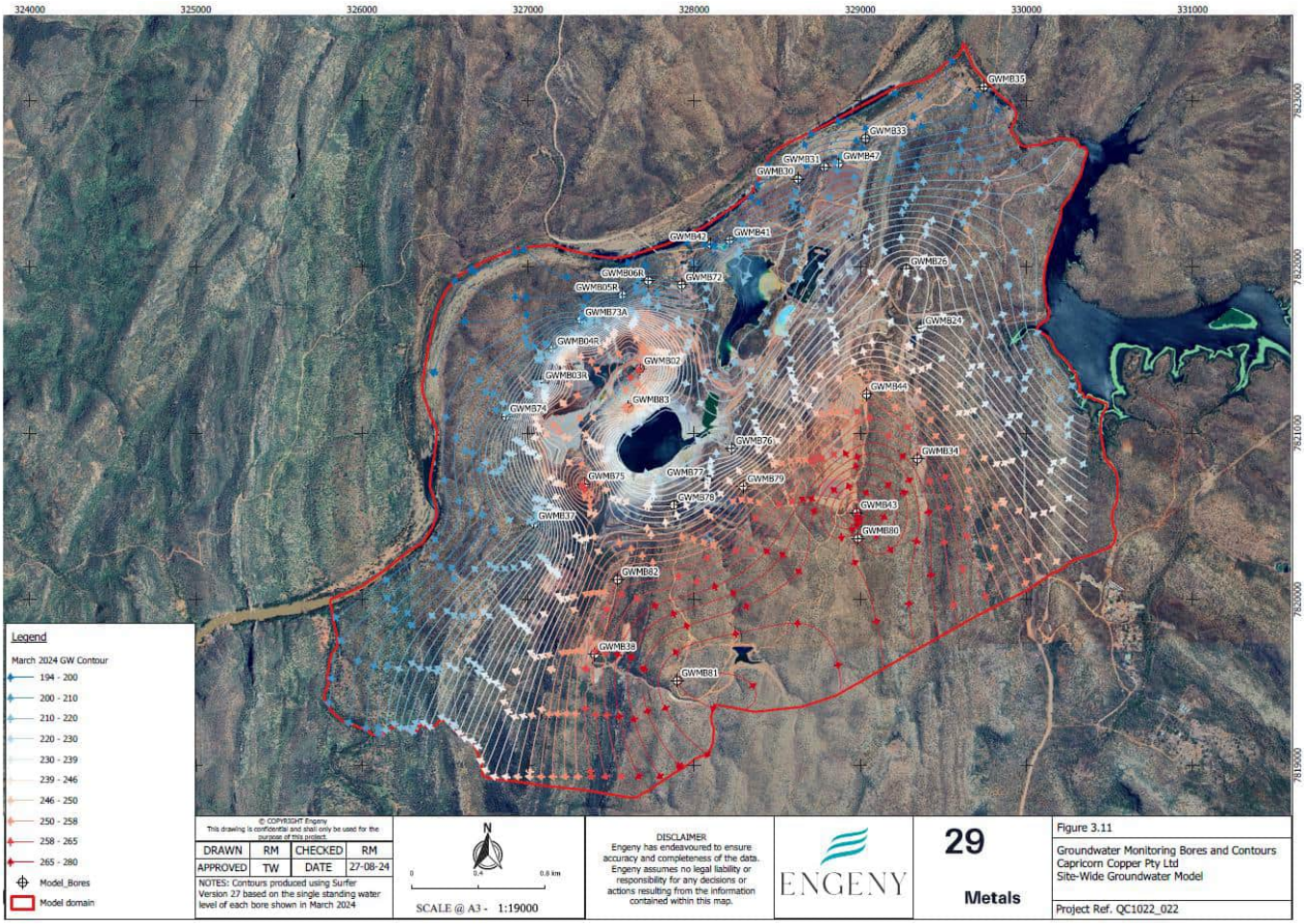


Figure 3.3: CCM Groundwater Monitoring Network and Groundwater Contours

A search of the Groundwater Dependent Ecosystems Atlas (GDE Atlas) identified the presence of potential Aquatic and Terrestrial GDEs in the vicinity of CCM, with an extract presented in Figure 3.4. Classification of each GDE in accordance with the GDE Atlas are presented below:

- Aquatic - ecosystems that rely on the surface expression of groundwater e.g. springs, wetlands and rivers.
- Terrestrial - ecosystems that rely on the subsurface presence of groundwater e.g. vegetation.
- Subterranean ecosystems - caves and aquifer ecosystems.

A portion of the total site is mapped as a moderate potential terrestrial groundwater dependent ecosystem, the bed of Gunpowder Creek is mapped as high potential terrestrial GDE, and Gunpowder Creek is mapped as low-moderate potential aquatic GDE.

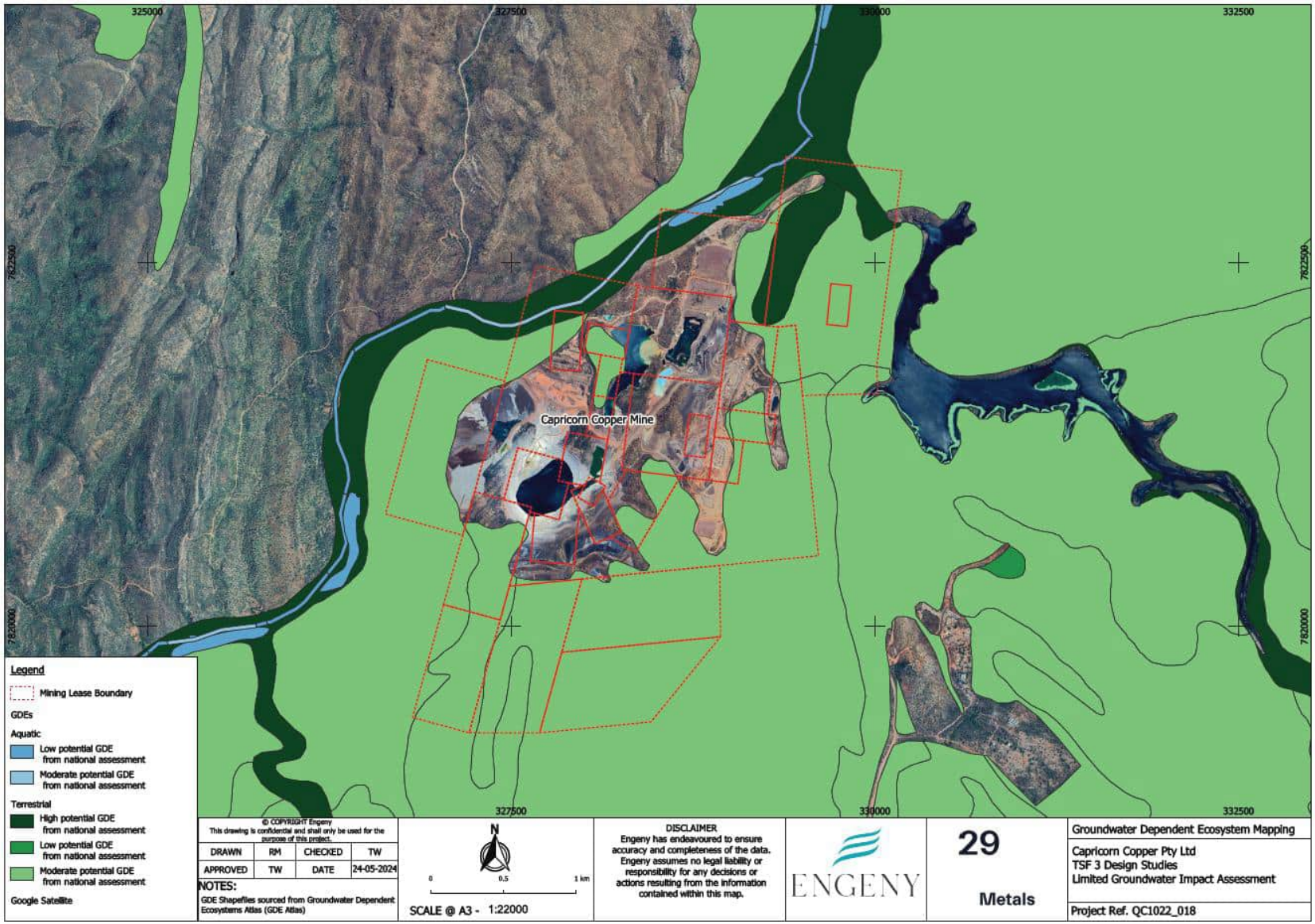


Figure 3.4: Groundwater Dependent Ecosystems Mapping for CCM

3.3 Environmental Values

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP) does not list environmental values (EV) or water quality objectives (WQO) for the Leichardt River Basin, however, the *Capricorn Copper Mine 2024 Post-wet REMP Report* (Hydrobiology, 2024) reports on relevant environmental values for receiving waters in the vicinity of CCM (adopted from the REMP Design Report (NRA Environmental Consultants, 2020)) and are displayed Table 3.1.

TABLE 3.1: NOMINATED ENVIROMENTAL VALUES FOR GUNPOWDER CREEK AND GREENSTONE CREEK AS DEFINED IN PREVIOUS REMP (TABLE ADAPTED FROM HYDROBIOLOGY, 2024)

Label	Environmental Value	Description	Gunpowder Creek (adjacent to CCM) [1]	Gunpowder Creek (downstream of CCM) [2]	Greenstone Creek (downstream of confluence with Magazine Creek)
	Aquatic ecosystem	The intrinsic value of aquatic ecosystems, habitat and wildlife in waterways, waterholes and riparian areas. For example, biodiversity, ecological interactions, plants, animals, key species and their habitat, food and drinking water.	Highly disturbed [3]	Moderately disturbed	Highly disturbed [3]
	Stock watering	Suitability of water supply for production of healthy livestock.	✓ [3]	✓	✓ [3]
	Secondary recreation	Health of humans during recreation which involves indirect contact and a low probability of water being swallowed. For example, wading, boating, rowing and fishing.	-	✓	-
	Visual appreciation	Amenity of waterways for recreation which does not involve contact with water. For example, walking and picnicking adjacent to a waterway.	✓ [3]	-	✓ [3]
	Industrial	Suitability of water supply for industrial use. For example, food, beverage, paper, petroleum and power industries, mining and minerals refining/processing. Industries usually treat water supplies to meet their needs.	Mining [3]	Mining	Mining [3]
	Cultural and spiritual values [4]	Cultural, spiritual and ceremonial values of water means its aesthetic, historical, scientific, social or other significance, to the past, present or future generations.	✓ [3]	✓	✓ [3]

Notes:

[1] Adjacent sites include GPA2, GPA4, GPA5 and GPA6. Although GPA2 is upstream of the causeway and the Mill Creek Dam release point, this site is likely to have been impacted by mining activities. This is likely to be due to backflow (Wood (1996) notes backflow occurs about 40 m upstream of the causeway – GPA2 is approximately 120 m upstream of the causeway) and/or pooling of mine-affected waters upstream of the causeway. For the purpose of EVs, site GPA2 is considered to be adjacent to the mine.

[2] The listed environmental values are subject to research and consultation with the Administering Authority and, as required, other stakeholders. Indications suggest the end of the mixing zone is nearer to 1 km downstream of the confluence of Greenstone Creek with Gunpowder Creek (NRA 2016).

[3] ANZG (2018) defines the mixing zone as an explicit area around effluent discharges where the management goals of the ambient waters do not need to be achieved and hence designated EVs may not be applied. The mixing zone for Greenstone Creek is considered to be from the confluence with Magazine Creek

downstream to the confluence with Gunpowder Creek. The mixing zone for Gunpowder Creek is considered to extend from around the causeway to a point downstream of the confluence with Greenstone Creek. Impacts within this zone have occurred since the early 1970s, with seepage from the Old (Mammoth) TSF and contaminated flows into Gunpowder Creek via Mill Creek. It is not considered appropriate to assign aquatic ecosystem EVs in the context of regulatory compliance (although it is appropriate to derive relevant guidelines to serve as trigger values) to the Gunpowder Creek and Greenstone Creek mixing zones.

Environmental values are site-specific and dependent on local factors, including land use and the pre-existing condition of the catchment relative to its position on the pristine-to-highly degraded continuum.

3.4 Receiving Environment Monitoring Program (REMP)

Capricorn Copper Mine 2024 Post-Wet REMP Report, prepared by Hydrobiology for Capricorn Copper Pty Ltd, dated September 2024 (Hydrobiology, 2024) considers groundwater quality in terms of interactions between surface water and groundwater, and influences of surface water quality on the receiving environment at CCM. The REMP report describes the annual results (July 2023 to June 2024) of the Receiving Environment Monitoring Program (REMP) and addresses conditions C4-1 to C4-3 of the EA for CCM.

The REMP report assesses stream flow, routine and release monitoring data for data collected during in the annual survey (undertaken in May). Data collected includes but is not limited to aquatic habitat, stream flow, water quality and biological indicators (macroinvertebrates). Survey sampling occurred at a series of test (located upstream, adjacent and downstream) and control (outside any influence from CCM) sites along Gunpowder, Magazine and Greenstone Creek.

The extracts below summarise the conclusions of the 2024 REMP report (Hydrobiology, 2024):

Overall, the trends do not indicate any notable impact from CCM on the habitat, stream flow or macroinvertebrate communities of the adjacent and downstream areas. Elevated metal/metalloid concentrations were noted at test sites within both the water and sediment which exceeded relevant guideline values – typically dissolved cobalt, copper, nickel, manganese and zinc. Importantly, it is evident that the release water is not associated with the noted elevations in metals and metalloids in the receiving environment, while recorded dissolved copper concentrations are largely present in non-bioavailable forms and below relevant aquatic DGVs. Therefore, recorded dissolved copper concentrations represent a low risk to aquatic ecosystem values of Gunpowder Creek.

There was no significant difference in macroinvertebrate community assemblage between test and control sites. Correlation analyses (BioENV) indicated that none of the assessed water and sediment analytes as well as the observed substrates explain the recorded macroinvertebrate community (i.e. p>0.05 and as such no significant result). Such a finding helps explain why the observed water and sediment analytes that were above relevant guidelines did not significantly reduce biodiversity at the test sites. In fact, the test sites were either similar or had improved biodiversity when compared to the control sites. This confirms that despite the elevation of various water and sediment analytes they do not impact the observed macroinvertebrate community assemblage.

The REMP (Hydrobiology, 2024) therefore considers that current site operations are unlikely to be significantly impacting the environmental values of the receiving environment, with reported exceedances consistent with previous exceedances, indicating no new or emerging trends in impacts.

3.5 Land Use and Habitable Dwellings

There are two habitable dwellings approx. 22km downstream of CCM and 8 – 10 km westward of Gunpowder Creek (no evidence of extraction) (Queensland Government, 2025). The closest known potential receptors within the Gunpowder Creek flow path are located on the Leichhardt River approximately 150 km downstream of the site, being the Lorraine Airport (and associated residential land uses) and the nearby irrigated agricultural development (and associated residential land uses). There are no visible bridges, infrastructure or observed Population at Risk (PAR) in the Gunpowder Creek flow path for over 25 km downstream (considered conservatively the maximum extent of any credible breach scenario for loss of life, refer Table 4.5), excluding Gunpowder Road which is not trafficable during wet weather and for which CCPL can control access.

What appears to be lightly trafficked roads were observed in the area, however these are considered to have a transient PAR, with likely infrequent use.

Grazing is the dominant land use within the area between the mine and Leichardt River. Land use and habitable dwellings located downstream of CCM are displayed in Figure 3.5.

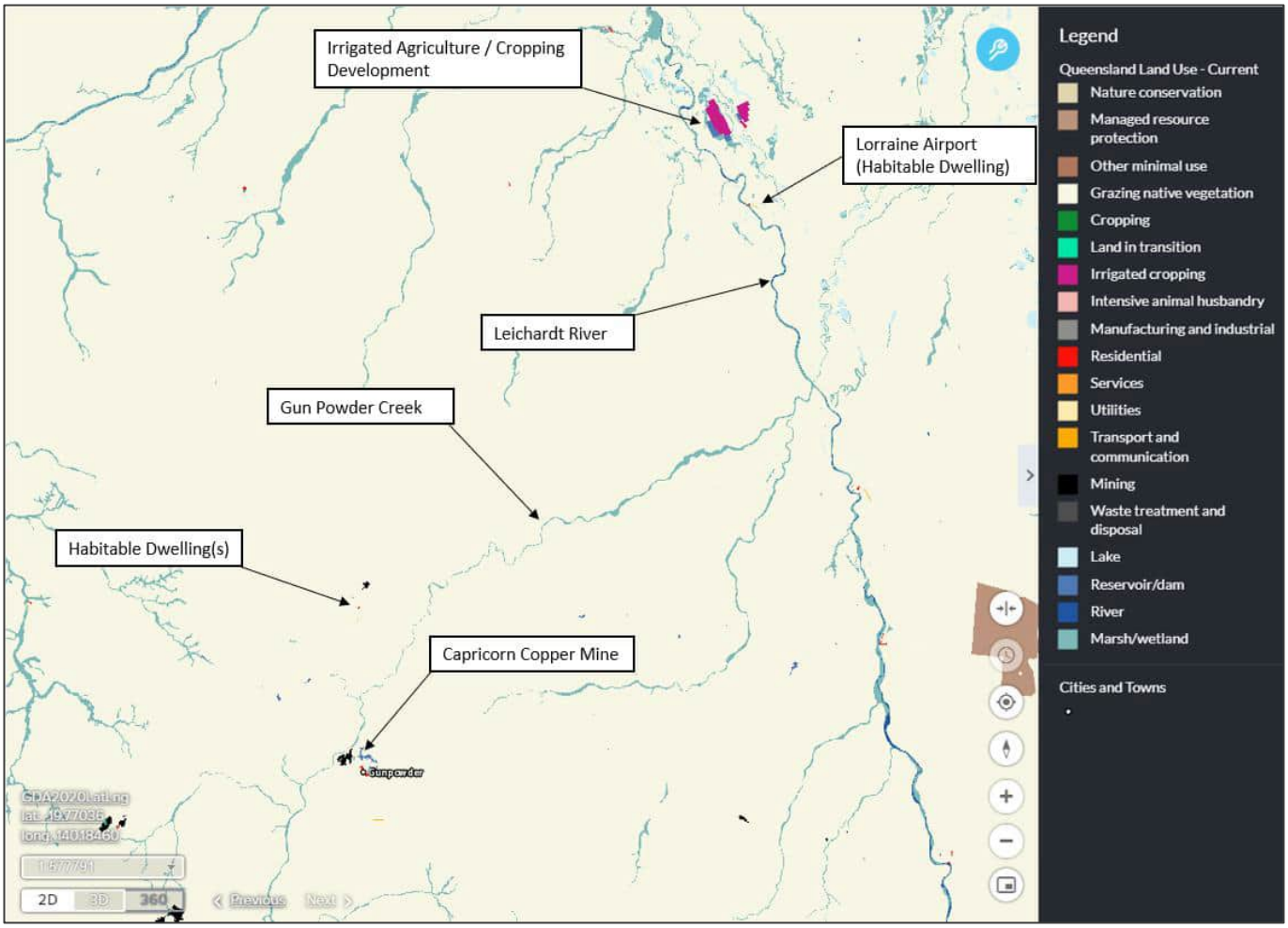


Figure 3.5: Downstream Land Use and Habitable Dwellings (Queensland Government, 2025)

3.6 Matters of State Environmental Significance

Matters of State Environmental Significance (MSES) are a component of the biodiversity state interest that is defined under the State Planning Policy (SPP). MSES include certain environmental values that are protected under Queensland legislation.

The matters given protection under Queensland environment laws and included as criteria for MSES are:

- Protected areas (all classes except coordinated conservation areas) – *Nature Conservation Act 1992.*
- Marine Parks (Marine National Park, Marine Conservation Park, Scientific Research, Preservation and Buffer zones) – *Marine Parks Act 2004.*
- Fish Habitat Areas (A and B) and Dugong Protection Areas – *Fisheries Act 1994.*
- High Conservation Value wetlands – *Environmental Protection Act 1994.*
- Wild River high preservation areas – *Wild Rivers Act 2005.*
- Threatened species (listed as 'endangered' or 'vulnerable') – *Nature Conservation Act 1992.*
- Threatened species essential habitat ('endangered' or 'vulnerable') – *Nature Conservation Act 1992* and *Vegetation Management Act 1999.*
- Regulated vegetation – Category A, B or C areas containing regional ecosystems (classified as 'endangered' or 'of concern'), wetlands and watercourses. Vegetation in Category R areas – *Vegetation Management Act 1999.*
- Legally secured offset areas – protected by a registered covenant, easement, agreement, or a development approval condition.

A search of Queensland Globe (Queensland Government, 2025) MSES layers identified the following environmentally significant areas located within, and downstream of, the boundary of CCM mining leases and along the overflow path:

- MSES Wildlife Habitat (Endangered or vulnerable wildlife) approximately 1 km east of the mining lease boundary and 2 km east of the proposed TSF3 footprint.
- Regulated Vegetation (Essential Habitat) approximately 2.5 km west-southwest and 6.2 km north-northeast of the proposed TSF3 footprint of the mining lease boundary.
- MSES Regulated vegetation (defined watercourse) within and adjacent to the approved mining leases, including an area within the proposed TSF3.
- Riparian Corridor and buffer along Gunpowder Creek adjacent to CCM.

It is noted that the mapped regulated vegetation within the footprint of the proposed TSF3 is currently not receiving surface water from upstream flows from the south as a result of the existing Upper Esperanza Diversion Dam (UEDD).

MSES located in an around CCM are shown in Figure 3.6 below, with Figure 3.7 presenting a more focussed view of the site.

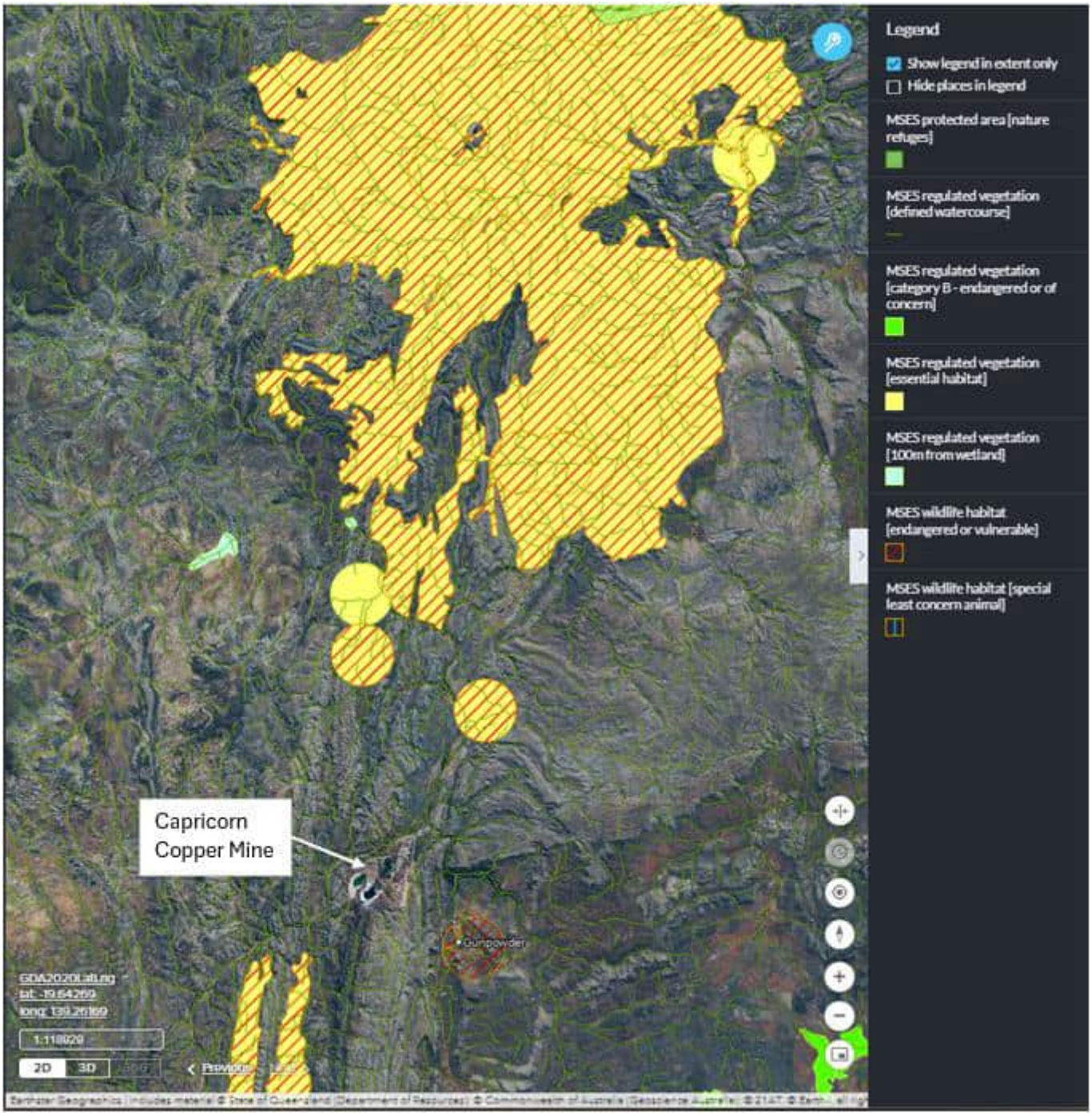


Figure 3.6: Matters of State and Environmental Significance (Queensland Government, 2025)

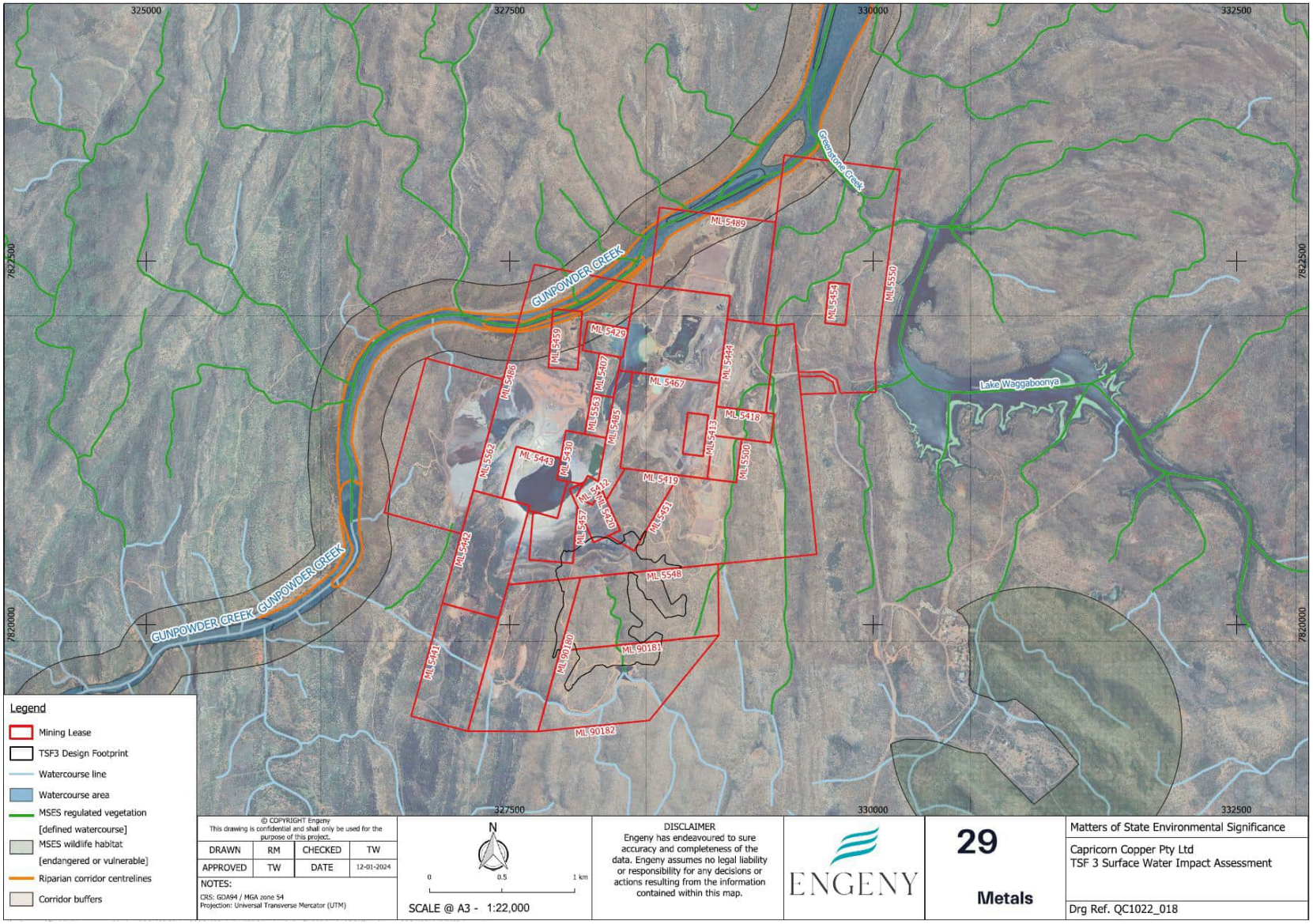


Figure 3.7: Matters of State and Environmental Significance Relative to the Mining Leases

3.7 Matters of National Environmental Significance

For the purposes of the SPP biodiversity state interest, Matters of National Environmental Significance (MNES) are those natural matters given statutory protection under Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* (DEHP, 2013a). Use of the Australian Government Department of the Environment Protected Matters Search Tool (http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf) on 14th July 2025 indicates the following MNES are located within a 25 km radius of CCM (refer to Figure 3.8):

- World Heritage Areas properties listed for natural values: None.
- National Heritage Areas places listed for natural values: None.
- Wetlands of international importance (listed under the Ramsar convention): None.
- Listed threatened ecological communities: None.
- Great Barrier Reef Marine Park: None.
- Commonwealth marine areas: None.
- Migratory species (protected under international agreements): 12 Listed Migratory Species, including the critically endangered Curlew Sandpiper (Calidris ferruginea) and vulnerable Freshwater Sawfish (Pristis pristis).
- Listed threatened species: 15 Listed Threatened Species, including the critically endangered Curlew Sandpiper (Calidris ferruginea).
- EPBC Act Referrals: 2.
- 18 Listed Marine Species under 'Other Matters Protected by the EPBC Act'.

Fifteen (15) threatened species have been identified within the site area, of these, four (4) are known to be present, four (4) are likely to be present and the remaining seven (7) may be present.

Twelve (12) migratory species have been identified within the site area, of these, two (3) are likely to be present, with nine (9) listed as may be present.

The EPBC Act referral located within the site (EPBC 2010/5581) for the CopperString Project was made in 2010 for the proposed action of constructing an alternating current transmission line and associated infrastructure. The EPBC referral lapsed on 18 March 2015.

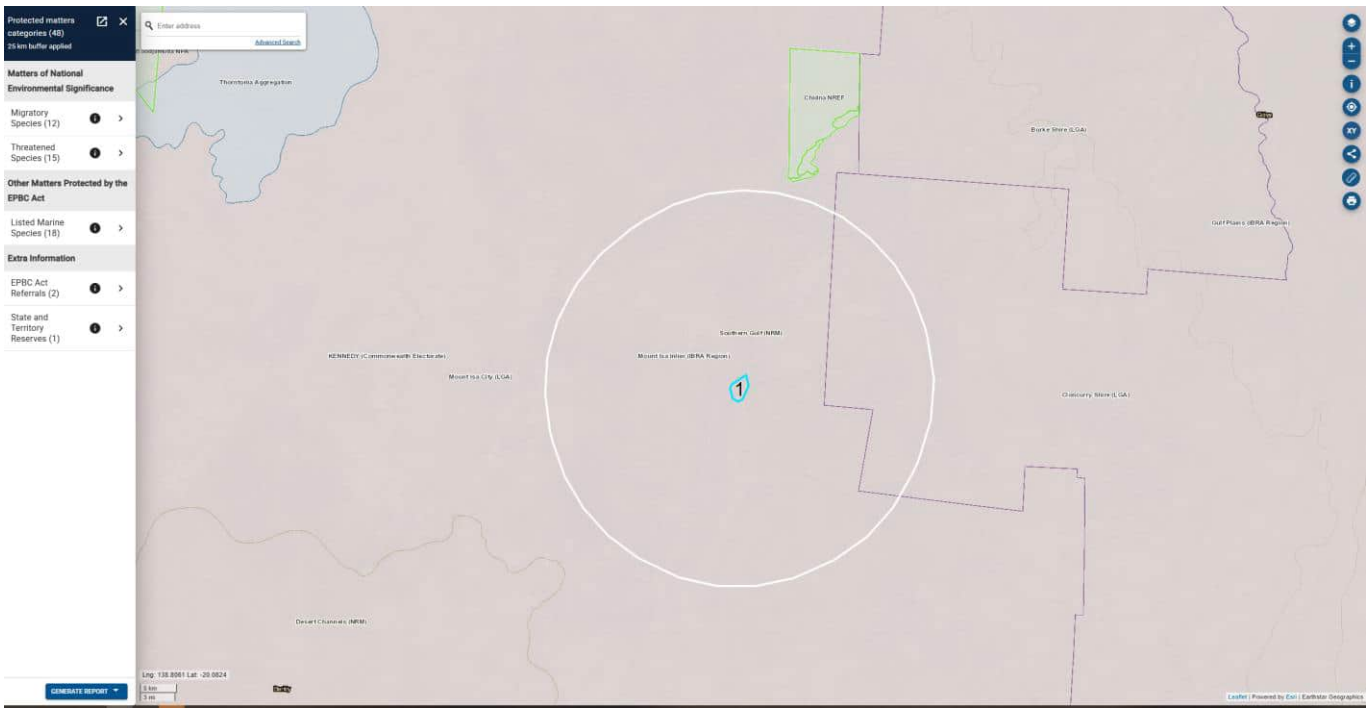


Figure 3.8: Protected Matter Search Area (Source: https://pmst.awe.gov.au/ Accessed 14 July 2025)

4. DETSI CONSEQUENCE CATEGORY ASSESSMENT

4.1 Overview

A consequence category assessment was undertaken for TSF3 in accordance with Version 5.04 of the *Manual.* The Manual sets out requirements for consequence category assessment and certification of the design of regulatory structures, constructed as part of environmentally relevant activities (ERAs) under the *Environmental Protection Act 1994* (Qld). The term regulated structures includes land-based containment structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity. Structures may be assessed using this Manual as being in one of three consequence categories: low, significant, or high. Where categories as a significant or high consequence, the structure is referred to as a regulated structure.

4.2 Methodology

The Manual for Assessing Consequence Categories and Hydraulic Performance of Structures requires the assessment of the consequences of the following failure event scenarios:

- 'Failure to contain – seepage' – spills or releases to ground and/or groundwater via seepage from the floor and/or sides of the structure. New structures, such as the proposed TSF3, are required to be assessed for this failure scenario.
- 'Failure to contain – overtopping' – spills or releases from the structure that result from loss of containment due to overtopping of the structure.
- 'Dam break' – collapse of the structure due to any possible cause.

For each failure event scenario, the consequences need to be assessed for the following categories of harm:

- Harm to humans.
- General environmental harm.
- General economic loss or property damage.

The consequence category for each type of harm is assigned based on the severity of harm as defined in Table 4.1.

TABLE 4.1: CONSEQUENCE CATEGORY ASSESSMENT CRITERIA[1] (TABLE 1 OF THE MANUAL)

Environmental Harm	Consequence Category		
	High	Significant	Low
Harm to Humans	Location such that people are routinely present in the failure path and if present loss of life to greater than 10 people is expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario.	Location such that people are routinely present in the failure path and if present loss of life to 1 person or greater but less than 10 people is expected[1]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario.	Location such that people are not routinely present in the failure path and loss of life is not expected[1]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario.
	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of 20 or more people being affected[4].	Location such that contamination of waters (surface and/or groundwater[2]) used for human consumption could result in the health of 10 or more people but less than 20 people being affected[3].	Location such that contamination of waters (surface and/or groundwater[2]) used for human consumption could result in the health of less than 10 people being affected[3].
General Environmental Harm	Location such that: a) Contaminants may be released to areas of MNES, MSES or HEV waters that are not already authorised to be disturbed to at least the same extent under other conditions of this authority subject to any applicable offset commitment (Significant Values); and b) Adverse effects[5] on Significant Values are likely; and c) The adverse effects[4] are likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $50,000,000; or ii) Remediation of damage is likely to take 3 years or more; or iii) permanent alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 5 km^2.	Location such that contaminants may be released so that adverse effects[4] (that are not already authorised to be disturbed to at least the same extent under other conditions of the authority subject to any applicable offset commitment) either: a) Would be likely to be caused to Significant Values but those adverse effects[4] would not be likely to meet the thresholds for the High consequence category and instead would be likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $10,000,000 but less than $50,000,000; or ii) Remediation of damage is likely to take more than 6 months but less than 3 years; or iii) Significant alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 1 km^2 but less than 5 km^2. or b) Would be likely to be caused to environmental values classed as slightly or moderately disturbed waters[6], wetland of general ecological significance[7], riverine areas, springs or lakes and associated flora and fauna (Moderate Values), and the adverse effects[4] are likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $20,000,000; or ii) Remediation of damage is likely to take more than 1 year; or iii) Significant alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 2 km^2.	Location such that either: a) Contaminants are unlikely to be released to areas of Significant Values or Moderate Values; or b) Contaminants are likely to be released to those areas but would be unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects[4].
General Economic Loss or Property Damage	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require $10 million or greater in rehabilitation, compensation, repair or rectification costs[8].	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require $1 million and greater but less than $10 million in rehabilitation, compensation, repair or rectification costs[7].	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair or rectification costs[7].

1.To be used for all failure event scenarios

2.'People routinely present in the failure path' could be considered to be people who occupy buildings or other places of occupation that lie within the failure impact zone. For the purposes of this Manual, this should refer to people other than site personnel engaged by the resource operation and located on the tenements and tenure associated with the resource operation; for other ERAs, it would be the 'premises referred to in the authority'. It should be noted that while this is appropriate for the assessment of consequence categories in accordance with this Manual, adherence to the requirements of this Manual does not limit, amend or change in any way, any other requirements to be complied with under relevant health and safety acts or legislation that requires the safety of site personnel to be considered.

3. When considering potential impacts on groundwater, it is not envisaged that a full hydrogeological assessment will be required in all cases. Any consideration of potential impacts on groundwater systems should consider the water quality of the potential receiving aquifer as well as the quality of fluid stored in the regulated dam. Existing groundwater drawdown in areas surrounding resource operations (e.g., drawdown as a result of mine pit or underground mine dewatering) can also be considered when assessing the consequence of dam seepage on groundwater systems.

4. 'An adverse effect on human health means a physiological effect on human health and does not include an impact on the quality of downstream water that merely negatively affects taste, and which is unlikely to cause persons to become physically ill.

5. Adverse effects includes chronic and acute effects where an acute effect is on living organism/s which results in severe symptoms that develop rapidly, and a chronic effect is an adverse effect on a living organism/s which develops slowly. In some instances, it may be necessary to carry out or reference existing ecological/toxicological studies to assess the impacts of contaminants on living organisms.

6. See Environmental Protection (Water and Wetland Biodiversity) Policy 2019 for definitions

7. Wetland of general ecological significance' means a wetland shown on a map of referable wetland as a 'general ecologically significant wetland' or 'wetland of other environmental value'.

8. This does not include the holder's own mine or gas production, on-site industrial or commercial assets, the holder's workers' accommodation, agricultural facilities on the holder's land such as a farm shed or farm dam or infrastructure solely for servicing the holder.

4.3 Assessment of Failure Scenarios

The failure event scenarios considered for the consequence category assessment for TSF3 are summarised in Table 4.2.

TABLE 4.2: FAILURE EVENT SCENARIOS CONSIDERED FOR TSF3

Failure Event Scenario	Potential Failure Causes	Comments
Failure to Contain - Seepage	Seepage through impoundment floor	Seepage from TSF3 through the northern embankment is proposed to be controlled and limited through the implementation of a grout curtain and geosynthetic liner system. However, the CCA does not consider any controls are in place. Seepage occurs through the fractured rock and geological faults/structures within the extents of TSF3. Seepage losses are expected to primarily occur to the north into EPit and west into the Esperanza Upper Cave Subsidence Zone (ESS Zone), although seepage may occur in any direction. There is the potential for seepage to flow northwest between these areas and downstream to Gunpowder Creek, which may result in a negative impact to the surrounding environment. If discharge were to occur, mine affected water (MAW) would likely be contained within local pools in Gunpowder Creek and concentrated by evaporation until being flushed out during significant flow events. In the absence of a detailed site groundwater model incorporating TSF3 being available (to be undertaken during detailed design) it is conservatively assumed that seepage impacts to Gunpowder Creek due to TSF3 may occur.
	Seepage through perimeter surfaces and embankments.	
Failure to Contain – Overtopping	Large rainfall event causing overflow discharge.	Spillway discharge is possible and will report to the EPit, and any spill from the EPit would report to MCD and then Hoover Dam. Overflows from Hoover Dam report to Gunpowder Creek. There is significant water storage capacity available between TSF3 and Hoover Dam, particularly within E-Pit.
	Operational failure of decant / dewatering pumping infrastructure during large rainfall event causing overflow discharge.	Pump failure is possible. Spillway discharge will report to the EPit and any spill from the EPit would report to MCD and then Hoover Dam. Overflows from Hoover Dam report to Gunpowder Creek. There is significant water storage capacity available between TSF3 and Hoover Dam, particularly within E-Pit.
Dam Break	Instability or piping (internal erosion) failure through embankments.	Instability or piping (internal erosion) failure is possible through embankments. Dam break flows may report to E-Pit, or to Snakeskin Gully. Dam break flows may reach Gunpowder creek where the Snakeskin gully diversion overtops or via E-Pit where the CCM integrated containment system is exceeded. There is significant storage capacity available between TSF3 and Hoover Dam, particularly within E-Pit. In the absence of a detailed failure impact assessment (to be undertaken during detailed design) it is conservatively assumed that dam breach flows may reach Gunpowder Creek.

Failure Event Scenario	Potential Failure Causes	Comments
	Large rainfall events causing overtopping failure of the embankments.	Overtopping failure is possible. Dam break flows may reach Gunpowder creek where the Snakeskin gully diversion overtops or via E-Pit where the CCM integrated containment system is exceeded. There is significant storage capacity available between TSF3 and Hoover Dam, particularly within E-Pit. In the absence of a detailed failure impact assessment (to be undertaken during detailed design) it is conservatively assumed that dam breach flows may reach Gunpowder Creek.

4.4 Assessment Results

4.4.1 General

The consequence category assessment is detailed in Table 4.3 for the elements of potential harm and Table 4.4 for the assessment of the three failure scenarios. The results are summarised in Table 4.5.

The overall consequence category of TSF3 is 'high' and therefore, it is considered a 'regulated' structure. Based on this assessment TSF3 is required to comply with seepage controls, spillway hydraulic capacity criteria and containment hydraulic criteria (DSA / MRL) stipulated in The Manual.

TABLE 4.3: HARM DESCRIPTION SUMMARY

Category of Harm	Description
Harm Humans	• Available landuse mapping (QGlobe) indicates that the nearest residential zoning is located approximately 120 km downstream of the mine along the Leichardt River, and the nearest agricultural operation located approximately 130 km downstream of the mine along the Leichardt River. • A number of groundwater bores (not associated with the mining operations) are located within a 20 km radius of mine, the nearest being approximately 5 km away. The operational status of the bores is unknown however, given the land use it is unlikely these bores would be used for human consumption, however, may be used for stock watering purposes. • Gunpowder road passes through the mine, however is infrequently used by third parties. CCM also have the ability to restrict access to the road if required.
General Environmental Harm	• MSES are located downstream of the mine, typically 'MSES Regulated Vegetation (Essential Habitat)' and 'MSES wildlife habitat (endangered or vulnerable)'. The closest mapped MSES is located approximately 4-4.3 km downstream. • MNES are located downstream of the mine. There are Protected Areas (Terrestrial and Marine), and Nationally Important Wetlands where the Leichardt River flows into the Gulf of Carpentaria, approximately 300 km downstream of the mine. • There are terrestrial and aquatic GDEs of low to high potential downstream of the mine (refer to Figure 3.4). • Environmental Values and Water Quality Objectives have not yet been determined for the Leichardt River Subbasin under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019. Receiving Water Contaminant Trigger Levels, and Groundwater Contaminant Trigger Levels have however been defined in the EA, and Environmental Values have been established as part of the REMP. Gunpower Creek is considered Highly Disturbed. Environmental Values identified include Aquatic Ecosystems, Stock Watering, Secondary Recreation, Visual Appreciation, Industrial, and Cultural and Spiritual Values.

Category of Harm	Description
	• The ESS Zone is located approximately 600 m to the west of TSF3, with the underground portal located at the northern end of the ESS Zone. There is connectivity between the ESS Zone and groundwater systems in the vicinity of CCM.
General Economic Loss or Property Damage	• Available landuse mapping (QGlobe) indicates that the nearest residential zoning is located approximately 120 km downstream of the mine along the Leichardt River, and the nearest agricultural operation located approximately 130 km downstream of the mine along the Leichardt River. • A number of groundwater bores (not associated with the mining operations) are located within a 20 km radius of mine, the nearest being approximately 5 km away. The operational status of the bores is unknown however, given the land use it is unlikely these bores would be used for human consumption, however, may be used for stock watering purposes. • The country in the vicinity of and downstream of the mine along Gunpower Creek and the Leichardt River are sparsely populated and developed. Predominant land use in the area is grazing with occasional mining operations and cropping. A stock route (tertiary) crosses Gunpowder Creek approximately 50 km downstream of the mine. • There is no significant civic infrastructure located downstream of the mine. Wills Development Road Bridge is located approximately 140 km downstream of the mine.

TABLE 4.4: CONSEQUENCE CATEGORY ASSESSMENT

Scenario	Assessment Comments	Consequence Rating	Scenario Consequence Category
Failure to Contain – Seepage	• Expected TSF3 stored water quality has been based on available water quality data for ETSF. The stored water quality is expected to be variable but on average acidic (~pH 4.4), moderately saline (EC 4,600 µS/cm), with a moderate concentration of sulfate (4,000 mg/L) and concentrations of metals and metalloids which exceed the EA trigger limits. For the purposes of CCA, the stored water is considered to be of moderate toxicity. • Historical migration of contaminants through groundwater has occurred from the CCM site to Gunpowder Creek. The sources of contaminants are not fully understood however ETSF, EPit, and MCD are potential candidates. Groundwater connectivity and seepage pathways for contaminants are not fully understood but are likely to be a combination of groundwater flow along historic (pre-mine) drainage lines and along fault structures. Ongoing works are being undertaken at CCM to intercept likely seepage paths to Gunpowder Creek. Considering the historical seepage of the site storages to downstream receptors, TSF3 will not be adding any new class of contaminants to the groundwater system and will act as a continuation of the potential load types, which is an existing risk that has been managed for previous TSFs at CCM (e.g. ETSF). • TSF3 is largely located within the Whitworth Quartzite, which is generally expected to have low permeability. Seepage through the existing WRD has potential to generate Acid-Metalliferous Drainage (AMD). • For the purposes of this assessment, **seepage is assessed as if there were no controls in** place and the environmental impacts from TSF3 are compared to the **existing ecosystem conditions**. • With a 300 m AHD pond (additional 20 m head to current conditions), the TSF3 will become a dominant recharge source, likely forcing flow to diverge not only west- northwest to EPit/ESS zone but also south and east, possibly creating new risk receptors (groundwater users, bores, GDEs, or surface water systems) especially if geological structures (faults, fractures) allow. Seepage from TSF3 can be described as a **divergent flow zone**, with seepage flowing radially outward from the TSF3 mound: – Strongest gradient west-northwest (to EPit), i.e. head differential increases, and seepage flow intensifies. The decant pond (and greatest head) will be formed against the E-WRD, which supports the strongest gradient being west to northwest, towards E-Pit. – New flow directions (overcomes natural gradient in some directions/ may reverse existing flow paths): – South toward mid-gradient terrain (previously less active zone). – East/southeast toward low-lying Lake Waggaboonya area or adjacent terrain (hydraulically lower than the TSF3). • **New seepage risk areas** include the south and southeast perimeter of TSF3, with seepage from TSF3 possibly inducing discharge to any fracture zones or interconnected weathered units in those directions. • A TSF pond head of 300 m AHD driving flow over 1.8–2.0 km creates a sufficient gradient to push seepage to the Gunpowder Creek/ Lake Waggaboonya over the long term, with TSF3 potentially acting as an active seepage source long after closure, extending the site's time as a seepage source. As such, there may be subsequent environmental harm to plants and animals from cumulative or long-term exposure in either Gunpowder Creek or Lake Waggaboonya. Extreme weather events (i.e. wet or dry) may compound these long-term impacts, particularly extreme wet events which would increase the magnitude and extent of seepage from the site. • The following assessment factors and findings were considered when assessing the category of environmental harm: – Hydraulic connectivity to receptors: Strong – EPit and ESS zone. New seepage risk areas, including toward low-lying Lake Waggaboonya, which has yet to be assessed for its habitat value. – Travel time to receptors: <100 years. The short- to medium-term impacts are expected to be similar to existing conditions with the potential of significant impacts in the long-term. – Sensitivity of receptors: Moderate to high – EPit water, ESS zone (void closure), and Lake Waggaboonya. – Depth to water table: Moderate–deep, but vertical gradients support migration. – Aquifer type: Mixed (weathered and fractured rock) – risk of preferential pathways. – Beneficial use and environmental value: Gunpowder and Greenstone Creeks have some EVs (refer to Section 3.3) and there are moderate potential aquatic and high potential terrestrial GDEs located along Gunpowder Creek immediately north of CCM. However, the trends displayed in the current REMP period (post wet 2024 to 2025) (Hydrobiology, 2024) do not indicate any notable consistent impact from CCM operations to the EVs of the receiving environment, with reported exceedances consistent with previous exceedances. – Comparison to existing conditions: It is considered TSF3 would not have significant impacts in the short- to medium-term but there is potential for long-term impacts that are commensurate with the 'Significant' category of environmental harm from accumulation of contaminants in downstream receptors long after closure leading to potential uptake in flora and fauna. • **Human:** Seepage from TSF3 may occur but is not expected to result in the health of 10 or more people being affected (**Low**). • **Environment:** Consequences of seepage from TSF3 are difficult to quantify, but incremental impacts from TSF3 relative to the existing ecosystems are expected to be up to the range of adverse impacts commensurate with the Significant consequence category. Remediation of adverse impacts are likely to take more than 6 months but less than 3 years. (**Significant**) • **Economic / Property:** Seepage from TSF3 may occur but is not expected to result in impacts that require $1 million or greater in rehabilitation, compensation, repair or rectification costs. (**Low**)	Human: Low Environment: Significant Economic: Low	**Significant**

Scenario	Assessment Comments	Consequence Rating	Scenario Consequence Category
Failure to Contain – Overtopping	• Spillway overflows will likely report to E-Pit and/or MCD. Overflows from MCD flow to Hoover Dam and then off-site to Gunpowder Creek. A number of proposed changes to the site configuration may influence spillway overflow paths and the likelihood of spillway overflows discharging offsite. These proposed changes may include placement of additional tailings in E-Pit and the construction of a diversion drain to direct clean catchment surface flows around E-Pit and into MCD. • There is currently approximately 3.5 Mm3 of available water storage within E-Pit (2.8 Mm3) and MCD (0.7 Mm3). It is considered unlikely but credible that TSF3 spillway overflows may discharge off-site, however this is dependent on the future state of the CCM site configuration, available on-site water storage, and the influence of other contributing catchments downstream of the TSF3 spillway. For the purposes of the CCA it has been conservatively assumed that TSF3 spillway overflows may discharge off-site. CCM currently operate the site under an integrated containment system with a required containment performance of 5% AEP. An expected upper bound contribution of TSF3 spillway overflows to Gunpowder Creek has been approximated based on a 5% AEP, 2-Month Wet Season containment performance requirement for the TSF3 catchment only at approximately 0.6 Mm3 (assuming no onsite storage). It is expected that under such a scenario, overflows would be significantly diluted from coincident surface water flows in Gunpowder Creek (Upstream Catchment ~ >2,500 km2). • Expected TSF3 stored water quality data has been based on available water quality data for E-TSF. The stored water quality is expected to be variable but on average acidic (~pH 4.4), moderately saline (EC 4,600 µS/cm), with a moderate concentration of sulfate (4,000 mg/L) and concentrations of metals, metalloids which exceed the EA trigger limits. For the purposes of CCA, the stored water is considered to be of moderate toxicity. • **Human:** Spillway overflows discharging off-site may occur but are unlikely to result in the contamination of waters (surface and/or groundwater) used for human consumption that could result in the heath of 10 or more persons being adversely affected. (Low). • **Environment:** Spillway overflows from TSF3 discharging off-site may occur. Consequences are difficult to quantify but are expected to be in the range of adverse impacts commensurate with the Significant consequence category. Remediation of adverse impacts are likely to take more than 6 months but less than 3 years. (Significant) • **Economic / Property:** Spillway overflows from TSF3 discharging off-site may occur but are not expected to result in impacts that require $1 million or greater in rehabilitation, compensation, repair or rectification costs. (Low)	Human: Low Environment: Significant Economic: Low	**Significant**
Failure to Contain – Dam Break	• Three possible TSF breach scenarios have been considered including a breach of the TSF3 Upper Esperanza Diversion Dam (UEDD) south into the Upper Esperanza Valley (UEV), a western breach of the TSF3 Esperanza Waste Rock Dump (E-WRD) towards the Underground Portal and Snakeskin Valley, and a northern breach of the TSF 3 E-WRD towards E-Pit and/or Mill Creek Dam. • Scenario 1 - Dam Breach (UEDD) – Dam Breach may report off site via Snakeskin Gully to Gunpowder Creek where the Snakeskin Gully Diversion (Temporary Diversion Embankment) overtops. • Scenario 2 - Dam Breach (E-WRD West) – Dam Breach may report off site via Snakeskin Gully to Gunpowder Creek where the Snakeskin Gully Diversion (Temporary Diversion Embankment) overtops • Scenario 3 - Dam Breach (E-WRD North) – Dam Breach may report off site via E-Pit / MCD to Gunpowder Creek particularly under the Flood Day Failure (FDF) scenario, where E-Pit is used for further tailings storage, or where the E-Pit diversion drain is constructed. Potential for cascade Failure of E-Pit Embankment and/or MCD Embankment. • The volume of a potential tailings dam breach has been estimated based on the expected tailings properties using the methods described by Rico et al. (2007) Upper Bound and Fontaine & Martin (2015) Lower Bound. The breach volume is expected to be within the range of 0.5 Mm3 to 2.3 Mm3. • The proportion of the breach volume expected to extend off-lease is dependent on the future site configuration and downstream storage present which is variable depending on the TSF breach scenario considered. The downstream storage to the south of UEDD in Upper Esperanza Valley prior to overtopping to Snakeskin Gully is approximately 0.8 Mm3. The downstream storage for a northern failure of the E-WRD to E-Pit and/or MCD is approximately 3.5 Mm3. • **Human:** The location of TSF3 is such that people are not routinely present in the failure path and loss of life is not expected (excluding personnel associated with the CCM operation) **(Low)**. A TSF3 breach off-site may occur but is not expected to result in the health of 10 or more people being affected **(Low)**. • **Environment:** A TSF3 breach off-site may occur. Consequences are difficult to quantify but are expected to be in the range of adverse impacts commensurate with the High consequence category. Remediation of adverse impacts is likely to take 3 years or more. The area of damage may exceed 5km2. **(High)** • **Economic / Property:** A TSF3 breach off-site may occur but impacts are unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects. **(Low)**	Human: Low Environment: High Economic: Low	**High**
Overall Consequence Category			**High**

TABLE 4.5: SUMMARY OF CONSEQUENCE CATEGORY RESULTS OF FAILURE SCENARIOS

Structure	Failure to Contain Seepage	Failure to Contain – Overtopping	Dam Break	Overall
TSF3	Significant	Significant	High	High

4.4.2 Containment and Detection Measures

Based on the outcomes of the DETSI consequence category assessments, the minimum required containment and detection measures for TSF3 is summarised below:

- Containment - Designed with a floor and sides of material that will minimise (or reduce) seepage to avoid the environmental harm in the significant consequence category in Table 1 and ensure that the environmental harm likely to occur is only as in the low consequence category of that table
- Leak Detection and Monitoring - Have a system that is appropriate to demonstrate that significant harm as per table 1 will not occur.

4.4.3 Spillway Capacity

Based on the outcomes of the DETSI consequence category assessments, the minimum required spillway capacity for TSF3 is summarised below:

- 1:1,000 AEP to 1:100,000 AEP + 1:10 AEP wave run-up.

4.4.4 Containment Storage

Based on the outcomes of the DETSI consequence category assessments, the required containment of TSF3 is summarised below:

- Wet Season Containment (DSA): 1:20 AEP.
- Storm Event Containment (ESS): 1:10 AEP 72 hr duration.

5. REFERENCES

DETSI. (2024). *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures .*

Engeny. (2025a). *Groundwater Impact Assessment - TSF3 EA Amendment.*

Engeny. (2025b). *QC1022_018-MEM-003-2 TSF3 Preliminary DSA and MRL Assessment.*

Hydrobiology. (2024). *Capricorn Copper Mine 2024 Post-Wet REMP Report.*

NRA Environmental Consultants. (2020). *Capricorn Copper Mine Receiving Environment Monitoring Program Design Report.*

Queensland Government. (2025, July 8). *Queensland Globe*. Retrieved from Retrieved from https://qldglobe.information.qld.gov.au/qldglobe

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.

(c) 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.

(d) 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.

(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.

APPENDIX A: CONSEQUENCE CATEGORY ASSESSMENT CERTIFICATION

Form of Certification
Preliminary Consequence Category Assessment for TSF3 at Capricorn Copper Mine

Name of Registered Professional Engineer providing certification:

Brendan Wallace

Address of Registered Professional Engineer providing certification:

L3 545 Queen Street, Brisbane QLD 4000

Statement of relevant experience

I hereby state that I am a Registered Professional Engineer of Queensland and meet the requirements of the definition of 'suitably qualified and experienced person'.

Statement of certification

All relevant material relied upon by me, including subsidiary certifications of specialist components, where required by the environmental authority, is provided in the attached report "TSF3 Preliminary Consequence Category Assessment - Rev 0"– dated 18 July 2025.

I hereby certify that the attached report "TSF3 Preliminary Consequence Category Assessment - Rev 0" – dated 18 July 2025 provides a preliminary assessment of the consequence category of TSF3 at Capricorn Copper Mine in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* published by the administering authority (ESR/2016/1933 Version 5.03, effective February 2024).

I, Brendan Wallace, declare that the information provided as part of this certification is true to the best of my knowledge. I acknowledge that it is an offence under section 480 of the Environmental Protection Act 1994 to give the administering authority a document containing information that I know is false, misleading or incomplete in a material particular.

Signed: _____

Brendan Wallace, RPEQ No. 15026

Date: 18 July 2025

Structure		TSF3 ANCOLD CCA				
Severity of Damage and Losses		**Severity Level**				**Description**
		Minor	**Medium**	**Major**	**Catastrophic**	
General						•Flood Day Failure (FDF) and Sunny Day Failure (SFD) considered. •Incremental impacts under FDF scenario likely to be small due to relative size of CCM site to upstream catchment area of Gunpowder Creek (>2,500 km2). • Three possible TSF breach scenarios have been considered including a breach of the TSF3 Upper Esperanza Diversion Dam (UEDD) south into the Upper Esperanza Valley (UEV) and Snake Skin Valley, a western breach of the TSF3 Esperanza Waste Rock Dump Embankment (E-WRD) towards the Underground Portal and Snake Skin Valley, and a northern breach of the TSF 3 E-WRD towards E-Pit and/or Mill Creek Dam (MCD). • A future gravity diversion is proposed for the Snake Skin Valley (the Clean Water Diversion Channel (CWDD)). For the purposes of the CCA, the CWDD is assumed to be in place to future protect the design of TFS3 should the CWDD be constructed. • Scenario 1 - Dam Breach (UEDD) – Dam Breach may report off site via Snake Skin Gully to Gunpowder Creek particularly where the CWDD is constructed. Potential for cascade failure of the CWDD Diversion Embankment. • Scenario 2 - Dam Breach (E-WRD West) – Dam Breach may report off site via Snake Skin Gully to Gunpowder Creek particularly where the CWDD is constructed. Potential for cascade failure of the CWDD Diversion Embankment. • Scenario 3 - Dam Breach (E-WRD North) – Dam Breach may report off site via E-Pit / MCD to Gunpowder Creek particularly under the Flood Day Failure (FDF) scenario, where E-Pit is used for further tailings storage, or where the E-Pit diversion drain is constructed. Potential for cascade Failure of E-Pit Embankment and/or MCD Embankment. • The volume of a potential tailings dam breach has been estimated based on the expected tailings properties using the methods described by Rico et al. (2007) Upper Bound and Fontaine & Martin (2015) Lower Bound. The breach volume is expected to be within the range of 0.3 Mm3 to 3.1 Mm3. • The proportion of the breach volume expected to extend off-lease is dependent on the future site configuration and downstream storage present which is variable depending on the TSF breach scenario considered. The downstream storage to the south of UEDD in UEV prior to overtopping to Snake Skin Gully is approximately 0.8 Mm3. The downstream storage for a northern failure of the E-WRD to E-Pit and/or MCD is approximately 3.5 Mm3. There is no downstream storage for a western failure of the E-WRD.
Total Infrastructure Costs	**Cost Estimate**					
Residential	<$1M	✓				• The nearest land use zoned residential is located approximately 120km downstream of the mine. Impacts from dam breach are unlikely.
Commercial	<$1M	✓				• The nearest land used zoned agricultural / cropping is located approximately 130 km downstream of the mine. Impacts from dam breach are unlikely.
Community Infrastructure	<$1M	✓				• The nearest community infrastructure is the Wills Development road bridge located approximately 140 km downstream of the mine. Impacts from dam breach are unlikely.
Dam Replacement or Repair Costs	$335M			✓		• Dam replacement or repair costs including clean up are expected to be approximately ($310M - Clean Up + $25M Dam Repair)
Total Estimated Cost	$100M - $1B			✓		
Impact on Dam Owner's Business						
Importance to the business				✓		•TSF3 is considered an essential asset to maintain production at CCM.
Effect on services provided by the owner		✓				•N/A - Tailings Dam
Effect on continuing credibility				✓		•High profile site with DES due to historical issues including poor surface water management and contamination of surface water / groundwater. •Likely national and international coverage. •Loss of social license possible. •Extreme discontent expected.
Community reaction and political implications				✓		•High profile site with DES due to historical issues including poor surface water management and contamination of surface water / groundwater. •Likely national and international coverage. •Loss of social license possible. •Extreme discontent expected.
Impact on financial viability				✓		•Publicly Listed Company. • Limited Portfolio of Income Producing Assets •Failure expected to be severe to crippling in the long term.
Value of water in the storage		✓				•N/A - Tailings Dam - Income is not derived from water storage. Based on current operations excess site water inventory is considered a liability.
Health and Social Impacts						
Public Health		✓				•Downstream environment is sparsely populated and developed. • The nearest land use zoned residential is located approximately 120km downstream of the mine. • The nearest land used zoned agricultural / cropping is located approximately 130 km downstream of the mine. •Extraction of drinking water from surrounding groundwater bores is unlikely. •<100 people of Public Health impacts expected.
Loss of Service to the community		✓				•Downstream environment is sparsely populated and developed. • The nearest land use zoned residential is located approximately 120km downstream of the mine. • The nearest land used zoned agricultural / cropping is located approximately 130 km downstream of the mine. •The nearest significant civic infrastructure is the Wills Development Road Bridge located approximately 140 km downstream of the mine. •<100 people of Loss of Service to the Community Impacts expected.
Cost of Emergency Management		✓				•Downstream environment is sparsely populated and developed. • The nearest land use zoned residential is located approximately 120km downstream of the mine. • The nearest land used zoned agricultural / cropping is located approximately 130 km downstream of the mine. •<1000 person days of Cost of Emergency Management impacts expected.
Dislocation of people		✓				•Downstream environment is sparsely populated and developed. • The nearest land use zoned residential is located approximately 120km downstream of the mine. • The nearest land used zoned agricultural / cropping is located approximately 130 km downstream of the mine. •<100 person months of dislocation of People impacts expected.
Dislocation of business		✓				•Downstream environment is sparsely populated and developed. • The nearest land use zoned residential is located approximately 120km downstream of the mine. • The nearest land used zoned agricultural / cropping is located approximately 130 km downstream of the mine. •<20 business months of Dislocation of Business impacts expected.
Employment affected			✓			•Downstream environment is sparsely populated and developed. • The nearest land use zoned residential is located approximately 120km downstream of the mine. • The nearest land used zoned agricultural / cropping is located approximately 130 km downstream of the mine. •Lost jobs are possible but limited to those related (directly or indirectly) to the CCM operation. •100 to 1000 jobs lost Employment Affected impacts expected.
Loss of heritage		✓				•Local Facility
Loss of recreational facility		✓				•Local Facility
Environmental Impacts						
Area of Impact				✓		•Area of impact estimated at up to approximately 11 km2 based on a total storage volume of 7.2 Mm3, a maximum breach volume of 3.1 Mm3 and an assumed depth of impact of 300 mm. •Area of impact expected to be >5km2 and <20km2
Duration of Impact				✓		•Clean up duration estimated at up to approximately 3-4 years, however residual impacts could last longer. •Duration of impacts expected to be >5 years and <20 years.
Stock and Fauna				✓		•Discharge from dam break may contaminate water supplies used by stock and fauna with contaminant uptake (Gunpower Creek / Leichardt River). •Significant dilution of contaminant concentrations under Flood Day Failure (FDF) likely.
Ecosystems				✓		•Discharge from dam break would have significant impacts on ecosystems with natural recovery expected after several wet seasons. Remediation possible over many years.
Rare and Endangered Species			✓			•Species exist with losses expected to be recovered over a number of years.
Population at Risk						•No off-site PAR is expected. •CCM advise that personnel working underground on average is between 13 and 20 persons. • A dam breach may impact underground personnel due to the proximity of the underground portal (west of TSF3) and the ventilation shaft (north of TSF3). •It is unlikely there would be any underground personnel during a FDF-Scenario.
Population at Risk						**Consequence Category based on PAR**
<20				✓		**High B**
Potential Loss of Life (PLL)						•No off-site PAR is expected. •CCM advise that personnel working underground on average is between 13 and 20 persons. • A dam breach may impact underground personnel due to the proximity of the underground portal (west of TSF3) and the ventilation shaft (north of TSF3). •It is unlikely there would be any underground personnel during a FDF-Scenario. •Fatality rates are difficult to estimate for such a breach scenario. A 100% fatality rate has been conservatively adopted.
Potential Loss of Life (PLL)						**Consequence Category based on PAR**
<20 (Assuming 100% Fatality Rate)				✓		**High A**

APPENDIX F: SURFACE WATER ASSESSMENT

MEMORANDUM

Project:	QC1022_018	Date:	13 May 2025
To:	Capricorn Copper Pty Ltd	From:	Sean Willis / Daniel Niven
ATT:		CC:	
Subject:	Tailings Storage Facility 3 Hydraulic Modelling Assessment		

1. INTRODUCTION

1.1 General

Capricorn Copper Pty Ltd, a wholly owned subsidiary of 29 Metals Limited (29 Metals), has engaged Engeny Australia (Engeny) to undertake the preliminary design of the proposed Tailings Storage Facility 3 (TSF3) located at Capricorn Copper Mine (CCM) in north-west Queensland. CCM is operated under Environmental Authority EPML 00911413 (EA), as in effect on 6th December 2023.

The preliminary design of TSF3 required two independent hydraulic assessments, being the sizing of the emergency spillway, and an associated assessment of the southern embankment height for the diversion of the external flows (Refer to Figure 1.1). This memorandum details the assessment of both components.

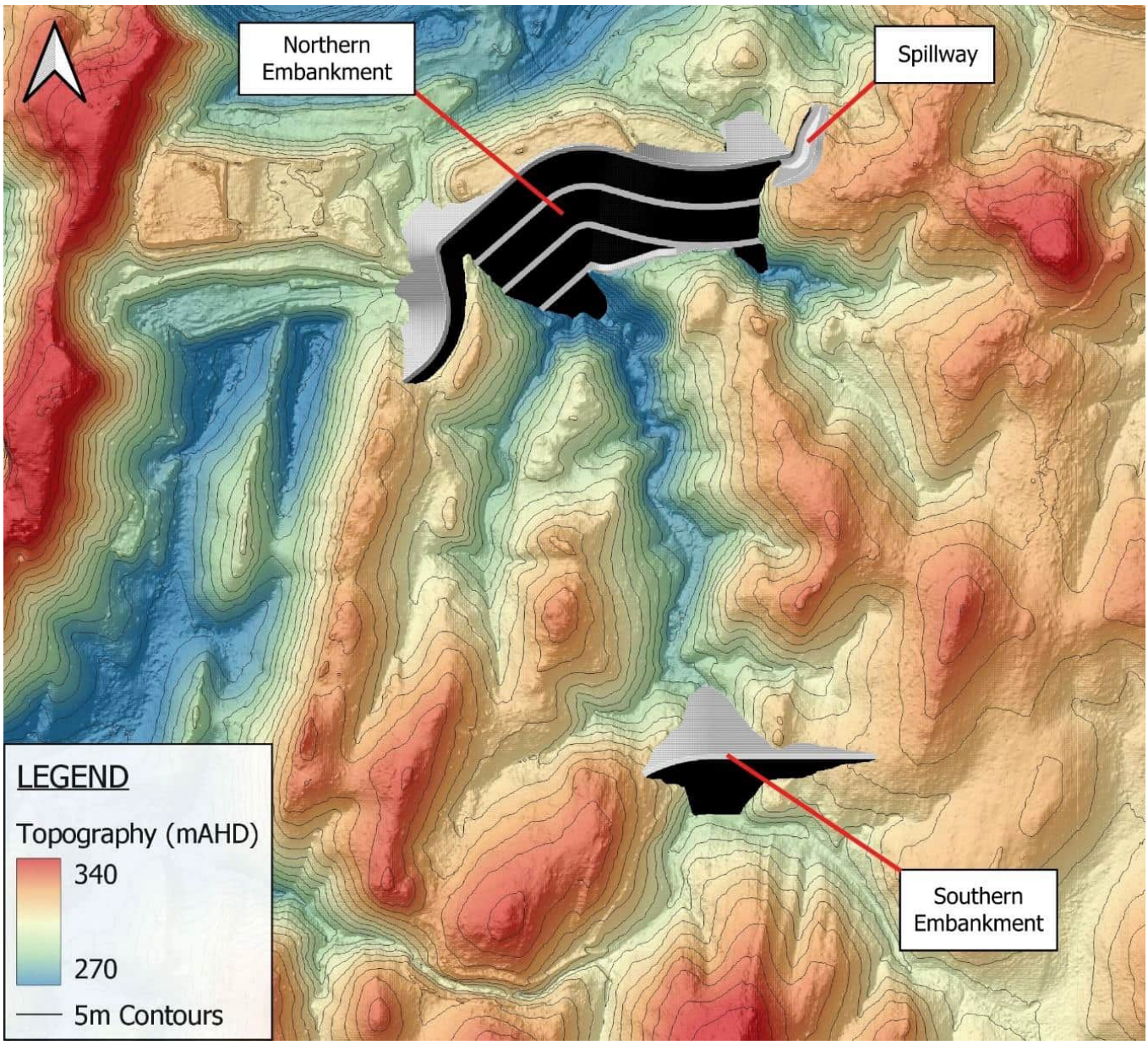


FIGURE 1.1: TSF3 GENERAL ARRANGEMENT

1.2 Project Objectives

The hydraulic assessment project objectives are summarised below:

- Determine the design of the TSF3 Spillway to safely convey the 1:100,000 Annual Exceedance Probably (AEP) plus allowance for 1:10 AEP wind wave run-up or Probable Maximum Flood (PMF) design storm events, whichever is more conservative.
- Determine maximum South Embankment elevation to safely divert the 1:100,000 AEP and PMF design storm events around TSF3 plus 0.5 m freeboard.

2. SPILLWAY ASSESSMENT

The TSF3 Spillway Assessment was undertaken to size the spillway in accordance with the ANCOLD Guidelines on Tailings Dam (ANCOLD, 2012). The preliminary Consequence Category Assessment (CCA) completed by Engeny (ref Q1022_018-REG-002-0 Preliminary CCA) was undertaken using the ANCOLD Guidelines on the Consequence Categories for Dams (ANCOLD, 2012) and the Department of Environmental Science and Innovation (DESI) Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933) (DESI, 2024). It was determined that the classification of the dam was "High A" under ANCOLD, and "High" under DESI. Therefore, the ANCOLD output which is the more conservative of the two was adopted, which recommends spillway needs to safely convey the greater of either the 1:100,000 AEP design flood event plus an allowance of 1:10 AEP wind wave run-up, or the PMF with no requirements for wave run-up. To undertake this, a hydrologic model assessment has been undertaken using the Watershed Boundary Network Model (WBNM).

2.1 Catchment Inputs

The TSF3 catchment was delineated using available site topographic data, captured on the 20th of July 2021, with a total catchment area of 79 ha This is shown in Figure 2.1.

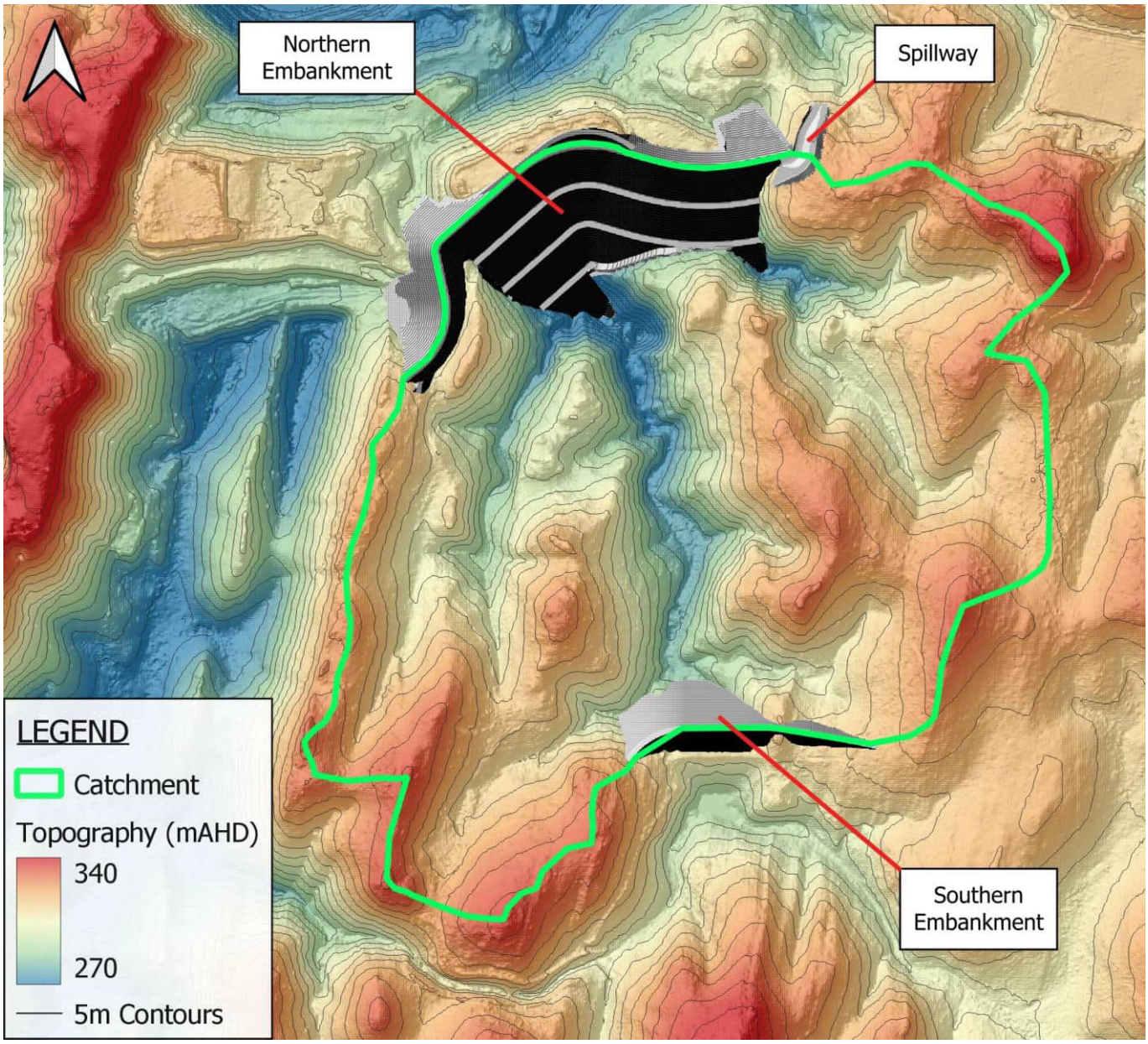


FIGURE 2.1: TSF3 SPILLWAY CATCHMENT EXTENT

2.2 Hydrological Inputs

The following sections detail the remaining hydrological inputs for the WBNM, gathered in accordance with the Australian Rainfall & Runoff 2019 (ARR2019) Guidelines (Ball et.al, 2019)

2.2.1 Design Rainfall – Extreme Events

The 1:100,000 AEP event was determined using a logarithmic interpolation approach as detailed by ARR2019, using the 1:1,000 AEP, 1:2,000 AEP and the Probable Maximum Precipitation (PMP) rainfall depths. The 1:1,000 AEP and 1:2,000 AEP design rainfall depths 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 -19.702, Longitude 139.3612. The PMP depths were determined using the *Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*, (Bureau of Meteorology, 2003) for event durations up to the 6-hours. The parameters used to estimate the PMP GSDM depths are provided in Table 2.1.

TABLE 2.1: PMP GSDM PARAMETERS

Parameter	Value
Fraction Smooth / Rough	0 / 1
Moisture Adjustment Factor (MAF)	1.00
Elevation Adjustment Factor (EAF)	1.00
Catchment Area (km^2)	0.08

2.2.2 Temporal Patterns

Both events (1:100,000 & PMF) have utilised GSDM historical ten temporal patterns and the Average Variability Method (AVM) for the 15 minutes to 6-hour durations.

2.2.3 Initial and Continuing Losses

The adopted initial and continuing losses were 0 mm and 1 mm/hr respectively.

2.2.4 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, which are considered appropriate for the extreme event assessment and catchment size.

2.3 TSF3 Design Inputs

The water storage curve above the proposed spillway level (312.2 m AHD) to embankment crest level (314.2 m AHD) is shown in Figure 2.2, has been derived from provided topographic data and the TSF3 preliminary design model. The proposed preliminary design for the TSF3 Spillway is detailed in Table 2.2, with the spillway rating curve provided in Figure 2.3, which was undertaken using the broad-crested weir equation.

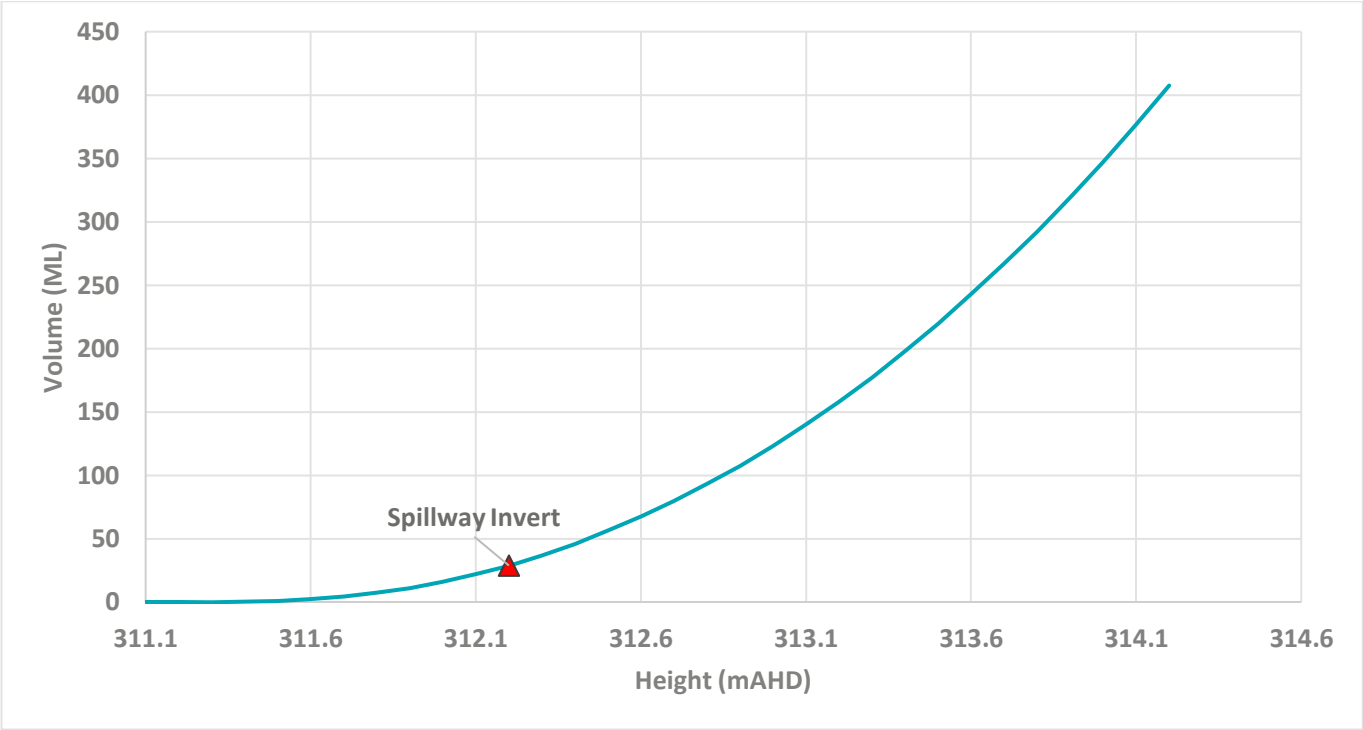


FIGURE 2.2**: TSF3 STORAGE CURVE**

TABLE 2.2: SPILLWAY DESIGN

Parameter	Value
Spillway Level	312.2 mAHD
Starting Water Level	312.2 mAHD
Crest Level	314.2 mAHD
Total Available Depth	2 m
Base Width	25 m
Spillway Batters	1H:1V
Longitudinal Slope	0.44%

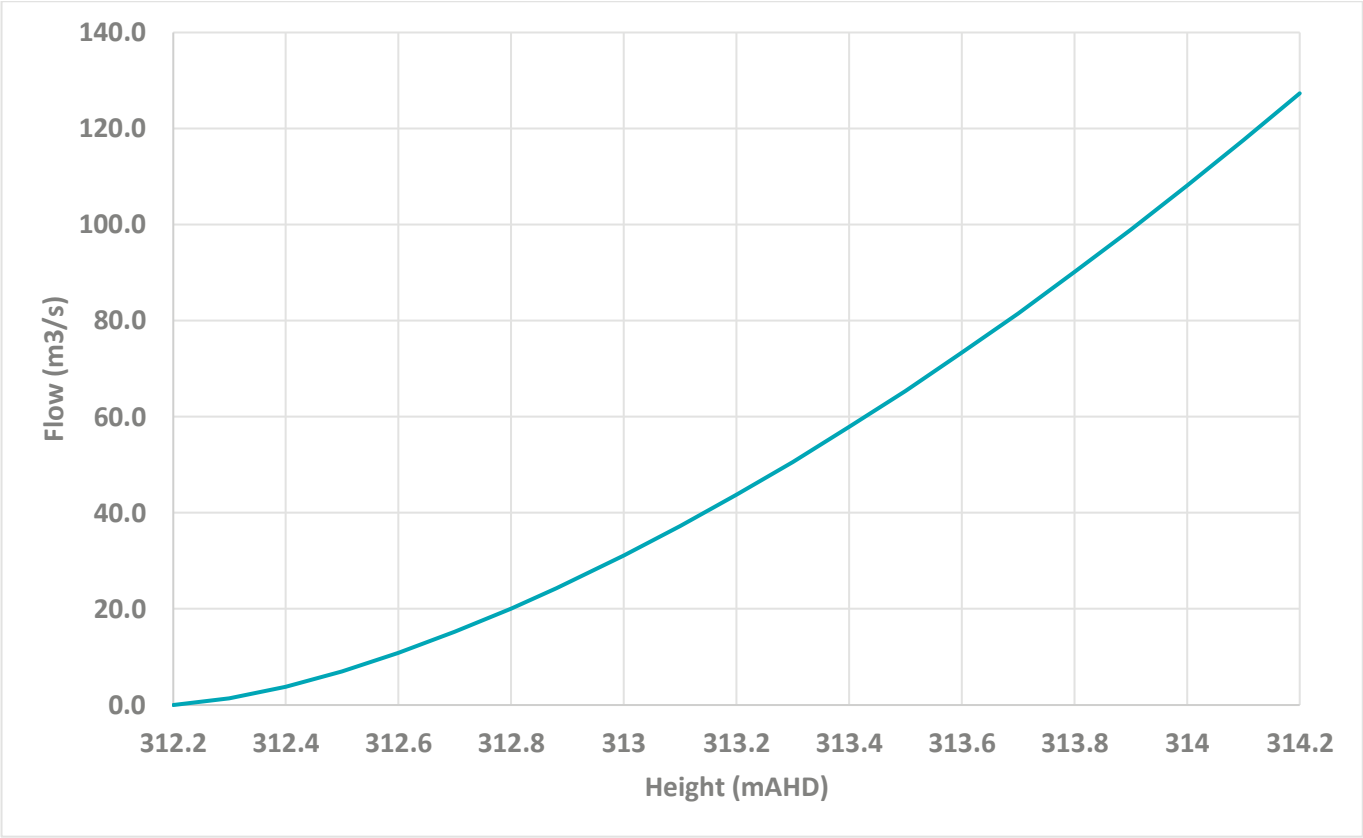


FIGURE 2.3: TSF3 SPILLWAY RATING CURVE

2.3.1 1:10 AEP Wave Run Up

The 1:10 AEP wind set-up and wave run-up has been estimated based on the methods detailed in Franzini et al, 1992, for both the maximum water depth and minimum expected water depth over the tailings surface. Figure 2.4 and Figure 2.5 provide the location and long section of the central radial. Table 2.3 provides the wave run up inputs, and the finalised 1:10 AEP Wind Wave Run-Up Allowance value of 0.59 m.

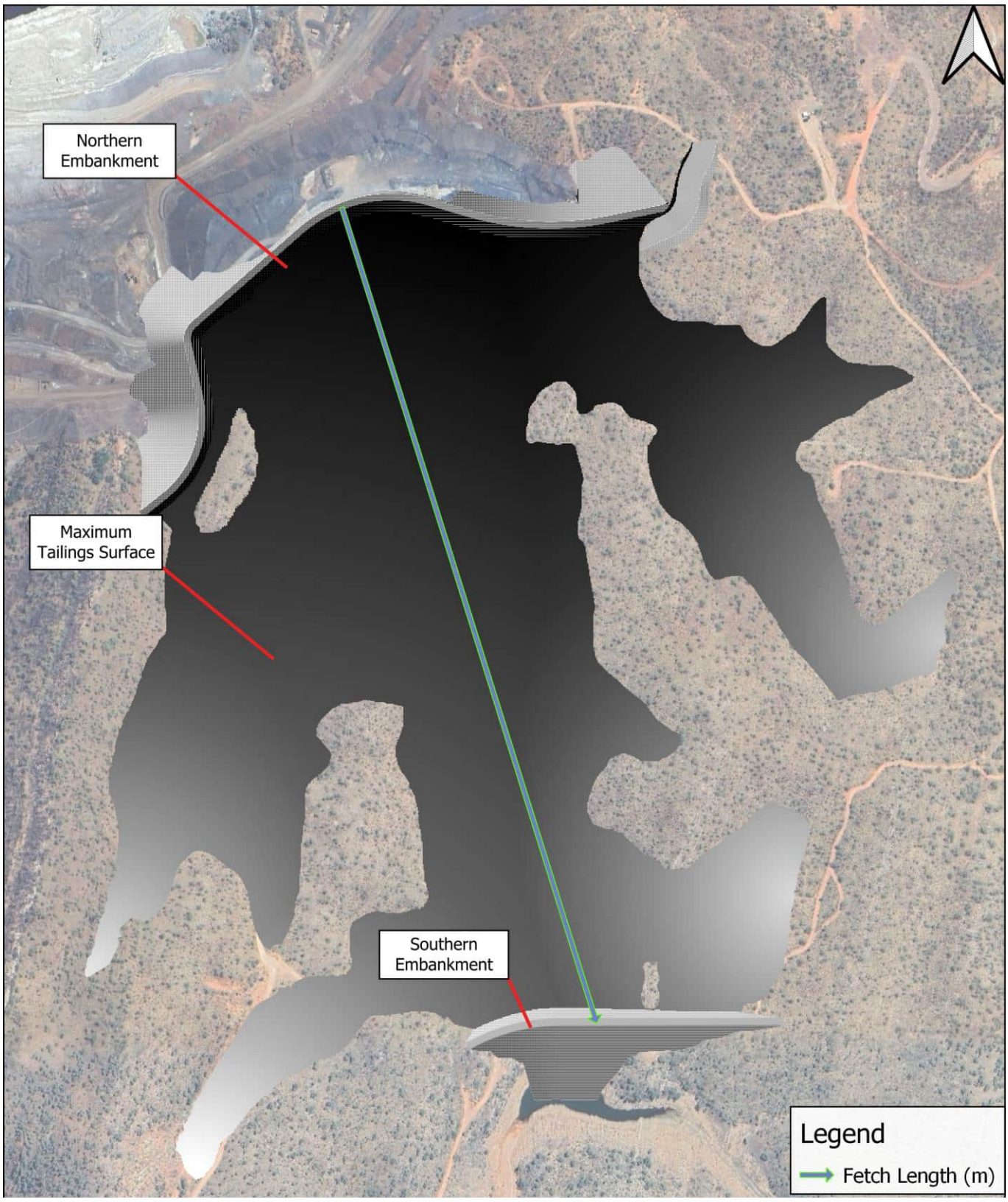


FIGURE 2.4: TSF3 Q10 WAVE RUN UP LENGTH

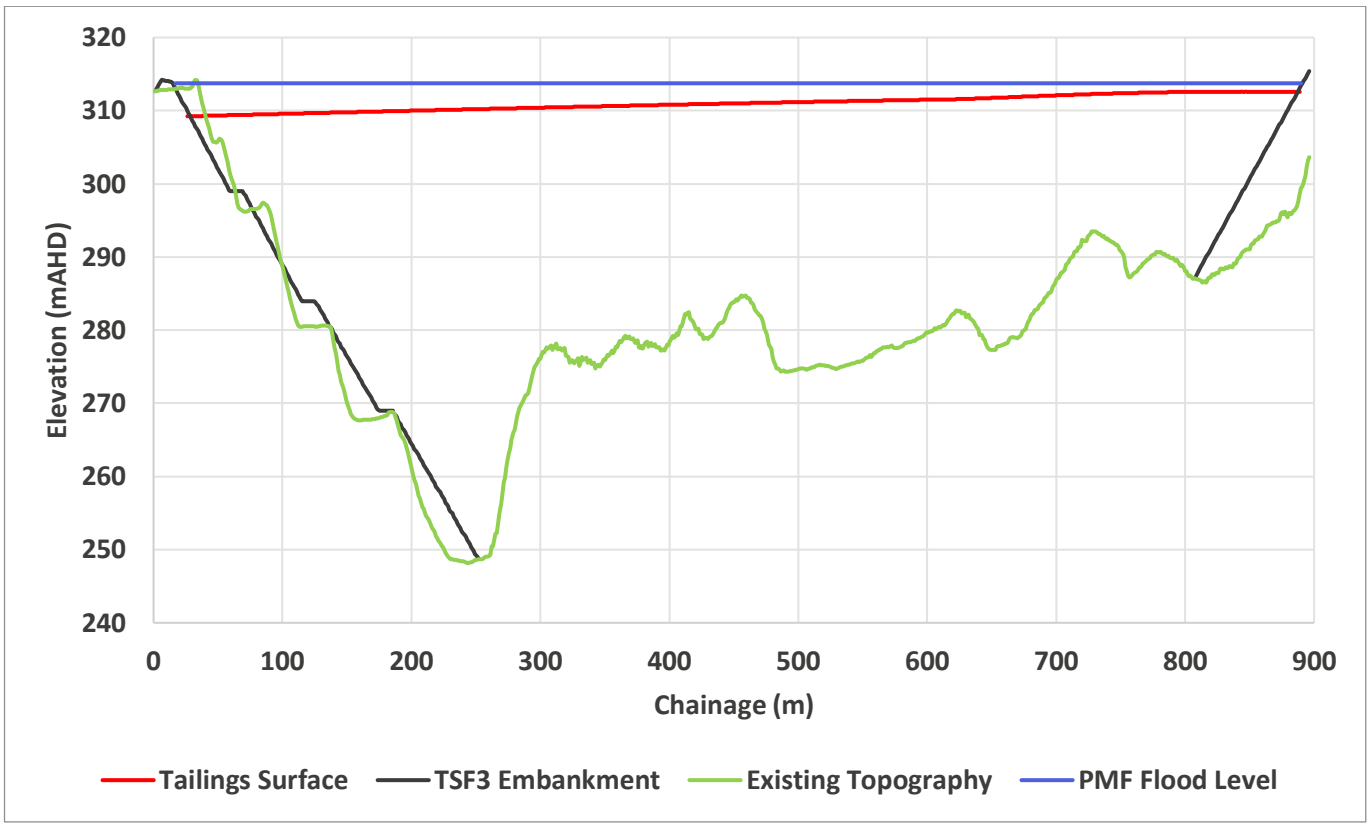


FIGURE 2.5: TSF3 Q10 WAVE RUN UP LONG SECTION

TABLE 2.3: 1:10 WAVE RUN UP INPUTS

Parameter	Value
Average Water Depth (based of peak flood height)	2.69 m
1:10 AEP Wind Speed (3-sec duration) – Region A0	34 m/s
Fetch Length (based of peak flood height)	0.77 km
Corrected Wind Speed	27 m/s
Wind Set-Up	0.034 m
Wave Run-Up	0.550 m
1:10 AEP Wind Wave Run-Up Allowance	0.59 m

2.4 Hydrological Model Results

Based on the preceding information, the critical spillway results for the 1:100,000 AEP and PMF events are provided in Table 2.4 with the 1:100,000 AEP event being the critical event from a flood rise perspective.

TABLE 2.4: TSF3 SPILLWAY MODELLING RESULTS

Parameter	1:100,000 AEP	PMF
Critical Storm Duration	1.5 hr	3 hr
Peak Spillway Outflow	50.8 m^3/s	84.8 m^3/s
Peak Flood Rise	1.10 m	1.54 m
Peak Flood Rise	313.30 mAHD	313.74 mAHD
Available Freeboard (Crest Level of 314.2 mAHD)	0.90 m (0.31 m with 1:10 Wave Run Up)	0.46 m
Peak Velocity	1.8 m/s	2.1 m/s

3. SOUTHERN EMBANKMENT ASSESSMENT

As part of the TSF3 preliminary design the existing Upper Esperanza Diversion Dam (UEDD) 'southern' embankment is proposed to be raised using a centreline method. The current UEDD and proposed raise act as a water storage and diversion embankment to divert clean surface water west of the Upper Esperanza Valley towards Snakeskin Valley. Under normal operating conditions, clean water stored behind the embankment is pumped out, however in flood conditions flows overtop a ridge saddle located to the west of the impoundment. The preliminary TSF3 spillway design assumes that external catchments are excluded; therefore the diversion is required to be capable of conveying external catchment flows to the same design performance standard as the TSF3 spillway.

The external clean catchment area to be diverted is approximately 194 ha. To support the TSF3 preliminary design, a flood assessment was undertaken to determine external flood heights against the raised southern embankment for the 1:100,000 AEP and PMF events.

3.1 Hydrological Model

The following section details the development of the WBNM hydrological model to provide inflow hydrographs for the hydraulic model.

3.1.1 Catchment Inputs

The external southern embankment catchment was delineated using available site topographic data, captured on the 20th of July 2021, and Shuttle Radar Topography Mission (SRTM) 30 m LiDAR, with a total catchment area of 194 ha. The catchment area is shown in Figure 3.1.

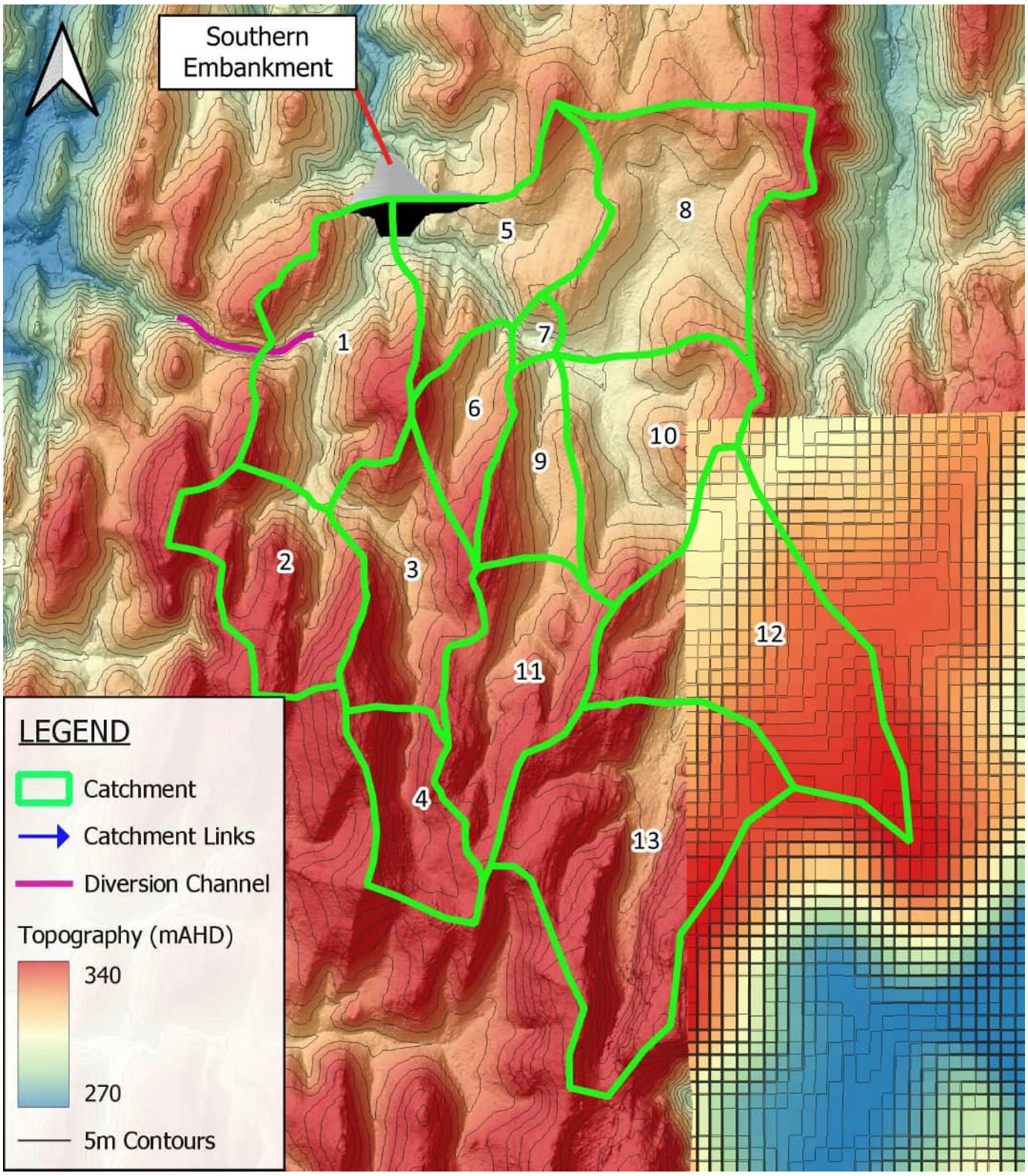


FIGURE 3.1: TSF3 SOUTHERN EMBANKMENT CATCHMENT EXTENT

3.1.2 Hydrological Inputs

As this assessment is adjacent to the TSF3 site, the same hydrological inputs have been used for this assessment.

3.2 Hydrological Model Results

TABLE 3.1 provides the critical duration, temporal pattern, and peak flow for the southern embankment hydrological model for sub-catchment 5. These durations and temporal patterns will be used for the hydraulic assessment.

TABLE 3.1: SOUTHERN EMBANKMENT MODELLING RESULTS

Event	1:100,000 AEP	PMPDF AEP
Peak Flow	119.6 m^3/s	200.5 m^3/s
Critical Duration	45 min TP8	1.5 hours TP3

3.3 Hydraulic Model Inputs

The following sections detail the development of the 2D TUFLOW hydraulic model.

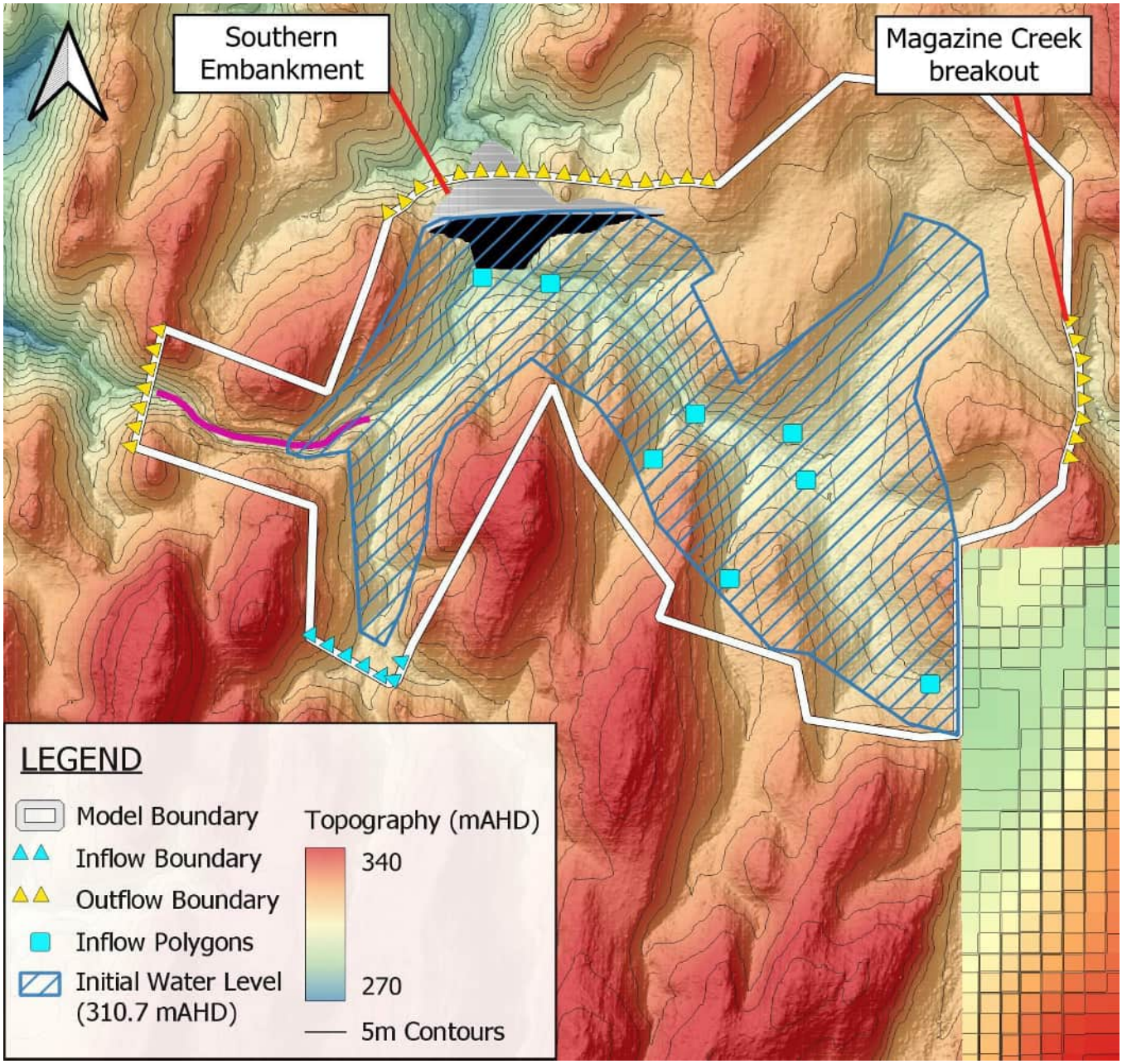


FIGURE 3.2: TSF3 SOUTHERN EMBANKMENT TUFLOW INPUTS

3.3.1 Boundary Conditions

Hydrographs generated for the sub-catchments identified in Figure 3.1 have been applied as inflow boundary conditions 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-catchment's outlet.

The model outflow boundary condition has been generated based on a stage-discharge relationship from the average topographic slope at the model outlet, with an average slope of 11%, based on the provided topography.

3.3.2 Surface Roughness

The catchment area has been modelled with a uniform Manning's Roughness corresponding to a value of 0.06 as light vegetation.

3.3.3 Model Resolution & Time Step

The latest TUFLOW GPU/HPC version 2023-03-AB, has been used for this assessment, which uses a variable time step for the model to provide stable hydraulic results. A model cell size of 5m has been used for this assessment, with a Sub-Grid-Sampling (SGS) size of 1m.

3.4 Hydraulic Model Results

Attached to this memo is the flood depth and velocity results for the 1:100,000 AEP and PMF event.

The flood depth results for the 1:100,000 AEP event is shown in Figure 3.3. A cross-section elevation profile is provided in Figure 3.4 showing the maximum flood height occurring for the 1:100,000 AEP and PMF events, with a maximum predicted flood height of 314.98 mAHD, which is tabulated in Table 3.2. The southern embankment raise preliminary design has a crest level of 317.10 mAHD, indicating that there is 2.12 m of available freeboard. The flood velocities against the embankment are minimal (≤0.1 m/s). Details on erosion protection will be further investigated in the detailed design, but at this stage are not expected to be necessary.

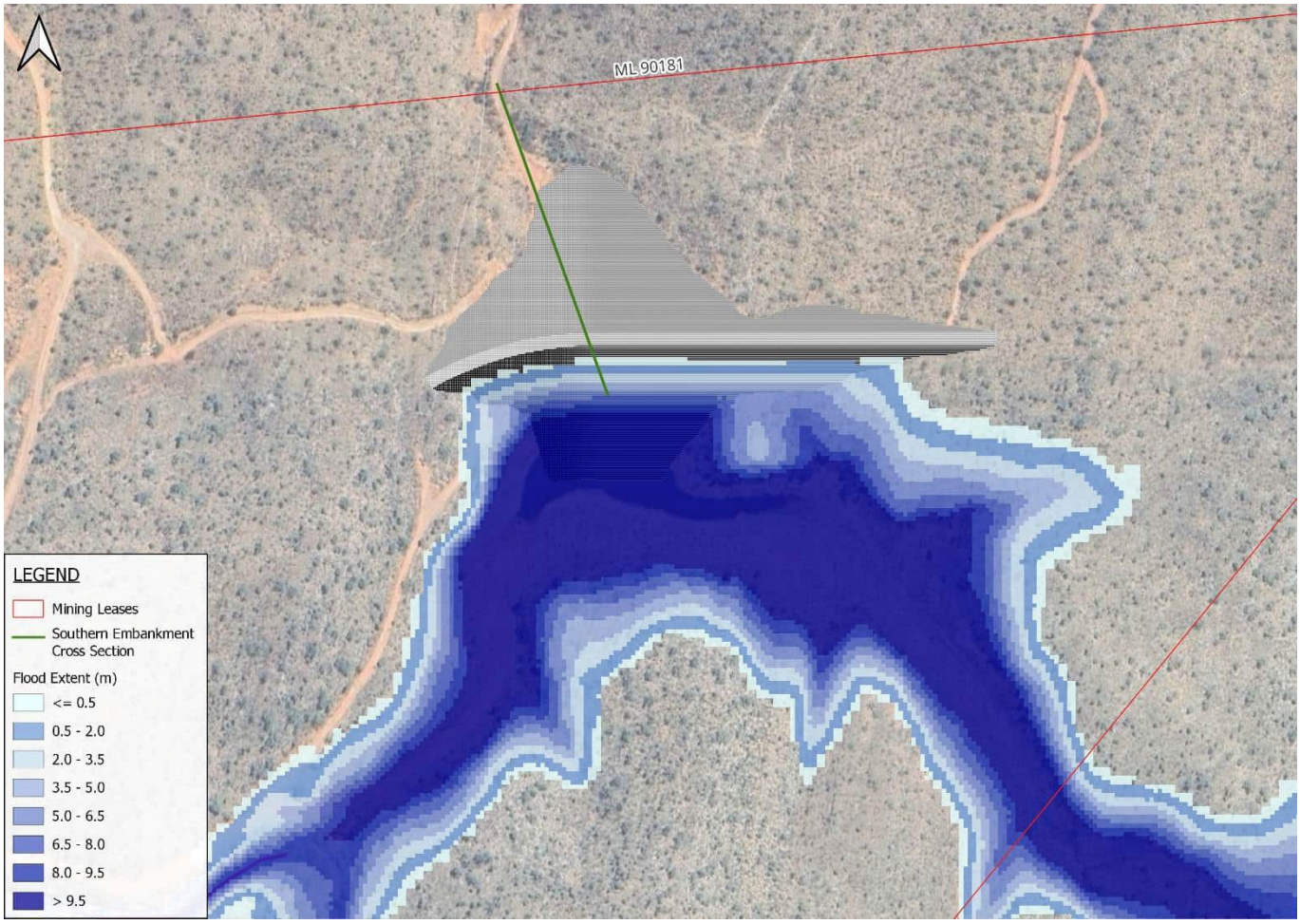


FIGURE 3.3: 1:100,000 AEP FLOOD DEPTH RESULTS

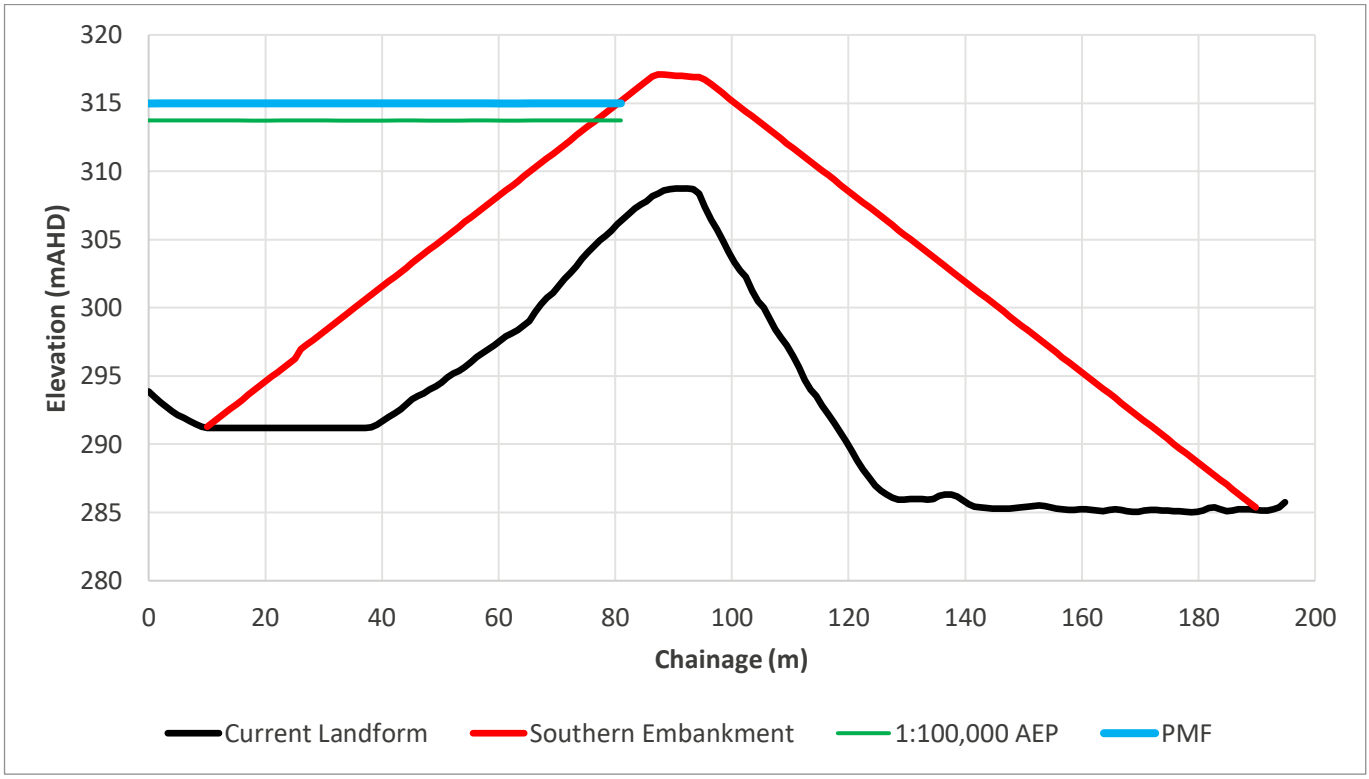


FIGURE 3.4: SOUTHERN EMBANKMENT ELEVATION PROFILE

TABLE 3.2: SOUTHERN EMBANKMENT HYDRAULIC RESULTS

Parameter	Height
Crest Level	317.10 mAHD
1:100,000 AEP Level	313.74 mAHD
PMP Level	314.98 mAHD

4. CONCLUSION

This memorandum has detailed the hydraulic assessments undertaken for the preliminary TSF3 design, detailing the design requirements of the TSF3 spillway and the flood conditions against the TSF3 southern embankment. Table 4.1, Table 4.2 and Table 4.3 provide the key results for the TSF3 spillway assessment and Table 4.4 provides the TSF3 southern embankment key results.

TABLE 4.1: TSF3 SPILLWAY DESIGN

Parameter	Value
Spillway Level	312.2 mAHD
Starting Water Level	312.2 mAHD
Crest Level	314.2 mAHD
Total Available Depth	2 m
Base Width	25 m
Batters	1H:1V

TABLE 4.2: TSF3 1:10 WAVE RUN UP INPUTS

Parameter	Value
Water Depth	2.69 m
1:10 AEP Wind Speed (3-sec duration) – Region A4	34 m/s
Fetch Length	0.77 km
Corrected Wind Speed	27 m/s
Wind Set-Up	0.034 m
Wave Run-Up	0.550 m
1:10 AEP Wind Wave Run-Up Allowance	0.59 m

TABLE 4.3: TSF3 SPILLWAY HYDRAULIC RESULTS

Parameter	1:100,000 AEP	PMPDF
Critical Storm Duration	1.5 hr	3 hr
Peak Spillway Outflow	50.8 m^3/s	84.8 m^3/s
Peak Flood Rise	1.10 m	1.54 m
Peak Flood Rise	313.30 mAHD	313.74 mAHD
Available Freeboard (Crest Level of 314.2 mAHD)	0.90 m (0.31 m with 1:10 Wave Run Up)	0.46 m
Peak Velocity	1.8 m/s	2.1 m/s

TABLE 4.4: TSF3 SOUTHERN EMBANKMENT FLOOD LEVELS

Parameter	Height
Crest Invert	317.10 mAHD
1:100,000 AEP Level	313.74 mAHD
PMP Level	314.98 mAHD

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APPENDIX A: TSF3 SOUTHERN EMBANKMENT FLOOD RESULTS

ML 90181

ML 90180

LEGEND

- Mining Leases

Flood Extent (m)

- <= 0.5
- 0.5 - 2.0
- 2.0 - 3.5
- 3.5 - 5.0
- 5.0 - 6.5
- 6.5 - 8.0
- 8.0 - 9.5
- > 9.5

R	DETAILS	DATE
1	Memorandum	12-05-2025

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DRAWN	LN	CHECKED	SW
APPROVED	SW	DATE	12-05-2025

N

0 0.1 0.2 km

SCALE @ A3 - 1:4,500
GDA94 / MGA zone 54

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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29 Metals

Attachment 1

TSF3 Southern Embankment Flood Immunity

1:100,000 AEP Flood Depth

Drg Ref.
Q1022_018-MEM-001

Q:\Projects\QC1022 29Metals\QC1022_018 *TSF 3 Design & Studies\05 Design\QGIS\Workspaces\QC1022_018 TFS3 Memo_LN.qgz

ML 90181

ML 90180

LEGEND

- Mining Leases

Flood Extent (m)

- <= 0.5
- 0.5 - 2.0
- 2.0 - 3.5
- 3.5 - 5.0
- 5.0 - 6.5
- 6.5 - 8.0
- 8.0 - 9.5
- > 9.5

R	DETAILS	DATE
1	Memorandum	12-05-2025

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DRAWN	LN	CHECKED	SW
APPROVED	SW	DATE	12-05-2025

N

0 0.1 0.2 km

SCALE @ A3 - 1:4,500
GDA94 / MGA zone 54

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DATA SOURCE
QLD Government Open Data Source

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29 Metals

Attachment 2

TSF3 Southern Embankment Flood Immunity

PMP Flood Depth

Drg Ref.
Q1022_018-MEM-002

Q:\Projects\QC1022 29Metals\QC1022_018 ^TSF 3 Design & Studies\05 Design\QGIS\Workspaces\QC1022_018 TFS3 Memo_LN.qgz

ML 90181

ML 90180

LEGEND

- Mining Leases

Flood Velocity (m/s)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 1.5
- > 1.5

R	DETAILS	DATE
1	Memorandum	12-05-2025

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DRAWN	LN	CHECKED	SW
APPROVED	SW	DATE	12-05-2025

N

0 0.1 0.2 km

SCALE @ A3 - 1:4,500
GDA94 / MGA zone 54

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DATA SOURCE
QLD Government Open Data Source

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29 Metals

Attachment 3

TSF3 Southern Embankment Flood Immunity

1:100,000 AEP Flood Velocity

Drg Ref.
Q1022_018-MEM-003

Q:\Projects\QC1022 29Metals\QC1022_018 ^TSF 3 Design & Studies\05 Design\QGIS\Workspaces\QC1022_018 TFS3 Memo_LN.qgz

ML 90181

ML 90180

LEGEND

- Mining Leases

Flood Velocity (m/s)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 1.5
- > 1.5

R	DETAILS	DATE
1	Memorandum	12-05-2025

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DRAWN	LN	CHECKED	SW
APPROVED	SW	DATE	12-05-2025

N

0 0.1 0.2 km

SCALE @ A3 - 1:4,500
GDA94 / MGA zone 54

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DATA SOURCE
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Attachment 4

TSF3 Southern Embankment Flood Immunity

PMP Flood Velocity

Drg Ref.
Q1022_018-MEM-004

Q:\Projects\QC1022 29Metals\QC1022_018 ^TSF 3 Design & Studies\05 Design\QGIS\Workspaces\QC1022_018 TFS3 Memo_LN.qgz

APPENDIX G: PRELIMINARY DSA ASSESSMENT

MEMORANDUM

Project:	TSF3 SWIA	Date:	9 May 2025
To:	CCMPL	From:	Tim Wallis
ATT:	Mike Gunner	CC:	Brendan Wallace; Travis Warren; Mick Hogan; Geraldine McGuire; Barry Shean
Subject:	TSF3 Preliminary DSA and MRL Assessment		

1. INTRODUCTION

1.1 Background

Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29Metals Limited (29Metals), owns and operates the Capricorn Copper Mine (CCM), located in Gunpowder, Northwest Queensland. CCM is operated under the approval of Environmental Authority EPML00911413 (EA) (dated 6 December 2023), administered by the Queensland Department of Environment, Science and Innovation (DESI).

Excessive site water inventory and the low remaining capacity in the current tailings storage facility (TSF), Esperanza TSF (ETSF) resulted in the suspension of mining and ore processing activities in March 2024. The site was subject to severe wet season rainfall events during both the 2022 and 2023 wet seasons. This resulted in the loss of critical infrastructure (flooding of the Esperanza Underground Mine, loss of the existing water treatment plant (WTP), workshops and warehouse area) as well as significant increases to the mine affected water (MAW) inventory which is primarily contained within Esperanza Pit (EPit).

CCPL plan to construct a new TSF (TSF3) at CCM. The new facility will provide approximately 6.5 to 7.5 years of tailings storage capacity and allow CCPL to resume ore processing at CCM. This will be accompanied by the construction of a new purpose built WTP.

1.2 TSF3 Consequence Category Assessment Results

As part of the TSF3 preliminary design (Engeny, 2025), a preliminary consequence category assessment (CCA) has been completed (refer to Table 1.1 below) as per guidance set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (ESR/2016/1933), Version 5.03 (*The Manual*) (DESI, 2024). Key findings of the CCA conclude that:

- Under the failure to contain scenario TSF3 has a preliminary consequence category of 'significant'; and
- Relevant key required hydraulic performance criteria for TSF3 are therefore:
  - A mandatory reporting level (MRL) corresponding to an extreme storm surge (ESS) volume resulting from the 1:20 AEP 72-hour storm volume assuming 100% runoff; and
  - A design storage allowance (DSA) equivalent to the 1:20 AEP wet season increase:
    - CCPL have chosen to adopt the method of operational simulation to estimate the DSA volume for the system of integrated regulated storages at CCM.
    - The system of integrated storages comprises the existing ETSF, Mill Creek Dam (MCD) and EPit as well as the proposed TSF3.

TABLE 1.1:TSF3 DESI CCA PRELIMINARY CONSEQUENCE CATEGORY ASSESSMENT

Failure Scenario	Consequence Category
Failure to Contain – Seepage	Low
Failure to Contain – Overtopping	Significant
Dam Break	High
Overall	High

1.3 Method of Operation Simulation Methodology

The preliminary DSA for the CCM integrated containment system including the proposed TSF3 has been assessed using the method of operational simulation and using the calibrated site water balance model (WBM) which is described in the CCM Site Water Management Plan Report (Engeny, 2024). The method of operational simulation is described in Appendix 2 of The Manual. This method for estimating DSA can be used at the discretion of a suitably qualified and experienced person where there is local historical monitoring data for a sufficient period to form a basis for robust validation of modelling methods and assumptions (DESI, 2024)

1.4 Limitations

Comprehensive documentation including a certified System Desigin plan (SDP) describing the modelling process including calibration, inputs, assumptions and results is required to provide sufficient detail to enable independent replication of the model representation and assessed performance outcomes. While this preliminary DSA and MRL assessment for the revised integrated containment system at CCM has been conducted as per guidance set out in *The Manual* it is subject to the following limitations:

- The assessment is based on the preliminary design for TSF3, and data and assumptions provided by CCM. As such results may change as the design progresses to finalisation.
- While a high-level summary of key inputs and assumptions has been provided it does not constitute a SDP and as such, a certified SDP will be submitted to DESI upon approval of the TSF3 major EA amendment and finalisation of the TSF3 design; and
- No certification is provided with this preliminary DSA and MRL assessment.

2. INPUT DATA AND ASSUMPTIONS SUMMARY

2.1 Model Input Data and Assumptions

Table 2.1 below summarises key input data and assumptions used in the DSA assessment. Where relevant data and assumptions have been carried over from existing reports reference has been provided to the relevant documents. As noted above, this document provides summary detail of the preliminary DSA MRL assessment for TSF3 however it is not intended to be a substitute for a detailed System Design Plan (SDP). The detailed SDP will be developed upon finalisation of the TSF3 design.

TABLE 2.1: TSF3 KEY INPUT DATA AND ASSUMPTIONS SUMMARY

Aspect	Description	Comment	Reference
Water balance model (WBM)	GoldSim WBM used for the method of operational simulation	The existing calibrated site WBM has been modified to include the proposed TSF3	• Refer to the CCM Site Water Management Plan Report (Engeny, 2024) for details of the existing WBM and calibration
Model schematic	Updated site WBM schematic showing incorporation of TSF3 into the integrated containment system.		• Details of the water management system provided by CCPL, refer to Figure 2.1 for WBM schematic
Production[1]	Assumed rate of ore processing	Full production assumed for duration of assessment (12 months): • Ore processed - 140 Kt/mon • Concentrate – 8.4 Kt/mon • Tailings produced – 131.6 Kt/mon • Tailings to paste – 11% • Tailings to TSF3 – 117.1 Kt/mon	• CCPL
Tailings properties	Assumed tailings properties used in WBM	• Settled density – 1.65 tonne/m^3 • Tailings specific gravity – 2.82 tonne/m^3 • Tailings volume deposited in TSF3 included in DSA assessment	• Refer to TSF3 preliminary Design report (Engeny, 2025)
Evaporators[2]	Mechanical evaporators installed in EPit	• Two banks in operation (6 units in total) • Mean availability - 69% • Efficiency - varies monthly • Aggregated feed rate (after availability and before application of evaporative efficiency) – 100 L/s	• Refer to Figure 2.1 for monthly efficiency • Evaporator configuration, availability and feed rate data provided by CCM

Aspect	Description	Comment	Reference
Water treatment	Treatment of mine affected water (MAW) for process use and controlled releases	• Assumed that the new Ausenco WTP will be in operation with 15 ML/d capacity (12.75 ML/d after 85% availability assumption), providing water to the process plant and other relevant demands. • Excess treated water stored in MCD prior to release to Gunpowder Creek • WTP sludge byproduct co-disposed in TSF3. Sludge generation assumed at 0.54%. Sludge volume included in DSA assessment.	• Refer to TSF3 preliminary Design report (Engeny, 2025)
Controlled releases[3]	• Releases of treated mine affected water (MAW).	• Controlled releases as per existing EA conditions (limited to 500ML per annum, max of 70ML per 72-hr, 1:10 dilution and 1.1m³/s trigger). • Treated water released from MCD at up to 70 ML/d (63 ML/d after 90% availability assumption)	• EPML00911413 (dated 6 December 2023).
Modelled representation of TSF3[4]	• Storage curve • Catchment area	• The TSF3 storage curve (refer to Figure 2.2) represents a worst-case scenario at the end of deposition when TSF3 water storage capacity is at a minimum. • Total catchment of 79 Ha which is comprised of tailings (39 Ha) and natural (40 Ha).	• Refer to TSF3 preliminary Design report (Engeny, 2025).
Operation of TSF3	• Decant pumping destinations and pump capacity. • Decant pond operation	• 200 L/s pump capacity • Maintain decant pond at optimal 1m depth (25.2 ML). • Pumped to EPit	• Pump preliminary sized to restore decant pond depth to 1m following inflow of ESS storm volume (171.4 ML, refer to Section 3.1) within 10 days.
Other water management operations	• Water transfers • Water demands (process, dust suppression, potable, etc.).		• Refer to the CCM Site Water Management Plan Report (Engeny, 2024).
Initial volumes	• Starting volumes for all storages in the system of integrated storages (ETSF, EPit, MCD and TSF3).	• ETSF assumed empty (no longer in operation). • TSF3 assumed to be at optimal 1 m pond depth (25.2 ML). • MCD assumed to be at existing DSA (RL 216.1 M AHD (313 ML)) • EPit initially assumed at existing DSA with final DSA assessment conducted assuming a starting level equivalent to the current EPit MRL (217.9 m AHD (1,293 ML))	

Notes

1 – Base case (Sc0) assumes full nameplate production. Sensitivity scenario (Sc3) considers NO production.

2 – Base case (Sc0) assessment assumes evaporators ON. Sensitivity scenario (Sc1) considers evaporators OFF

3 – Base case (Sc0) assessment assumes releases ON. Sensitivity scenario (Sc2) considers releases OFF

4 – Catchment landuse sensitivity scenario considered (Sc4).

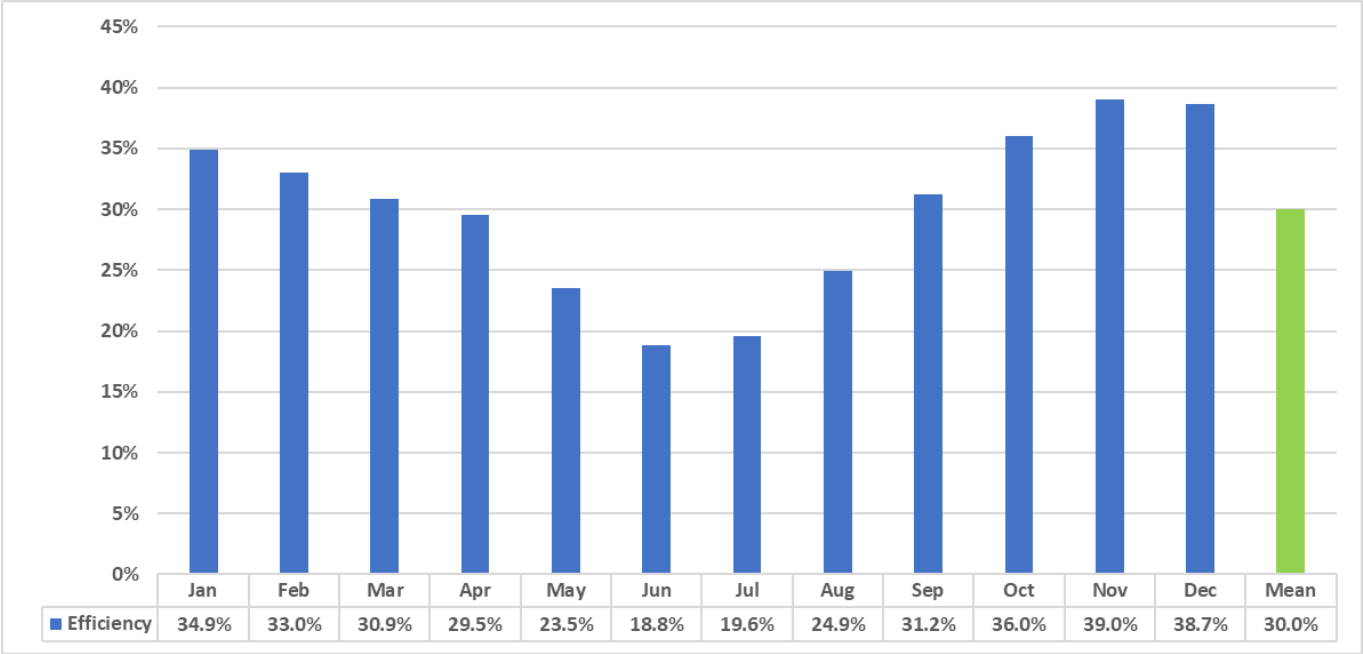


Figure 2.1: Modelled Evaporator Efficiency

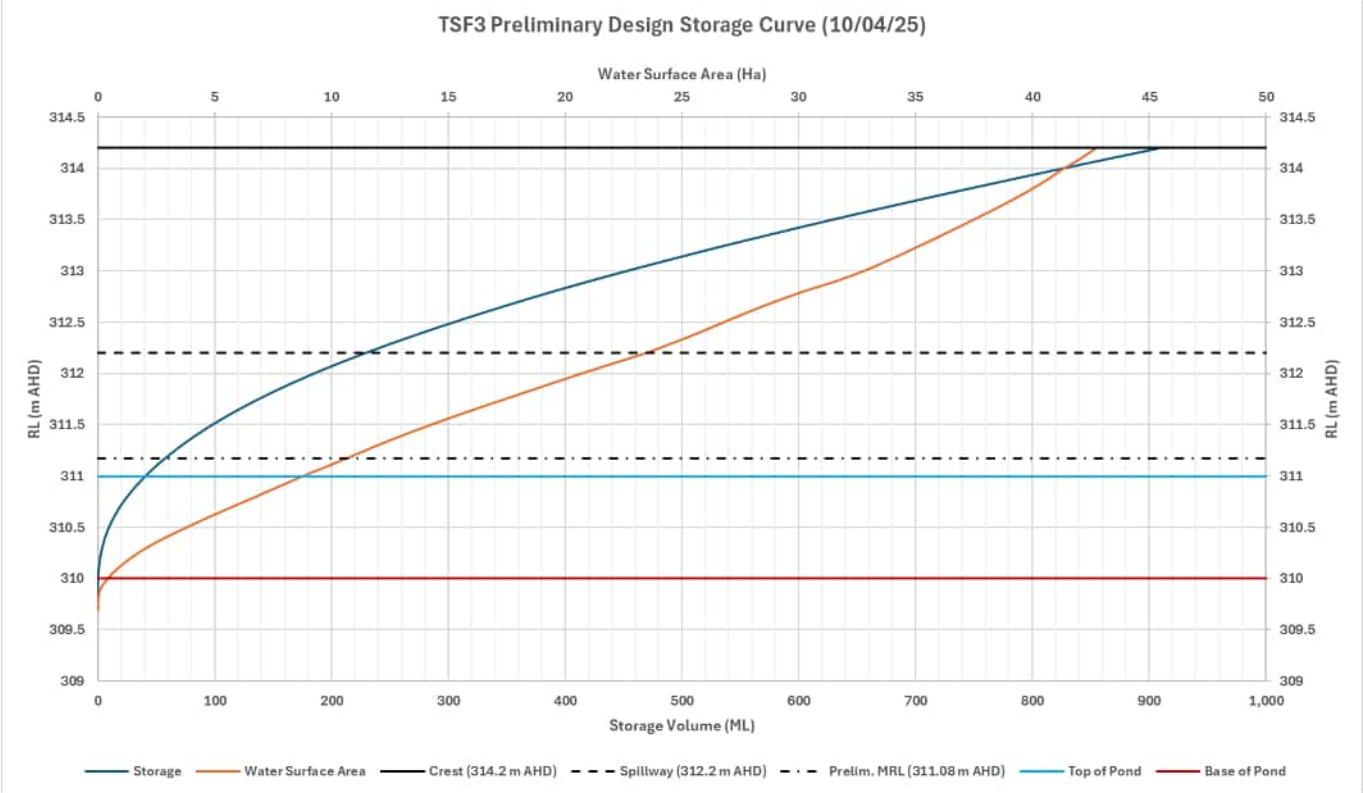
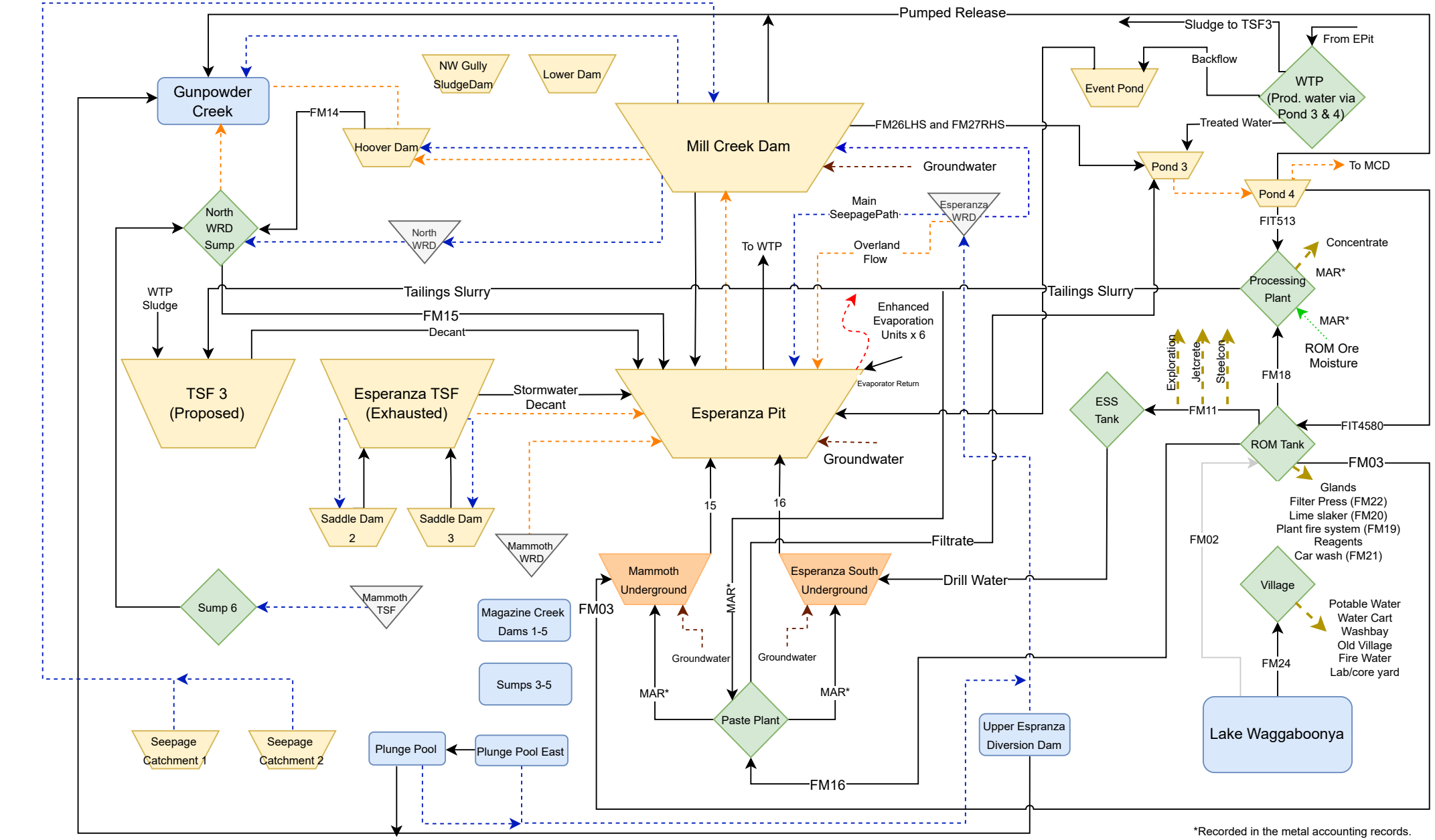


Figure 2.2: TSF Storage Curve



*Recorded in the metal accounting records.

Legend

- Clean Water System
- Storage
- Underground Mine
- Sump or Plant Item
- Seepage Catchment
- Pumped Flow
- Seepage
- Overflow
- Groundwater Inflow
- Inflow (labelled)
- Overflow
- Outflow (labelled)
- Not Currently Operating

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Water Management Schematic

TSF3 SWIA - Proposed WMS Arrangement

Job Number: QC1022_018
Revision: 18
Drawn: TW
Checked: TW
Date: 9/05/2025

2.2 Modelling Approach

Table 2.2 below summarises the adopted modelling approach.

TABLE 2.2: MODELLING APPROACH

Aspect	Description	Comment
Simulation duration and realisations	• Length of modelled simulation	• One year commencing 1 Nov • 134 realisations
Climate data	• Input climate data – rainfall and evaporation	• SILO Data Drill
Model timestep		• Daily
Adopted Desigin Simulation Margin	• In accordance with *The Manual*, a DSM has been applied to the 1:20 AEP wet season accumulation volume to provide conservative compensation for uncertainty in model inputs and model accuracy.	• 25% DSM adopted as per (Engeny, 2023a)
Sensitivity scenarios	• The DSA has been tested for sensitivity to key inputs or assumptions.	• Refer to Section 3.3

3. ASSESSMENT RESULTS

3.1 Preliminary ESS and MRL

As noted in Section 1.2, TSF3 is required to have a MRL equivalent to the ESS volume resulting from the 1:10 AEP 72-hour storm assuming 100% runoff. Table 3.1 summarises the results of the preliminary ESS and MRL assessment and indicates that the preliminary ESS is 171.4 ML which equates to a MRL of 311.18 m AHD.

TABLE 3.1: TSF3 PRELIMINARY ESS AND MRL RESULT

Aspect	Comment
1:10 72-hr rainfall depth	217 mm
TSF3 total catchment	79 Ha
Extreme Storm Surge (ESS)	171.4 ML
TSF3 Spillway level	312.2 m AHD
Preliminary Mandatory Reporting Level (MRL)	311.18 m AHD

3.2 Preliminary DSA

The preliminary 1:20 AEP wet season inventory increase for the ETSF, EPIT, MCD and TSF3 integrated system is summarised as follows:

- Combined 1:20 AEP (95th percentile or 5% AEP) wet season inventory increase in EPit, ETSF, MCD and the proposed TSF3 (refer Figure 3.1) – **434 ML**.
- Design Simulation Margin – **25% (109 ML).**
- Combined Design Storage Allowance for EPit, ETSF, MCD and proposed TSF3 – **543 ML.**

It is noted that as the estimated integrated containment system DSA is less than combined MRL volume, MRL would be adopted for DSA as the DSA cannot be less than the MRL. The current combined MRL volume of MCD and EPit is 678ML with an additional 171.4 ML preliminarily estimated for TSF3. In total, the combined MRL volume for the integrated containment system is therefore 849.4 ML and this would be adopted for the system DSA (Table 3.2).

TABLE 3.2: PRELIMINARY MRL AND DSA SUMMARY

Storage	MRL	DSA
Mill Creek Dam (MCD)	234.6 ML (217.7 m AHD)	234.6 ML (217.7 m AHD)
Esperanza Pit (EPit)	443.4 ML (217.9 m AHD)	443.4 ML (217.9 m AHD)
Esperanza TSF (ETSF)	N/A - provided within EPit	N/A - provided within EPit
TSF3 (preliminary)	171.4 ML (311.18 m AHD)	171.4 ML (311.18 m AHD)

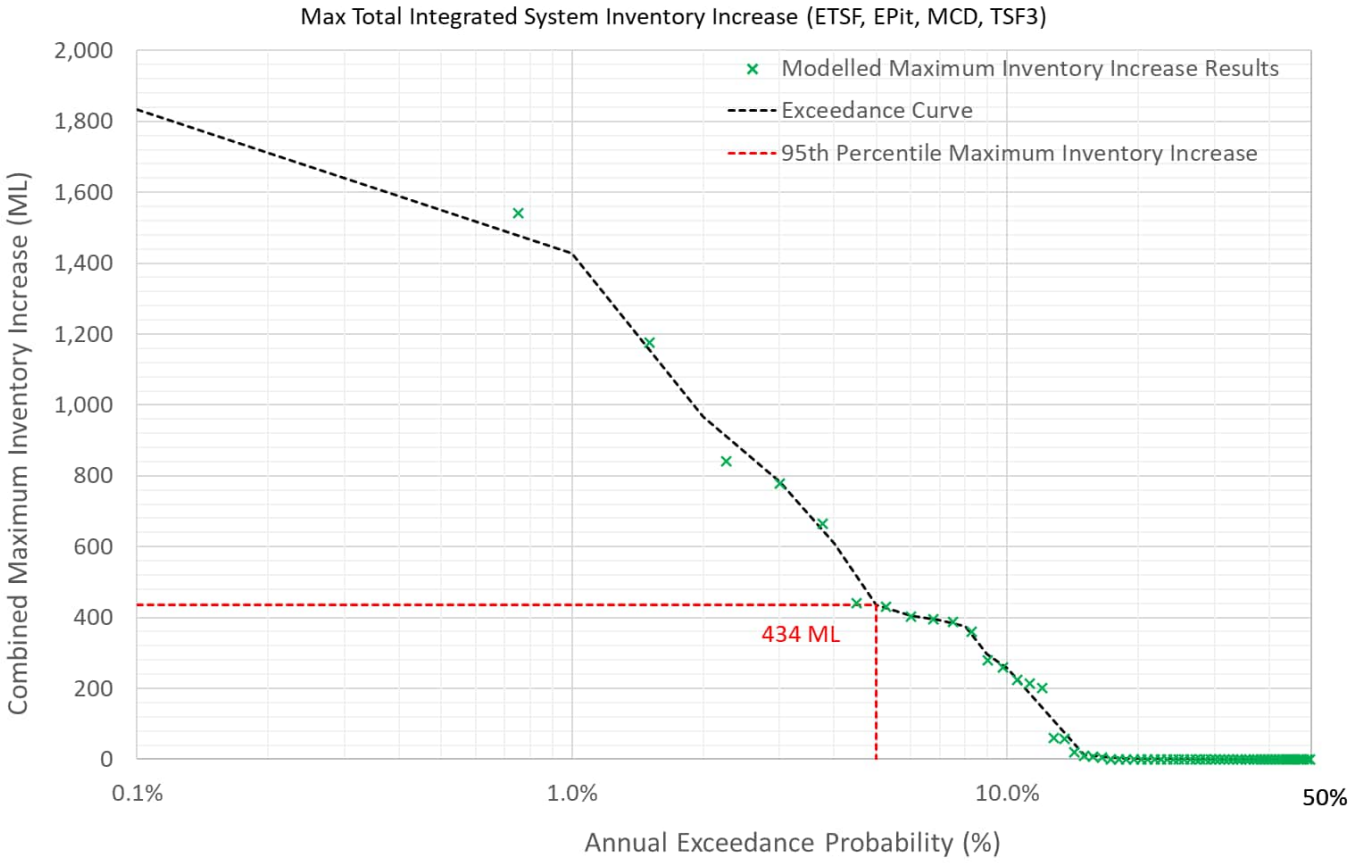


Figure 3.1: DSA Result for CCM Integrated System Including Proposed TSF3

3.3 DSA Sensitivity Assessment

Several sensitivity analysis scenarios were completed using the WBM to assess the sensitivity of the DSA volume to key inputs and assumptions. Scenarios assessed and results are summarised in Table 3.3 below:

- Each sensitivity scenario resulted in an increase to the Base Case DSA (Sc0) with the no evaporators (Sc1) resulting in the largest increase (141%) to the base case (Sc0) DSA.
- While the results of Scenario 1 and 2 (no evaporators and no releases respectively) result in an estimated DSA 141% and 110% of the total MRL respectively, both represent unlikely scenarios and significant additional contingency storage (approximately 2.6 GL) is available in EPit between the MOL and spillway level.
- The preliminary DSA results for the integrated containment system including the proposed TSF3 indicate that adoption of the combined system MRL volume as the system DSA provides significant contingency to contain the estimated Combined 1:20 AEP (95th percentile or 5% AEP) wet season inventory increase.

TABLE 3.3: SENSITIVITY ASSESSMENT SUMMARY

Scenario	Name	Description	DSA (ML)	DSA with 25% DSM (ML)	DSA Change from Base Case	System Total MRL (ML)	DSA % of System MRL
Sc0	Base Case	• Controlled releases of treated MAW to Gunpowder Creek ON • Full production • Evaporators ON	434	543	N/A	849	51%
Sc1	Evaporators	• Epit mechanical evaporators OFF	1,045	1,307	141%	849	123%
Sc2	No release	• NO controlled releases of treated MAW to Gunpowder Creek	913	1,141	110%	849	107%
Sc3	No production	• NO ore processed (underground mine dewatering, evaporators and releases maintained)	827	1033	90%	849	97%
Sc4	100% tailings surface	• 100% of TSF3 catchment assumed to comprise tailings	592	739	36%	849	70%

4. SUMMARY

A preliminary DSA and MRL assessment for the proposed TSF3 has been completed as part of the TSF3 preliminary design. Key conclusions are that:

- A preliminary CCA for TSF3 indicates that TSF3 will require:
  - A MRL corresponding to an ESS volume resulting from the 1:20 AEP 72-hour storm volume assuming 100% runoff; and
  - A DSA equivalent to the 1:20 AEP wet season increase.
- TSF3 will form part of the existing integrated containment system that comprises ETSF, EPit and MCD.
- The preliminary TSF3 ESS volume of 171.4 ML will be allocated to TSF3.
- Using the method of operational simulation DSA for the integrated containment system has preliminarily been estimated as 434 ML. This volume has increased since the previous assessment due to:
  - Reduction in the number of evaporators (approximately 130 ML increase to DSA)
  - Changes to runoff parameters resulting from model calibration update (approximately 80 ML increase in DSA)
  - General updates and improvements to the WBM to better represent the WMS including the water treatment system and release functions, revised storage curves for EPit and MCD
- A DSM of 25% has been applied to the DSA volume which results in a total system DSA volume of 543 ML.
- The total estimated combined MRL volume for the system is 849 ML and would therefore also be the DSA volume as the DSA cannot be less than the MRL volume.
- DSA volumes for MCD, EPit and TSF3 would therefore be equivalent to the MRL.
- In the unlikely event of an exceedance of an inflow volume exceeding the proposed combined DSA/MRL volume, significant contingency storage is available within the integrated containment system. This volume of approximately 2.6 GL is available within EPit and, while not used for normal operations, may act as a temporary storage to contain additional inflows in excess of the DSA/MRL volume.
- Practical considerations of operating MCD and EPit with the same RL for DSA and MRL have not been considered in this assessment however it is recommended that CCM consider implementation of a normal operating level lower than DSA/MRL. Under normal operations this would limit incoming transfers to MCD or EPit and provide for a rainfall/runoff buffer and reduce the likelihood of frequent MRL exceedances.

5. REFERENCES

DESI. (2024). *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933. Version 5.03).*

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APPENDIX H: SEEPAGE ASSESSMENT

MEMORANDUM

Project:	TSF 3 Preliminary Design Studies	Date:	19 July 2024
To:	29 Metals	From:	Congrui Li and Yohannes Yihdego
ATT:	Michael Hogan	CC:	Brendan Wallace and Travis Warren
Subject:	TSF3 Groundwater 2D Seepage Modelling		

Introduction

Engeny has developed a two-dimensional (2D) model in SEEP/W (GeoStudio 2023.1.2 version 23.1.2.11) as part of the preliminary design of the proposed tailings storage facility, TSF 3. The purpose of the model is to estimate the extent of seepage to groundwater as a result of the proposed TSF3.

The assessment of potential groundwater impacts related to TSF 3 are reported separately in the TSF 3 Groundwater Impact Assessment (Engeny ,2024b)

This modelling aims to replicate and improve on a previous seepage study by ATC Williams (2023), developed to assess the seepage risk associated with a water storage for the same Upper Esperanza Valley that was proposed at the time.

Updates to the SEEP/W model include:

- Update of the geological structures (Engeny, 2024a).
- Inclusion of tailings storage to the model.
- Inclusion of decant pond to the model.
- Inclusion of unsaturated flow in the model.
- Application of a seepage face along the north embankment to the Esperanza Pit (EPit).

The model cross section has been selected to align with the expected south-north groundwater flow-path from TSF3 to E Pit, which is considered to be a sink for TSF3 (ATCW, 2023). A decant pond will form above the tailings against the northern embankment. The orientation of the model cross-section in relation to the TSF3, E Pit and site geology is shown in Figure 1. The SEEP/W model cross-section with boundary conditions is shown in Figure 2.

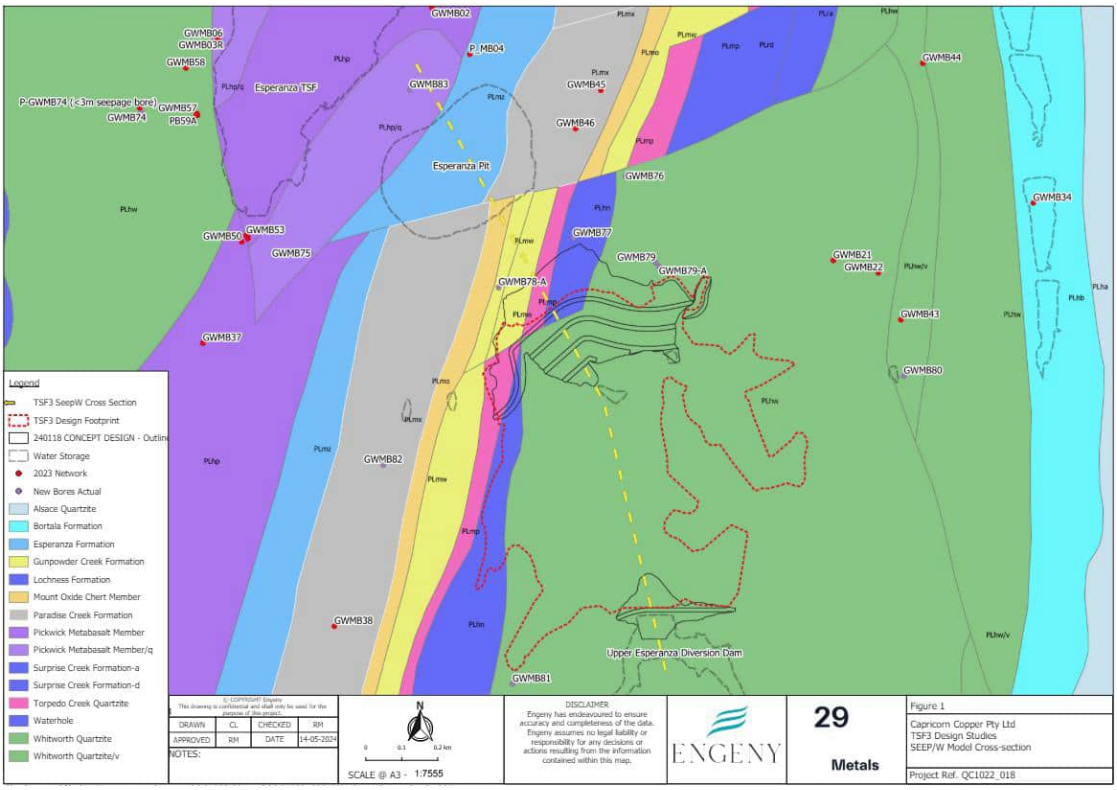


FIGURE 1: MODEL CROSS-SECTION LOCATION

Boundary Conditions

Model boundary conditions were assigned to represent the groundwater system (Figure 2):

- A constant head (RL 214.7 m) was applied at the Esperanza Pit to represent the water level within the pit as surveyed in October 2022.
- A constant head was applied across the expected extent of the decent pond above the tailings to represent the maximum design water level (RL 310.1 m) of the decant pond under normal operating conditions.
- Constant head boundaries were specified at the southern (RL 266 m) and northern (RL 247 m) limits of the model. The values applied were obtained from the previous SEEP/W model (ATC Williams, 2023).
- Seepage faces were applied along the waste rock embankment of TSF3 and the natural ground surface in the downstream of the TSF3 to allow the development of water seepage (Figure 2).

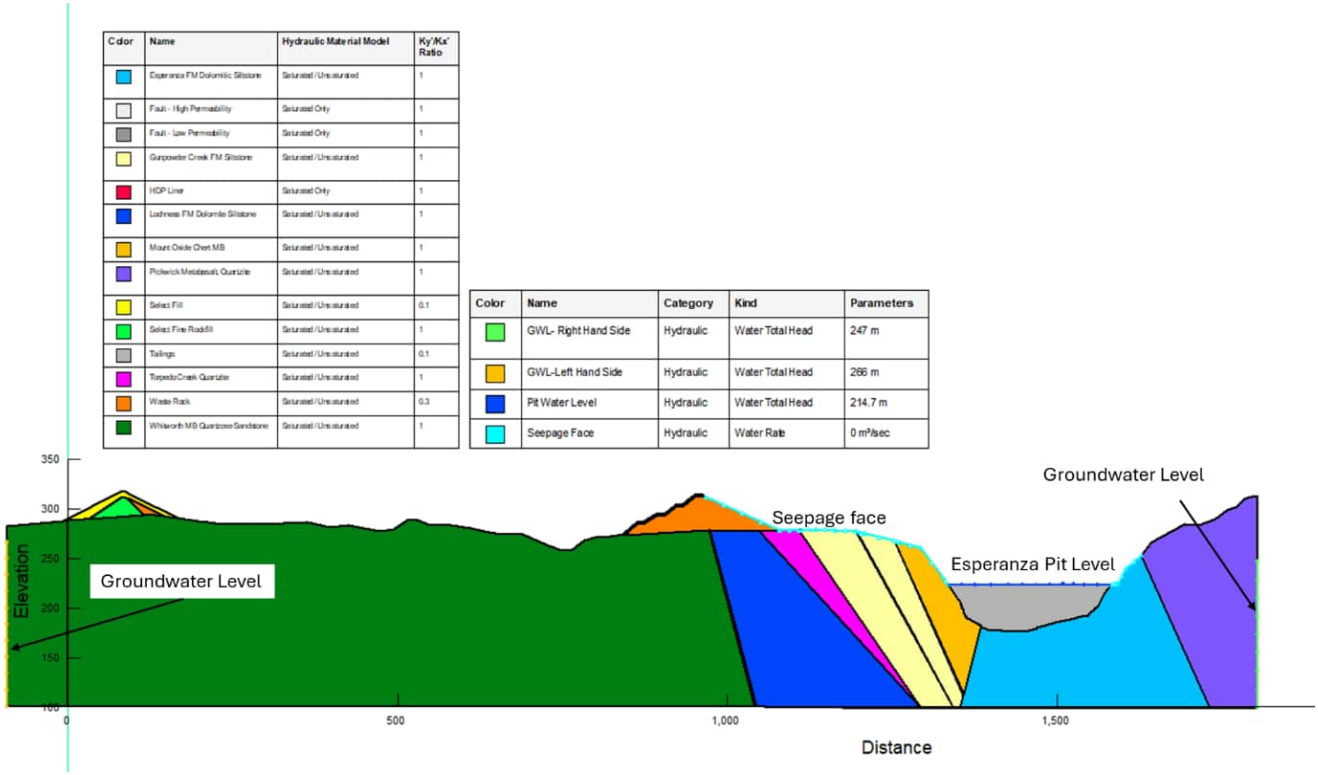


FIGURE 2: MODEL CROSS-SECTION BASE CASE

Material Parameters

Material parameters applied for the seepage modelling were obtained from the previous SEEP/W model (ATCW, 2023). Additions to the model include:

- The waste rock embankment will be covered by a low permeable geomembrane liner, nominally a High Density Polyethylene (HDPE) liner overlying a select fill cushion layer.
- Materials are simulated with unsaturated/saturated flow, allowing for variance of the water content in the materials which may affect the permeability and flow rate in the unsaturated area.
- The model assumes the hydraulic conductivity (K) of the faults decreases with depth, and therefore a low permeable fault material was assigned below 100m depth of the ground surface.

A summary of the adopted K values are listed in Table 1.

TABLE 1: MATERIAL PARAMETERS FOR SEEPAGE ANALYSES

Geological Unit / Structure	Hydraulic Conductivity, Kx, sat (m/s)	Material Mode	Ky/Kx	Residual Water Content	Saturated Water Content
Esperanza FM Dolomitic Siltstone	5.8E-07	Saturated/Unsaturated	1	0.05	0.2
Fault – High Permeability	5.2E-06	Saturated	1	-	-
Fault – Low Permeability	5.2E-09	Saturated	1	-	-
Gunpowder Creek FM Siltstone	2.3E-07	Saturated/Unsaturated	1	0.05	0.2
Lochness FM Dolomite, Siltstone	5.6E-06	Saturated/Unsaturated	1	0.05	0.2
Mount Oxide Chert MB	5.8E-07	Saturated/Unsaturated	1	0.05	0.2
Pickwick Metabasalt, Quartzite	1.0E-06	Saturated/Unsaturated	1	0.05	0.2
Select Fine Rockfill	1.0E-05	Saturated/Unsaturated	1	0.08	0.4

Geological Unit / Structure	Hydraulic Conductivity, Kx, sat (m/s)	Material Mode	Ky/Kx	Residual Water Content	Saturated Water Content
Select Fill	1.0E-07	Saturated/Unsaturated	0.1	0.12	0.38
Tailings	7.4E-07	Saturated/Unsaturated	0.1	0.13	0.46
Torpedo Creek Quartzite	9.0E-07	Saturated/Unsaturated	1	0.05	0.2
Waste Rock	1.0E-05	Saturated/Unsaturated	0.3	0.075	0.3
Whitworth MB Quartzose Sandstone	1.5E-08	Saturated/Unsaturated	1	0.05	0.2
HDP Liner	1.0E-12	Saturated	1	-	-

Assumptions and Limitations

The assumptions and limitations applied to the seepage modelling include:

- This seepage analysis was conservatively adopted for the modelling to represent the existing, long-term conditions (namely, inflow equals outflow). Seasonal variation was not accounted for, hence transient modelling was not undertaken.
- Groundwater levels at the far southern and northern boundary of the model were assumed to be static.
- No changes in the permeability of the faults within the model were considered after the commencement of water storage within the Upper Esperanza Valley.
- The seepage analysis was undertaken to predict the long-term change in groundwater levels and therefore any changes in seepage flow rates. This is considered to be a conservative strategy given that the steady state condition is not expected to establish in the Upper Esperanza Valley once tailings storage commences.
- The effect of underground mining on the groundwater under TSF3 was not considered in this study due to the limited monitoring data in this area.
- The flow along the faults is not represented in the model as the major flow path is assumed to be from TSF3 to the open pit.
- The section selected for the model (replicated from ATCW, 2023) is noted to exclude the Paradise Formation geological unit, which faults at the interface of the Esperanza Pit.
- The foundation of TSF3 (e.g. Quartzose Sandstone) was assumed to be relatively low permeability value and isotropic.

Model Scenarios

The base case scenario (Figure 2) represents the area without tailings to indicate groundwater differences from ATCW model with updated geological data.

The model simulation contains two scenarios to estimate effect of tailings storage and a proposed HDP liner on seepage from TSF3.

- Scenario 1 assumes the tailings are placed directly on the waste rock embankment (no liner) with the decant pond at maximum normal operating level (Figure 3).
- Scenario 2 assumes Scenario 1 and includes a low permeable liner and select fill cushion layer added between the tailings and waste rock embankment. (Figure 4).

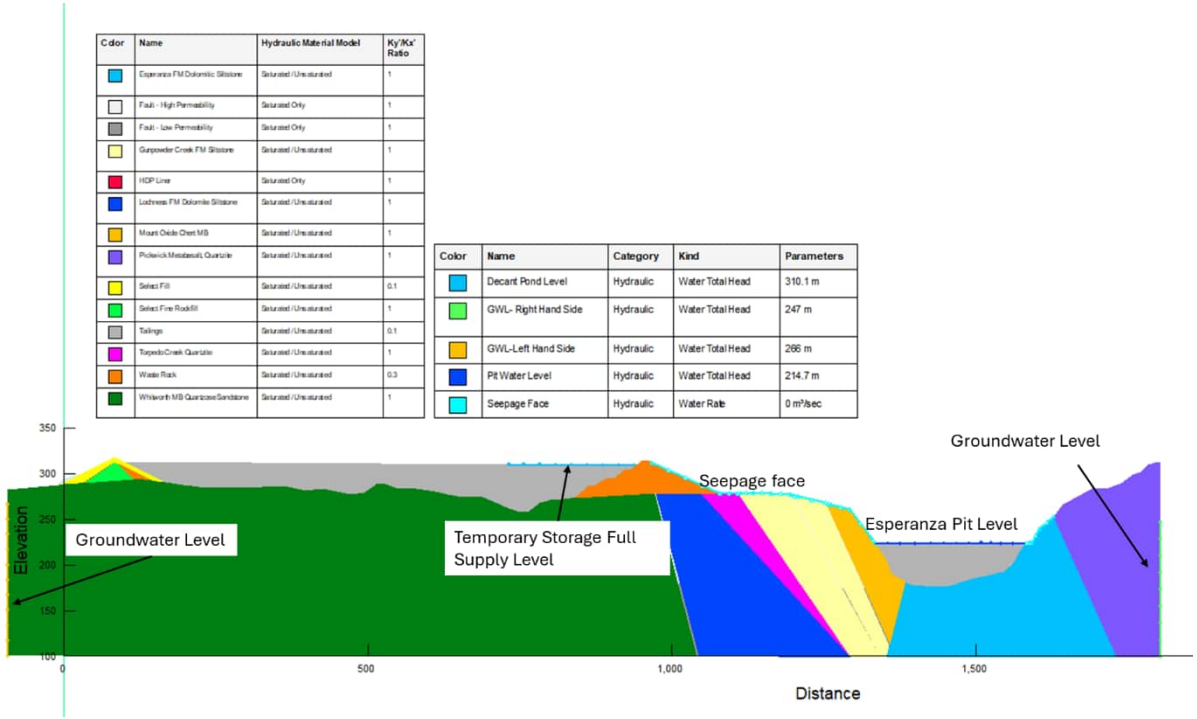


FIGURE 3: MODEL CROSS-SECTION WITHOUT HDPE LINER (SCENARIO 1)

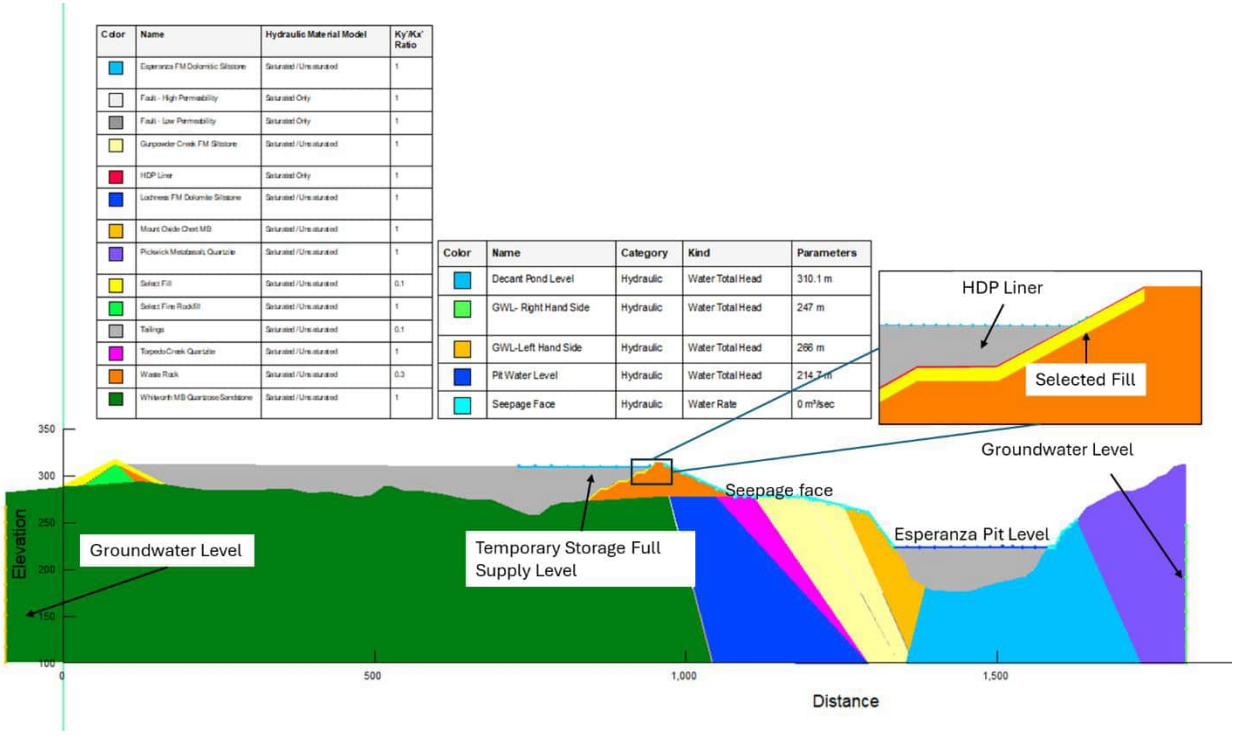


FIGURE 4: MODEL CROSS-SECTION WITH HDPE LINER (SCENARIO 2)

Model Results

Base Case

The modelled natural groundwater table without tailings is shown in Figure 5. The groundwater depth ranges from approximately 34 to 55 m (RL 260 to 220 m) in the tailings area. The seepage rate to the Esperanza Pit is 0.01m^3/m/d. These results are consistent with the outputs from ACTW (2023), which concluded the water depth was from ~30 to 70m and rate was 0.01m^3/m/d.

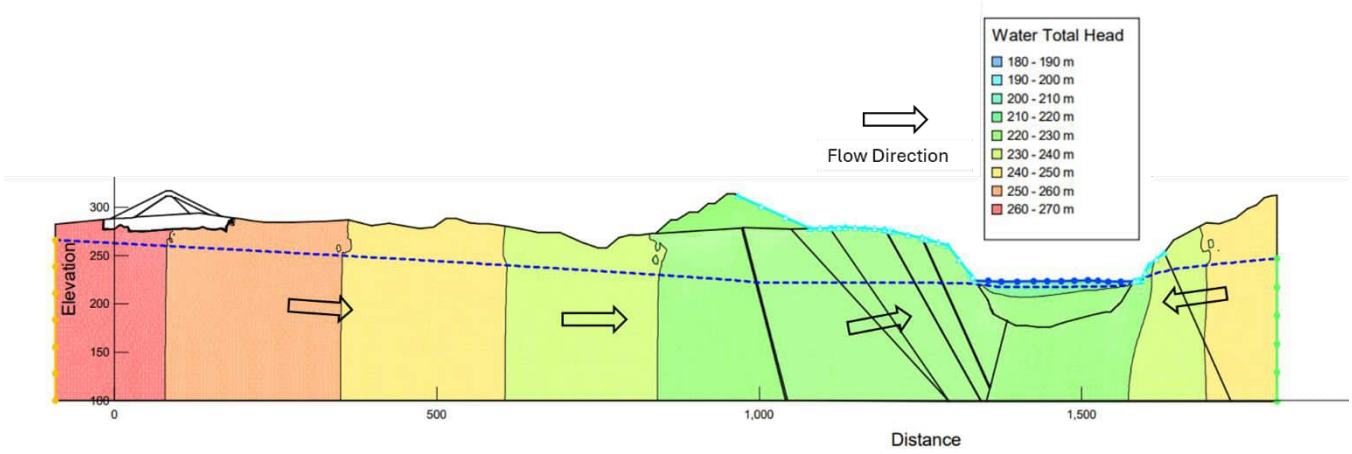


FIGURE 5: WATER TABLE IN THE DOWNSTREAM OF TSF3 – BASE CASE

Scenario 1 - Without Liner

Without the HDPE liner, the water from decant pond flows into the waste rock embankment and remains a relatively shallow aquifer (~6 to 20m depth from the surface) along the downstream ground. The model shows the groundwater table could raise and diverge at location of x=500 m in the natural ground due to infiltration from the decant pond. At the divergence location, the water table is raised by 59 m (from RL 244 m in the base case to RL 303m) (Figure 6), indicating a potential change of the groundwater flow direction to the south as a result of the tailings storage. Seepage occurs at approximately RL 231 m in the wall of the open pit at a rate of 0.30m^3/d/m (Table 2).

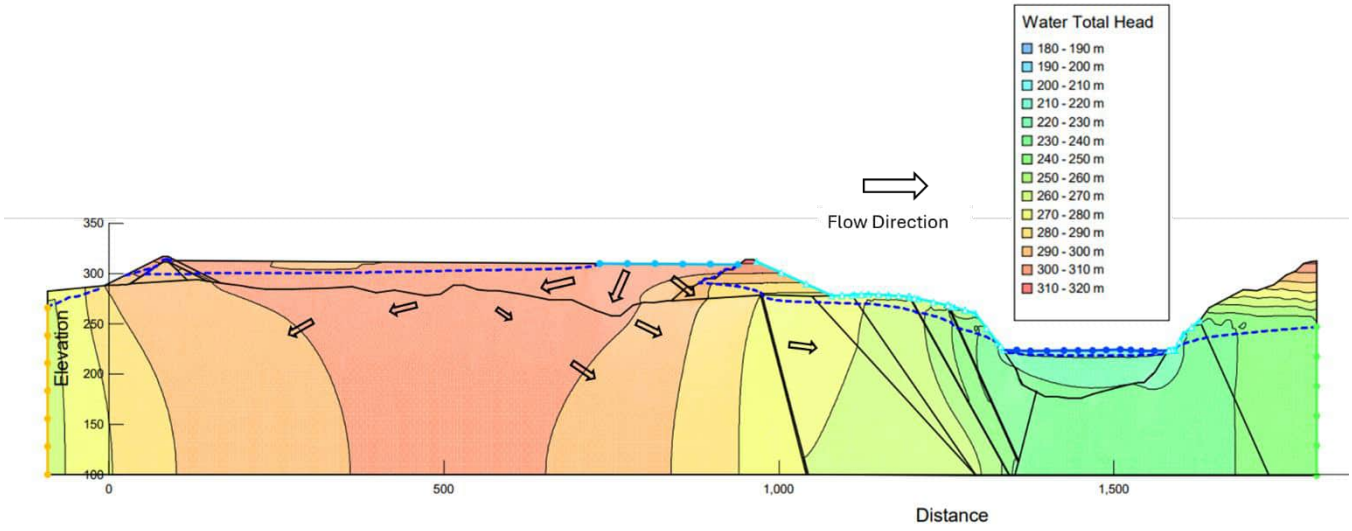


FIGURE 6: WATER TABLE IN THE DOWNSTREAM OF TSF3 – WITHOUT LINER

Scenario 2 – With HDPE Liner

With the liner, the water from the decant pond enters into the groundwater through the bottom of the tailings. The result shows the flow diverges at the location of x=650 m (Figure 7). The divergence location moves further north compared with the non-liner case, indicating more water may flow southward. At this divergence location, the water table in the tailings storage area increases by 65 m from RL 239 m (in the base case) to RL 304 m and indicates a potential change of the groundwater flow direction to the south as a result of the tailings storage. The water table remains relatively high (RL 280 m), decreasing to RL 230 m near the fault due to the high permeability of the fault and Lochness FM Dolomite Siltstone. Seepage from the pit surface is reduced to 0.05m^3/d/m with the addition of a liner (Table 2).

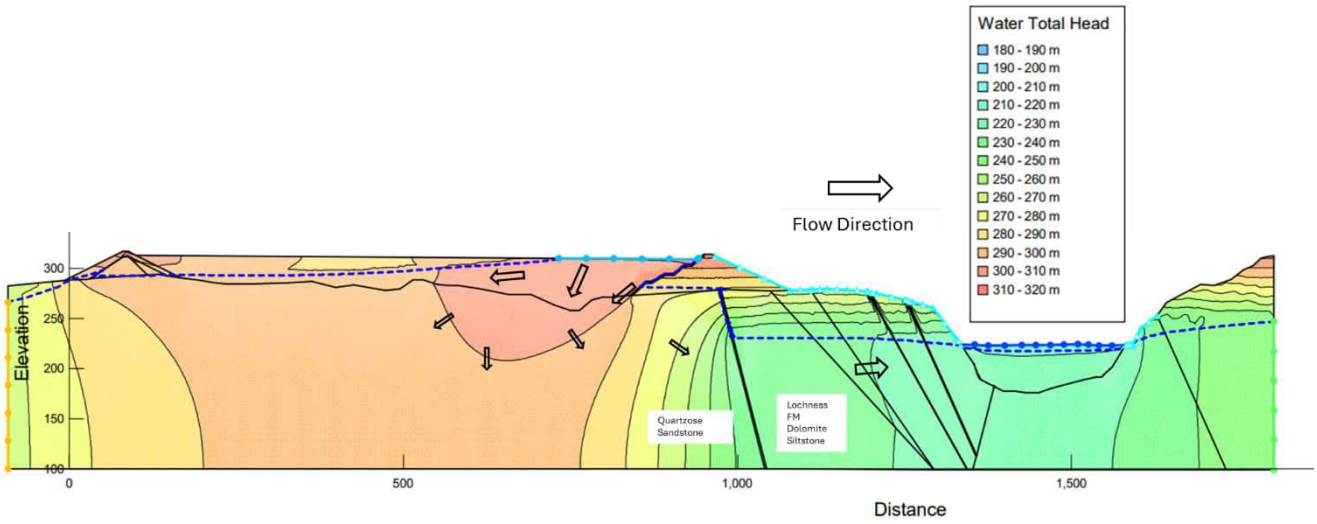


FIGURE 7: WATER TABLE IN THE DOWNSTREAM OF TSF3 – WITH HDP LINER

Predicted Water Rate

Water flow rate through selected sections is summarised in Table 2. With the construction of TSF3, groundwater flow to the Esperanza Pit will increase. Meanwhile, flow rates across the sections of fault and Esperanza Pit could be significantly decreased due to the installation of the HDPE liner. The total rate with liner was 12% of that without liner. The total amount of water rate is predicted to be 0.06 $m^3/d/m$ higher than the base case.

TABLE 2: PREDICTED WATER RATE

Scenario	Predicted Water Rate ($m^3/d/m$)		
	Fault	Esperanza Pit	Rate Difference
Base Case	0.001	0.01	N/A
Without Liner	0.31	0.30	0.59
With HDP Liner	0.02	0.05	0.06

Discussion and Conclusion

This study investigated the effect of tailings storage on seepage within the proposed TSF3. The numerical modeling of the proposed TSF3 has concluded that:

- The modelled groundwater table and flow rate in base case are similar to the results from previous ATCW (2023) model.
- The proposed TSF3 with decant pond is likely to result in increased seepage to EPit and raising of groundwater levels from 20 to 50 m, (RL 240 to 270 m) between the EWRD and EPit, if constructed without a liner relative to the existing base case (no TSF3).
- Seepage will occur from the proposed TSF 3, through the EWRD to EPit at a predicted rate of 0.30 $m^3/d/m$, as modelled without a liner.
- The groundwater level could increase, and the direction may be changed southward with the development of tailings and decant pond. The water infiltrated from decant pond could form a divergence at the location of x = 500 m (Scenario 1) and 650 m (Scenario 2).
- Scenario 1 (no liner) shows a groundwater surface within the stored tailings at approximate RL 303 m, 59 m above the base case groundwater surface of RL 244 m at the divergent location.
- Scenario 2 (with liner) shows a groundwater surface within the stored tailings at approximate RL 304 m, 65 m above the base case groundwater surface of RL 239 m at the divergent location.
- Seepage is expected be reduced by 84% with the introduction of a liner at the interface with the EWRD relative to the no liner case.

It is noted that the water table level and seepage rate may be overestimated due to the dewatering activities from nearby underground mines in CCM, which may lead to groundwater drawdown. Recent monitoring data from GWMB81 (Figure 1) shows the water table in the

south of TSF 3 is 10m higher than the current model boundary head. The increased head in the southern boundary may have an effect on the model results.

The section selected for the model (ATCW, 2023) is noted to exclude the Paradise Formation geological unit, which faults at the interface of the EPit. It is not clear whether this additional geological unit will have an effect on the modelled seepage rates.

Field observations (Engeny, 2024) suggest a relatively high weathered zone may exist in the upper Quartzose Sandstone. The model results show that the groundwater table is sensitive to the permeability of the Quartzose Sandstone below the tailings. Therefore, field evidence is needed to understand the heterogeneity and permeability of the foundation and faults.

Modelling indicates that there is potential for the groundwater to experience divergence of flow and flow both south of TSF3 and north towards E-Pit.

Recommendations

Recommendations for further works to inform a future model include:

- Confirm the assumed homogenous permeability of the Quartzose Sandstone that forms the foundation of TSF3 through confirmatory drilling.
- Confirm the assumed permeability of the faults within the model through installation of groundwater bores in the proposed footprint and conducting hydraulic testing.
- Confirm the existing as-constructed condition of the Upper Esperanza Diversion Dam (UEDD) and update the assumed permeability of the UEDD to determine the potential for groundwater flow to be altered.
- Confirm the constant head boundaries applied.
- Complete calibration of the model to include dewatering bores to account for any impact of dewatering activities including underground mining on groundwater levels.
- Complete modelling using additional cross-sections to include assessment of seepage through the Paradise Creek Formation on both sides of the current cross-section.
- Complete transient modelling to account for seasonal variation and recharge in groundwater levels.

References

ATC Williams. 2023. Capricorn Copper, Temporary Water Storage Options Assessment: Hydrogeological Risk and Impact Assessment.

Engeny. 2024a. Capricorn Copper Mine TSF3 Geological Mapping Report.

Engeny. 2024b. Capricorn Copper Mine TSF 3 Groundwater Impact Assessment.

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APPENDIX I: LIMITED SURFACE WATER IMPACT ASSESSMENT

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Surface Water Impact Assessment

TSF 3 EA Amendment

QC1022_018-REP-003-2

14 APRIL 2025

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	20/05/2024	Draft for client review	Rebecca Malaj	Tim Wallis	Brendan Wallace	Travis Warren
1	12/07/2024	Final	Rebecca Malaj	Tim Wallis	Brendan Wallace	Travis Warren
2	14/04/2025	Updated Final	Rebecca Malaj	Tim Wallis	Brendan Wallace	Travis Warren
Signatures:						

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1. INTRODUCTION

Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29Metals Limited (29Metals), owns and operates the Capricorn Copper Mine (CCM), located in Gunpowder, Northwest Queensland. CCM is operated under the approval of Environmental Authority EPML00911413 (EA) (dated 6 December 2023), administered by the Queensland Department of Environment, Tourism, Science and Innovation (DETSI).

CCM is located approximately 32 km northwest of the town of Gunpowder in the Mount Isa Mining District, approximately 140 km north of Mount Isa. The site is comprised of twenty-nine (29) mining leases (MLs) (ML5407, ML5412, ML5413, ML5418, ML5419, ML5420, ML5429, ML5430, ML5441, ML5442, ML5443, ML5444, ML5451, ML5454, ML5457, ML5459, ML5467, ML5485, ML5486, ML5489, ML5500, ML5548, ML5549, ML5550, ML5562, ML5563, ML90180, ML90181 and ML90182), shown in Figure 1.1.

This limited surface water impact assessment report is provided to support a major EA amendment for the proposed additional Tailings Storage Facility #3 (TSF3) at the CCM.

CCPL engaged Engeny Australia Pty Ltd (Engeny) to develop a water balance model and undertake a limited surface water impact assessment to identify potential impacts from the proposed additional TSF3 at the CCM.

1.1 Site Background

CCM has been subject to mining activities dating back to 1927. Mining effort has varied over the life of the mine. Mining activity included active underground mining within Mammoth and Esperanza South underground mines up until January 2009. CCM was placed in care and maintenance in February 2009 until February 2011, with underground mining recommencing in May 2011. Operations then continued until April 2013, when the site was again returned to care and maintenance. CCPL acquired the site in 2015 and successfully recommenced operations in 2017. CCPL have been operating on the site since 2017 and have recently suspended operations in March 2024.

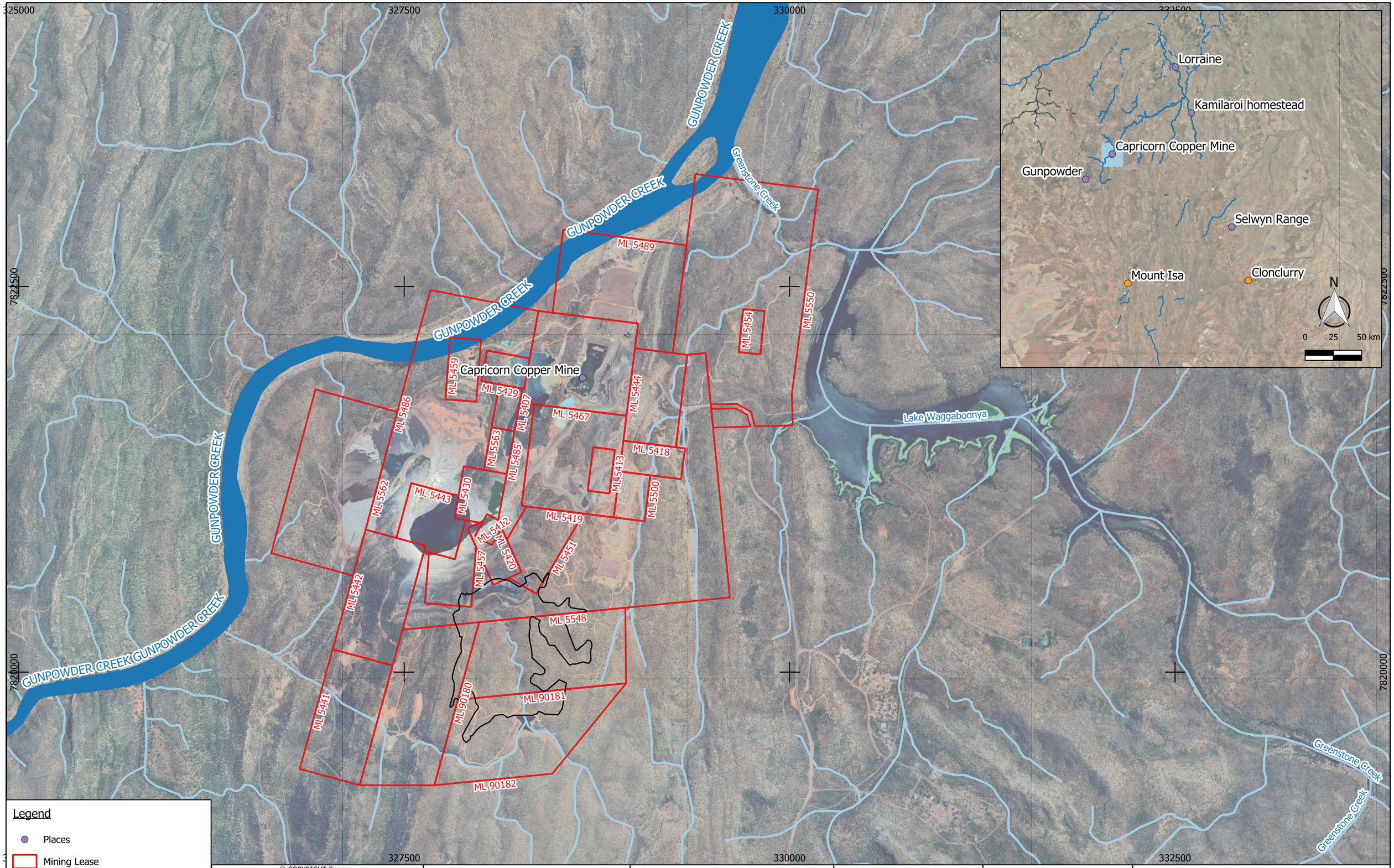
1.1.1 Current Operations

Due to high water inventory and low remaining capacity in Esperanza TSF (ETSF), mining and ore processing were suspended in March 2024. In addition, the site was subject to severe wet season rainfall events during both the 2022 and 2023 wet seasons. This resulted in the loss of critical infrastructure (flooding of the Esperanza Underground Mine, loss of the existing reverse osmosis water treatment plant (WTP), workshops and warehouse area) as well as significant increases to the mine affected water (MAW) inventory which is primarily contained within Esperanza Pit (EPit).

The 2024 wet season compounded the impacts of the previous two wet seasons, leading to the above areas remaining flooded since the initial impact in 2022.

In addition to the proposed TSF3, CCPL have initiated a program of water management system (WMS) improvements aimed at reducing the use of raw water, minimising the generation of MAW, increasing the utilisation of existing EA conditions to release more treated water to Gunpowder Creek and increasing the rate of water destruction through mechanical evaporators.

TSF3 is intended to provide approximately 6.5 to 7.5 years of additional tailings storage capacity at CCM.



Legend

- Places
- Mining Lease
- TSF3 Design Footprint
- Basin Watercourse area
- Watercourse line
- Watercourse area

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DRAWN	RM	CHECKED	TW
APPROVED	TW	DATE	12-01-2024

NOTES:
CRS: GDA94 / MGA zone 54
Projection: Universal Transverse Mercator (UTM)

SCALE @ A3 - 1:22,000

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29

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Site Locality and Proposed TSF3 Location

Capricorn Copper Pty Ltd
TSF 3 Surface Water Impact Assessment

Drg Ref. QC1022_018

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1.2 Report Scope and Methodology

29M are required to lodge a Surface Water Impact Assessment (SWIA) with DETSI as part of the EA amendment application for the proposed TSF3 to quantify and, if necessary, mitigate any potential impacts to the receiving environment. The scope of work and methodology for this limited SWIA is as follows:

- A desktop study of the Project surface water setting.
- A baseline surface water quality assessment including:
  - A review and analysis of surface water quality monitoring data collected as part of the CCMs surface water quality monitoring program.
- Water balance modelling of the Project to assess the performance of the CCM mine water management system (WMS) following the construction of TSF3.
- An assessment of the Project's effects on surface water flows and quality.

1.3 Report Structure

This limited surface water impact assessment report is structured as follows:

- Section 1 – Introduction.
- Section 2 – Regulatory Requirements.
- Section 3 – Surface Water Setting.
- Section 4 – CCM Water Management System.
- Section 5 – Surface Water Quality Assessment.
- Section 6 – Water Balance Assessment.
- Section 7 – Limited Surface Water Impact Assessment.
- Section 8 – Risk Assessment.
- Section 9 – Management and Mitigation.
- Section 10 - Conclusions.

2. REGULATORY REQUIREMENTS

2.1 Environmental Protection Act

The *Environmental Protection Act 1994* (Qld) (EP Act) was established to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes[1].

The purpose of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water and Wetland Biodiversity) is to achieve the objectives of the EP Act in relation to waters and wetlands. EPP Water and Wetland Biodiversity provides a framework for the protection of environmental values (i.e., surface water uses) associated with Queensland rivers, streams, wetlands, lakes, aquifers, estuaries, and coastal areas.

Under this framework, environmental values (EVs) for specific catchments and drainage basins have been formalised and listed in Schedule 1 of the EPP Water and Wetland Biodiversity. For other waters, a site-specific assessment of the potential environmental values is required. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) includes a management framework that has been adopted in the EPP Water and Wetland Biodiversity.

2.2 Environmental Authority

DETSI is the administering authority of the EP Act. The EP Act requires that mining projects be undertaken in accordance with an approved Environmental Authority (EA). CCM EA (EPML00911413 (DETSI, 2023)) provides authorisation for the following Environmentally Relevant Activities (ERAs):

- Schedule 3 17: Mining copper ore.
- Ancillary 08 - Chemical Storage 1: Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a).
- Ancillary 08 - Chemical Storage 3: Storing more than 500 cubic metres of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c).
- Ancillary 31 - Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000t.
- Ancillary 33 - Crushing, milling, grinding, or screening crushing, grinding, milling or screening more than 5000t of material in a year.

The proposed amendment to the EA is the addition of a new tailings storage facility (TSF).

The following conditions of the EA will require amendment following approval of the proposed TSF3:

- Schedule A – Table 1 (Authorised Disturbance) states the approved area of disturbance.
- Schedule G – Table 1 (Regulated Dams) states the max operating level, design storage allowance and mandatory reporting levels for regulated dams.

2.3 Water Act

The Water Act is the principal legislation for the sustainable management of Queensland's water resources. The Water Act provides the framework within which surface water resources are planned, allocated and used in Queensland. The surface water provisions of the Water Act are administered by the Queensland Department of Regional Development, Manufacturing and Water (DRDMW).

The management of surface water resources is achieved through the following key measures:

- Granting authorisations for taking or interfering with surface water; and

[1] https://www.stateoftheenvironment.des.qld.gov.au/pollution/management-responses/legislation/environmental-protection-act-1994

- Preparing water plans for any part of Queensland, reserving unallocated water resources, as well as prescribing processes for releasing unallocated water.

Runoff originating from potentially mine-affected catchment areas is currently directed to the WMS (refer to Section 4). The Project will result in an increase to the size of the catchment reporting to the mine WMS and results from the internally draining catchment of TSF3. Consequently, the Project is expected to result in an increase to existing volumes of water captured by the mine WMS. No changes are expected to CCMs existing raw water demand and raw water will continue to be sourced from Lake Waggaboonya when operational demands are not met from treatment of mine affected water for reuse in operations.

2.3.1 Water Act 2000 Authorisations

The *Water Act 2000* authorises the take or interference with surface water under specific circumstances (e.g. emergencies, stock watering, etc). For mining activities authorised under an EA, the Water Act authorises:

- The take of overland flow (i.e., only water that is not in a watercourse or lake); and
- Interference with the flow of any surface water by impoundment (e.g., a dam, weir or excavated water storage) or diversion, provided that the impacts have been assessed as part of the EA approval process and the EA contains appropriate conditions.

As noted above, additional interception of overland flow currently intercepted by the CCM WMS is expected by the Project and results from the internally draining footprint of TSF3. The Project includes a raise of the existing Upper Esperanza Diversion Dam (UEDD) and does not require the construction of any additional water diversions or impoundments.

2.3.2 Gulf Water Plan 2007

The *Water Act 2000* allows for the Minister to prepare water plans for any part of Queensland, reserve unallocated water resources and prescribe processes for releasing unallocated water. The *Gulf Water Plan 2007 (Water Plan)* manages surface water resources within the Water Plan area. The Water Plan area comprises a total of eight catchments located in north Queensland. The project site is in the Leichhardt River catchment as defined in Schedule 3 of the Water Plan.

Raw water demands for CCM are currently sourced from Lake Waggaboonya when operational demands are not met from treatment of mine affected water for reuse in operations. The Project is not expected to change raw water demand and CCM will not be seeking additional sources of raw water.

2.4 EPBC Act Protected Matters

A search of Protected Matters has been completed for the site, inclusive of a 25km buffer, using the Australian Government Department of Climate Change, Energy, Environment and Water Protected Matters Search Tool (https://pmst.awe.gov.au/). The search extent is shown in Figure 2.1, with the site location (feature area) indicated by the number “1”. The complete search results are provided in Appendix A.

Search results returned the following:

- World Heritage Properties: None.
- National Heritage Places: None.
- Wetlands of International Importance (Ramsar Wetlands): None.
- Great Barrier Reef Marine Park: None.
- Commonwealth Marine Area: None.
- Listed Threatened Ecological Communities: None.
- Listed Threatened Species: 14.
- Listed Migratory Species: 12.
- EPBC Act Referrals: 2.

Fourteen (14) threatened species have been identified within the site area, of these, four (4) are known to be present, three (3) are likely to be present and the remaining seven (7) may be present.

Eleven (11) migratory species have been identified within the site area, of these, two (2) are likely to be present, with nine (9) listed as may be present.

The EPBC Act referral located within the site (EPBC 2010/5581) for the CopperString Project was made in 2010 for the proposed action of constructing an alternating current transmission line and associated infrastructure. The EPBC referral lapsed on 18 March 2015.

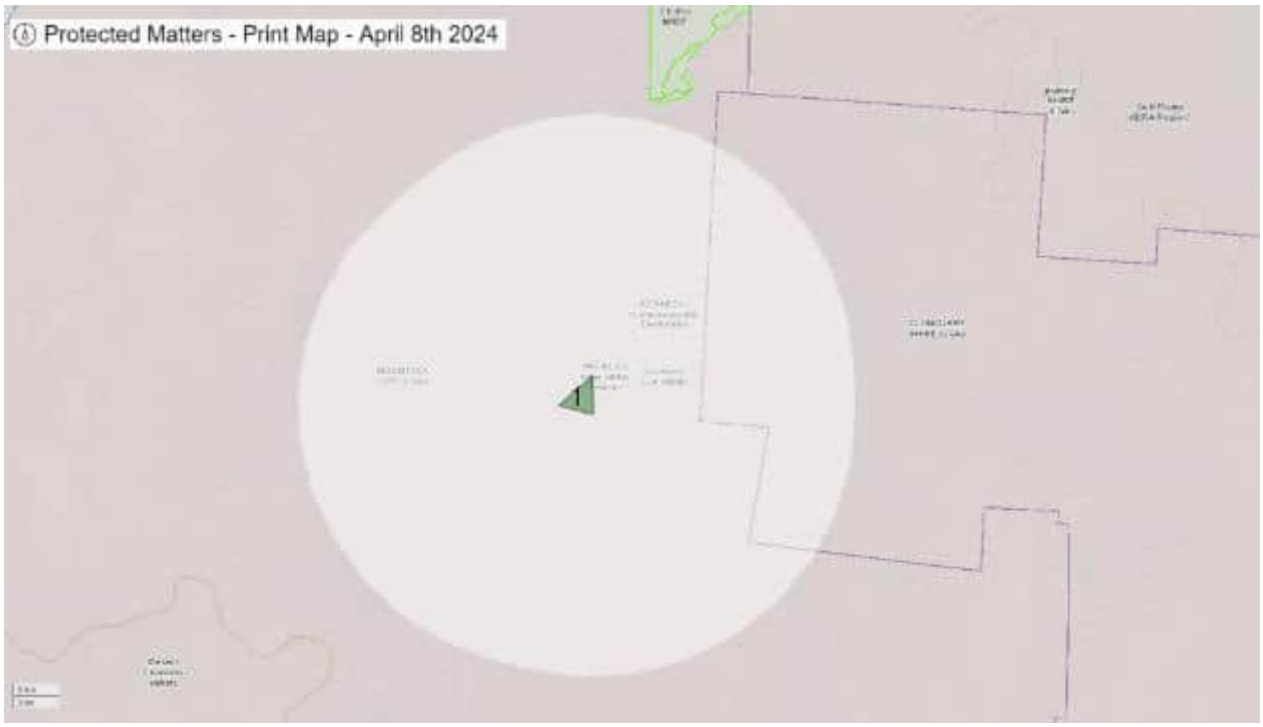


FIGURE 2.1: PROTECTED MATTERS SEARCH AREA (SOURCE: HTTPS://PMST.AWE.GOV.AU/ ACCESSED 8 APRIL 2024)

2.5 Matters of State Environmental Significance

A search of Queensland Globe Matters of State Environmental Significance (MSES) layers (refer to Figure 2.2) shows the following areas identified within the project site:

- MSES regulated vegetation (defined watercourse) within and adjacent to the approved mining leases, including an area within the proposed TSF3.
- MSES wildlife habitat (endangered or vulnerable) approximately one kilometre east of the mining lease boundary and two kilometres east of the proposed TSF3 footprint.
- Riparian Corridor and buffer along Gunpowder Creek.

It is noted that the mapped regulated vegetation within the footprint of the proposed TSF3 is currently not receiving surface water from upstream flows from the south as a result of the existing Upper Esperanza Diversion Dam (UEDD).

325000
327500
330000
332500
7822500
7820000

GUNPOWDER CREEK
GUNPOWDER CREEK
GUNPOWDER CREEK
Greenstone Creek
Lake Waggaboonya

ML 5489
ML 5454
ML 5550
ML 5459
ML 5429
ML 5444
ML 5486
ML 5407
ML 5467
ML 5563
ML 5485
ML 5418
ML 5413
ML 5562
ML 5443
ML 5430
ML 5500
ML 5419
ML 5412
ML 5420
ML 5457
ML 5451
ML 5442
ML 5548
ML 90180
ML 90181
ML 5441
ML 90182

Legend

- Mining Lease
- TSF3 Design Footprint
- Watercourse line
- Watercourse area
- MSES regulated vegetation [defined watercourse]
- MSES wildlife habitat [endangered or vulnerable]
- Riparian corridor centrelines
- Corridor buffers

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DRAWN	RM	CHECKED	TW
APPROVED	TW	DATE	12-01-2024

NOTES:
CRS: GDA94 / MGA zone 54
Projection: Universal Transverse Mercator (UTM)

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29
Metals

Matters of State Environmental Significance

Capricorn Copper Pty Ltd
TSF 3 Surface Water Impact Assessment

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3. SURFACE WATER SETTING

3.1 Regional Catchments and Drainage

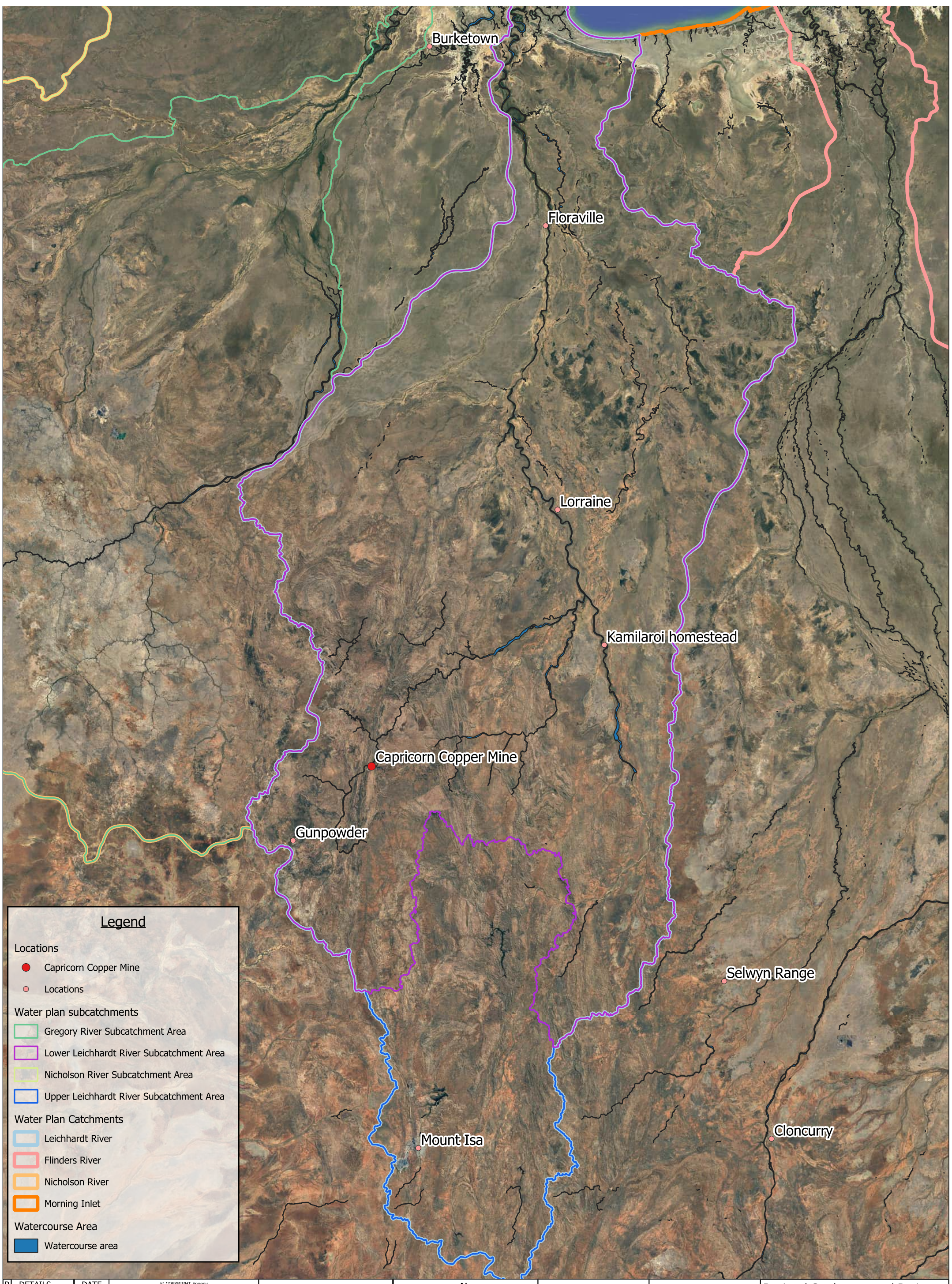
The Project is in the Leichhardt River drainage sub-basin area in the Leichhardt Drainage Basin. The Leichhardt drainage basin has a total catchment area of 32,882.2 km[2].

The Leichhardt River rises in the Selwyn Ranges, 40 kilometres southeast of Mount Isa. It flows in a northerly direction, through the city of Mount Isa and Lake Moondarra, before passing through Julius Dam. It is joined by its major tributary, Gunpowder Creek, 15 kilometres downstream of Kamilaroi homestead. Another major tributary, Fiery Creek, joins the river 70 kilometres downstream of Lorraine. The Alexandra River enters the river from the east, just below Floraville, before the Leichhardt River finally passes through a vast coastal plain and enters the Gulf of Carpentaria 30 kilometres northeast of Burketown[3]. The location of the project site in relation to the catchment is presented in Figure 3.1.

The Project is located east of Gunpowder Creek (Figure 3.2). Run-off from CCM flows into Gunpowder Creek, which also receives licensed releases of treated mine-affected water that enters the creek system at the EA-nominated release point (W1, Figure 3.2). Magazine Creek flows into Greenstone Creek, which flows into Gunpowder Creek downstream of the mining activities. Gunpowder Creek flows into Leichhardt River, approximately 100 km north-east of CCM.

[2] https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/basin-leichhardt/

[3] http://www.bom.gov.au/qld/flood/brochures/leichhardt/leichhardt.pdf



R	DETAILS	DATE
0	For Information Only	19/04/2024

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APPROVED	TW	DATE	19-04-2024

NOTES:
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Projection: Universal Transverse Mercator (UTM)

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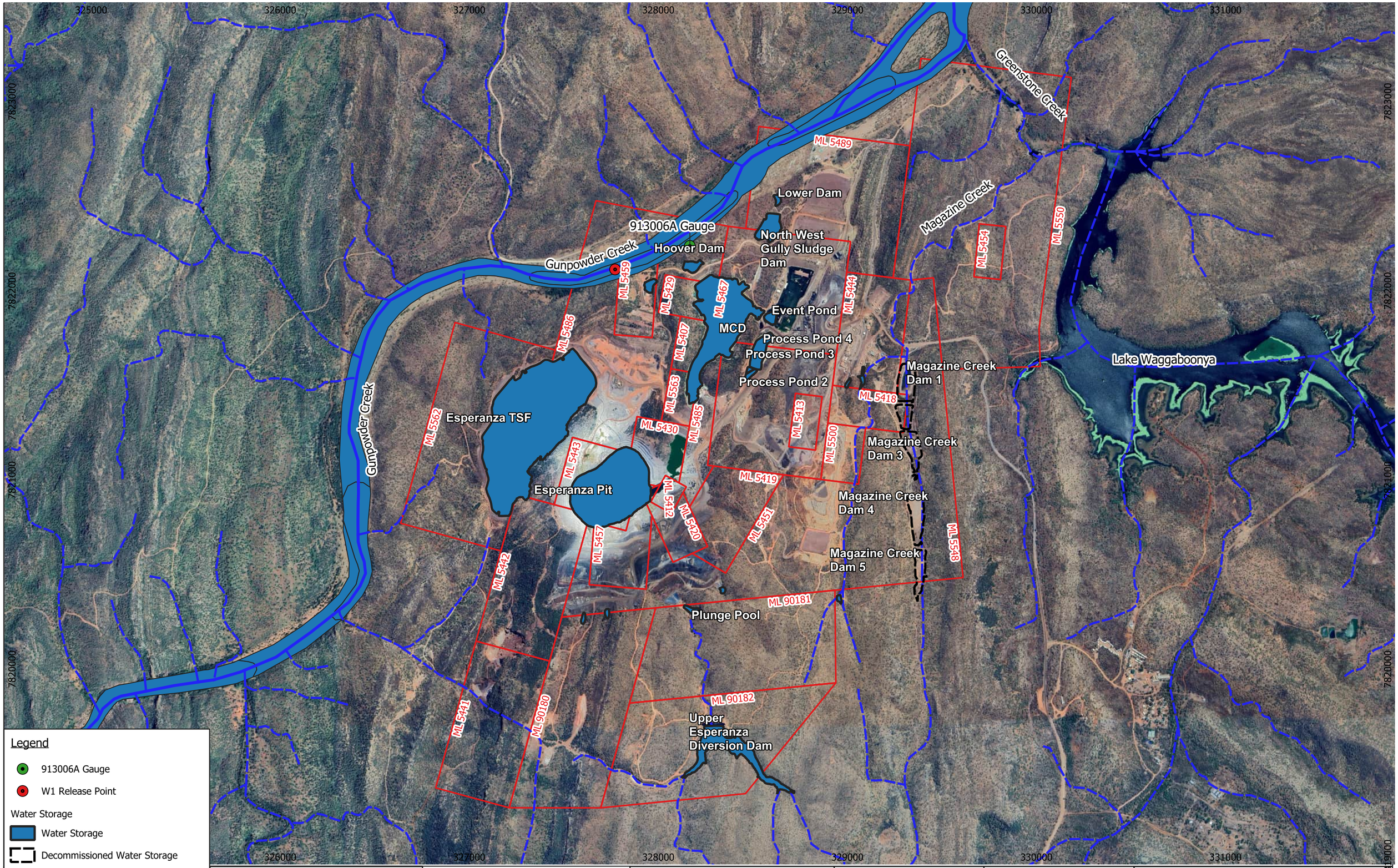
29 Metals

Regional Catchments and Drainage

Capricorn Copper Mine
TSF3 Limited SWIA

Project Ref: QC1022_018

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Legend

- 913006A Gauge
- W1 Release Point

Water Storage

- Water Storage
- Decommissioned Water Storage

Watercourse line

- Gunpowder Creek
- Unnamed tributary
- Watercourse area
- Mining Lease

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DRAWN	RM	CHECKED	TW
APPROVED	TW	DATE	26-04-2024

NOTES:

CRS: GDA94 / MGA zone 54
Projection: Universal Transverse Mercator (UTM)

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Metals

Surface Water Setting

Capricorn Copper Pty Ltd
TSF 3 Surface Water Impact Assessment

Drg Ref. QC1022_018

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3.1.1 Gunpowder Creek

Gunpowder Creek is the receiving waterway for any water discharged from site operations. Gunpowder Creek joins the Leichardt River approximately 100 km north-east of the mine and is located within the Leichardt River drainage sub-basin area in the Leichardt Drainage Basin.

Gunpowder Creek (adjacent to CCM) has been classified as a highly disturbed aquatic ecosystem and is considered moderately disturbed downstream of the mine (NRA 2022). Gunpowder Creek is utilised for primary industries (livestock drinking water) and mining activities. Recreational uses have been identified as visual recreational use and downstream of CCM, secondary recreation only e.g. boating and fishing with no swimming.

CCM generally drains to the north towards Mill Creek Dam (MCD) which provides for water supply to site operations and pumped releases to Gunpowder Creek. Seepage and overflows from MCD are intercepted by Hoover Dam and pumped back to EPit which is the main bulk water storage for mine affected water at CCM.

The authorised release point is located west of the Hoover Dam on Gunpowder Creek (W1 Release Point, shown in Figure 3.2), approximately 2 km upstream of the confluence between Gunpowder Creek and Greenstone Creek. Releases of treated mine affected water to Gunpowder Creek is only allowed in accordance with the conditions in Schedule C of the EA, or previously in accordance with Environmental Protection Order E100127175.

3.1.2 Greenstone Creek

Greenstone Creek is located to the east of CCM and has a confluence with Gunpowder Creek approximately 2km downstream of the authorised release point (refer to Figure 3.2 above). The Creek has been classified as a highly disturbed aquatic ecosystem utilised for primary industries (livestock drinking water), mining and visual recreational use (NRA 2022). Greenstone Creek is impounded by Greenstone Creek Dam (Lake Waggaboonya) which is located to the east of CCM and has a capacity of 14,000 ML. Lake Waggaboonya was constructed in the 1960s to supply raw water to CCM and other nearby by mining operations (Lady Annie mine, located approximately 25 km west of CCM).

3.1.3 Magazine Creek

Magazine Creek, a tributary of Greenstone Creek is located to the east of CCM and enters Greenstone Creek approximate 300m downstream of the Greenstone Creek Dam. The Creek is utilised for primary industries (livestock drinking water) and mining (NRA 2022). Magazine Creek previously contained five (5) stormwater ponds which retained stormwater following the wet season and was historically used to supply raw water to the mine. These ponds have since been decommissioned (refer to Figure 3.2), with no ongoing impoundment or pumping of water for use as raw water.

3.2 Climate

CCM is located within the grassland Köppen major climate zone and experiences hot humid summers, summer dominant rainfall and winter drought. Long term climate data for the site has been obtained from the Scientific Information for Landowners (SILO) climate database facility hosted by DETSI using a Data Drill extracted for the site location (Lat, Long -19.70 139.35 (decimal degrees)). The SILO climate data record produces 136 years of daily climatic data (1889-2025) at the site location based on interpolation of historical nearby weather station data. The following sections provide further description of rainfall, evaporation and temperature for the site.

3.2.1 Rainfall

CCM is in a region of North Queensland that can experience significant, cyclonically influenced rainfall events during summer and is predominantly dry in winter. Table 3.1 and Figure 3.3 below show monthly and annual rainfall for CCM:

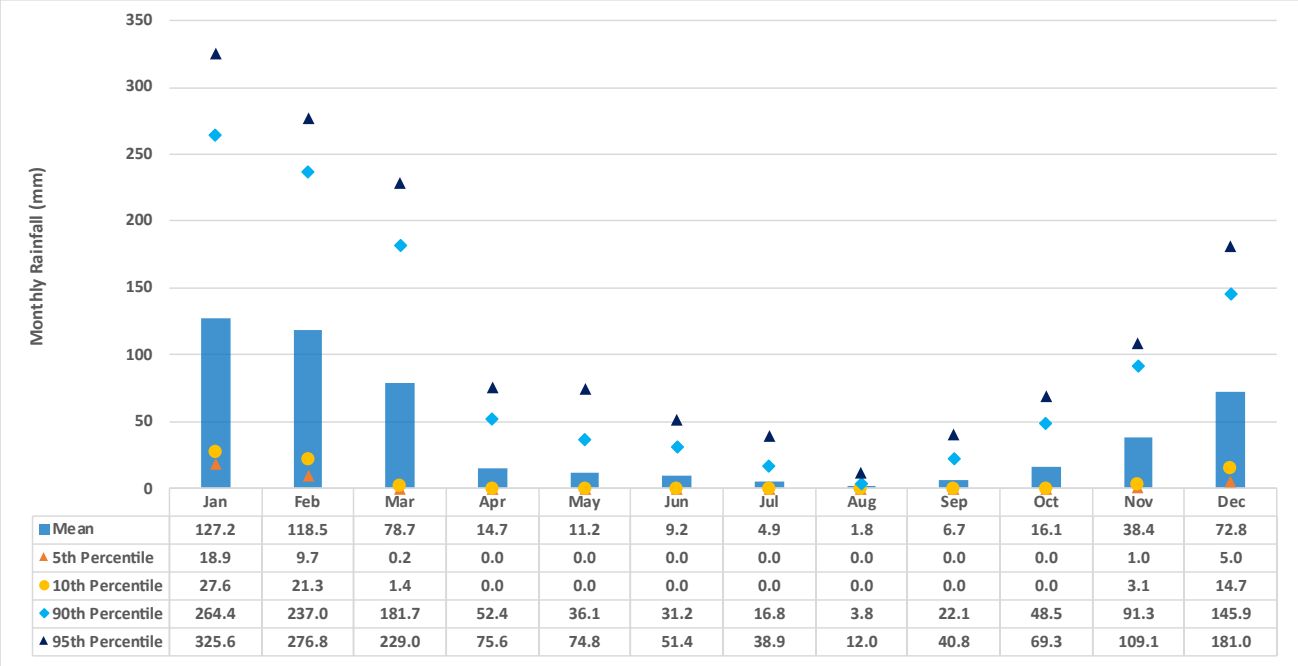
- Mean annual rainfall is 498.9 mm (Table 3.1) and subject to a strong seasonal distributed with 87% of the mean monthly rainfall occurring within the wet season months of November through March (Figure 3.3).
  - Mean monthly wet season rainfall ranges from 38.4 mm in November to 127.2 mm in January.
- A winter dry season extends from April through October where mean monthly rainfall ranges from 16.1 mm in October to 1.8 mm in August.
- From Table 3.1 annual rainfall is subject to significant variability indicating potential for:
  - prolonged drought – a 5% likelihood that annual rainfall will be 202 mm or less which represents only 40% of the mean annual total.
  - significant wet season rainfall – a 5% likelihood that annual rainfall will be 953 mm or more which is 191% of the mean annual total.

- Potential for significant wet season variability is similarly demonstrated in Figure 3.3 where there is significant variation from the mean. For example, the 5th percentile result for January is 18.9 mm (15% of the mean of 126.3 mm) and the 95th percentile result for January of 325.6 mm is 259% of the mean.

In summary, rainfall at CCM is subject to a strong seasonal distribution with a majority of rainfall occurring during a wet season extending from November through March. However, wet season rainfall is also likely to be subject to significant variability with potential for periods of extended drought and intense flooding rainfall.

TABLE 3.1: ANNUAL RAINFALL STATISTICS (SILO DATA DRILL, 1889-2025)

Statistic	Annual Rainfall (mm)
5th Percentile	202
10th Percentile	251
Median	460
Mean	498.9
90th Percentile	813
95th Percentile	**953**



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	127.2	118.5	78.7	14.7	11.2	9.2	4.9	1.8	6.7	16.1	38.4	72.8
5th Percentile	18.9	9.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	5.0
10th Percentile	27.6	21.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	14.7
90th Percentile	264.4	237.0	181.7	52.4	36.1	31.2	16.8	3.8	22.1	48.5	91.3	145.9
95th Percentile	325.6	276.8	229.0	75.6	74.8	51.4	38.9	12.0	40.8	69.3	109.1	181.0

FIGURE 3.3: MONTHLY RAINFALL (SILO DATA DRILL, 1889-2025)

3.2.1.1 2022 and 2023 Wet Seasons

As noted in Section 1.1.1, CCM has been subject to severe rainfall events during both the 2022 and 2023 wet seasons. Comparison of site-recorded rainfall data with long term SILO Data Drill (Table 3.2 below) indicates that:

- The 2022 5-month (November through March) rainfall total of 1,503 mm represents 345% of the long-term (SLIO Data Drill) average; and

The 2023 5-month (November through March) rainfall total of 772 mm represents 177% of the long-term (SILO Data Drill) average. These results are demonstrative of the rainfall variability experienced at CCM.

TABLE 3.2: 2022 AND 2023 EXTREME WET SEASON RAINFALL

Wet Season	Rainfall (mm)[1]	Period	Percentage of Long Term Average[2]
2022	1,503	Nov 2022 to Mar 2023	345%
2023	772	Nov 2023 to Mar 2024	177%

Notes

1 Site data

2 SILO Data Drill

3.2.2 Evaporation

Figure 3.4 below shows mean monthly pan evaporation for CCM. From the figure it can be see that under average conditions evaporation is significantly in excess of mean rainfall (Figure 3.3). Mean monthly evaporation is seasonally distributed with rates highest from October through March and lowest from April through September.

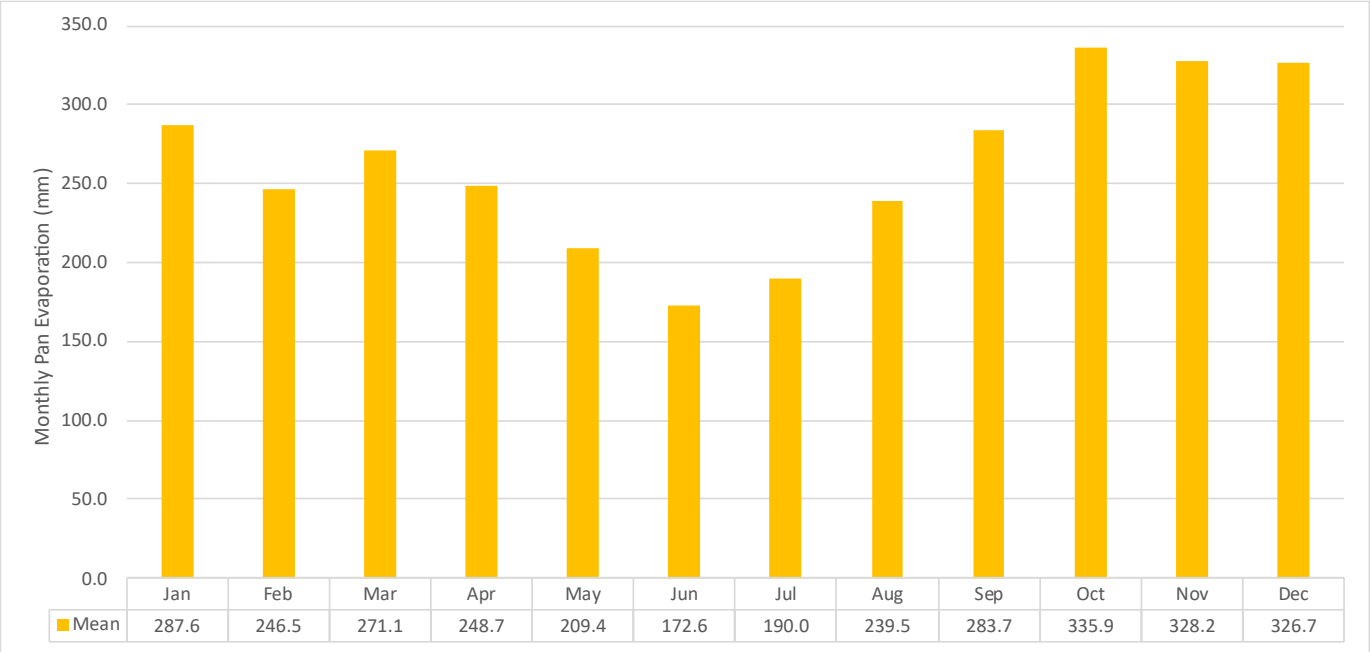
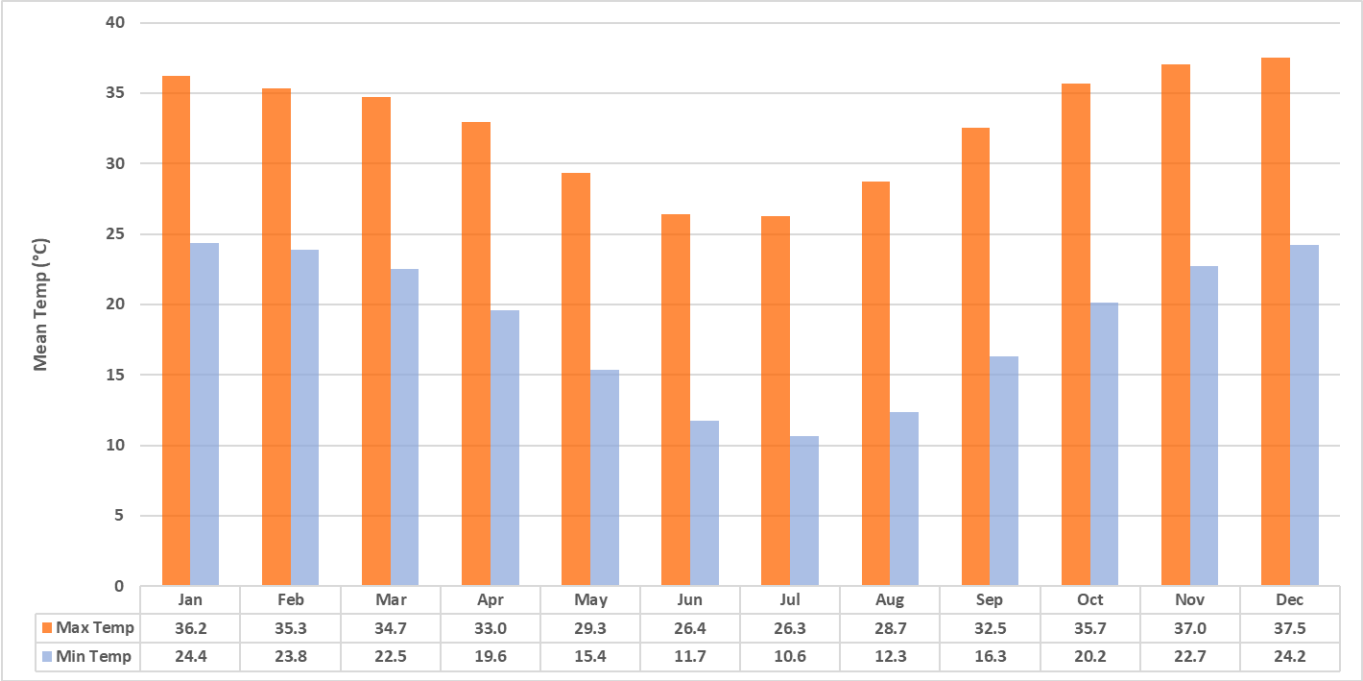


FIGURE 3.4: MONTHLY PAN EVAPORATION (SILO DATA DRILL, 1970-2024)

3.2.3 Temperature

Mean monthly maximum and minimum temperatures are shown below in Figure 3.5 and indicate an extended hot summer period where mean temperatures exceed 35°C from October through February and a mild winter where mean maximum temperature remain above 25° for all months. Mean minimum temperature ranges from a maximum of 24.4°C in January to a minimum of 10.6°C in July.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max Temp	36.2	35.3	34.7	33.0	29.3	26.4	26.3	28.7	32.5	35.7	37.0	37.5
Min Temp	24.4	23.8	22.5	19.6	15.4	11.7	10.6	12.3	16.3	20.2	22.7	24.2

FIGURE 3.5: MEAN MONTHLY TEMPERATURE (SILO DATA DRILL, 1970-2024)

3.3 Streamflow Monitoring

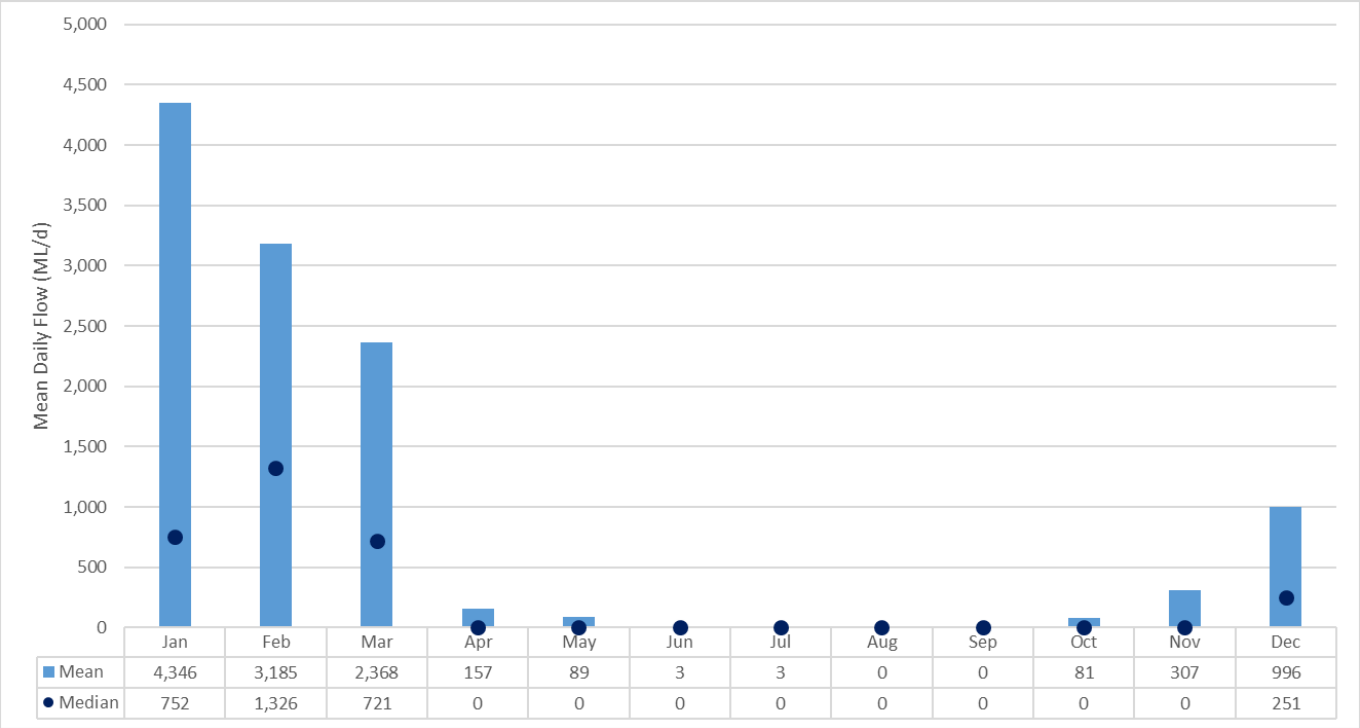
The Queensland Department of Regional Development, Manufacturing and Water (DRDMW) maintains a streamflow monitoring station (913006A, Gunpowder Creek at Gunpowder) located downstream of the causeway in close proximity to CCM (refer to Figure 3.2). Table 3.3 summarises key data for the gauge; Figure 3.6 and Figure 3.7 show mean monthly flow and flow duration respectively:

- Streamflow in Gunpowder Creek at CCM shows a highly seasonal distribution with streamflow typically restricted to a high flow season extending from December through March and greatest through January where mean daily flow is approximately 4,346 ML/d (Figure 3.6).
- Streamflow is considered highly ephemeral, variable, and episodic with flows subject quick recession following cessation of significant rainfall.
- Cease to flow conditions are present on approximately 71% of all days (Figure 3.7).
- Comparing mean and median monthly flows during the high flow season (Figure 3.6) months indicates significant potential for variable streamflow which is consistent with the variable monthly rainfall shown in Figure 3.3.

In summary, streamflow in Gunpowder Creek at CCM is highly ephemeral and typically restricted to a high flow season extending from December through March. Streamflow during the high flow season is likely to be variable and subject to relatively quick recession following rainfall. Cease to flow conditions are dominant, occurring on more than 71% of all days.

TABLE 3.3: 913006A (GUNPOWDER CREEK AT GUNPOWDER) SUMMARY

Aspect	Comments
Gauge location	-19.6878 139.3607 (decimal degrees)
Gauge catchment	2,427 km^2
Gauge start	27/01/1971
Length of record	54 years
Status	Active



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	4,346	3,185	2,368	157	89	3	3	0	0	81	307	996
Median	752	1,326	721	0	0	0	0	0	0	0	0	251

FIGURE 3.6: 913006A (GUNPOWDER CREEK) – MEAN MONTHLY FLOW (1971-2024)

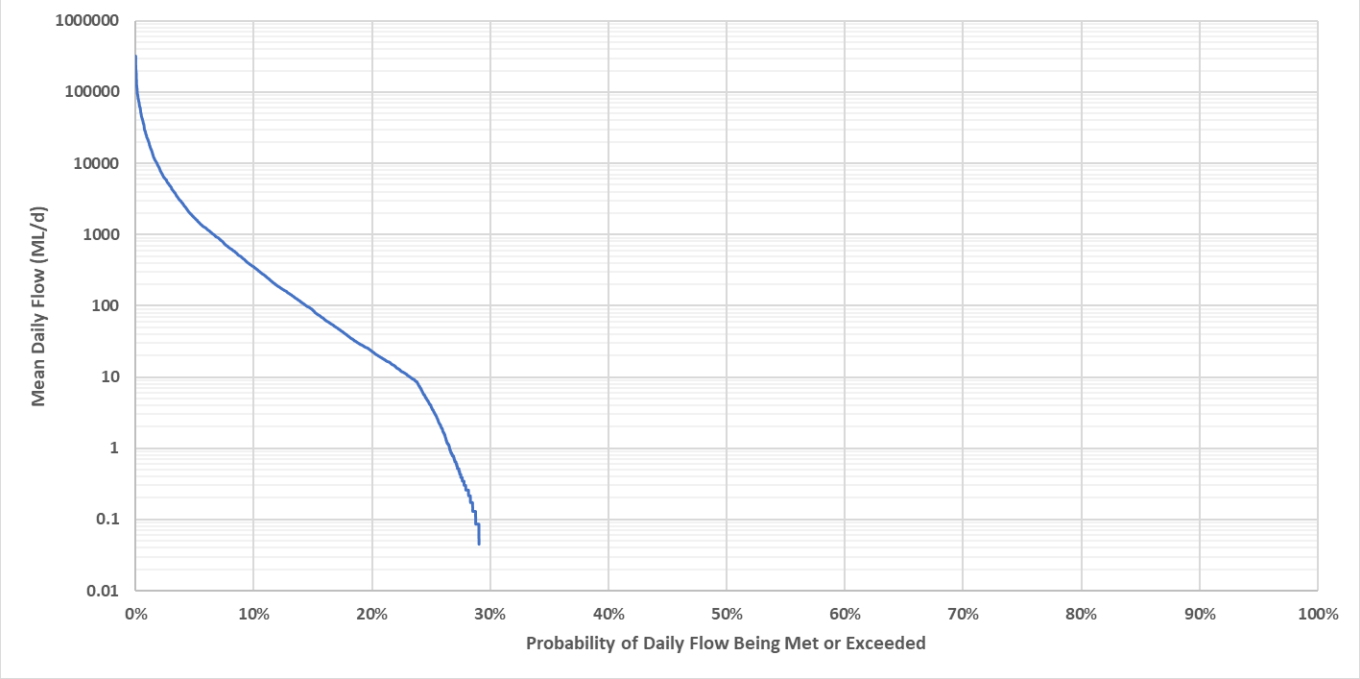


FIGURE 3.7: 913006A (GUNPOWDER CREEK) – DAILY FLOW DURATION (1971-2024)

3.4 Geology and Hydrogeology

Detailed solid geological mapping for Queensland indicates that the proposed TSF3 is located in the Upper Esperanza Valley (UEV) within the Whitworth Quartzite, which is comprised of massive medium to coarse-grained feldspathic to quartzose sandstone, fine purple sandstone and mudflake conglomerate.

Structural mapping provided by 29Metals (ATC Williams, 2023) indicates that there is an unconformity located to the west of the UEV (along the mapped contact of the Whitworth Quartzite), and an inferred fault lies in an east-west direction within the southern extent of the UEV

(Figure 3.8). No other faults or fractures are mapped within the extent of the UEV. The UEV is bounded by north-south trending ridges. The valley is covered with a thin layer of colluvium, with scree located on the upper slopes of the surrounding ridges (Engeny, 2024).

Groundwater within the extent of the UEV is expected within the shallow perched aquifer system and the deep fractured rock aquifer system. The extent of the shallow aquifer is limited to the extent of the colluvium present on the valley floor and sides. Near CCM, soils are thin over most areas including valley floors, and this is expected to also occur within the extent of the UEV (Engeny, 2024).

Groundwater within the colluvium is localised and recharged from direct rainfall. Due to the ridges surrounding the extent of the UEV, the shallow aquifer is not expected to be hydraulically connected to any other surficial aquifers at CCM (ATC Williams, 2023). The Whitworth Quartzite is a relatively impermeable aquitard due to re-crystallisation during regional metamorphism which resulted in little to no primary porosity in the quartzite.

The hydraulic conductivity of the quartzite is low (in the order of 10^{-7} m/sec), with areas of higher permeability present in the secondary porosity associated with fractures. The near-surface zone of higher permeability in the fractured rock aquifer (associated with delaminating siltstones and shales) is not likely to be present due to the absence of any mapped siltstone or shale within the extent of the UEV (Engeny, 2024).

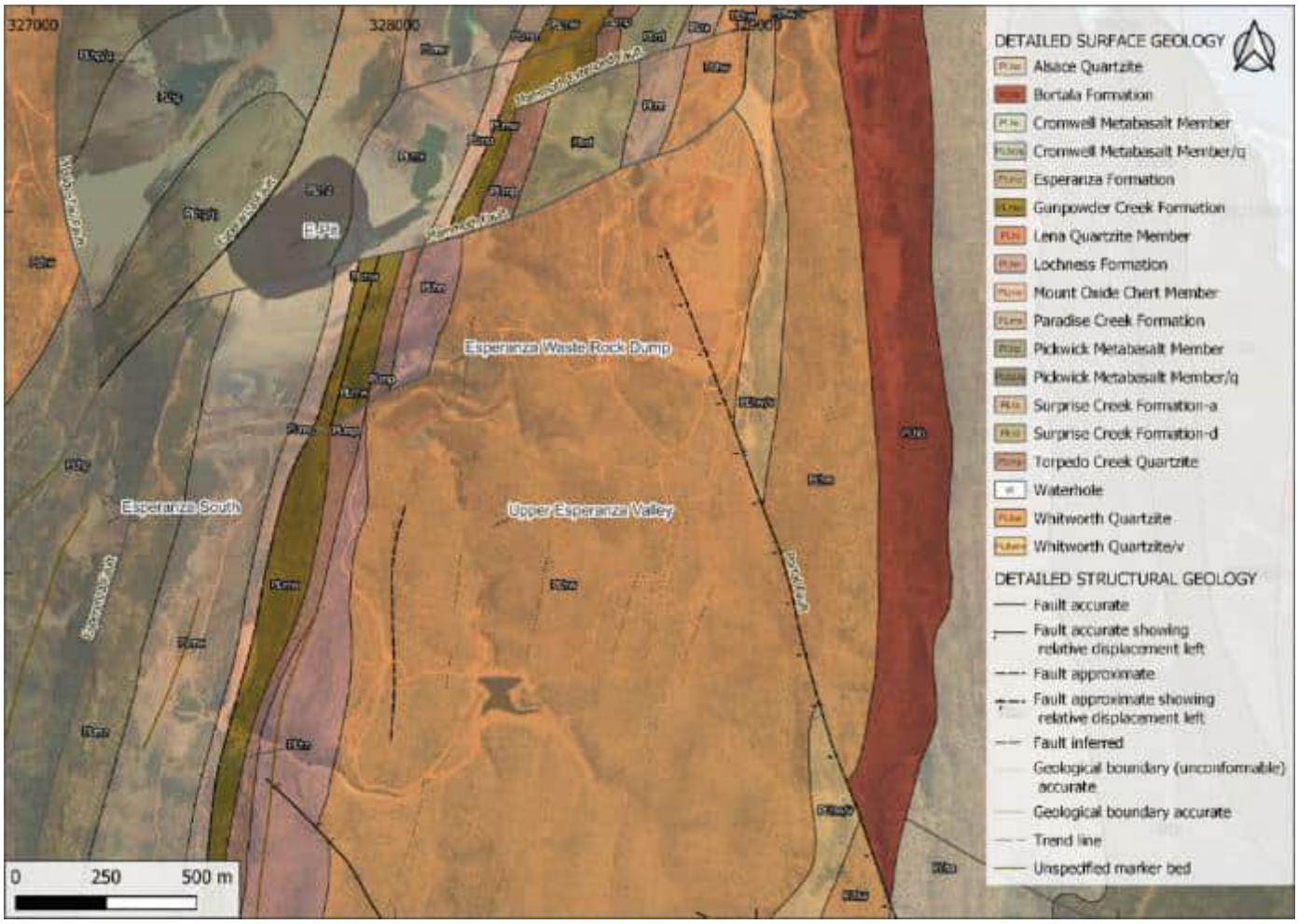


FIGURE 3.8 UPPER ESPERANZA VALLEY DETAILED SURFACE GEOLOGY (ENGENY, 2024)

4. CCM WATER MANAGEMENT SYSTEM

4.1 Water Management System Overview

The CCM water management system (WMS) has been developed to manage the generation, storage, distribution, reuse, and discharge (as per EA release conditions) of all waters (including groundwater) captured and generated by the site. As noted in Section 1.1, the site has suspended operations and is undertaking a program of infrastructure improvements and upgrades to reduce the current MAW inventory and improving operational water use efficiency.

The CCM WMS comprises the following key components; each are discussed in more detail in the

CCM Water Management Plan (Engeny, 2024b):

- Mine water storages.
- Tailings storage facilities.
- Underground workings and storages.
- Water transfer infrastructure including pipelines and pumps.
- External (third party) water supplies.

In addition to the components listed above, the following infrastructure (in addition to TSF3) are proposed to support the transition back to, and sustaining of mining and ore processing operations:

- A new water treatment plant (WTP); and
- Dedicated EPit seepage collection sump created within the footprint of the existing MCD impoundment which will provide separation between treated MAW stored in MCD prior to release and lower quality seepage which originates from EPit if EPit water level exceeds the maximum operating level (MOL) of 222 m AHD[4].

4.2 Key Water Management System Objectives

The purpose of the CCM WMS includes:

- Managing the containment and storage of MAW runoff and seepage.
- Managing the containment and dewatering of tailings.
- Maintenance of a reliable supply of treated MAW for operational water demands.
- Minimise the site's reliance on external water supplies through improvements to MAW recycling efficiency and supply to operational water demands.
- Minimise the accumulation of MAW through enhanced evaporation (mechanical evaporators) and controlled releases.
- Managing the supply of raw water from Lake Waggaboonya.
- Diversion of clean runoff around the site using clean water diversions, dams and drains.
- Erosion and sediment control.

Table 4.1 summarises the types of water on site and the management strategy employed for each water type.

[4] Operational exceedance of EPit MoI is not planned for the future operations at CCM however, due to the currently elevated water level in Epit following the 2022 and 2023 wet seasons, separation of treated MAW and Epit seepage is required to ensure that the quality of treated MAW stored in MCD prior to release does not become adversely impacted by lower quality seepage from EPit.

TABLE 4.1: WATER TYPES GENERATED BY CCM AND OVERALL WATER MANAGEMENT STRATEGIES

Type of Water	Definition	Management Strategy
Clean Runoff	Runoff from all areas that are not affected by mining activities.	Drains and dams are used to separate and divert clean catchment runoff to receiving waterways.
Sediment Runoff	Runoff which only contains elevated suspended sediments due to mining disturbance.	Runoff with increased sediment loads is captured and treated using sediment dams to reduce suspended solids prior to discharging from site.
Mine Affected Water (MAW)	Includes any water that contacts stockpiles, mining areas, plant areas, pit areas and groundwater entering underground activities.	Maintain separation from other water types, recycle and evaporate to the greatest extent possible and discharge as per EA release conditions. All MAW should be stored in the EPit.
Treated MAW	Mine affected water that has been treated by the WTP.	Treated MAW will be used to meet the site's operational (non-potable) water demands and may also be released to Gunpowder Creek. Treated water from the WTP will be pumped to Pond 3 and 4 for subsequent use for operational demands; excess treated water will be stored in MCD prior to discharge to Gunpowder Creek as per EA release conditions.
Raw Water	The site has access to raw water from Lake Waggaboonya to supply raw water demands. This water is untreated and is used in various operational processes or when supplies of treated MAW are unavailable.	Minimise consumption where possible through reuse of MAW and operation of the WTP.
Potable Water	Water for drinking and sanitation purposes.	Maintain supply to demands ensuring treatment to the required standards. Raw water from Lake Waggaboonya is treated prior to its use as potable water.

4.3 Existing Regulated Water Storages

The existing CCM water management system is primarily made up of Esperanza Pit (EPit), Esperanza Tailings Storage Facility (ETSF) and Mill Creek Dam (MCD) which form an integrated water containment system (henceforth referred to as the integrated containment system (ICS)). EPit, ETSF and MCD are all assessed as having a significant consequence category for 'failure to contain – spill' and a high consequence category for 'dam breach' (Engeny Australia Pty Ltd, 2023). Therefore, all three storages are required to achieve the following hydraulic design criteria as outlined in Schedule G – Table 1 of the Environmental authority EPML00911413 (DETSI, 2023):

- Design Storage Allowance (DSA):
  - 1:20 AEP 2-month wet season plus process inputs during period.
- Mandatory Reporting Level (MRL):
  - The runoff from a 1:10 Annual Exceedance Probability (AEP) 72-hour duration storm; plus
  - 1:10 AEP, 72hr duration storm event containment is provisioned within the Esperanza Pit.
- Spillway Capacity:
  - 1:100,000 AEP flood plus wave run-up allowance for 1:10 AEP wind OR Probable Maximum Flood (PMF).

The combined system DSA for the ICS is currently allocated between EPit and MCD with the ESS requirement for ETSF allocated to EPit.

- The combined DSA for EPit, ETSF, and MCD is 1,903.2 ML.
- The DSA volume allocated to MCD is 494 ML (RL 216.1 m).
- The DSA Volume allocated to EPit is 1409.2 ML (RL 207.7 m).

- The DSA Volume allocated to ETSF is provisioned within the EPit. Excluding the ETSF decant sump area[5], the ETSF structure is to contain no surface water as of 1st November each year.

Table 4.2 below summarises the each of the existing storages in the CCM ICS.

TABLE 4.2: CCM REGULATED WATER STORAGES

Storage	Maximum Operating Level (m AHD)	Design Storage Allowance (DSA) Volume (ML)	Functional Description
Esperanza Pit (EPit)	222	1,409	• Former open cut pit historically used to store tailings and currently used to store MAW. • Receives pumped inflows from ETSF, Mammoth and Esperanza South Underground Mines and will also receive decant from TSF3 once operational. • May receive spillway overflow from ETSF and TSF3 when operational. • Authorised release point for pumped discharges to Gunpowder Creek. • May transfer pumped outflows to Mill Creek Dam. • Will provide supply of water to proposed WTP. • Receives seepage from Esperanza WRD. • Pump supply to evaporators (enhanced evaporation). • Will receive Sump 6, Hoover dam, NWRD and event pond pumped inflows (currently sent to MCD).
Esperanza Tailings Storage Facility (ETSF)	284	The DSA Volume allocated to ETSF is provisioned within the EPit	• Previously used for tailings storage. • Receives pumped inflows from Saddle Dams 2 and 3. • Transfers pumped outflows to Esperanza Pit. • Pump supply to evaporators (enhanced evaporation).
Mill Creek Dam (MCD)	216.1	494	• Currently used to store mine affected water (MAW) however will be used to store treated MAW prior to release to Gunpowder Creek as per EA conditions once the proposed WTP is operational. • Can pump back to pond 3 and 4 to provide additional treated MAW if WTP is offline. • Currently receives pumped inflows from Sump 6, Hoover Dam, NWRD and event pond. These flows are in the process of being diverted to EPit. • Transfer of excess water to EPit.

4.4 TSF3 Preliminary Design Summary

TSF3 is proposed to be located in the Upper Ezperanza Valley, between the Ezperanza Waste Rock Dump (EWRD) and the Upper Ezperanza Diversion Dam (UEDD) (refer to Figure 1.1) and will be formed from the raising and reprofiling of the existing EWRD and UEDD. A new booster pump station will be constructed north of the EWRD. Tailings will be delivered via a ring pipeline with four discharge spigot locations around the southern extents of TSF3. Tailings will beach in a northern direction with the decant pond formed at the EWRD end of the TSF3 impoundment. Key aspects of the TSF preliminary design include:

- Reprofiling of the EWRD embankment to enable construction of an upstream geomembrane liner tied into the foundation and abutment with an anchored concrete plinth and grout curtain. This is expected to reduce the rate of seepage through the EWRD embankment including additional acid generation during operation and closure, and to reduce the magnitude of saturation settlement in the EWRD.
- Centreline raise (which eliminates the requirement for an upstream raise on deposited tailings) of the UEDD embankment include incorporation or replacement / repair of the existing geomembrane liner and grout curtain as appropriate.
- Direction of the TSF3 spillway to EPit to reduce the likelihood of containment loss to the receiving environment.

[5] The ETSF decant sump area includes the ETSF decant sump end-of-pipe and a surrounding area of 50m radius and must be located at least 100m away from all ETSF saddle dams and embankments.

- Reduction in the final tailings storage capacity to enable temporary accommodation of the Extreme Storm Storage (ESS).

Under normal operating conditions the decant pond will be maintained in a minimum condition (1m depth). Depending on conditions, decant water will be pumped to the following locations:

- Under normal operations decant water will be pumped to the EPit for treatment via the proposed new WTP.
- During and following rainfall events when the decant pond is subject to additional stormwater inflows, decant pumping will be directed to the EPit.
- In the event that water quality monitoring of the decant pond indicates sufficient water quality, decant water may be pumped directly to pond 3 or to the MCD (to avoid having to needlessly retreat through the WTP).

A detailed description of the TSF3 preliminary design is provided in the TSF3 Preliminary Design Report (Engeny, 2025).

4.4.1 Esperanza Waste Rock Dump

Construction of the EWRD occurred sometime after the commencement of mining at Esperanza Pit (EPit), circa 1997. The EWRD appears to have infilled existing drainage lines which drain waters to the north and is intercepted by EPit. The EWRD is known to contain potentially acid forming waste rock and general waste deposits from the previous operator, Birla Mount Gordon, as described in the Esperanza WRD Waste Disposal Management Plan (BMG, 2014).

4.4.2 Upper Esperanza Diversion Dam

The Upper Esperanza Diversion Dam (UEDD) was constructed as part of ongoing water management control measures at Birla's Mount Gordon mine during the 2009 dry season. During the 2009-2010 wet season, seepage was observed at the downstream toe of the dam. This was controlled by installation of a pump to return seepage to the diversion channel. Back analysis of seepage data in conjunction with onsite observations and knowledge of the construction methods indicated that the seepage was most likely passing through the dam foundations and not due to a fault in the GCL membrane (GHD, 2010).

The investigations carried out by GHD found there to be a highly complex joint system, with many of the joints being randomly oriented. Recurring joints included those that struck and dipped along the bedding plane (i.e. approximately 10 to 30 degrees strike and between 55 and 65 degrees west dip), as well as a set that struck in the same direction as the bedding plane, but dipped between 30 and 60 degrees east (GHD, 2010).

The UEDD repair works consisted of general earthworks and slope corrections, grout curtain installation, plinth construction, and installation of a HDPE liner. The objective of the works is to minimise seepage through the foundations by the use of a grout curtain, and through the embankment (and therefore through the foundations on the downstream side of the plinth) by the use of a HDPE liner.

CCM are currently progressing preliminary investigations to determine the cause of apparent ingress of clean water through the UEDD to the north including dewatering of the UEDD while monitoring seepage at the v-notch weir and piezometric levels in the UEDD piezometer during dewatering, and inspection of the liner and liner – grout curtain connection.

The current design of TSF3 incorporates a number of controls to reduce seepage through the southern embankment including:

- Verification of the adequacy of the existing grout curtain via conformation grouting, and extension of the grout curtain to enable the centreline raise of the UEDD.
- Verification of the adequacy of the existing HDPE liner including inspection and testing, and where inadequate repair or replacement as appropriate.
- Decant pond remote from the UEDD embankment.
- Low permeability tailings deposited against the internal embankment.
- UEDD continued to be dewatered via pumping.
- Remote and convoluted drainage path from TSF3 to Gunpowder Creek.

4.5 Mill Creek Dam Compartmentalisation

The EPit MOL (222 m AHD) has been adopted by CCPL to reduce the likelihood of seepage entering MCD. Large rainfall events over the 2022 and 2023 wet seasons have led to an elevated water level in EPit which in turn has resulted in seepage from EPit entering MCD. Seepage inflows to MCD from EPit have the potential to reduce the quality of treated water stored in MCD prior to release possibly rendering stored water unsuitable for release under existing EA conditions. To minimise the potential for seepage originating from EPit having a deleterious impact on the quality of treated water stored in MCD, CCPL are currently considering the construction of a cutoff structure (e.g., grout curtain or similar) across the ETSF ramp to provide a barrier to seepage entering MCD from EPit.

4.5.1 Preliminary TSF3 Consequence Category Assessment

Preliminary consequence category assessments have been undertaken to inform the preliminary design of TSF3 including a Queensland Department of Environment, Science and Innovation (DESI) CCA and Australian National Committee on Large Dams (ANCOLD) CCA. The DES CCA was undertaken in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933), Version 5.03. The ANCOLD CCA was undertaken in accordance with the Guidelines on the Consequence Categories for Dams (ANCOLD, 2012). Details of the preliminary CCAs are provided in the TSF3 Preliminary Design Report (Engeny, 2024) and the results of the DES CCA is summarised below in Table 4.3.

As a result of the preliminary DESI CCA, relevant hydraulic criteria for TSF3 will be the same as those currently required for the existing regulated storages (Section 4.3).

TABLE 4.3: TSF3 DESI CCA PRELIMINARY CONSEQUENCE CATEGORY ASSESSMENT

Failure Scenario	Consequence Category
Failure to Contain – Seepage	Low
Failure to Contain – Overtopping	Significant
Dam Break	High
Overall	High

4.5.2 TSF 3 Preliminary DSA and MRL Assessment

A preliminary MRL and DSA assessment (refer to Appendix B) have been completed for TSF3 and the ICS which will additionally incorporate the proposed TSF3. Results are summarised in Table 4.4 and Table 4.5 below:

- The preliminary ESS for TSF3 is 171.4 ML which equates to a MRL of 331.18 m AHD.
- The preliminary 1:20 AEP wet season inventory increase for the ETSF, EPIT, MCD and TSF3 integrated system is summarised as follows:
  - Combined 1:20 AEP (95th percentile or 5% AEP) wet season inventory increase in EPit, ETSF, MCD and the proposed TSF3 – **434 ML**.
  - Design Simulation Margin – **25% (109 ML).**
  - Combined Design Storage Allowance for EPit, ETSF, MCD and proposed TSF3 – **543 ML.**

As the estimated ICS DSA is less than combined MRL volume, MRL is adopted for DSA as the DSA cannot be less than the MRL. The current combined MRL volume of MCD and EPit is 678ML with an additional 171.4 ML preliminary ESS estimated for TSF3. In total, the combined MRL volume for the ICS is therefore 849.4 ML and this would also be adopted for the system DSA.

TABLE 4.4: TSF3 PRELIMINARY ESS AND MRL RESULT

Aspect	Comment
1:10 72-hr rainfall depth	217 mm
TSF3 total catchment	79 Ha
Extreme Storm Surge (ESS)	171.4 ML
TSF3 Spillway level	312.2 m AHD
Preliminary Mandatory Reporting Level (MRL)	311.18 m AHD

TABLE 4.5: CCM INTEGRATED CONTAINMENT SYSTEM INCLUDING TSF3 PRELIMINARY DSA AND MRL SUMMARY

Storage	MRL	DSA
Mill Creek Dam (MCD)	234.6 ML (217.7 m AHD)	234.6 ML (217.7 m AHD)
Esperanza Pit (EPit)	443.4 ML (217.9 m AHD)	443.4 ML (217.9 m AHD)
Esperanza TSF (ETSF)	N/A - provided within EPit	N/A - provided within EPit
TSF3 (preliminary)	171.4 ML (311.18 m AHD)	171.4 ML (311.18 m AHD)

4.6 Preliminary Integrated Containment System Operational Controls

Existing rules governing the distribution of excess water between EPit and MCD under wet-season and contingency conditions are designed to prevent uncontrolled overflow during wet weather events and maintain minimal water inventory in ETSF. Detailed descriptions of the existing rules are provided in the CCM water management plan (Engeny, 2024b). Operation of TSF3 will be similarly managed to minimise inventories of water stored on TSF3. As a result of the preliminary DSA assessment completed for TSF3 (Section 4.5.2), preliminary revised operating rules have been nominated for MCD and EPit along with rules for the operation of the proposed TSF3 (refer to Table 4.6 below). It is highlighted that the operating rules presented in Table 4.6 are preliminary and that detailed rules will be developed following finalisation of the TSF3 design, completion of a final DSA assessment for the ICS and through CCPLs bi-annual site water management plan updates. The overarching intent of the preliminary ICS operating rules are to:

- Maintain low decant pond inventory in TSF3 (nominal 1m depth) and ETSF (noting that ETSF is almost exhausted and therefore pumping only comprises direct rainfall and stormwater runoff) via pumped decant to EPit (or Pond 3 if water is of acceptable quality).
- To the greatest extent possible, maintain MCD at or below DSA/MRL through supply to site water demands and compliant controlled releases to Gunpowder Creek.
- Store excess MAW in EPit and maintain supply to site water demands via transfer from EPit to the proposed WTP.
- Transfer water from MCD to EPit when MCD exceeds DSA/MRL to reduce the risk of immediate overflow.
- Maintain site operations.

TABLE 4.6: PRELIMINARY OPERATING RULES FOR THE CCM INTEGRATED CONTAINMENT SYSTEM

Regulated Dam	Operating Rules
Esperanza Tailings Storage Facility (ETSF)	1. Maintain decant pumping of rainfall and stormwater inflow (no further tailings deposition currently proposed due to exhaustion) to ensure decant pond volumes are minimised and there is no ponding of water against any embankment and the pond extent remains greater than 100 m from the saddle dam embankments in accordance with Conditions G9-3 of Environmental Authority EPML00911413.
TSF3 (Proposed)	The following preliminary rules have been proposed for operation of TSF3. Following approval of the TSF3 EA amendment the CCM system design plan (SDP) will be updated and certified to incorporate operation of TSF3. 1. During dry weather employ a sufficient rate of decant pumping to EPit (or Pond 3 if water of acceptable quality) to maintain a decant pond target operating depth of 1m and supply the proposed WTP. 2. Following rainfall and stormwater runoff into TSF3, decant pumping will increase in order to expediate a return to the target operating depth. Preliminary decant pump sizing (refer to Section 4.4) has adopted a decant pump capacity of 200 L/s which is sufficient to dewater the estimated ESS (extreme storm surge, refer to Section 4.4) volume within 14 days to EPit.
Esperanza Pit (EPit)	1. Maintain supply to WTP to supply site needs and ensure MCD is maintained near DSA with treated MAW. 2. Transfer directly to MCD only if: water quality in EPit is of a suitable quality (i.e., meets EA release conditions) and: a. MCD water level is below DSA/MRL level. 3. Maintain supply to the EPit evaporators (enhanced evaporation). 4. Authorised pumped release to Gunpowder Creek where needed to manage inventories if Conditions C2-1 to C2-9 of Environmental Authority EPML00911413 can be met (although this is now expected to occur via pond 4 or MCD).
Mill Creek Dam (MCD)	1. Pump to EPit when: a. MCD water level is above DSA/MRL level and EPit water level is below 222 m AHD. 2. Authorised pumped release to Gunpowder Creek if Conditions C2-1 to C2-9 of Environmental Authority EPML00911413 can be met. 3. Pump to pond 3 when WTP is offline and treated MAW is required for operational needs.

Regulated Dam	Operating Rules
Site Operations	1. Maintain site operations including: a. Operation of the Water Treatment Plant and supply of treated water to the processing plant and MCD prior to release. b. Operation of the EPit evaporators.

5. SURFACE WATER QUALITY ASSESSMENT

The potential for the construction of TSF3 to impact to surface water quality is considered to be unlikely. An assessment of the recent existing monitoring data from locations near to the proposed TSF location has been completed to determine the risk to surface water as a result of the proposed TSF3. The applicable Environmental Values (EVs) and Water Quality Objectives (WQOs) to the area are described below.

5.1 Environmental Values

EVs for water are the qualities that make it suitable for supporting aquatic ecosystems and human water uses. These qualities need to be protected from the effects of habitat alteration, waste releases, contaminated run-off and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use[6].

EVs and water quality objectives (WQOs) established under the EPP (Water and Wetland Biodiversity):

- provide significant cost efficiencies to government, industry and other groups by establishing a single set of agreed WQOs for legislative and non-legislative planning and water quality management.
- support current and planned future investments by government, industry and the community, in built and natural environments.
- meet the increasing public expectation that government will protect the state's waterways from pollution and minimise economic, social (including public health) and environmental risks associated with declines in water quality.

The EPP (Water and Wetland Biodiversity) Schedule 1 does not list environmental values (EV) or water quality objectives (WQO) for the Leichardt River Basin.

The WQOs for a water that is not in Schedule 1 are the set of water quality guidelines (e.g. the Queensland Water Quality Guidelines and the Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality 2018) for all indicators that will protect all EVs for the water.

The CCM 2023 and 2024 Post-wet REMP Reports (Hydrobiology, 2023; Hydrobiology, 2024) nominate relevant environmental values for receiving waters in the vicinity of CCM, shown in Table 5.1 below.

TABLE 5.1: NOMINATED EVS FOR GUNPOWDER CREEK AND GREENSTONE CREEK AS DEFINED IN THE PREVIOUS REMP (NRA, 2022) (HYDROBIOLOGY, 2023) (HYDROBIOLOGY, 2024)

Environmental Value	Gunpowder Creek (adjacent CCM)[7]	Gunpowder Creek (downstream of CCM)[8]	Greenstone Creek (downstream of confluence with Magazine Creek)
Aquatic ecosystem	Highly disturbed[9]	Moderately disturbed	Highly disturbed[9]
Stock watering	Livestock drinking water[9]	Livestock drinking water	Livestock drinking water[9]
Recreation and aesthetics	Visual recreational use[9]	Secondary recreational use	Visual recreational use[9]
Industrial	Mining[9]	Mining	Mining[9]
Cultural and spiritual[10]	Cultural and spiritual[9]	Cultural and spiritual	Cultural and spiritual[9]

[6] https://environment.des.qld.gov.au/__data/assets/pdf_file/0029/86663/factsheet-evs-wqos-epp-water.pdf

[7] Adjacent sites include GPA2, GPA4, GPA5 and GPA6. Although GPA2 is upstream of the causeway and the Mill Creek Dam release point, this site is likely to have been impacted by mining activities. This is likely due to backflow (Wood (1996) notes backflow occurs about 40 m upstream of the causeway – GPA2 to approximately 120 m upstream of the causeway) and/or pooling of mine-affected waters upstream of the causeway.

[8] The listed environmental values are subject to research and consultation with the administering authority and, as required, other stakeholders. Indications suggest the end of the mixing zone is nearer to 1 km downstream of the confluence of Greenstone Creek with Gunpowder Creek (NRA, 2016).

[9] ANZG (2018) defines the mixing zone as an explicit area around effluent discharges where the management goals of the ambient waters do not need to be achieved and hence designated EVs may not be applied. The mixing zone for Greenstone Creek is considered to be from the confluence with Magazine Creek downstream to the confluence with Gunpowder Creek. The mixing zone for Gunpowder Creek is considered to extend from around the causeway to a point downstream of the confluence with Greenstone Creek. Impacts within this zone have occurred since the early 1970s, with seepage from the Old (Mammoth) TSF and contaminated flows into Gunpowder Creek via Mill Creek. It is not considered appropriate to assign aquatic ecosystem EVs in the context of regulatory compliance (although it is appropriate to derive relevant guidelines to serve as trigger values) to the Gunpowder Creek and Greenstone Creek mixing zones.

[10] Although cultural and spiritual values have been assigned, no specific WQOs/SQOs have been nominated for these values.

5.2 Water Quality Objectives

WQOs are long-term goals for water quality management. They are measures, levels or narrative statements of indicators of water quality that protect EVs. They define what the water quality should be to protect the EVs—after consideration of the socio-economic assessment of protecting the water quality[11].

CCPL have submitted an EA amendment application to amend relevant trigger levels and contaminant limits; Table 5.2 below details existing trigger levels and contaminant limits for surface water monitoring as outlined in the current EA.

Nine (9) years of reference site data from sample location GPU1 (refer to Figure 5.1) obtained between January 2014 and February 2025 (n=241) has been reviewed to determine the 80th and 95th percentiles in accordance with Table 5.2. The results are presented in Table 5.3. It is noted that selection of values based on the criteria presented in EA Schedule C – Table 4 results in contaminant limits assigned at values lower than the nominated trigger levels for the following parameters (total concentrations):

- Arsenic
- Boron
- Cadmium
- Chromium
- Manganese
- Nickel

This is due to the 95th percentile calculated value being lower than the EA nominated trigger level for these metals. As a result, the lower calculated 80th percentile value has been adopted as the trigger level for these analytes, shown in bold in Table 5.3.

TABLE 5.2: RECEIVING WATERS CONTAMINANT TRIGGER LEVELS AND CONTAMINANT LIMITS (EA SCHEDULE C – TABLE 4)

Parameter	Water Quality	
	Trigger Level	Contaminant Limit
pH (pH units)	6.0-8.5	
EC (µS/cm)	435	TBD
Sulphate (mg/L)	250	1,000
Fluoride (mg/L)	80th percentile[1] of reference site concentration[2]	2
Major cations	For interpretive purposes	
Major anions	For interpretive purposes	
Aluminium	80th percentile[1] of reference site[2] concentration[3] or 55 µg/L, whichever is higher	95th percentile[1] of reference site[2] concentration[3] or 5 mg/L, whichever is lower
Arsenic[5]	80th percentile[1] of reference site[2] concentration[3] or 13 µg/L, whichever is higher	95th percentile[1] of reference site[2] concentration[3] or 0.5 mg/L, whichever is lower
Boron	80th percentile[1] of reference site[2] concentration[3] or 370 µg/L, whichever is higher	95th percentile[1] of reference site[2] concentration[3] or 5 mg/L, whichever is lower
Cadmium	80th percentile[1] of reference site[2] concentration[3] or 0.2 µg/L, whichever is higher	95th percentile[1] of reference site[2] concentration[3] or 0.01 mg/L, whichever is lower
Chromium[5]	80th percentile[1] of reference site[2] concentration[3] or 1.0 µg/L, whichever is higher	95th percentile[1] of reference site[2] concentration[3] or 1 mg/L, whichever is lower
Cobalt	80th percentile[1] of reference site[2] concentration[3]	95th percentile[1] of reference site[2] concentration[3] or 1 mg/L, whichever is lower
Copper	80th percentile[1] of reference site[2] concentration[3] or 1.4 µg/L, whichever is higher	95th percentile[1] of reference site[2] concentration[3] or 1 mg/L, whichever is lower

[11] https://environment.des.qld.gov.au/__data/assets/pdf_file/0029/86663/factsheet-evs-wqos-epp-water.pdf

Parameter	Water Quality	
	Trigger Level	Contaminant Limit
Lead	80th percentile[1] of reference site[2] concentration[3] or 3.4 µg/L, whichever is higher	95th percentile[1] of reference site[2] concentration[3] or 0.01 mg/L, whichever is lower
Manganese	80th percentile[1] of reference site[2] concentration[3] or 1900 µg/L, whichever is higher	95th percentile[1] of reference site[2] concentration[3]
Nickel	80th percentile[1] of reference site[2] concentration[3] or 11 µg/L, whichever is higher	95th percentile[1] of reference site[2] concentration[3] or 1 mg/L, whichever is lower
Uranium	80th percentile[1] of reference site[2] concentration[3]	95th percentile[1] of reference site[2] concentration[3] or 0.2 mg/L, whichever is lower
Zinc	80th percentile[1] of reference site[2] concentration[3] or 8 µg/L	95th percentile[1] of reference site[2] concentration[3] or 20 mg/L, whichever is lower
Total Hardness	For interpretive purposes only	
Total Organic Carbon	Not applicable	
Particle size distribution	Not applicable	

1. Must be determined in accordance with QWQG (2009) and ANZECC (2000) methodology.

2. Reference sites are specified in Schedule C - Table 3 (Receiving Waters Monitoring Locations).

3. Where the 80th/95th percentile of a water quality trigger level/contaminant limit is exceeded at a receiving water site and the reference site also exceeds this concentration during the release/flow event, the value of the reference site applies as the water quality trigger level/contaminant limit for the duration of the event.

4. Site specific trigger levels and contaminant limits for water quality (80th and 95th percentile of reference site concentration) must be calculated in accordance with QWQG (2009) and ANZECC (2000) methodology if sufficient monitoring data is available. The environmental authority holder must maintain a database documenting all relevant water quality monitoring data and calculation of 80th/95th percentiles adopted as water quality trigger levels and contaminant limits.

5. Routine analysis for this parameter is based on combined/total species of the element, where the exceedance of the WQO is identified, an additional sample must be taken and analysed as soon as practicable to determine and quantify speciated forms of this element. This does not apply to sediment analysis.

6. For all water quality monitoring, metals and metalloids must be measured and reported as both total (unfiltered) and dissolved (field filtered) concentrations.

7. All stream sediment sampling must be undertaken in accordance with AS 5667.12 Guidance on Sampling of Bottom Sediments of 1998.

TBD – The holder must determine a trigger level and contaminant limit for Electrical Conductivity in accordance with the REMP, relevant provisions of the Environmental Protection (Water) Policy 2009 and ANZECC (2000) methodology before 1 October 2013.

TABLE 5.3: RECEIVING WATERS CONTAMINANT TRIGGER LEVELS AND CONTAMINANT LIMITS (UPDATED WITH REFERENCE SITE DATA)

Parameter	Water Quality	
	Trigger Level	Contaminant Limit
pH (pH units)	6.0-8.5	
EC (µS/cm)	$95^{\%20}$ (**435**)	**473**^{Max}
Sulphate (mg/L)	250	1,000
Fluoride (mg/L)	**6**$^{\%80}$	**11.75**$^{\%95}$ (2)
Major cations	For interpretive purposes	
Major anions	For interpretive purposes	
Aluminium	**1108** µg/L$^{\%80}$ or 55 µg/L, whichever is higher	**3.47** mg/L$^{\%95}$ or 5 mg/L, whichever is lower
Arsenic[5]	**2** µg/L$^{\%80}$ or 13 µg/L, whichever is higher	**0.00315** mg/L$^{\%95}$ or 0.5 mg/L, whichever is lower
Boron	**90** µg/L$^{\%80}$ or 370 µg/L, whichever is higher	**0.146** mg/L$^{\%95}$ or 5 mg/L, whichever is lower
Cadmium	**0.12** µg/L$^{\%80}$ or 0.2 µg/L, whichever is higher	**0.00018** mg/L$^{\%95}$ or 0.01 mg/L, whichever is lower
Chromium[5]	**0.1** µg/L$^{\%80}$ or 1.0 µg/L, whichever is higher	**0.001** mg/L$^{\%95}$ or 1 mg/L, whichever is lower
Cobalt	**3** µg/L$^{\%}$	**0.007** mg/L$^{\%95}$ or 1 mg/L, whichever is lower
Copper	**10** µg/L$^{\%80}$ or 1.4 µg/L, whichever is higher	**0.0242** mg/L$^{\%95}$ or 1 mg/L, whichever is lower
Lead	**5** µg/L$^{\%80}$ or 3.4 µg/L, whichever is higher	0.0109 mg/L$^{\%95}$ or **0.01** mg/L, whichever is lower

Parameter	Water Quality	
	Trigger Level	Contaminant Limit
Manganese	**223.2** µg/L$^{\%80}$ or 1900 µg/L, whichever is higher	**0.4326** mg/L$^{\%95}$
Nickel	**3** µg/L$^{\%80}$ or 11 µg/L, whichever is higher	**0.006** mg/L$^{\%95}$ or 1 mg/L, whichever is lower
Uranium	**1** µg/L$^{\%80}$	**0.00165** mg/L$^{\%95}$ or 0.2 mg/L, whichever is lower
Zinc	**20** µg/L$^{\%80}$or 8 µg/L, whichever is higher	**0.032** mg/L$^{\%95}$ or 20 mg/L, whichever is lower

$^{\%}$ - percentile calculated

^{Max} - Maximum Value Reported

5.3 Surrounding Surface Water

Surface water near to the proposed TSF3 footprint is presented in Figure 5.1. The figure shows the mapped unnamed tributaries within the surrounding area.

The UEDD is the receiving water body for the closest drainage lines. It is considered unlikely for water from the UEDD to drain into Gunpowder Creek to the west.

The tributary to the east of the proposed TSF3 footprint drains to Magazine Creek. The existing Sump Catchment 3 water storage is located between the TSF3 footprint and the confluence with Magazine Creek.

Legend

- TSF3 Design Footprint

Surface Water

- EA SW Locations
- Surface Water

Watercourse line

- Major
- Minor
- Mining Lease

Google Satellite



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This drawing is confidential and shall only be used for the purpose of this project.

DRAWN	RM	CHECKED	BW
APPROVED	RM	DATE	13-05-2025

NOTES:

N

0 0.4 0.8 km

SCALE @ A3 - 18000

DISCLAIMER
Engeny has endeavoured to ensure accuracy and completeness of the data. Engeny assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

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Metals

Surface Water Monitoring

Capricorn Copper Pty Ltd
Surface Water Impact Assessment

Project Ref. QC1022_018

5.3.1 Surrounding Surface Water Quality

The closest existing surface water monitoring locations to the proposed TSF3 are REHAB02 (approximately 400 m northeast of the TSF3 design footprint perimeter, MGU1 (approximately 700 m east of the TSF3 footprint perimeter) and GPU1 (approximately 2 km west of the TSF3 footprint perimeter). Monitoring locations are presented in Figure 5.1.

- Locations MGU1 and GPU1 are background surface water locations regularly monitored as part of the Receiving Environment Monitoring Program (REMP) for CCM.
- REHAB02 is located at the spillway of Heap Leach Pad 2.
- UEDD water quality is monitored as part of the regulated dams monitoring for CCM.

The most recent monitoring data from the surrounding locations is presented in Table 5.4. The presented data shows no obvious impact from existing mine operations, with the exception of the REHAB02 location, which reports reduced pH and elevated arsenic, cobalt, copper, manganese, nickel and zinc when compared to the updated EA contaminant limits.

TABLE 5.4: SURROUNDING SURFACE WATER QUALITY

Lab Ref	MGU1 (2024 Average n=47)	GPU1 (2024 Average n=52)	UEDD (2024 Average n=2)	REHAB02 (2024 Average n=2)	EA Contaminant Limit
pH Value ALS	6.56	7.77	6.35	4.87	6.0-8.5
Electrical Conductivity (µS/cm)	27.44	124.63	25.5	92	473
Sulphate as SO4 (mg/L)	3.53	4.82	5.5	27	1000
Fluoride - Total (mg/L)	0.051	0.155	<0.01	<0.1	11.75
Aluminium - Dissolved (mg/L)	0.0708	0.029	0.01	0.06	3.47
Aluminium - Total (mg/L)	1.198	0.908	0.245	2.255	3.47
Arsenic - Dissolved (mg/L)	0.00008	<0.001	<0.001	<0.001	0.00315
Arsenic - Total (mg/L)	0.00029	0.001	<0.001	0.018	0.00315
Boron - Dissolved (mg/L)	<0.05	<0.05	<0.05	<0.05	0.146
Boron - Total (mg/L)	<0.05	<0.05	<0.05	<0.05	0.146
Cadmium - Dissolved (mg/L)	<0.0001	0.0001	<0.0001	<0.0001	0.00018
Cadmium - Total (mg/L)	<0.0001	0.0001	<0.0001	<0.0001	0.00018
Chromium - Dissolved (mg/L)	0.00002	<0.001	<0.001	<0.001	0.001
Chromium - Total (mg/L)	NA	NA	NA	NA	0.001
Cobalt - Dissolved (mg/L)	0.0005	0.0013	<0.001	0.0305	0.007
Cobalt - Total (mg/L)	0.0013	0.0021	0.001	0.0625	0.007
Copper - Dissolved (mg/L)	0.0032	0.0036	0.005	0.7095	0.0242
Copper - Total (mg/L)	0.0091	0.0072	0.013	1.014	0.0242
Lead - Dissolved (mg/L)	<0.001	<0.001	<0.001	<0.001	0.01

Lab Ref	MGU1 (2024 Average n=47)	GPU1 (2024 Average n=52)	UEDD (2024 Average n=2)	REHAB02 (2024 Average n=2)	EA Contaminant Limit
Lead - Total (mg/L)	0.00027	0.0015	<0.001	0.005	0.01
Manganese - Dissolved (mg/L)	0.023	0.0169	0.003	0.312	0.4326
Manganese - Total (mg/L)	0.045	0.1	0.018	0.6015	0.4326
Nickel - Dissolved (mg/L)	0.0002	0.002	<0.001	0.005	0.006
Nickel - Total (mg/L)	0.0014	0.0022	<0.001	0.0115	0.006
Uranium - Dissolved (mg/L)	<0.001	<0.001	<0.001	<0.001	0.00165
Uranium - Total (mg/L)	<0.001	<0.001	<0.001	<0.001	0.00165
Zinc - Dissolved (mg/L)	0.0027	0.0113	0.009	0.01	0.032
Zinc - Total (mg/L)	0.0019	0.00931	0.0035	0.048	0.032
Ammonia as N (mg/L)	0.077	0.088	NA	0.085	For interpretive purposes only

5.3.2 Predicted TSF3 Water Quality

The water quality of water stored in the future TSF3 is considered to be of a similar quality to that of the existing Esperanza TSF, given the ore blend and processing remain unchanged. Recent monitoring results are summarised in Table 5.5 and compared to the EA receiving water contaminant limits (Schedule C – Table 4 of EPML00911413). Average water quality data from ETSF collected between January and December 2024 report reduced pH and elevated EC, sulphate, aluminium, arsenic, cadmium, cobalt, copper, manganese, nickel, uranium and zinc.

TABLE 5.5: ESPERANZA TSF WATER QUALITY

Parameter	Count	Min	Max	Average	EA Contaminant Limit
pH Value ALS	4	3.62	5.69	4.4075	6.0-8.5
Electrical Conductivity (µS/cm)	4	2470	3950	3042.5	473
Sulphate as SO4 (mg/L)	4	1240	2930	1940	1000
Fluoride - Total (mg/L)	4	0.2	0.9	0.425	11.75
Aluminium - Dissolved (mg/L)	4	0.08	10.2	5.0875	3.47
Aluminium - Total (mg/L)	4	0.39	18.3	7.5975	3.47
Arsenic - Dissolved (mg/L)	4	<0.001	0.005	0.002	0.00315
Arsenic - Total (mg/L)	4	0.003	0.019	0.01	0.00315
Boron - Dissolved (mg/L)	4	<0.05	<0.05	<0.05	0.146
Boron - Total (mg/L)	4	<0.05	0.06	0.015	0.146
Cadmium - Dissolved (mg/L)	4	<0.0001	0.0012	0.000375	0.00018
Cadmium - Total (mg/L)	4	<0.0001	0.0023	0.000675	0.00018
Chromium - Dissolved (mg/L)	4	<0.001	0.012	0.0055	0.001
Chromium - Total (mg/L)	4	NA	NA	NA	0.001
Cobalt - Dissolved (mg/L)	4	0.26	3.25	1.592	0.007
Cobalt - Total (mg/L)	4	0.409	6.14	2.5065	0.007
Copper - Dissolved (mg/L)	4	1.53	50.3	21.4475	0.0242
Copper - Total (mg/L)	4	2.45	96.2	34.39	0.0242
Lead - Dissolved (mg/L)	4	<0.001	0.001	0.00025	0.01
Lead - Total (mg/L)	4	<0.001	0.002	0.001	0.01
Manganese - Dissolved (mg/L)	4	1.27	13.1	5.1925	0.4326
Manganese - Total (mg/L)	4	1.99	23.5	8.46	0.4326
Nickel - Dissolved (mg/L)	4	0.055	0.837	0.41025	0.006
Nickel - Total (mg/L)	4	0.087	1.57	0.63225	0.006
Uranium - Dissolved (mg/L)	4	<0.001	0.015	0.0065	0.00165
Uranium - Total (mg/L)	4	<0.001	0.028	0.0105	0.00165
Zinc - Dissolved (mg/L)	4	0.062	0.793	0.29475	0.032
Zinc - Total (mg/L)	4	0.101	1.46	0.48675	0.032
Hardness - Total as CaCO3 (mg/L)	4	951	2120	1515.25	For interpretive purposes only

5.4 Receiving Environment Monitoring Program (REMP)

Capricorn Copper Mine *2023 Post-Wet REMP Report*, V3-0, (Hydrobiology, 2023) and Capricorn Copper Mine *2024 Post-Wet REMP Report* (Hydrobiology, 2024) have been reviewed as part of this limited surface water impact assessment. The reports consider groundwater quality in terms of interactions between surface water and groundwater and influences on surface water quality on the receiving environment at CCM.

Elevated concentrations of pH, EC, fluoride, sulphate and metals were reported in the downstream test sites when compared to the upgradient control sites. Overall, most exceedances recorded during the 2023 / 2024 REMP period were also recorded during the 2022 / 2023 REMP period and analytes were typically within ranges previously detected (Hydrobiology, 2024). Additionally, wet season data indicates that downstream sites in Gunpowder Creek showed fewer exceedances than upstream sites that were closer to the release point.

Importantly, it is evident that the release water is not associated with the noted elevations in metals and metalloids in the receiving environment, while recorded dissolved copper concentrations are largely present in non-bioavailable forms and below relevant aquatic DGVs. Therefore, recorded dissolved copper concentrations represent a low risk to aquatic ecosystem values of Gunpowder Creek (Hydrobiology, 2024).

Hydrobiology (2024) assesses the potential for surface water and groundwater interaction based on the ionic composition of samples obtained in 2024 and report that ground and surface water interaction is not suspected at Gunpowder Creek or Greenstone Creek, based on the piper diagram analysis completed. There appeared to be surface and groundwater interaction within Magazine Creek at test site MGA1 (Hydrobiology, 2024). There are no REMP monitoring locations in the vicinity of the proposed TSF3, therefore the risk of surface water connectivity to groundwater proximal to TSF3 has not been assessed to date. As the UEV was an existing waterway prior to construction of the EWRD and UEDD, connectivity of surface water to groundwater is considered possible. It is however noted that the construction of the UEDD including the external HDPE liner and grout curtain, and the Plunge Pool HDPE liners and grout curtains have likely intercepted this surficial connectivity of surface water to groundwater.

5.5 Potential to Spill

The design of the TSF includes the following mitigation measures to prevent surface water from exiting the existing mine water management infrastructure:

- The spillway is designed to overflow to the existing Esperanza Pit and all surface water will be contained within the existing water management system.
- The construction of the TSF has incorporated a liner to minimise potential seepage through the EWRD to the Esperanza Pit.

Due to the factors described above, the perceived risks to water quality as a result of the proposed TSF3 are related to the potential for infiltration to groundwater rather than to surface water quality.

5.6 Risk to Groundwater

The Groundwater within the extent of the UEV is expected within the shallow perched aquifer system and the deep fractured rock aquifer system. The extent of the shallow aquifer is limited to the extent of the colluvium present on the valley floor and sides. In the vicinity of CCM, soils are thin over most areas including valley floors, and this is expected to also occur within the extent of the UEV (Engeny, 2024).

Groundwater within the colluvium is localised and recharged from direct rainfall. Due to the ridges surrounding the extent of the UEV, the shallow aquifer is not expected to be hydraulically connected to any other surficial aquifers at CCM (ATC Williams, 2023). The UEV is located within the Whitworth Quartzite, which is considered to be a relatively impermeable aquitards due to re-crystallisation during regional metamorphism which resulted in little to no primary porosity in the quartzite.

The hydraulic conductivity of the quartzite is assumed to be low (in the order of 10^{-7} m/sec), with areas of higher permeability present in the secondary porosity associated with fractures. The near-surface zone of higher permeability in the fractured rock aquifer (associated with delaminating siltstones and shales) is not likely to be present due to the absence of any mapped siltstone or shale within the extent of the UEV.

Groundwater modelling indicates that the main control on infiltration and seepage from TSF3 is the installation of a HDPE liner. The liner is required to limit the infiltration of groundwater through the Esperanza Waste Rock Dump to the Esperanza Pit, the receiving body for the groundwater (Engeny, 2024).

Naturally elevated metals concentrations for Aluminium (Al), Cadmium (Cd), Cobalt (Co), Copper (Cu), Lead (Pb), Manganese (Mn), Uranium (U) and Zinc (Zn) are reported in the GWMB81 reference bore. Groundwater monitoring of two (2) bores in the vicinity of the proposed TSF 3 indicate elevated EC, total metals (aluminium, chromium, copper and zinc) and dissolved zinc in exceedance of the EA trigger limits. Groundwater quality is not expected to be impacted by the proposed TSF 3, provided the liner is installed and the base of the structure is demonstrated to have low hydraulic conductivity. Any overflows from the proposed TSF 3 are designed to flow into the existing mine water management system and are not expected to impact groundwater quality (Engeny, 2024).

The site data provided indicates that any works associated with the proposed TSF 3 will not impact the receiving environment and with due consideration of the provided site data and the REMP (Hydrobiology, 2024), it is considered that the proposed TSF 3 will have no additional impact on environmental values.

6. WATER BALANCE ASSESSMENT

6.1 Site Water Balance Model Overview

A calibrated GoldSim water balance model (WBM) of the CCM water management system has been developed (Engeny, 2024b) and is used to improve understanding of the water management system performance and provide a decision-making and inventory forecasting tool. The key objectives of the water balance model include:

- Assess the containment performance of the CCM water management system and the hydraulic performance of regulated structures.
- Assess DSA for the proposed ETSF, TSF3, EPit and MCD ICS.
- Improve decision making and management to improve overall water management system performance and containment (i.e., maintaining DSA performance, improve water use efficiency across site and minimise the requirement to release treated water).
- Improve understanding of water flows around site (e.g., catchment runoff, evaporation losses, etc.).

The development and calibration of the CCM water balance model is documented in the CCM WMP (Engeny, 2024b) and the model schematic is shown in Figure 6.5 below.

6.2 Water Balance Model Assessment

The CCM WBM has been used to assess potential surface water impacts to the receiving environment resulting from the proposed TSF3. The WBM has been updated to include discrete representation of TSF3, and the performance of the CCM WMS has been assessed over a period of seven years (representing the estimated design life for TSF3) using a Monte Carlo simulation. To assess the impact of TSF3 under a range of historical climatic conditions, multiple simulations (known as realisations) were performed. The only difference between each realisation is the input climate data (rainfall and evaporation) which consists of 134 years (1889 to 2024) of data obtained from the BoM SILO Data Drill. Running on a daily timestep, the first model realisation simulates the CCM WMS utilising climate data from 1889 to 1894. The second realisation then utilises climate data from the period 1890 to 1895, the third from 1891 to 1896, and so on. This process allows for a total of 132 model realisations (known as a Monte Carlo simulation) to be run from the available climate data.

Model input data and assumptions are identical to those detailed in the preliminary MRL and DSA assessment (refer to Appendix B:) with the exception that the model is run for a simulation duration of seven years instead of one year. This allows for identification of any potential accumulation of water within the CCM WMS which could result in the uncontrolled release of MAW to the receiving environment.

Table 6.1 shows key model assumptions.

TABLE 6.1: TSF3 WATER BALANCE ASSESSMENT – KEY MODEL ASSUMPTIONS SUMMARY (REFER TO APPENDIX A: FOR ADDITIONAL DETAILS)

Aspect	Assumption
Simulation Duration, number of realisations and input climate data	• 7 years (consistent with proposed TSF3 design life) • 134 realisations • SILO Data Drill
Simulation start	• 1 November 2025
Initial volumes	• MCD – As at 18/04/25 (442 ML (217.30 m AHD) • EPit – As at 18/04/25 (1,856 ML (223.27 m AHD)[1] • ETSF – 0ML • TSF3 – 25 ML (1m decant pond depth)
Production	• Full production (140,000 tonnes/month ore processed) for duration of simulation
EPit evaporators[12]	• Two banks of 3 units each (6 total) operating in EPit • 69% availability • Variable monthly efficiency (refer to Appendix B:)

[12] The number of evaporator units operating and availability assumption has been revised subsequent to the WMP (Engeny, 2024b), additional details are presented in Appendix B:

Aspect	Assumption
Controlled releases	• As per existing EA (EPML00911413)
TSF3	• Storage curve derived from final tailings surface • Decant pump capacity 200 L/s • Catchment area representative of the final tailings surface which comprises the maximum tailings beach footprint. Total catchment of 79 Ha comprises of 39 Ha tailings and 40 Ha natural and ratio of natural:tailings remains constant. • The TSF3 preliminary DSA assessment has also considered a worst-case catchment sensitivity with the TSF catchment comprising entirely of tailings beach. Long term runoff coefficients from the adopted AWBM parameters (Engeny, 2024b) are approximately 16% for natural and 49% for tailings.

6.2.1 Water Balance Modelling Results

Figure 6.1 and Figure 6.2 show total water inventory for the CCM ICS and for TSF3 respectively while Figure 6.3 and Figure 6.4 show water level for EPit and MCD respectively:

- P99 and maxim water inventory results (Figure 6.1) show an increase during the first year as a result of the initial inventory however for the remaining years the combined drawdown of process water demand, releases and evaporators provides sufficient combined drawdown to prevent accumulation of water within the ICS.
  - P50 (median) results show a strong negative water balance such that following initial drawdown in the first year, water levels in EPit (the main MAW storage) generally remain at the minimum storage level which is i.e., 2m depth of water cover over the previously deposited tailings (Figure 6.3).
  - Water levels in MCD (Figure 6.4) generally remain at or below the existing DSA level.
- As a result of the initial water level adopted, some overflow from TSF3 to EPit for the P99 and maximum result is indicated in Figure 6.2: (decant pumping from TSF3 is assumed to stop if EPit MOL is exceeded) however for the remaining years overflow from TSF3 to EPit. It is also noted that the storage curve adopted for TSF3 represents the final tailings surface and as such significant water storage would be available in TSF3 for the majority of the time prior to exhaustion.
- No overflows to Gunpowder Creek from Hoover Dam are seen.

In summary, TSF3 is not expected to materially increase the likelihood of an uncontrolled discharge to the receiving environment from the CCM ICS. Water balance assessment has indicated that some overflows from TSF3 may occur however the modelling has assumed a storage capacity for TSF3 conservatively based on the final tailings surface therefore providing the minimum of water storage capacity expected at exhaustion. While the potential for a cascade overflow pathway from TSF3 to Gunpowder Creek is present (via EPit to MCD to Hoover Dam), Figure 6.3: shows that significant contingency storage capacity remains available in EPit.

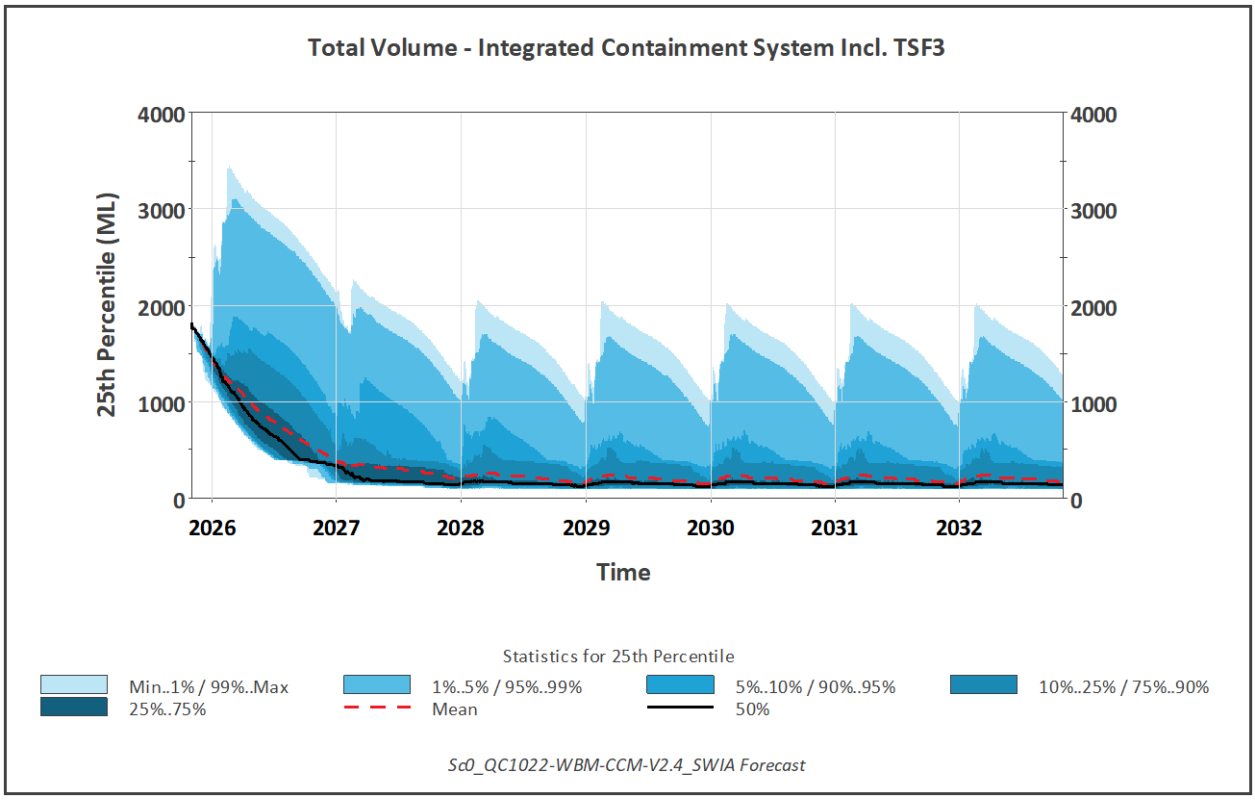


FIGURE 6.1: CCM INTEGRATED CONTAINMENT SYSTEM INVENTORY

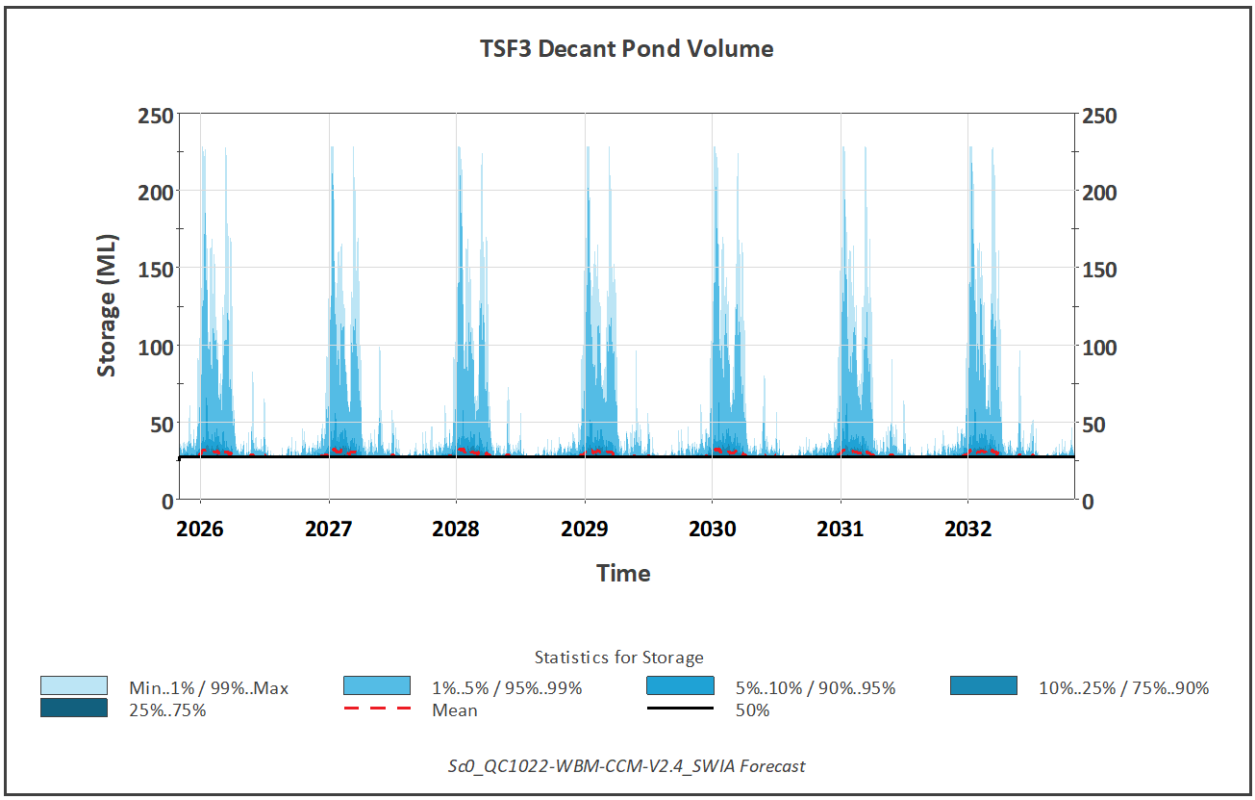


FIGURE 6.2: TSF3 INVENTORY VOLUME (FINAL TAILINGS SURFACE ADOPTED)

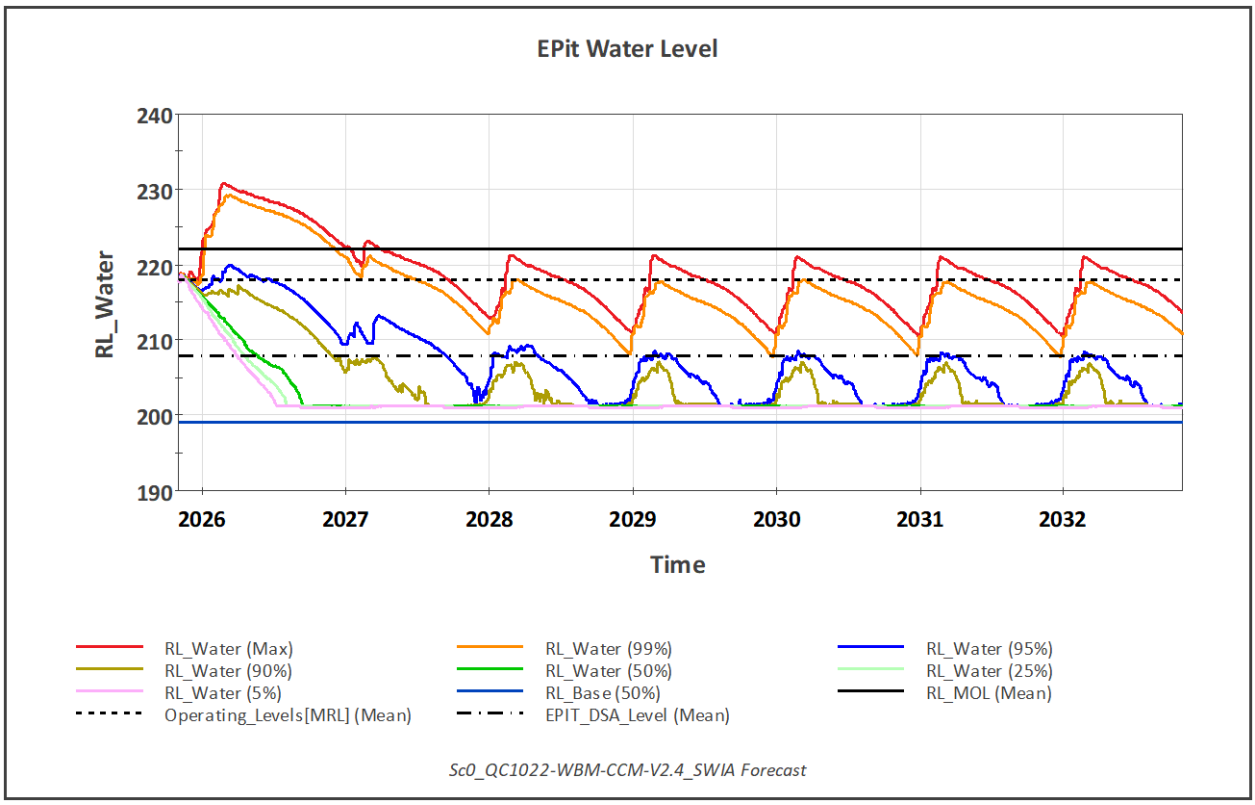


FIGURE 6.3: EPIT WATER LEVEL RESULT

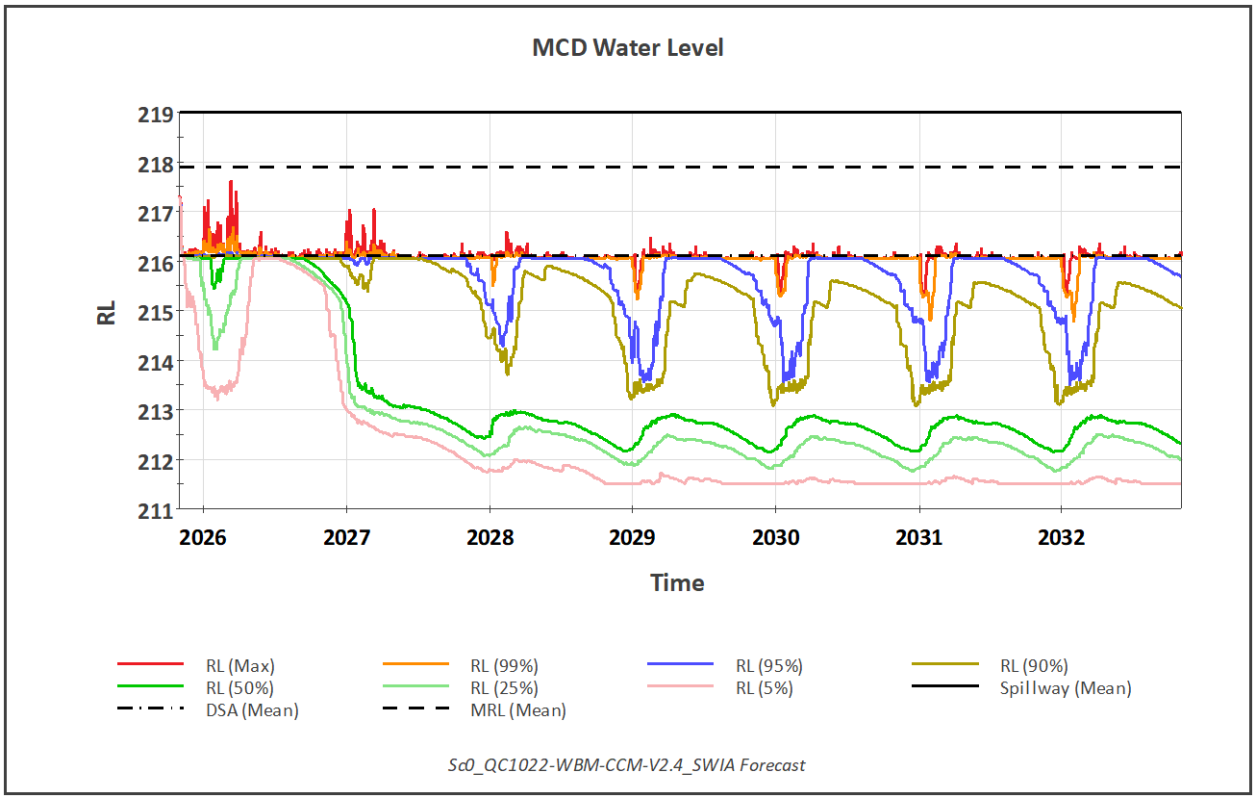
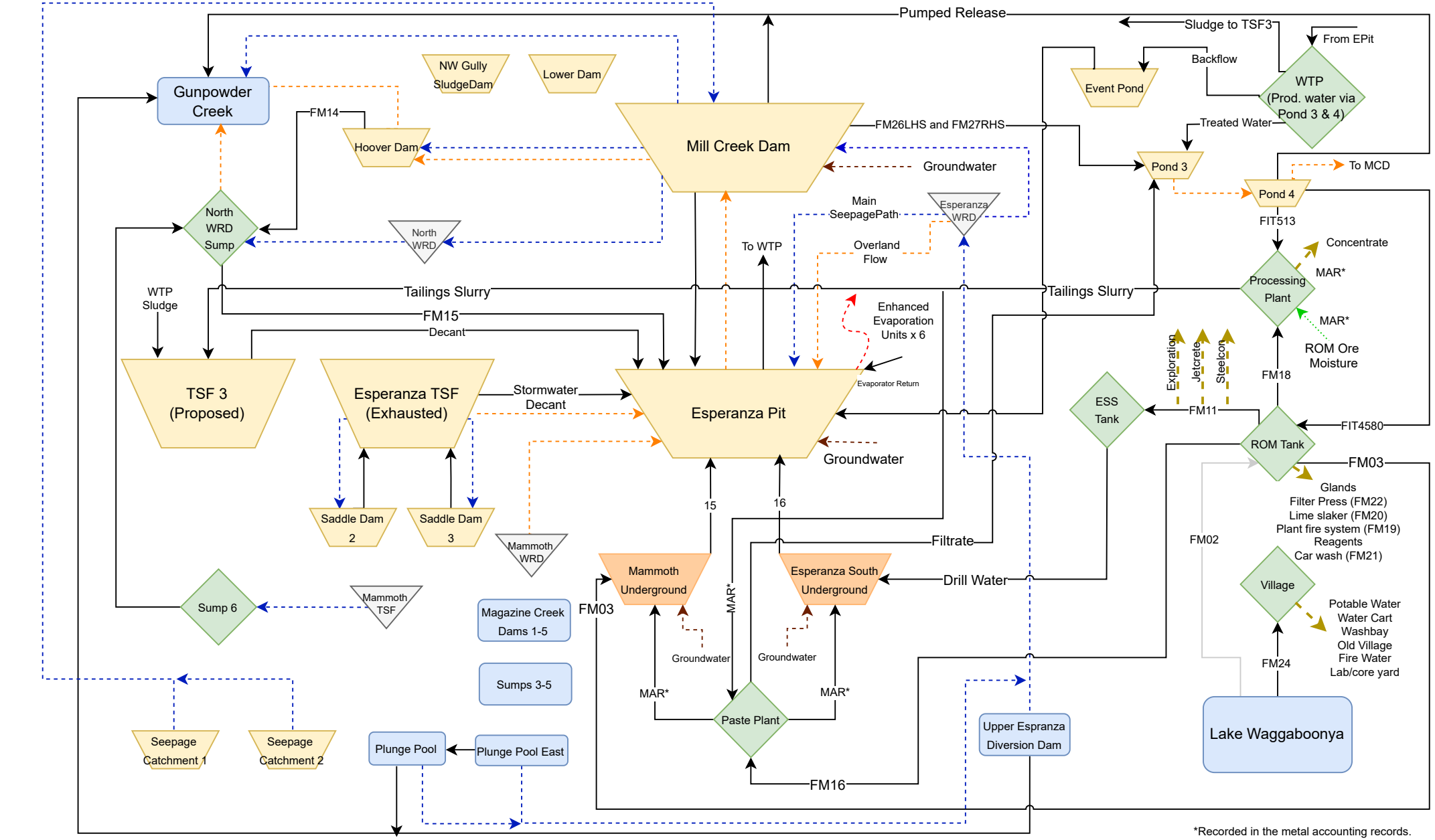


FIGURE 6.4: MCD WATER LEVEL RESULT



*Recorded in the metal accounting records.

Legend

- Clean Water System
- Storage
- Underground Mine
- Sump or Plant Item
- Seepage Catchment
- Pumped Flow
- Seepage
- Overflow
- Groundwater Inflow
- Inflow (labelled)
- Overflow
- Outflow (labelled)
- Not Currently Operating

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29 Metals

29Metals

Water Management Schematic

TSF3 SWIA - Proposed WMS Arrangement

Job Number: QC1022_018
Revision: 18
Drawn: TW
Checked: TW
Date: 9/05/2025

7. LIMITED SURFACE WATER IMPACT ASSESSMENT

7.1 Overview of Project Effects and Impacts

Water balance assessment for TSF 3 has shown that the Project does not increase the likelihood of uncontrolled discharges of mine affected water to Gunpowder Creek via Hoover Dam spillway (which discharges to Gunpowder Creek). Therefore, the Project is not expected to impact surface water flow in Gunpowder Creek.

Groundwater seepage modelling results (reference) indicate that the main control on TSF 3 infiltration and seepage is the proposed liner at the face of the EWRD.

7.2 Surface Water Quality Effects

The reviewed data indicates that historical mining activity has impacted the water quality in Gunpowder Creek over the life of the mine, however, the addition of TSF 3 to the mine site infrastructure is not expected to have a material impact on water quality in Gunpowder Creek as:

- The risk of surface water reaching Gunpowder Creek in an uncontrolled release event is extremely low.
- The TSF is designed to overflow to the north into the existing water management system to the Esperanza Pit.
- No predicted seepage from TSF 3 due to design controls including the proposed liner.
- The current water REMP monitoring has not reported impact to the aquatic ecology in Gunpowder Creek, despite exceedances in the WQOs.

7.3 Surface Water Flow Effects

Water balance modelling for TSF3 indicates that overflows from the CCM ICS (via MCD or Hoover Dam) to the receiving environment are unlikely. While some overflows from both ETSF and TSF3 are expected, these are directed to EPit and therefore contained within the ICS. Some minor reduction in flow to Gunpowder Creek is expected due to the diversion of the TSF3 footprint into the CCM WMS however this is expected to have a negligible impact on streamflow downstream of CCM as:

- The size of the TSF3 footprint diverted into the CCM WMS (79 Ha) represents approximately 0.03% of the Gunpowder Creek upstream of CCM (247,700 Ha or 2,470 km^2); and
  - The existing footprint of the proposed TSF3 is currently comprised of the residual Upper Esperanza Creek catchment downstream of the UEDD and upstream of the EWRD. Runoff from the catchment is currently collected in the Plunge Pool sump and pumped to Gunpowder Creek via an existing drainage line. Runoff contributions from the TSF3 catchment to Gunpowder Creek are therefore:
    - Already significantly impacted and subject to losses; and
  - Do not materially contribute to existing flow in Gunpowder Creek.

7.4 Impacts on Downstream Surface Water Users

Based on review of the site data, no additional discharge of mine affected water to Gunpowder Creek will be required as a result of the proposed TSF3. Therefore, TSF3 will have no additional impact on downstream surface water users.

7.5 Impacts on Environmental Values

Environmental values assigned for Gunpowder Creek include aquatic ecosystems, primary industry, recreational and cultural and spiritual values.

Gunpowder Creek is utilised for primary industries (livestock drinking water) and mining. Recreational uses have been identified as visual recreational use, with downstream of mine considered as secondary recreation only e.g., boating and fishing.

Aquatic Ecosystems: The data reviewed indicated that the mine activities in the REMP monitoring period have not impacted the aquatic ecology in Gunpowder Creek, despite exceedances in the WQOs for the REMP. The proposed TSF 3 is not expected to impact the existing authorised discharges from the site, and no risk of overtopping external to the existing mine water management system is expected with the proposed design.

Primary Industry: The recent water quality parameters analysed are all within livestock drinking water recommended trigger values for copper and total dissolved solids.

Recreational uses and cultural and spiritual values: are assumed to be protected through the continued assessment against the WQO and protection of aquatic ecosystem EV.

The site data provided indicates that any works associated with the proposed TSF 3 will not impact the receiving environment and with due consideration of the provided site data and the REMP (Hydrobiology, 2024), it is considered that the proposed TSF 3 will have no additional impact on environmental values.

8. RISK ASSESSMENT

An environmental risk assessment has been conducted for TSF3 in relation to potential impacts on surface water resources. Using the information presented in previous sections, and the likelihood of occurrence and consequence criteria (Table 8.1 and Table 8.2), the significance of the risks was identified using Table 8.3. This approach is consistent with AS/NZS ISO 31000:2018 Risk Management – Principles and Guidelines. The significance of the risks is described below:

- Extreme significance: a significant risk with a high likelihood of impact which is considered unacceptable or intolerable and may be irreversible or persistent.
- High significance: a significant risk with a high likelihood of impact which is considered unacceptable or intolerable and is contained on the mining lease or reversible.
- Medium significance: a level of risk which is not acceptable with moderate severity with impacts persisting over time that can be mitigated.
- Low significance: the risk is low with any impacts, short in duration and reversible.

TABLE 8.1: LIKELIHOOD CRITERIA

Rank	Likelihood	Description
A	Almost Certain	A common event that is likely to occur in the industry many times per year
B	Likely	An event likely to occur more than once a year in the industry
C	Possible	An event that may occur in the industry over 10 years
D	Unlikely	An event not likely to occur in the industry over 10 years
E	Rare	An event that has not previously been experienced in the industry but may occur in exceptional circumstances

TABLE 8.2: CONSEQUENCE CRITERIA

Consequence	Description
1-Minor	Minimal impact on ecosystem; contained on mining lease, and/or reversible in one shift
2-Low	Moderate impact on ecosystem; contained on mining lease, and/or reversible in 1 to 5 years
3-Moderate	Significant impact on ecosystem; impact contained on mining lease, and /or reversible in ~10 years
4-Major	Significant harm or irreversible impact (for example to World Heritage area); widespread, catchment area, long term, greater than 10 years
5-Catastrophic	Significant harm or irreversible impact on high value receptors or environmental values (for example to World Heritage area); widespread, long term

TABLE 8.3: RISK MATRIX

Consequence	1-Minor	2-Low	3-Moderate	4-Major	5-Catastrophic
Likelihood					
A-Almost Certain	Medium	High	High	Extreme	Extreme
B-Likely	Medium	Medium	High	High	Extreme
C-Possible	Low	Medium	Medium	High	High
D-Unlikely	Low	Low	Medium	Medium	High
E-Rare	Low	Low	Low	Medium	High

Table 8.4 presents a summary of the risk to both surface water flow and quality as a result of TSF3. Risk is considered low due to:

- No uncontrolled discharges are expected from the CCM WMS resulting from TSF3 and consequently no changes are expected to the existing surface water flow regime in Gunpowder Creek.
- Predicted rates of seepage flow to groundwater as a result of TSF3 will be reduced significantly with the inclusion of a liner.

TABLE 8.4: RISK OF POTENTIAL SURFACE WATER IMPACTS

Aspect	Risk Event	Likelihood	Consequence	Residual Risk	Justification and Control
Surface Water Flow	Changes to the existing flow regime (including baseflow) in Gunpowder Creek	E - Rare	1 - Minor	Low	TSF3 is not expected to result in any material change to the existing flow regime in Gunpowder Creek. The 79Ha of the TSF3 footprint removed from the 247,700 Ha Gunpowder Creek catchment at CCM represents 0.3% of the total catchment. Water balance modelling for TSF3 indicates that while overflows from TSF3 are expected, sufficient residual capacity remains in the integrated containment system (specifically EPit) such that overflows to Gunpowder Creek are considered unlikely.
Surface Water Quality	Reduction in water quality resulting from increased seepage expression in Gunpowder Creek	E - Rare	2 - Low	Low	TSF3 is not expected to result in any increase in seepage flow to Gunpowder Creek and is considered to have negligible impact on flow. REMP data indicates impacts to receiving environment and macroinvertebrate health are not increasing. CCPL is not seeking to increase the requirement for discharge of MAW to Gunpowder Creek and releases would continue to be in accordance with existing EA conditions.

9. MANAGEMENT AND MITIGATION

There is minor and localised impact predicted to occur to the groundwater systems from the construction and operation of TSF3. However, the following mitigation and management strategies are proposed for the project.

The design of TSF3 has been engineered to minimise seepage to groundwaters. The following engineering controls will be implemented:

- the proposed design will be constructed in accordance with the seepage mitigation measures including a liner.
- testing of construction materials will take place in accordance with Australian Standard AS1289 Methods for Testing Soils for Engineering Purposes to ensure the required material specifications are achieved.
- a certified 'As Constructed' report will be prepared for the raise by a suitably qualified engineer.

TSF3 will be operated to minimise seepage to groundwaters. The following operational controls will be implemented:

- maintain minimum supernatant water at an appropriate water level in the storage to minimise instability risk of the external embankments, seepage rates and the risk of discharge through overtopping.
- maximise the beneficial reuse of supernatant water in processing to limit external sourcing of raw water to meet processing demands.

TSF3 will be monitored to understand the response of the groundwater system to the project. The following groundwater monitoring strategies will be implemented:

- groundwater levels and quality will be monitored on a quarterly basis (as per the EA) at the newly installed bores surrounding the TSF3 structure, including the background bore (GWMB81) to monitor for any adverse effects caused by the amendment.
- operation and management of water levels to maintain optimal conditions for tailings storage.

It is also proposed that routine inspections be carried out to monitor for potential seepage from the TSF3 embankment. If seepage is detected from TSF3, further seepage management measures may be required to be implemented, although this is considered unlikely.

10. CONCLUSIONS

Surface water quality data supplied for review for the project has determined that TSF3 is unlikely to impact water quality and the environmental values of Gunpowder Creek.

- The site data provided indicates that any works associated with the proposed TSF 3 is not likely to have any significant impact on the receiving environment. This is supported by the Hydrobiology 2024 REMP report, which concludes that overall, the trends displayed in the current REMP period do not indicate any notable impact from CCM operations to the environmental values (EVs) (human use - livestock drinking and recreational aesthetics; and aquatic ecosystems) of the receiving environment.

Review of the CCM water management system and Water balance assessment of the proposed TSF3 has found that:

- P99 and maximum water inventory results show an increase during the first year as a result of the initial inventory however for the remaining years the combined drawdown of process water demand, releases and evaporators provides sufficient control to prevent accumulation of water within the ICS.
- As a result of the initial water level adopted, some overflow from TSF3 to EPit for the P99 and maximum result is indicated (decant pumping from TSF3 is assumed to stop if EPit MOL is exceeded) however for the remaining years overflow from TSF3 to EPit. It is also noted that the storage curve adopted for TSF3 represents the final tailings surface and as such significant water storage would be available in TSF3 for the majority of the time prior to exhaustion.
- Under the proposed conditions, no uncontrolled discharges from Hoover Dam to Gunpowder Creek are expected.

The Project risk assessment has found that the risk to both surface water flow and water quality from TSF3 is low.

11. 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.

(c) 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.

(d) 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.

(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.

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APPENDIX A: EPBC ACT PROTECTED MATTERS REPORT

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Apr-2024

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	15
Listed Migratory Species:	12

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	1
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	2
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species			[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.			
Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Amytornis dorotheae Carpentarian Grasswren [558]	Endangered	Species or species habitat known to occur within area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area	In feature area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Rostratula australis](#)			
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area	In feature area
MAMMAL			
[Macroderma gigas](#)			
Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Macrotis lagotis](#)			
Greater Bilby [282]	Vulnerable	Species or species habitat may occur within area	In feature area
REPTILE			
[Acanthophis hawkei](#)			
Plains Death Adder [83821]	Vulnerable	Species or species habitat likely to occur within area	In feature area
[Elseya lavarackorum](#)			
Gulf Snapping Turtle [67197]	Endangered	Species or species habitat may occur within area	In feature area
[Varanus mertensi](#)			
Mertens' Water Monitor, Mertens's Water Monitor [1568]	Endangered	Species or species habitat known to occur within area	In feature area
SHARK			
[Pristis pristis](#)			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area

Listed Migratory Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
[Apus pacificus](#)			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Marine Species			
[Pristis pristis](#)			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
Migratory Terrestrial Species			

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area	In feature area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area	In feature area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat likely to occur within area	In feature area
Migratory Wetlands Species			
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area	In feature area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area	In feature area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat likely to occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In buffer area only
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area	In feature area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area	In feature area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat may occur within area	In feature area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area overfly marine area	In feature area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area	In feature area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat likely to occur within area overfly marine area	In feature area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat likely to occur within area	In buffer area only
[Rostratula australis as Rostratula benghalensis (sensu lato)](#) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Reptile			
[Crocodylus johnstoni](#) Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area	In feature area

Extra Information

State and Territory Reserves			[Resource Information]
Protected Area Name	Reserve Type	State	Buffer Status
Chidna	Nature Refuge	QLD	In buffer area only

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
CopperString Project	2010/5581	Controlled Action	Completed	In feature area
Mount Oxide Copper Project	2010/5564	Controlled Action	Completed	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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APPENDIX B: PRELIMINARY DSA AND MRL ASSESSMENT

MEMORANDUM

Project:	TSF3 SWIA	Date:	9 May 2025
To:	CCMPL	From:	Tim Wallis
ATT:	Mike Gunner	CC:	Brendan Wallace; Travis Warren; Mick Hogan; Geraldine McGuire; Barry Shean
Subject:	TSF3 Preliminary DSA and MRL Assessment		

1. INTRODUCTION

1.1 Background

Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29Metals Limited (29Metals), owns and operates the Capricorn Copper Mine (CCM), located in Gunpowder, Northwest Queensland. CCM is operated under the approval of Environmental Authority EPML00911413 (EA) (dated 6 December 2023), administered by the Queensland Department of Environment, Science and Innovation (DESI).

Excessive site water inventory and the low remaining capacity in the current tailings storage facility (TSF), Esperanza TSF (ETSF) resulted in the suspension of mining and ore processing activities in March 2024. The site was subject to severe wet season rainfall events during both the 2022 and 2023 wet seasons. This resulted in the loss of critical infrastructure (flooding of the Esperanza Underground Mine, loss of the existing water treatment plant (WTP), workshops and warehouse area) as well as significant increases to the mine affected water (MAW) inventory which is primarily contained within Esperanza Pit (EPit).

CCPL plan to construct a new TSF (TSF3) at CCM. The new facility will provide approximately 6.5 to 7.5 years of tailings storage capacity and allow CCPL to resume ore processing at CCM. This will be accompanied by the construction of a new purpose built WTP.

1.2 TSF3 Consequence Category Assessment Results

As part of the TSF3 preliminary design (Engeny, 2025), a preliminary consequence category assessment (CCA) has been completed (refer to Table 1.1 below) as per guidance set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (ESR/2016/1933), Version 5.03 (*The Manual*) (DESI, 2024). Key findings of the CCA conclude that:

- Under the failure to contain scenario TSF3 has a preliminary consequence category of 'significant'; and
- Relevant key required hydraulic performance criteria for TSF3 are therefore:
  - A mandatory reporting level (MRL) corresponding to an extreme storm surge (ESS) volume resulting from the 1:20 AEP 72-hour storm volume assuming 100% runoff; and
  - A design storage allowance (DSA) equivalent to the 1:20 AEP wet season increase:
    - CCPL have chosen to adopt the method of operational simulation to estimate the DSA volume for the system of integrated regulated storages at CCM.
    - The system of integrated storages comprises the existing ETSF, Mill Creek Dam (MCD) and EPit as well as the proposed TSF3.

TABLE 1.1:TSF3 DESI CCA PRELIMINARY CONSEQUENCE CATEGORY ASSESSMENT

Failure Scenario	Consequence Category
Failure to Contain – Seepage	Low
Failure to Contain – Overtopping	Significant
Dam Break	High
Overall	High

1.3 Method of Operation Simulation Methodology

The preliminary DSA for the CCM integrated containment system including the proposed TSF3 has been assessed using the method of operational simulation and using the calibrated site water balance model (WBM) which is described in the CCM Site Water Management Plan Report (Engeny, 2024). The method of operational simulation is described in Appendix 2 of The Manual. This method for estimating DSA can be used at the discretion of a suitably qualified and experienced person where there is local historical monitoring data for a sufficient period to form a basis for robust validation of modelling methods and assumptions (DESI, 2024)

1.4 Limitations

Comprehensive documentation including a certified System Desigin plan (SDP) describing the modelling process including calibration, inputs, assumptions and results is required to provide sufficient detail to enable independent replication of the model representation and assessed performance outcomes. While this preliminary DSA and MRL assessment for the revised integrated containment system at CCM has been conducted as per guidance set out in *The Manual* it is subject to the following limitations:

- The assessment is based on the preliminary design for TSF3, and data and assumptions provided by CCM. As such results may change as the design progresses to finalisation.
- While a high-level summary of key inputs and assumptions has been provided it does not constitute a SDP and as such, a certified SDP will be submitted to DESI upon approval of the TSF3 major EA amendment and finalisation of the TSF3 design; and
- No certification is provided with this preliminary DSA and MRL assessment.

2. INPUT DATA AND ASSUMPTIONS SUMMARY

2.1 Model Input Data and Assumptions

Table 2.1 below summarises key input data and assumptions used in the DSA assessment. Where relevant data and assumptions have been carried over from existing reports reference has been provided to the relevant documents. As noted above, this document provides summary detail of the preliminary DSA MRL assessment for TSF3 however it is not intended to be a substitute for a detailed System Design Plan (SDP). The detailed SDP will be developed upon finalisation of the TSF3 design.

TABLE 2.1: TSF3 KEY INPUT DATA AND ASSUMPTIONS SUMMARY

Aspect	Description	Comment	Reference
Water balance model (WBM)	GoldSim WBM used for the method of operational simulation	The existing calibrated site WBM has been modified to include the proposed TSF3	• Refer to the CCM Site Water Management Plan Report (Engeny, 2024) for details of the existing WBM and calibration
Model schematic	Updated site WBM schematic showing incorporation of TSF3 into the integrated containment system.		• Details of the water management system provided by CCPL, refer to Figure 2.1 for WBM schematic
Production[1]	Assumed rate of ore processing	Full production assumed for duration of assessment (12 months): • Ore processed - 140 Kt/mon • Concentrate – 8.4 Kt/mon • Tailings produced – 131.6 Kt/mon • Tailings to paste – 11% • Tailings to TSF3 – 117.1 Kt/mon	• CCPL
Tailings properties	Assumed tailings properties used in WBM	• Settled density – 1.65 tonne/m^3 • Tailings specific gravity – 2.82 tonne/m^3 • Tailings volume deposited in TSF3 included in DSA assessment	• Refer to TSF3 preliminary Design report (Engeny, 2025)
Evaporators[2]	Mechanical evaporators installed in EPit	• Two banks in operation (6 units in total) • Mean availability - 69% • Efficiency - varies monthly • Aggregated feed rate (after availability and before application of evaporative efficiency) – 100 L/s	• Refer to Figure 2.1 for monthly efficiency • Evaporator configuration, availability and feed rate data provided by CCM

Aspect	Description	Comment	Reference
Water treatment	Treatment of mine affected water (MAW) for process use and controlled releases	• Assumed that the new Ausenco WTP will be in operation with 15 ML/d capacity (12.75 ML/d after 85% availability assumption), providing water to the process plant and other relevant demands. • Excess treated water stored in MCD prior to release to Gunpowder Creek • WTP sludge byproduct co-disposed in TSF3. Sludge generation assumed at 0.54%. Sludge volume included in DSA assessment.	• Refer to TSF3 preliminary Design report (Engeny, 2025)
Controlled releases[3]	• Releases of treated mine affected water (MAW).	• Controlled releases as per existing EA conditions (limited to 500ML per annum, max of 70ML per 72-hr, 1:10 dilution and 1.1m³/s trigger). • Treated water released from MCD at up to 70 ML/d (63 ML/d after 90% availability assumption)	• EPML00911413 (dated 6 December 2023).
Modelled representation of TSF3[4]	• Storage curve • Catchment area	• The TSF3 storage curve (refer to Figure 2.2) represents a worst-case scenario at the end of deposition when TSF3 water storage capacity is at a minimum. • Total catchment of 79 Ha which is comprised of tailings (39 Ha) and natural (40 Ha).	• Refer to TSF3 preliminary Design report (Engeny, 2025).
Operation of TSF3	• Decant pumping destinations and pump capacity. • Decant pond operation	• 200 L/s pump capacity • Maintain decant pond at optimal 1m depth (25.2 ML). • Pumped to EPit	• Pump preliminary sized to restore decant pond depth to 1m following inflow of ESS storm volume (171.4 ML, refer to Section 3.1) within 10 days.
Other water management operations	• Water transfers • Water demands (process, dust suppression, potable, etc.).		• Refer to the CCM Site Water Management Plan Report (Engeny, 2024).
Initial volumes	• Starting volumes for all storages in the system of integrated storages (ETSF, EPit, MCD and TSF3).	• ETSF assumed empty (no longer in operation). • TSF3 assumed to be at optimal 1 m pond depth (25.2 ML). • MCD assumed to be at existing DSA (RL 216.1 M AHD (313 ML)) • EPit initially assumed at existing DSA with final DSA assessment conducted assuming a starting level equivalent to the current EPit MRL (217.9 m AHD (1,293 ML))	

Notes

1 – Base case (Sc0) assumes full nameplate production. Sensitivity scenario (Sc3) considers NO production.

2 – Base case (Sc0) assessment assumes evaporators ON. Sensitivity scenario (Sc1) considers evaporators OFF

3 – Base case (Sc0) assessment assumes releases ON. Sensitivity scenario (Sc2) considers releases OFF

4 – Catchment landuse sensitivity scenario considered (Sc4).

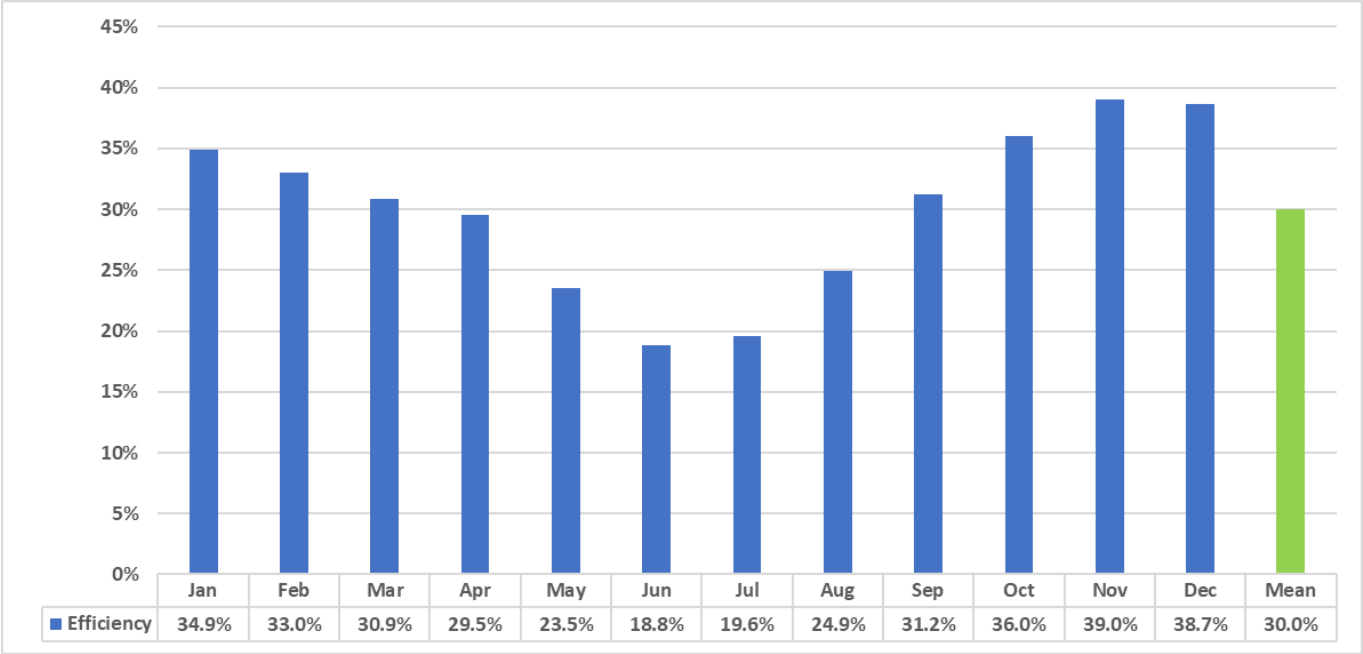


Figure 2.1: Modelled Evaporator Efficiency

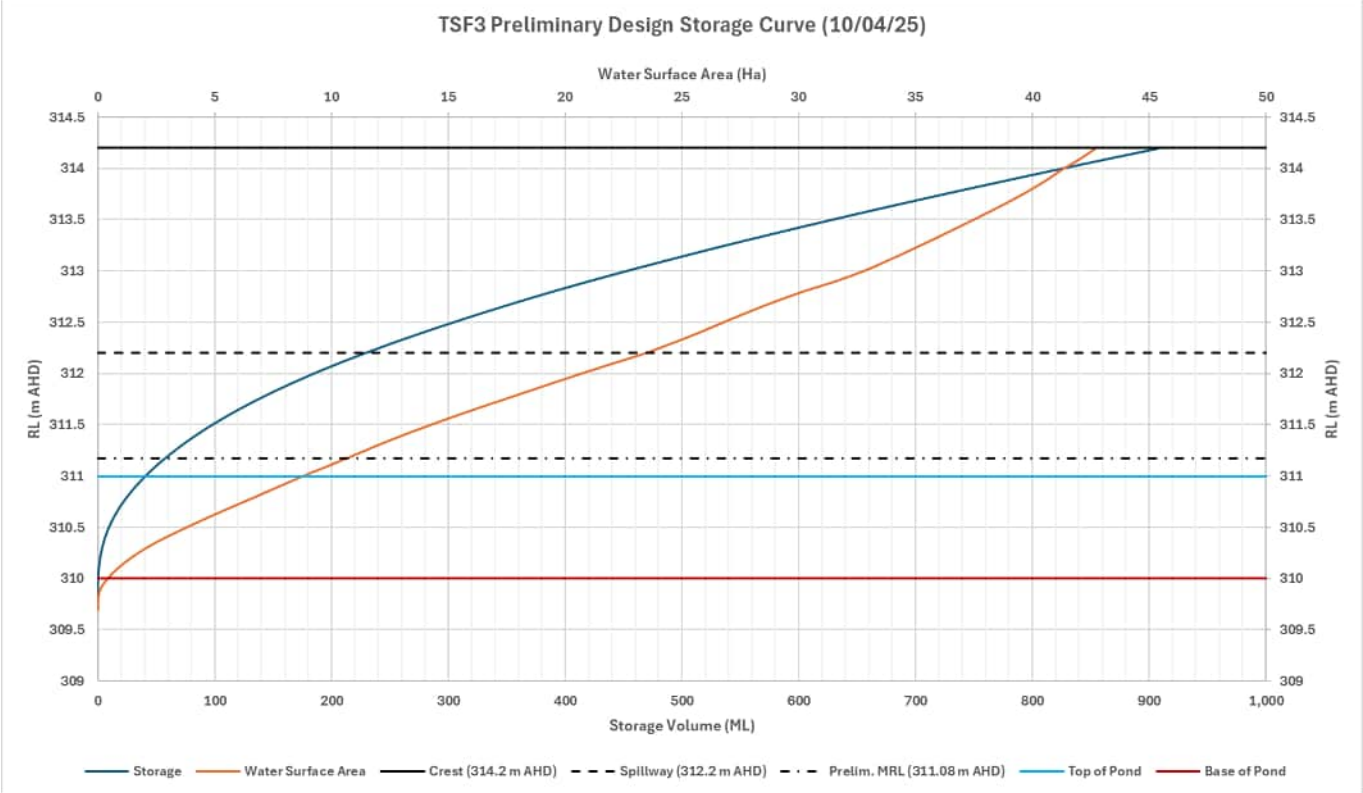
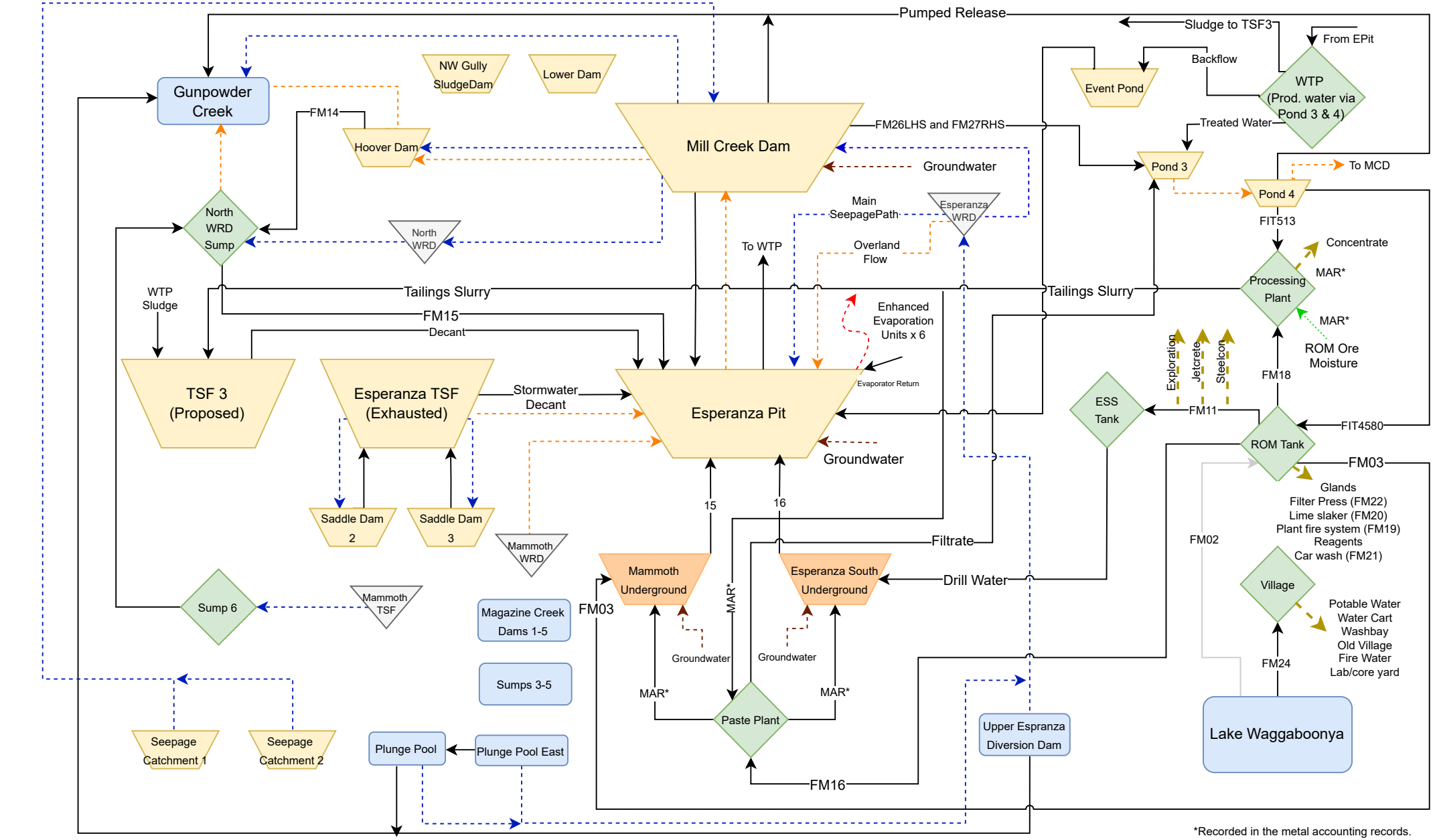


Figure 2.2: TSF Storage Curve



*Recorded in the metal accounting records.

Legend

- Clean Water System
- Storage
- Underground Mine
- Sump or Plant Item
- Seepage Catchment
- Pumped Flow
- Seepage
- Overflow
- Groundwater Inflow
- Inflow (labelled)
- Overflow
- Outflow (labelled)
- Not Currently Operating

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Water Management Schematic

TSF3 SWIA - Proposed WMS Arrangement

Job Number: QC1022_018
Revision: 18
Drawn: TW
Checked: TW
Date: 9/05/2025

2.2 Modelling Approach

Table 2.2 below summarises the adopted modelling approach.

TABLE 2.2: MODELLING APPROACH

Aspect	Description	Comment
Simulation duration and realisations	• Length of modelled simulation	• One year commencing 1 Nov • 134 realisations
Climate data	• Input climate data – rainfall and evaporation	• SILO Data Drill
Model timestep		• Daily
Adopted Desigin Simulation Margin	• In accordance with *The Manual*, a DSM has been applied to the 1:20 AEP wet season accumulation volume to provide conservative compensation for uncertainty in model inputs and model accuracy.	• 25% DSM adopted as per (Engeny, 2023a)
Sensitivity scenarios	• The DSA has been tested for sensitivity to key inputs or assumptions.	• Refer to Section 3.3

3. ASSESSMENT RESULTS

3.1 Preliminary ESS and MRL

As noted in Section 1.2, TSF3 is required to have a MRL equivalent to the ESS volume resulting from the 1:10 AEP 72-hour storm assuming 100% runoff. Table 3.1 summarises the results of the preliminary ESS and MRL assessment and indicates that the preliminary ESS is 171.4 ML which equates to a MRL of 311.18 m AHD.

TABLE 3.1: TSF3 PRELIMINARY ESS AND MRL RESULT

Aspect	Comment
1:10 72-hr rainfall depth	217 mm
TSF3 total catchment	79 Ha
Extreme Storm Surge (ESS)	171.4 ML
TSF3 Spillway level	312.2 m AHD
Preliminary Mandatory Reporting Level (MRL)	311.18 m AHD

3.2 Preliminary DSA

The preliminary 1:20 AEP wet season inventory increase for the ETSF, EPIT, MCD and TSF3 integrated system is summarised as follows:

- Combined 1:20 AEP (95th percentile or 5% AEP) wet season inventory increase in EPit, ETSF, MCD and the proposed TSF3 (refer Figure 3.1) – **434 ML**.
- Design Simulation Margin – **25% (109 ML).**
- Combined Design Storage Allowance for EPit, ETSF, MCD and proposed TSF3 – **543 ML.**

It is noted that as the estimated integrated containment system DSA is less than combined MRL volume, MRL would be adopted for DSA as the DSA cannot be less than the MRL. The current combined MRL volume of MCD and EPit is 678ML with an additional 171.4 ML preliminarily estimated for TSF3. In total, the combined MRL volume for the integrated containment system is therefore 849.4 ML and this would be adopted for the system DSA (Table 3.2).

TABLE 3.2: PRELIMINARY MRL AND DSA SUMMARY

Storage	MRL	DSA
Mill Creek Dam (MCD)	234.6 ML (217.7 m AHD)	234.6 ML (217.7 m AHD)
Esperanza Pit (EPit)	443.4 ML (217.9 m AHD)	443.4 ML (217.9 m AHD)
Esperanza TSF (ETSF)	N/A - provided within EPit	N/A - provided within EPit
TSF3 (preliminary)	171.4 ML (311.18 m AHD)	171.4 ML (311.18 m AHD)

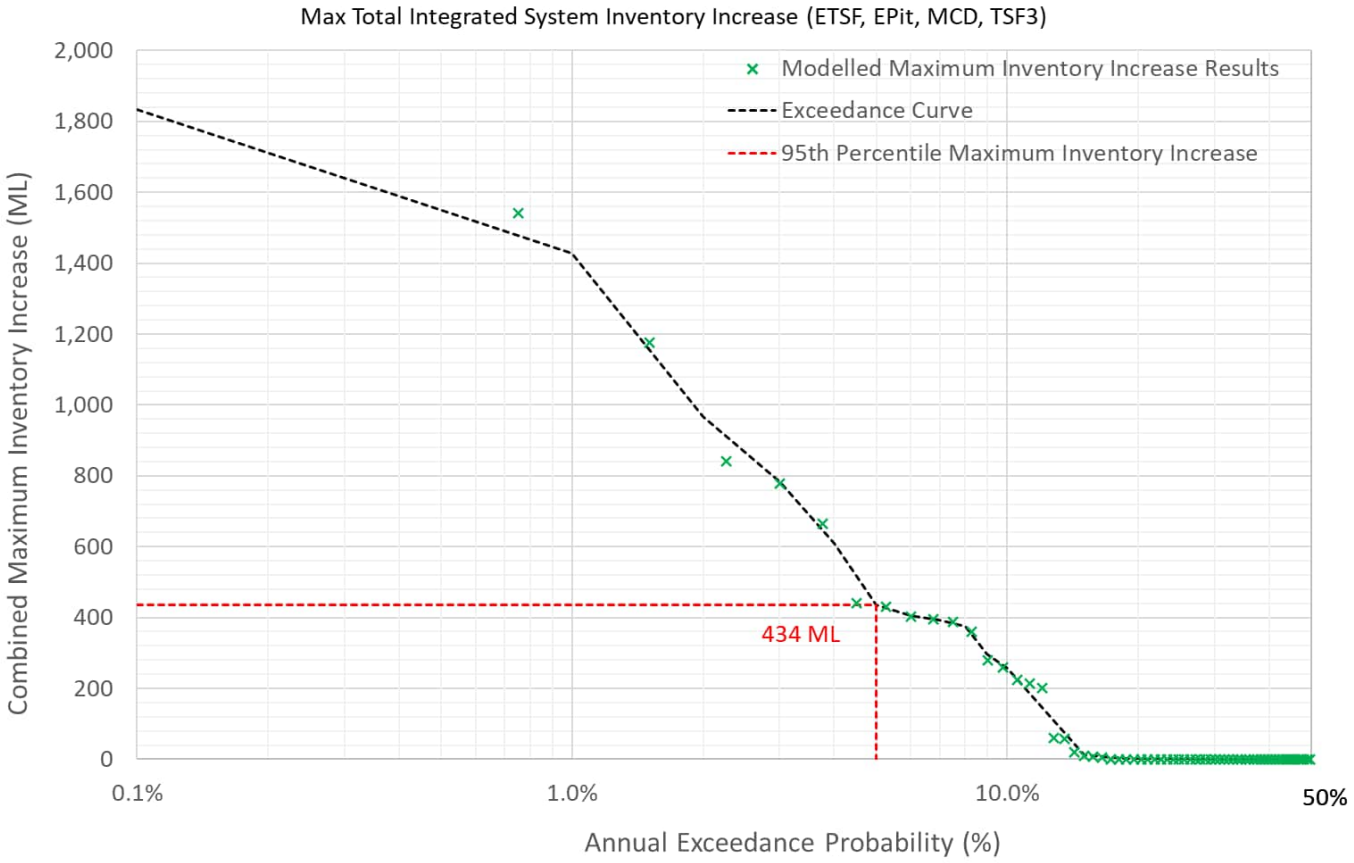


Figure 3.1: DSA Result for CCM Integrated System Including Proposed TSF3

3.3 DSA Sensitivity Assessment

Several sensitivity analysis scenarios were completed using the WBM to assess the sensitivity of the DSA volume to key inputs and assumptions. Scenarios assessed and results are summarised in Table 3.3 below:

- Each sensitivity scenario resulted in an increase to the Base Case DSA (Sc0) with the no evaporators (Sc1) resulting in the largest increase (141%) to the base case (Sc0) DSA.
- While the results of Scenario 1 and 2 (no evaporators and no releases respectively) result in an estimated DSA 141% and 110% of the total MRL respectively, both represent unlikely scenarios and significant additional contingency storage (approximately 2.6 GL) is available in EPit between the MOL and spillway level.
- The preliminary DSA results for the integrated containment system including the proposed TSF3 indicate that adoption of the combined system MRL volume as the system DSA provides significant contingency to contain the estimated Combined 1:20 AEP (95th percentile or 5% AEP) wet season inventory increase.

TABLE 3.3: SENSITIVITY ASSESSMENT SUMMARY

Scenario	Name	Description	DSA (ML)	DSA with 25% DSM (ML)	DSA Change from Base Case	System Total MRL (ML)	DSA % of System MRL
Sc0	Base Case	• Controlled releases of treated MAW to Gunpowder Creek ON • Full production • Evaporators ON	434	543	N/A	849	51%
Sc1	Evaporators	• Epit mechanical evaporators OFF	1,045	1,307	141%	849	123%
Sc2	No release	• NO controlled releases of treated MAW to Gunpowder Creek	913	1,141	110%	849	107%
Sc3	No production	• NO ore processed (underground mine dewatering, evaporators and releases maintained)	827	1033	90%	849	97%
Sc4	100% tailings surface	• 100% of TSF3 catchment assumed to comprise tailings	592	739	36%	849	70%

4. SUMMARY

A preliminary DSA and MRL assessment for the proposed TSF3 has been completed as part of the TSF3 preliminary design. Key conclusions are that:

- A preliminary CCA for TSF3 indicates that TSF3 will require:
  - A MRL corresponding to an ESS volume resulting from the 1:20 AEP 72-hour storm volume assuming 100% runoff; and
  - A DSA equivalent to the 1:20 AEP wet season increase.
- TSF3 will form part of the existing integrated containment system that comprises ETSF, EPit and MCD.
- The preliminary TSF3 ESS volume of 171.4 ML will be allocated to TSF3.
- Using the method of operational simulation DSA for the integrated containment system has preliminarily been estimated as 434 ML. This volume has increased since the previous assessment due to:
  - Reduction in the number of evaporators (approximately 130 ML increase to DSA)
  - Changes to runoff parameters resulting from model calibration update (approximately 80 ML increase in DSA)
  - General updates and improvements to the WBM to better represent the WMS including the water treatment system and release functions, revised storage curves for EPit and MCD
- A DSM of 25% has been applied to the DSA volume which results in a total system DSA volume of 543 ML.
- The total estimated combined MRL volume for the system is 849 ML and would therefore also be the DSA volume as the DSA cannot be less than the MRL volume.
- DSA volumes for MCD, EPit and TSF3 would therefore be equivalent to the MRL.
- In the unlikely event of an exceedance of an inflow volume exceeding the proposed combined DSA/MRL volume, significant contingency storage is available within the integrated containment system. This volume of approximately 2.6 GL is available within EPit and, while not used for normal operations, may act as a temporary storage to contain additional inflows in excess of the DSA/MRL volume.
- Practical considerations of operating MCD and EPit with the same RL for DSA and MRL have not been considered in this assessment however it is recommended that CCM consider implementation of a normal operating level lower than DSA/MRL. Under normal operations this would limit incoming transfers to MCD or EPit and provide for a rainfall/runoff buffer and reduce the likelihood of frequent MRL exceedances.

5. REFERENCES

DESI. (2024). *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933. Version 5.03).*

Engeny. (2023a). *Capricorn Copper Ltd Pty. Water Balance Model report.*

Engeny. (2024). *Capricorn Copper Mine Water Management Plan.*

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6. DISCLAIMER

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APPENDIX J: LIMITED GROUNDWATER IMPACT ASSESSMENT

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Groundwater Impact Assessment

TSF3 EA Amendment

QC1022_018-REP-004-2

29 JULY 2025

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	22/07/2024	Client Issue	Rebecca Malaj	Yohannes Yihdego	Brendan Wallace	Travis Warren
1	16/05/2025	Client Issue - Update	Rebecca Malaj	Yohannes Yihdego	Brendan Wallace	Travis Warren
2	29/07/2025	Client Issue - Update	Rebecca Malaj	Yohannes Yihdego	Brendan Wallace	Travis Warren
Signatures:						

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1. INTRODUCTION

Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29Metals Limited (29Metals), owns and operates the Capricorn Copper Mine (CCM), and have engaged Engeny Australia Pty Ltd (Engeny) to undertake a limited groundwater impact assessment to identify potential impacts from the proposed tailings storage facility 3 (TSF3) at the CCM.

To inform the assessment and build on the existing 2D numerical model developed by ATC Williams (2023b), CCPL and Engeny have completed the following activities on the site:

- Geological mapping of the proposed TSF3 (Engeny, 2024 – QC1022_018-REP-001-1).
- Geological investigation at fifteen (15) bore and twenty-four (24) test pit locations.
- Installation of fourteen (14) groundwater monitoring bores as part of a site-wide groundwater investigation, six (6) of which are located near the proposed TSF3. An additional four (4) bores are proposed to be installed within the TSF3 footprint, however, these bores are yet to be approved for installation.
- A site wide geophysical investigation informed by airborne geophysics (magnetic and radiometric) and a surface LOUPE TEM which allowed for increased understanding of geological and structural relationships and informed the citing of the installed groundwater monitoring bores.

A 3D transient groundwater model is currently under development to test the assumptions made in previous models. Further investigation and technical studies have been proposed to determine the permeability of the foundation and faults, along with actual groundwater levels within the TSF3 footprint.

This report aims to present the findings of the groundwater investigation to date and provide a framework for further investigation into the potential impact to groundwater as a result of the proposed TSF3.

1.1 Project Location

The CCM is located in northwest Queensland, Australia, approximately 140 kms north of Mount Isa and 2.5 kms northwest of the settlement of Gunpowder. Gunpowder Creek, a tributary to the Leichhardt River which flanks the mine to the north and west. The mine is bordered to the east by Lake Waggaboonya. The site is an underground mine, with an exhausted open cut void, and other significant structures related to mining as shown in Figure 1.1.

The Mount Isa district has a rich history of copper and base metal mining, being renowned for a wealth of iron oxide copper gold ore deposits. CCM has been subject to mining activities dating back to 1927. Mining effort has varied over the life of the mine. GHD (2021d) detail the mining activity including active underground mining within Mammoth and Esperanza South underground mines up until January 2009. CCM was placed in care and maintenance in February 2009 until February 2011, with underground mining recommencing in May 2011. Operations then continued until April 2013, when the site was again returned to care and maintenance. Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29M acquired the site in 2015 and successfully recommenced operations in 2017 and have recently transitioned to care and maintenance in March 2024.

CCM operates the site in accordance with Environmental Authority EPML00911413 (EA). The site is comprised of twenty-nine (29) mining leases (MLs) (ML5407, ML5412, ML5413, ML5418, ML5419, ML5420, ML5429, ML5430, ML5441, ML5442, ML5443, ML5444, ML5451, ML5454, ML5457, ML5459, ML5467, ML5485, ML5486, ML5489, ML5500, ML5548, ML5549, ML5550, ML5562, ML5563, ML90180, ML90181 and ML90182).

1.2 Project Description

To achieve the CCM Tailings Management Plan (CCM, 2025) objectives a new long-term tailings storage solution has been developed with the proposed TSF3. The proposed TSF3 preliminary design is based on the ATC Williams Life of Mine Tailing Storage Facility Options Study (ATC Williams, 2023b).

The proposed TSF3 will provide additional tailings storage for approximately 6.5-7.5 years. TSF3 will be formed via a centreline raise of the existing Upper Ezperanza Diversion Dam (UEDD) for its southern embankment, and the raising and reprofiling of the existing Esperanza Waste Rock Dump (EWRD) comprising its northern embankment.

Following the construction of supporting tailings infrastructure (booster pump) north of the EWRD at the Mine Industrial Area (MIA), tailings will be deposited in a down valley discharge manner along the southern extents of TSF3 via a new tailings delivery ring pipeline to four discharge spigots. Tailings will beach in a northern direction (varying beach slopes) with the decant pond formed against the EWRD.

Under normal operating conditions the decant pond will be maintained in a minimum condition, with decant water pumped to either the Esperanza Pit (EPit), Mill Creek Dam (MCD), Pond 3, or the proposed new water treatment plant, with the decant water destination dependent on water quality.

An emergency overflow spillway is located near the eastern side of the of the northern embankment. The spillway alignment and design are provisional, however is intended to reduce the risks of embankment instability and erosion, and to prevent release of mine affected water into an existing clean catchment which is proposed to be diverted away from EPit to MCD. The spillway is proposed to also form part of the closure design of TSF3 to convey surface flows from the TSF3 cap. During the operational phase spillway overflows should they occur will report to EPit.

No additional changes are required to existing operations and as such production, water demands, tailings production, consequence categories for regulated structures onsite, etc. will remain unchanged.

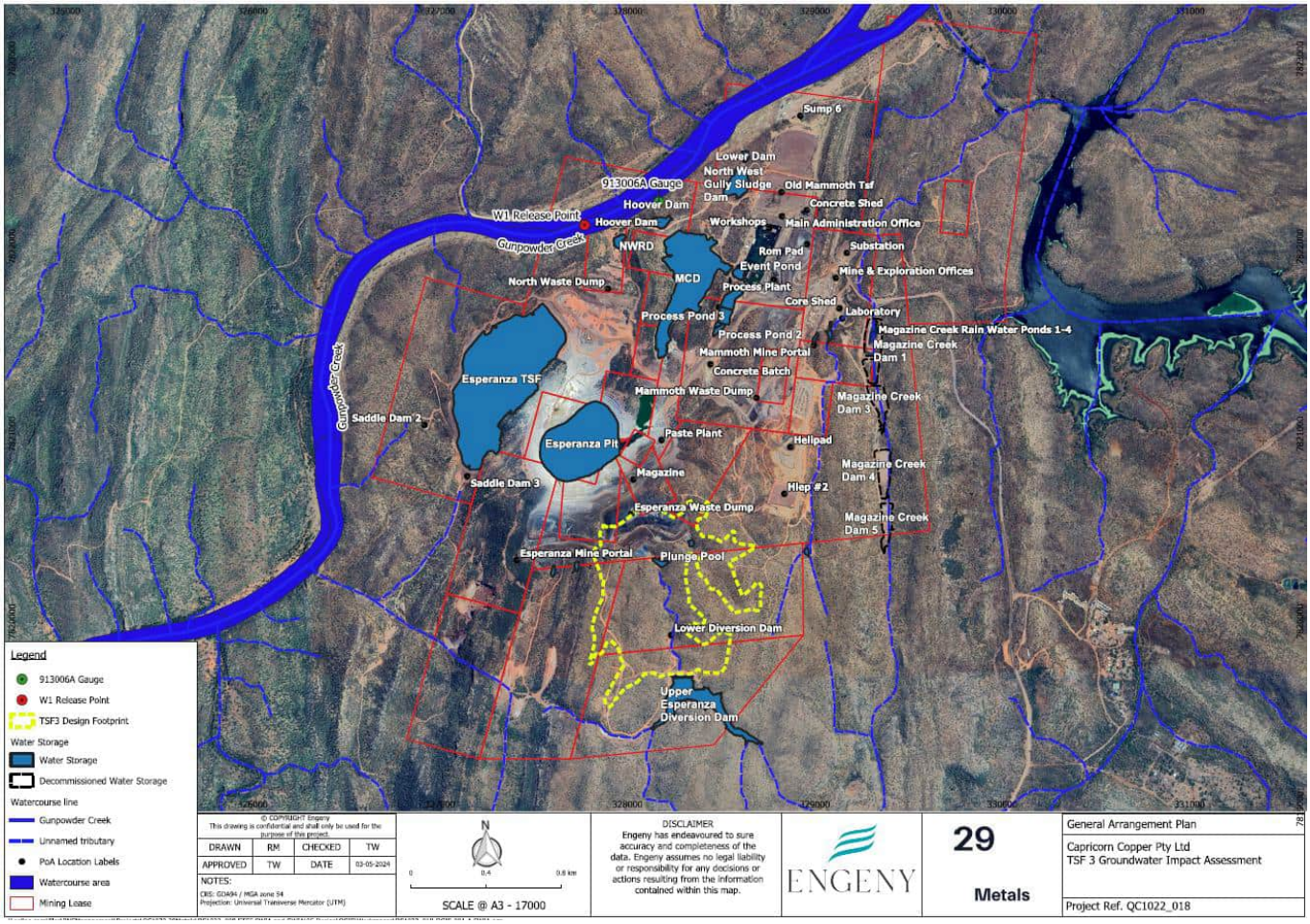


Figure 1.1: General Arrangement Plan

1.3 Scope, Objectives and Methodology

CCPL are required to lodge an assessment of impacts from the proposed TSF3 with the Department of Environment, Tourism, Science and Innovation (DETSI) with the EA amendment application for the Project to quantify and, if necessary, mitigate any potential impacts to the receiving environment. The scope of work and methodology for the groundwater impact assessment are as follows:

- A desktop study of all relevant information including published maps of drainage, surface geology and vegetation, site-specific topography data and relevant streamflow data (where available) to identify features relevant to the groundwater assessment.

- Validation, through a numerical groundwater flow model that the proposed TSF3 meets the stated performance objectives for containment of seepage and limits impacts to receiving environments.
- An assessment of the effects on groundwater water flows and quality and the associated impacts on groundwater users and environmental features reliant on groundwater (i.e. groundwater dependent ecosystems) because of TSF3.
- Development of additional groundwater monitoring and management measures, if required.

A two-dimensional (2D) numerical groundwater flow model was previously developed to estimate the extent of water level impact from the proposed TSF3 in a seepage study by ATC Williams (2023b). Engeny has developed a numerical model in SEEP/W to improve on the previous seepage study, informed by data obtained from recent field studies completed at CCM.

This report provides a summary of the 2D numerical modelling (SEEP/W) findings to date, noting that several key elements of the assessment have not been completed, including proposed targeted aquifer testing.

Further data received subsequent to the development of the model will be incorporated into the site-wide 3D numerical model that is currently under development, to be reported separately.

2. REGULATORY REQUIREMENTS

2.1 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (Qld) (EP Act) was established to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes[1].

The purpose of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water and Wetland Biodiversity) is to achieve the object of the EP Act in relation to waters and wetlands. EPP Water and Wetland Biodiversity provides a framework for the protection of environmental values (i.e., surface water uses) associated with Queensland rivers, streams, wetlands, lakes, aquifers, estuaries, and coastal areas.

Under this framework, environmental values (EVs) for specific catchments and drainage basins have been formalised and listed in Schedule 1 of the EPP Water and Wetland Biodiversity. For other waters, a site-specific assessment of the potential environmental values is required. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) includes a management framework that has been adopted in the EPP Water and Wetland Biodiversity.

Sections 126A and 227AA of the EP Act identify the requirements for site-specific EAs and EA amendment applications, where a resource project involves the exercise of underground water rights or a change to the exercise of underground water. A change to the exercise of underground water rights may include:

- Adding a tenure to the EA;
- A significant change to the nature or scale of existing activities;
- Significant change to the volumes of water proposed to be taken; or,
- A change to the predictions of impacts to environmental values compared with previous assessments.

The Project will not incur a change to underground water rights.

2.2 Environmental Authority

DETSI is the administering authority of the EP Act. The EP Act requires that mining projects be undertaken in accordance with an approved Environmental Authority (EA). CCM EA (EPML00911413 (DESI 2023)) provides authorisation for the following Environmentally Relevant Activities (ERAs):

- Schedule 3 17: Mining copper ore.
- Ancillary 08 - Chemical Storage 1: Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a).
- Ancillary 08 - Chemical Storage 3: Storing more than 500 cubic metres of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c).
- Ancillary 31 - Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000t.
- Ancillary 33 - Crushing, milling, grinding, or screening Crushing, grinding, milling or screening more than 5000t of material in a year.

The proposed amendment to the EA is the addition of a new tailings storage facility (TSF).

The following conditions of the EA will require amendment following approval of the proposed TSF3:

- Schedule A – Table 1 (Authorised Disturbance) states the approved area of disturbance.
- Schedule G – Table 1 (Regulated Dams) states the max operating level, design storage allowance and mandatory reporting levels for regulated dams.

[1] https://www.stateoftheenvironment.des.qld.gov.au/pollution/management-responses/legislation/environmental-protection-act-1994

2.3 Water Act 2000

The Water Act is the principal legislation for the sustainable management of Queensland's water resources. The Water Act provides the framework within which surface water resources are planned, allocated and used in Queensland. The surface water provisions of the Water Act are administered by the Queensland Department of Regional Development, Manufacturing and Water (DRDMW).

The management of surface water resources is achieved through the following key measures:

- Granting authorisations for taking or interfering with surface water; and
- Preparing water plans for any part of Queensland, reserving unallocated water resources, as well as prescribing processes for releasing unallocated water.

Chapter 3 of the Water Act 2000 provides for the management of impacts on underground water (groundwater) due to the exercise of underground water rights by resource tenure holders. As above, the exercise of water rights is not required for the TSF3 Project.

2.3.1 Water Plan (Gulf) 2007

The Project is located within the applicable area of the *Water Plan (Gulf) 2007* which defines the availability, and regulates, the take of surface water and groundwater in a sustainable manner.

The *Water Plan (Gulf) 2007* area comprises a total of eight catchments located in north Queensland. The project site is in the Leichhardt River catchment as defined in Schedule 3 of the *Water Plan (Gulf) 2007 and* is not in the Great Artesian Basin (GAB) or any other Groundwater Management Area for groundwater.

Given the project will not take groundwater and is not in a groundwater management area, not specific requirements related to the *Water Plan (Gulf) 2007* apply for groundwater management.

2.4 EPBC Act Protected Matters

A search of Protected Matters has been completed for the site, inclusive of a 25km buffer, using the Australian Government Department of Climate Change, Energy, Environment and Water Protected Matters Search Tool (https://pmst.awe.gov.au/). The search extent is shown in Figure 2.1, with the site location (feature area) indicated by the number "1". The complete search results are provided in Appendix A.
Search results returned the following:

- World Heritage Properties: None.
- National Heritage Places: None.
- Wetlands of International Importance (Ramsar Wetlands): None.
- Great Barrier Reef Marine Park: None.
- Commonwealth Marine Area: None.
- Listed Threatened Ecological Communities: None.
- Listed Threatened Species: 14.
- Listed Migratory Species: 12.
- EPBC Act Referrals: 2.

Fourteen (14) threatened species have been identified within the site area, of these, four (4) are known to be present, three (3) are likely to be present and the remaining seven (7) may be present.

Eleven (11) migratory species have been identified within the site area, of these, two (2) are likely to be present, with nine (9) listed as may be present.

The EPBC Act referral located within the site (EPBC 2010/5581) for the CopperString Project was made in 2010 for the proposed action of constructing an alternating current transmission line and associated infrastructure. The EPBC referral lapsed on 18 March 2015.

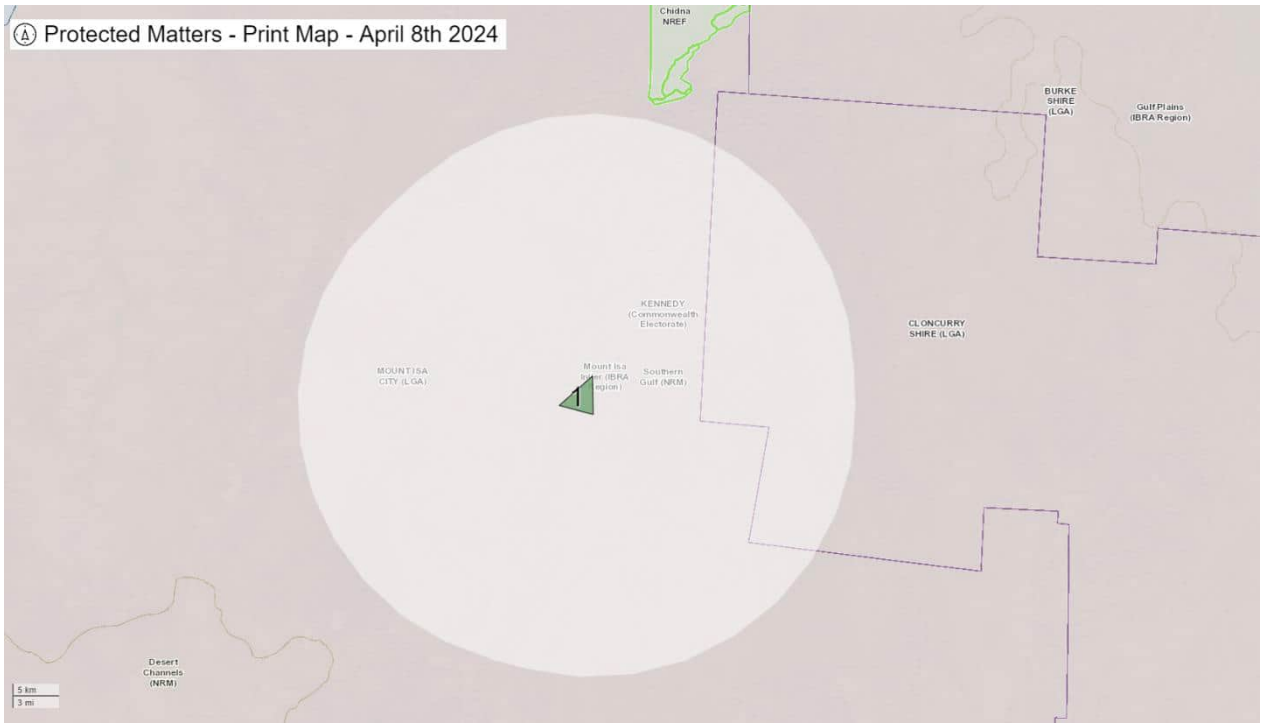


Figure 2.1: Protected Matters Search Area (Source: https://pmst.awe.gov.au/ accessed 8 april 2024)

2.5 Matters of State Environmental Significance

A search of Queensland Globe Matters of State Environmental Significance (MSES) layers (refer to Figure 2.2) shows the following areas identified within the project site:

- MSES regulated vegetation (defined watercourse) within and adjacent to the approved mining leases, including an area within the proposed TSF3.
- MSES wildlife habitat (endangered or vulnerable) approximately one kilometre east of the mining lease boundary and two kilometres east of the proposed TSF3 footprint.
- Riparian Corridor and buffer along Gunpowder Creek.

It is noted that the mapped regulated vegetation within the footprint of the proposed TSF3 is currently not receiving surface water from upstream flows from the south as a result of the existing Upper Esperanza Diversion Dam (UEDD).

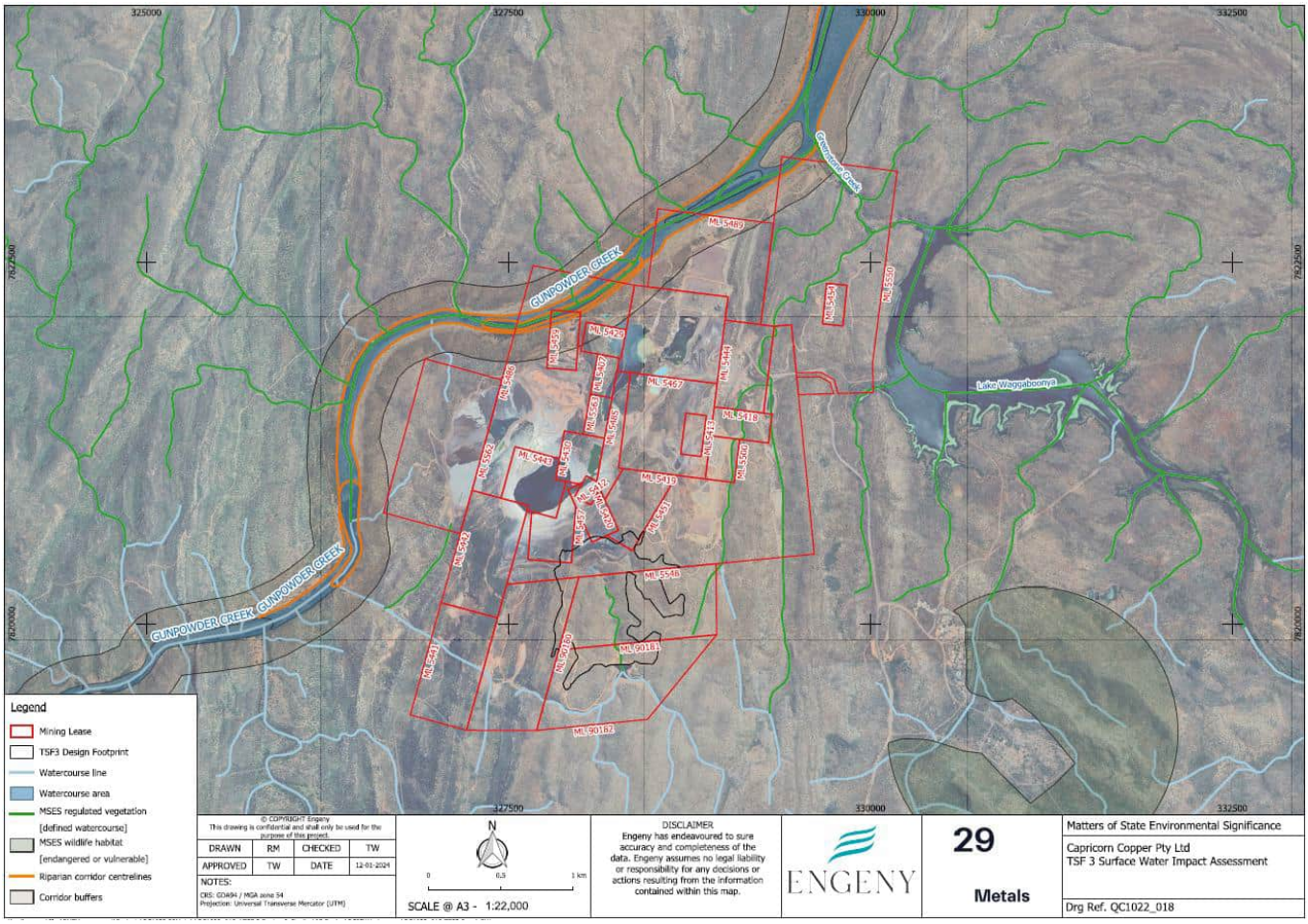


Figure 2.2: Matters of State Environmental Significance

3. ENVIRONMENTAL SETTING

3.1 Regional Catchments and Drainage

The Project is in the Leichhardt River drainage sub-basin area in the Leichhardt Drainage Basin. The Leichhardt drainage basin has a total catchment area of 32,882.2 km.

The Leichhardt River rises in the Selwyn Ranges, 40 kilometres southeast of Mount Isa. It flows in a northerly direction, through the city of Mount Isa and Lake Moondarra, before passing through Julius Dam. It is joined by its major tributary, Gunpowder Creek, 15 kilometres downstream of Kamilaroi homestead. Another major tributary, Fiery Creek, joins the river 70 kilometres downstream of Lorraine. The Alexandra River enters the river from the east, just below Floraville, before the Leichhardt River finally passes through a vast coastal plain and enters the Gulf of Carpentaria 30 kilometres northeast of Burketown. The location of the project site in relation to the catchment is presented in Figure 3.1.

The Project is located east of Gunpowder Creek. Run-off from CCM flows into Gunpowder Creek, which also receives licensed releases of treated mine-affected water that enters the creek system at the EA-nominated release point (W1, Figure 3.2). Magazine Creek flows into Greenstone Creek, which flows into Gunpowder Creek downstream of the mining activities. Gunpowder Creek flows into Leichhardt River, approximately 100 km north-east of CCM.

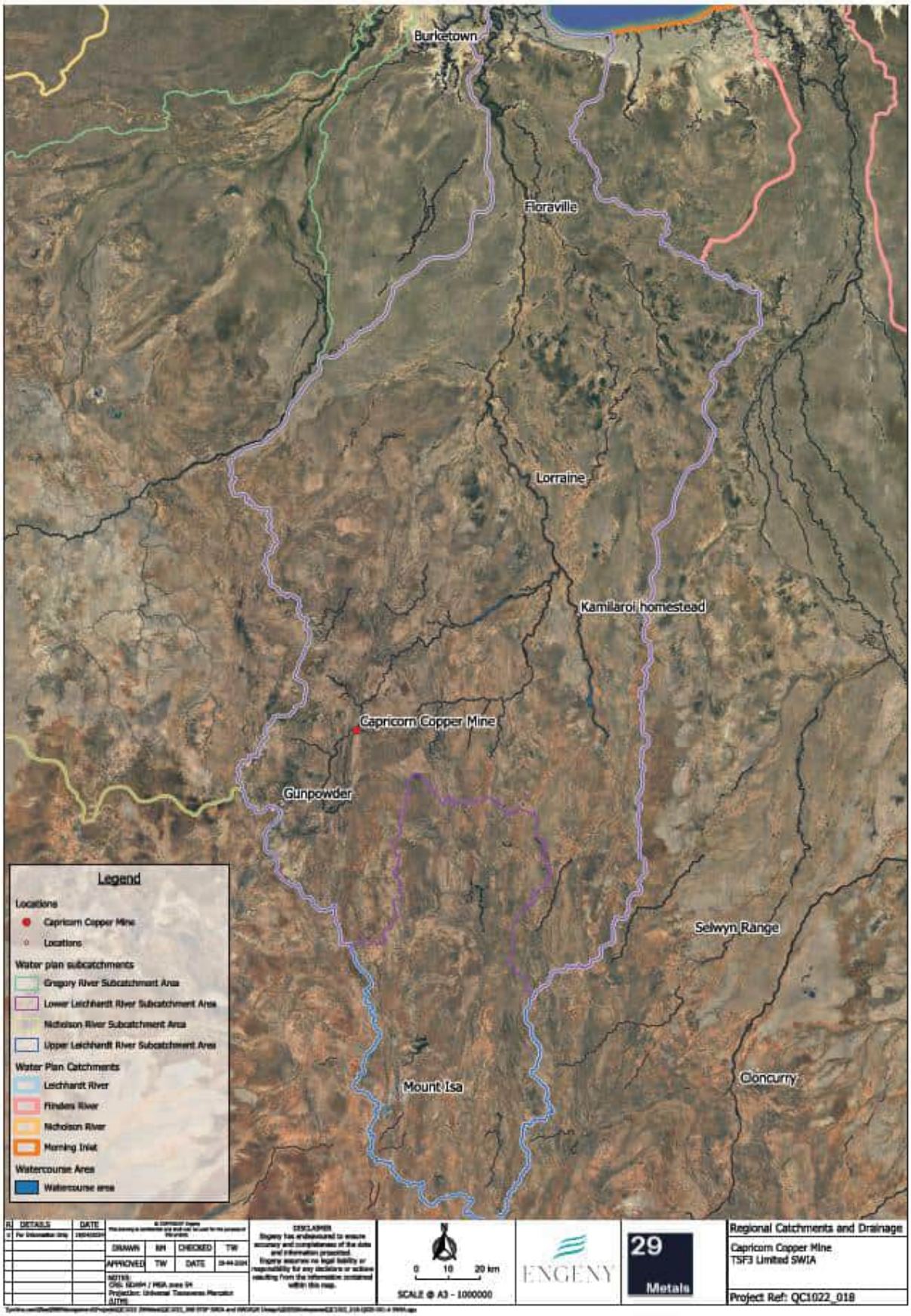


Figure 3.1: Regional Catchments and Drainage

3.1.1 Gunpowder Creek

Gunpowder Creek is the receiving waterway for release waters from the site operations. Gunpowder Creek joins the Leichardt River approximately 100 km north-east of the mine and is located within the Leichardt River drainage sub-basin area in the Leichardt Drainage Basin.

CCM generally drains to the north with the Mill Creek Dam (MCD) being the main mine water storage receiving catchment runoff and overflows from upstream storages with potential to overtop to Gunpowder Creek. Seepage and overflows from the MCD are collected at Hoover Dam and pumped back to the MCD. Releases of treated mine affected water (MAW) to Gunpowder Creek is only authorised in accordance with the conditions in Schedule C of the EA. The release point is located west of the Hoover Dam on Gunpowder Creek (W1) (refer to Figure 3.2), approximately 2 km upstream of the confluence between Gunpowder Creek and Greenstone Creek.

Gunpowder Creek (adjacent to CCM) has been classified as a highly disturbed aquatic ecosystem and is considered moderately disturbed downstream of the mine (NRA 2022). Gunpowder Creek is utilised for primary industries (livestock drinking water) and mining. Recreational uses have been identified as visual recreational use, with downstream of mine considered as secondary recreation only e.g. boating and fishing.

Streamflow in Gunpowder Creek at CCM is highly ephemeral and typically restricted to a high flow season extending from December through March (refer to Table 3.1 and Figure 3.3). Streamflow during the high flow season is likely to be variable and subject relatively quick recession following rainfall. Cease to flow conditions are dominant, occurring on more than 70% of all days.

3.1.2 Greenstone Creek

Greenstone Creek has been classified as a highly disturbed aquatic ecosystem utilised for primary industries (livestock drinking water), mining and visual recreational use (NRA 2022). Greenstone Creek is impounded by Greenstone Creek Dam (Lake Waggaboonya) adjacent CCM and has a capacity of 14,000 ML. Lake Waggaboonya was constructed in the 1960s to supply raw water to CCM and other nearby by mining operations (Lady Annie).

3.1.3 Magazine Creek

Magazine Creek is utilised for primary industries (livestock drinking water) and mining (NRA 2022). Magazine Creek previously contains five (5) stormwater ponds which retained stormwater following the wet season and was historically used to supply raw water to the mine. These ponds have now been decommissioned, with no ongoing impoundment or pumping of water for use as raw water.



Figure 3.2: CCM Receiving Waterways and Surface Water Monitoring Locations

TABLE 3.1: FLOW STATION 913006A GUNPOWDER CREEK AT GUNPOWDER

Aspect	Comments
Gauge location	-19.6878, 139.3607 (decimal degrees)
Gauge catchment	2,427 km^2
Gauge start	27/01/1974
Status	Active

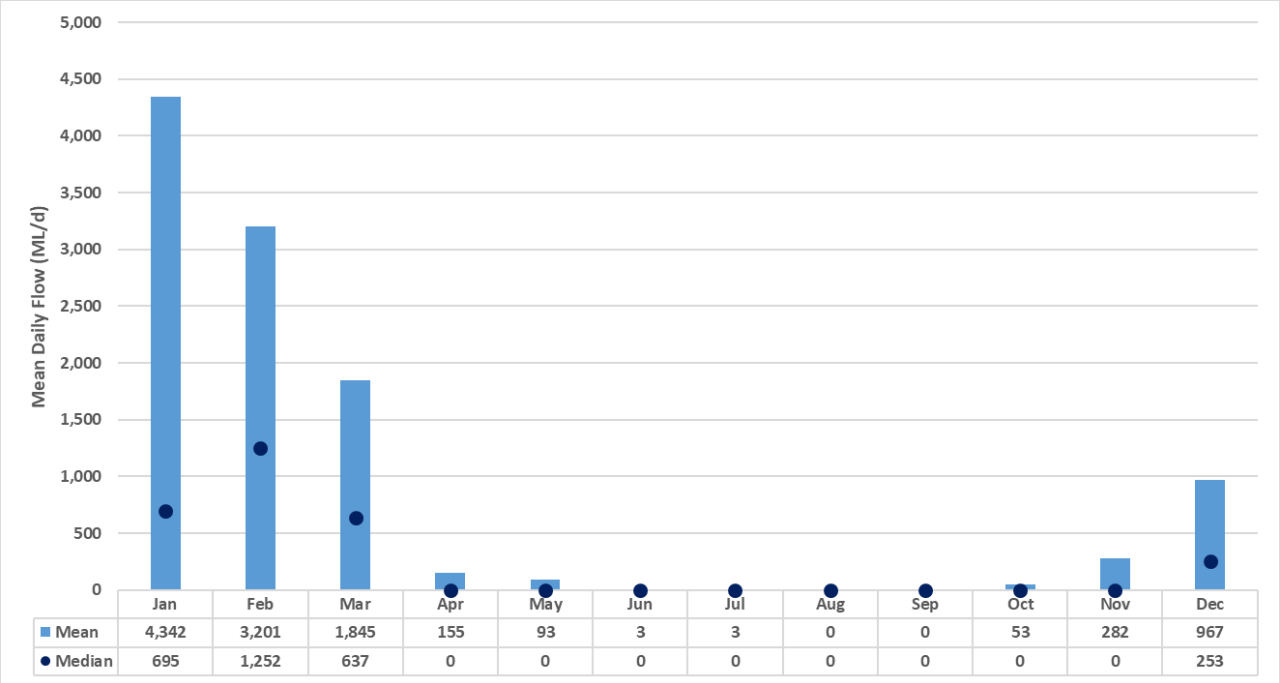


Figure 3.3: 913006A (Gunpowder Creek) – Mean Monthly Flow (1971-2023)

3.2 Climate

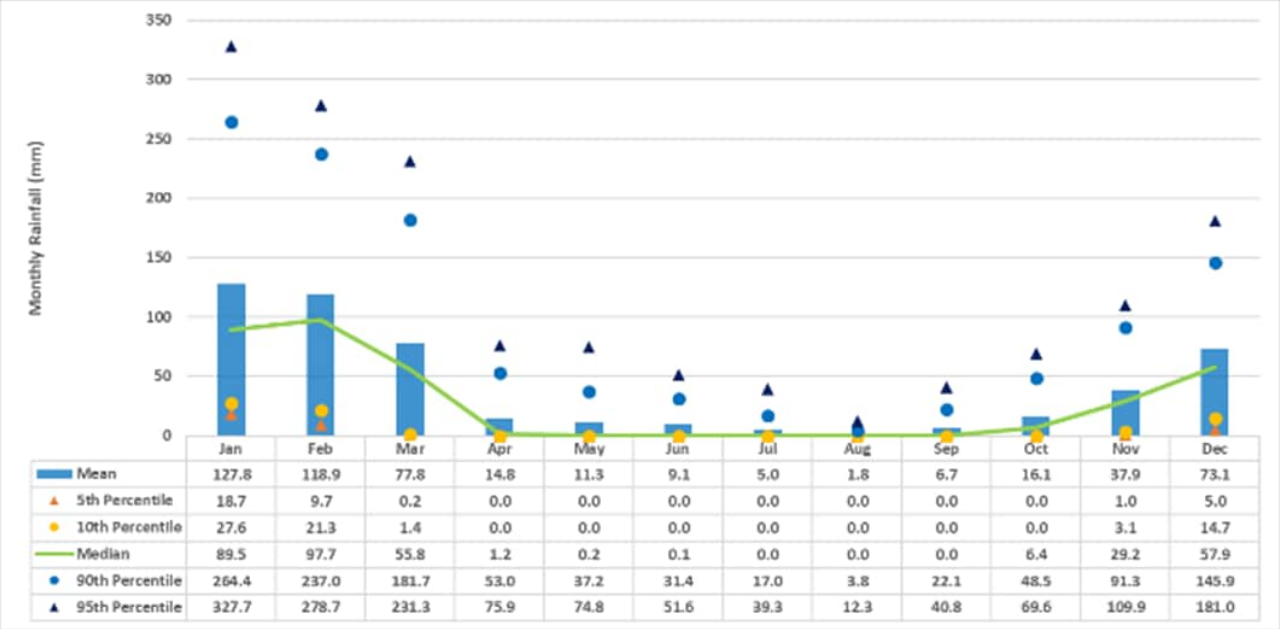
CCM is located within the grassland Köppen major climate zone which is characterised by hot humid summers, summer dominant rainfall and winter drought. Long term climate data for the site have been obtained from the Scientific Information for Land Owners (SILO) climate database facility hosted by the Department of Environment and Science (DES) using a Data Drill extracted for the site location (Lat, Long -19.70 139.35; decimal degrees)). The SILO climate data record produces 134 years of daily climatic data (1889-2024) at the site location based on interpolation of historical nearby weather station data. The following sections provide further description of rainfall, evaporation and temperature for the site.

3.2.1 Rainfall

CCM is in a region of North Queensland that can experience significant, cyclonically influenced rainfall events during summer and is predominantly dry in winter. Rainfall at CCM is subject to a strong seasonal distribution with a majority of rainfall occurring during a wet season extending from November through March. However, wet season rainfall is also likely to be subject to significant variability with potential for periods of extended drought and intense flooding rainfall (refer to Table 3.2 and Figure 3.4).

TABLE 3.2: ANNUAL RAINFALL STATISTICS (SILO, 1889-2024)

Statistic	Annual Rainfall (mm)
5th Percentile	200
10th Percentile	249
Median	460
Mean	498
90th Percentile	805
95th Percentile	956



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	127.8	118.9	77.8	14.8	11.3	9.1	5.0	1.8	6.7	16.1	37.9	73.1
5th Percentile	18.7	9.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	5.0
10th Percentile	27.6	21.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	14.7
Median	89.5	97.7	55.8	1.2	0.2	0.1	0.0	0.0	0.0	6.4	29.2	57.9
90th Percentile	264.4	237.0	181.7	53.0	37.2	31.4	17.0	3.8	22.1	48.5	91.3	145.9
95th Percentile	327.7	278.7	231.3	75.9	74.8	51.6	39.3	12.3	40.8	69.6	109.9	181.0

Figure 3.4: Monthly Rainfall (SILO, 1889-2024)

CCM has been subject to severe rainfall events during both the 2022 and 2023 wet seasons. Comparison of site-recorded rainfall data with long term SILO Data Drill (Table 3.3 below) indicates that:

- The 2022 five-month (November through March) rainfall total of 1,503 mm represents 345% of the long-term (SILO Data Drill) average; and
- The 2023 five-month (November through March) rainfall total of 772 mm represents 177% of the long-term (SILO Data Drill) average.

These results are demonstrative of the rainfall variability experienced at CCM.

TABLE 3.3: 2022 AND 2023 WET SEASON RAINFALL

Wet Season	Rainfall (mm)[1]	Period	Percentage of Long Term Average[2]
2022	1,503	Nov 2022 to Mar 2023	345%
2023	772	Nov 2023 to Mar 2024	177%

Notes
[1] Site Data
[2] SILO Data Drill

3.2.2 Evaporation

Figure 3.5 illustrates mean monthly pan evaporation for CCM. Mean monthly evaporation is seasonally distributed with rates highest from October through March and lowest from April through September. Evaporation rates are comparatively more consistent than rainfall and is approximately four times higher than the average rainfall. AGE (2001) estimated groundwater recharge rates at 3% of the annual average rainfall.

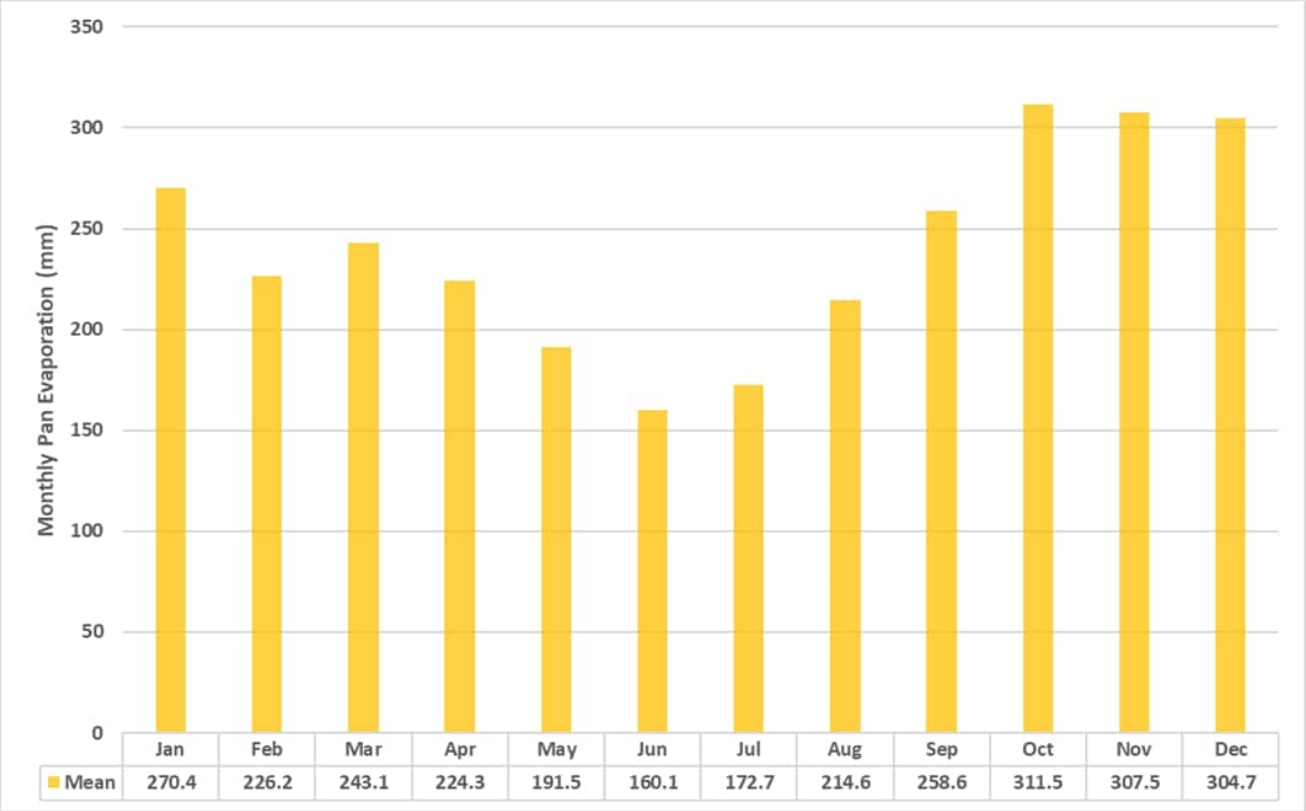


Figure 3.5: Monthly Pan Evaporation (SILO, 1970-2024)

3.2.3 Temperature

Mean monthly maximum and minimum temperatures are shown below in Figure 3.6 and indicate an extended hot summer period where mean temperatures exceed 35°C from October through February and a mild winter where mean maximum temperature remain above 25° for all months. Mean minimum temperature ranges from a maximum of 24.4°C in January to a minimum of 10.6°C in July.

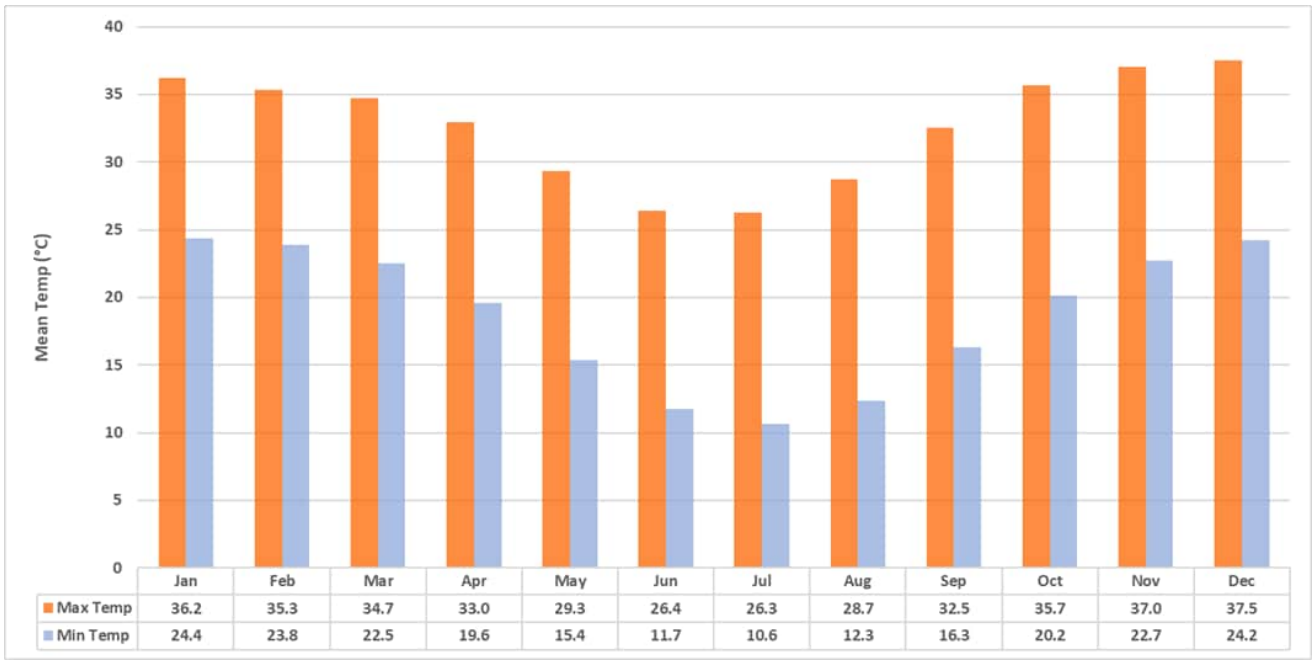


Figure 3.6: Mean Monthly Temperature (SILO, 1970-2024)

3.3 Regional Topography

CCM is situated in the undulating, hilly terrain of Mount Gordon, resulting in an elevation range of approximately 155 meters from 193 mAHD to 348 mAHD. The topography in the area has been significantly modified by mining operations, with the construction of significant surface infrastructure for mining including tailing storage facilities, waste rock dumps, open cut pit, ore processing facility, underground portals and dams.

3.4 Geological Setting

3.4.1 Regional Geology

CCM sits within the Western Fold Belt of the Mount Isa Inlier. Mineralisation in the area is associated with faults relating to the Mount Gordan Fault Zone (outcrops to the west of CCM), which generally separates gently folded McNamara Group rocks of the Lawn Hill Platform to the west from older tightly folded rocks of the Haslingden Group to the east.

Mineralisation at CCM is hosted by Proterozoic units at various stratigraphic levels, ranging from Haslington Group rocks at the Mammoth deposit (at E-Pit), to McNamara Group units at Esperanza.

All stratigraphic relationships such as lithology age, formation groups and bedding relationships for all the regional geological units (i.e., Lawn Hill Platform, Haslingden Group, McNamara Group, etc.) are presented in Engeny (2025) TSF3 Geological Mapping Report (QC1022_018-REP-001-1), included in Appendix B. These stratigraphic relationships help verify any future investigations and measurements taken at CCM.

4. TSF3 DETAIL

4.1 TSF3 Construction

TSF3 is proposed to be located between the EWRD and UEDD and bound by the surrounding ridges. The site topography consists of roughly north-south striking undulating ridges which are incised by a main drainage line which forms the Upper Esperanza Valley (UEV) and is bound by the EWRD in the north and by the UEDD in the south. The proposed TSF3 preliminary design is shown in Figure 4.1.

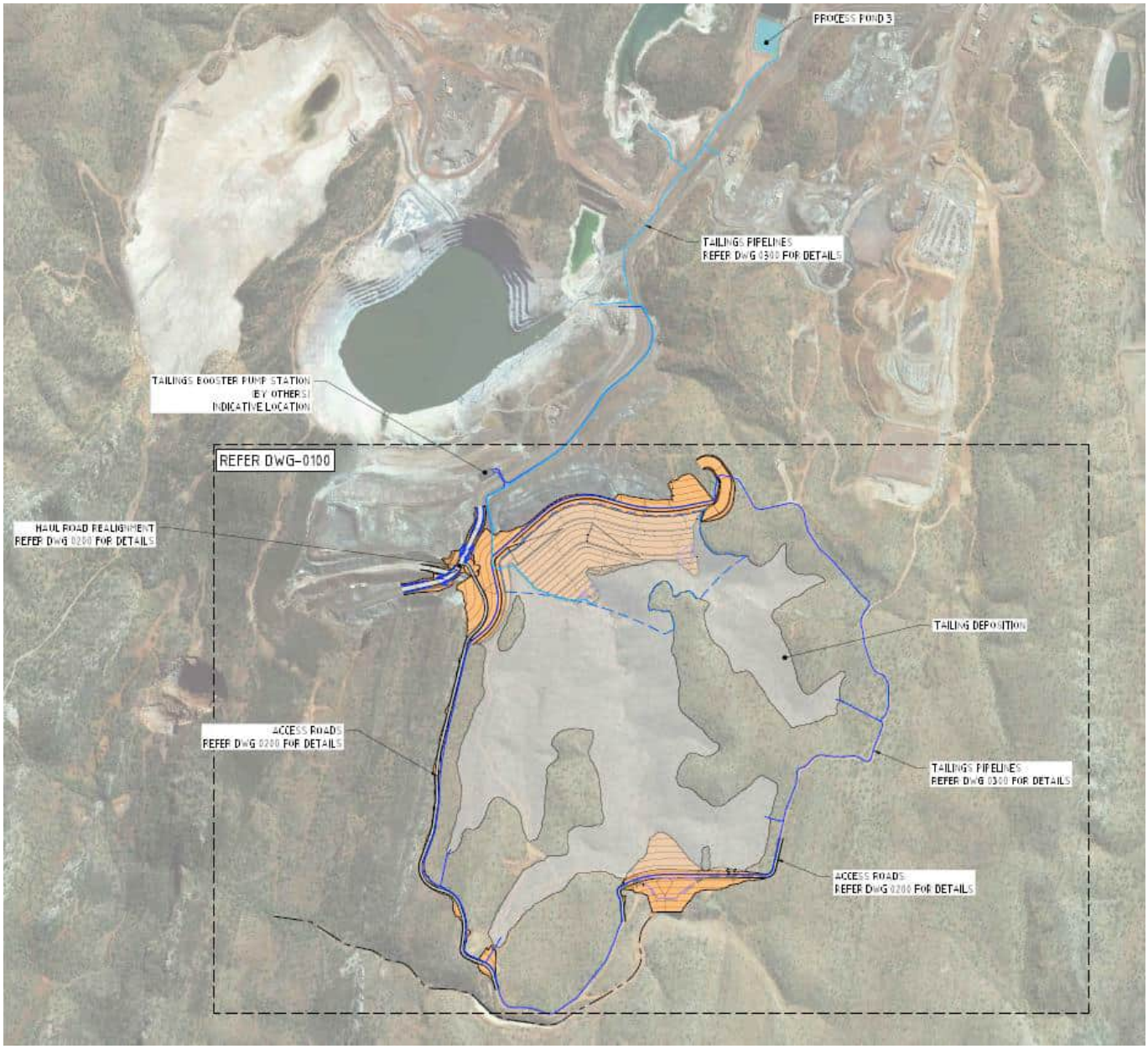


Figure 4.1: TSF3 Preliminary Design (Extract from Drawing QC1022-018-DWG-0010)

Primarily, the construction activities will be at the northern and southern embankments as described below.

4.1.1 Northern Embankment Design

The typical design for the northern embankment is shown in Figure 4.2.

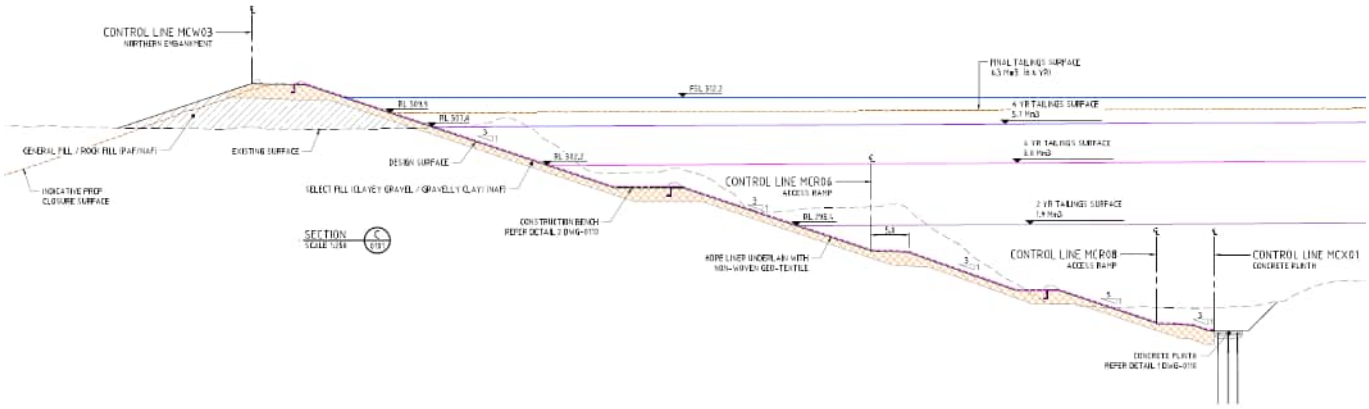


Figure 4.2: Tailings Deposition – Rate of Rise (Northern Embankment)

The provisional construction sequence is as follows:

1. Undertake bulk earthworks using NAF/PAF General Fill / Rock Fill to form the northern embankment and reprofile the upstream batter. Areas of the northern embankment which may drain to a clean catchment (e.g. Upper Snakeskin Valley) to be constructed from NAF General Fill / Rock Fill.
2. Construct geomembrane liner cushion layer using Select Fill (Clayey GRAVEL / Gravelly CLAY). The preliminary design allows for a typically 3m wide (1m thick) Select Fill layer, thickened to 2m thick at the batter benches to facilitate anchoring of the geomembrane liner. Where required the Select Fill layer may be separated into two material types to transition from the existing rock fill to the cushion layer to prevent loss of fines in the cushion layer during operation.
3. Construct concrete plinth and grout curtain and install geomembrane liner.

4.1.2 Southern Embankment Design

The typical design for the southern embankment is shown in Figure 4.3.

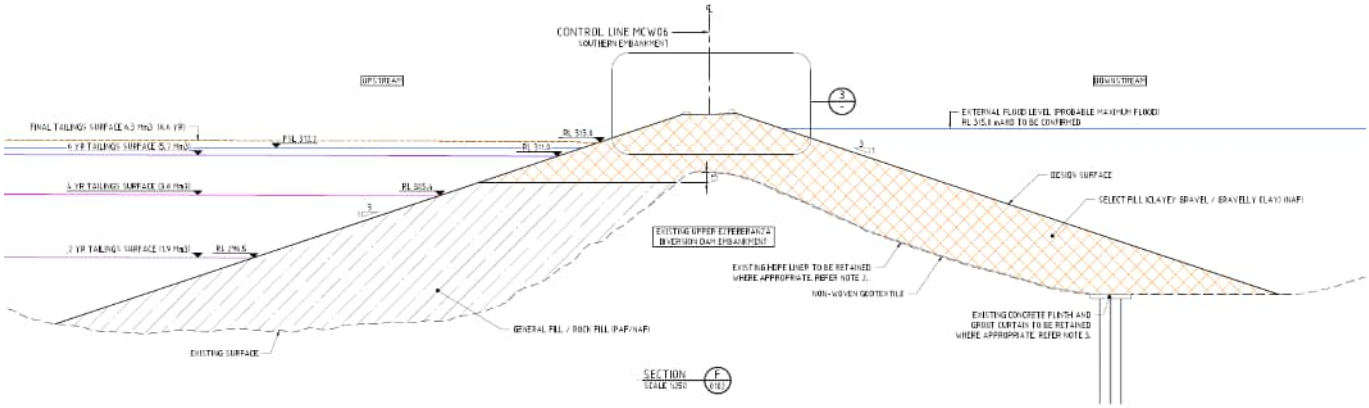


Figure 4.3: Tailings Deposition – Rate of Rise (Southern Embankment)

The provisional construction sequence is as follows:

1. Verify adequacy of existing grout curtain (e.g. through conformation grouting) and HDPE geomembrane liner (e.g through inspection and testing) and repair / replace / remediate where required. Extend grout curtain and concrete plinth to accommodate centreline raise.
2. Undertake centreline raise using NAF/PAF General Fill / Rock Fill (internal batter) and Select Fill (Clayey Gravel / Gravelly Clay) (crest and external batter). Tie low permeability Select Fill into concrete plinth / grout curtain extension. Existing HDPE liner to be protected by non-woven geotextile or similar prior to Select Fill placement.

4.2 EWRD Construction

Construction of the EWRD occurred sometime after the commencement of mining at Esperanza Pit (EPit), circa 1997. The EWRD appears to have infilled existing drainage lines which drain waters to the north. The EWRD is known to contain potentially acid forming waste rock and general waste deposits from the previous operator, Birla Mount Gordon, as described in the Esperanza WRD Waste Disposal Management Plan (BMG, 2014).

4.3 UEDD Construction and Repairs

The Upper Esperanza Diversion Dam (UEDD) was constructed as part of ongoing water management control measures at Birla's Mount Gordon mine during the 2009 dry season. During the 2009-2010 wet season, seepage was observed at the downstream toe of the dam. This was controlled by installation of a pump to return seepage to the diversion channel. Back analysis of seepage data in conjunction with onsite observations and knowledge of the construction methods indicated that the seepage was most likely passing through the dam foundations and not due to a fault in the GCL membrane (GHD, 2010).

The investigations carried out by GHD found there to be a highly complex joint system, with many of the joints being randomly oriented. Recurring joints included those that struck and dipped along the bedding plane (i.e. approximately 10 to 30 degrees strike and between 55 and 65 degrees west dip), as well as a set that struck in the same direction as the bedding plane, but dipped between 30 and 60 degrees east (GHD, 2010).

The UEDD repair works consisted of general earthworks and slope corrections, grout curtain installation, plinth construction, and installation of a HDPE liner. The objective of the works was to minimise seepage through the foundations by the use of a grout curtain, and through the embankment (and therefore through the foundations on the downstream side of the plinth) by the use of a HDPE liner.

CCM are currently progressing preliminary investigations to determine the cause of apparent ingress of clean water through the UEDD to the north including dewatering of the UEDD while monitoring seepage at the v-notch weir and piezometric levels in the UEDD piezometer during dewatering, and inspection of the liner and liner – grout curtain connection.

The current design of TSF3 incorporates a number of controls to reduce seepage through the southern embankment including:

- Vertification of the adequacy of the existing grout curtain via conformation grouting, and extension of the grout curtain to enable the centreline raise of the UEDD.
- Verification of the adequacy of the existing HDPE liner including inspection and testing, and where inadequate repair or replacement as appropriate.
- Decant pond remote from the UEDD embankment.
- Low permeability tailings deposited against the internal embankment.
- UEDD continued to be dewatered via pumping.
- Remote and convoluted drainage path from TSF3 to Gunpowder Creek.

4.4 TSF 3 Topography

The UEV runs roughly south-east / north-west and drains waters to the north toward the E-Pit. The base of the UEV beneath the Upper UEDD exists at approximately RL 287 mAHD and drops to RL 249 mAHD beneath the EWRD, falling at a grade of approximately 5%. Valley sides which form the abutments of the TSF3 and UEDD rise at approximately 37% and 20% [grade] respectively. Valley sides in the tributary lines either side of the UEV (denoted by blue arrows in Figure 4.4) have similar properties to the UEV. The topography in the UEV and adjacent valleys present difficulty for LV access and the ability to build access tracks.

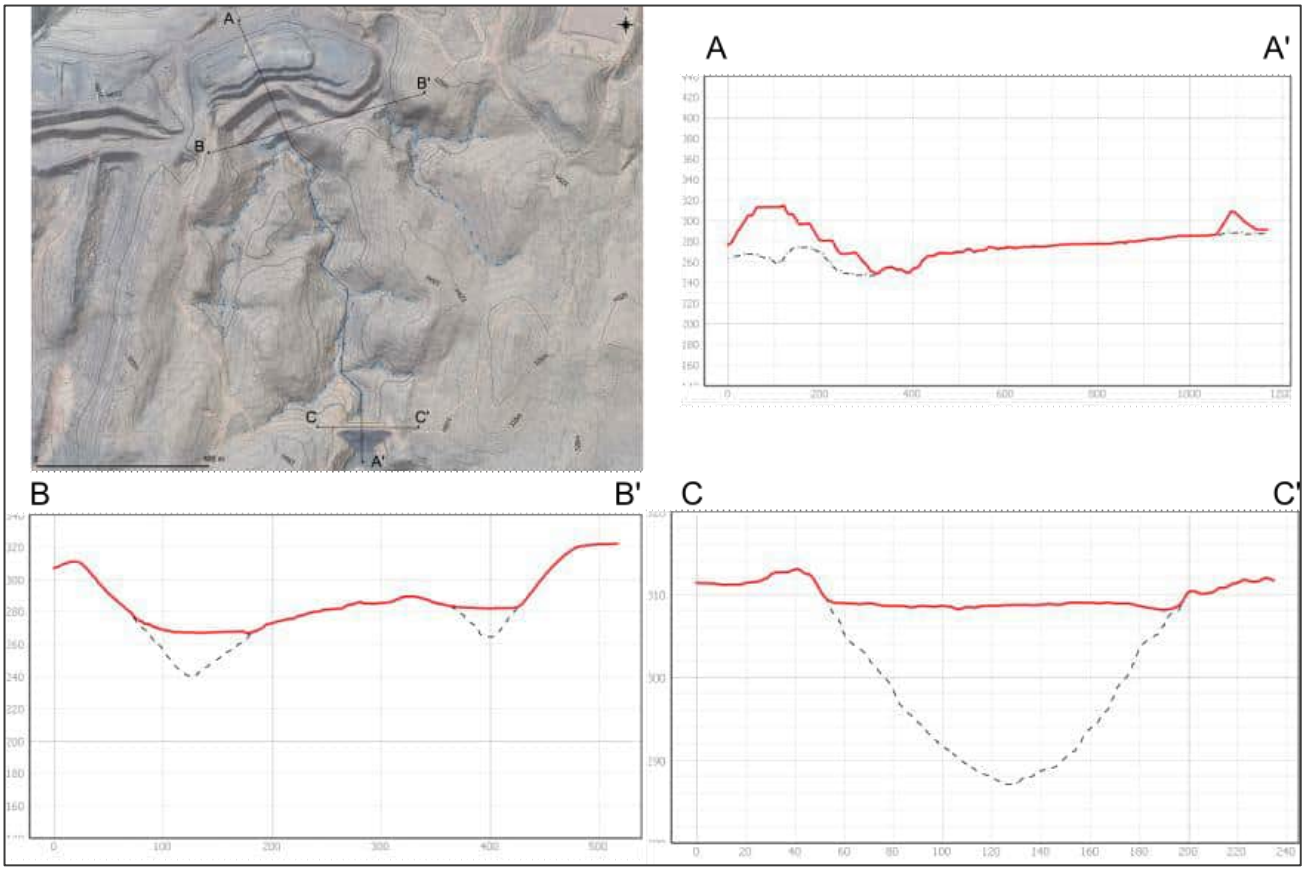


Figure 4.4: Topographical Sections Through The UEV

Note: Inferred ground surface beneath the embankments based on historical imagery are shown in dashed black above.

5. TSF3 CONCEPTUAL HYDROGEOLOGICAL MODEL

The purpose of this section is to define the conceptualisation of the hydrogeological conditions influencing TSF3, informing the development of the numerical model.

5.1 Geology of the Upper Esperanza Valley

The Queensland detailed solid geological mapping indicates that the UEV is located within the Whitworth Quartzite, which is comprised of massive medium to coarse-grained feldspathic to quartzose sandstone, fine purple sandstone and mud flake conglomerate. The valley is covered with a thin layer of colluvium, with scree located on the upper slopes of the surrounding ridges (refer to Figure 5.1).

5.1.1 Geophysical Assessments

Interpretation of airborne geophysical datasets was completed by Southern Geoscience Consultants (SGC) in 2023 to identify structural settings, domains, and fault distribution. SGC used freely available [open source and State Government] aeromagnetic (AMAG), radiometric (RAD), and airborne EM (AEM) surveys to inform the geophysical interpretations against existing or known faults derived from the Geological Survey of Queensland (GSQ) 1:250,000 scale Camooweal and 1:100,000 scale Mammoth geology maps.

All faults identified by SGC consultants are presented in Figure 5.1 below. SGC noted that their structural interpretation of the magnetic data improves the understanding of the geological structures in the area, refines the geometry of certain known faults and potentially identifies local, subtle faults that may not have been previously recognised.

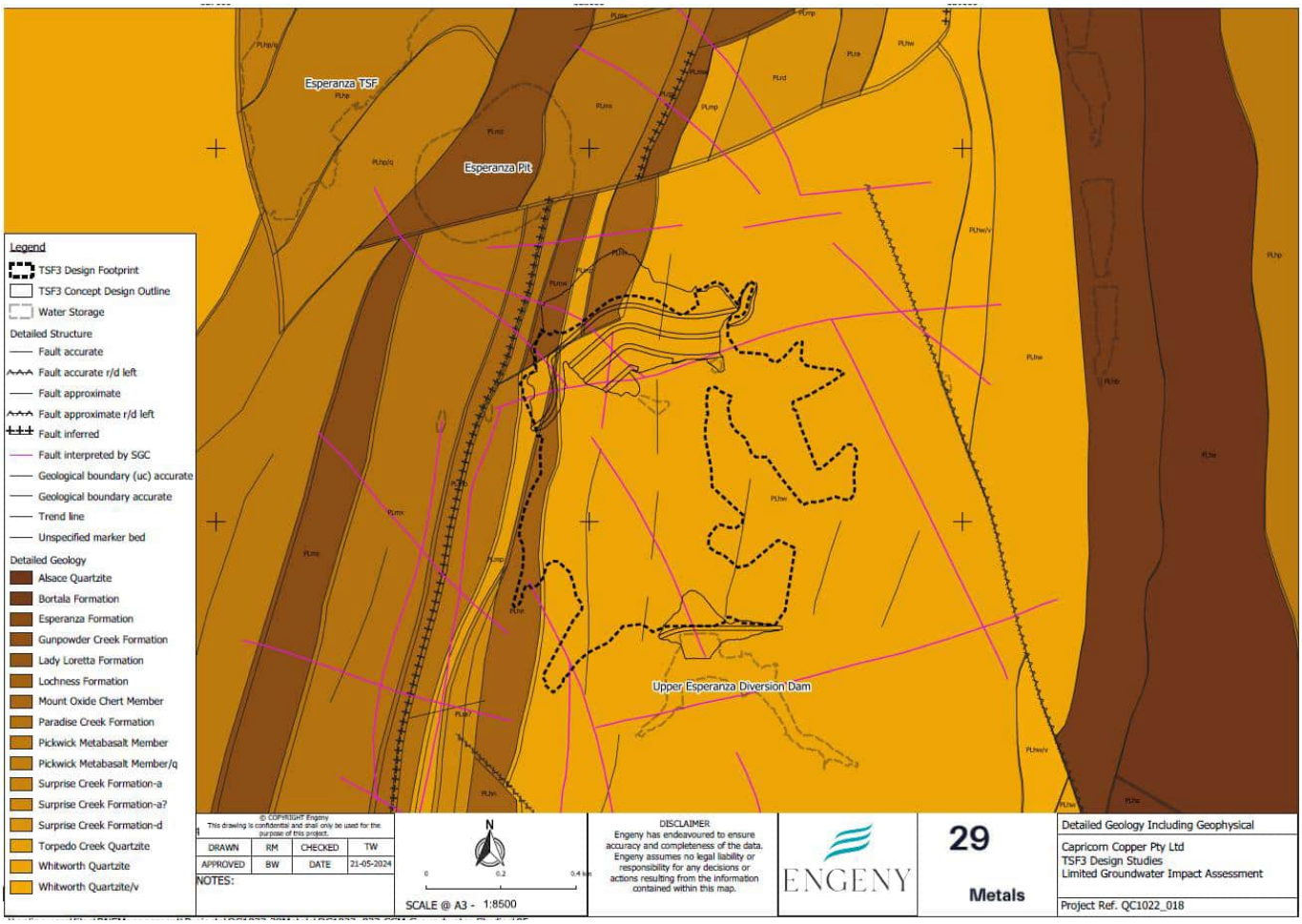


Figure 5.1: Detailed Geology Including SGC Geophysical Interpretation

5.2 Hydrogeology

Groundwater within the extent of the UEV is expected within the shallow perched aquifer system and the deep fractured rock aquifer system. The extent of the shallow aquifer is limited to the extent of the colluvium present on the valley floor and sides. In the vicinity of CCM, soils are thin over most areas including valley floors, and this is expected to also occur within the extent of the UEV.

Groundwater within the colluvium is localised and recharged from direct rainfall. Due to the ridges surrounding the extent of the UEV, the shallow aquifer is not expected to be hydraulically connected to any other surficial aquifers at CCM (ATC Williams, 2023a and 2023b). The UEV is located within the Whitworth Quartzite, which is considered to be a relatively impermeable aquitards due to re-crystallisation during regional metamorphism which resulted in little to no primary porosity in the quartzite.

The hydraulic conductivity of the quartzite is low (in the order of 10^{-7} m/sec), with areas of higher permeability present in the secondary porosity associated with fractures (ATC Williams, 2023b). The near-surface zone of higher permeability in the fractured rock aquifer (associated with delaminating siltstones and shales) is not likely to be present due to the absence of any mapped siltstone or shale within the extent of the UEV (ATC Williams, 2023b). The recent geophysical assessment indicates the potential for unmapped faults to be present within the UEV (refer to Figure 5.1).

5.3 Groundwater Levels and Flow Directions

The groundwater monitoring network at CCM is presented in Figure 5.2. Five (5) groundwater monitoring bores have recently been installed in the area surrounding the proposed TSF3 footprint (GWMB78, GWMB79, GWMB80, GWMB81 and GWMB82). Bore installation details, including average standing water levels for the wells obtained between January and December 2024, are presented in Table 5.1.

Figure 5.2 presents inferred groundwater contours calculated from the average standing water levels obtained across the site between 23 February 2023 and 1 May 2024, inclusive of the newly installed bores (refer to Table 5.2). The direction of flow of groundwater is generally to the north. Groundwater levels mostly mimic a subdued version of the surface elevation. Elevated groundwater is noted surrounding GWMB21 and GWMB22 and at GWMB75.

Groundwater contours generated in the absence of groundwater observation data from the TSF3 footprint and using surface topography suggests that groundwater may flow to the west from TSF3. This is currently being tested with the development of the transient groundwater model and may require additional groundwater monitoring locations to be installed and monitored to confirm. A key assumption to the design of TSF3 is that all potential seepage from the TSF will be captured in EPit.

TABLE 5.1: TSF3 GROUNDWATER MONITORING NETWORK

Bore ID	Date Installed	Easting (GDA 94)	Northing (GDA 94)	Depth	Screened Interval	SWL at installation	Surface RL (mAHD)	Average SWL (mbTOC)	RL at TOC (mAHD)	Average SWL (mAHD)
GWMB78	19/03/24	327877	7820567	42.5	36.5-42.5	Dry	288.05	48.815	288.905	240.09
GWMB79	01/02/24	328295.65	7820679.127	50	47-50	Dry	302.218	51.40	302.886	251.486
GWMB80	06/01/24	328986.223	7820366.201	48.41	38-47	46.7	303.664	33.849	304.593	270.744
GWMB81	01/02/24	327898.608	7819510.11	50	47-50	49.81	322.479	48.968	323.217	274.249
GWMB82	04/02/24	327539.28	7820118.859	21.7	18.5-21.5	6.53	271.933	14.839	272.538	257.699

TABLE 5.2: CCM GROUNDWATER MONITORING NETWORK

Bore ID	Purpose	Easting	Northing	Average SWL (mbTOC)	mAHD (toc)	SWL (mAHD)
GWMB02	Esperanza TSF	327673.066	7821388.541	18.660	278.695	260.035
GWMB03R	Esperanza TSF	327078	7821301	56.675	277.21	220.535
GWMB04R	Esperanza TSF	327150.055	7821506.754	61.180	288.017	226.837
GWMB05R	Esperanza TSF	327567.392	7821831.145	83.641	285.288	201.647
GWMB06R	Esperanza TSF	327723.676	7821917.018	88.126	291.575	203.448
GWMB08	Old TSF	328723.194	7822122.067	1.580	215.717	214.137
GWMB11	Old SX Tanks / Mill Creek Dam	328719.031	7822011.25	0.480	215.869	215.389
GWMB12	Old SX Tanks / Mill Creek Dam	328664.925	7821976.584	0.320	215.134	214.814
GWMB13	Old SX Tanks / Mill Creek Dam	328656.04	7821925.297	0.580	215.179	214.599
GWMB18	North WRD	328026.512	7822135.585	2.752	199.926	197.174

Bore ID	Purpose	Easting	Northing	Average SWL (mbTOC)	mAHD (toc)	SWL (mAHD)
GWMB19	North WRD	327956.192	7822064.673	3.890	201.713	197.823
GWMB21	Heap Leach Pads	328789.403	7820685.798	3.600	314.163	310.563
GWMB22	Heap Leach Pads	328914.288	7820651.477	4.751	311.614	306.863
GWMB24	Magazine Creek Raw Water Dams	329365.988	7821630.302	26.182	260.966	234.784
GWMB26	Heap Leach Pads / Magazine Creek	329279.06	7821987.436	7.401	244.421	237.02
GWMB30	North West Gully Dam	328624.361	7822529.577	5.029	202.485	197.456
GWMB31	Old TSF / Gunpowder Creek	328783.714	7822601.379	18.854	222.951	204.097
GWMB32	Old TSF / Gunpowder Creek	328884.085	7822707.373	4.360	199.078	194.718
GWMB33	Old TSF / Gunpowder Creek	329031.715	7822772.548	6.673	200.042	193.368
GWMB34	Magazine Creek Raw Water Dams	329345.095	7820845.594	8.380	266.396	258.016
GWMB35	Gunpowder Creek	329744.666	7823085.36	3.435	196.607	193.172
GWMB37	Esperanza South	327037.005	7820456.172	20.161	231.73	211.569
GWMB38	Esperanza South	327402.509	7819668.854	3.604	262.909	259.304
GWMB41	North WRD / Mill Creek	328213.926	7822162.012	6.618	206.869	200.251
GWMB42	North WRD / Mill Creek	328100.284	7822136.061	3.467	201.51	198.043
GWMB43	Old Heap Leach / Magazine Creek	328977.235	7820520.98	16.184	296.185	280.001
GWMB44	Old Heap Leach / Magazine Creek	329037.779	7821233.901	27.146	285.833	258.687
GWMB45	Esperanza Pit	328143.204	7821159.397	1.690	227.462	225.772

Bore ID	Purpose	Easting	Northing	Average SWL (mbTOC)	mAHD (toc)	SWL (mAHD)
GWMB47	Esperanza Pit	328871.816	7822621.668	19.050	223.223	204.173
GWMB48	Old TSF	328775.9	7822505	20.691	Surface RL 228.503	207.812
GWMB63	North WRD	327797.84	7821816.07	40.620	Surface RL 227.46	225.38
GWMB64	North WRD	328306	7821421	9.119	Surface RL 223.22	188.081
GWMB65	North WRD	327917.4	7822109	6.726	Surface RL 228.503	194.173
GWMB66	North WRD	327954.3	7822093	5.760	Surface RL 266	192.34
GWMB72	Esperanza TSF	327924.065	7821891.359	28.915	231.87	202.955
GWMB73	Esperanza TSF	327315.515	7821675.018	84.235	286.612	202.377
GWMB74	Esperanza TSF / Gunpowder Creek	326866.272	7821100.527	18.570	232.473	213.903
GWMB75	Esperanza TSF / Gunpowder Creek	327337.62	7820694.87	70.260	334.266	264.006
GWMB76	Esperanza Pit	328225	7820908	13.460	241.46	228
GWMB77	Esperanza Pit	328082	7820717	28.250	266.518	238.268
GWMB78	Esperanza Pit / TSF3	327877	7820567	48.990	288.905	239.915
GWMB79	Esperanza Pit / TSF3	328295.65	7820679.127	50.847	302.886	252.039
GWMB80	TSF 3	328986.223	7820366.201	34.718	304.593	269.874
GWMB81	TSF 3	327898.608	7819510.11	48.670	323.217	274.547
GWMB82	TSF 3	327539.28	7820118.859	11.420	272.538	261.118
GWMB83	Esperanza Pit	327604	7821155	24.875	283.387	258.512

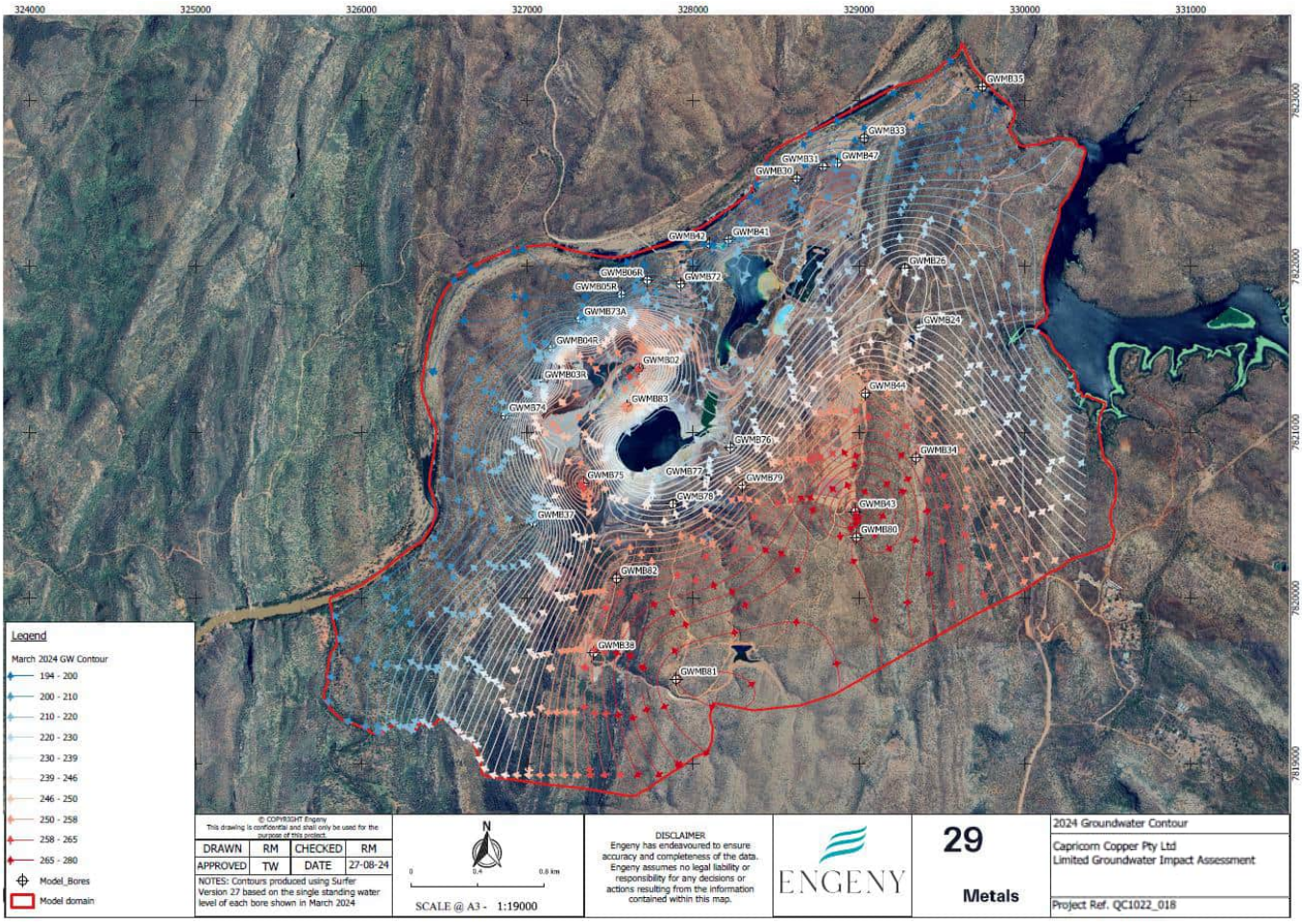


Figure 5.2: Groundwater Contours

5.3.1 Groundwater Impacts from Underground Mining

Two underground mines are located within 1km of the proposed TSF3. Mammoth (MAM) is located to the northeast and Esperanza South (ESS) to the northwest of the proposed TSF3. GHD (2021) details the mining activity including active underground mining within MAM and ESS underground mines up until January 2009.

GHD (2019) suggested the groundwater inflow to the underground mines is minor due the low hydraulic conductivity, however, the average pumping rate of the MAM and ESS are 614 and 278 m^3/d, respectively (GHD, 2020). Further, previous investigations have indicated that the measured groundwater levels in GWMB44 and GWMB37 were affected by underground mining (Engeny, 2023; GHD, 2020). The underground mines are therefore considered to be groundwater sinks.

5.4 Waste Characteristics

Engeny (Engeny, 2024) presents a summary of the characterisation of waste at the CCM site and is summarised below (refer to Appendix D:). A total of 356,698 assays from 7,127 exploration bores, including sulfur content, have been obtained of the mined material to date, the results of which have been used to develop block models for all deposits across the site. Based on review of the block models, the following observations are relevant:

- The ESS underground generally has high sulphur (>5.0) in the majority of the assessed materials to be mined, increasing with depth.
- The MAM underground generally has high sulphur (>5.0) in the majority of the assessed materials to be mined, with increasing sulphur along the strike of the ore body.
- The GST underground mine generally has lower sulphur (<2.0), increasing with depth.
- The PTO underground mine generally has moderate sulphur (<3.0), increasing with depth.

Significant risk of AMD has been identified within:

- The waste rock across the site.
- Tailings which classify as PAF coupled with geochemical enrichment and an increased risk of leaching of these metals with a reduction in pH.

5.4.1 Waste Rock

Sampling and analysis of waste rock materials from three (3) bores drilled during geotechnical investigations surrounding the Esperanza Waste Rock Dump (EWRD) report:

- Total Sulfur between 0.1% and 15.6 % averaging 4.4 %.
- ANC between 3.3 and 35.0 kgH_2SO_4/t averaging 18.1 kgH_2SO_4/t.
- NAPP values between -15.6 and 477.0 kgH_2SO_4/t averaging 125.6 kgH_2SO_4/t.

Because of relatively little ANC and large NAP values, 3 samples from bores 2 and 5 classify as NAF, the remaining 14 samples classify as PAF.

- Total metals arsenic, cobalt, copper and manganese were enriched (GAI >3), in addition to elevated levels of cadmium, lead, mercury, nickel and zinc.
- Leachable metals include cobalt (between 0.1 and 11.7 mg/L), copper (between 0.1 and 263 mg/L), manganese (between 0.4 and 41.4 mg/L), nickel (between 0.4 and 0.6 mg/L) and zinc (between 0.4 and 8.8 mg/L).

5.4.2 Tailings

A summary of the relevant characteristics for tailings includes:

- The tailings generally comprise sandy silty clay with low to moderate plasticity. The USCS classification of the tailing would be silty-clay/clayey-silt.
- Tailings average settled density of 1.40 dmt/m^3.
- The permeability of the tailings is low, and with consolidation, tailings permeability decreases.

Past geochemical testing (Environmental Earth Scientists 2012, EMM 2015, GHD 2018) has shown that the historic tailings exhibit high concentrations of total S and sulfide-S, hence have a high Maximum Potential Acidity (MPA), with limited Acid Neutralising Capacity (ANC). This correlates to strongly positive Net Acid Production Potential (NAPP) values indicating a high probability of being acid-forming. This suggestion is further supported by low Net Acid Generation (NAG) pH test results.

Multi-element testing indicates that tailings samples are significantly enriched (Geochemical Abundance Indices (GAI) of 3 or greater) in silver (Ag), arsenic (As), bismuth, (Bi), copper (Cu), lead (Pb), antimony (Sb) and thallium (TI) (Environmental Earth Scientists, 2012).

5.4.2.1 Static Testing

Recent sampling and analysis of 11 composite (necessitated due to the sizes of the samples) samples of tailings (a mixture of crushed and pulverized and raw ESS, MAM, GST ores) obtained between December 2022 and November 2023. These tailings materials were confirmed to classify as PAF with:

- Total Sulfur between 3.4 % and 7.2 % averaging 5.0 %.
- ANC between 1.3 and 17.0 kgH_2SO_4/t averaging 10.8 kgH_2SO_4/t.
- NAPP values between 90 and 280 kgH_2SO_4/t averaging 144 kgH_2SO_4/t.
- Total metals arsenic, cobalt and copper were enriched (GAI >3), in addition to elevated levels of lead and nickel.
- Leachable metals under acidic conditions include aluminium (between 0.5 and 1.3 mg/L), cobalt (between 1.4 and 3.7 mg/L), copper (between 17.0 and 70.9 mg/L), manganese (between 1.4 and 2.0 mg/L), nickel (between 0.4 and 1.1 mg/L) and zinc (between 0.6 and 0.8 mg/L).
- Leachable metals under neutral conditions include aluminium (between 0.02 and 0.03 mg/L), arsenic (between 0.004 and 0.04 mg/L), cobalt (between 0.01 and 4.06 mg/L), copper (between 0.01 and 31.4 mg/L), manganese (between 0.03 and 2.32 mg/L), nickel (between 0.004 and 1.16 mg/L) and zinc (between 0.03 and 0.53 mg/L).

5.4.2.2 Kinetic Testing

A single composite kinetic leach column (KLC) is currently under analysis at ALS laboratory in Brisbane and is yet to be officially reported. Preliminary assessments and observations include (Figure 5.3):

- pH is rapidly decreasing as sulphate and EC increase indicating substantial mobility of solute elements.
- Major cations, following an increased concentration, decreased to low levels, particularly, in the cases of potassium and sodium. Calcium and magnesium are also high but while the former is constantly increasing indicating high reactivity and mobility of calcium base elements, the latter element is decreasing as, potentially, its base mineral is rapidly consumed.
- Sulphide oxidation ratios (SOR) following a steady decrease is increasing as the reactivity of sulphides are increasing.

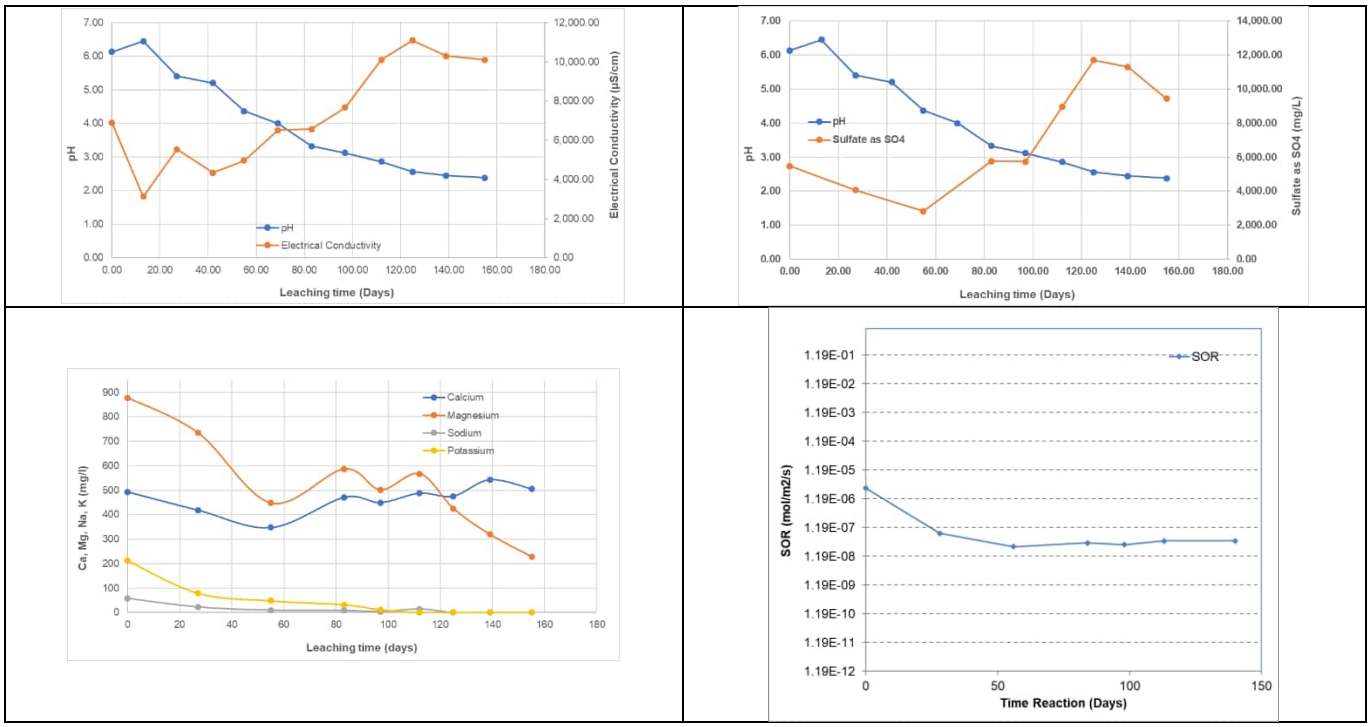


Figure 5.3: Tailings Kinetic Leach Column.

5.5 Groundwater Dependent Ecosystems

A search of the Groundwater Dependent Ecosystems Atlas (GDE Atlas) reveals the presence of potential Aquatic and Terrestrial GDEs, presented in Figure 5.4. Classification of each GDE in accordance with the GDE Atlas are presented below:

- Aquatic - ecosystems that rely on the surface expression of groundwater e.g. springs, wetlands and rivers
- Terrestrial - ecosystems that rely on the subsurface presence of groundwater e.g. vegetation
- Subterranean ecosystems - caves and aquifer ecosystems

A portion of the total site is mapped as a moderate potential terrestrial groundwater dependent ecosystem, the bed of Gunpowder Creek is mapped as high potential terrestrial GDE and Gunpowder Creek is mapped as low-moderate potential aquatic GDE. An extract of the mapping is presented in Figure 5.4.

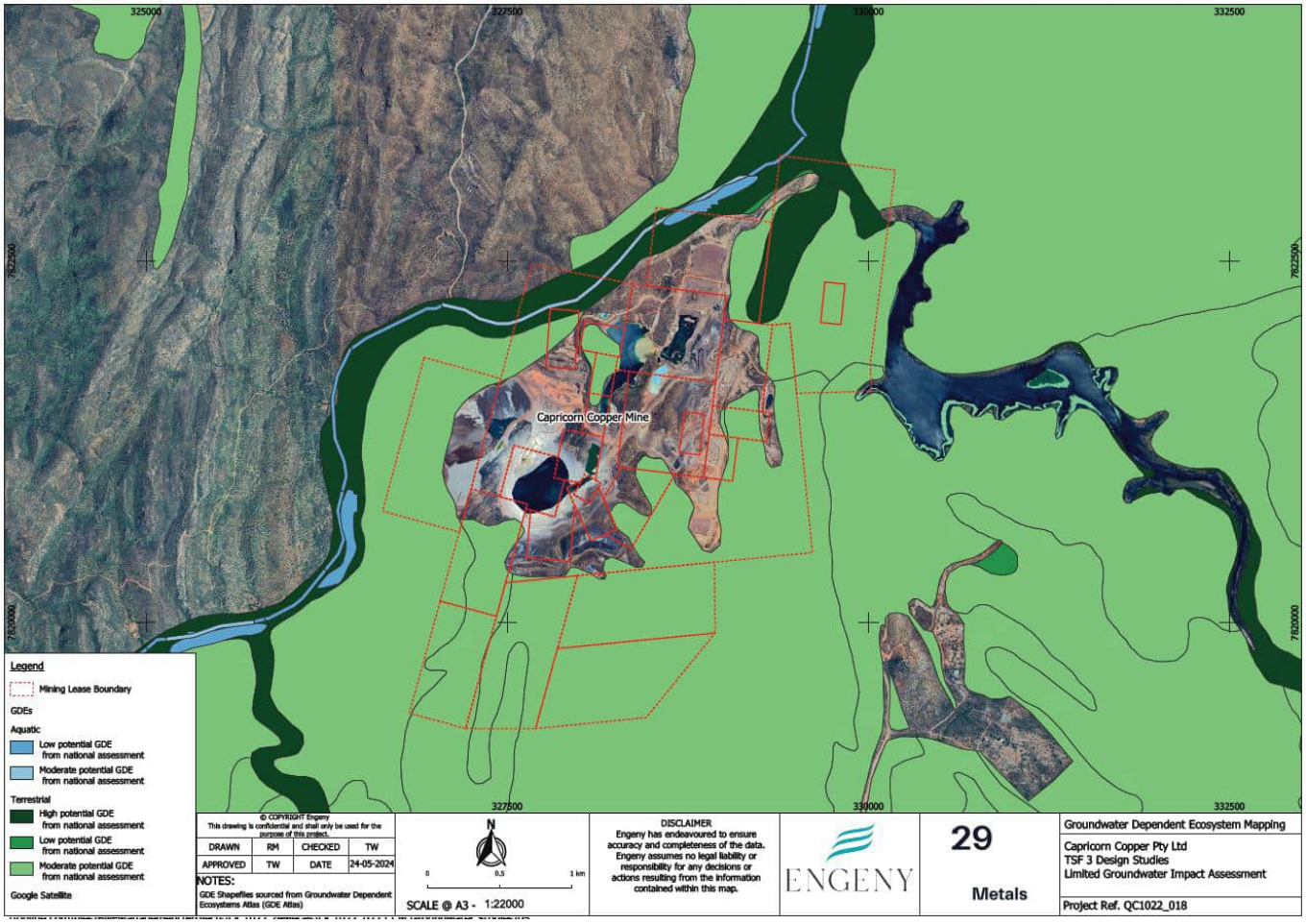


Figure 5.4: Groundwater Dependent Ecosystems

5.5.1 Regional Ecosystem Mapping

Regional ecosystem mapping has been completed at the proposed TSF3 site (Williams, 2023) (Refer Figure 5.5). Regional ecosystem 1.7.7a described as small fruited ghost gum hills is mapped within the TSF3 footprint. The layers observed include:

Tree layer: Corymbia capricornia (small fruited ghost gum) dominates and is typically the only tree. However, Eucalyptus leucophloia (snappy gum) is sometimes present, especially near the boundary with RE 1.11.2a.

Shrub layer: A range of watles, e.g. Acacia hammondii, Acacia retivenea and Petalosigma quadriloculare (quinine) are common shrubs. The tall and whippy Triumfetta micrantha and Triumfetta plumigera are common in places.

Ground layer: Triodia pungens (spinifex) dominates the ground layer, with scatered herbs such as Bulbostylis barbata. A patch of the near threatened vine Ipomoea antonschmidii grows along a track edge surrounded by this RE in the centre of the study site (see associated protected plant survey report).

Weeds: Only Calotropis procera (calotrope) is present in a few spots along track edges. (Williams, 2023)

Corymbia capricornia, also known as the White Gum, generally has a root system that can reach 10-15 feet (3-4.5 meters) in depth. Therefore, it is considered less likely that the vegetation in the vicinity of the proposed TSF3 is dependent on groundwater.

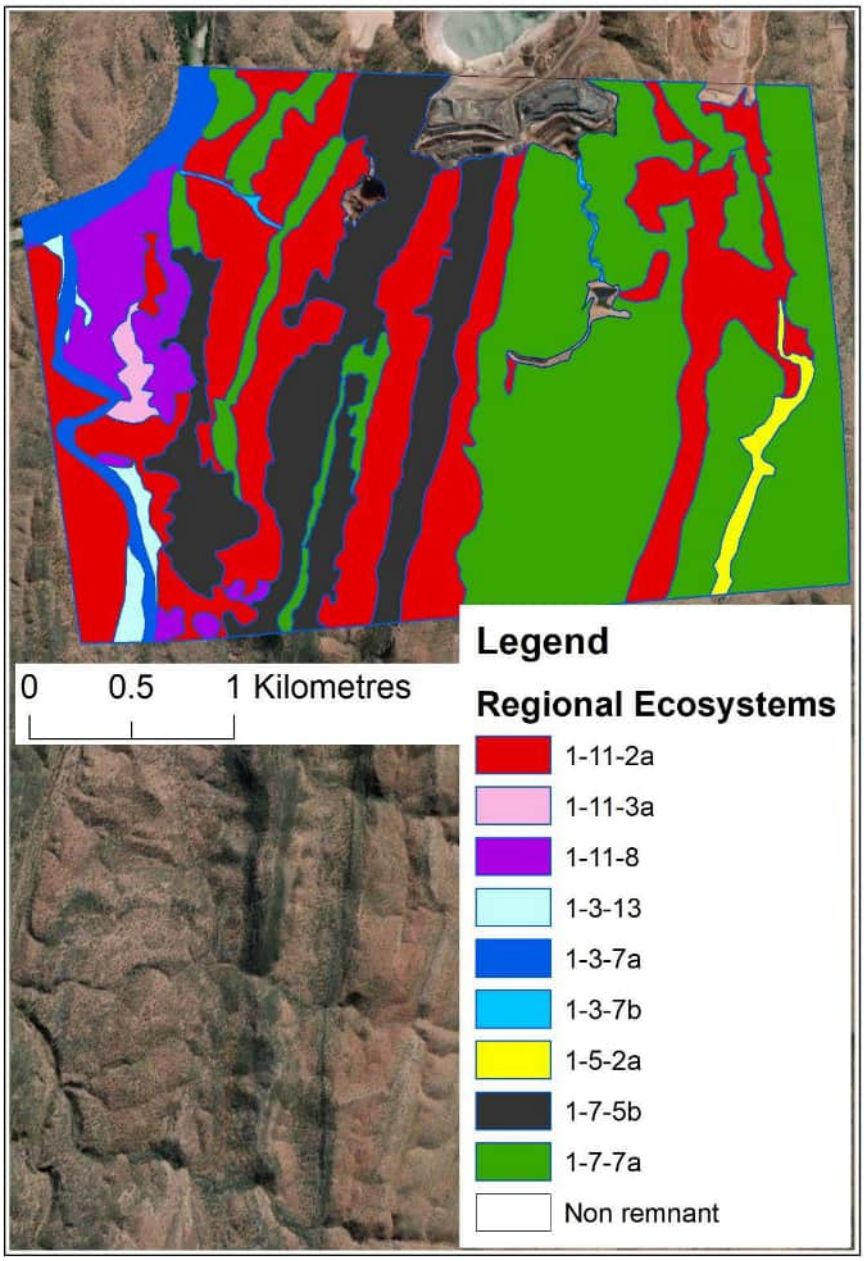


Figure 5.5: Regional Ecosystem Mapping (Williams, 2023)

5.6 Registered Water Bores

A search of the registered water bores was completed using Queensland Globe. Three (3) active bores were identified as present outside of the mining lease boundaries, with an additional bore list as abandoned and destroyed. Bore 146737 is listed for the role of mine monitoring, the other two (2) existing bores do not have a role listed, however, water quality was noted as potable in both bore reports, indicating potential for beneficial reuse. The bore details are summarised in Table 5.3 and bore locations presented in Figure 5.6. The two (2) bores (#146236 and #163777) that have been identified as potentially utilised for beneficial use are located east and north of the site, with #163777 located north of Gunpowder Creek.

TABLE 5.3: OFF-SITE REGISTERED BORE DETAIL

Registered number	Status	Type	Role	SWL	Water Quality	Drilled date	Distance and direction from site
69321	Abandoned and Destroyed	Sub-Artesian Facility	Not Listed	Not Listed	Not Listed	Not Listed	3.5 km SE
146236	Existing	Sub-Artesian Facility	Not Listed	-6	"POTABLE"	2-Nov-09	5.1 km E
146737	Existing	Sub-Artesian Facility	Mine Monitoring	-48	Not listed	9-Feb-12	1.3 km SSE
163777	Existing	Sub-Artesian Facility	Not Listed	-22	"POTABLE"	21-Oct-16	4.8 km N

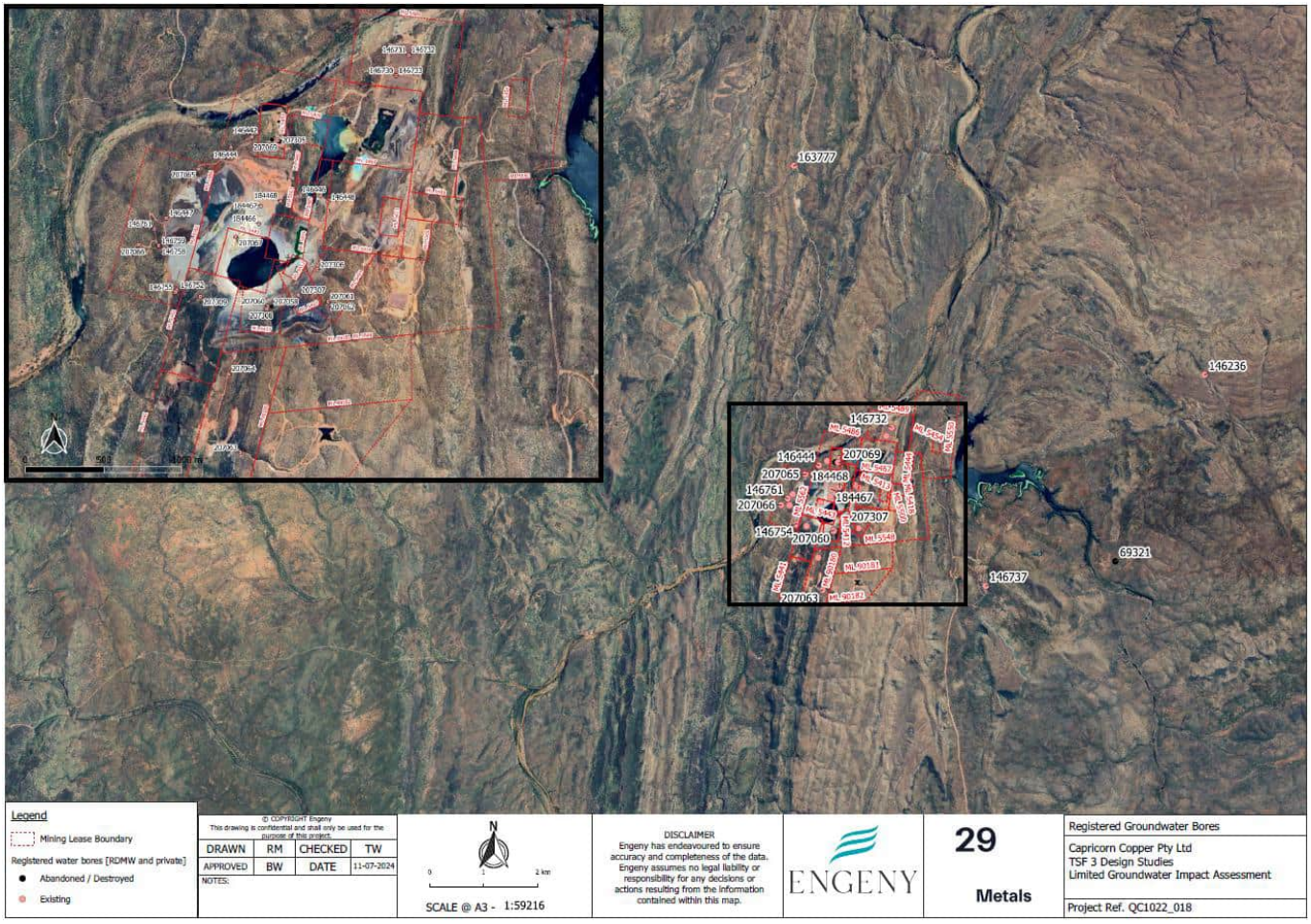


Figure 5.6: Registered Bores

6. ENVIRONMENTAL VALUES

6.1 Environmental Values

EVs for water are the qualities that make it suitable for supporting aquatic ecosystems and human water uses. These qualities need to be protected from the effects of habitat alteration, waste releases, contaminated run-off and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use[2].

EVs and water quality objectives (WQOs) established under the EPP (Water and Wetland Biodiversity):

- provide significant cost efficiencies to government, industry and other groups by establishing a single set of agreed WQOs for legislative and non-legislative planning and water quality management.
- support current and planned future investments by government, industry and the community, in built and natural environments.
- meet the increasing public expectation that government will protect the state's waterways from pollution and minimise economic, social (including public health) and environmental risks associated with declines in water quality.

The EPP (Water and Wetland Biodiversity) Schedule 1 does not list environmental values (EV) or water quality objectives (WQO) for the Leichardt River Basin.

The WQOs for a water that is not in schedule 1 are the set of water quality guidelines (e.g. the Queensland Water Quality Guidelines and the Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality 2018) for all indicators that will protect all EVs for the water.

The CCM 2024 Post-wet REMP Report (Hydrobiology, 2024) (REMP) nominates relevant environmental values for receiving waters in the vicinity of CCM, shown in Table 6.1 below.

TABLE 6.1: NOMINATED EVS FOR GUNPOWDER CREEK AND GREENSTONE CREEK AS DEFINED IN THE PREVIOUS REMPS (NRA, 2022) (HYDROBIOLOGY, 2023) (HYDROBIOLOGY, 2024)

Environmental Value	Gunpowder Creek (adjacent CCM)[3]	Gunpowder Creek (downstream of CCM)[4]	Greenstone Creek (downstream of confluence with Magazine Creek)
Aquatic ecosystem	Highly disturbed[5]	Moderately disturbed	Highly disturbed[9]
Stock watering	Livestock drinking water[9]	Livestock drinking water	Livestock drinking water[9]
Recreation and aesthetics	Visual recreational use[9]	Secondary recreational use	Visual recreational use[9]
Industrial	Mining[9]	Mining	Mining[9]
Cultural and spiritual[6]	Cultural and spiritual[9]	Cultural and spiritual	Cultural and spiritual[9]

[2] https://environment.des.qld.gov.au/__data/assets/pdf_file/0029/86663/factsheet-evs-wqos-epp-water.pdf

[3] Adjacent sites include GPA2, GPA4, GPA5 and GPA6. Although GPA2 is upstream of the causeway and the Mill Creek Dam release point, this site is likely to have been impacted by mining activities. This is likely due to backflow (Wood (1996) notes backflow occurs about 40 m upstream of the causeway – GPA2 to approximately 120 m upstream of the causeway) and/or pooling of mine-affected waters upstream of the causeway.

[4] The listed environmental values are subject to research and consultation with the administering authority and, as required, other stakeholders. Indications suggest the end of the mixing zone is nearer to 1 km downstream of the confluence of Greenstone Creek with Gunpowder Creek (NRA, 2016).

[5] ANZG (2018) defines the mixing zone as an explicit area around effluent discharges where the management goals of the ambient waters do not need to be achieved and hence designated EVs may not be applied. The mixing zone for Greenstone Creek is considered to be from the confluence with Magazine Creek downstream to the confluence with Gunpowder Creek. The mixing zone for Gunpowder Creek is considered to extend from around the causeway to a point downstream of the confluence with Greenstone Creek. Impacts within this zone have occurred since the early 1970s, with seepage from the Old (Mammoth) TSF and contaminated flows into Gunpowder Creek via Mill Creek. It is not considered appropriate to assign aquatic ecosystem EVs in the context of regulatory compliance (although it is appropriate to derive relevant guidelines to serve as trigger values) to the Gunpowder Creek and Greenstone Creek mixing zones.

[6] Although cultural and spiritual values have been assigned, no specific WQOs/SQOs have been nominated for these values.

6.2 Water Quality Objectives

WQOs are long-term goals for water quality management. They are measures, levels or narrative statements of indicators of water quality that protect EVs. They define what the water quality should be to protect the EVs—after consideration of the socio-economic assessment of protecting the water quality[7].

The EA sets out trigger levels and contaminant limits for groundwater water monitoring, shown in Table 6.2.

TABLE 6.2: SCHEDULE C – TABLE 6 (GROUNDWATER TRIGGER LEVELS AND CONTAMINANT LIMITS)

Parameter*	Trigger Level (µg/L unless otherwise specified)	Contaminant Limit (mg/L unless otherwise specified)
pH (pH units)	6.0 – 8.5	
EC (µS/cm)	435	1,000
Sulphate (SO_4^{2-})	80th percentile[1] of reference bore level[2] or 250 mg/L, whichever is higher	95th percentile[1] of reference bore[2] concentration[3] or 1,000, whichever is lower
Fluoride (F^-)	80th percentile[1] of reference bore concentration[2]	2
Major cations	For interpretive purposes only	
Major anions	For interpretive purposes only	
Aluminium	80th percentile[1] of reference bore[2] concentration[3] or 55, whichever is higher	95th percentile[1] of reference bore[2] concentration[3] or 5, whichever is lower
Arsenic[4]	80th percentile[1] of reference bore[2] concentration[3] or 13, whichever is higher	95th percentile[1] of reference bore[2] concentration[3] or 0.5, whichever is lower
Boron	80th percentile[1] of reference bore[2] concentration[3] or 370, whichever is higher	95th percentile[1] of reference bore[2] concentration[3] or 5, whichever is lower
Cadmium	80th percentile[1] of reference bore[2] concentration[3] or 0.2, whichever is higher	95th percentile[1] of reference bore[2] concentration[3] or 0.01, whichever is lower
Chromium[4]	80th percentile[1] of reference bore[2] concentration[3] or 1.0, whichever is higher	95th percentile[1] of reference bore[2] concentration[3] or 1, whichever is lower
Cobalt	80th percentile[1] of reference bore[2] concentration[3]	95th percentile[1] of reference bore[2] concentration[3] or 1, whichever is lower
Copper	80th percentile[1] of reference bore[2] concentration[3] or 1.4, whichever is higher	95th percentile[1] of reference bore[2] concentration[3] or 1, whichever is lower
Lead	80th percentile[1] of reference bore[2] concentration[3] or 3.4, whichever is higher	95th percentile[1] of reference bore[2] concentration[3] or 0.01, whichever is lower
Manganese	80th percentile[1] of reference bore[2] concentration[3] or 1900, whichever is higher	95th percentile[1] of reference bore[2] concentration[3]
Nickel	80th percentile[1] of reference bore[2] concentration[3] or 11, whichever is higher	95th percentile[1] of reference bore[2] concentration[3] or 1, whichever is lower
Uranium	80th percentile[1] of reference bore[2] concentration[3]	95th percentile[1] of reference bore[2] concentration[3] or 0.2, whichever is lower
Zinc	80th percentile[1] of reference bore[2] concentration[3] or 8.0	95th percentile[1] of reference bore[2] concentration[3] or 20, whichever is lower
Total Hardness	**For interpretive purposes only**	

[1] Must be determined in accordance with QWQG (2009) and ANZECC (2000) methodology.

[7] https://environment.des.qld.gov.au/__data/assets/pdf_file/0029/86663/factsheet-evs-wqos-epp-water.pdf

[2] Reference bores are specified in Schedule C - Table 5 (Groundwater Monitoring Locations and Frequency).

[3] Where the 80th/95th percentile of a groundwater trigger level/contaminant limit is exceeded for a compliance bore and the reference bore also exceeds this concentration during the same sampling event, the value of the reference bore applies as the groundwater trigger level/contaminant limit for that sampling event.

[4] Site specific trigger levels and contaminant limits for groundwater (80th and 95th percentile of reference site concentration) must be calculated in accordance with QWQG (2009) and ANZECC (2000) methodology if sufficient monitoring data is available. The environmental authority holder must maintain a database documenting all relevant groundwater monitoring data and calculation of 80th/95th percentiles adopted as groundwater trigger levels and contaminant limits.

*Note: The holder may provide the administering authority with a report to enable the review of specified parameters and contaminant limits for protection of environmental values of receiving waters and their applicability.

80th and 95th percentile values calculated in the 2023 Annual Groundwater report have been applied to the most recent groundwater results to allow for interpretation of groundwater quality. The resulting trigger levels and contaminant limits are presented in Table 6.3.

TABLE 6.3: TRIGGER VALUES AND COMPLIANCE LIMITS FOR 2023

Parameter	Trigger Level (EA TL)	80th Percentile	Contaminant Limit (EA CL)	95th Percentile	Trigger Level	Source	Contaminant Limit	Source
pH	6.0-8.5				6.0-8.5			EA
Electrical Conductivity (µS/cm)	435		1000		435	EA	1000	EA
Sulfate SO_4 (mg/L)	250	36	1000	51.95	250	EA	250	EA TL %
Fluoride (mg/L)	80th percentile	0.3	2	0.4	0.3	80th %	2	EA
Dissolved Aluminium (mg/L)	0.055	0.04	5	0.0475	0.055	EA	0.055	EA TL %
Total Aluminium (mg/L)	0.055	0.668	5	4.226	0.662	80th %	4.226	95th %
Dissolved Arsenic (mg/L)	0.013	0.002	0.5	0.002	0.013	EA	0.013	EA TL %
Total Arsenic (mg/L)	0.013	0.008	0.5	0.026	0.013	EA	0.026	95th %
Dissolved Boron (mg/L)	0.37	0.06	5	0.06	0.37	EA	0.37	EA TL %
Total Boron (mg/L)	0.37	0.06	5	0.06	0.37	EA	0.37	EA TL %
Dissolved Cadmium (mg/L)	0.0002	0.00016	0.01	0.00034	0.0002	EA	0.00034	EA TL %
Total Cadmium (mg/L)	0.0002	0.0003	0.01	0.00045	0.0002	EA	0.00045	95th %
Dissolved Chromium (mg/L)	0.001	0.001	1	0.001	0.001	EA	0.001	95th %
Total Chromium (mg/L)	0.001	0.0104	1	0.036	0.0104	80th %	0.036	95th %
Dissolved Cobalt (mg/L)	80th percentile	0.006	1	0.0202	0.006	80th %	0.0202	95th %

Parameter	Trigger Level (EA TL)	80th Percentile	Contaminant Limit (EA CL)	95th Percentile	Trigger Level	Source	Contaminant Limit	Source
Total Cobalt (mg/L)	80th percentile	0.0124	1	0.031	0.0124	80th %	0.031	95th %
Dissolved Copper (mg/L)	0.0014	0.058	1	0.1861	0.058	80th %	0.1861	95th %
Total Copper (mg/L)	0.0014	0.1968	1	0.439	0.1968	80th %	0.439	95th %
Dissolved Lead (mg/L)	0.0034	0.001	0.01	0.001	0.0034	EA	0.0034	EA TL %
Total Lead (mg/L)	0.0034	0.0044	0.01	0.0175	0.0044	EA	0.0175	95th %
Dissolved Manganese (mg/L)	1.9	0.4172	None	0.6037	1.9	EA	1.9	EA TL %
Total Manganese (mg/L)	1.9	0.8794	None	2.02	1.9	EA	2.02	95th %
Dissolved Nickel (mg/L)	0.011	0.003	1	0.009	0.011	EA	0.011	EA TL %
Total Nickel (mg/L)	0.011	0.01	1	0.0255	0.011	EA	0.0255	95th %
Dissolved Uranium (mg/L)	80th percentile	0.002	0.2	0.002	0.002	80th %	0.002	95th %
Total Uranium (mg/L)	80th percentile	0.002	0.2	0.0027	0.002	80th %	0.0027	95th %
Dissolved Zinc (mg/L)	0.008	0.0446	20	0.1305	0.0446	80th %	0.1305	95th %
Total Zinc (mg/L)	0.008	0.051	20	0.1161	0.051	80th %	0.1161	95th %

6.3 Groundwater Quality

Groundwater quality data is available from the following newly installed bores (refer to Figure 5.2):

- GWMB80, located west and upgradient of TSF3 and downgradient of HLEP2, sampled 12 times between 12/02/24 and 12/01/25.
- GWMB81, located upgradient of TSF3 and outside of any impact from site operations, sampled three (3) times between 22/04/24 and 21/08/24.
- GWMB82, located east of TSF3 and the indicative receiver of any potential impact from TSF3, sampled 12 times between 12/02/24 and 12/01/25.
- GWMB77, located north of TSF3, east of EPit and downgradient of HLEP2, sampled six (6) times between February 2024 and January 2025.
- GWMB78, located northwest of TSF3, targeted to the geophysics mapped fracture, measured nine (9) times between May and December 2024 and reported as either dry or with not enough water to sample in each event.
- GWMB79 located north of TSF 3 and northwest of the EWRD, measured eight (8) times between April and December 2024 and reported as dry in each event.

Surface water quality data (n=4) obtained from the existing ETSF between 13/01/24 and 21/12/24 has been reviewed to understand the representative water quality within the existing Esperanza tailings storage facility on site.

The water monitoring data from the newly installed wells and surface water from the ETSF is presented in Table 6.4 compared to the 2023 EA groundwater trigger and contaminant limits. The results indicate naturally elevated metals concentrations for Aluminium (Al), Cadmium (Cd), Cobalt (Co), Copper (Cu), Lead (Pb), Manganese (Mn), Uranium (U) and Zinc (Zn) in the GWMB81 reference bore.

Elevated total metals concentrations above the EA contaminant level for Al, Pb, Mn and Zn. Metals above EA trigger limits for Cd, Co, Cu and U, along with elevated dissolved Co and Mn in the upgradient reference bore GWMB81.

GWMB80 (west of TSF3) reports elevated electrical conductivity (EC), Sulphate, Fluoride and total metals above the EA trigger limits (Al, As, Co, Pb, Mn, Ni, U and Zn) and elevated dissolved metals (As, Co, Mn and Zn).

GWMB82 (east of TSF3) reports elevated EC, sulphate, dissolved Cr, total and dissolved Mn and total and dissolved U above the EA contaminant limits. Fluoride, total metals (Al) and dissolved metals (Co and Zn) in exceedance of the EA trigger limits. This indicates the presence of mine affected groundwater at this location, likely from HLEP2.

GWMB77 (downstream of TSF3) reports average concentrations of EC, Sulphate, total metals (Al, As, Cd, Co, Cu, Mn, Ni, U and Zn) and dissolved metals (Al, Cd, Co, Cu, Mn, Ni, U and Zn) in exceedance of the EA groundwater contaminant limits. Trigger limit exceedances are reported for pH, Fluoride and total Pb.

ETSF water quality reports EC, Sulphate, elevated metals Al, Cd, Co, Cu, Mn, Ni, U and Zn (total and dissolved) and dissolved Cr in exceedance of the EA contaminant limits. Average concentrations of fluoride and total metals (Al, As, Cd, Cr, Mn, Ni and Zn) and dissolved metals (Al, Cd, Cr, Mn, Ni, and Zn) in exceedance of the EA trigger limits.

The recent monitoring results from GWMB77 indicate that there is potential for influence from the pre-mining alignment of the UEV that was heavily modified with the construction of the EWRD. This is indicative of potential transport of contaminants through the former alignment of the waterway. As seen in Figure 6.1, groundwater bore locations GWMB76 and GWMB77 align with the former alignment of the lowest elevations and the assumed alignment of the former drainage line that was present prior to the construction of the EWRD. This may be indicative of a preferential pathway for groundwater.

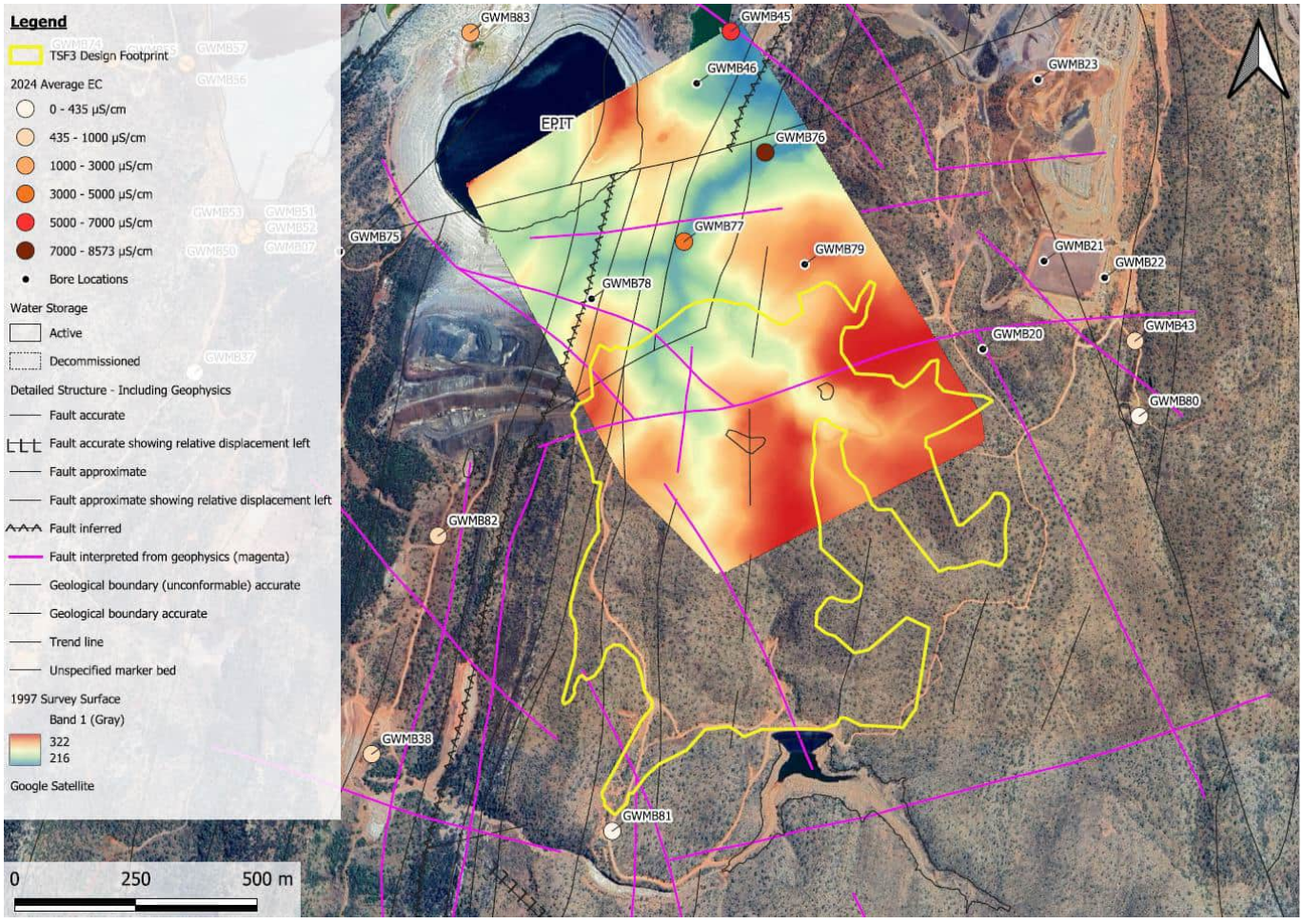


Figure 6.1: TSF3 Groundwater EC Concentrations

TABLE 6.4: GROUNDWATER MAXIMUM REPORTED CONCENTRATIONS

Sample Detail	EA trigger limit*	EA Contaminant limit*	GWMB80 (n=12 12/2/24-12/1/25) West of TSF3			GWMB81 (n=3 22/4/24 – 21/8/24) Upgradient of TSF3 - REFERENCE			GWMB82 (n=10 28/3/24 – 12/1/25) East of TSF3			ETSF (n=4 13/1/24 – 21/12/24) Representative TSF Water			GWMB77 (n=6 10/2/24-12/1/25) Downstream of TSF3		
Analyte			Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
pH	6.0-8.5	6.0-8.5	7.05	7.8	7.269	6.27	7.03	6.65	7.01	7.36	7.183	NR	NR	NR	5.85	6.34	6.11
Electrical Conductivity (µS/cm)	435	1000	232	733	416.45	231	378	282.33	479	1620	838.3	2470	3950	3042.5	3820	7040	4966
Sulphate as SO4 (mg/L)	250	250	<1	95	19.33	5	10	6.66	3	789	172.6	1240	2930	1940	2880	5750	3960
Fluoride - Total (mg/L)	0.3	2	0.1	0.2	0.175	<0.1	0.1	0.033	0.2	0.3	0.23	0.2	0.9	0.425	0.4	0.7	0.53
Aluminium - Dissolved (mg/L)	0.055	0.055	<0.01	0.04	0.006	<0.01	0.01	0.0066	<0.01	0.05	0.015	0.08	10.2	5.08	0.03	0.16	0.0933
Aluminium - Total (mg/L)	0.662	4.226	0.01	4.16	1.213	6.07	9.38	7.716	0.01	0.7	0.154	0.39	18.3	7.59	6.96	65.2	44.74
Arsenic - Dissolved (mg/L)	0.013	0.013	<0.001	0.018	0.0094	0.003	0.006	0.0043	<0.001	0.011	0.0025	<0.001	0.005	0.002	<0.001	0.002	0.0013
Arsenic - Total (mg/L)	0.013	0.026	0.001	0.018	0.0099	0.006	0.01	0.0073	<0.001	0.012	0.003	0.003	0.019	0.01	0.027	0.061	0.0466
Boron - Dissolved (mg/L)	0.37	0.37	<0.05	0.14	0.039	<0.05	<0.05	<0.05	<0.05	0.09	0.014	<0.05	<0.05	<0.05	0.07	0.18	0.13
Boron - Total (mg/L)	0.37	0.37	<0.05	0.12	0.039	<0.05	<0.05	<0.05	<0.05	0.12	0.02	<0.05	0.06	0.015	0.08	0.2	0.133
Cadmium - Dissolved (mg/L)	0.0002	0.00034	<0.0001	<0.001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0012	0.00037	0.0005	0.0011	0.00075
Cadmium- Total (mg/L)	0.0002	0.00045	<0.0001	0.0001	0.000008	<0.0001	0.0004	0.00026	<0.0001	<0.0001	<0.0001	<0.0001	0.0023	0.00067	0.0005	0.0013	0.000816
Chromium - Dissolved (mg/L)	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	0.0005	<0.001	0.012	0.0055	<0.001	<0.001	<0.001
Chromium - Total (mg/L)	0.0104	0.036	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt - Dissolved (mg/L)	0.006	0.0202	0.001	0.014	0.0044	0.009	0.015	0.012	<0.001	0.015	0.0045	0.26	3.25	1.592	2.44	4.44	3.063
Cobalt - Total (mg/L)	0.0124	0.031	0.002	0.017	0.008	0.011	0.03	0.023	<0.001	0.012	0.0055	0.409	6.14	2.506	1.37	5	2.948
Copper - Dissolved (mg/L)	0.058	0.1861	<0.001	0.005	0.0004	<0.001	<0.001	<0.001	<0.001	0.007	0.0015	1.53	50.3	21.44	2.03	6.98	4.066
Copper - Total (mg/L)	0.1968	0.439	<0.001	0.073	0.0195	0.044	0.346	0.18	0.002	0.056	0.0194	2.45	96.2	34.39	5.34	16.5	11.046
Lead - Dissolved	0.0034	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.00025	<0.001	<0.001	<0.001
Lead - Total (mg/L)	0.0044	0.0175	<0.001	0.007	0.0024	0.005	0.018	0.013	<0.001	0.003	0.0003	<0.001	0.002	0.001	0.003	0.006	0.005
Manganese - Dissolved (mg/L)	1.9	1.9	0.574	3.39	1.982	0.946	3.96	2.48	0.061	2.03	1.0391	1.27	13.1	5.19	8.22	17	12.55
Manganese - Total (mg/L)	1.9	2.02	0.495	4.28	2.64	1.04	4.44	3.003	0.064	2.68	1.1145	1.99	23.5	8.46	6.31	22.4	12.096
Nickel - Dissolved (mg/L)	0.011	0.011	<0.001	0.006	0.0024	0.003	0.006	0.005	0.001	0.009	0.003	0.055	0.837	0.4102	0.424	0.951	0.6168
Nickel - Total (mg/L)	0.011	0.0255	0.003	0.012	0.0057	0.013	0.027	0.019	0.002	0.009	0.0044	0.087	1.57	0.632	0.382	1.07	0.6845
Uranium - Dissolved (mg/L)	0.002	0.002	<0.001	0.005	0.00141	<0.001	<0.001	<0.001	0.002	0.009	0.0052	<0.001	0.015	0.0065	0.004	0.034	0.0205
Uranium - Total (mg/L)	0.002	0.0027	<0.001	0.01	0.00208	<0.001	0.002	0.0013	0.003	0.011	0.007	<0.001	0.028	0.0105	0.012	0.103	0.0665
Zinc - Dissolved (mg/L)	0.0446	0.1305	<0.005	0.017	0.00458	<0.005	0.026	0.0116	<0.005	0.108	0.02	0.062	0.793	0.294	0.606	1.3	0.823
Zinc - Total (mg/L)	0.051	0.1161	<0.005	0.07	0.0298	0.04	0.154	0.0943	0.01	0.032	0.0169	0.101	1.46	0.486	0.526	1.51	0.9701

* 80th and 95th percentiles from the 2023 Annual Groundwater Report

NR – no results

7. POTENTIAL IMPACTS

7.1.1 TSF3 Potential Seepage Pathways

To assess for potential seepage pathways beneath the TSF3 embankments and through the TSF3 impoundment, geological faults (and inferred geological faults) identified by SGC were plotted against the boundary of the proposed TSF3 maximum tailings deposition extents (Engeny, 2025). The intersection of these faults with the maximum tailings deposition extents were used to inform the basis for mapping targets as these faults represent the most likely foundation seepage pathways through potentially broken or weathered rock.

Geological mapping was completed in these areas to identify structures (Engeny 2025, presented in Appendix B). Eight (8) target mapping areas were identified for this mapping program based on access constraints and fault type, as well as three (3) additional fault structures identified during the mapping program, presented in Figure 7.1 below.

The geological mapping (Engeny, 2025) concluded that:

- The upstream extents of the proposed TSF3 embankments and the TSF3 impoundment area is contained within Quartzite, quartzose sandstones and chert lithologies (belonging to the Whitworth Quartzite, Lochness Formation and Torpedo Creek Quartzite respectively). These rock units appear to be well cemented, have low porosity, are high strength and with tight or healed discontinuities (joints and faults). This indicates an overall low permeability (defect controlled or similar) and likely presents a low risk to seepage.
- Defined joint sets are noted within the Whitworth Quartzite are summarised as follows:
  - Bedding: 73° / 294.
  - Joint Set 1: 69° / 173.
  - Joint Set 2: 71° / 008.
  - Joint Set 3: 28° / 088.
- Geological structures (investigated through mapping targets 1-9) intersecting the TSF3 impoundment showed to have no surface expression and the discontinuities (joints and bedding) in these areas appear to remain unchanged from the typical descriptions described here-in. Generally, structures such as shear zones and faults would generally need to exhibit open jointing, a halo of weak and weathered material to allow for high hydraulic conductivity, which is not consistent with what was found during the mapping program.
- Some discrete areas of Breccia (at additional mapping target 11) were noted, however, were not wide-spread and appeared to be discontinuous in nature and do not present a material risk of seepage.
- The geological mapping program was expanded on site to areas outside of the TSF3 embankment and impoundment area (at additional mapping target 9) to better understand adjacent geological conditions in the Paradise Creek Formation. In general, these appears to be less favourable for the TSF3 location for the following reasons:
  - Higher degree of weathering and lower strength was noted, i.e. less competent materials.
  - Highly brecciated material and open fractures noted adjacent identified fault areas, (which is different to the TSF3 areas which showed no surface expression).
- Further mapping of this unit will be required during subsequent phases of design to confirm the hydrogeological characteristics of the materials at depth. Near surface weathering processes are likely to result in a more permeable horizon, which should improve (i.e become less permeable with depth). A baseline (sentinel) monitoring bore will be required in this unit, ideally drilled along, and through, one of the priority faults mapped as extending from the proposed TSF3 reservoir to the west.

Engeny (2025) recommended confirmatory drilling to be completed to intersect high angle beds and joint sets as much as possible to confirm low risk of seepage.

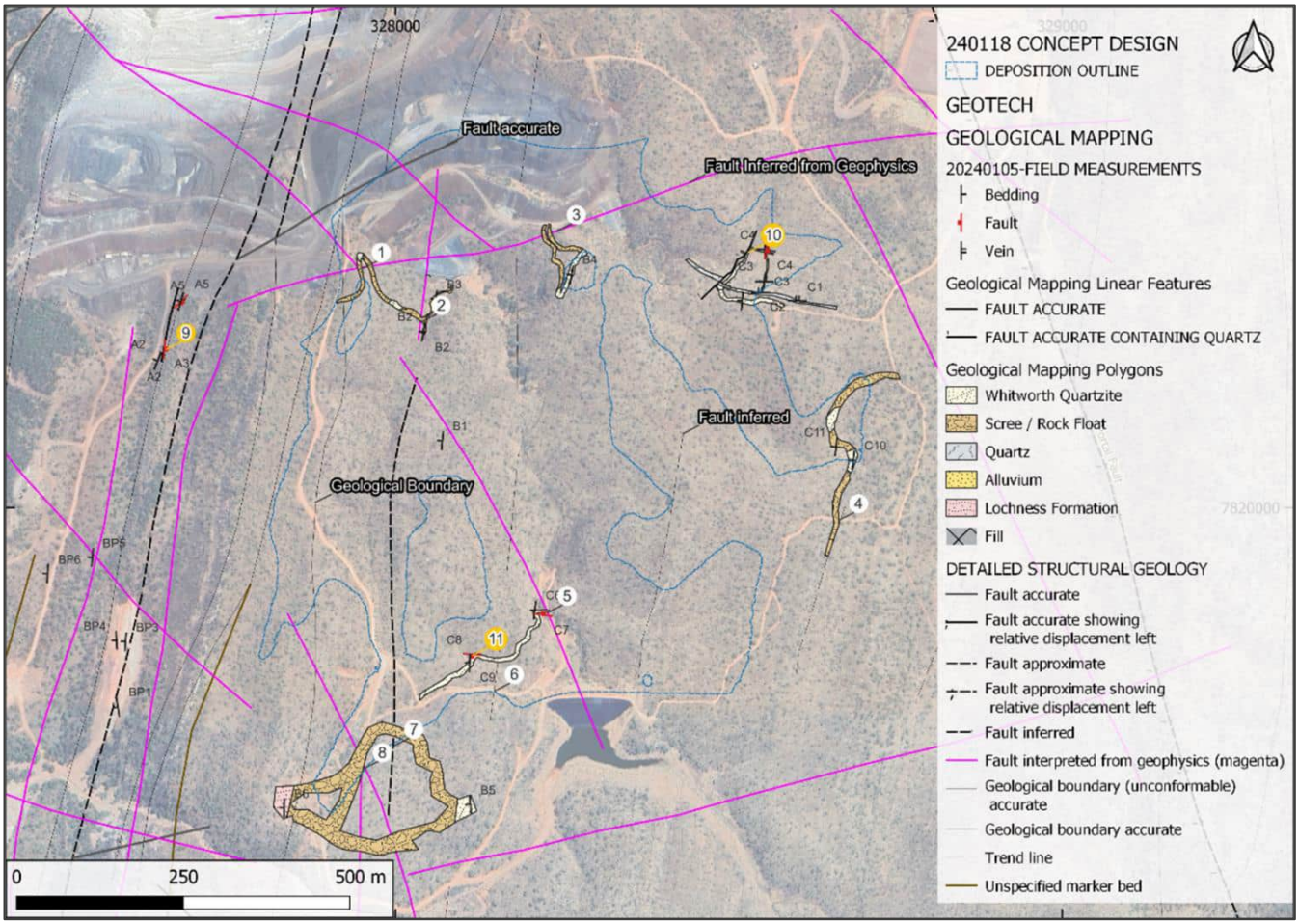


Figure 7.1: Completed Geological Mapping Areas

7.1.2 ATC Williams (2023b) SEEP/W Model

A two-dimensional (2D) model was developed in SEEP/W by ATC Williams (2023b) to estimate the potential seepage from the proposed TSF3. A northwest to southeast cross-section was selected to align with the groundwater flow-path from the UEV to the EPit (refer to Figure 7.2). The model developed by ATC Williams included a simplistic vertically orientated geological composition. The current condition model showed groundwater flowing to EPit. The ATC Williams (2023b) model was simulated with constant head of the UEV to the maximum design water level and no storage of tailings.

The assessment concluded that:

- The shallow aquifer within the extent of the UEV is not expected to be hydraulically connected to any other surficial aquifers at CCM.
- The geology underlying the extent of the UEV (the Whitworth Quartzite) is considered to have a low hydraulic conductivity. This is expected to limit the rate of groundwater movement away from the UEV.
- Groundwater contours indicate the groundwater flow is in the direction of EPit. Any seepage associated with water storage within the UEV is expected to ultimately discharge into the pit. As shown in Figure 7.2, any potential seepage through the UEV surrounding faults will also be intercepted by the pit. Seepage modelling indicates that the maximum level of water storage within the UEV is associated with an increase in seepage of approximately 0.7 m^3/day/m to EPit.

A copy of the ATCW,2023 SEEP/W report is included as Appendix C:.

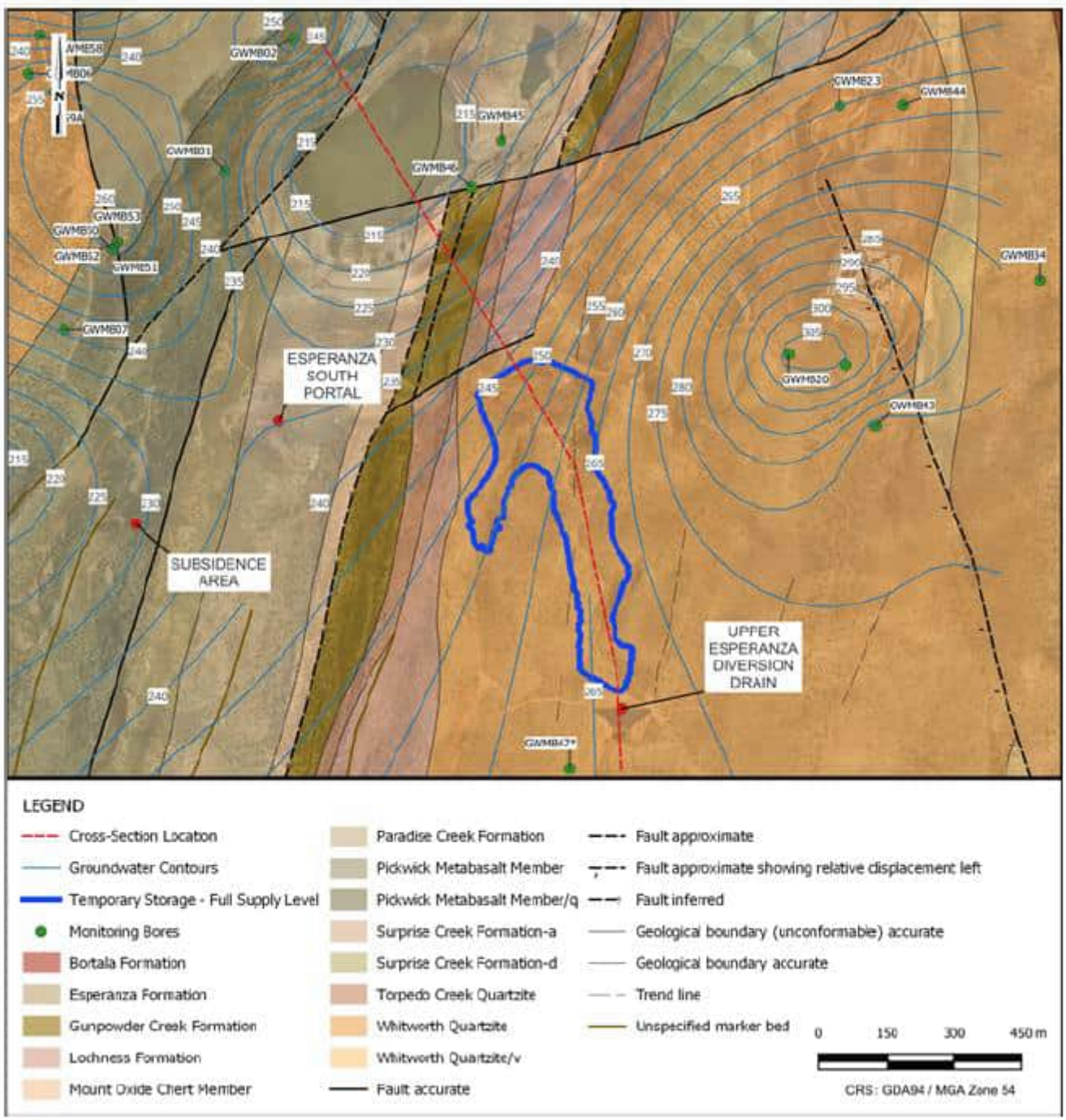


Figure 7.2: ATC Williams Model Cross-Section (Diagram 5, ATC Williams, 2023B)

7.1.3 Engeny (2024) SEEP/W Model

Engeny (2024a) developed a two-dimensional (2D) model in SEEP/W (GeoStudio 2023.1.2 version 23.1.2.11) as part of the preliminary design of the proposed tailings storage facility, TSF3. The purpose of the model was to estimate the extent of seepage impact to groundwater because of the proposed TSF3.

The modelling aimed to replicate and improve on a previous seepage study by ATC Williams (2023), developed to assess the seepage risk associated with a water storage for the same Upper Esperanza Valley that was proposed at the time.

Updates to the SEEP/W model included:

- Update of the geological structures (Engeny, 2024).
- Inclusion of tailings storage to the model.

- Inclusion of decant pond to the model.
- Inclusion of unsaturated flow in the model.
- Application of a seepage face along the north embankment to the Esperanza Pit (EPit).

The model cross section was selected to match that of the ATC Williams model, approximately southeast to northwest through the TSF3 footprint. This cross section was selected to align with the expected southeast to northwest groundwater flow-path from TSF3 to E Pit, which is considered to be a sink for TSF3 (ATCW, 2023). A decant pond will form above the tailings against the northern embankment. The orientation of the model cross-section in relation to the TSF3, E Pit and site geology is shown in Figure 7.3.

7.1.3.1 Model Parameters

Material parameters applied for the seepage modelling were obtained from the previous SEEP/W model (ATCW, 2023). Additions to the model include:

- The waste rock embankment will be covered by a low permeable geomembrane liner, nominally a High Density Polyethylene (HDPE) liner overlying a select fill cushion layer.
- Materials are simulated with unsaturated/saturated flow, allowing for variance of the water content in the materials which may affect the permeability and flow rate in the unsaturated area.
- The model assumes the hydraulic conductivity (K) of the faults decreases with depth, and therefore a low permeable fault material was assigned below 100m depth of the ground surface.

The SEEP/W model cross-section with boundary conditions is shown in Figure 7.4.

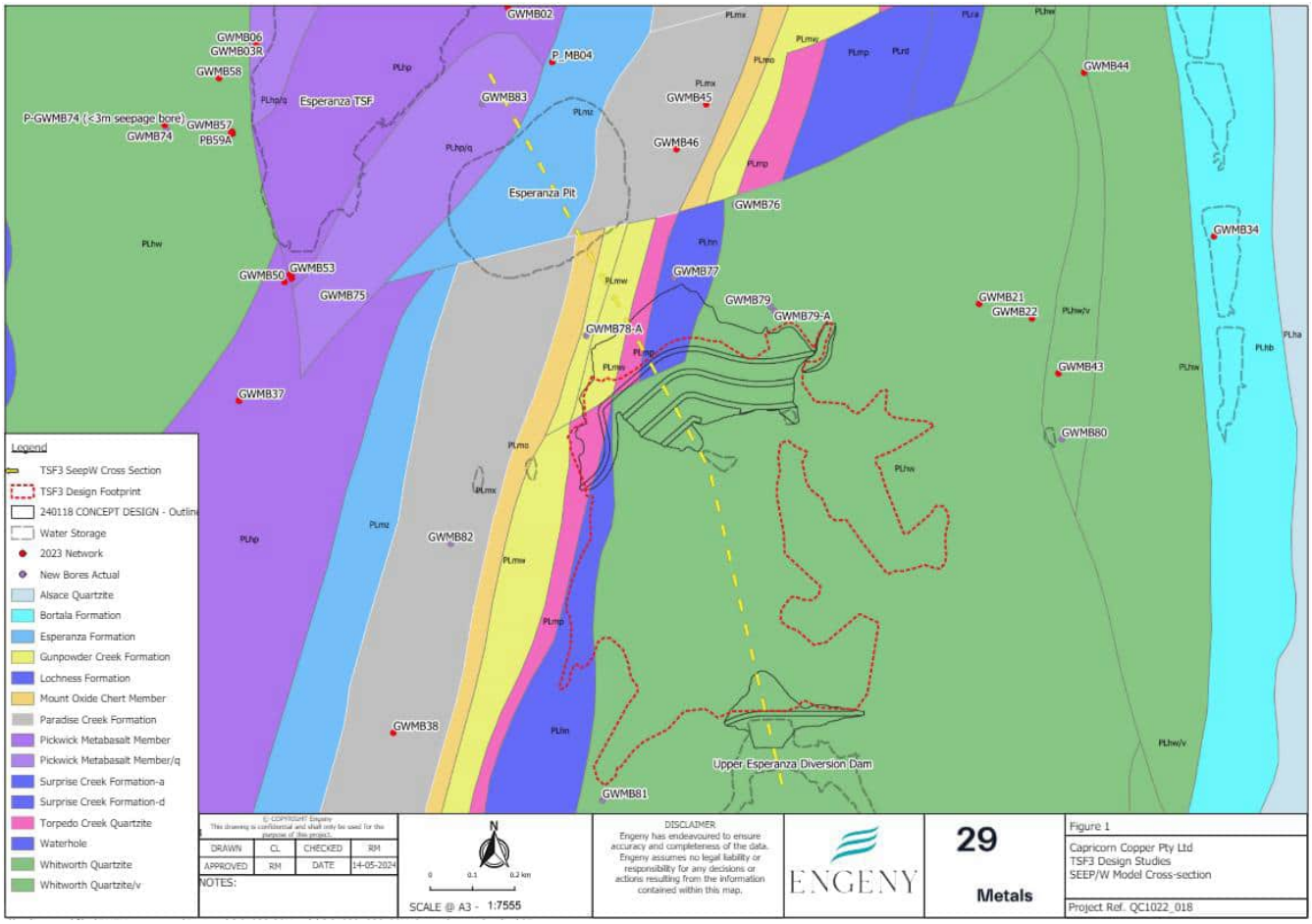


Figure 7.3: SEEP/W Model Cross Section

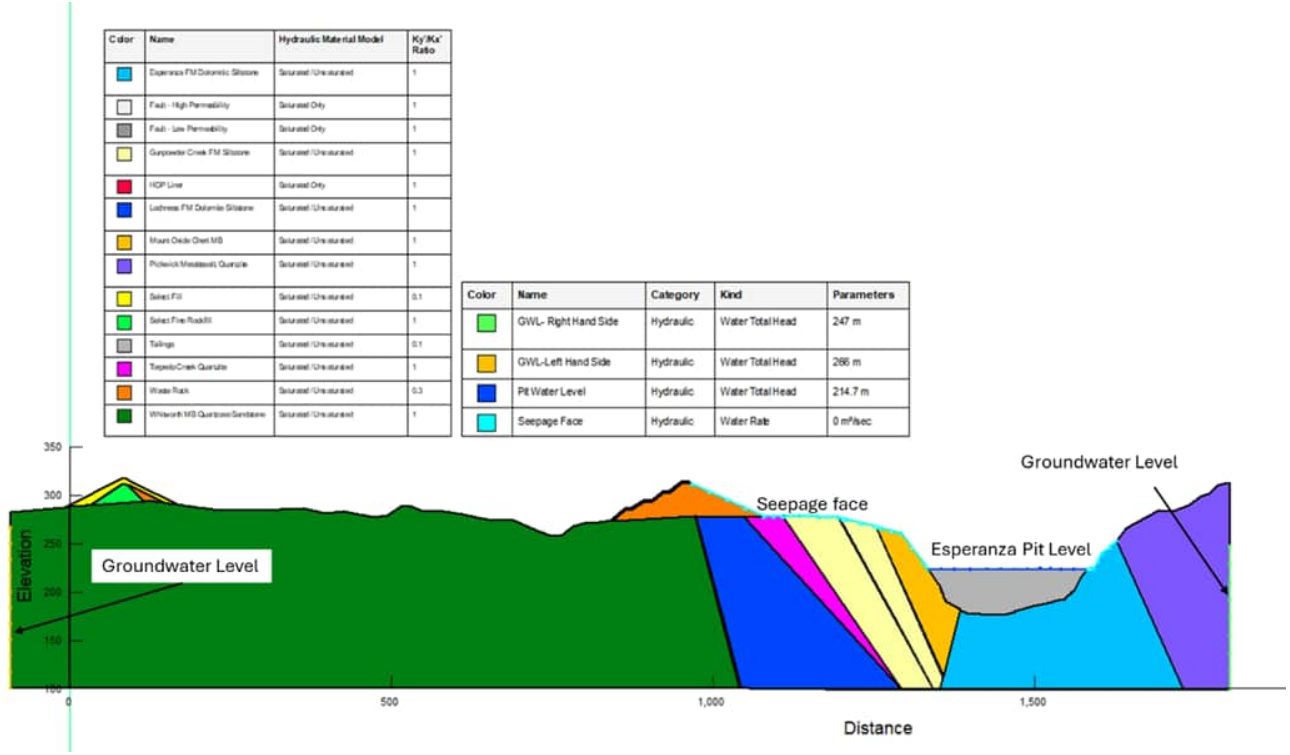


Figure 7.4: Model Cross-Section Base Case with Boundary Conditions

7.1.3.2 Model Scenarios

The base case scenario represents the area without tailings to indicate groundwater differences from ATCW model with updated geological data.

The model simulation contains two scenarios to estimate effect of tailings storage and a proposed HDP liner on seepage from TSF3.

- Scenario 1 assumes the tailings are placed directly on the waste rock embankment (no HDPE liner) with the decant pond at maximum normal operating level (Figure 7.6).
- Scenario 2 assumes Scenario 1 and includes a low permeability HDPE liner and select fill cushion layer added between the tailings and waste rock embankment. (Figure 7.7).

7.1.3.3 Base Case

The modelled natural groundwater table without tailings is shown in Figure 7.5. The groundwater depth ranges from approximately 34 to 55 m (RL 260 to 220 m) in the tailings area. The seepage rate to the Esperanza Pit is 0.01m^3/m/d. These results are consistent with the outputs from ACTW (2023), which concluded the water depth was from ~30 to 70m and rate was 0.01m^3/m/d.

7.1.3.4 Scenario 1: Without HDPE Liner

Without the HDPE liner, the water from decant pond flows into the waste rock embankment and remains a relatively shallow aquifer (~6 to 20m depth from the surface) along the downstream ground. The model shows the groundwater table could raise and diverge at location of x=500 m in the natural ground due to infiltration from the decant pond. At the divergence location, the water table is raised by 59 m (from RL 244 m in the base case to RL 303m) (Figure 7.6), indicating a potential change of the groundwater flow direction to the south as a result of the tailings storage. Seepage occurs at approximately RL 231 m in the wall of the open pit at a rate of 0.30m^3/d/m.

7.1.3.5 Scenario 2: With HDPE Liner

With the liner, the water from the decant pond enters into the groundwater through the bottom of the tailings. The result shows the flow diverges at the location of x=650 m (Figure 7.7). The divergence location moves further north compared with the non-liner case, indicating more water may flow southward. At this divergence location, the water table in the tailings storage area increases by 65 m from RL 239 m (in the base case) to RL 304 m and indicates a potential change of the groundwater flow direction to the south as a result of the tailings storage. The water table remains relatively high (RL 280 m), decreasing to RL 230 m near the fault due to the high permeability of the fault and Lochness FM Dolomite Siltstone. Seepage from the pit surface is reduced to 0.05m^3/d/m with the addition of a liner.

7.1.3.6 Predicted Water Rate

Water flow rate through selected sections is summarised in Table 7.1. With the construction of TSF3, groundwater flow to the Esperanza Pit will increase. Meanwhile, flow rates across the sections of fault and Esperanza Pit could be significantly decreased due to the installation of the HDPE liner. The total rate with liner was 12% of that without liner. The total amount of water rate is predicted to be 0.06 $m^3/d/m$ higher than the base case.

TABLE 7.1: PREDICTED WATER RATE

Scenario	Predicted Water Rate ($m^3/d/m$)		
	Fault	Esperanza Pit	Rate Difference
Base Case	0.001	0.01	N/A
Without Liner	0.31	0.30	0.59
With HDP Liner	0.02	0.05	0.06

The numerical modeling of the proposed TSF3 concluded that:

- The modelled groundwater table and flow rate in base case are similar to the results from previous ATCW (2023) model.
- The proposed TSF3 with decant pond is likely to result in increased seepage to E Pit and raising of groundwater levels from 20 to 50 m, (RL 240 to 270 m) between the EWRD and EPit, if constructed without a liner relative to the existing base case (no TSF3).
- Seepage will occur from the proposed TSF 3, through the EWRD to EPit at a predicted rate of 0.30 $m^3/d/m$, as modelled without a liner.
- The groundwater level could increase, and the direction may be changed southward with the development of tailings and decant pond. The water infiltrated from decant pond could form a divergence at the location of x = 500 m (Scenario 1) and 650 m (Scenario 2).
- Scenario 1 (no liner) shows a groundwater surface within the stored tailings at approximate RL 303 m, 59 m above the base case groundwater surface of RL 244 m at the divergent location.
- Scenario 2 (with liner) shows a groundwater surface within the stored tailings at approximate RL 304 m, 65 m above the base case groundwater surface of RL 239 m at the divergent location.
- Seepage is expected be reduced by 84% with the introduction of a liner at the interface with the EWRD relative to the no liner case.

It is noted that the divergent location indicates the potential for a change in groundwater flow across this area of the site which could potentially flow to the west that needs to be considered as part of the TSF3 design.

Recommendations for further works to inform a future model include:

- Confirm the assumed homogenous permeability of the Quartzose Sandstone that forms the foundation of TSF3 through confirmatory drilling.
- Confirm the assumed permeability of the faults within the model through installation of groundwater bores in the proposed footprint and conducting hydraulic testing.
- Confirm the existing as-constructed condition of the Upper Esperanza Diversion Dam (UEDD) and update the assumed permeability of the UEDD to determine the potential for groundwater flow to be altered.
- Confirm the constant head boundaries applied.
- Complete calibration of the model to include dewatering bores to account for any impact of dewatering activities including underground mining on groundwater levels.
- Complete modelling using additional cross-sections to include assessment of seepage through the Paradise Creek Formation on both sides of the current cross-section.
- Complete transient modelling to account for seasonal variation and recharge in groundwater levels.

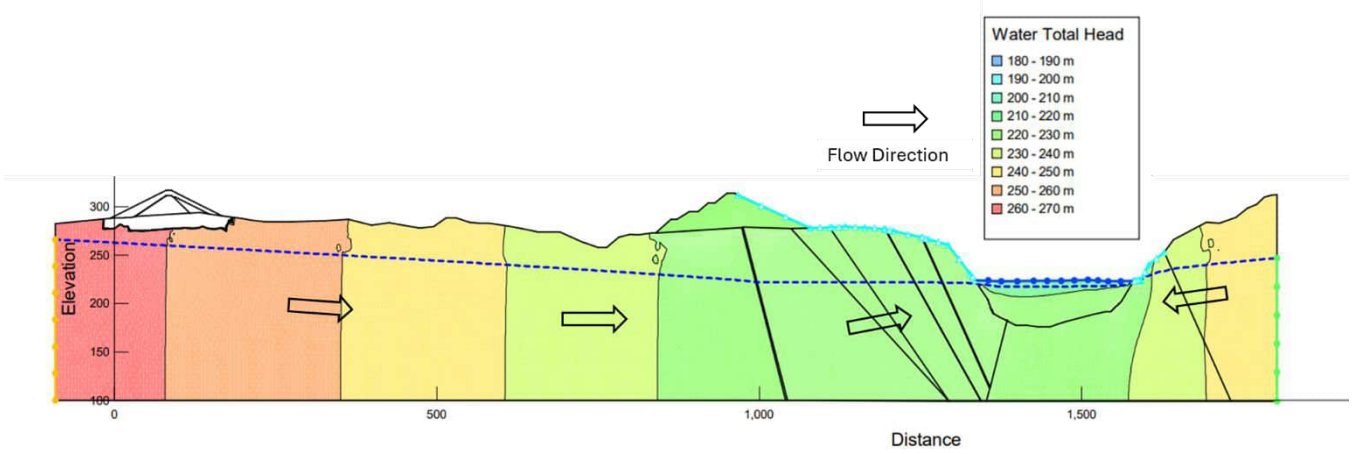


Figure 7.5: Water Table in The Downstream of TSF3 – Base Case

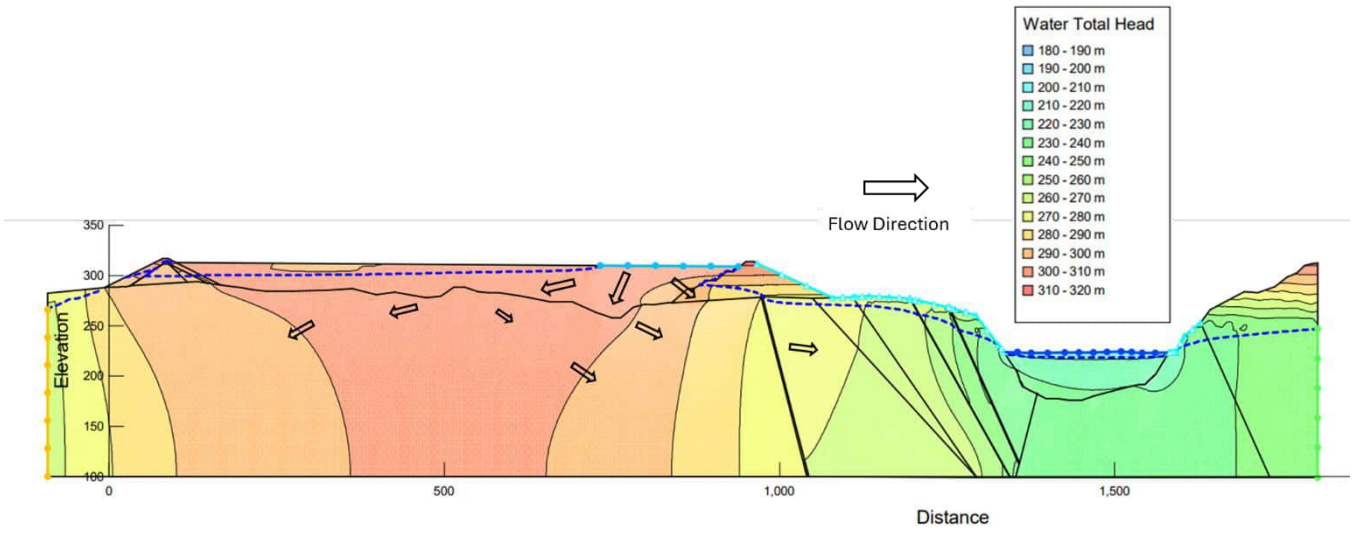


Figure 7.6: Water Table in the Downstream OF TSF3 – SCenario 1: Without Liner

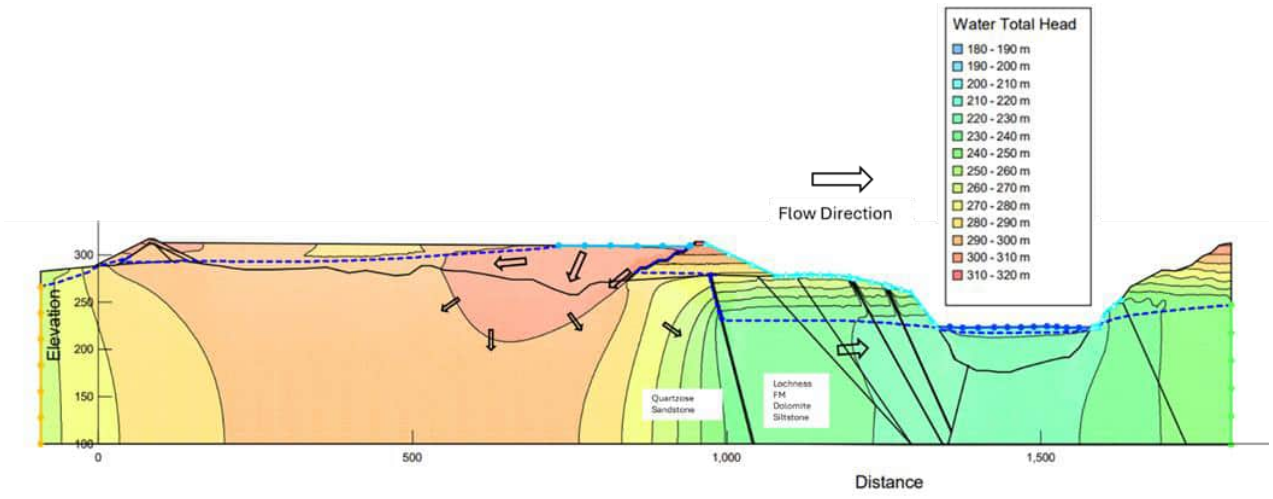


Figure 7.7: Water Table in the Downstream of TSF3 – Scenario 2: With HDPE Liner

7.2 Surface Water and Groundwater Interaction

Typical interaction between surface water and groundwater at CCM is assumed to be limited to the percolation of surface water to the shallow alluvial aquifer (where present) on the site. Seepage of groundwater expressed in the surface water of Gunpowder Creek has previously been identified within the wider CCM site, however, no evidence of surface water and groundwater interaction has been identified in the vicinity of the proposed TSF3.

The proposed TSF3 is located within a mapped watercourse line (refer to Figure 3.2), which has been modified with the construction of the UEDD to not receive surface water from upstream sources. It is assumed that there is significant potential for surface water and near surface groundwater interaction within this mapped drainage feature.

Hydrobiology (2024) assesses the potential for surface water and groundwater interaction based on the ionic composition of samples obtained in 2024 and report that ground and surface water interaction is not suspected at Gunpowder Creek or Greenstone Creek, based on the piper diagram analysis completed. There appeared to be surface and groundwater interaction within Magazine Creek at test site MGA1 (Hydrobiology, 2024).

There are no REMP monitoring locations in the vicinity of the proposed TSF3, therefore the risk of surface water connectivity to groundwater proximal to TSF3 has not been assessed to date. As the UEV was an existing waterway prior to construction of the EWRD and UEDD, connectivity of surface water to groundwater is considered possible. It is however noted that the construction of the UEDD including the external HDPE liner and grout curtain, and the Plunge Pool HDPE liners and grout curtains have likely intercepted this surficial connectivity of surface water to groundwater.

7.2.1 Historical Seepage

The Esperanza Tailings Storage Facility (ETSF) has been identified as a previous seepage source at CCM. Groundwater modelling previously completed for ETSF (Engeny, 2023b) indicates that the main control on infiltration and seepage from the ETSF is the level of the pond on the ETSF and interception of seepage at the NWRD sump. A higher pond level leads to a higher contact surface for infiltration and higher levels of saturation in the ETSF; hence a low (minimum) pond level is crucial to maintaining hydraulic conditions in the ETSF so that seepage cannot occur through the shallow, weathered and fractured shallow lithologies, while also reducing seepage underneath the northern embankment (Engeny, 2023b).

Increased levels of seepage from ETSF have been associated with:

- Low tailings density, high rates of water retention and utilisation of the ETSF for water management (storage) which led to significant ponding of surface water. With the cessation of mining in EPit in 2005, water storage was moved to EPit, beaching practices improved, and seepage rates reduced.
- The earlier low tailings density achieved resulted in significant volumes of water entrained in tailings which resulted in significant seepage developing following raises in 2009/2010 and 2011/2012. These raising periods included construction of seepage collection systems at Saddle Dams 2 and 3 and at NWRD and significantly improved beaching practices resulting in high density tailings and the entrainment of significantly less water within tailings.
- During 2018-2019 ETSF was used for water storage to achieve enhanced evaporation. This was found to cause a significant increase in seepage intercepted in NWRD Sump and the practice was subsequently ceased (GHD, 2021a).

Potential seepage from ETSF is currently managed within the mine water management system and the addition of TSF3 is not expected to impact seepage rates to Gunpowder Creek.

8. LIMITED GROUNDWATER IMPACT ASSESSMENT

8.1 Groundwater Flow

A water balance assessment (Engeny, 2025) has shown that the proposed TSF3 does not increase the likelihood of uncontrolled discharges of mine affected water to Gunpowder Creek; hence the proposed TSF3 is not anticipated to impact surface water flow (quantity and quality) in Gunpowder Creek.

Groundwater modelling indicates that the main control on infiltration and seepage from TSF3 is the installation of a HDPE liner. The liner is required to limit the infiltration of groundwater through the EWRD to EPit.

Modelling assumes the base of the proposed TSF3 has a low hydraulic conductivity, however, modelling indicates that there may be a change to groundwater flow as a result of the proposed TSF3 through the creation of a groundwater divide. However, it is noted that the geological mapping has recommended confirmatory drilling into identified risk areas where brecciated material was noted in the field investigation to confirm low risk of seepage.

8.2 Water Quality

Groundwater monitoring of reference bore GWMB81 in the vicinity of the proposed TSF3 indicates elevated concentrations of Cd, Co, Cu, Pb, Ni, U and Zn in exceedance of EA groundwater trigger levels and Al and Mn in exceedance of EA groundwater contaminant limits. This indicates elevated natural background concentrations of Al, Cd, Co, Cu, Pb, Mn, U and Zn within the Whitworth Quartzite geological unit.

Hydrobiology (2024) assesses the potential for surface water and groundwater interaction based on the ionic composition of samples obtained in 2024 and report that ground and surface water interaction is not suspected at Gunpowder Creek or Greenstone Creek, based on the piper diagram analysis completed. There appeared to be surface and groundwater interaction within Magazine Creek at test site MGA1 (Hydrobiology, 2024). There are no REMP monitoring locations in the vicinity of the proposed TSF3, therefore the risk of surface water connectivity to groundwater proximal to TSF3 has not been assessed to date. As the UEV was an existing waterway prior to construction of the EWRD and UEDD, connectivity of surface water to groundwater is considered possible. It is however noted that the construction of the UEDD including the external HDPE liner and grout curtain and the Plunge Pool HDPE liners and grout curtains have likely intercepted this surficial connectivity of surface water to groundwater.

Groundwater quality is not expected to be severely impacted by the proposed TSF3, provided the liner is installed and the base of the structure is demonstrated to have low hydraulic conductivity. Any overflows from the proposed TSF3 are designed to flow into the existing mine water management system and are not expected to impact groundwater quality.

Historical mining activity has impacted groundwater and surface water quality in Gunpowder Creek over the life of the mine; however, the impacts on Gunpowder Creek will not increase as a result of the proposed TSF3. Previously noted impacts to Gunpowder Creek have been attributed to seepage from water stored in ETSF, which are currently managed within the mine water management system.

The data analysis for surface water quality completed by (Engeny, 2023) indicated that for Gunpowder Creek:

- pH is stable or increasing.
- Sulfate is decreasing upstream and has no trend at the site or downstream.
- Electrical Conductivity is stable.
- Copper concentrations are decreasing at the site and downstream locations.

Therefore, it is considered the amendments to site operations and seepage management implemented by CCM have positively impacted on the water quality of Gunpowder Creek since 29M took over operations in 2017. This is supported by REMP monitoring data (Hydrobiology, 2023) and (Hydrobiology, 2024), where macroinvertebrate communities were either similar or more diverse between treatments despite elevated metal/metalloid concentrations observed within sediment and water samples. Overall, the trends displayed in the previous two REMP periods do not indicate any notable impact from CCM operations to the environmental values (EVs) (human use - livestock drinking and recreational aesthetics; and aquatic ecosystems) of the receiving environment.

8.3 Impact to Downstream Users

Based on a review of the site data, the predicted increase in seepage rates to EPit and the seepage management systems in place at the CCM site, no additional discharge of mine affected water will be required to Gunpowder Creek because of the proposed TSF3. Therefore, TSF3 will have no additional impact on downstream users.

8.4 Impacts on Environmental Values

Environmental values (EVs) assigned for Gunpowder Creek include aquatic ecosystems, primary industry, recreational and cultural and spiritual values, with identified uses of primary industries (livestock drinking water) and mining. Recreational uses have been identified as visual recreational use, with the area downstream of the mine identified as secondary recreational use.

Aquatic Ecosystems: The data reviewed indicated that the mine activities in the REMP monitoring period have not impacted the aquatic ecology in Gunpowder Creek, despite exceedances in the WQOs for the REMP. The proposed TSF3 is not expected to impact the existing authorised discharges from the site, and no risk of overtopping external to the existing mine water management system is expected with the proposed design.

Primary Industry: The recent water quality parameters analysed are all within livestock drinking water recommended trigger values for copper and total dissolved solids.

Recreational uses and cultural and spiritual values: are assumed to be protected through the continued assessment against the WQO and protection of aquatic ecosystem EV.

The site data provided indicates that any works associated with the proposed TSF3 will not impact the receiving environment and with due consideration of the provided site data and the REMP (Hydrobiology, 2023), it is considered that the proposed TSF3 will have no additional impact on environmental values.

9. RISK ASSESSMENT

An environmental risk assessment was undertaken for the proposed TSF3 in relation to potential impacts on surface and groundwater resources. Using the information presented in this document, and the likelihood of occurrence and consequence criteria (Table 9.1 and Table 9.2), the significance of the risks was identified using Table 9.3. This approach is consistent with AS/NZS ISO 31000:2018 Risk Management – Principles and Guidelines. The significance of the risks is described below:

- Extreme significance: a significant risk with a high likelihood of impact which is considered unacceptable or intolerable and may be irreversible or persistent.
- High significance: a significant risk with a high likelihood of impact which is considered unacceptable or intolerable and is contained on the mining lease or reversible.
- Medium significance: a level of risk which is not acceptable with moderate severity with impacts persisting over time that can be mitigated.
- Low significance: the risk is low with any impacts, short in duration and reversible.

TABLE 9.1: LIKELIHOOD CRITERIA

Rank	Likelihood	Description
A	Almost Certain	A common event that is likely to occur in the industry many times per year
B	Likely	An event likely to occur more than once a year in the industry
C	Possible	An event that may occur in the industry over 10 years
D	Unlikely	An event not likely to occur in the industry over 10 years
E	Rare	An event that has not previously been experienced in the industry but may occur in exceptional circumstances

TABLE 9.2: CONSEQUENCE CRITERIA

Consequence	Description
1-Minor	Minimal impact on ecosystem; contained on mining lease, and/or reversible in one shift
2-Low	Moderate impact on ecosystem; contained on mining lease, and/or reversible in 1 to 5 years
3-Moderate	Significant impact on ecosystem; impact contained on mining lease, and /or reversible in ~10 years
4-Major	Significant harm or irreversible impact (for example to World Heritage area); widespread, catchment area, long term, greater than 10 years
5-Catastrophic	Significant harm or irreversible impact on high value receptors or environmental values (for example to World Heritage area); widespread, long term

TABLE 9.3: RISK MATRIX

Consequence	1-Minor	2-Low	3-Moderate	4-Major	5-Catastrophic
Likelihood					
A-Almost Certain	Medium	High	High	Extreme	Extreme
B-Likely	Medium	Medium	High	High	Extreme
C-Possible	Low	Medium	Medium	High	High
D-Unlikely	Low	Low	Medium	Medium	High
E-Rare	Low	Low	Low	Medium	High

As summarised in Table 9.4 below, risks to both surface water and groundwater flow and quality have been identified as a result of the proposed TSF3:

- Groundwater Dependent Ecosystems are mapped as present within and surrounding the TSF3 footprint.
- The former alignment of the drainage line observed in the 1997 survey for the EWRD indicates the potential for a preferential pathway to exist that connects the TSF3 footprint to MCD.
- No uncontrolled discharges are expected from the CCM WMS resulting from TSF3 and consequently no changes are expected to the existing surface water flow regime in Gunpowder Creek.
- Predicted rates of seepage flow to groundwater as a result of TSF3 is reduced from 0.30m³/d/m to 0.05m³/d/m with the addition of a liner.
- Seepage modelling predicts a groundwater divide created as a result of tailings storage in the proposed TSF3. There is potential for increased flooding to the ESS underground mine west of TSF3 as a result of a groundwater changes to groundwater flow.
- Inspection of the proposed TSF3 has not indicated potential for seepage within the TSF3 footprint, however, due to the inconsistency of material observed, additional studies are recommended to confirm the assumed low permeability of the base of TSF3.

The risk assessment has identified an overall medium risk for TSF 3 until the assumptions regarding the permeability of the TSF3 base can be confirmed and 3D groundwater modelling confirms the absence of the predicted groundwater divide.

TABLE 9.4: RISK OF POTENTIAL SURFACE WATER AND GROUNDWATER IMPACTS

Environmental Value	Risk Event	Consequence	Likelihood	Residual Risk	Justification and Control
Surface Water	Changes to the existing flow regime (including reduction in baseflow) in Gunpowder Creek	1 - Minor	E - Rare	Low	TSF3 is not expected to result in any change to the existing flow regime in Gunpowder Creek, and no overflow events from the integrated containment system up to the P99 event.
	Reduction in water quality resulting from increased seepage expression in Gunpowder Creek	2 - Low	E - Rare	Low	TSF3 is not expected to result in any increase in seepage flow to Gunpowder Creek and is considered to have negligible impact on flow.
	Uncontrolled slow and long-term release of low pH, sulfate and metal laden water into receiving environment	3 - Moderate	D - Unlikely	Medium	Proposed seepage controls (Grout curtain and liner) are expected to manage any major seepage from TSF3. EPit will be the major receiving environment for any seepage resulting from TSF3. REMP data indicates impacts to receiving environment and macroinvertebrate health are not increasing. Confirmation of the permeability of the base of the TSF is recommended.
Groundwater Dependent Ecosystem (GDEs)	Impacting groundwater levels and/or discharge of low pH and metal contaminated water into receiving environment	3 - Moderate	C - Possible	Medium	Terrestrial and aquatic GDEs are mapped within the mining lease areas and project footprint. Low and moderate potential aquatic GDEs are mapped within Gunpowder Creek adjacent to the site. Moderate potential terrestrial GDEs on the site relate to vegetation relying on groundwater based on national assessment. Discharging of seepage influxes to the environment will be relatively minimal and if required, will be managed in accordance with the requirements of the Environmental Authority. Ground truthing of GDEs is recommended to inform impact

Environmental Value	Risk Event	Consequence	Likelihood	Residual Risk	Justification and Control
					assessment, given it is likely they may not exist within the project footprint.
Groundwater	Groundwater Flow (bore/aquifer yield and water levels) changes to the existing flow regime (including baseflow) in Gunpowder Creek	3 - Moderate	C - Possible	Medium	Potential changes to the groundwater flow direction have been identified in the seepage modelling. TSF3 is predicted to result in a minor increase in seepage to EPit.
	Reduction in groundwater quality resulting from increased seepage	3 - Moderate	D - Unlikely	Medium	TSF3 is expected to result in a minor increase in seepage flow and is considered to have minimal impact on existing flow and salt loads.
	Increased flooding of the ESS underground resulting from a change in groundwater flow as a result of TSF3	3 - Moderate	C - Possible	Medium	Potential changes to the groundwater flow direction have been identified in the seepage modelling. TSF3 is predicted to result in a minor change in groundwater flow to the west of TSF3.

10. MITIGATION AND MANAGEMENT

There is moderate localised impact predicted to occur to the groundwater systems from the construction and operation of TSF3. However, the following mitigation and management strategies are proposed for the project.

The design of TSF3 has been engineered to minimise seepage to groundwaters. The following engineering controls are proposed:

- the proposed design will be constructed in accordance with the seepage mitigation measures including a low permeability geomembrane liner tied into the foundation and abutments with a grout curtain.
- The low permeability tailings are expected to hydraulically limit seepage through the floor of the TSF3.
- A centreline raise of the existing UEDD has been adopted in lieu of an internal raise. This methodology reduces material quantities while enabling the existing seepage control measures (Geosynthetic Clay Liner (GCL), High Density Polyethylene Liner, Concrete Plinth and Grout Curtain) to be retained within the raise design and provide a bi-directional seepage control (i.e. internal seepage originating from the clean Upper Ezperanza Catchment and external seepage originating from TSF3).
- The EWRD crest level has been raised to accommodate the design spillway overflow event, and the final tailings deposition surface has been lowered to accommodate the Extreme Storm Storage (ESS) allowance and a nominal 1m operating decant pond depth.
- Testing of construction materials will take place in accordance with Australian Standard AS1289 Methods for Testing Soils for Engineering Purposes to ensure the required material specifications are achieved.
- Aa certified 'As Constructed' report will be prepared for the TSF 3 by a suitably qualified engineer.

TSF3 will be operated to minimise seepage to groundwaters. The following operational controls will be implemented:

- During TSF3 operation, under normal operating conditions, decant pond maintained in a minimum condition (nominal 1m deep maximum normal decant operating water depth) with water pumped to either E-Pit, Mill Creek Dam (MCD), Pond 3, or the proposed new Water Treatment Plant (WTP) with the decant water destination dependent of the water quality.
- DSA containment requirements shared across site water storages to achieve 5% site containment performance.
- TSF3 ESS (1:10 72 hr rain event) to be temporarily contained within TSF3, prior to being dewatered to other site water storages.
- Spillway overflows to be directed towards E-Pit.
- External flood ingress from southern Upper Ezperanza Valley diversion up to the PMF event allowed for.
- Maximise the beneficial reuse of supernatant water in processing to limit external sourcing of raw water to meet processing demands.

TSF3 will be monitored to understand the response of the groundwater system to the project. The following groundwater monitoring strategies will be implemented:

- Groundwater levels and quality will be monitored on a quarterly basis (as per the EA) at the newly installed bores surrounding the TSF3 structure, including the background bore (GWMB81) to monitor for any adverse effects caused by the amendment.
- The adopted monitoring instrumentation for preliminary design includes:
  - Surface Movement.
  - Pore Pressure.
  - Seepage Monitoring.
- Operation and management of water levels to maintain optimal conditions for tailings storage.

It is also proposed that routine inspections be carried out to monitor for potential seepage from the TSF3 embankment. If seepage is detected from TSF3, further seepage management measures may be required to be implemented, although this is considered unlikely.

11. MONITORING

Groundwater monitoring is recommended to be completed in line with the requirements of EA EPML00911413 and include:

Schedule A – Monitoring and Measurements

(A4-1) The holder must record, compile and keep for a minimum of seven (7) years all measurements and monitoring results required under a condition of this environmental authority.

(A4-2) The holder must ensure that all monitoring required under a condition of this environmental authority is conducted:

(a) By a competent person/s;

(b) In accordance with methods prescribed in the latest edition of the administering authority's monitoring and sampling manual;

(c) Using representative samples; and

(d) For laboratory analysis, by a laboratory with appropriate accreditation for the specific method of analysis (NATA accredited unless the administering authority agrees to alternative standards in writing).

(A4-3) All instruments and devices used for the measurement or monitoring of any parameter or quality characteristic required by a condition of this environmental authority must be calibrated, appropriately operated and maintained.

(A4-4) The following information must be recorded for all monitoring and measurements required under a condition of this environmental authority:

(a) The date and time when the sample was taken;

(b) The person/s conducting the sampling;

(c) The location where the sample was taken;

(d) Pertinent details relating to the sampling (i.e., stream flow or relevant observations);

(e) For laboratory analyses, all chain of custody, certificate of analysis and quality control/assurance documents.

(A4-5) Any monitoring plan, system or program required to be developed and implemented by a condition of this environmental authority must be reviewed at least once every three (3) years by a suitably skilled and competent person for effectiveness in identifying environmental impacts and amended promptly as required.

(A4-6) Within five (5) days of a request from the administering authority, the holder must make available for inspection in the form and by the means requested by the administering authority, all or any of the following:

(a) Monitoring results or records required under a condition of this environmental authority.

(b) Reports or plans required under a condition of this environmental authority.

(c) Details of any investigation required under a condition of this environmental authority.

(A4-7) The holder must implement available measures to enable all monitoring required under a condition of this environmental authority to be conducted.

Note: Available measures could include establishing and maintaining safe all-weather access to a monitoring location by upgrading roads/tracks, use of suitable automated sampling devices, developing alternative routes or utilising alternative transport.

Schedule C – Water – Groundwater

(C5-1) Groundwater quality and hydraulic head (m AHD) must be monitored at the locations and frequencies specified in Schedule C - Table 5 (Groundwater Monitoring Locations and Frequency) and identified in Schedule I – Plan 3 (Groundwater Monitoring Locations) for all parameters listed in Schedule C - Table 6 (Groundwater Trigger Levels and Contaminant Limits) (Table 6.2).

(C5-2) Groundwater from compliance bores identified in Schedule C - Table 5 (Groundwater Monitoring Locations and Frequency) must not exceed any of the contaminant limits defined in Schedule C - Table 6 (Groundwater Trigger Levels and Contaminant Limits) (Table 6.2).

(C5-3) If a groundwater parameter for a compliance bore identified in Schedule C - Table 5 (Groundwater Monitoring Locations and Frequency) exceeds the trigger level stated in Schedule C - Table 6 (Groundwater Trigger Levels and Contaminant Limits) (Table 6.2), the holder must compare the contaminant level of the compliance bore to the contaminant level of the reference bore; and,

(a) If the contaminant level of the compliance bore is less than the contaminant level of the reference bore, no action is to be taken; or

(b) If the contaminant level of the compliance bore is greater than the contaminant level of the reference bore, complete an investigation on the potential for environmental harm to occur in accordance with ANZECC (2000) methodology within three (3) months of identifying this exceedance.

Note: Where exceedance of a trigger level has occurred and is under investigation in accordance with condition (C5-3) (b), no further reporting is required for subsequent trigger events of that parameter during the course of the investigation.

(C5-4) Groundwater monitoring bores must be constructed and operated in accordance with methods prescribed in the latest edition of the Agriculture and Resource Management Council of Australia and New Zealand manual titled Minimum Construction Requirements for Water Bores in Australia.

(C5-5) The holder must develop and implement a groundwater monitoring program within three (3) months of the commencement of underground mining. The program must include:

(a) monitoring of contaminants listed in Schedule C - Table 6 (Groundwater Trigger Levels and Contaminant Limits).

(b) sufficient locations to detect changes in groundwater elevation contours and flow direction.

Water General

(C8-1) Water samples collected from monitoring locations specified in Schedule C - Water of this authority must be taken:

(d) Within forty-eight hours of each other for all receiving waters sediment samples and groundwater quality samples.

11.1 Groundwater Monitoring and Management Plan

The Groundwater Monitoring & Management Plan (GMMP) (QC1022_018-REP-007-0, Engeny, 2025) (**Appendix E:**) provides a structured framework to protect and manage groundwater resources related to the by the proposed TSF3.

Key objectives of the GMMP include detecting groundwater quality/level changes, ensuring EA compliance, and improving hydrogeological understanding. The monitoring network comprises 59 bores across six precincts, with seven TSF3-specific bores (GWMB76–82), monitored quarterly (compliance) or monthly (background), assessing parameters like pH, EC, and metals (e.g., Cu, Zn) per ANZG 2018 guidelines. Methods involve dip meters for levels and lab analysis (ICP/MS) for quality, with QA/QC (e.g., 1:20 duplicates). Initial 2D steady-state modeling predicts low risks to Environmental Values (EVs), with a 3D transient model due September 2025 to refine seepage/quality predictions.

The GMMP will be implemented to ensure the adequacy and continual improvement of the monitoring program, and ensure regular updates of the numerical groundwater model and associated prediction of impacts from the proposed TSF3.

11.1.1 Proposed TSF3 Monitoring Locations

The details of the proposed groundwater monitoring bores for TSF3 are described below in Table 11.1 and locations presented in Figure 11.1. Background bores are proposed to be monitored monthly to obtain baseline concentrations and quarterly for compliance bores.

TABLE 11.1: PROPOSED TSF3 MONITORING BORES

Bore ID	Compliance / Background Bore	Purpose/reasons	Monitoring Frequency
GWMB81	Background	Baseline groundwater conditions associated with proposed TSF 3.	Monthly
GWMB80	Background	Baseline groundwater conditions associated with proposed TSF 3.	Monthly
GWMB76	Compliance	Targeting seepage pathway between TSF 3 and EPit.	Quarterly
GWMB77	Compliance	Targeting seepage pathway between TSF 3 and EPit.	Quarterly
GWMB78	Compliance	Targeting seepage pathway between TSF 3 and EPit.	Quarterly

Bore ID	Compliance / Background Bore	Purpose/reasons	Monitoring Frequency
GWMB79	Compliance	Targeting seepage pathway between TSF 3 and EPit.	Quarterly
GWMB82	Background	Background to EPit located in the Paradise Creek Formation. To assess spatial and temporal changes in water quality. Understand the spatial and temporal extent of water quality impacts. Assess potential impacts on groundwater quality.	Monthly



Figure 11.1: TSF3 Monitoring Locations

12. CONCLUSION

The review of provided data for the proposed TSF3 indicates that the risk to the receiving environment as a result of the additional tailings storage is low to medium. The mitigation measures to control the risk of seepage identified in Section 10 are considered appropriate to manage the potential seepage risk, provided the permeability of the base of the proposed TSF3 is confirmed. Once the permeability of the base is confirmed, the likelihood of impacts to EV's and groundwater will reduce to unlikely, providing a greater level of confidence to the numerical model produced.

13. REFERENCES

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14. QUALIFICATIONS

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

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

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APPENDIX A: DESKTOP DATA

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Apr-2024

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	15
Listed Migratory Species:	12

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	1
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	2
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species			[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.			
Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Amytornis dorotheae Carpentarian Grasswren [558]	Endangered	Species or species habitat known to occur within area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area	In feature area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Rostratula australis](#)			
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area	In feature area
MAMMAL			
[Macroderma gigas](#)			
Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Macrotis lagotis](#)			
Greater Bilby [282]	Vulnerable	Species or species habitat may occur within area	In feature area
REPTILE			
[Acanthophis hawkei](#)			
Plains Death Adder [83821]	Vulnerable	Species or species habitat likely to occur within area	In feature area
[Elseya lavarackorum](#)			
Gulf Snapping Turtle [67197]	Endangered	Species or species habitat may occur within area	In feature area
[Varanus mertensi](#)			
Mertens' Water Monitor, Mertens's Water Monitor [1568]	Endangered	Species or species habitat known to occur within area	In feature area
SHARK			
[Pristis pristis](#)			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area

Listed Migratory Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
[Apus pacificus](#)			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Marine Species			
[Pristis pristis](#)			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
Migratory Terrestrial Species			

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area	In feature area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area	In feature area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat likely to occur within area	In feature area
Migratory Wetlands Species			
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area	In feature area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area	In feature area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat likely to occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In buffer area only
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area	In feature area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area	In feature area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat may occur within area	In feature area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area overfly marine area	In feature area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area	In feature area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat likely to occur within area overfly marine area	In feature area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat likely to occur within area	In buffer area only
[Rostratula australis as Rostratula benghalensis (sensu lato)](#) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Reptile			
[Crocodylus johnstoni](#) Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area	In feature area

Extra Information

State and Territory Reserves			[Resource Information]
Protected Area Name	Reserve Type	State	Buffer Status
Chidna	Nature Refuge	QLD	In buffer area only

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
CopperString Project	2010/5581	Controlled Action	Completed	In feature area
Mount Oxide Copper Project	2010/5564	Controlled Action	Completed	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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APPENDIX B: GEOLOGICAL MAPPING REPORT

ENGENY

CAPRICORN COPPER PTY LTD

Capricorn Copper Mine

TSF3 Geological Mapping Report

QC1022_018-REP-001-1

12 MAY 2025

DISCLAIMER

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

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	28/03/2024	Client Review	Alex Leotta	Deryk Forster / Brendan Wallace	Brendan Wallace	Brendan Wallace
1	12/05/2025	Client Issue	Deryk Forster	Brendan Wallace	Brendan Wallace	Brendan Wallace
Signatures:						

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1. INTRODUCTION

Capricorn Copper Pty Ltd (Capricorn Copper) have engaged Engeny to undertake a geological mapping program to support the detailed design of the proposed Tailings Storage Facility 3 (TSF3) including the assessment of potential seepage risks, the detailed design of required seepage controls, and the identification of potential borrow materials for the construction and closure of TSF3. TSF3 is proposed to be located between the existing Ezperanza Waste Rock Dump (ERWD) and Upper Ezperanza Diversion Dam (UEDD) at Capricorn Copper Mine (CCM) located around 130km north-west of Mount Isa, Queensland.

As part of the geological mapping program scope of works, a desktop review of previous geotechnical, geophysical, and hydrogeological investigation and assessment data / documentation and previous dam construction data was undertaken. The outcome of this review suggested the following:

- Available clayey borrow material for TSF3 embankments material may be limited.
- Faults identified through geophysical assessments have not been ground truthed. Additionally, any fault characteristics regarding dip orientation and physical characteristics regarding mineralogy, material weathering and strength are unknown.
- There is limited geotechnical drillhole data to inform the detailed design of TSF3 including required seepage controls, existing embankment conditions, and embankment founding conditions.

This report presents the objectives, scope, geological field mapping results and further works required to support geotechnical aspects of the TSF3 detailed design.

1.1 Objectives

The key objectives of the geological mapping program were to:

- Evaluate existing borrow pits and assess prospective areas/materials for future borrow pit production.
- Field reconnaissance of mapped lithological/stratigraphic units to better understand their typical geotechnical/geomechanical characteristics.
- Ground truth faults identified by desktop geophysical analyses and shown in the available 1:250,000 surface geological map.
- Identify any additional faults or deleterious materials which may impact the TSF3 design.
- Develop target areas for further geotechnical investigation required as part of detailed design.

1.2 Scope

The scope of the geotechnical mapping program include:

- Desktop review of existing geological data to inform mapping targets and prospective borrow areas.
- Delivery of a 3-day mapping program carried out by a Principal Engineering Geologist and Senior Engineering Geologist. The mapping consisted of the following:
  - Site walk over and measurement of geological structures.
  - Tactile assessment of prospective borrow materials.

1.3 Battery Limits

The geological mapping program targeted prospective borrow areas identified during desktop review and the TSF3 embankment footprint and tailings impoundment areas, particularly where intersecting faults were identified. These target areas are shown in Figure 1.1. Assessment of the existing Ezperanza Waste Rock Dump (EWRD) and Upper Esperanza Diversion Dam (UEDD) are outside the scope of this geological assessment.

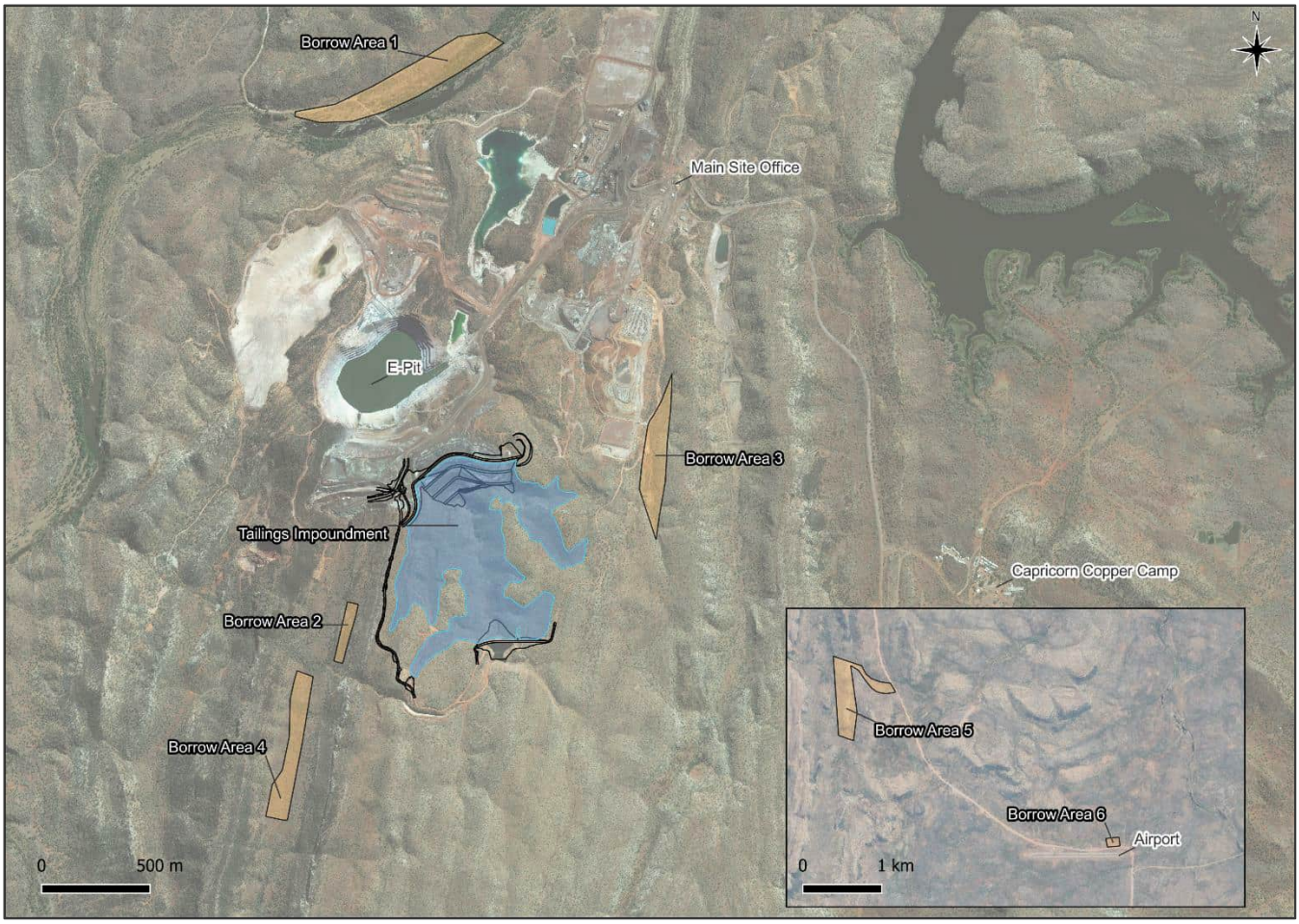


FIGURE 1.1: BATTERY LIMITS OF GEOLOGICAL MAPPING PROGRAM

1.4 Conventions

The following conventions apply to this report:

- All geometric measurements are metric.
- Coordinates are in metres and relative to GDA94 MGA Zone 55 horizontal datum and all Reduced Levels (RL) report to Australian Height Datum (AHD).
- All bearings (unless noted otherwise) are presented as degrees clockwise from grid (true) north and have been adjusted for site magnetic declination which, at the time of investigation, was 5.4° East. All inclination data is measured and noted in degrees relative to horizontal.
- All geological measurements regarding the geometry of surfaces present within the rock mass (unless noted otherwise) such as bedding, joints or other structural features provided in this report are presented as Dip Angle / Dip Direction (°).
- Where strike measurements have been calculated from dip-direction measurement, the American right-hand rule has been adopted.
- All stereonets[1] presented herein are lower hemisphere and equal area, with polar or equatorial overlays as appropriate.

1.5 Abbreviations

- E Pit – Esperanza Pit.
- EWRD – Esperanza Waste Rock Dump.

[1] A conceptual representation of geological structures illustrating the orientation of geological structures, such as bedding planes, fault lines and joints.

- UEV – Upper Esperanza Valley.
- UEDD – Upper Esperanza Diversion Dam.
- EF – Esperanza Fault.
- MF – Mammoth Fault.
- MEF – Mammoth Extended Fault.

2. BACKGROUND

Prior to the mapping program, a desktop study was conducted to understand site geology and identify mapping targets. The information available and summary of geological information is described in the following sections.

2.1 Available Information

Table 2.1 below outlines the information reviewed as part of the desktop study and field assessment.

TABLE 2.1: AVAILABLE DATA

Data Type	Date	Author	Title
Imagery	-	Microsoft Corporation	Bing Satellite
	1972	QImagery	QAP2255049.jpg
LiDAR	July 2020	Capricorn Copper	Gunpowder 20Jul2021 WV3 50cm DTM GDA94 MGA54 1m Extended.dem
Geological	1998	Richardson, S M and Moy, A D	Gunpowder Copper Deposits, in *Geology of Australian and Papua New Guinean Mineral Deposits,* pp743 -752.
	1975	Mitchell, J W and Moore, G. P	Mammoth Copper Deposit, in *Northwest Queensland Province,* pp 383-389.
	2008	Keys, D L	Mechanical localisation of copper deposits in the Mt Isa Inlier, North Queensland.
	2022	GSQ	1:100,000 geology dataset GSQ, STRUCTURAL AND DETAILED
Design Reports	Oct-06	GHD Pty Ltd	Mill Creek Dam
	Oct-06	GHD Pty Ltd	Mill Creek Dam Drawing Set
	Nov-19	GHD Pty Ltd	Esperanza Spillway Raise
	Jan-22	GHD Pty Ltd	Esperanza Tailings Storage Facility raise to RL284
	Jul-22	GHD Pty Ltd	Esperanza Tailings Storage Facility raise to RL287.7
	Jul-23	ATC Williams Pty Ltd	Capricorn copper, temporary water storage options assessment.
Geotechnical Reports	Jan-19	GHD Pty Ltd	Borrow Area Investigations
	Sep-20	GHD Pty Ltd	Esperanza Pit Factual Geotechnical Investigation
	Apr-23	ATC Williams Pty Ltd	Esperanza TSF Conceptual Model and Seepage Assessment Report

Notes: the 1:250,000 scale state geophysical data (RTP 1DV, RTP) were reviewed, however, were not used owing to the relevance (insufficient level of detail).

2.2 Site Description

2.2.1 General

The proposed TSF3 embankments (EWRD and UEDD) are located around 1.8 and 2.5km south of the main site offices respectively and are accessed via the mine access tracks and haul roads shown in Figure 2.2.

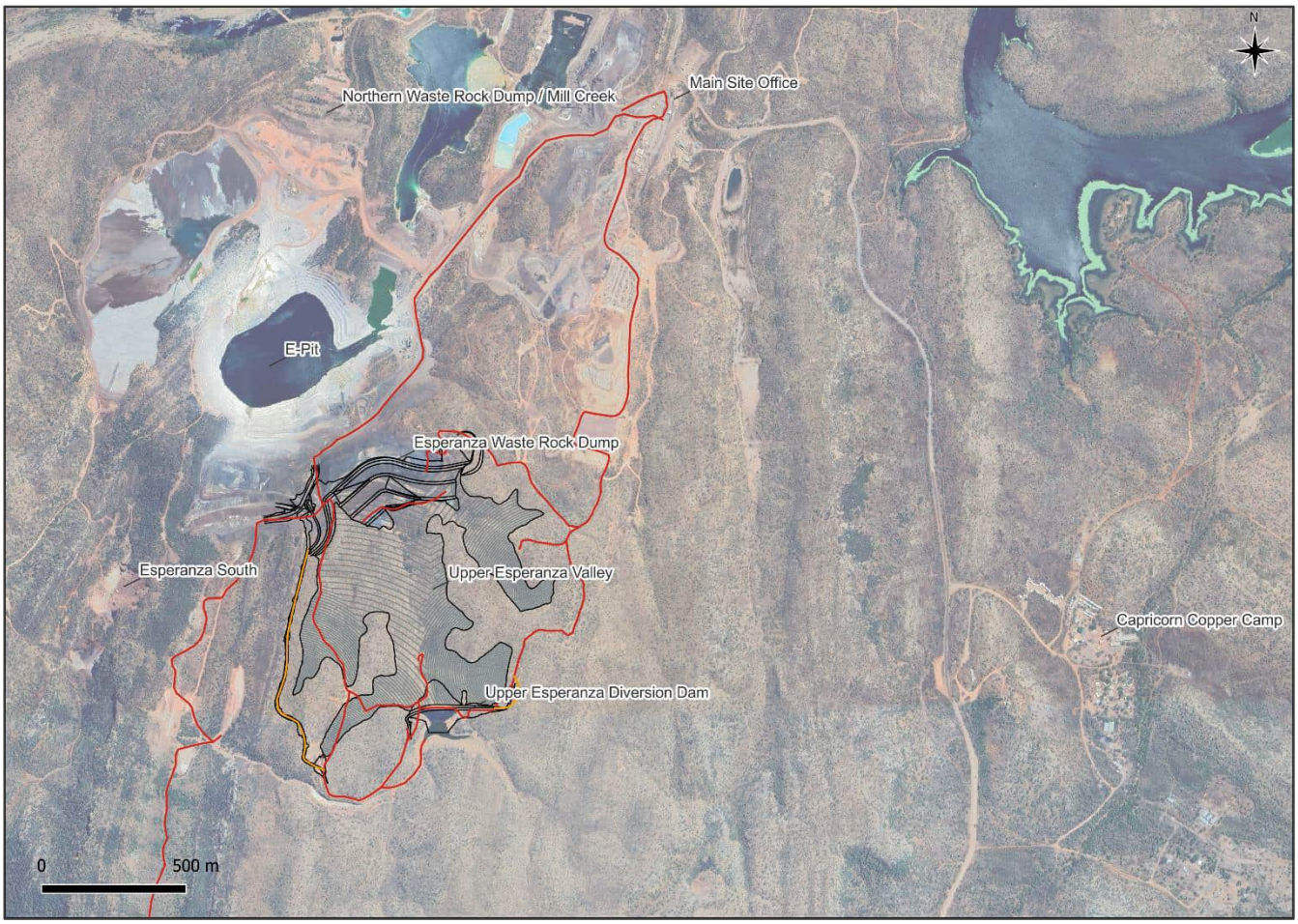


FIGURE 2.1: GENERAL ARRANGEMENT (ACCESS TRACKS/HAUL ROADS SHOWN IN RED, PROPOSED TRACKS SHOWN IN YELLOW)

The site topography consists of roughly north-south striking undulating ridges which are incised by a main drainage line which forms the Upper Esperanza Valley (UEV) and is bound by the EWRD in the north and by the UEDD in the south . TSF3 is proposed to be located between the EWRD and UEDD and bound by the surrounding ridges.

The UEV runs roughly south-east / north-west and drains waters to the north toward the E-Pit. The base of the UEV beneath the Upper UEDD exists at approximately RL 287 mAHD and drops to RL 249 mAHD beneath the EWRD, falling at a grade of approximately 5%. Valley sides which form the abutments of the TSF3 and UEDD rise at approximately 37% and 20% [grade] respectively. Figure 2.3 below illustrates the main topographic features within the study area.

Valley sides in the tributary lines either side of the UEV (denoted by blue arrows in Figure 2.2) have similar properties to the UEV. The topography in the UEV and adjacent valleys present difficulty for LV access and the ability to build access tracks.

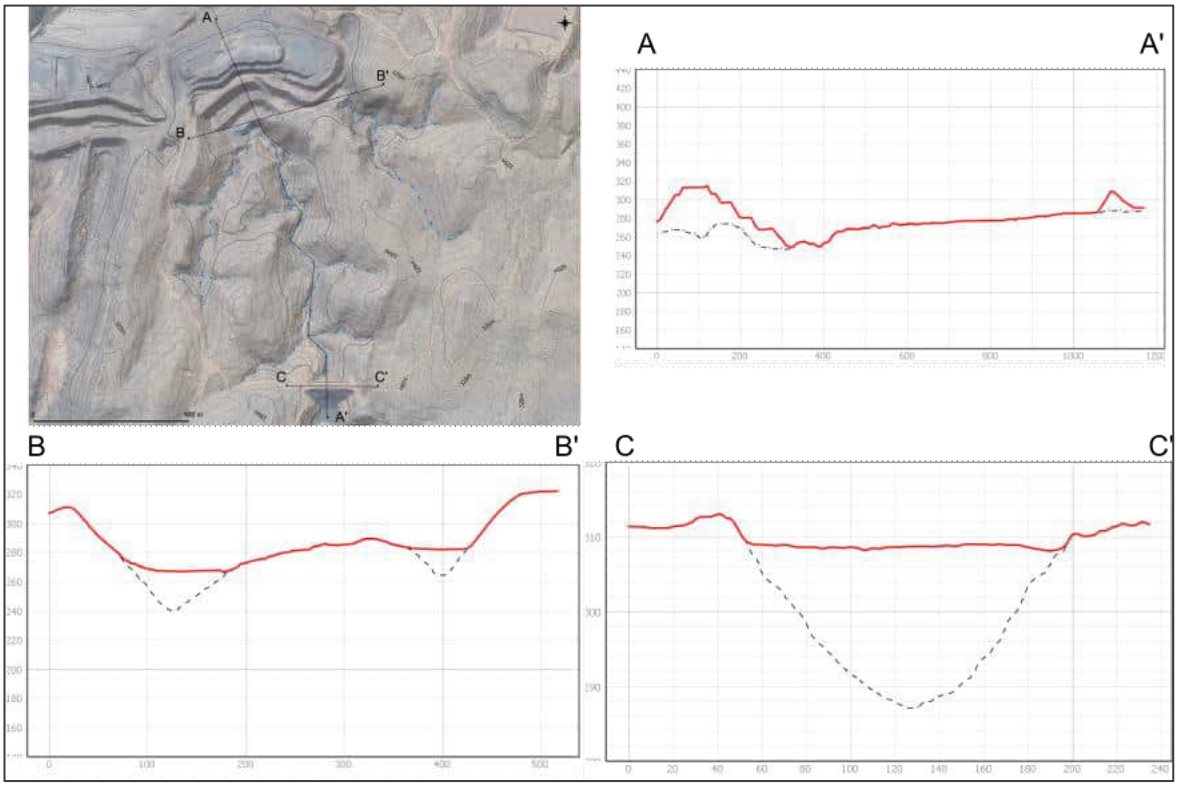


FIGURE 2.2: TOPOGRAPHICAL SECTIONS THROUGH THE UEV. NOTE: INFERRED GROUND SURFACE BENEATH THE EMBANKMENTS BASED ON HISTORICAL IMAGERY ARE SHOWN IN DASHED BLACK ABOVE.

2.2.2 Waste Rock Dump and Dam Development

Construction of the EWRD occurred sometime after the commencement of mining at Esperanza Pit (E-Pit) circa 1997. The EWRD appears to have infilled existing drainage lines which drain waters to the north (refer Figure 2.3). Subsequent to the field mapping program, a historic survey of the area prior to the development of the EWRD was located. This survey confirms the interpretation shown in Figure 2.3.

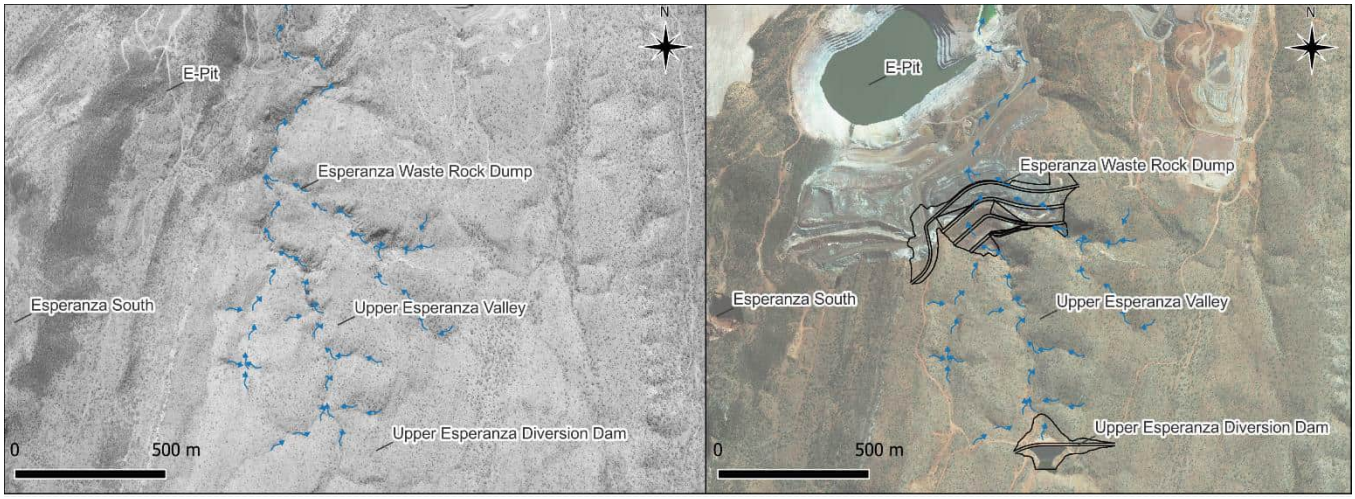


FIGURE 2.3: IMAGERY 1972, PRE E-PIT DEVELOPMENT COMPARED TO CURRENT ARRANGEMENT OF E-PIT.

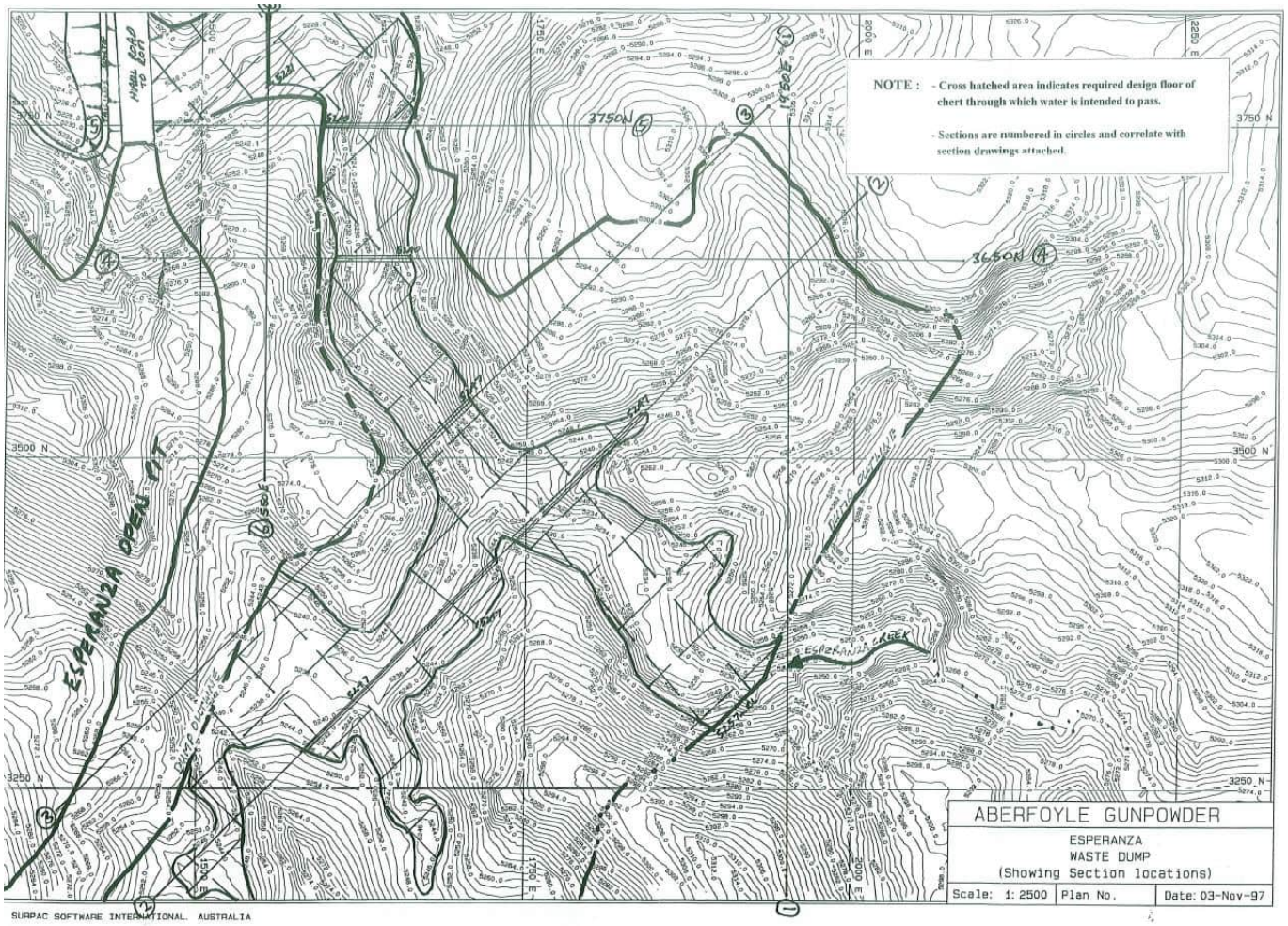


FIGURE 2.4: HISTORICAL SURVEY, PRE E-PIT DEVELOPMENT (GOLDER, 1997)

2.3 Geological Setting

2.3.1 Regional Geology

CCM sits within the Western Fold Belt of the Mount Isa Inlier (refer Figure 2.5). Mineralisation in the area is associated with faults relating to the Mount Gordan Fault Zone (outcrops to the west of CCM), which generally separates gently folded McNamara Group rocks of the Lawn Hill Platform to the west from older tightly folded rocks of the Haslingden Group to the east. Mineralisation at CCM is hosted by Proterozoic units at various stratigraphic levels, ranging from Haslington Group rocks at the Mammoth deposit (at E-Pit), to McNamara Group units at Esperanza (refer Figure 2.6).

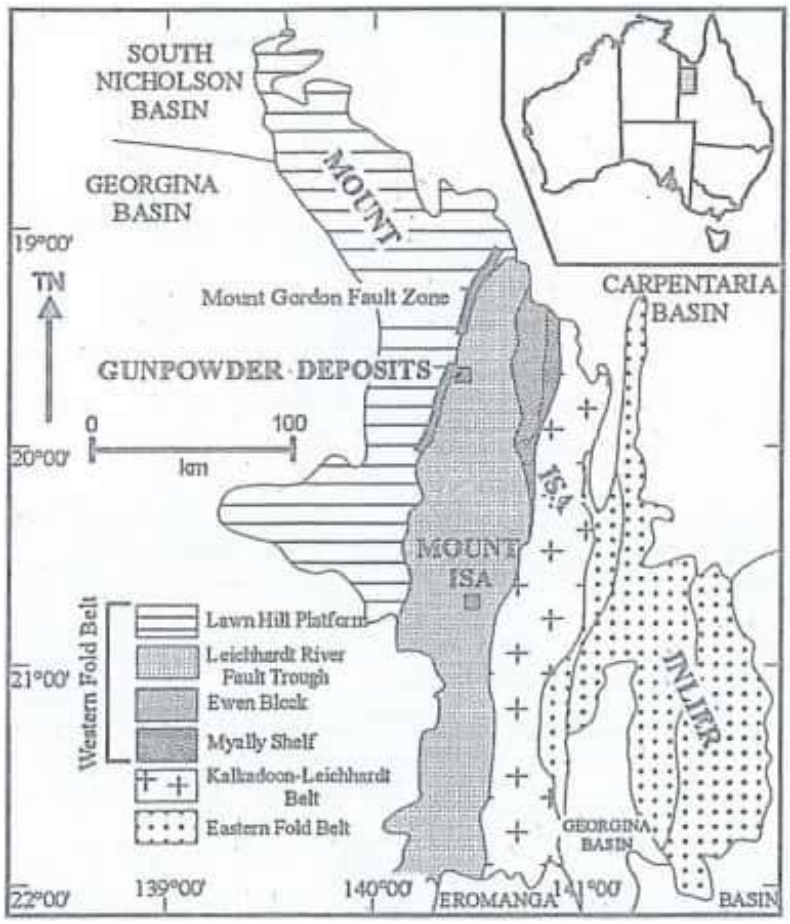


FIGURE 2.5: LOCATION OF CAPCOPPER MINE AFTER BLAKE ET AL. (1990)

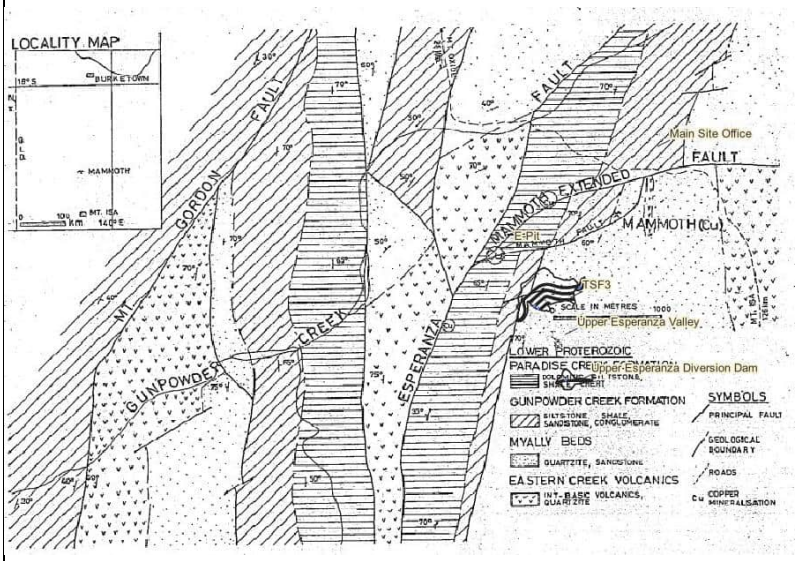


FIGURE 2.6: LOCATION OF MAIN GEOLOGICAL UNITS AND STRUCTURAL FEATURES

All stratigraphic relationships such as lithology age, formation groups and bedding relationships for all the regional geological units (i.e., Lawn Hill Platform, Haslingden Group, McNamara Group, etc.) are presented on the Figure 2.7. These stratigraphic relationships help verify any future investigations and measurement taken at CCM.

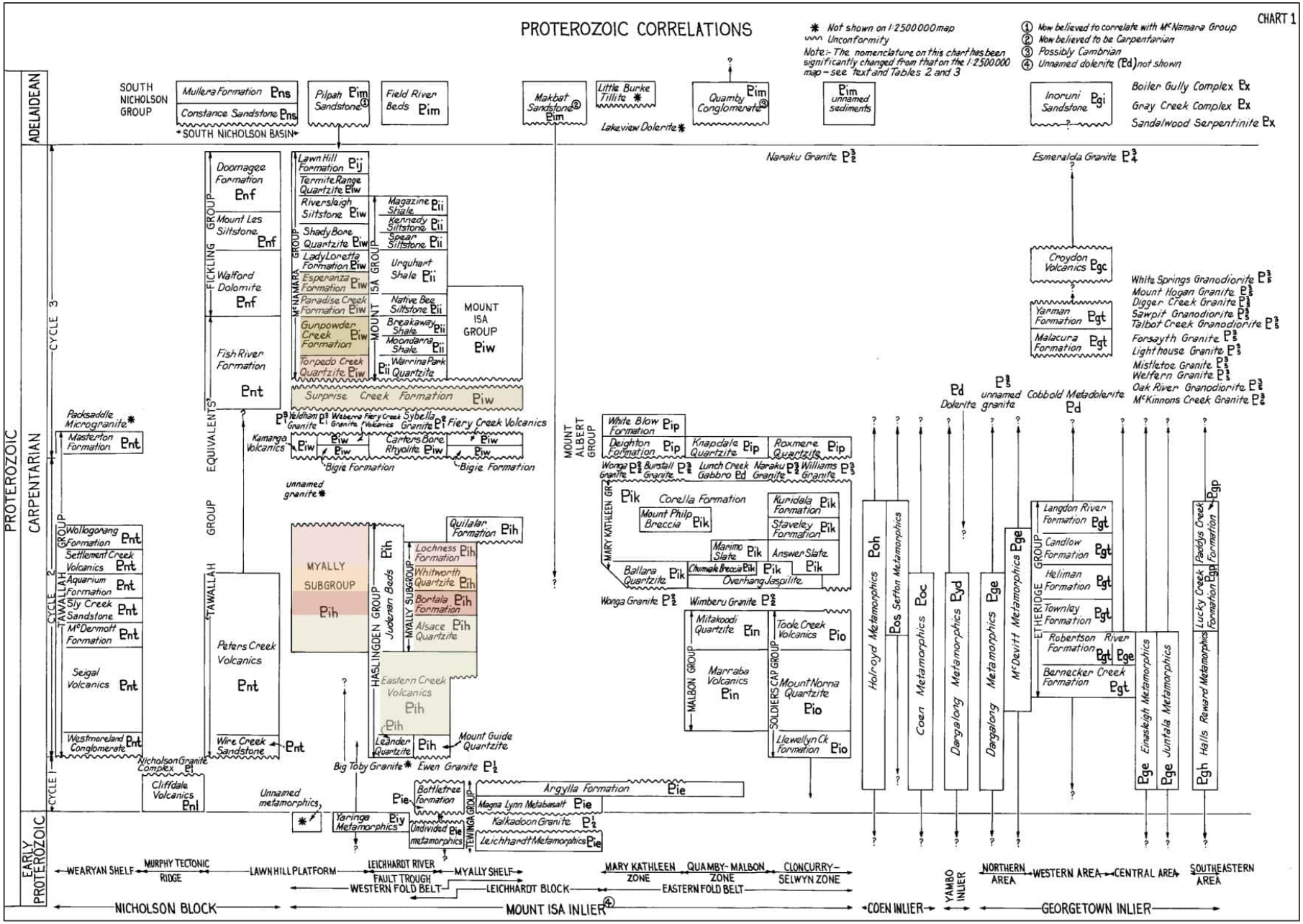


FIGURE 2.7: MOUNT ISA INLIER STRATIGRAPHIC SECTION AND STRATIGRAPHIC CORRELATIONS. ALL SHADED UNITS ARE OUTCROPPING AT THE TSF3 PROJECT AREA, (GEOLOGICAL SURVEY OF QUEENSLAND, 1983)

2.3.2 Structure

Deformation at CCM is related to four phases (D_1-D_4) of the 1620 to 1550 million-year (Ma) Isan Orogeny (Blake, 1990) . At the site, D_1 is reflected as an east-trending lineation. Regional and mesoscopic, upright, north-trending folds and greenschist facies metamorphism relate to deformation during D_2. Major faulting (including the faults noted at CCM) are generally thought to have occurred during D_3. D_4 is expressed as a number of mutual overprinting fracture cleavages. (Blake, 1990)

Faults associated with the Regional Mount Gordan Fault Zone outcrop at CCM as the NNE striking Esperanza Fault (EF) and the ENE-trending cross faults including the Mammoth and Mammoth Extended Faults (MF and MEF). Descriptions of each of these main faults is described below after (Mitchell, 1975) and (Richardson, 1998).

Esperanza Fault (EF)

The EF is a NNE-trending regional structure dipping around 55-70° west. The MEF and MF splay off the EF in a poorly understood area just south of the orebody. Movement along the EF is interpreted to be dextral reverse.

Mammoth Extended Fault (MEF)

The MEF is a normal fault with displacement of the north block eastwards approximately 600-700m. It strikes north-east and dips steeply south-east but swings to a north-north-east strike with westerly dip immediately north-east of the mine.

The MEF is the main structure controlling mineralisation at the Esperanza deposit. At surface, the MEF is expressed by strong shearing of ferruginous siltstone for several metres from the Esperanza chert boundary.

Mammoth Fault (MF)

The ENE-trending MF is mapped at surface striking into the Esperanza area, however its location and the nature of its termination are poorly constrained. Dip of the MF varies by location, though is noted to be dipping roughly 70° toward south at Mammoth (E Pit location) and is inferred as sub-vertical dipping north where the MF meets the MEF. It's understood the area between the MF and MEF represents a single broad zone of fault breccia. Exposures of the MEF and MF are sparse in outcrop, however the MF is interpreted to be a sinistral reverse fault.

2.3.3 Stratigraphy

Available stratigraphic geological descriptions of the site have been previously detailed by (Keyser, 1958), (Carter, 1961) and (Keys, 2008). The stratigraphic column is shown in Figure 2.8 and detailed surface mapping of all units is shown in Figure 2.9; which displays the Geological Survey of Queensland 1:100,000 dataset, which expands on previous geological units shown in Figure 2.6.

Relevant units are described in detail in the following sections from oldest to newest, which trend from east to west over the site.

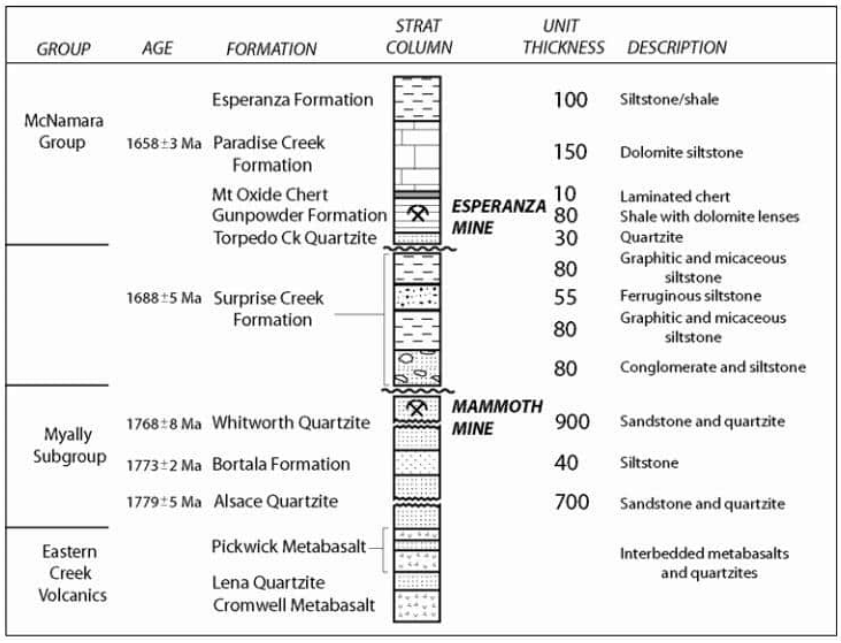


FIGURE 2.8: STRATIGRAPHIC COLUMNS AFTER (KEYS, 2008)

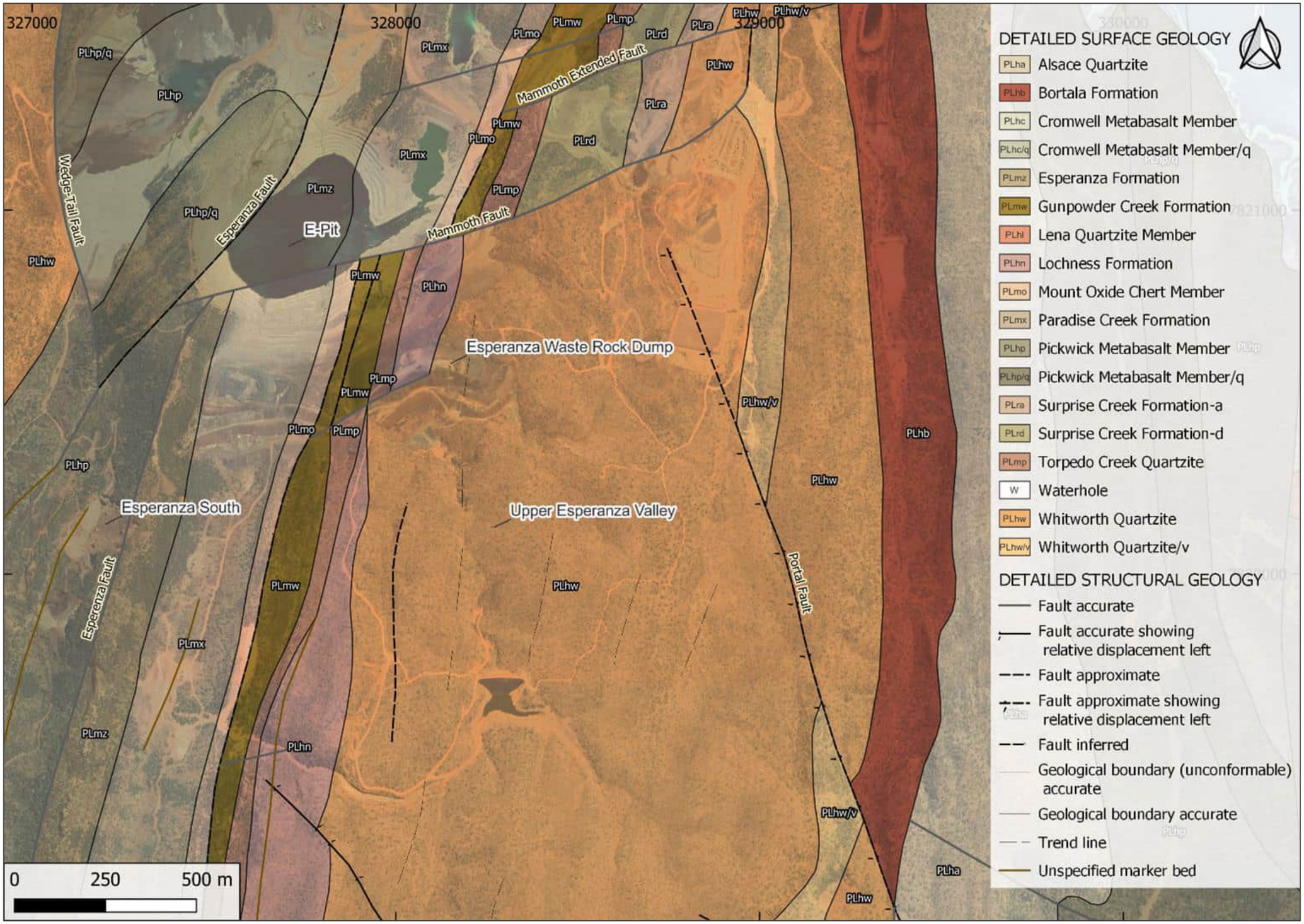


FIGURE 2.9: DETAILED GEOLOGICAL MAPPING

Eastern Creek Volcanics (ECV)

Outcrop extends over an extensive area south-east of CCM and includes the Cromwell Metabasalt, Lena Quartzite, and Pickwick Metabasalt. Generally, these are fine to medium grained meta-basalts and meta-andesites with porphyritic and amygdaloidal structures. Interbeds of quartzites and minor grey fissile shales occur throughout these units. Towards the top of the unit, the sediment to volcanic ratio increases and the volcanics contain a considerable amount of andesites and trachytes, indicating a change in magmatic chemistry. The upper limit of the ECV is taken as the last volcanic flow before transitioning to the Myally Subgroup.

Myally Subgroup

Conformably overlying the ECV are the Myally subgroup. The dominant rock is the Whitworth Quartzite which is a massive, poorly bedded, homogenous quartzite formed by regional metamorphism of the original arenite rock. Composition is variable and rocks can range from lithic, to arkosic, and chloritic arenites. Arenites with high clay content are largely unmetamorphosed (interpreted here as the Lochness Formation) and occurs toward the top of the sequence. The important feature of these being the lithic sandstone at the top of the formation which is the host rock for the mineralisation at the Mammoth deposit. Metamorphism appears to be limited to silicification of the more silica rich elements of the unit, with original sedimentary textures and bedding clearly recognisable, with ripples, cross beds, and trough cross beds abundant in outcrop.

The Whitworth Quartzite dips to the west between 60° and 80°, striking roughly north-south in the mine area. Lensing, load casts, ripple marks and mud cracks and intraformational brecciation have been recorded within the Whitworth quartzite. The most significant mineralisation is hosted by several discrete orebodies in dilational veins and breccias (Keys, 2008). The mineralisation is comprised of a range of copper species, dominantly chalcopyrite, bornite and chalcocite.

McNamara Group

The Whitworth Quartzite is unconformably overlain by the McNamara Group sediments including Torpedo Creek Quartzite, Gunpowder Creek, Paradise Creek Formation, and Esperanza Formation, all of which outcrop directly west of the TSF3 embankment. The unconformity strikes approximately north-south but dips at approximately 50° to the west giving an angular separation of 20° to 30° between the units above and below (Keys, 2008).

There are no detailed descriptions available for the Torpedo Creek formation as the formation was previously grouped with Gunpowder Creek formations. Lithological descriptions for Gunpowder Creek are noted as being divisible into three lithological sequences including:

- Upper sequence of micaceous siltstone-shale with dolomite lenses.
- Central siltstone-ferruginous sandstone-quartzite sequence.
- Lower conglomerate-siltstone-sandstone sequence.

These sequences are unlikely to outcrop within the project area as the formation thins south of the MEF and MF.

The Paradise Creek Formation consists of a basal chert marker bed and a finely bedded white siltstone, followed [upward] by a sequence of finely bedded, brown, dolomitic siltstones, and cherts. The formation sediments strike roughly north-south and dip at 60°-70°. Ripple marks and other sedimentary structures indicate a shallow water, restricted environment. These are overlain by a sequence of ferruginous siltstones and shales which are graphitic at depth. The top of the sequence in the area is the stromatolitic chert which is silicified and contains both columnar and laminae types of stromatolite.

2.4 Existing Site Information

2.4.1 Geophysical Assessments

Interpretation of airborne geophysical datasets was completed by Southern Geotechnical Consultants (SGC) in 2023 to identify structural settings, domains, and fault distribution. SGC used freely available [open source and State Government] aeromagnetic (AMAG), radiometric (RAD), and airborne EM (AEM) surveys to inform the geophysical interpretations against existing or known faults derived from the Geological Survey of Queensland (GSQ) 1:250,000 scale Camooweal and 1:100,000 scale Mammoth geology maps.

The SGC assessment identified four characteristic fault types which are summarised in Table 2.2.

TABLE 2.2: FAULT DESCRIPTION SUMMARY

Fault Type	Description
Major faults	Structures observed through the whole Area of Investigation (AOI) and beyond. Mostly interpreted to be related to major tectonic events such as super basin developments or Mt Isa orogeny.
Major faults - inferred	Same definition as major faults but associated with more subtle magnetic features and therefore assigned a lower degree of confidence.
Minor faults	Structures with shorter extents, less displacement, splays from larger faults and fractures.
Minor faults - inferred	Less clear / lower confidence minor faults.

All faults identified by SGC consultants are presented in Figure 2.10 below. SGC noted that their structural interpretation of the magnetic data improves the understanding of the geological structures in the area, refines the geometry of certain known faults and potentially identifies local, subtle faults that may not have been previously recognised.

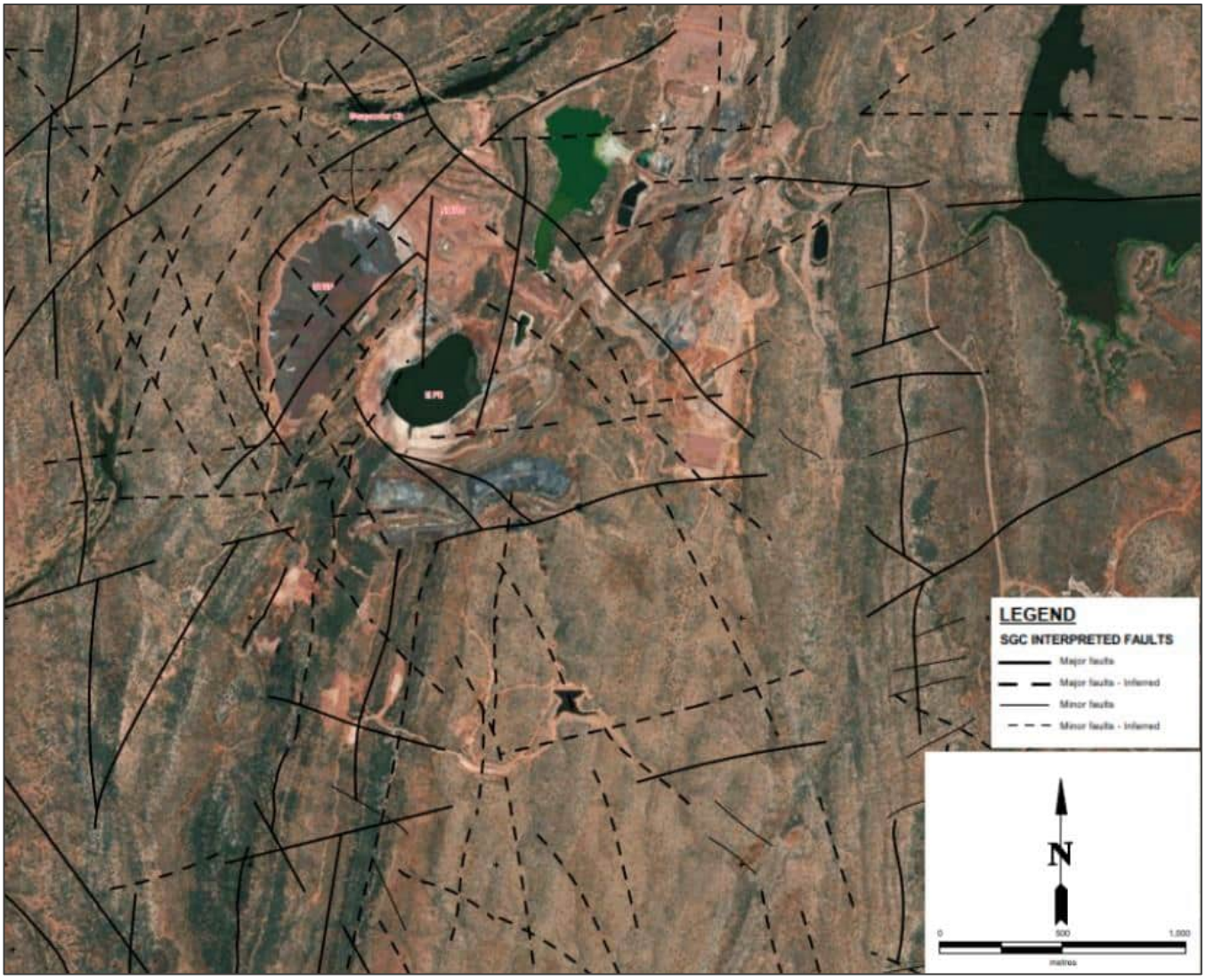


FIGURE 2.10: SGC GEOPHYSICAL INTERPRETATION

2.4.2 Existing Site Investigations

Previous investigations assessed as part of the geological mapping program desktop review are limited to the GHD 2019 field investigations which were completed to evaluate potential growth medium and low permeability clay borrow areas at CCM. The field investigations consisted of 51 test pits across five sites excavated with a 20-tonne excavator and progressed to a maximum depth of 4.3 m. All investigations are shown on Figure 2.11 and a summary of the investigation findings are presented in Table 2.3:.

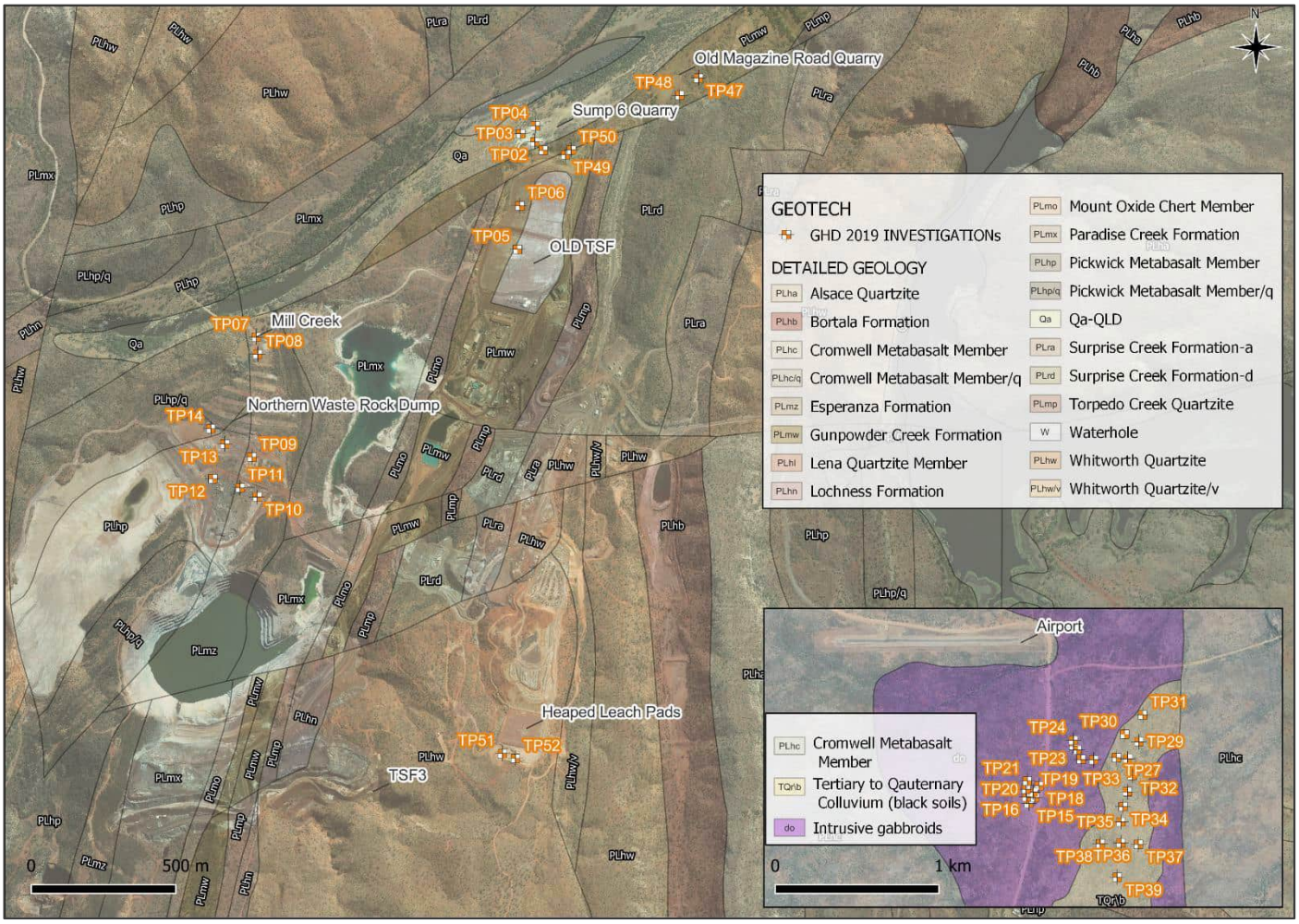


FIGURE 2.11: GHD BORROW AREAS PRESENTED AGAINST DETAILED SURFACE MAPPING

TABLE 2.3: GHD 2019 BORROW AREA RESULTS

Borrow Type	Borrow Area	Geological Formation	Available Test Pits	Viable Borrow Area Y/N	Comments	Indicative Volume Available
Growth Medium Borrow	Old Magazine Road	Gunpowder Creek Formation	TP47, TP48	Y	The samples collected from the test pits indicated Silt with gravel and Silty GRAVEL. Geochemical testing indicated that the material is NAF and suitable for use as a cover material.	Based on the limited testing, it is estimated that there is approximately **40,000 m³** of material suitable for use as a growth medium, as estimated by GHD 2019.
	Sump 6 Borrow	Alluvium, Gunpowder Creek Formation	TP01,TP02,TP03, TP04, TP49,TP50	N	The material in the face of the existing borrow indicated in-situ Sandy SILT and Gravelly SILT. Geochemical testing of the samples indicated low capacity potentially acid forming material, indicating that the borrow would not be suitable for use in a closure cover.	N/A
	North Rock Quarry/Mill Creek	Esperanza Formation	TP07,TP08	N	The test pits indicated that there is a shallow layer of Gravel with silt overlying bed rock at the toe of the quarry. Visual assessments of the quarry face indicated that there is likely to be rock at very shallow depths higher in the quarry. Based on the test pits and visual observation it is unlikely that there is significant volume of suitable material for construction.	N/A
	North Waste Rock Dump	Fill	TP09,TP10,TP11,TP12, TP13,TP14	Y	The North Waste Rock Dump (NWRD) comprises waste rock mined from the Esperanza Pit, generally the material is inert. A total of six test pits were excavated in the NWRD area, typically the material was relatively consistent, comprising of Gravelly SILT and Gravelly CLAY with Sand. During the excavation of the test pits the material appeared to have a high gravel content, during laboratory testing this was found to be cemented clay, which broke down during testing. The material from the NWRD would be suitable for growth medium	An approximate area of **75,000 m²** is available for borrowing. This results in a total volume of growth medium of **350,000 m³**, as reported by GHD 2019. Should a capillary break layer be required, material could be screened from the NWRD.
Clay Borrow	Airport Borrow	Cromwell Metabasalt	TP15,TP16,TP17, TP18,TP19,TP20,TP21, TP22,TP23,TP24,TP25,TP26	Unknown	No assessment was made by GHD specifically on the Cromwell Metabasalt.	Unknown
		Colluvium	TP27,TP28,TP29,TP30, TP31,TP32,TP33,TP34,TP3, TP36,TP37,TP38,TP39	Y	It is interpreted the area identified to the east of Gunpowder road with clay typically 1 m deep, overlying dolerite was the mapped colluvium geology.	The area investigated was approximately **210,000 m²**, resulting in approximately **210,000 m³** of clay material, as estimated by GHD 2019.

2.5 Target Mapping Areas

The primary goal of this program was to validate the interpretation of airborne geophysical data, which had identified a series of possible faults that traversed the proposed TSF3 storage area and its abutments. These structures, and those mapped by the Geological Survey of Queensland (which includes faults mapped as part of the exploration of the leases since discovery of the original orebody), were located in the field and observed to determine their characteristics, allowing their potential to act as a seepage path to be considered.

Mapping, for the purposes of engineering of the proposed embankment or seepage control measures, was not completed as part of this assessment as this mapping is of a higher resolution and requires the foundation footprint to be more clearly defined. As such, this mapping will occur as part of the detailed design phase.

2.5.1 TSF3 Potential Seepage Pathways

To assess for potential seepage pathways beneath the TSF3 embankments and through the TSF3 impoundment, geological faults (and inferred geological faults) identified in Sections 2.3.2 and 2.4.1 above have been plotted against the boundary of the proposed TSF3 maximum tailings deposition extents. The intersection of these faults with the maximum tailings deposition extents were used to inform the basis for mapping targets as these faults represent the most likely foundation seepage pathways through potentially broken or weathered rock. It is possible that further faults are present, and detailed geological mapping will be required prior to construction to identify any additional risk zones. It is, however, most likely that the faults of sufficient size to be discernible on geophysical imagery, are expected to present the greatest risk.

Eight (8) target mapping areas were identified for this mapping program based on access constraints and fault type and are presented in Figure 2.11 below.

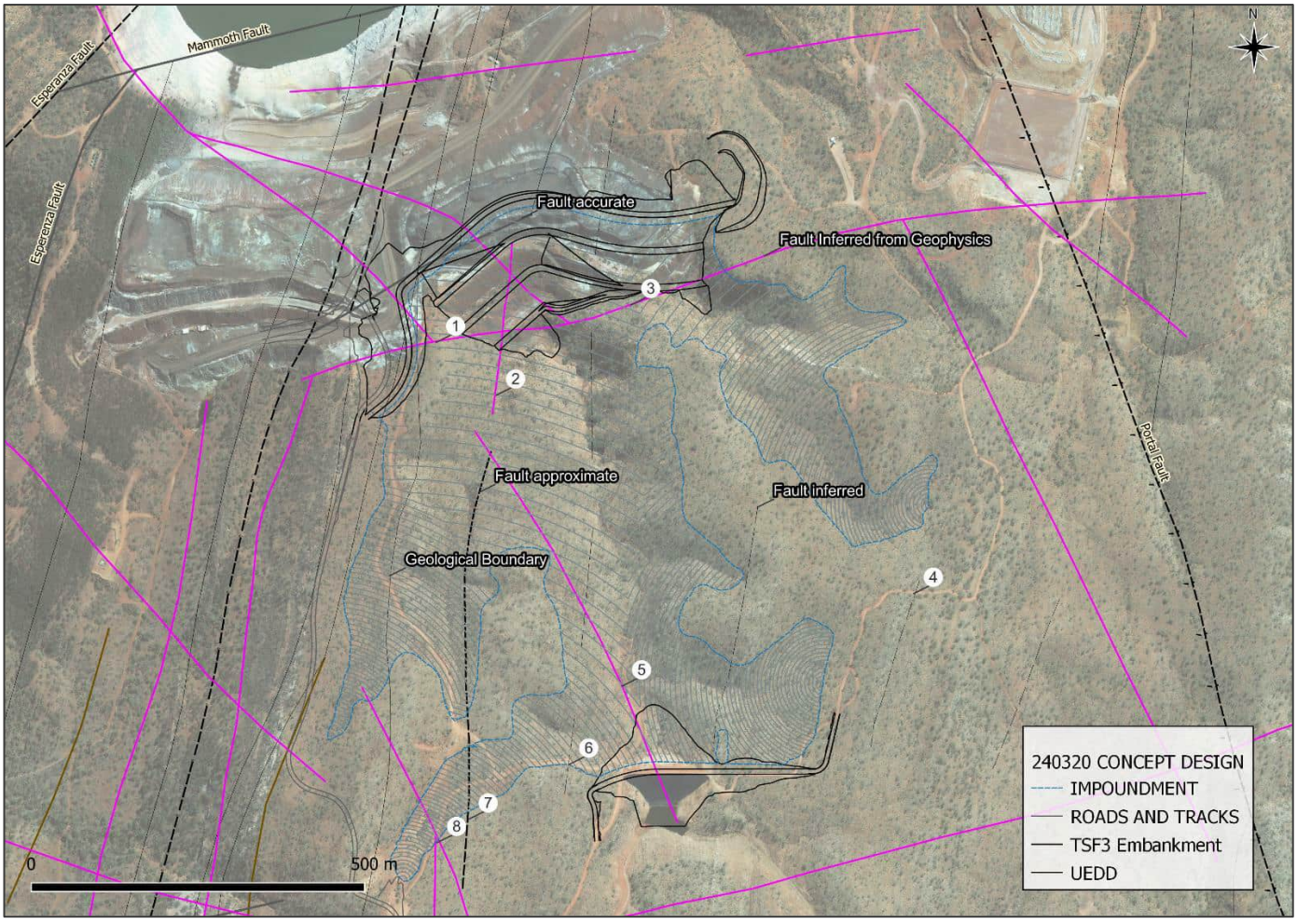


FIGURE 2.12: TSF3 TARGET MAPPING AREAS IDENTIFIED BY NUMBER

2.5.2 Natural Abutments

The proposed storage area is bounded to the east and west by natural rock ridges. To the east, the abutment comprises silicified arenite/quartzite of the Whitworth Quartzite, with the western bank and abutment consisting of a combination of Whitworth Quartzite, directly underlying the proposed tailings to the top of the ridge, unconformably bounded to the west by the Lochness formation, the Torpedo Creek Quartzite, the Gunpowder Creek formation, the Mount Oxide Chert Member, and the Paradise Creek formation to the west. The base of the Esperanza formation is marked by a stromatolitic chert layer, which serves as a local marker bed.

The quartzites of the Whitworth and Alsace are reported to be hydraulically tight, with increased permeability in the [surficial] weathered zone to approximately 30 m below ground level, with the clays and silts generally washed from the joint surfaces over time. As depth increases, the defects decrease in aperture and the hydraulic conductivity decreases significantly. Further, the quartzites contain quartz blows, dominated by milky quartz, that persist along a northwest trending strike. The fluids responsible for the emplacement of these milky quartz features post dates the silicification of the broader rock mass. The quartzites, likely due to their higher initial permeability [being arenites] have undergone significant silicification, to report very high strength rocks that are highly resistant to weathering across the majority of the proposed impoundment and eastern abutment.

The western abutment is underlain by the Whitworth Quartzite, which dips westerly. As mentioned, the rocks of the McNamara Group, which also dip steeply to the west. These rocks are generally fine grained and unlike the Whitworth Quartzite, lack silicification across the majority of the unit. Those sub-units containing arenaceous rocks, have undergone silicification, however the pelitic rocks are typically non-silicic, dominated by dolomitic and calcareous carbonates, the former being dominant. The fine-grained nature of these units, in addition to the lack of silica, allow these rocks to behave more plastically, allowing shearing and local deformation, which results in some re-healing of the rock mass along faults and shears. The primary permeability of the unit is expected to be low, with flow likely to pass along open defects and geological structures. The presence of dolomitic and calcareous horizons presents a small risk of increased permeability, however karstic terrain is not anticipated in the TSF3 area.

During later phases of design, the natural abutments, and the opposing hillslopes, will require geological mapping to confirm those structures, interpreted to be faults or shears, from existing mapping and geophysical interpretation. The section below (Figure 2.13) provides an indication of mapping areas for future phases.

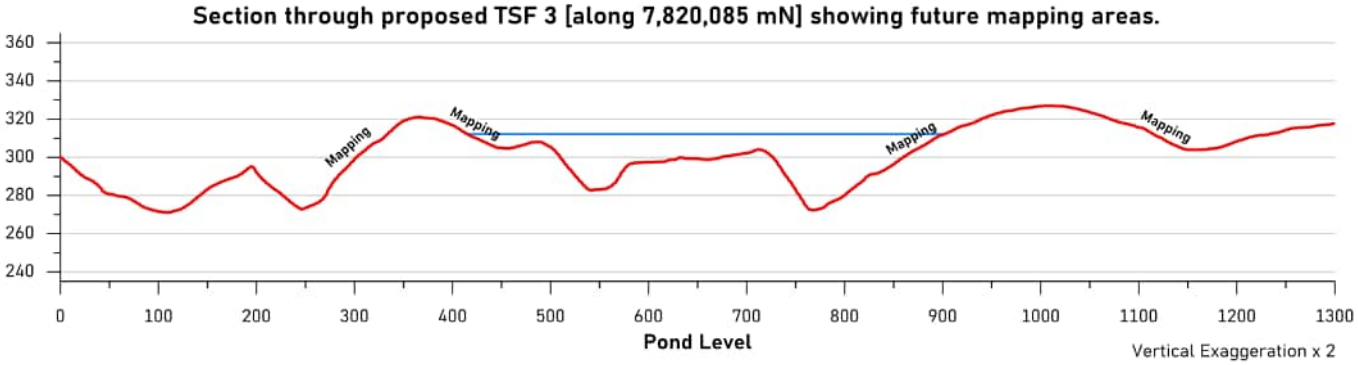


FIGURE 2.13: INDICATIVE FUTURE MAPPING AREAS

2.5.3 Borrow Area Investigations

To assess for potential borrow areas the following was considered:

- Quaternary soil deposits noted from detailed 1:100,000 surface geology datasets.
- Locations of mafic[2] rock types (which typically weather more readily into clayey or silty soils) noted from detailed 1:100,000 surface geology datasets.
- Potential soil deposits adjacent to low velocity flow areas along drainage systems.
- Existing quarries or borrow pits on/off site.

[2] Mafic rocks include basalts and ECV rock types.

Six (6) potential borrow sites (including the TSF3 impoundment area) were identified for further investigation and are shown previously in Figure 2.14.

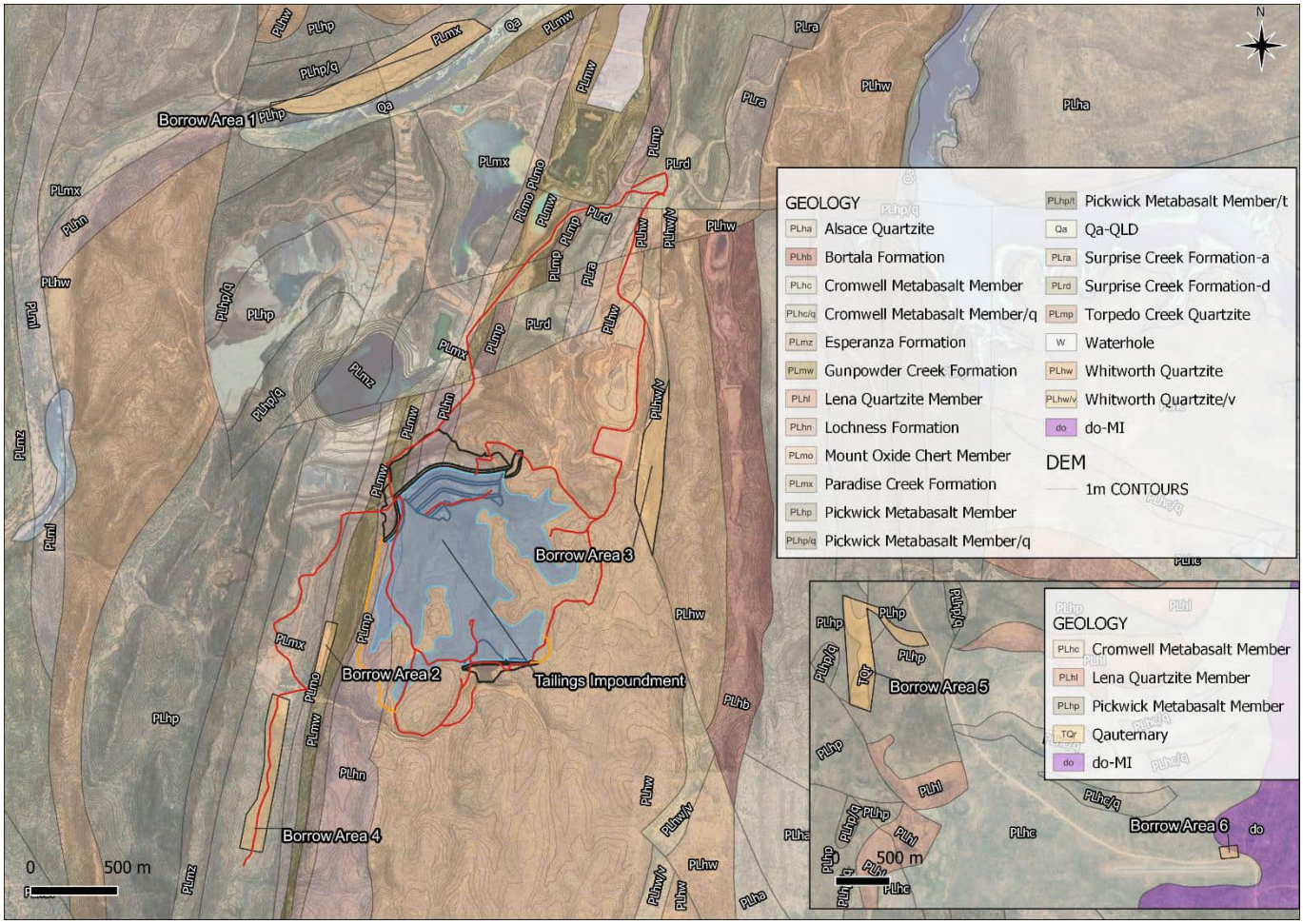


FIGURE 2.14: TARGET BORROW AREA SUMMARY

3. GEOLOGICAL MAPPING RESULTS

3.1 General

The geological mapping program was completed at CCM between 05 – 07 January 2024 by Deryk Forster (Principal Engineering Geologist) and Alex Leotta (Senior Engineering Geologist). The mapping program was completed under client escort. All measurements were taken with a Brunton Geological Compass [relative to Magnetic North] and mapping tracks were recorded with Garmin eTrex SE hand held GPS using all available constellations, relative to GDA2020 Z54. All mapping tracks and lithological units are displayed within Appendix A and detailed lithological descriptions are provided in the following sections.

3.2 Lithology

All lithological descriptions are presented in Table 3.1.

TABLE 3.1: LITHOLOGY SUMMARY

Lithology Group	**Formation**	**Site Area /** Borrow Area Designation **(refer** Figure 2.14 **)**	**Lithological Descriptions/Comments**	Weathering and Strength
Eastern Creek Volcanics	**Cromwell Metabasalt**	Borrow Area 6	Typical profiles consisted of a thin cover of low plasticity Silty CLAY (< 0.5 – 1.0 m) generally underlain by gabbro which typically outcropped as massive, with phaneritic pyroxene, plagioclase and minor amphibole. Minor andesite was observed west of the access road, and south of the airport runway and was slightly to moderately weathered and high strength, aphanitic to phaneritic amphiboles and plagioclase.	**Gabbro:** Very high strength, fresh. **Andesite:** Slightly to moderately weathered and high strength.
	Pickwick Metabasalt	East of Borrow Area 4.	Little to no soil generation was observed at ground surface. Dominant rock type consisted of basalt which was dark grey, aphanitic.	Moderately weathered and at high strength.
Myally Group	**Whitworth Quartzite**	TSF Impoundment Area	No soil cover. Unit consisted of poorly to well bedded well cemented fine grained and medium grained quartz-arenites and quartzites. Bedding ranged from 200mm to 2m spacing with trough cross bedding and ripples commonly observed throughout the impoundment area.	Slightly weathered to fresh and high to very high strength.

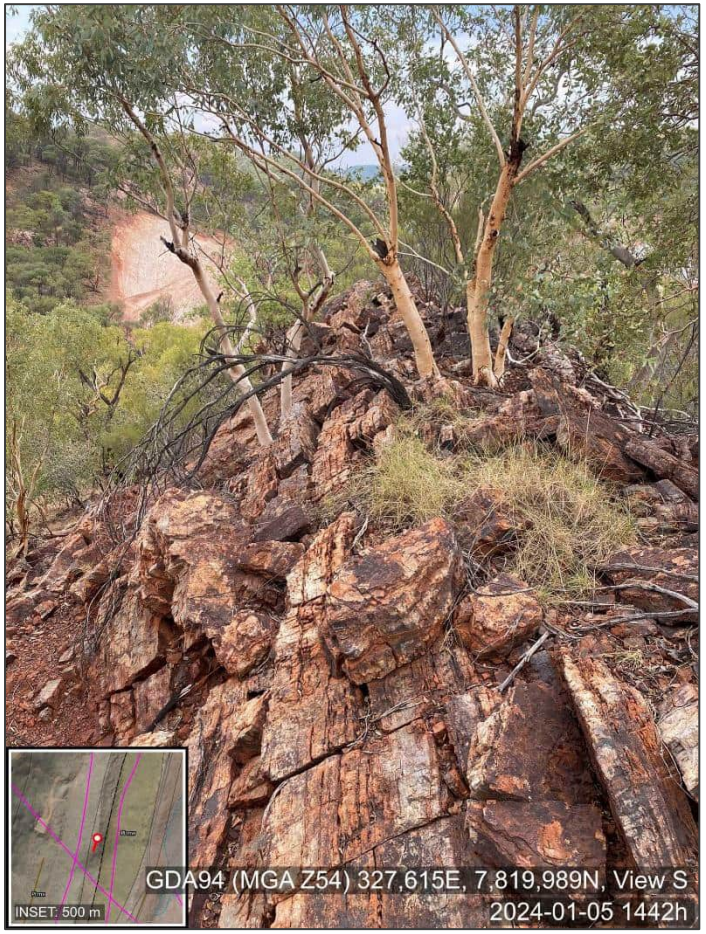
Lithology Group	Formation	Site Area / Borrow Area Designation (refer Figure 2.14)	Lithological Descriptions/Comments	Weathering and Strength
	Lochness Formation	Immediately east of TSF3 Impoundment	Little to no soil cover. Dominant rock type was a feldspathic arenite. Minor interbedded siltstone was observed.	Moderately weathered, low to moderate strength. Slightly weathered, high strength
McNamara Group	**Torpedo Creek Quartzite**	Immediately east of TSF3 Impoundment	Punctuates the ridge line directly to the west of the proposed TSF3 embankment and forms the eastern margin of Borrow Area 2. Dominant rock type was fine to medium grained, well cemented Quartzite with jointing at typically 400-600mm spacings.	Slightly weathered to fresh, high to very high strength.
	Gunpowder Creek Formation	Immediately east of TSF3 Impoundment	No geological mapping was conducted along the gunpowder creek formation.	N/A
	Mt Oxide Chert Member	Eastern border of Borrow Area 2.	Pale grey to white, cryptocrystalline chert. Forms the western border of Borrow Area 2.	Slightly weathered to fresh, high to very high strength.
	Paradise Creek Formation	Borrow Area 2	Dominant rock type is a yellow, fine to medium grained arenite with lesser dolomitic siltstone and is bound by a siliceous stromatolite marker bed in the west. Faults outcropping in the Paradise Creek formation are marked by low fracture spacing (10-20mm) and precipitation of native copper and manganese along the fault surface, refer to Section 3.4.	**Arenite:** Moderately weathered, high strength. **Dolomitic Siltstone:** Moderate to highly weathered, moderate strength. **Stromatolite marker bed:** high strength, slightly weathered to fresh.

3.3 Bedding and Jointing

3.3.1 General

Lithology Group	Formation	Bedding / Jointing (Dip / Dip Direction)	Typical Site Photo
Eastern Creek Volcanics	**Cromwell Metabasalt**	**Gabbro:** Joint orientations not recorded, joint spacing 200 mm – 600 mm at surface. **Andesite/Basalt:** No joint orientations recorded, however, rock mass encountered at surface is blocky with defect spacing between 60 – 200 mm.	 Photo Description: Andesite/Basalt pictured adjacent the airport.
	Pickwick Metabasalt	No joint orientations recorded, however, rock mass encountered at surface is blocky with defect spacing between 60 – 200 mm.	**No photo available**

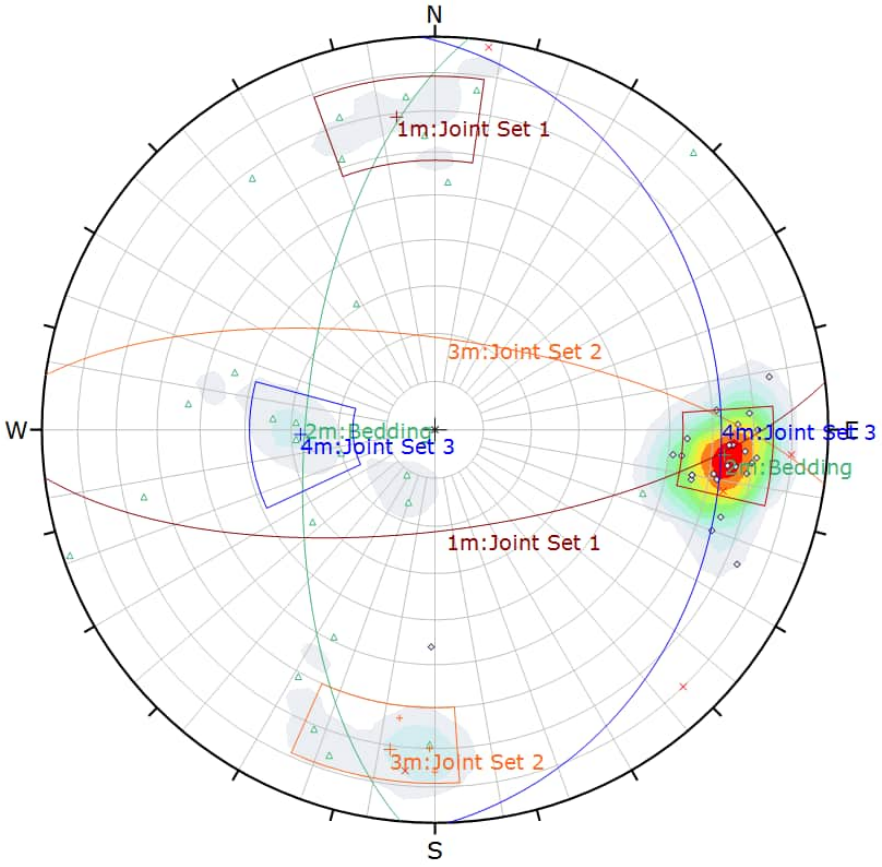
Lithology Group	Formation	Bedding / Jointing (Dip / Dip Direction)	Typical Site Photo
Myally Group	**Whitworth Quartzite**	**Bedding:** ~73° / ~294 **Jointing:** Typically 3 main joint sets present 1) 69° / 173 2) 71° / 008 3) 28° / 088 Joints typically spaced ~300 mm apart, tight with manganese staining.	 Photo taken near UEDD.
	Lochness Formation	**Bedding:** 54° / ~272 **Jointing:** Insufficient outcrop mapped to determine joint sets. Although likely similar to Whitworth Quartzite.	**No photo available**
McNamara Group	**Torpedo Creek Quartzite**	**Bedding:** ~60° / ~274	**No photo available**
	Gunpowder Creek Formation	N/A	N/A

Lithology Group	Formation	Bedding / Jointing (Dip / Dip Direction)	Typical Site Photo
	Mt Oxide Chert Member	**Bedding:** 69° / ~274 **Jointing:** No measurements taken, however, one steep joint set dipping north (or orthogonal to bedding) is present.	 Photo taken on the eastern boundary of the existing southern borrow pit.

Lithology Group	Formation	Bedding / Jointing (Dip / Dip Direction)	Typical Site Photo
	Paradise Creek Formation	**Bedding:** 54° / ~272 **Jointing:** Two joint sets measured 61° / 029 72° / 163 Joint spacing varied throughout the unit and was typically related to the proximity of fault structures for the arenite. Where it was adjacent to faulting the joints appeared to be open and spacing is typically 60 – 200 mm. Outside of faulting fractures are 200 – 600 mm spacing and tight. Within dolomitic siltstone (as observed within the southern borrow) displays well developed fissility, however, joint sets were not identified during the site visit.	 **Arenite** (taken 200 m south of the EWRD adjacent the LV access road)  **Dolomitic Siltstone** Photo taken from existing southern borrow pit.

3.3.2 Stereoplots

All field measurements were analysed in Rocscience's Dips [Version 8] software to confirm joint populations plotting all measurements against an equal area lower hemisphere stereoplot. This was progressed to confirm orientations acquired remotely from existing and proposed boreholes, and to ensure any proposed intrusive investigations were correctly aligned so as to provide un- or less-biased data; as discussed in Section 4. The field measurements are presented in Figure 3.1.



Symbol	TYPE	Quantity
◇	Bedding	25
×	Fault	5
△	Joint	26
+	Vein	3

Color	Density Concentrations
	0.00 - 2.20
	2.20 - 4.40
	4.40 - 6.60
	6.60 - 8.80
	8.80 - 11.00
	11.00 - 13.20
	13.20 - 15.40
	15.40 - 17.60
	17.60 - 19.80
	19.80 - 22.00

Contour Data	Pole Vectors
Maximum Density	21.22%
Contour Distribution	Fisher
Counting Circle Size	1.0%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		69	173	Joint Set 1
2m		63	275	Bedding
3m		71	8	Joint Set 2
4m		28	88	Joint Set 3

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Hemisphere	Lower
Projection	Equal Area

Figure 3.1: Summary of Measured Structures

3.4 Fault Structures

The mapping program specifically focused on the mapping targets identified in Section 2.5, as well as three (3) additional fault structures identified during the mapping program (Refer to Figure 3.2). Shaded areas in Figure 3.2 indicate areas covered during the field mapping program.

Geological mapping was completed in these areas to identify structures evidence by the following observations in outcrop:

- Offset bedding strike;
- Weathered or weak material;
- Increased jointing; and
- Brecciated material.

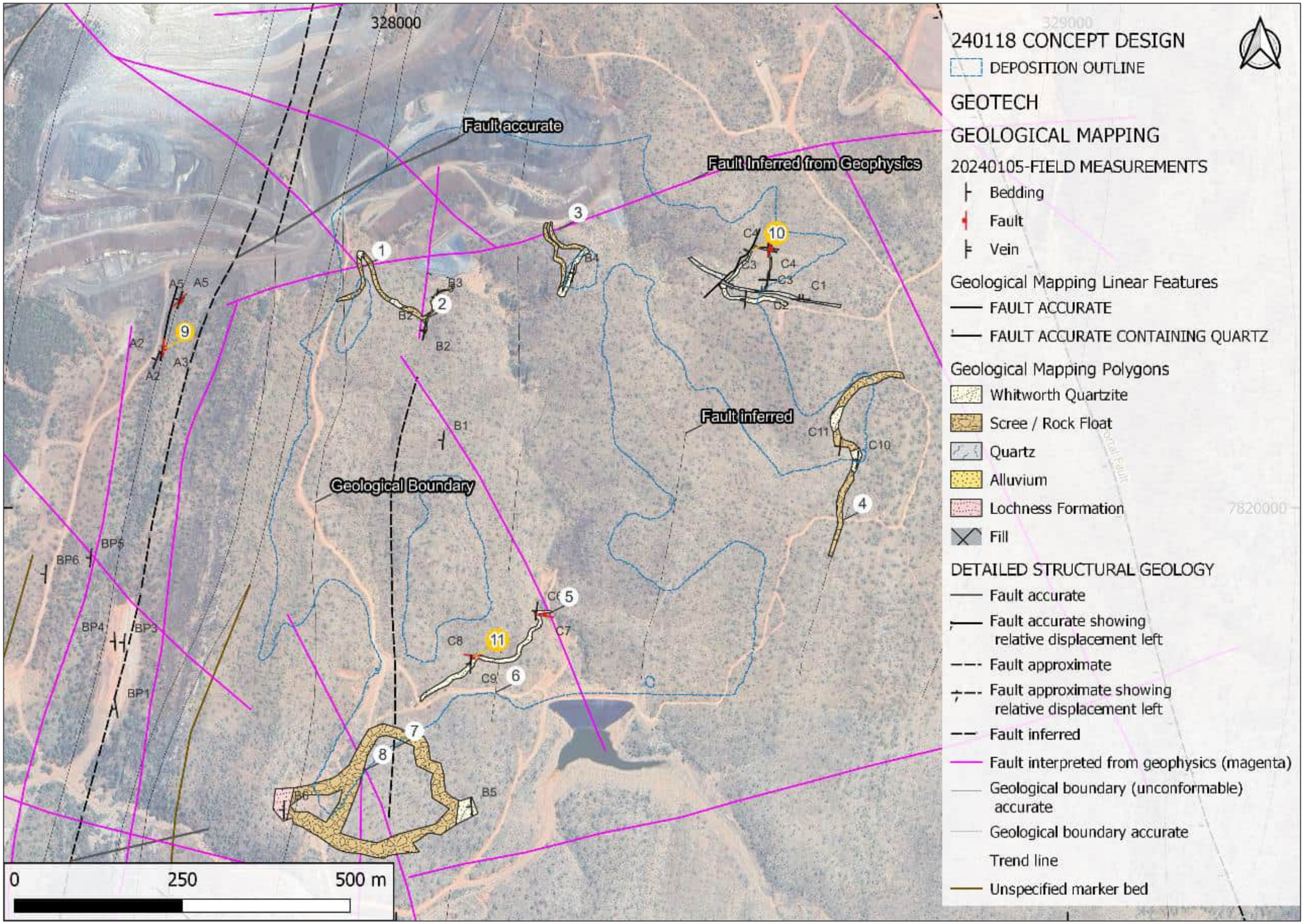


FIGURE 3.2: COMPLETED GEOLOGICAL MAPPING AREAS

TABLE 3.2: FAULT MAPPING RESULTS

Target No.	Original Structure Identification Method	Surface Expression (Y/N)	Comments / Description	Seepage Risk /Potential Treatment (low/medium/ high)	Typical Site Photo
1	Geophysics	N	Very little outcropping rock, mostly scree. Where rock does outcrop, joint spacing averages ~300 mm and is tight.	**Low** – no treatment expected.	 Taken 100m upstream of the TSF3 embankment within the Upper Esperanza Valley.
2	Geophysics	N			
3	Geophysics	N			
4	1:100,000 Detailed Mapping	N	Very little outcropping rock, mostly scree. No obvious fault indicators.	**Low** – no treatment expected.	N/A

Target No.	Original Structure Identification Method	Surface Expression (Y/N)	Comments / Description	Seepage Risk /Potential Treatment (low/medium/ high)	Typical Site Photo
5	Geophysics	N	No continuous seams. Some discontinuous breccia zones observed (striking roughly ~90° and extend for around 5m), however, no other information that would indicate large continuous geological structures. High to Very High Strength, slightly weathered to fresh.	**Low** – no treatment expected, breccia outside dam embankment and contained within tailings impoundment.	 Photo taken around 50m south of the downstream toe of the UEDD.
6	1:100,000 Detailed Mapping	N	Very little outcropping rock, mostly scree. No obvious fault indicators. Where outcrop occurred, dominated by quartzite with clear bedsets and strikelines.	**Low** – no treatment expected.	**N/A**
7	1:100,000 Detailed Mapping	N			
8	Geophysics	N			
Additional Features Identified During Mapping Program					

Target No.	Original Structure Identification Method	Surface Expression (Y/N)	Comments / Description	Seepage Risk /Potential Treatment (low/medium/ high)	Typical Site Photo
9	Identified during mapping	Y	Fault observed in Paradise Creek Formation. Rock either side of the fault surface shows fracture habit and spacing roughly 10-20 mm orthogonal to bedding. The fault material itself is characterised by thick (~ 10 mm) manganese oxide along fault surface with granular gouge material and native copper(?).	N/A – Outside of dam impoundment area, for reference only.	 Photo taken at mapping target 9, as shown on Figure 3.2
10	Identified during mapping	Y	Identified by strike separation (totalling 30 m) of quartz veins striking parallel to bedding. Quartz veins are around 1 m thick and the fault surface was identified by en-echelon veining along the strike of the fault. Fault material was completely healed, very high strength and fresh. Any jointing observed in the vicinity appears tight.	**Low** – no treatment expected.	 Photo taken at mapping target 10, as shown on Figure 3.2

Target No.	Original Structure Identification Method	Surface Expression (Y/N)	Comments / Description	Seepage Risk /Potential Treatment (low/medium/ high)	Typical Site Photo
11	Identified during mapping	Y	Fault breccia 600 mm thick, striking ~275°, re-healed, high to very high strength, slightly weathered to fresh, competent material.	**Low** – no treatment expected.	

Photo taken at mapping target 11, as shown on Figure 3.2

3.5 Borrow Areas

The target borrow areas mapped were limited to the battery limits displayed previously in Figure 2.14. The mapping program focused on finding material of lower permeability for use in embankment construction and closure capping.

Results of the borrow area assessment are presented in Table 3.3 below.

TABLE 3.3: BORROW AREA ASSESSMENT SUMMARY

Target No.	Target Lithology	Viable Borrow Source (Y/N)	Comments / Description
Borrow Area 1	Gunpowder Creek Alluvium	N	Mostly consisted of gravels and sand with oversize (cobbles and boulders) dominating the area.
Borrow Area 2	Existing Southern Borrow / Paradise Creek Formation	Y	Viable borrow source for a small amount of clay and potential crushed aggregate or bedding material through pallid siltstones and dolomitic siltstones. Rock aggregate sizes and breaking habit of rocks to be confirmed by follow up test pitting program.
Borrow Area 3	Residual Soils and XW ECV	N	Little to no residual soil development.
Borrow Area 4	Future Diversion Drain Cut / Paradise Creek Formation	Y	Viable borrow source for a small amount of clay and potential crushed aggregate or bedding material. Rock aggregate sizes and breaking habit of rocks to be confirmed by follow up test pitting program.
Borrow Area 5	Quaternary Alluvium/Colluvium	N	Soils dominated by sands, silts and gravels.
Borrow Area 6	Airport, residual and XW ECV	Y	Clayey soils noted just north-west airstrip adjacent the access road, this could be opened together with the previously identified borrow area located nearby by GHD in 2019.
Tailings Impoundment Area	Whitworth Quartzite	N	Little to no residual soil development.

4. CONCLUSIONS & RECOMMENDATIONS

4.1 Conclusions

The following conclusions may be drawn from the desktop assessment and geological mapping program completed to date.

General:

- Access to the TSF3 impoundment area is limited due to high strength rock at surface and undulating terrain, which dictates the requirement for advanced planning for future access tracks to potential borehole drilling locations and placement of LV tracks around the proposed TSF3 impoundment extents.
- Review of historic aerial imagery from 1972 shows the waste rock dump to be constructed over and infilled an old drainage line which connects to the UEV. It is unclear what preparation was completed to remove unfavourable materials (alluvium, organise detritus, etc) prior to the placement of waste rock.

Lithology, Structures and Seepage Pathways (Rock):

- The upstream extents of the proposed TSF3 embankments and the TSF3 impoundment area is contained within Quartzite, quartzose sandstones and chert lithologies (belonging to the Whitworth Quartzite, Lochness Formation and Torpedo Creek Quartzite respectively). These rock units appear to be well cemented, have low porosity, are high strength and with tight or healed discontinuities (joints and faults). This indicates an overall low permeability (defect controlled or similar) and likely presents a low risk to seepage.
- Defined joint sets are noted within the Whitworth Quartzite are summarised as follows:
  - Bedding: 73° / 294.
  - Joint Set 1: 69° / 173.
  - Joint Set 2: 71° / 008.
  - Joint Set 3: 28° / 088.
- Geological structures (investigated through mapping targets 1-9) intersecting the TSF3 impoundment showed to have no surface expression and the discontinuities (joints and bedding) in these areas appear to remain unchanged from the typical descriptions described here-in. Generally, structures such as shear zones and faults would generally need to exhibit open jointing, a halo of weak and weathered material to allow for high hydraulic conductivity, which is not consistent with what was found during the mapping program.
- Some discrete areas of Breccia (at additional mapping target 11) were noted, however, were not wide-spread and appeared to be discontinuous in nature and do not present a material risk of seepage.
- The geological mapping program was expanded on site to areas outside of the TSF3 embankment and impoundment area (at additional mapping target 9) to better understand adjacent geological conditions in the Paradise Creek Formation. In general, these appears to be less favourable for the TSF3 location for the following reasons:
  - Higher degree of weathering and lower strength was noted, i.e. less competent materials.
  - Highly brecciated material and open fractures noted adjacent identified fault areas, (which is different to the TSF3 areas which showed no surface expression).
- Further mapping of this unit will be required during subsequent phases of design to confirm the hydrogeological characteristics of the materials at depth. Near surface weathering processes are likely to result in a more permeable horizon, which should improve (i.e. become less permeable with depth). A baseline (sentinel) monitoring bore will be required in this unit, ideally drilled along, and through, one of the priority faults mapped as extending from the proposed TSF3 reservoir to the west.

Borrow Areas (low permeability soils)

- Borrow areas 1, 3, 5 and 6 showed little to no soil development at surface and does not present viable options for low permeability borrow sources.

- Borrow areas 2 and 4 appear to be a viable borrow source for a small amount of clay and potential crushed aggregate or bedding material. The volume of clay available, rock aggregate sizes and breaking habit of rocks will need to be confirmed by a follow up test pitting program. The test pitting program should follow the bedding strike of the Paradise Creek Formation, which is the source rock.
- Areas immediately north-east of the access road adjacent the airstrip appear to have the highest available quantities of low permeability clay, along with previous areas identified by the GHD investigation in 2019.

4.2 Recommendations

Based on the outcomes of the desktop assessment and field geological mapping program, recommendations and actions are provided in Table 4.1.

TABLE 4.1: RECOMMENDATIONS

Consideration	Recommendation	Action Needed
Access for subsequent investigations.	All follow up investigations shall be scheduled in areas that provide reasonable access, i.e., utilise existing access tracks, accessible benches of the waste rock dump, etc. Thought should be given during preliminary design for the design and placement of future access tracks where existing access tracks are inundated by the TSF3 extents.	**Yes**, currently being completed as part of preliminary and detailed design.
Waste Rock Dump Geometry	Confirmatory boreholes are recommended to constrain the geometry of the waste rock dump and confirm ground conditions beneath the dump through the old drainage lines identified through aerial imagery.	**Yes**. Additional boreholes are detailed in the geotechnical brief *QC1022_018-SOW-001-0-Geotechnical Investigation Brief.pdf* dated 9 February 2024.
Sub-surface lithology and fracture properties below dam embankment	Although seepage through fractures and low strength rock has been identified through geological mapping as being low risk, confirmatory boreholes are recommended. Boreholes shall be inclined and directed such that each hole intersects high angle interbeds and joint sets as much as possible. Optimal borehole dip and azimuth of 60°/210 has been identified via stereographic review (refer Figure 3.1).	**Yes**. Additional boreholes are detailed in the geotechnical brief *QC1022_018-SOW-001-0-Geotechnical Investigation Brief.pdf* dated 9 February 2024.
Borrow Area Investigations (at Borrow areas 2 and 4).	These areas require confirmatory test pitting to assess the suitability and volume of clay and potential crushed aggregate for bedding material.	**Yes**. Additional test pits are detailed in the geotechnical brief *QC1022_018-SOW-001-0-Geotechnical Investigation Brief.pdf* dated 9 February 2024.
Borrow Area Investigations – Airport Quaternary Colluvium borrow source.	GHD have previously identified the Airport Quaternary Colluvium borrow source as having ~210,000m^3 of low permeability clay. Follow up survey is required to confirm volumes.	**Yes,** CapCopper to complete follow up survey.

5. REFERENCES

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6. QUALIFICATIONS

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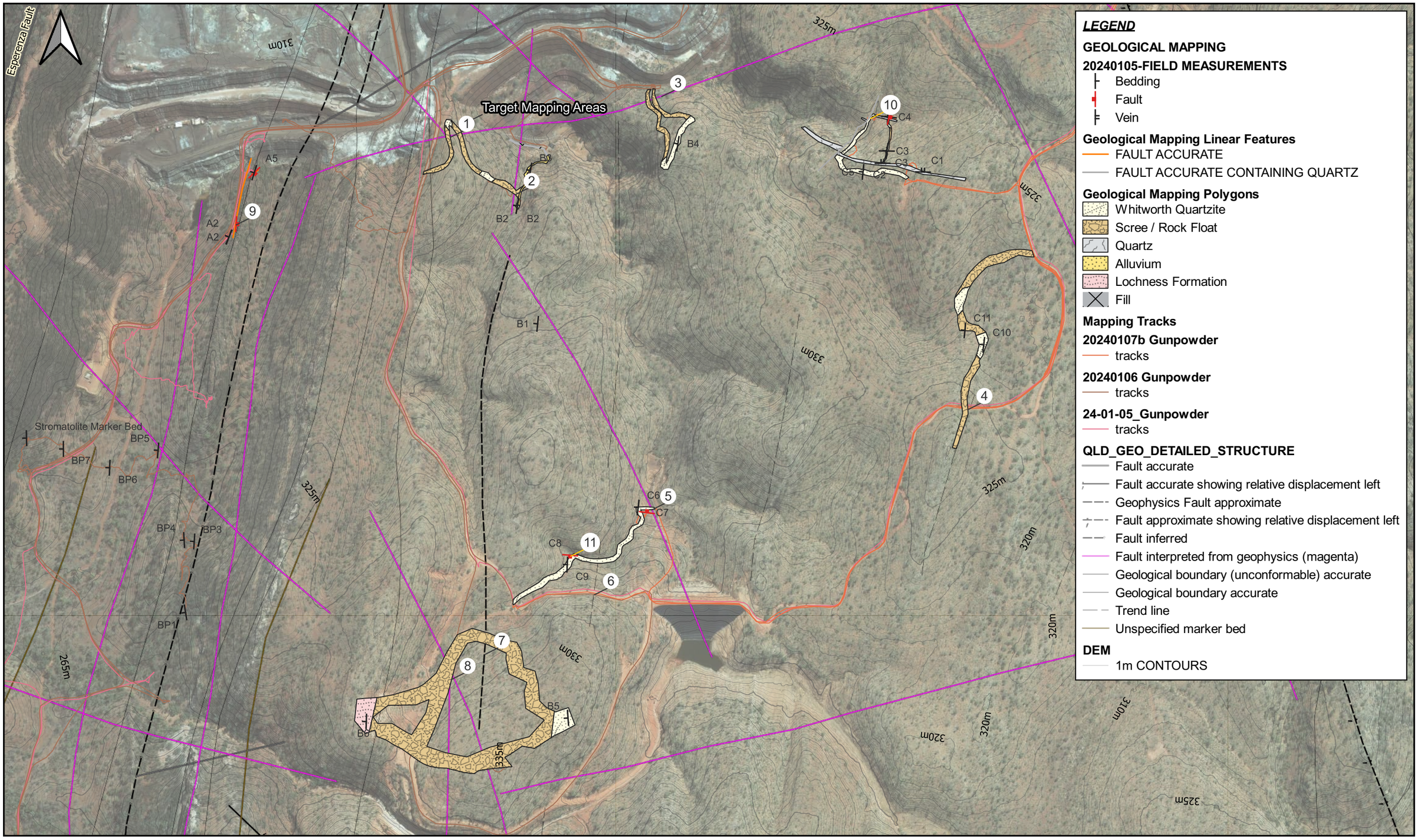
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APPENDIX A: GEOLOGICAL MAPPING FIGURE



LEGEND

GEOLOGICAL MAPPING

20240105-FIELD MEASUREMENTS
- Bedding
- Fault
- Vein

Geological Mapping Linear Features
- FAULT ACCURATE
- FAULT ACCURATE CONTAINING QUARTZ

Geological Mapping Polygons
- Whitworth Quartzite
- Scree / Rock Float
- Quartz
- Alluvium
- Lochness Formation
- Fill

Mapping Tracks

20240107b Gunpowder
- tracks

20240106 Gunpowder
- tracks

24-01-05_Gunpowder
- tracks

QLD_GEO_DETAILED_STRUCTURE
- Fault accurate
- Fault accurate showing relative displacement left
- Geophysics Fault approximate
- Fault approximate showing relative displacement left
- Fault inferred
- Fault interpreted from geophysics (magenta)
- Geological boundary (unconformable) accurate
- Geological boundary accurate
- Trend line
- Unspecified marker bed

DEM
- 1m CONTOURS

SCALE: 1:5,000
HORIZONTAL DATUM: GDA94 MGA ZONE 54
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

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No.	BY	DATE	REVISION	APPD
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DOC NUMBER	DOCUMENT TITLE
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DRAWN	AL	CHECKED	BW
APPROVED	BW	DATE	21/03/24
RPEQ	-	RPEQ No.	-

CAPRICORN COPPER PTY LTD

GEOLOGICAL MAPPING
CAPRICORN COPPER MINE - TSF3
SHEET 1 OF 1

Original size	Drg No.	Rev.
A3	QC1022-018-SKE-0004	0

APPENDIX B: MAPPING NOTES

TSF3 Geological Mapping Notes

Capircorn Copper Mine

Project:	TSF3 Preliminary Design
Date:	5/01/2024 to 7/01/2024
Revision:	0
Work By:	AL
Reviewed:	DJF

ENGENY

Site ID	Time Stamp	Date	Obs. ID	Easting	Northing	Type	Dip	Direction	Description
A1	14:04	5/01/2024	1	327,616.00	7,820,000.00				Paradise Creek Formation, chert, grey, dull, earth interbeds and stromatilitic, subvertical bedding.
A2	14:57	5/01/2024	1	327,643.00	7,820,220.00	Bedding	73	294	Boundary between competent and highly fractured (fault affected material). Fracture habit and spacing roughly 10-20 mm orthogonal to bedding.
A2	14:57	5/01/2024	2	327,643.00	7,820,220.00	Joint	61	029	Boundary between competent and highly fractured (fault affected material). Fracture habit and spacing roughly 10-20 mm orthogonal to bedding.
A2	14:57	5/01/2024	3	327,643.00	7,820,220.00	Joint	72	163	Boundary between competent and highly fractured (fault affected material). Fracture habit and spacing roughly 10-20 mm orthogonal to bedding.
A2	14:57	5/01/2024	4	327,643.00	7,820,220.00	Bedding	64	290	Boundary between competent and highly fractured (fault affected material). Fracture habit and spacing roughly 10-20 mm orthogonal to bedding.
A3	15:05	5/01/2024	1	327,653.00	7,820,238.00	Fault	80	274	Fault material characterised by thick (~ 10 mm) manganese oxide along fault surface with granular gouge material and ¿native copper.
A4	15:15	5/01/2024	1	327,671.00	7,820,310.00				Accommodation fault, 300 mm spacing separating C-structures
A5	15:21	5/01/2024	1	327,678.00	7,820,309.00	Fault	80	316	Fault surface, striated surface, highly fractured, though rehealed, rock structure to ~ 10 m either side of fault.
A5	15:21	5/01/2024	2	327,678.00	7,820,309.00	Bedding	65	287	Fault surface, striated surface, highly fractured, though rehealed, rock structure to ~ 10 m either side of fault.
BP		5/01/2024	1	327,583.00	7,819,701.00	Bedding	75	261	Siltstone, off white to purplish pink to red, chalky (¿dolomitic), highly weathered, thinly laminated, low to medium, slatey cleavage, fissile.
BP		5/01/2024	2	327,583.00	7,819,701.00				Possible sulfide casts, ¿pyrite. Appearance similar to Zebra Stone, grades upward from pale, chalky, leached, to iron oxide rich, red to dark red + MnO on defects.
BP		5/01/2024	1	327,595.00	7,819,799.00	Bedding	68	274	Pale Siltstone
BP		5/01/2024	1	327,581.00	7,819,801.00	Bedding	69	267	Red Siltstone
BP		5/01/2024	1	327,545.00	7,819,925.00	Bedding	71	275	Yellow Arenite
BP		5/01/2024	1	327,478.00	7,819,901.00	Bedding	65	273	Dolomitic + Stromatolitic Siltstone
BP		5/01/2024	1	327,414.00	7,819,927.00	Bedding	71	270	Change to arenite to west from dolomitic siltstone to east
Stromatolite Marker Bed		5/01/2024	1	327,363.00	7,819,942.00	Bedding	66	269	Stromatolite marker bed, siliceous, grey, high strength, SW-Fr
B1	10:07	6/01/2024	1	328,070.00	7,820,100.00	Bedding	70	276	Whitworth Sandstone
B2	10:17	6/01/2024	1	328,042.00	7,820,263.00	Bedding	56	281	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	2	328,042.00	7,820,263.00	Joint	29	086	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	3	328,042.00	7,820,263.00	Joint	69	001	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	4	328,042.00	7,820,263.00	Joint	29	093	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	5	328,042.00	7,820,263.00	Joint	16	020	Whitworth Sandstone (East of Creek)
B2	10:17	6/01/2024	6	328,042.00	7,820,263.00	Joint	31	148	Whitworth Sandstone (West of Creek)
B2	10:17	6/01/2024	7	328,042.00	7,820,263.00	Bedding	56	280	Whitworth Sandstone (West of Creek)
B3	10:32	6/01/2024	1	328,060.00	7,820,312.00	Bedding	62	280	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	2	328,060.00	7,820,312.00	Joint	76	018	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	3	328,060.00	7,820,312.00	Joint	53	096	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	4	328,060.00	7,820,312.00	Joint	32	053	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	5	328,060.00	7,820,312.00	Joint	74	175	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	6	328,060.00	7,820,312.00	Joint	88	071	Joint spacing averages ~ 300 mm, tight with manganese staining.
B3	10:32	6/01/2024	7	328,060.00	7,820,312.00	Joint	65	077	Joint spacing averages ~ 300 mm, tight with manganese staining.

B4	12:17	6/01/2024	1	328,264.00	7,820,349.00	Bedding	61	279	Slope break, natural bench. Fine grained, dominantly quartz, minor feldspar or oxidised sulfide providing pinkish hue.
B4	12:17	6/01/2024	2	328,264.00	7,820,349.00	Joint	34	094	Slope break, natural bench. Fine grained, dominantly quartz, minor feldspar or oxidised sulfide providing pinkish hue.
B4	12:17	6/01/2024	3	328,264.00	7,820,349.00	Joint	62	161	Slope break, natural bench. Fine grained, dominantly quartz, minor feldspar or oxidised sulfide providing pinkish hue.
B4	12:17	6/01/2024	4	328,264.00	7,820,349.00	Joint	76	187	Slope break, natural bench. Fine grained, dominantly quartz, minor feldspar or oxidised sulfide providing pinkish hue.
B5	14:19	6/01/2024	1	328,112.00	7,819,555.00	Bedding	61	266	Sandstone
B6	13:56	6/01/2024	1	327,833.00	7,819,550.00	Bedding	54	272	Feldspathic sandstone and siltstone, medium strength, highly weathered. Lochness Formation.
C1	11:21	7/01/2024	1	328,603.00	7,820,310.00	Vein	70	001	Fine grained, white multiphase stockwork quartz blow bordering Lochness Formation.
C2	11:30	7/01/2024	1	328,547.00	7,820,322.00	Vein	76	000	Quartz Blow
C3	11:30	7/01/2024	1	328,553.00	7,820,339.00	Bedding	69	278	Lochness
C3	11:30	7/01/2024	2	328,553.00	7,820,339.00	Bedding	46	001	Quartz Blow
C4	11:48	7/01/2024	1	328,556.00	7,820,386.00	Vein	63	007	Quartz Vein
C4	11:48	7/01/2024	2	328,556.00	7,820,386.00	Bedding	56	280	Whitworth
C4	11:48	7/01/2024	3	328,556.00	7,820,386.00	Fault	64	282	Whitworth
C5	12:10	7/01/2024	1	328,520.00	7,820,310.00	Joint	64	178	
C5	12:10	7/01/2024	2	328,520.00	7,820,310.00	Joint	49	026	
C5	12:10	7/01/2024	3	328,520.00	7,820,310.00	Bedding	53	276	
C6	12:26	7/01/2024	1	328,209.00	7,819,846.00	Joint	71	022	200-300mm spacing, 2m+ trace length, tight.
C6	12:26	7/01/2024	2	328,209.00	7,819,846.00	Joint	11	032	200-300mm spacing, 2m+ trace length, tight.
C6	12:26	7/01/2024	3	328,209.00	7,819,846.00	Joint	86	223	200-300mm spacing, 2m+ trace length, tight.
C6	12:26	7/01/2024	4	328,209.00	7,819,846.00	Bedding	64	277	Whitworth
C7	12:45	7/01/2024	1	328,221.00	7,819,839.00	Fault	88	188	Fault breccia, starts as fracture zone and progresses into clast supported, semi-healed high strength Breccia. Individual clasts can be plucked with force or hammer blow. Some loose gravel from the breccia observed.
C8	12:50	7/01/2024	1	328,115.00	7,819,780.00	Fault	76	005	Fault breccia 600mm thick, totally healed.
C9	12:53	7/01/2024	1	328,111.00	7,819,767.00	Joint	44	106	
C9	12:53	7/01/2024	2	328,111.00	7,819,767.00	Joint	68	144	
C9	12:53	7/01/2024	3	328,111.00	7,819,767.00	Bedding	64	273	
C9	12:53	7/01/2024	4	328,111.00	7,819,767.00	Joint	20	076	
C10	13:20	7/01/2024	1	328,687.00	7,820,071.00	Joint	46	287	
C10	13:20	7/01/2024	2	328,687.00	7,820,071.00	Bedding	66	277	
C11	13:26	7/01/2024	1	328,661.00	7,820,091.00	Bedding	51	276	
C11	13:26	7/01/2024	2	328,661.00	7,820,091.00	Joint	53	183	

APPENDIX C: ATC WILLIAMS MODEL

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122073.05M01 Rev 0

15 August 2023

29Metals Limited, Capricorn Copper Mine

By email: Michael Hogan (Michael.Hogan@29metals.com.au)
CC: Tara Garrood (Tara.Garrood@29metals.com)

ATTENTION: Michael Hogan

Dear Michael,

CAPRICORN COPPER, TEMPORARY WATER STORAGE OPTIONS ASSESSMENT: HYDROGEOLOGICAL RISK AND IMPACT ASSESSMENT

1 INTRODUCTION

Capricorn Copper Mine (CCM) experienced high levels of rainfall over the 2022/2023 wet season. This resulted in the Esperanza South Underground Mine (ESS) experiencing significant flooding that resulted in the cessation of production. 29Metals estimates that the surplus water present at the site is in excess of 1 Mm^3 (1 Gl).

In order to provide a short-term alternative for the CCM site excess water storage and support the ongoing Life of Mine (LoM) tailings management strategy update, 29Metals is currently assessing the feasibility of storing water in the Upper Esperanza Valley (UEV).

ATC Williams (ATCW) was commissioned by 29Metals to complete a desktop assessment of the potential impacts of water storage in the UEV on the groundwater system at CCM, presented in this report.

2 REGIONAL SETTING

Previous reports have outlined the regional geology of CCM **[1]**. The Paleoproterozoic units form geological basement present at CCM which comprise the Haslingden, Calvert and McNamara Groups. Copper mineralisation is hosted within the Whitworth Quartzite of the Haslingden Group, the Surprise Creek Formations of the Calvert Group, and the Mt Oxide Chert and Esperanza Formations of the McNamara Group.

The basement is overlain by the Cambrian Mt Henry Formation and Beetle Creek Formation. Above these formations there is a mix of Jurassic to Cretaceous aged sandstone, conglomerate, siltstone and claystone. The sequence is capped at surface by a Tertiary colluvium and Quaternary alluvium.

Diagram 1 presents the regional geology in the vicinity of the UEV. The regional stratigraphy at CCM (as outlined in **[1]**) is shown in **Diagram 2**.

Significant fault structures exist across CCM (**Diagram 1**). Prominent faults include the north-south trending Wedgetail, Esperanza and Portal faults, and the east-northeast trending Mammoth and Mammoth Extended faults.

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Hydrogeologist report **[1]** notes that there are three main types of groundwater occurrence within the vicinity of CCM:

- Shallow, perched aquifers in the surficial sediments along the sides and floor of valleys;
- Fractured rock aquifers best developed in the near-surface zone with a depth of up to 30 m; and
- Solution cavity aquifers locally developed in the dolomitic siltstones and in the deeply weathered zone above the Esperanza ore deposit.

The shallow perched aquifers are small and ephemeral. Generally, these aquifers only contain water following significant rainfall events, prior to infiltration to the underlying fractured rock aquifer.

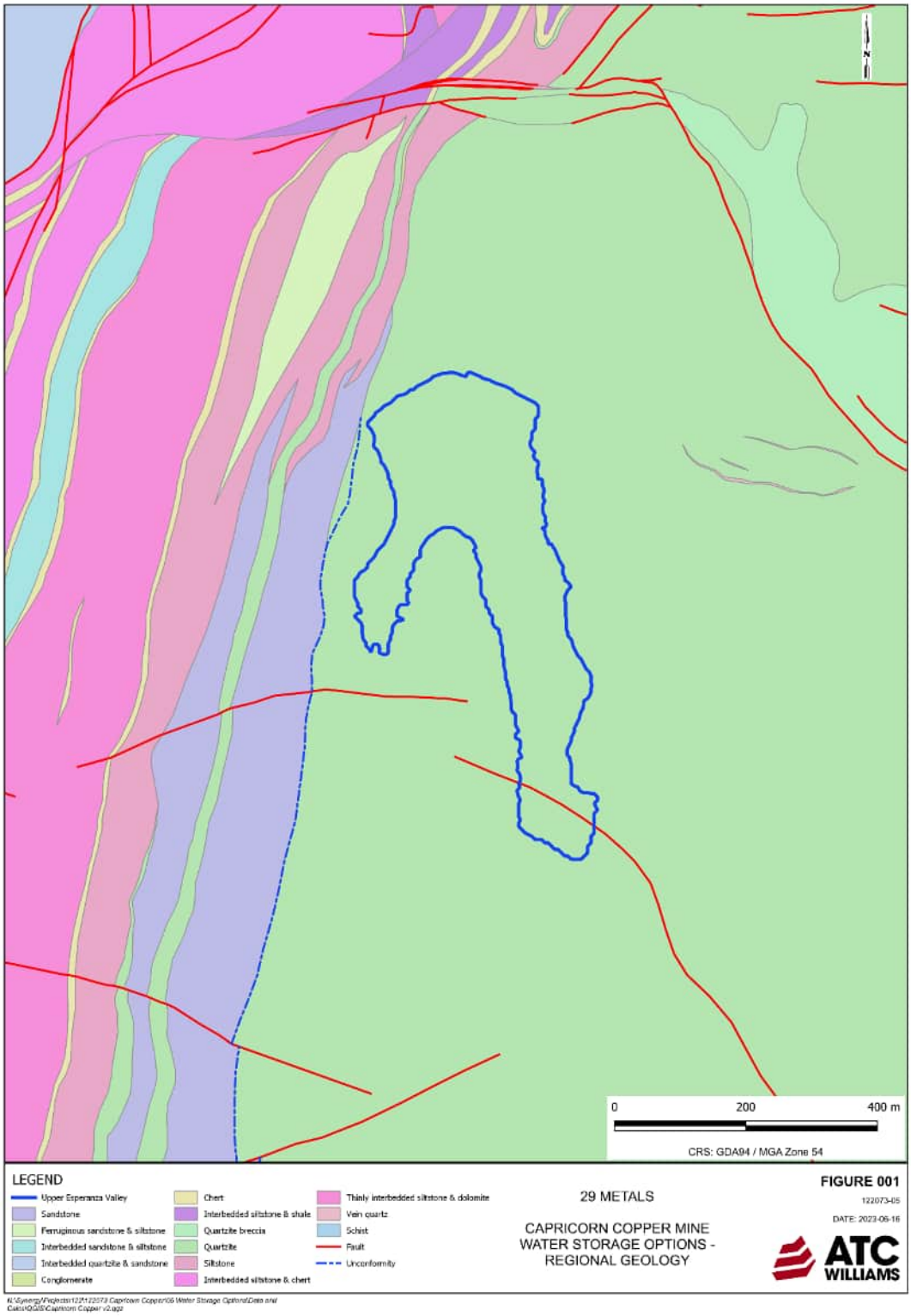
The main groundwater system is hosted within the fractured rock aquifers at depths of up to 100 m below the surface. This aquifer generally hosts the water table, with groundwater elevation influenced by factors such as topography and the presence of site infrastructure.

Where laminated siltstones and shales are present at CCM, the upper 10 – 30 m of these sequences have a higher permeability than the general rock mass. The increased hydraulic conductivity is due to stress release allowing the rocks to delaminate and develop open bedding plan fissures **[2]**.

The regional fault structures act as aquifer boundaries and/or groundwater flow conduits. Groundwater flow within the non-faulted areas of rock mass is highly compartmentalised with low permeability. Overall, the majority of groundwater flow is restricted to permeable fault zones that act as conduits **[2]**.

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DIAGRAM 1: REGIONAL GEOLOGY



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DIAGRAM 2: REGIONAL STRATIGRAPHY

Basin	Age	Group	Subgroup	Formation /Member	Lithology symbol	Description
	Quaternary	Alluvium				Flood-plain alluvium: Clay, silt, sand and gravel.
	Tertiary	Colluvium				Colluvial and residual clay, silt, sand and gravel on older land.
	Jurassic - Cretaceous					Sandstone, conglomerate, siltstone and claystone.
	Middle Cambrian			Beetle Creek Formation		Chert and siliceous shale, basal conglomerate.
	Neoproterozoic - Early Cambrian			Mount Hendry Formation		Conglomerate, feldspathic sandstone and shale.
Isa Superbasin	Paleoproterozoic (1670 - 1645 Ma)	McNamara Group		Lady Loretta Formation		Stromatolitic siltstone, limestone and shale.
				Esperanza Formation		Stromatolitic chert and dolomite, siliceous and dolomitic sandstone.
				Breakaway Shale		Grey siliceous siltstone and shale.
				Paradise Creek Formation		Stromatolitic dolomite and dolomitic siltstone, with limestone interbeds.
				Mount Oxide Chert Member		Grey laminated chert.
				Gunpowder Creek Formation		Arenite, mudrock: Laminated siltstone, dolomitic and carbonaceous siltstone, fine-grained sandstone, feldspathic and pyritic quartzite, pebbly clayey sandstone.
				Torpedo Creek Quartzite		White to medium quartzite, with gypsum pseudomorphs locally
Calvert Superbasin	Paleoproterozoic (1690 - 1670 Ma)			Surprise Creek Formation		Quartzite, sandstone, calcareous sandstone, conglomerate, siltstone and shale
				Bigie Formation		Purple-brown sandstone, pebbly sandstone, tuff, conglomerate and red-brown siltstone
Leichhardt Superbasin	Paleoproterozoic (1790 - 1760 Ma)	Haslingden Group	Myally Subgroup	Quilalar Formation		Fine to medium-grained feldspathic to quartzose sandstone.
				Lochness Formation		Dolomitic, feldspathic sandstone and siltstone and laminated ferruginous sandstone
				Whitworth Quartzite		Massive medium to coarse-grained feldspathic to quartzose sandstone, fine purple sandstone and mudflake conglomerate.
				Bortala Formation		Flaggy, fine-grained feldspathic sandstone, dolomitic sandstone, micaceous and tuffaceous siltstone, twith grey-green chert.
				Alsace Quartzite		Fine to coarse-grained feldspathic sandstone, orthoquartzite; minor siltstone.
			Eastern Creek Volcanics	Pickwick Metabasalt Member		Grey-green metabasalt, red-brown trachybasalt, amygdaloidal metabasalt; feldspathic quartzite and orthoquartzite
				Lena Quartzite Member		Feldspathic quartzite and orthoquartzite with rare pebbles
				Cromwell Metabasalt Member		Metabasalt, flow-top breccia and tuff
				Leander Quartzite		Orthoquartzite, feldspathic quartzite; schist, arkose, metabasalt
Ewan Block	Paleoproterozoic			Ewen Granite		Coarse porphyritic granite and granodiorite, microgranite, pegmatite

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3 UPPER ESPERANZA VALLEY

The UEV is an enclosed surface water catchment located approximately 500 m south of the Esperanza Pit, and 600 m east of the ESS mine. The topography of the area is presented in **Diagram 3**. 29Metals has indicated that the water which will be moved to the UEV will be treated prior to storage.

The Queensland detailed solid geological mapping indicates that the UEV is located within the Whitworth Quartzite, which is comprised of massive medium to coarse-grained feldspathic to quartzose sandstone, fine purple sandstone and mudflake conglomerate.

Structural mapping provided by 29Metals indicates that there is an unconformity located to the west of the UEV (along the mapped contact of the Whitworth Quartzite), and an inferred fault lies in an east-west direction within the southern extent of the UEV (**Diagram 1**). No other faults or fractures are mapped within the extent of the UEV.

The UEV is bounded by north-south trending ridges. The valley is covered with a thin layer of colluvium, with scree located on the upper slopes of the surrounding ridges.

3.1 Hydrogeology

Groundwater within the extent of the UEV is expected within the shallow perched aquifer system and the deep fractured rock aquifer system.

The extent of the shallow aquifer is limited to the extent of the colluvium present on the valley floor and sides. In the vicinity of CCM, soils are thin over most areas including valley floors, and this is expected to also occur within the extent of the UEV.

Groundwater within the colluvium is localised and recharged from direct rainfall. Due to the ridges surrounding the extent of the UEV, the shallow aquifer is not expected to be hydraulically connected to any other surficial aquifers at CCM (**Diagram 3**).

The UEV is located within the Whitworth Quartzite, which is considered to be a relatively impermeable aquitards due to re-crystallisation during regional metamorphism which resulted in little to no primary porosity in the quartzite **[3]**. The hydraulic conductivity of the quartzite is low (in the order of 10^{-7} m/sec) **[2]**, with areas of higher permeability present in the secondary porosity associated with fractures.

The near-surface zone of higher permeability in the fractured rock aquifer (associated with delaminating siltstones and shales) is not likely to be present due to the absence of any mapped siltstone or shale within the extent of the UEV.

3.2 Risks

Given the low hydraulic conductivity of the quartzite, it is likely that the volume of seepage losses from the impoundment will be low if water is stored in the UEV to the designated level. Any mounding associated with the storage of water within the UEV is therefore expected to be minimal. Available geology information indicates that there are no known faults and fractures transecting across the extent of the proposed UEV pond. On this basis the risk of preferential flow paths is low.

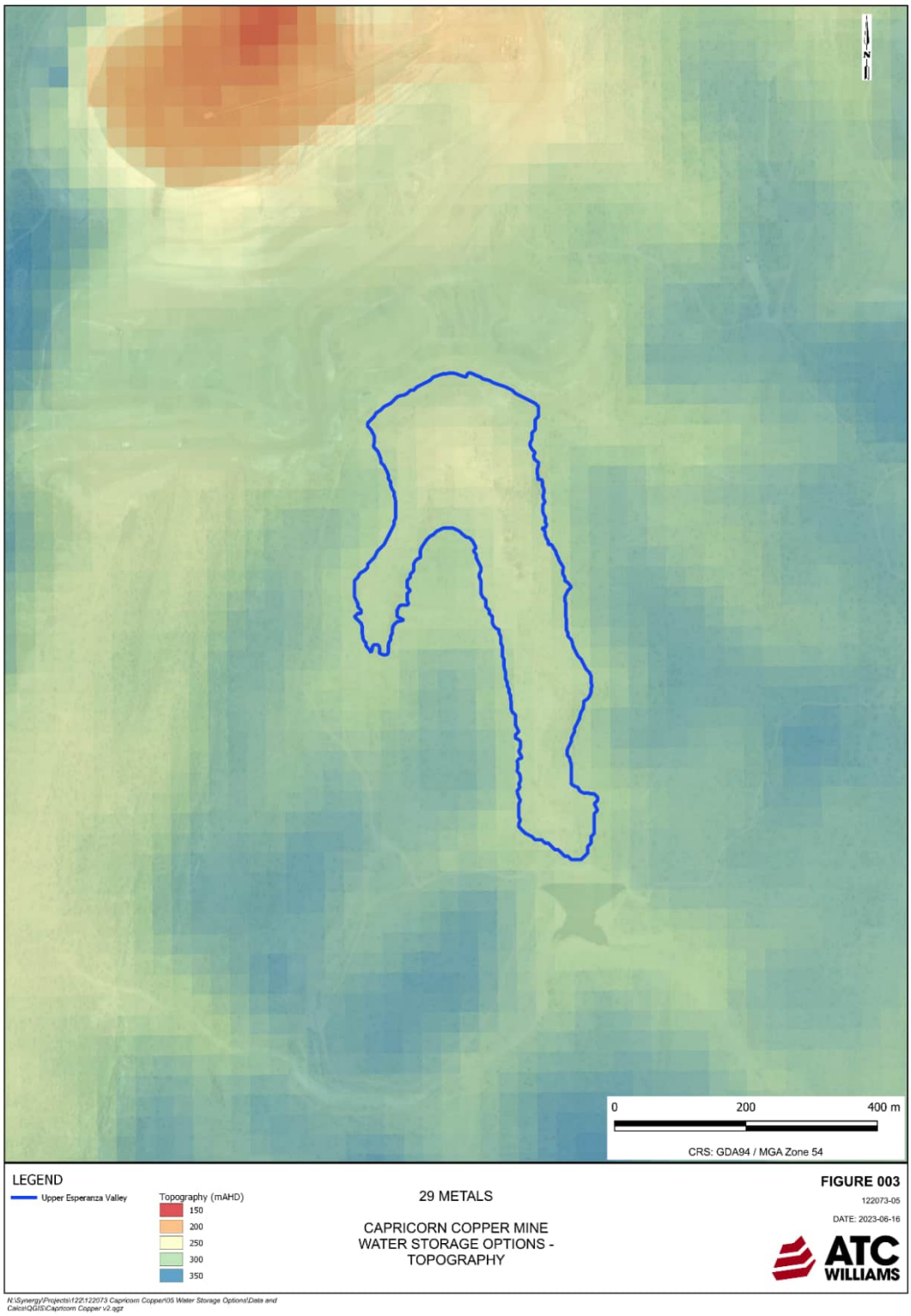
As the shallow aquifer is contained within the quartzite ridges that surround the UEV (**Diagram 3**), any seepage that may occur will be contained within the UEV. Additionally, the low hydraulic conductivity of the quartzite will retard the movement of any seepage within the fractured rock aquifer.

The July 2022 groundwater contours presented in **Diagram 4** indicate that groundwater flow in the vicinity of the UEV is to the northwest north, in the direction of the Esperanza Pit. Any potential groundwater migration from the UEV will follow the hydraulic gradient that exists toward the Esperanza Pit and will ultimately discharge into the pit.

As 29Metals have indicated that any water pumped to the UEV would be treated prior to storage, the risk to groundwater quality is considered to be low.

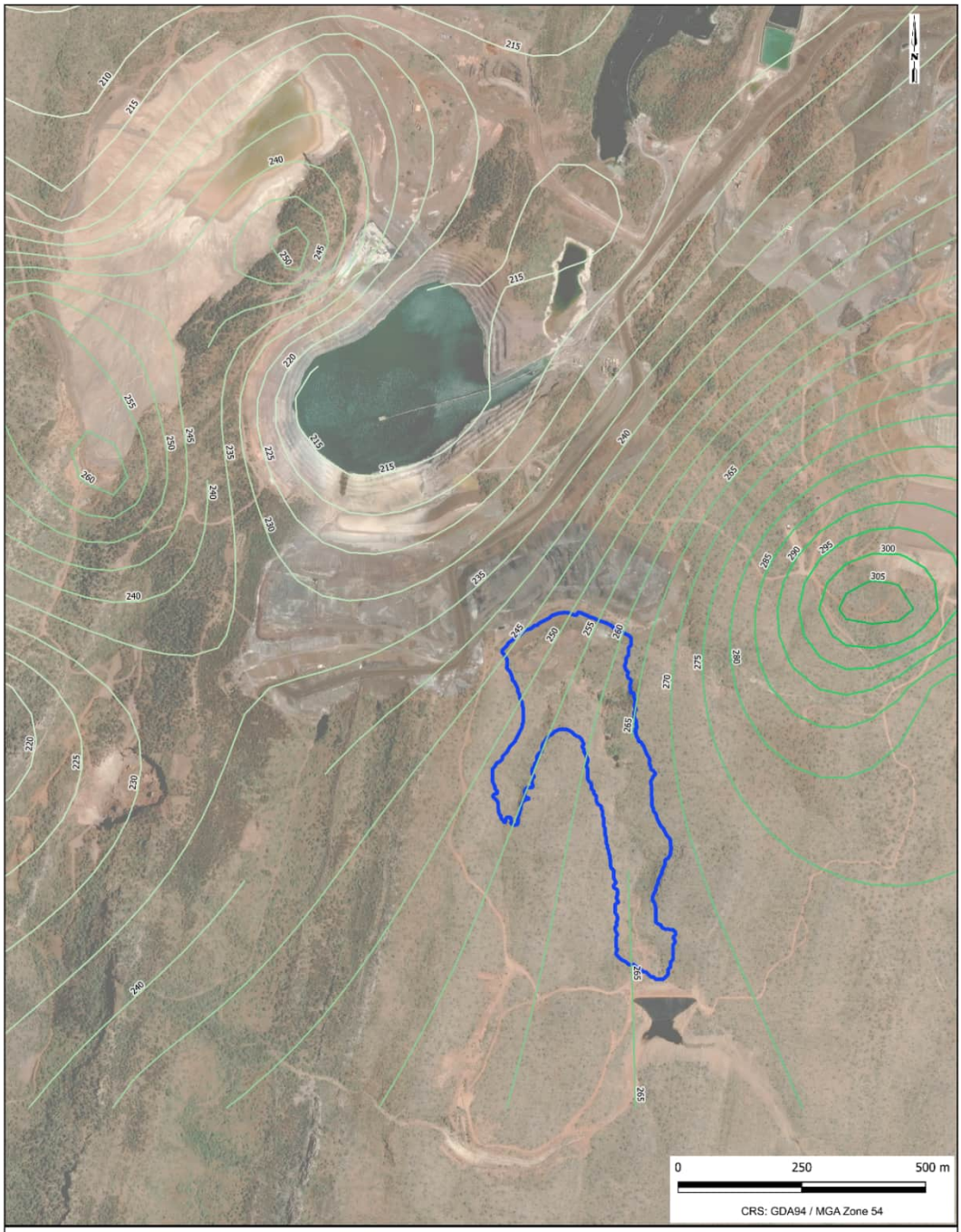
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DIAGRAM 3: TOPOGRAPHY OF THE UPPER ESPERANZA VALLEY



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DIAGRAM 4: JANUARY 2022 GROUNDWATER CONTOURS



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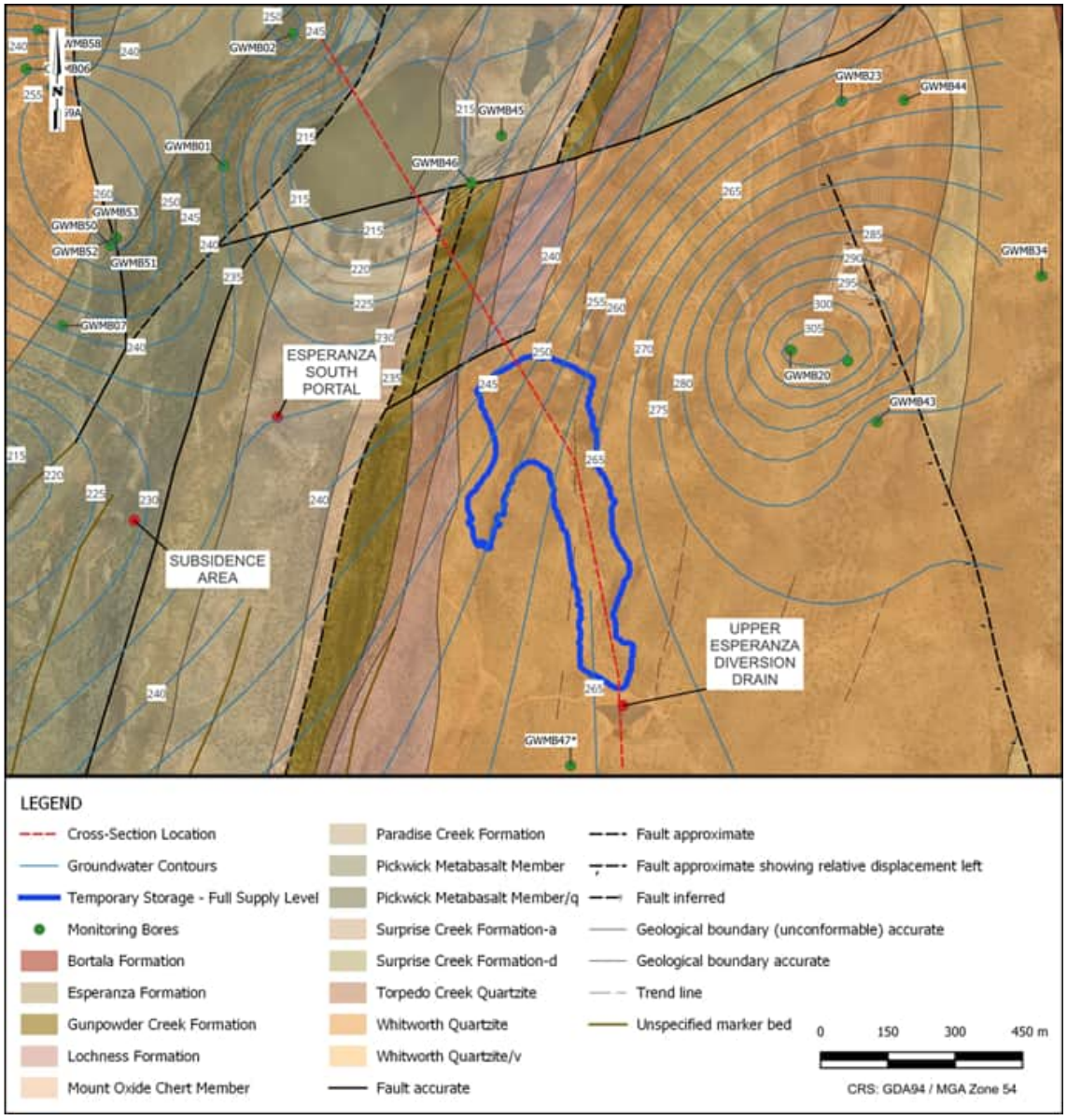
4 SEEPAGE ANALYSIS

4.1 Overview

A two-dimensional (2D) model was developed in SEEP/W to estimate the potential seepage from the proposed water storage in the UEV. The section adopted for the modelling was chosen to align with the groundwater flow-path from the UEV to the Esperanza Pit given the significant hydraulic gradient between the two. This is considered appropriate to assess any potential increase in seepage associated with water storage within the UEV.

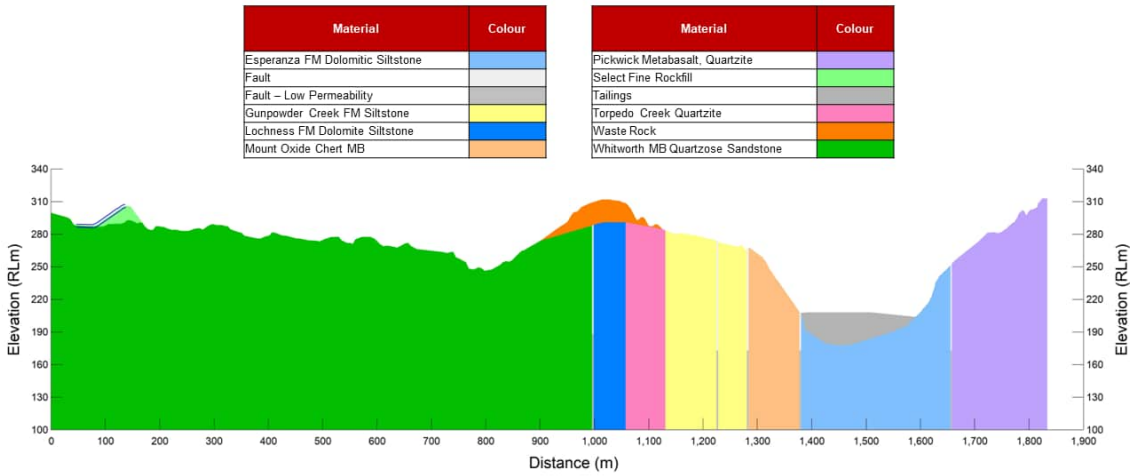
The model cross-section runs approximately northwest to southeast. The orientation of the model cross-section in relation to the UEV, Esperanza Pit and site geology is shown in **Diagram 5**. The simplified seepage model is shown in **Diagram 6**.

DIAGRAM 5: MODEL CROSS-SECTION LOCATION



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DIAGRAM 6: MODEL CROSS-SECTION



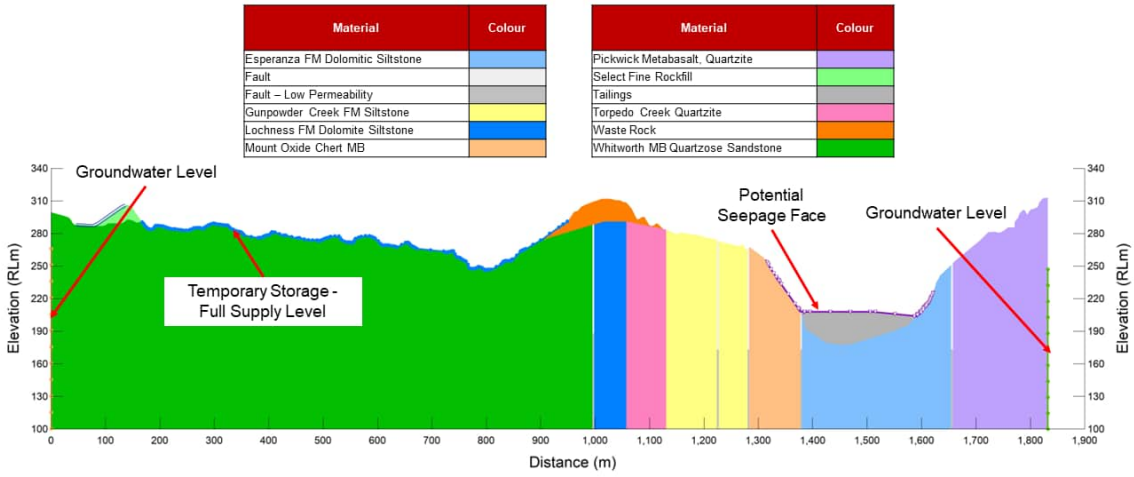
4.2 Boundary conditions

Model boundary conditions were assigned to represent the groundwater system:

- A constant head was applied at the Esperanza Pit to represent the water level within the pit as surveyed in October 2022 **[5]**.
- A constant head was applied to the extent of the UEV to represent the maximum design water level.
- Seepage faces were assigned to the slope area above the Esperanza Pit.
- Constant head boundaries were specified at the far left (southern) and far right (northern) limits of the model. The values applied were estimated from observed water level in monitoring bores, GWMB47 (southern) and GWMB02 (northern) (**Diagram 5**).

Diagram 7 shows the boundary conditions applied to the model.

DIAGRAM 7: MODEL BOUNDARY CONDITIONS



4.3 Adopted material parameters

The material parameters for the geological units were adopted from previous seepage modelling completed by ATCW **[4]**. As previous modelling work indicated that the transmissivity of the

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faults decreases with depth, a low permeability fault material was applied below a depth of 100 m to take this into account **[4]**.

TABLE 1 summarises the adopted permeability values and anisotropy ratios.

TABLE 1: MATERIAL PARAMETERS FOR SEEPAGE ANALYSES

Material	Permeability, $k_{x,sat}$ (m/s)	k_y/k_x
Esperanza FM dolomitic siltstone	5.8E-07	1
Fault – High Permeability	5.2E-06	1
Fault – Low Permeability	5.2E-09	1
Gunpowder Creek FM Siltstone	2.3E-07	1
Lochness FM Dolomite, Siltstone	5.6E-06	1
Mount Oxide Chert MB	5.8E-07	1
Pickwick Metabasalt, Quartzite	1.0E-06	1
Select fine rockfill	1.0E-05	1
Tailings	7.4E-07	0.1
Torpedo Creek Quartzite	9.0E-07	1
Waste rock	1.0E-05	0.3
Whitworth MB Quartzose Sandstone	1.5E-08	1

4.4 Assumptions and limitations

The assumptions and limitations applied to the seepage modelling include:

- A steady-state seepage analysis was conservatively adopted for the modelling to represent the existing, long-term conditions (namely, inflow equals outflow).
- Groundwater levels at the far southern and northern limits of the model were assumed to be static.
- No changes in the permeability of the faults within the model were taken into account after the commencement of water storage within the UEV.
- A steady-state seepage analysis was undertaken to predict the change in groundwater levels and therefore any changes in seepage flow rates. This is considered to be a conservative strategy given that the steady state condition is not expected to establish in the UEV once water storage commences.

4.5 Seepage analysis results

The results of the analysis are presented in **Attachment A**.

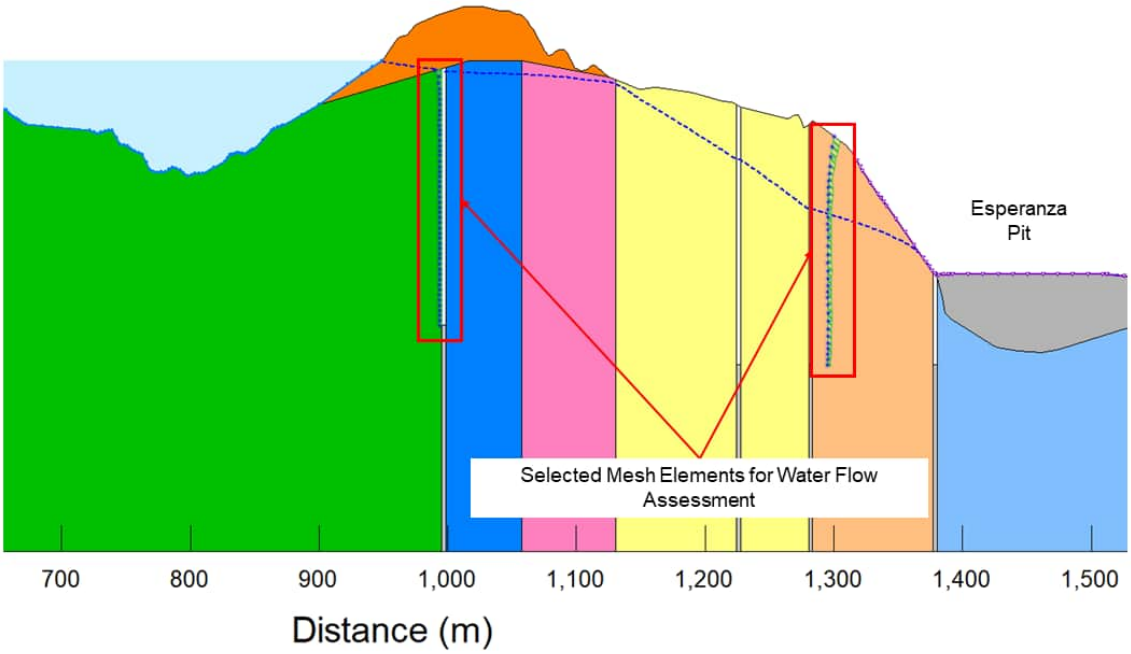
Diagram 8 illustrates the model elements considered for the assessment of water flow into the Esperanza Pit. The predicted seepage rates/variations to the EPit are summarised in **TABLE 2**. It should be noted that the seepage rates are reported per linear meter thickness of the model.

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TABLE 2: PREDICTED SEEPAGE RATES

Scenario	Predicted Seepage Rate (m^3/day/m)			Figure No. (Attachment A)
	Fault	Esperanza Pit	Total Seepage Difference	
Current Conditions – Esperanza Pit water level at 214.7 m	0.003	0.010	-	A-1
UEV – maximum water storage level at 291 m	0.010	0.675	0.672	A-2

DIAGRAM 8: SELECTED LINES FOR WATER FLOW ASSESSMENT



5 SUMMARY AND DISCUSSION

The risk and impact assessment into the proposed UEV water storage has concluded that:

- The shallow aquifer within the extent of the UEV is not expected to be hydraulically connected to any other surficial aquifers at CCM.
- The geology underlying the extent of the UEV (the Whitworth Quartzite) is considered to have a low hydraulic conductivity. This is expected to limit the rate of groundwater movement away from the UEV.
- Groundwater contours indicate the groundwater flow is in the direction of the Esperanza Pit. Any seepage associated with water storage within the UEV is expected to ultimately discharge into the pit. As shown in **Diagram 5**, any potential seepage through the UEV surrounding faults will also be intercepted by the pit.Seepage modelling indicates that the maximum level of water storage within the UEV is associated with an increase in seepage of approximately 0.7 m^3/day/m to the Esperanza Pit.

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6 REFERENCES

[1] Hydrogeologist.com.au, 2022. Hydrogeological Assessment of the Capricorn Copper Mine. Prepared for 29Metals Pty Ltd. Project number 4118. 12 July 2022.

[2] RLA, 2012. Investigations Into Groundwater Contamination as part of an Environmental Evaluation. Prepared for Birla Mount Gordon Mine. September 2012.

[3] GHD, 2012. Report for Esperanza Tailings Dam Raise – Master Seepage Report. Prepared for Birla Mount Gordon. May 2012.

[4] ATC Williams, 2023. Esperanza Tailings Storage Facility Lift 2 Seepage Assessment. Prepared for Capricorn Copper Pty Ltd. January 2023.

[5] Brolga Tech, 2022. Bathymetric Survey of Esperanza Pit and Mill Creek Dam. Prepared for Capricorn Copper Pty Ltd. October 2022.

Yours sincerely,

AMANDA CLEMENTS

Senior Hydrogeologist

BEHROOZ GHAHREMAN NEJAD

Chief Technical Officer / Senior Principal Engineer

Attachments:

1. Seepage Assessment Results
2. UEV Storage Curve

ATTACHMENTS

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ATTACHMENT 1 – SEEPAGE ASSESSMENT RESULTS

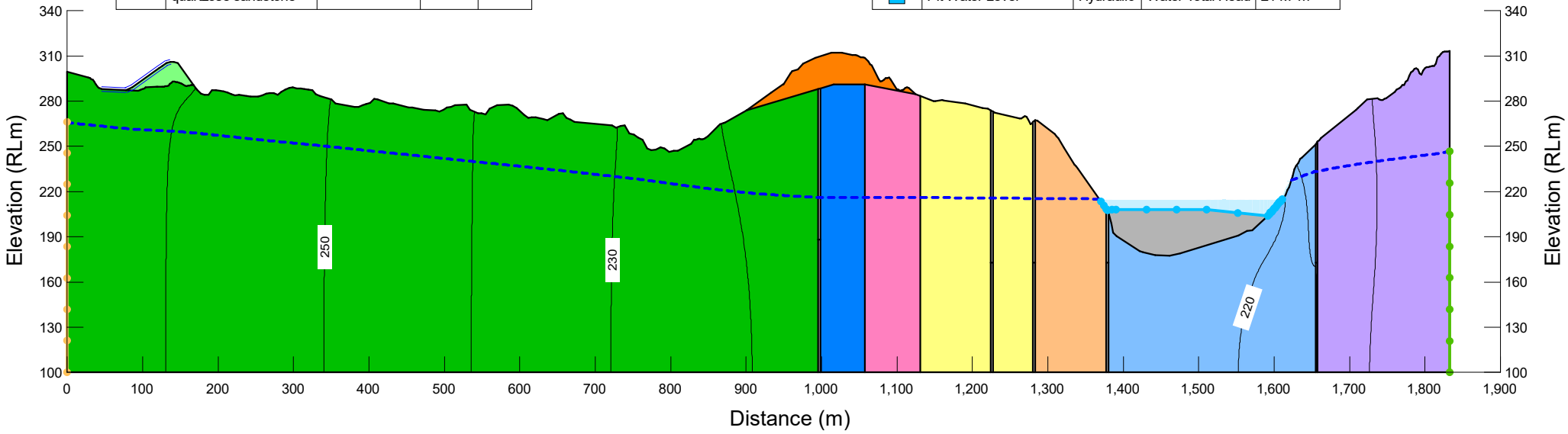
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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio
	Esperanza FM Dolomitic siltstone	Saturated Only	5.8e-07	1
	Fault	Saturated Only	5.2e-06	1
	Fault - Low Permeability	Saturated Only	5.2e-09	1
	Gunpowder Creek FM Siltstone	Saturated Only	2.3e-07	1
	Lochness FM Dolomite, siltstone	Saturated Only	5.6e-06	1
	Mount Oxide Chert MB	Saturated Only	5.8e-07	1
	Pickwick Metabasalt, Quartzite	Saturated Only	1e-06	1
	Select Fine Rockfill	Saturated Only	1e-05	1
	Tailings	Saturated Only	7.4e-07	0.1
	Torpedo Creek Quartzite	Saturated Only	9e-07	1
	Waste Rock	Saturated Only	1e-05	0.3
	Whitworth MB quartzose sandstone	Saturated Only	1.5e-08	1

Notes:
- Dashed blue line represents model's prediction;
- Contours represent Water Total Head (m).

Color	Name	Category	Kind	Parameters
	GWL - Left Hand Side	Hydraulic	Water Total Head	266 m
	GWL - Right Hand Side	Hydraulic	Water Total Head	247 m
	Pit Water Level	Hydraulic	Water Total Head	214.7 m



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CAPRICORN COPPER PTY LTD - CAPRICORN COPPER MINE

UPPER ESPERANZA TEMPORARY WATER STORAGE - SEEPAGE ASSESSMENT

Steady-State Seepage - Current Conditions

Date: 15/06/2023 | Job No: 122073.05

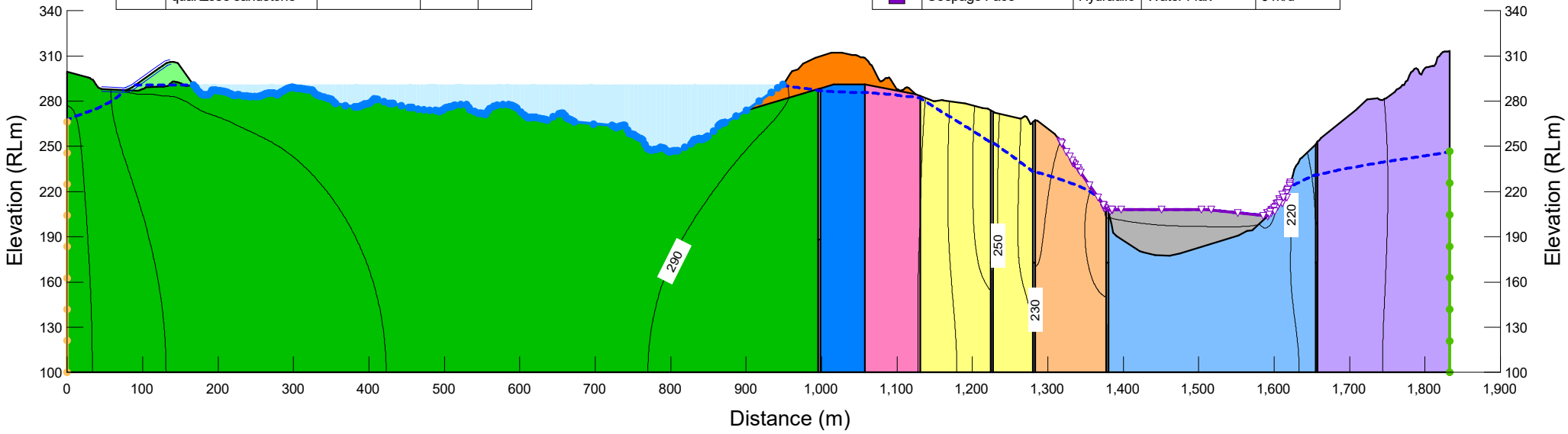
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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio
	Esperanza FM Dolomitic siltstone	Saturated Only	5.8e-07	1
	Fault	Saturated Only	5.2e-06	1
	Fault - Low Permeability	Saturated Only	5.2e-09	1
	Gunpowder Creek FM Siltstone	Saturated Only	2.3e-07	1
	Lochness FM Dolomite, siltstone	Saturated Only	5.6e-06	1
	Mount Oxide Chert MB	Saturated Only	5.8e-07	1
	Pickwick Metabasalt, Quartzite	Saturated Only	1e-06	1
	Select Fine Rockfill	Saturated Only	1e-05	1
	Tailings	Saturated Only	7.4e-07	0.1
	Torpedo Creek Quartzite	Saturated Only	9e-07	1
	Waste Rock	Saturated Only	1e-05	0.3
	Whitworth MB quartzose sandstone	Saturated Only	1.5e-08	1

Notes:
- Dashed blue line represents model's prediction;
- Contours represent Water Total Head (m).

Color	Name	Category	Kind	Parameters
	GWL - Left Hand Side	Hydraulic	Water Total Head	266 m
	GWL - Right Hand Side	Hydraulic	Water Total Head	247 m
	Max Storage Level	Hydraulic	Water Total Head	291 m
	Seepage Face	Hydraulic	Water Flux	0 m/d



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CAPRICORN COPPER PTY LTD - CAPRICORN COPPER MINE

UPPER ESPERANZA TEMPORARY WATER STORAGE - SEEPAGE ASSESSMENT

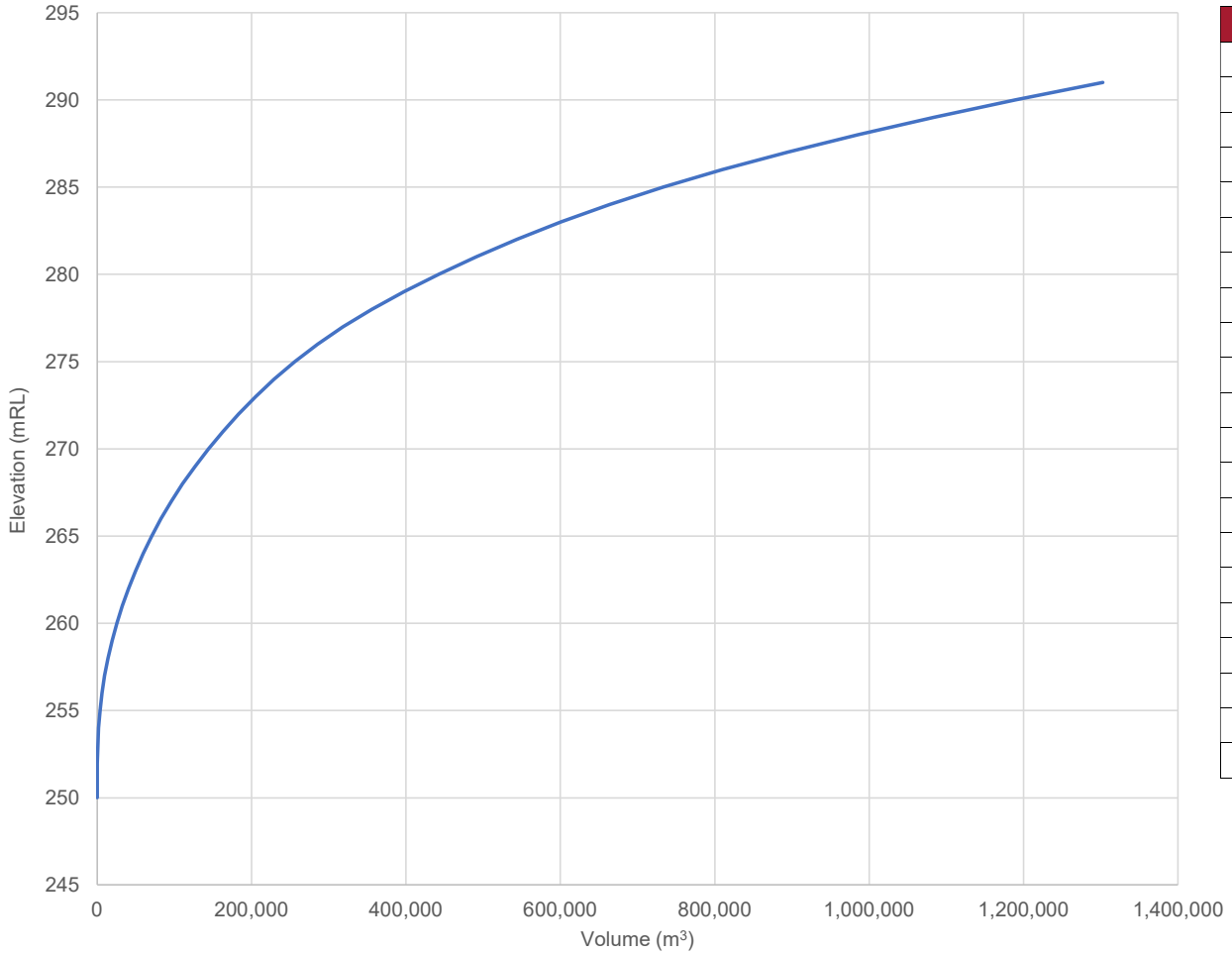
Steady-State Seepage - Full Supply Level

Date: 15/06/2023 | Job No: 122073.05

N:\Synergy\Projects\122\122073 Capricorn Copper\05 Water Storage Options\Data and Calcs\SeepW\

ATTACHMENT 2 – UEV STORAGE CURVE

TAILINGS.WATER.WASTE.



Elevation (mRL)	Volume (m³)	Elevation (mRL)	Volume (m³)
250	0	271	162,853
251	16	272	183,184
252	197	273	205,259
253	691	274	229,156
254	1,700	275	255,616
255	3,538	276	285,247
256	6,134	277	318,313
257	9,553	278	355,741
258	13,875	279	397,147
259	19,122	280	442,353
260	25,388	281	491,163
261	32,688	282	543,566
262	40,859	283	600,634
263	49,884	284	663,891
264	59,788	285	733,338
265	70,738	286	809,734
266	82,794	287	893,953
267	96,075	288	985,363
268	110,753	289	1,083,853
269	126,803	290	1,189,509
270	144,134	291	1,302,350

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Capricorn Copper Pty Ltd

Capricorn Copper Mine

Temporary Water Storage Options Assessment: Hydrogeological Risk and Impact Assessment

Upper Esperanza Valley (UEV) Storage Curve

Date: 15/08/2023 **Job No:** 122073-05

Figure B-1

N:\Synergy\Projects\122\122073 Capricorn Copper\05 Water Storage Options\Documents\M01\Attachment B - UEV Storage Curve.xlsx

APPENDIX D: SUMMARY OF WASTE AND TAILINGS CHARACTERISATION FOR CAPRICORN COPPER MINE

MEMORANDUM

Project:	PRCP Waste and Tailings Characterisation	Date:	30 May 2024
To:	Capricorn Copper Pty Ltd	From:	Travis Warren
Att:	Geraldine McGuire	CC:	Carel van der Westhuizen
Subject:	Summary of Waste and Tailings Characterisation for Capricorn Copper Mine		

WASTE AND TAILINGS CHARACETRISATION

PRCP Guideline (Section 3.6.1)

Characterise mine wastes in a report that describes the likely physical behaviour and chemical reactivity of the waste materials under the conditions in which they would be stored. The report must address the constituent elements present, and their likely future speciation and mobility.

All mined material should be classified on its propensity to be potentially acid or non-acid forming, to generate neutral metalliferous or saline drainage, and its susceptibility to weathering.

Review of Historic Waste and Tailings Characterisation

Historically mining at the Capricorn Copper Mine (CCM) occurred at the Esperanza Pit (EPit) with subsequent underground mining at the Esperanza, Mammoth and Greenstone deposits. Mine waste materials are stored within Tailings Storage Facilities (ETSF, Old TSF and EPit) and waste rock dumps (North Waste Dump, Mammoth Waste Rump, and Esperanza Waste Dump). Since the mine has been operated by multiple entities, the historic management of these wastes are difficult to ascertain and assess, with Capricorn Copper Pty Ltd (Capricorn Copper) now developing a management plan to investigate and characterise stored materials, as well as projected future waste materials.

Capricorn Copper is currently also undertaking investigations and assessments for the detailed design of the proposed new life of mine TSF including the identification of potential borrow materials for the construction and closure proposed to be located between the existing Ezperanza Waste Rock Dump (EWRD) and Upper Ezperanza Diversion Dam.

The following documents, in chronological order, included reference to historic waste characterisations and management relevant to this assessment and are summarised in Table 1.

A detailed summary of all available laboratory data is provided in Attachment 1.

A detailed sampling and analysis plan for to inform future geochemical analysis for tailings is provided as Attachment 2.

Table 1: Historical Waste Characterisation Studies

<table>
<tr><th>Source</th><th>Relevant Content</th></tr>
<tr><td>Natural Resource Assessments Pty Ltd (NRA), 1994: Waste Rock Characterisation, Esperanza Project.

NRA Technical Note, 2021.</td><td>The copper bearing ores at the E-Pit is hosted within the Paradise Creek Formation with rock types consisting of dolomitic siltstone, ferruginous siltstone, graphitic material, interbedded chert, quartzite, kaolinitic material (potential cover material) and ore. Seventy-eight (78) samples from drill cores resulted in characterisation of the ferruginous siltstone, graphitic material, quartzite and ore material as potentially acid forming (PAF). Interbedded cherts were characterised as inert and the dolomitic siltstone as acid neutralising. Kaolinitic materials (potential cover material) was approximately 66% non-acid forming (NAF) and 33% inert. The total sulphur content (S) varied between 0.04 and 48.2 % S, averaging 4.92 % S, with pH between 2.8 and 11.9, averaging 5.8, and electrical conductivity (EC) between 0.1 and 10.5 dS/m averaging 1.66 dS/m. A summary of the results by Lithology is shown below.

<table>
<tr><th>Rock Type</th><th>Number of Samples</th><th>Non-Acid Forming (%)</th><th>Potential Acid Forming (%)</th></tr>
<tr><td>Dolomitic siltstone</td><td>10</td><td>100</td><td>0</td></tr>
<tr><td>Ferruginous siltstone</td><td>20</td><td>5</td><td>95</td></tr>
<tr><td>Graphitic material</td><td>27</td><td>18.5</td><td>81.5</td></tr>
<tr><td>Interbedded cherts</td><td>5</td><td>0</td><td>100</td></tr>
<tr><td>Quartzite</td><td>2</td><td>100</td><td>0</td></tr>
<tr><td>Kaolinitic material*</td><td>3</td><td>0</td><td>100</td></tr>
<tr><td>Ore material</td><td>11</td><td>0</td><td>100</td></tr>
</table>
Characterisation of 20 samples of underground mining waste from the Paradise Creek Formation in terms of sulfur content and acid generating potential resulted in two samples (10%) classifying as high risk (Rating 1: significant sulfur and PAF), four (20%) were classified as medium risk (Rating 3: significant sulfur but Uncertain) with the remaining samples classifying as NAF and acid consuming (NAF-AC).

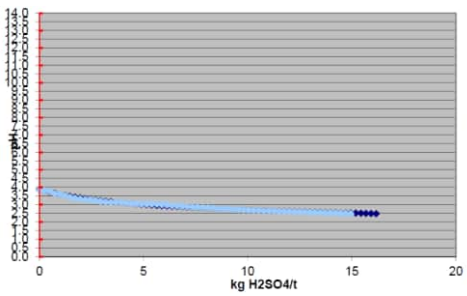
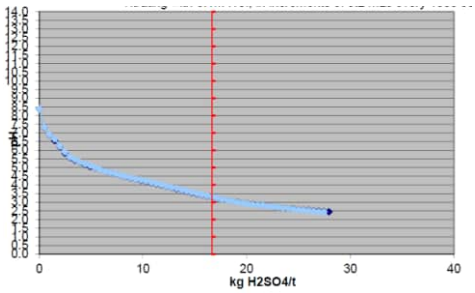
Where significant sulfur concentrations were present, leachate risk was not calculated due to the expected poor quality of leachates i.e. large sulfur concentrations are most likely to generate acid with associated mobilisation of heavy metals and metalloids such as aluminium, arsenic, cadmium, cobalt, chromium and selenium.</td></tr>
<tr><td>Woodward-Clyde, 1998: Gunpowder Copper Expansion Project, Tailings Dam Design Report</td><td>The E-Pit generated approximately 20 million tonnes of waste that was placed in the North Waste Dump and Esperanza Waste Dump, both with capacities of 9 million m^3 each. The different rock types were geochemically characterised as:

▪ Acid Neutralising: Dolomitic Siltstone (2.8 million tonnes).
▪ Inert: Quartzite, Chert, Ferruginous Siltstones (7.4 million tonnes).
▪ Acid Forming: Siltstone and Shale (9.8 million tonnes).

Conceptually waste rock was to be placed on a dump floor lined with acid neutralising waste and encapsulating acid forming waste with inert waste. The surface of both waste dumps was to comprise of fine grade compacted inert waste to form a nominal capping layer. The E-TSF embankment with a clay core and foundation cut-off that abuts the North Waste Dump was constructed with run of mine waste from the E-Pit.</td></tr>
<tr><td>GeoCompute Pty Ltd, 2001: Geochemical Evaluation Water Quality and Storage Integrity of the Esperanza Tailings Dam and Esperanza Open Pit and Sulphide Oxidation Process with Specific Reference to Copper-Cobalt Ore Bodies.</td><td>This report presents an evaluation of the tailings dam at the site in response to a request from a previous operator (Western Metals Copper Limited) to assess the potential for contaminant bearing fluids to escape from the ETSF, the EPit and the North Waste Dump including additional contaminant due to a high rainfall event in the wet season of 2000-2001.

The most relevant findings pertaining to waste characterisation include:

▪ The pyrite content of Esperanza tailings at 70% and the Mammoth tailings at 50%.
▪ Substantial leachable metals and sulphate in the North Waste Dump which is extremely permeable and requires a contoured top surface shedding water coupled with a low air penetration impermeable cover (not just compaction) to prevent oxygentaed water penetrating the 50m high dump (current rate is 3 days).
▪ Increasing seepage from the E-TSF because of increasing hydraulic head due to high rainfall (lag time of about 6 months; rate in May 2001 was 275 ML/day).</td></tr>
</table>

Source	Relevant Content
Environmental Earth Sciences, 2012: Geochemical Technical Memo for the Esperanza Tailings Storage Facility, Pursuant to Item E4-1(e) of Environmental Authority MIN100489906	This memo details the geochemical characterisation study of tailings materials at the E-TSF. Static geochemical test work on two samples (tailings [TSF] and end-of-pipe tailings [Sep-Tails-Comp obtained from a spigot]) exhibits high concentrations of total sulfur with little to no Acid Neutralising Capacity (ANC) correlating to having strongly positive Net Acid Producing Potential (NAPP) values, thereby indicating that the Esperanza tailings have a high probability of being acid forming. This is further supported by high Net Acid Generating (NAG) values at pH 4.5 and 7.0 for both samples, and no to negligible fizz ratings of 0 and 1, which indicate that there no discernible signs of carbonate for acid neutralisation. Variations between the samples for pH (3.1 and 7.9), EC (13.9 dS/m and 1.24 dS/m) and sulfate (75,900 mg/kg and 6,620 mg/kg) respectively, indicate that the TSF sample has oxidised and is producing acid. As there was no measurable ANC in sample TSF (likely to have been fully consumed by sulfide oxidation), the Acid Buffering Characteristic Curve (ABCC) for sample Sep-Tails-Comp closely aligns to the reference curve at ANC of 15 kg/H_2SO_4 of ferroan dolomite and to a lesser extent, siderite which indicates likely poor reactivity and limited efficacy of the ANC present (i.e. it over-estimates any buffering potential).  TSF  Sep-Tails-Comp Multi-element testing indicated that both samples are significantly enriched (Geochemical Abundance Index [GAI] of 3 or greater) in silver (Ag), arsenic (As), bismuth (Bi), copper (Cu), lead (Pb), antimony (Sb) and thallium (TI). The potential acid generation results from this study concur with the pore water geochemistry study (HLA-EnviroScience's, 2000) that noted the potential for acid generation and mechanisms, both geochemical and site operational, that could exacerbate oxidation of sulfide from the TSF and mobilisation of metals. The memo concluded and recommended that: ▪ Owing to the high acid production potential, and evidence of current acid generation, of the Esperanza tailings materials, the management procedures developed in the Esperanza TSF Operations, Maintenance and Surveillance (OSM) Manual (GHD, 2012), should be adhered to. ▪ To prevent, or at least minimise the oxidation of sulfidic tailings, tailings deposition should include: o Discharge of least-possible water content tailings. o Ensure tailings dry in thin layers that maximise consolidation and reduce oxygen ingress (diffusion). o Ensure water is directed to the decant to reduce seepage and maximise water recycling. ▪ Collect end-of-pipe samples of tailings monthly and analyse for total sulfur, ANC, pH (field and laboratory, including pore water), EC (field and laboratory, including pore water) to determine if changes in the mined ore bodies and/or metallurgical processing impact the geochemical composition of tailings. ▪ Since the tailings are enriched in Al, As, Bi, Cu, Pb, Sb and Tl, these elements should be included in monitoring programs (i.e. decant, pore water, seepage) in addition to pH, total dissolved salts (TDS), major cations (Na, Ca, Mg, K), anions (Cl, HCO_3, SO_4, NO_3).
Earth Systems, 2020:	The Quantitative X-Ray Diffraction (QXRD) analyses of 28 tailings samples to identify the presence of iron-oxide phases (e.g., goethite, hematite) that may facilitate sulfate removal from process water in the E-Pit via bacterially induced pyrite precipitation showed that the dominant mineral in the tailings is quartz, with smaller proportions of pyrite, muscovite, kaolinite and siderite. The Maximum Potential Acidity (MPA) calculated from the mineralogy is elevated (16 to 109 kg H2SO4/t) due to the presence of pyrite (0.8 to 6.5 wt.%). The calculated ANC is generally low (<6.2 kg H_2SO_4/t). Therefore, the NAPP (NAPP = MPA - ANC) of these samples ranges from 14 to 104 kg H_2SO_4/t of tailings; hence all samples classify as PAF.
Capricorn Copper Definitive Feasibility Report: Chapter 7-Processing	Chapter 7 of the Capricorn Copper Definitive Feasibility Report presents NAPP and NAG tests performed on rougher tailings samples to characterise the Acid Forming Potential (AFP) of the rougher tailings of each Metallurgical Domain to identify potential ore zones that may be used to cap regulated storage facilities. The Rougher Tailings from Greenstone (GRN) is nett-acid consuming, and it is likely that this processing stream can be used as an inert cap for

<table>
<tr><th>Source</th><th>Relevant Content</th></tr>
<tr><td></td><td>
rehabilitation. Tailings from the Mammoth chalcocite also have low sulphur content and may be blended with GRN ores to increase the volume of capping material present. The other domains will likely require a subsequent flotation stage to further remove pyrite if they are to be neutral or net-acid consuming.

Ore Reserves: Mammoth, ESS and GST.

Metallurgical Domains: Mammoth Deeps: Mammoth bornite and Mammoth chalcocite; ESS: ESS fine chalcocite plus high pyrite; ESS coarse chalcocite and hematite and Greenstone: GST (GRN).
<table>
<tr><td>Test</td><td>Units</td><td>ESS Hm</td><td>MM Cc</td><td>ESS Coarse</td><td>ESS Fine Cc</td><td>MM Bn</td><td>GRN</td><td>ESP HG</td></tr>
<tr><td colspan="2">Nett Acid Producing Potential</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>NAPP</td><td>kgH_2SO_4/t</td><td>27.2</td><td>1.7</td><td>26.4</td><td>34.7</td><td>24.2</td><td>-53.1</td><td>45.4</td></tr>
<tr><td colspan="2">Nett Acid Generation</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>pH (OX)</td><td>pH unit</td><td>2.8</td><td>3.6</td><td>3.1</td><td>2.9</td><td>2.8</td><td>9.3</td><td>2.7</td></tr>
<tr><td>NAG (pH 4.5)</td><td>kgH_2SO_4/t</td><td>14.1</td><td>1.4</td><td>5</td><td>23.0</td><td>15.9</td><td><0.1</td><td>13.5</td></tr>
<tr><td>NAG (pH 7.0)</td><td>kgH_2SO_4/t</td><td>18.9</td><td>2.6</td><td>9.2</td><td>26.7</td><td>19.7</td><td><0.1</td><td>30.3</td></tr>
<tr><td colspan="2">Acid Neutralising Capacity</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ANC</td><td>kgH_2SO_4/t</td><td><0.5</td><td>4.4</td><td>1.7</td><td>0.8</td><td>4.9</td><td>54.0</td><td>7.2</td></tr>
<tr><td>Fizz Rating</td><td>Fizz unit</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td colspan="2">Total Sulphur</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total S</td><td>%S</td><td>0.89</td><td>0.20</td><td>0.92</td><td>1.16</td><td>0.95</td><td>0.03</td><td>1.72</td></tr>
</table>
Most the flotation tailings are acid generating, as confirmed by the NAPP and NAG tests undertaken as part of the Met Test work program (refer to Section 7.3.8.5.5). GST is an exception, having acid consuming potential; hence is suitable for cover materials. Recommendations for further work included testing on the higher sulphur domains to reduce their AFP.
</td></tr>
<tr><td>Environmental Geochemistry International (EGI), 2023: Initial ARD Management Review of the Mammoth Old Tailings Storage Facility - Capricorn Copper</td><td>
Capricorn Copper Mine consists of five known copper deposits: Mammoth, Greenstone, Esperanza South, Esperanza and Pluto, of which underground mining is currently active at Mammoth and Esperanza South. The Mammoth Deposit is hosted by the Whitworth Quartzite, part of the Myally sub-group, which is a massive pink feldspathic, medium to coarse grained, poorly bedded and homogenous quartzite which formed by the silicification of the original arenite. The copper sulphide mineralisation is mainly a mix of chalcocite, bornite and chalcopyrite, with pyrite most likely associated with bornite and chalcopyrite. There is less pyrite at Mammoth than Esperanza South. The Mammoth decline and development drives sit within the host Whitworth Quartzite, with a halo of variable sulphide content leading into the ore zone.

The Esperanza South Deposit is shear hosted occurring in graphitic shales of the Esperanza Formation. Mineralisation is largely restricted to this unit, preferentially in sheared and silicified zones, with some minor incursion into the adjoining Paradise Creek Formation, a dolomitic siltstone largely devoid of sulphide. Copper sulphides are dominated by chalcocite with lesser bornite in the upper parts of the deposit, with chalcopyrite dominating at depth associated with pyrite. Sulphides can be massive and semi-massive. The Esperanza South Deposit decline and a significant portion of the development drives are within the mainly barren Paradise Creek Formation and are expected to be mainly devoid of sulphide.

There are two dominant styles of mineralisation at CCM:

(1) Breccia-hosted copper deposits in quartzites (includes Mammoth, Mammoth North and Greenstone): hematite, and more distally, chlorite alteration is characteristic of this deposit style. Copper mineralisation occurs as breccia infill and is zoned chalcocite (primary infill in central milled breccia), bornite (defines the margin of the main structural zone and typically occurs in crackle breccia and chalcopyrite (the outer zone of copper mineralisation in veins and crackle breccia).

(2) Shear-hosted copper deposits in shales and siltstones (includes Esperanza-Pluto and Esperanza South): mineralisation occurs as chalcocite veins with lesser bornite in the upper parts and transitions into a chalcopyrite-pyrite dominant copper ore at depth. Other characteristics of this deposit includes significant silver by-product increasing with depth, increasing cobalt, nickel and arsenic with depth associated with pyrite.

This document reviewed:
▪ EMM, 2015. Final Cover Design, Old Tailings Storage Facility and Heap Leach Pad Number 2, Mt Gordon Mine.
</td></tr>
</table>

Source	Relevant Content
	Excavation of 10 test pits at the Old TSF showed the tailings cover comprises a plant growth medium of around 60 cm with a 30 to 40 cm lower permeability layer and a 20 cm coarse layer below which was most likely used to help support equipment during placement of the cover. Forty samples were submitted for standard geochemical characterisation of cover materials and underlying tailings. Total S of the tailings were generally over 1% and acid neutralising capacity was generally 0 kg H2SO4/t indicating the tailings are PAF with no lag, consistent with the low pH of less than 4 in water extracts. The only two samples from the coarse layer also had S greater than 1% indicating PAF waste rock may have been used in construction. ▪ *GHD, 2018: Capricorn Copper Pty Ltd, Rehabilitation Strategy, Old TSF and HLEP#2 and Rehabilitation of Old TSF and HLEP2 Cover Design Report.* The excavation of 10 test pits on the Old TSF through the cover system into the tailings and the drilling of six bores to the full depth of the TSF and into natural ground showed the cover thickness was generally around 90 cm, but could be up to 2 m. The tailings were damp or wet at 10m below ground surface. Geochemical results confirmed all tailings had high total S > 1% with negligible ANC generally < 10 kg H2SO4/t and were PAF. Samples in test pits closer to surface generally had total S values of 1.0 % to 1.5 %, compared to much higher S at depth in the drillholes of 2.5 % to 5.8 %, reflecting either variable tailings sources over time or the effects of extended leaching of the near surface tailings materials over the 40 years since deposition ceased. Sulphate S results account for 20% to 50% of the total S, even at depth, indicating sulphide oxidation and generation of ARD salts throughout the tailings pile. Multi-element data shows the tailings solids still contain high metal contents: Ag (2 to 10 mg/kg), Co (60 to 380 mg/kg) and Cu (0.1 to 1.2%). Geochemical test results confirm the high residual ARD potential of the Old TSF, the presence of ARD oxidation products that will be readily mobilised, and high metal concentrations readily liberated under acid conditions. Seepage management comprises collection of seepage, which is responsive to rainfall, from the Old TSF (a valley-fill facility, in addition to runoff and seepage from the surrounding ROM areas, waste rock, concentrate storage, and workshop) in the down-gradient Sump 6. Groundwater modelling by GHD (2019) indicated that the majority of seepage reporting to Sump 6 is likely to be due to the catchment upgradient of the TSF. Water quality monitoring at Sumps 6 shows generally consistent low pH < 5 and often less than 4, high SO4 usually > 4,000 mg/L, and high dissolved Cu > 100 mg/L. Whilst groundwater has circumneutral to slightly acidic pH in the same periods where Sump 6 has a low pH, SO4 concentrations are still high at between 1,000 and 3,000 mg/L, confirming the influence of ARD.

A detailed review of the above documents indicate that AMD is generated by:

- Exposure of mineralised rock open cut faces, ROM stockpiles, exposed floor, and roof surfaces of underground mines.
- Through disposal of waste rock and tailings.

There is substantial evidence of rainwater infiltrating through the tailings and waste rock. The hydration of red hematite to yellow limonite (goethite) is clearly visible and common where waste rocks are exposed with copper sulphides with a green coating, and jarosite (an oxidation product of iron sulphides), providing further evidence of infiltrating rain and runoff water.

- The Mammoth waste is moderately acidic, with an average pH value of approximately 4, characterised by variable amounts of oxidisable sulfur and very low ANC; it classifies as PAF-LC.

  Seepage from these wastes is predicted to be moderately acidic, with pH values between 3.5 and 4.0, and sulphate concentrations of 1,000 to 4,000 mg/L. Concentrations of copper and other metals (particularly manganese and cobalt) will be elevated, but significantly lower than that expected from oxidation of sulphidic Esperanza waste.
- The black sulphidic Esperanza waste has a much higher capacity to produce acid than does the Mammoth waste.

  The black sulphidic waste is extremely reactive when exposed to oxygen and water. Evidence of rapid oxidation of the sulphides to blue copper oxides and sulphates within several days of exposure to the atmosphere was previously observed. However, most of the black sulphidic waste appears to be fresh material when the superficial layer of oxidised material, formed since when the material was first exposed, had been removed.

Geotechnical testing of the historic tailings (Maunsell, 2008 and GHD 2008 and 2009) indicating that the tailings:

- Comprise sandy silty clay with low to moderate plasticity.
- Have dried on the surface of Esperanza TSF to a density of 1.4 to 1.6 t/m^3 which is approximately 78% to 87% maximum dry density, indicating further density would be achievable with compaction.

- Hydraulic conductivity is low (between 1.5 x 10^{-7} and 5 x 10^{-9} m/s).
- The dominant mineral in tailings is quartz, with pyrite (0.8 to 6.5 wt. %), muscovite, kaolinite and siderite.

Geochemical testing (Woodward Clyde 1998, Environmental Earth Scientists 2012, EMM 2015, GHD 2018, Engeny 2024) has shown that the historic and current tailings exhibit high concentrations of Total S, hence have a high Maximum Potential Acidity (MPA), with limited Acid Neutralising Capacity (ANC). This correlates to large positive Net Acid Production Potential (NAPP) values indicating a high probability of being acid-forming. This is further supported by low Net Acid Generation (NAG) pH values.

Multi-element analysis indicates that the tailings are significantly enriched (Geochemical Abundance Indices, GAI's, of 3 or greater) in silver (Ag), arsenic (As), bismuth, (Bi), copper (Cu), lead (Pb), antimony (Sb) and thallium (TI) [Environmental Earth Scientists 2012, Engeny 2024].

Current Waste and Tailings Characterisation

A total of 356,698 assays from 7,127 exploration bores, including sulfur content, were obtained of the mined material to date, the results of which have been used to develop block models for all deposits across the site as shown in Figure 1.

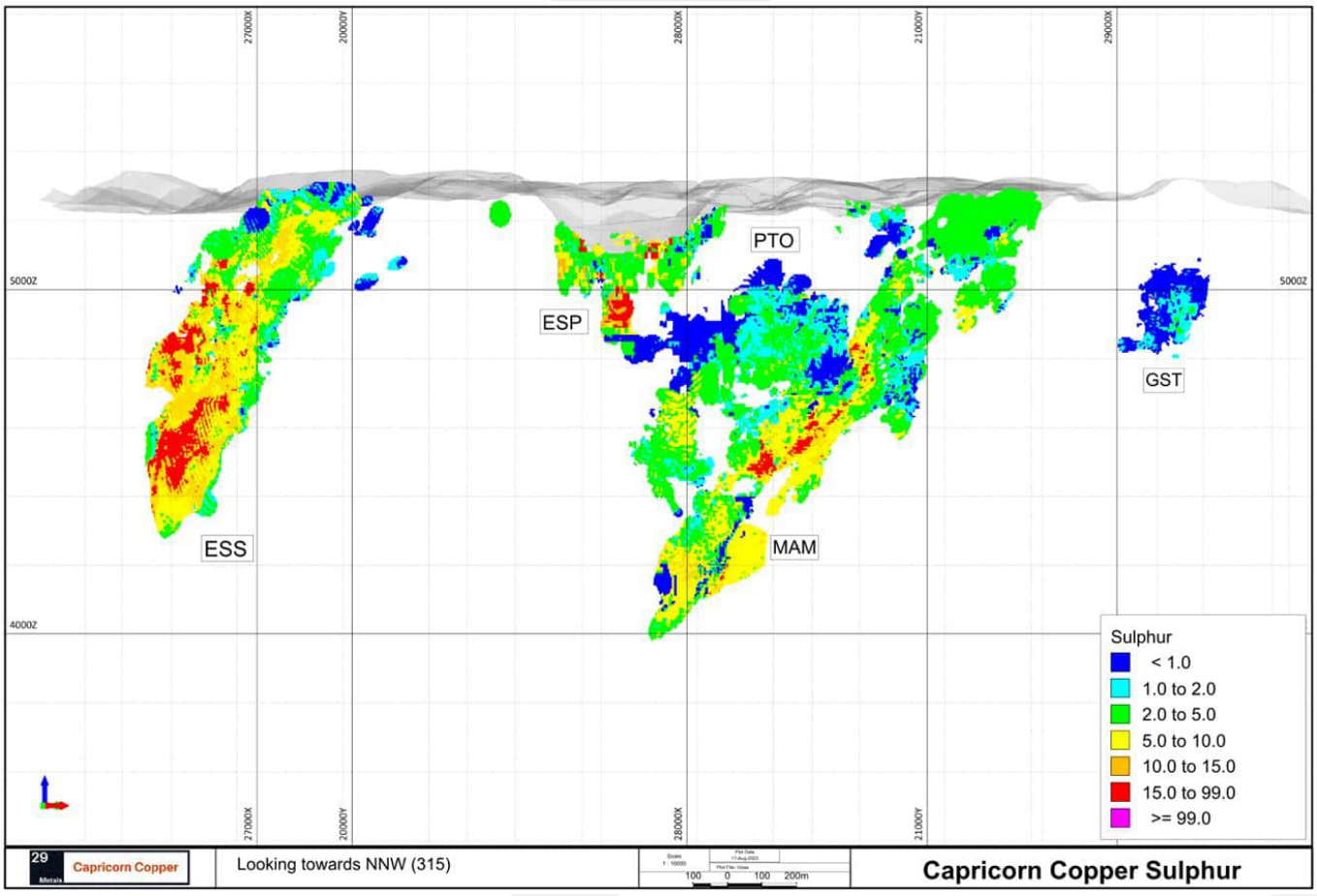


Figure 1: Block Model Capricorn Copper Mine.

For the remaining life of mine, waste tonnages by mine until 2035 are shown in Table 2 with recommended sample density for classification of waste.

Based on review of the block models, the following observations are relevant:

- The ESS underground generally has high sulphur (>5.0) in the majority of the assessed materials to be mined, increasing with depth.
- The MAM underground generally has high sulphur (>5.0) in the majority of the assessed materials to be mined, with increasing sulphur along the strike of the ore body.
- The GST underground mine generally has lower sulphur (<2.0), increasing with depth.
- The PTO underground mine generally has moderate sulphur (<3.0), increasing with depth.

Table 2: Waste Tonnages by Mine

Mine	Waste Rock (t)	% of Total	Indicative Number of Samples for Characterisation
Esperanza: ESP	516,204	16	8 - 26
Esperanza South: ESS	1,185,311	36	8 - 26
Greenstone: GST	234,953	7	8 - 26
Mammoth Deeps: MAMD	861,243	26	8 - 26
Mammoth: MAMR	104,672	3	8
Pluto (PLU)	376,669	11	8 - 26
Total (t)	3,279,053	100	26 - 80

Note: Indicative sample numbers were determined using Table 4: Suggested Phase 1 Characterisation Sampling Frequency (based on tonnage when sampled without prior information) of the *Draft Guidance for Materials Characterisation* Department of Mines Western Australia, 2016.

The mine is currently merging the assay data with lithological data to further refine the block models.

Mining is ongoing at the Mammoth and Esperanza South mines and whilst there is uncertainty with regard to the blend of ore and therefore if the tailings stream is homogenous, the rate of deposition of tailings is anticipated to be around 100,000t per month which equates to 2.5 samples per month. However, initially up to five (5) samples a month (1 per day for five days) for up to three months will be required to build a site-specific data set. A detailed characterisation program for tailings has been designed, CCM Sampling and Analysis Plan (QC1022_016-RPT-001-0)(SAP) and is included as Appendix 2 to this memo. The SAP aims to ensure a contemporary understanding of the geochemical characteristics of the tailings to inform the risks associated with the placement of tailings within the E-Pit where previously up to 6.6Mt of tailings were deposited between approximately July 2017 and January 2022. The objective of the SAP for the characterisation of tailings is to obtain a geochemical assessment of representative samples in accordance with relevant legislation, and to document the tailings geochemistry and assess whether these characteristics have the potential to impact the downstream environment including groundwater. The sampling also extended to three locations associated with the Esperanza Waste Rock Dump and the Upper Esperanza Diversion Dam.

The deliverables from the work include:

- Technical memoranda summarising the classification of the waste streams sampled and recommendations pertaining to mitigation measures to prevent environmental harm from the generation of acid and metalliferous drainage where required.
- The analytical results will be used to inform subsequent updates of the tailings and waste management plan and the requirements for further sampling.

To date, in terms of this sampling program, samples were obtained from:

- 17 samples of Quartzite/Siltstone comprising sandy GRAVEL with silt and clay, gravelly SAND, CLAY with sand, sandy CLAY, sandy CLAY with gravel from 3 bores (TSF-BH1, 2 and 5) drilled during geotechnical investigations to ascertain the geochemical characteristics of these materials as shown in Figure 2.
- A total of 11 composite (necessitated due to the sizes of the samples) samples of tailings (a mixture of crushed and pulverized and raw ESS, MAM, GST ores) obtained between December 2022 and November 2023.

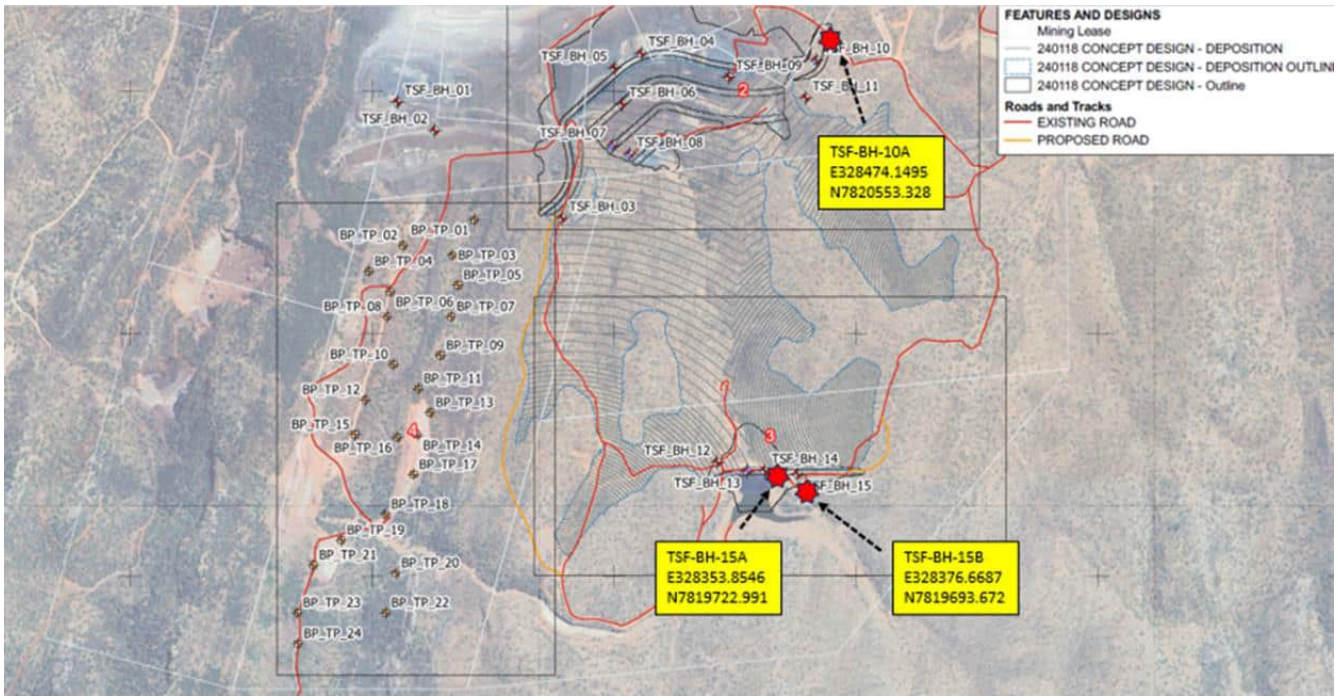


Figure 2: Locations of Sampling Bores.

Waste Rock

The results from the analysis are included as Appendix 1 to this memo. These materials contain:

- Total Sulfur between 0.1% and 15.6 % averaging 4.4 %.
- ANC between 3.3 and 35.0 kgH_2SO_4/t averaging 18.1 kgH_2SO_4/t.
- NAPP values between -15.6 and 477.0 kgH_2SO_4/t averaging 125.6 kgH_2SO_4/t.

Because of relatively little ANC and large NAP values, 3 samples from bores 2 and 5 classify as NAF, the remaining 14 samples classify as PAF.

- Total metals arsenic, cobalt, copper and manganese were enriched (GAI >3), in addition to elevated levels of cadmium, lead, mercury, nickel and zinc.
- Leachable metals include cobalt (between 0.1 and 11.7 mg/L), copper (between 0.1 and 263 mg/L), manganese (between 0.4 and 41.4 mg/L), nickel (between 0.4 and 0.6 mg/L) and zinc (between 0.4 and 8.8 mg/L).

Tailings

The results from the analysis are included as Appendix B to this memo. These materials contain:

- Total Sulfur between 3.4 % and 7.2 % averaging 5.0 %.
- ANC between 1.3 and 17.0 kgH_2SO_4/t averaging 10.8 kgH_2SO_4/t.
- NAPP values between 90 and 280 kgH_2SO_4/t averaging 144 kgH_2SO_4/t.

Because of little ANC and large positive NAP values all the samples classify as PAF.

- Total metals arsenic, cobalt and copper were enriched (GAI >3), in addition to elevated levels of lead and nickel.
- Leachable metals under acidic conditions include aluminium (between 0.5 and 1.3 mg/L), cobalt (between 1.4 and 3.7 mg/L), copper (between 17.0 and 70.9 mg/L), manganese (between 1.4 and 2.0 mg/L), nickel (between 0.4 and 1.1 mg/L) and zinc (between 0.6 and 0.8 mg/L).

- Leachable metals under neutral conditions include aluminium (between 0.02 and 0.03 mg/L), arsenic (between 0.004 and 0.04 mg/L), cobalt (between 0.01 and 4.06 mg/L), copper (between 0.01 and 31.4 mg/L), manganese (between 0.03 and 2.32 mg/L), nickel (between 0.004 and 1.16 mg/L) and zinc (between 0.03 and 0.53 mg/L).

Geochemical Hazard Assessment of Materials

Significant risk of AMD has been identified within:

- The waste rock across the site.
- Tailings which classify as PAF coupled with geochemical enrichment and an increased risk of leaching of these metals with a reduction in pH.

Recommendations

The following recommendations are made:

- Refining of the block model regarding major lithologies coupled with further sampling and analysis to facilitate obtaining materials suitable for cover materials during rehabilitation and closure.
- Continued sampling of tailings. Larger sample sizes are imperative to facilitate detailed laboratory analysis in accordance with the SAP. Kinetic column testing is to be undertaken.

Regarding management and rehabilitation measures, the following:

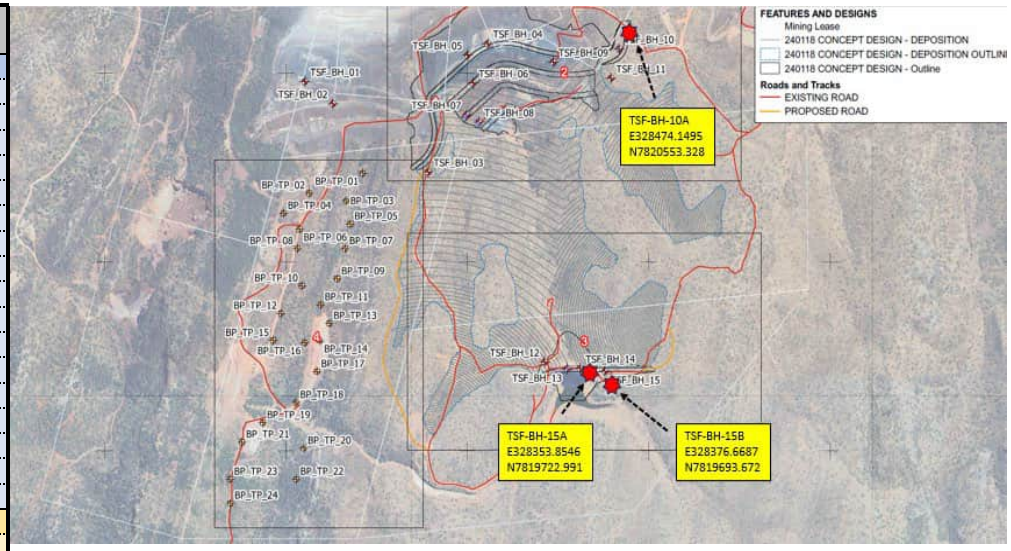
- Adequate buffer areas are to be identified and engineered cover materials are to be located to ensure safe, sustainable, and non-polluting waste landforms to prevent impacts on the downstream environment hence it is imperative to locate and separate these materials from the waste streams. As mining progresses, waste materials are to be screened continuously to ascertain their suitability for use during closure and rehabilitation.
- Further investigations and assessments into the treatment of tailings to minimise their risk to the downstream environment in accordance with the SAP.

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Sample ID	Location	Weathering	Description	Lithology	Depth
Materials from Geotechnical Bores at TSF 3 for re-use/construction					
1	TSF3_BH_02	Transitional/Fresh	sandy GRAVEL	Quartzite/Siltstone	5.0-5.1m
2	TSF3_BH_05	Transitional/Fresh	COBBLES (50%) in a sandy GRAVEL matrix (50%)	Quartzite/Siltstone	5.4-5.5m
3	TSF3_BH_05	Transitional/Fresh	COBBLES (40%) in a sandy GRAVEL matrix (60%)	Quartzite/Siltstone	10.0-10.1m (rock)
4	TSF3_BH_05	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	19.1-19.2m
5	TSF3_BH_05	Transitional/Fresh	CLAY with sand	Quartzite/Siltstone	19.9-20.0m
6	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	0.0-0.1m
7	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	0.2-0.4m
8	TSF3_BH_01	Transitional/Fresh	sandy CLAY dark brown	Quartzite/Siltstone	1.0-1.1m
9	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL	Quartzite/Siltstone	1.9-2.0m
10	TSF3_BH_01	Transitional/Fresh	gravelly SAND with silt	Quartzite/Siltstone	2.9-3.0m
11	TSF3_BH_01	Transitional/Fresh	sandy CLAY with gravel	Quartzite/Siltstone	3.6-3.7m
12	TSF3_BH_01	Transitional/Fresh	sandy CLAY with gravel	Quartzite/Siltstone	4.8-4.9m
13	TSF3_BH_01	Transitional/Fresh	CLAY with sand	Quartzite/Siltstone	11.9-12.0m
14	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	16.9-17.0m
15	TSF3_BH_01	Transitional/Fresh	CLAY with gravel/sandy GRAVEL with clay	Quartzite/Siltstone	18.0-18.5m
16	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL	Quartzite/Siltstone	21.9-22.0m
17	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	15.0-15.5m
Tailings:					
1	Dec 2022 Week 1	A mixture of crushed and pulverized and raw ESS, MAM, GST ores.			
2	Dec 2022 Week 3				
3	Dec 2022 Week 4				
4	Jan 2023 Week 1				
5	Feb 2023 Week 2				
6	Feb 2023 Week 3				
7	Feb 2023 Week 4				
8	March 2023 Week 1				
9	August 2023 Week 1				
10	August 2023 Week 2				
11	November 2023 Week 2				
1	16/10/22 Final Tail DS	Composite pulp samples.			
2	16/10/22 Final Tail NS				
3	23/10/22 Final Tail DS				
4	23/10/22 Final Tail NS				
5	30/10/22 Final Tail DS				
6	30/10/22 Final Tail NS				
7	6/11/22 Final Tail DS				
8	6/11/22 Final Tail NS				
9	13/11/22 Final Tail DS				
10	13/11/22 Final Tail NS				
11	20/11/22 Final Tail DS				
12	27/11/22 Final Tail DS				
13	27/11/22 Final Tail NS				
14	4/12/22 Final Tail DS				
15	4/12/22 Final Tail NS				
16	18/12/22 Final Tail DS				
17	18/12/22 Final Tail NS				
18	25/12/22 Final Tail DS				
19	25/12/22 Final Tail NS				
20	1/01/23 Final Tail DS				
21	1/01/23 Fianl Tail NS				
22	15/1/23 Final Tail DS				
23	15/1/23 Final Tail NS				
24	12/2/23 Final Tail DS				
25	12/2/23 Final Tail NS				
26	19/2/23 Final Tail DS				
27	19/2/23 Final Tail NS				



Sample ID	Location	Weathering	Description	Lithology	Bulk Density	Moisture Content	S	S	S-SO_4	TOS	S_{CR}	TIC	TOC	TC	$pH_{(1:2)}$	$EC_{(1:2)}$	pH_f	pH_{ox}	pH_{ox}/NAGpH	$NAG_{pH\ 4.5}$	$NAG_{pH\ 7.0}$	AFP/MPA	ANC	NAPP		Classification
					kg/m^3	%	(Total Metal)	0.01	0.01	TOS=S-S-SO_4	0.005	0.02	0.02	0.02	0.1	1	0.1	0.1	0.1	0.1	0.1	MPA=TOS*30.6	0.5	Laboratory	NAPP=AP-ANC	
										%						µS/cm								kgH_2SO_4/t		
1	TSF	Transitional/Fresh	Wallumbilla Formation	Shale (Rock)	1,130	14	1.14	1.09	0.57	0.52	0.74	0.07	1.70	1.77	5.2	3,330	4.9	2.2	2.9	11.2	20.2	15.94	11.4	22.0	4.5	Potentially Acid Forming - Low Capacity (PAF-LC)
Materials from Geotechnical Bores at TSF 3 for re-use/construction: ALS Work Order:																										
1	TSF3_BH_02	Transitional/Fresh	sandy GRAVEL	Quartzite/Siltstone	-	7.9	-	0.10	0.07	0.03	-	<0.02	0.11	0.11	-	-	5.5	4.0	6.7	<0.1	0.4	0.9	3.3	-0.2	-	NAF - non-acid forming
2	TSF3_BH_05	Transitional/Fresh	COBBLES (50%) in a sandy GRAVEL matrix (50%)	Quartzite/Siltstone	-	9.6	-	0.60	0.19	0.41	-	0.35	1.58	1.93	-	-	5.0	3.2	8.4	<0.1	<0.1	12.5	29.1	-10.7	-	NAF - non-acid forming
3	TSF3_BH_05	Transitional/Fresh	COBBLES (40%) in a sandy GRAVEL matrix (60%)	Quartzite/Siltstone	-	-	-	0.41	0.29	0.12	-	1.97	0.42	2.39	-	-	6.7	6.2	8.1	<0.1	<0.1	3.7	28.1	-15.6	-	NAF - non-acid forming
4	TSF3_BH_05	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	-	9.2	-	3.32	1.39	1.93	-	0.37	0.45	0.82	-	-	3.8	2.5	2.9	18.1	30.4	59.1	<0.5	102.0	-	PAF - potentially acid forming
5	TSF3_BH_05	Transitional/Fresh	CLAY with sand	Quartzite/Siltstone	-	19.8	-	3.08	1.65	1.43	-	<0.02	0.39	0.39	-	-	3.7	2.9	3.0	20.9	46.1	43.8	<0.5	94.2	-	PAF - potentially acid forming
6	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	-	9.3	-	6.38	3.20	3.18	-	<0.02	0.92	0.92	-	-	3.3	2.2	2.2	84.2	110.0	97.3	<0.5	195.0	-	PAF - potentially acid forming
7	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	-	12.0	-	10.90	6.83	4.07	-	<0.02	0.85	0.85	-	-	3.1	2.1	1.9	174.0	209.0	124.5	<0.5	334.0	-	PAF - potentially acid forming
8	TSF3_BH_01	Transitional/Fresh	sandy CLAY dark brown	Quartzite/Siltstone	-	10.0	-	15.60	12.90	2.70	-	<0.02	0.84	0.84	-	-	3.0	2.1	2.0	120.0	204.0	82.6	<0.5	477.0	-	PAF - potentially acid forming
9	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL	Quartzite/Siltstone	-	8.8	-	1.73	0.50	1.23	-	<0.02	1.30	1.30	-	-	3.7	2.5	2.6	25.0	36.7	37.6	<0.5	52.9	-	PAF - potentially acid forming
10	TSF3_BH_01	Transitional/Fresh	gravelly SAND with silt	Quartzite/Siltstone	-	14.5	-	1.17	0.07	1.10	-	4.51	0.24	4.75	-	-	3.8	2.5	4.5	<0.1	12.2	33.7	<0.5	35.8	-	PAF - potentially acid forming
11	TSF3_BH_01	Transitional/Fresh	sandy CLAY with gravel	Quartzite/Siltstone	-	12.2	-	2.99	1.76	1.23	-	0.43	0.49	0.92	-	-	3.4	2.4	3.3	4.4	14.4	37.6	<0.5	91.5	-	PAF - potentially acid forming
12	TSF3_BH_01	Transitional/Fresh	sandy CLAY with gravel	Quartzite/Siltstone	-	11.5	-	3.05	1.76	1.29	-	0.29	0.37	0.66	-	-	3.6	2.3	2.7	25.3	40.1	39.5	<0.5	93.3	-	PAF - potentially acid forming
13	TSF3_BH_01	Transitional/Fresh	CLAY with sand	Quartzite/Siltstone	-	10.4	-	1.82	0.96	0.86	-	0.27	0.06	0.33	-	-	4.0	2.4	2.9	10.1	17.4	26.3	<0.5	55.7	-	PAF - potentially acid forming
14	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	-	6.9	-	10.20	9.81	0.39	-	0.49	0.97	1.46	-	-	5.1	2.4	2.3	83.3	103.0	11.9	35.0	277.0	-	PAF - potentially acid forming
15	TSF3_BH_01	Transitional/Fresh	CLAY with gravel/sandy GRAVEL with clay	Quartzite/Siltstone	-	24.7	-	4.52	4.14	0.38	-	0.52	0.44	0.96	-	-	4.2	2.3	2.5	50.6	68.1	11.6	13.2	125.0	-	PAF - potentially acid forming
16	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL	Quartzite/Siltstone	-	20.9	-	1.09	0.20	0.89	-	<0.02	0.11	0.11	-	-	4.1	2.4	3.0	7.9	10.8	27.2	5.5	27.8	-	PAF - potentially acid forming
17	TSF3_BH_01	Transitional/Fresh	sandy GRAVEL with silt	Quartzite/Siltstone	-	8.2	-	6.99	6.77	0.22	-	0.06	1.36	1.42	-	-	4.3	2.1	2.3	85.0	98.5	6.7	12.7	201.0	-	PAF - potentially acid forming
Tailings: ALS Work Order Samples 1 to 11: EB2415337, 20 May 2024 and Work Order Samples 1 to 27: BR23079597, 5 April 2023																										
1	Dec 2022 Week 1	A mixture of crushed and pulverized and raw ESS, MAM, GST ores.			-	<1.0	-	3.80	0.84	2.97	-	-	-	-	-	-	-	-	-	-	-	-	9.4	107.0	-	**PAF - potentially acid forming**: classification based on Total Sulfur concentration (>0.3%S) and large positive NAG values (>5) exceeding ANC (Fizz Rating between 0 and 1 indicative of very low to low ANC).
2	Dec 2022 Week 3				-	----	-	3.78	----	-	-	-	-	-	-	-	-	-	-	-	-	-	14.0	102.0	-	
3	Dec 2022 Week 4				-	----	-	5.50	----	-	-	-	-	-	-	-	-	-	-	-	-	-	12.4	156.0	-	
4	Jan 2023 Week 1				-	<1.0	-	6.20	1.05	5.15	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	190.0	-	
5	Feb 2023 Week 2				-	----	-	5.92	----	-	-	-	-	-	-	-	-	-	-	-	-	-	7.5	174.0	-	
6	Feb 2023 Week 3				-	----	-	6.10	----	-	-	-	-	-	-	-	-	-	-	-	-	-	15.2	171.0	-	
7	Feb 2023 Week 4				-	----	-	4.64	----	-	-	-	-	-	-	-	-	-	-	-	-	-	13.6	128.0	-	
8	March 2023 Week 1				-	----	-	5.39	----	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0	157.0	-	
9	August 2023 Week 1				-	<1.0	-	3.39	0.78	2.61	-	-	-	-	-	-	-	-	-	-	-	-	9.3	94.4	-	
10	August 2023 Week 2				-	----	-	3.49	----	-	-	-	-	-	-	-	-	-	-	-	-	-	17.0	89.8	-	
11	November 2023 Week 2				-	1.2	-	7.16	1.09	6.07	-	-	-	-	-	-	-	-	-	-	-	-	1.3	218.0	-	
1	16/10/22 Final Tail DS	Composite pulp samples.			-	-	-	3.0	-	-	-	-	-	-	-	-	-	-	2.5	49	65	-	-	-	-	**PAF - potentially acid forming**: classification based on Total Sulfur concentration (>0.3%S), NAG pH (<4.5) and NAG values (>5).
2	16/10/22 Final Tail NS				-	-	-	4.3	-	-	-	-	-	-	-	-	-	-	2.2	79	96	-	-	-	-	
3	23/10/22 Final Tail DS				-	-	-	3.6	-	-	-	-	-	-	-	-	-	-	2.5	58	70	-	-	-	-	
4	23/10/22 Final Tail NS				-	-	-	4.2	-	-	-	-	-	-	-	-	-	-	2.4	67	84	-	-	-	-	
5	30/10/22 Final Tail DS				-	-	-	2.8	-	-	-	-	-	-	-	-	-	-	2.6	44	61	-	-	-	-	
6	30/10/22 Final Tail NS				-	-	-	4.2	-	-	-	-	-	-	-	-	-	-	2.4	74	94	-	-	-	-	
7	6/11/22 Final Tail DS				-	-	-	3.3	-	-	-	-	-	-	-	-	-	-	2.5	62	96	-	-	-	-	
8	6/11/22 Final Tail NS				-	-	-	1.9	-	-	-	-	-	-	-	-	-	-	2.8	32	54	-	-	-	-	
9	13/11/22 Final Tail DS				-	-	-	4.7	-	-	-	-	-	-	-	-	-	-	2.5	78	97	-	-	-	-	
10	13/11/22 Final Tail NS				-	-	-	4.0	-	-	-	-	-	-	-	-	-	-	2.3	61	78	-	-	-	-	
11	20/11/22 Final Tail DS				-	-	-	6.5	-	-	-	-	-	-	-	-	-	-	2.4	91	119	-	-	-	-	
12	27/11/22 Final Tail DS				-	-	-	4.0	-	-	-	-	-	-	-	-	-	-	2.5	71	90	-	-	-	-	
13	27/11/22 Final Tail NS				-	-	-	11.7	-	-	-	-	-	-	-	-	-	-	2.4	82	126	-	-	-	-	
14	4/12/22 Final Tail DS				-	-	-	2.7	-	-	-	-	-	-	-	-	-	-	2.8	51	67	-	-	-	-	
15	4/12/22 Final Tail NS				-	-	-	2.5	-	-	-	-	-	-	-	-	-	-	3.0	27	55	-	-	-	-	
16	18/12/22 Final Tail DS				-	-	-	4.1	-	-	-	-	-	-	-	-	-	-	2.4	72	91	-	-	-	-	
17	18/12/22 Final Tail NS				-	-	-	4.3	-	-	-	-	-	-	-	-	-	-	2.4	76	97	-	-	-	-	
18	25/12/22 Final Tail DS				-	-	-	3.0	-	-	-	-	-	-	-	-	-	-	2.6	57	77	-	-	-	-	
19	25/12/22 Final Tail NS				-	-	-	2.8	-	-	-	-	-	-	-	-	-	-	2.7	39	51	-	-	-	-	
20	1/01/23 Final Tail DS				-	-	-	7.0	-	-	-	-	-	-	-	-	-	-	2.4	114	142	-	-	-	-	
21	1/01/23 Fianl Tail NS				-	-	-	6.1	-	-	-	-	-	-	-	-	-	-	2.4	98	120	-	-	-	-	
22	15/1/23 Final Tail DS				-	-	-	3.6	-	-	-	-	-	-	-	-	-	-	2.4	71	85	-	-	-	-	
23	15/1/23 Final Tail NS				-	-	-	3.8	-	-	-	-	-	-	-	-	-	-	2.4	74	91	-	-	-	-	
24	12/2/23 Final Tail DS				-	-	-	5.9	-	-	-	-	-	-	-	-	-	-	2.3	99	127	-	-	-	-	
25	12/2/23 Final Tail NS				-	-	-	5.5	-	-	-	-	-	-	-	-	-	-	2.3	87	113	-	-	-	-	
26	19/2/23 Final Tail DS				-	-	-	4.2	-	-	-	-	-	-	-	-	-	-	2.4	68	96	-	-	-	-	
27	19/2/23 Final Tail NS				-	-	-	4.3	-	-	-	-	-	-	-	-	-	-	2.4	78	95	-	-	-	-	

Location	Description	Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Aluminium	Antimony	Arsenic	Barium
									mg/kg													
Materials from Geotechnical Bores at TSF 3 for re-use/construction; EB2412108, 1 April 2024																						
TSF3_BH_02	sandy GRAVEL			102	<10	<1	<50	<1	8	51	244		71	192	0.1		8	<5			<5	18
TSF3_BH_05	COBBLES (50%) in a sandy GRAVEL matrix (50%)			99	30	<1	<50	<1	7	7	331		6	100	<0.1		5	<5			<5	25
TSF3_BH_05	COBBLES (40%) in a sandy GRAVEL matrix (60%)			31	30	<1	<50	<1	4	43	133		<5	5,650	<0.1		16	<5			<5	24
TSF3_BH_05	sandy GRAVEL with silt			107	35	<1	<50	<1	13	105	2,230		148	460	0.2		37	<5			6	47
TSF3_BH_05	CLAY with sand			78	<10	<1	<50	<1	<2	113	8,880		20	304	0.2		34	<5			<5	25
TSF3_BH_01	sandy GRAVEL with silt			422	10	<1	<50	<1	7	149	2,700		161	68	0.4		69	<5			9	38
TSF3_BH_01	sandy GRAVEL with silt			701	<10	<1	<50	3	8	130	657		563	44	0.6		51	<5			5	44
TSF3_BH_01	sandy CLAY dark brown			919	10	<1	<50	2	12	53	1,360		296	69	0.4		44	<5			9	42
TSF3_BH_01	sandy GRAVEL			524	<10	<1	<50	4	16	82	1,240		63	410	0.1		23	<5			20	139
TSF3_BH_01	gravelly SAND with silt			30	<10	<1	<50	<1	2	300	3,910		<5	840	<0.1		20	<5			<5	136
TSF3_BH_01	sandy CLAY with gravel			48	<10	<1	<50	<1	2	394	3,730		7	953	<0.1		52	<5			<5	84
TSF3_BH_01	sandy CLAY with gravel			145	<10	<1	<50	<1	25	319	1,290		17	1,010	<0.1		46	<5			9	70
TSF3_BH_01	CLAY with sand			136	<10	<1	<50	<1	26	279	694		<5	1,190	<0.1		33	<5			16	89
TSF3_BH_01	sandy GRAVEL with silt			838	<10	<1	<50	4	14	670	4,720		133	1,450	0.3		168	<5			24	269
TSF3_BH_01	CLAY with gravel/sandy GRAVEL with clay			862	<10	<1	<50	<1	33	441	2,170		124	1,210	0.2		109	<5			16	257
TSF3_BH_01	sandy GRAVEL			321	<10	<1	<50	<1	8	332	1,030		36	700	<0.1		46	<5			9	41
TSF3_BH_01	sandy GRAVEL with silt	-	-	2,000	<10	<1	<50	2	40	886	3,130	-	144	1,060	0.3	-	172	<5	-	-	18	235
Tailings: ALS Work Order EB2415337																						
Dec 2022 Week 1		5,670	7	433	---	---	<50	<1	45	213	1,980	39,200	66	206	0.3	<2	73	<5	3.0	1.3	7	10
Dec 2022 Week 3		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dec 2022 Week 4		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Jan 2023 Week 1		2,910	11	994	---	---	<50	<1	50	194	2,330	52,300	98	122	0.4	3	75	<5	<2	1.2	<5	8
Feb 2023 Week 2		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Feb 2023 Week 3		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Feb 2023 Week 4		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
March 2023 Week 1		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
August 2023 Week 1		5,670	6	982	---	---	<50	<1	50	188	5,390	58,400	69	348	0.3	<2	80	<5	<2	1.2	6	15
August 2023 Week 2		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
November 2023 Week 2		5,370	12	2,250	---	---	<50	<1	56	135	5,010	58,500	109	155	0.4	2	64	<5	2.0	0.9	6	15
16/10/22 Final Tail DS																						
16/10/22 Final Tail NS																						
23/10/22 Final Tail DS																						
23/10/22 Final Tail NS																						
30/10/22 Final Tail DS																						
30/10/22 Final Tail NS																						
6/11/22 Final Tail DS																						
6/11/22 Final Tail NS																						
13/11/22 Final Tail DS																						
13/11/22 Final Tail NS																						
20/11/22 Final Tail DS																						
27/11/22 Final Tail DS																						
27/11/22 Final Tail NS																						
4/12/22 Final Tail DS																						
4/12/22 Final Tail NS																						
18/12/22 Final Tail DS																						
18/12/22 Final Tail NS																						
25/12/22 Final Tail DS																						
25/12/22 Final Tail NS																						
1/01/23 Final Tail DS																						
1/01/23 Final Tail NS																						
15/1/23 Final Tail DS																						
15/1/23 Final Tail NS																						
12/2/23 Final Tail DS																						
12/2/23 Final Tail NS																						
19/2/23 Final Tail DS																						
19/2/23 Final Tail NS		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Assessment Levels ASC NEPM Environmental Investigation Level (EIL)		-	-	-	40	-	-	-	60	-	270	-	470	-	-	-	30	-	-	-	-	280

Location	Description	Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Strontium	Uranium	Vanadium	Zinc
Geochemical Abundance Index (GAI) - Calculation		**71,000**	**5**	**6**	**500**	**6**	**10**	**0.4**	**100**	**8**	**30**	**56,300**	**38**	**1,000**	**0.06**	**2**	**50**	**0.4**	**250**	**2**	**160**	**90**
Materials from Geotechnical Bores at TSF 3 for re-use/construction;																						
TSF3_BH_02	sandy GRAVEL	#VALUE!	#VALUE!	4	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-5	2	2	#VALUE!	0	-3	0	#VALUE!	-4	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-3
TSF3_BH_05	COBBLES (50%) in a sandy GRAVEL matrix (50%)	#VALUE!	#VALUE!	3	-3	#VALUE!	#VALUE!	#VALUE!	-6	-1	3	#VALUE!	-3	-4	#VALUE!	#VALUE!	-3	#VALUE!	#VALUE!	#VALUE!	-6	#VALUE!
TSF3_BH_05	COBBLES (40%) in a sandy GRAVEL matrix (60%)	#VALUE!	#VALUE!	2	-3	#VALUE!	#VALUE!	#VALUE!	-5	2	2	#VALUE!	#VALUE!	2	#VALUE!	#VALUE!	-3	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-2
TSF3_BH_05	sandy GRAVEL with silt	#VALUE!	#VALUE!	6	-3	#VALUE!	#VALUE!	#VALUE!	-4	3	6	#VALUE!	-1	-2	1	#VALUE!	-1	#VALUE!	#VALUE!	#VALUE!	-5	-2
TSF3_BH_05	CLAY with sand	#VALUE!	#VALUE!	1	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	3	8	#VALUE!	-2	-2	1	#VALUE!	-1	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-2
TSF3_BH_01	sandy GRAVEL with silt	#VALUE!	#VALUE!	6	-3	#VALUE!	#VALUE!	#VALUE!	-4	4	5	#VALUE!	-2	-4	2	#VALUE!	-3	#VALUE!	#VALUE!	#VALUE!	-5	-2
TSF3_BH_01	sandy GRAVEL with silt	#VALUE!	#VALUE!	6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-3	3	5	#VALUE!	-1	-3	2	#VALUE!	-2	#VALUE!	#VALUE!	#VALUE!	-4	-2
TSF3_BH_01	sandy CLAY dark brown	#VALUE!	#VALUE!	7	-3	#VALUE!	#VALUE!	#VALUE!	-2	4	5	#VALUE!	-2	-4	2	#VALUE!	-1	#VALUE!	#VALUE!	#VALUE!	-4	-2
TSF3_BH_01	sandy GRAVEL	#VALUE!	#VALUE!	6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-3	3	5	#VALUE!	0	-2	0	#VALUE!	-2	#VALUE!	#VALUE!	#VALUE!	-3	0
TSF3_BH_01	gravelly SAND with silt	#VALUE!	#VALUE!	2	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-6	5	6	#VALUE!	#VALUE!	-1	#VALUE!	#VALUE!	-3	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0
TSF3_BH_01	sandy CLAY with gravel	#VALUE!	#VALUE!	2	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-6	5	6	#VALUE!	-3	-1	#VALUE!	#VALUE!	-3	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-1
TSF3_BH_01	sandy CLAY with gravel	#VALUE!	#VALUE!	4	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-3	5	6	#VALUE!	-2	#VALUE!	#VALUE!	#VALUE!	-1	#VALUE!	#VALUE!	#VALUE!	-5	-1
TSF3_BH_01	CLAY with sand	#VALUE!	#VALUE!	4	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-3	5	4	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	-1	#VALUE!	#VALUE!	#VALUE!	-4	-1
TSF3_BH_01	sandy GRAVEL with silt	#VALUE!	#VALUE!	6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-3	5	6	#VALUE!	-1	0	2	#VALUE!	-1	#VALUE!	#VALUE!	#VALUE!	-3	1
TSF3_BH_01	CLAY with gravel/sandy GRAVEL with clay	#VALUE!	#VALUE!	7	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-2	5	6	#VALUE!	-1	0	1	#VALUE!	-1	#VALUE!	#VALUE!	#VALUE!	-4	1
TSF3_BH_01	sandy GRAVEL	#VALUE!	#VALUE!	5	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-4	5	5	#VALUE!	-1	-1	#VALUE!	#VALUE!	-1	#VALUE!	#VALUE!	#VALUE!	-5	-2
TSF3_BH_01	sandy GRAVEL with silt	#VALUE!	#VALUE!	8	#VALUE!	#VALUE!	#VALUE!	2	-2	6	6	#VALUE!	1	-1	2	#VALUE!	1	#VALUE!	#VALUE!	#VALUE!	-4	1
Tailings																						
Dec 2022 Week 1		-4	-0	6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-2	-4	5	-1	0	-3	2	#VALUE!	#VALUE!	0	#VALUE!	#DIV/0!	-1	-5	-4
Dec 2022 Week 3		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Dec 2022 Week 4		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Jan 2023 Week 1		-5	-1	7	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-2	-4	6	-1	-1	-4	2	-0	-3	#VALUE!	#VALUE!	-1	#VALUE!	-4	-4
Feb 2023 Week 2		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Feb 2023 Week 3		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Feb 2023 Week 4		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
March 2023 Week 1		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
August 2023 Week 1		-4	-0	6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-2	-4	7	-1	-0	-2	2	#VALUE!	-0	#VALUE!	#VALUE!	-1	-5	-3	-3
August 2023 Week 2		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
November 2023 Week 2		-4	-0	6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-2	-4	7	-1	-0	-2	2	#VALUE!	-0	#VALUE!	#VALUE!	#DIV/0!	-2	-5	-3
16/10/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16/10/22 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23/10/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23/10/22 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
30/10/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
30/10/22 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
6/11/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
6/11/22 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
13/11/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
13/11/22 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
20/11/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27/11/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27/11/22 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
4/12/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
4/12/22 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
18/12/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
18/12/22 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
25/12/22 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
25/12/22 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
1/01/23 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
1/01/23 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
15/1/23 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
15/1/23 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
12/2/23 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
12/2/23 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
19/2/23 Final Tail DS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
19/2/23 Final Tail NS		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Geochemical Abundance Index (Trigger Level ≥3)																						
Materials from Geotechnical Bores at TSF 3 for re-use/construction;																						
TSF3_BH_02	sandy GRAVEL	#VALUE!	#VALUE!	4	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	2	2	#VALUE!	0	0	0	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0
TSF3_BH_05	COBBLES (50%) in a sandy GRAVEL matrix (50%)	#VALUE!	#VALUE!	3	0	#VALUE!	#VALUE!	#VALUE!	0	0	3	#VALUE!	0	0	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	#VALUE!
TSF3_BH_05	COBBLES (40%) in a sandy GRAVEL matrix (60%)	#VALUE!	#VALUE!	2	0	#VALUE!	#VALUE!	#VALUE!	0	2	2	#VALUE!	#VALUE!	2	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0
TSF3_BH_05	sandy GRAVEL with silt	#VALUE!	#VALUE!	6	0	#VALUE!	#VALUE!	#VALUE!	0	3	6	#VALUE!	1	0	1	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	0
TSF3_BH_05	CLAY with sand	#VALUE!	#VALUE!	1	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	3	8	#VALUE!	0	0	1	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0
TSF3_BH_01	sandy GRAVEL with silt	#VALUE!	#VALUE!	6	0	#VALUE!	#VALUE!	#VALUE!	0	4	5	#VALUE!	0	0	2	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	0
TSF3_BH_01	sandy GRAVEL with silt	#VALUE!	#VALUE!	6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	3	5	#VALUE!	0	0	2	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	0
TSF3_BH_01	sandy CLAY dark brown	#VALUE!	#VALUE!	7	0	#VALUE!	#VALUE!	2	0	4	5	#VALUE!	0	0	2	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	0
TSF3_BH_01	sandy GRAVEL	#VALUE!	#VALUE!	5	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	4	5	#VALUE!	0	0	0	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	0
TSF3_BH_01	gravelly SAND with silt	#VALUE!	#VALUE!	2	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	5	6	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0
TSF3_BH_01	sandy CLAY with gravel	#VALUE!	#VALUE!	2	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	5	6	#VALUE!	0	0	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0
TSF3_BH_01	sandy CLAY with gravel	#VALUE!	#VALUE!	4	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	5	6	#VALUE!	0	0	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0
TSF3_BH_01	CLAY with sand	#VALUE!	#VALUE!	4	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	5	4	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	0
TSF3_BH_01	sandy GRAVEL with silt	#VALUE!	#VALUE!	6	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	5	6	#VALUE!	0	0	2	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	1
TSF3_BH_01	CLAY with gravel/sandy GRAVEL with clay	#VALUE!	#VALUE!	7	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	5	6	#VALUE!	0	0	1	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	1
TSF3_BH_01	sandy GRAVEL	#VALUE!	#VALUE!	5	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0	5	5	#VALUE!	0	0	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	#VALUE!	0	0
TSF3_BH_01	sandy GRAVEL with silt	#VALUE!	#VALUE!	8	#VALUE!	#VALUE!	#VALUE!	2	0	6	6	#VALUE!	1	0	2	#VALUE!	1	#VALUE!	#VALUE!	#VALUE!	0	1
Tailings																						
Dec 2022 Week 1		0	0	6	#VALUE!

Sample ID	Location	pH	Electrical Conductivity @ 25°C	TDS	Alkalinity				Anions			Cations				Ratios		Water Leachable Metals																						
					Hydroxide Alkalinity as $CaCO_3$	Carbonate Alkalinity as $CaCO_3$	Bicarbonate Alkalinity as $CaCO_3$	Total Alkalinity as $CaCO_3$	Sulfate	Chloride	Silicon	Calcium	Magnesium	Sodium	Potassium	$NaCl$	SO_4:Cl	Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Strontium	Uranium	Vanadium	Zinc
			µS/cm	mg/L	mg/L																																	
Leachable Metals: ASLP (with Acetic Acid; ratio 1:20)																																						
Materials from Geotechnical Bores at TSF 3 for re-use/construction; ALS Work Order EB2415139, 1 April 2024																																						
TSF3_BH_02	sandy GRAVEL																		<0.1			---			0.6	1.5		---	2.3									---
TSF3_BH_05	COBBLES (50%) in a sandy GRAVEL matrix (50%)																		<0.1			---			<0.1	3.9		---	1.2									---
TSF3_BH_05	COBBLES (40%) in a sandy GRAVEL matrix (60%)																		<0.1			---			0.1	0.2		---	19.1									---
TSF3_BH_05	sandy GRAVEL with silt																		<0.1			---			3.2	31.6		<0.1	9.7									---
TSF3_BH_05	CLAY with sand																		<0.1			---			5.9	263.0		---	16.8									---
TSF3_BH_01	sandy GRAVEL with silt																		<0.1			---			6.9	82.1		<0.1	3.1									---
TSF3_BH_01	sandy GRAVEL with silt																		<0.1			---			6.0	19.9		<0.1	4.2	<0.0010								---
TSF3_BH_01	sandy CLAY dark brown																		<0.1			---			1.6	14.2		<0.1	1.8	<0.0010								---
TSF3_BH_01	sandy GRAVEL																		<0.1			<0.05			1.2	2.2		---	5.4									1.80
TSF3_BH_01	gravelly SAND with silt																		<0.1			---			5.6	32.6		---	21.6									3.60
TSF3_BH_01	sandy CLAY with gravel																		<0.1			---			10.6	66.4		---	33.2									---
TSF3_BH_01	sandy CLAY with gravel																		<0.1			---			8.7	14.2		---	27.6									---
TSF3_BH_01	CLAY with sand																		<0.1			---			7.2	7.0		---	40.5									---
TSF3_BH_01	sandy GRAVEL with silt																		<0.1			<0.05			3.8	22.7		<0.1	4.9			0.50						1.00
TSF3_BH_01	CLAY with gravel/sandy GRAVEL with clay																		<0.1			---			2.4	17.4		<0.1	8.0			0.40						8.80
TSF3_BH_01	sandy GRAVEL																		<0.1			---			4.6	4.6		---	13.3			---						---
TSF3_BH_01	sandy GRAVEL with silt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	---	-	-	2.8	17.5	-	<0.1	4.9	---	-	0.60	-	-	-	-	-	3.10
Tailings: ALS Work Order EB2415337																																						
Dec 2022 Week 1											19.7							1.3	<0.1	<0.1		0.4	<0.05	<0.1	1.4	17.0	0.2	<0.1	1.5	<0.0010	<0.1	0.4	<0.05	<0.1	0.010	<0.1	0.70
Dec 2022 Week 3																																						
Dec 2022 Week 4																																						
Jan 2023 Week 1											1.0							0.5	<0.1	<0.1		0.3	<0.05	<0.1	3.7	40.5	0.1	<0.1	2.0	<0.0010	<0.1	1.1	<0.05	<0.1	0.018	<0.1	0.80
Feb 2023 Week 2																																						
Feb 2023 Week 3																																						
Feb 2023 Week 4																																						
March 2023 Week 1																																						
August 2023 Week 1											8.3							0.8	<0.1	<0.1		0.3	<0.05	<0.1	1.4	48.1	0.1	<0.1	1.9	<0.0010	<0.1	0.4	<0.05	<0.1	0.009	<0.1	0.60
August 2023 Week 2																																						
November 2023 Week 2											4.0							0.8	<0.1	<0.1		0.3	<0.05	<0.1	2.1	70.9	0.1	<0.1	1.4	<0.0010	<0.1	0.5	<0.05	<0.1	<0.001	<0.1	0.60
16/10/22 Final Tail DS																																						
16/10/22 Final Tail NS																																						
23/10/22 Final Tail DS																																						
23/10/22 Final Tail NS																																						
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19/2/23 Final Tail NS		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leachable Metals: ASLP (with DI Water; ratio 1:20)																																						
Materials from Geotechnical Bores at TSF 3 for re-use/construction; ALS Work Order EB2415139, 1 April 2024																																						
TSF3_BH_02	sandy GRAVEL								840										<0.1			---			<0.1	<0.1		---	0.4									---
TSF3_BH_05	COBBLES (50%) in a sandy GRAVEL matrix (50%)								12,400										<0.1			---			<0.1	0.1		---	0.5									---
TSF3_BH_05	COBBLES (40%) in a sandy GRAVEL matrix (60%)								3,540										<0.1			---			<0.1	<0.1		---	4.0									---
TSF3_BH_05	sandy GRAVEL with silt								68,000										0.1			---			3.0	10.6		<0.1	10.6									---
TSF3_BH_05	CLAY with sand								43,000										0.1			---			6.1	228.0		---	17.3									---
TSF3_BH_01	sandy GRAVEL with silt								95,500										<0.1			---			4.4	40.9		<0.1	2.5									---
TSF3_BH_01	sandy GRAVEL with silt								########										<0.1			---			6.6	14.9		<0.1	4.5	<0.0010								---
TSF3_BH_01	sandy CLAY dark brown								80,000										<0.1			---			1.2	4.3		<0.1	1.4	<0.0010								---
TSF3_BH_01	sandy GRAVEL								37,000										<0.1			<0.05			0.6	0.2		---	0.4									<0.5
TSF3_BH_01	gravelly SAND with silt								52,900										<0.1			---			5.9	23.7		---	22.4									2.5
TSF3_BH_01	sandy CLAY with gravel								37,000										<0.1			---			11.7	41.0		---	36.1									---
TSF3_BH_01	sandy CLAY with gravel								38,700										<0.1			---			10.5	15.3		---	35.3									---
TSF3_BH_01	CLAY with sand								25,600										<0.1			---			7.2	2.1		---	41.4									---
TSF3_BH_01	sandy GRAVEL with silt								11,800										<0.1			<0.05			2.3	0.4		<0.1	3.2			0.4						0.4
TSF3_BH_01	CLAY with gravel/sandy GRAVEL with clay								11,300										<0.1			---			2.4	2.0		<0.1	8.1			0.4						4.6
TSF3_BH_01	sandy GRAVEL								26,600										<0.1			---			3.5	1.3		---	11.5			---						---
TSF3_BH_01	sandy GRAVEL with silt								6,640										<0.1			<0.1			<0.1	<0.1		<0.1	<0.1			<0.1						<0.1
Tailings: ALS Work Order EB2415337		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dec 2022 Week 1											1.6							0.03	0.010	0.042		0.18	0.0002	<0.001	0.01	0.07	<0.05	<0.001	0.03	<0.0001	0.021	0.004	<0.01	0.068	<0.001	<0.01	0.04
Dec 2022 Week 3																																						
Dec 2022 Week 4																																						
Jan 2023 Week 1											1.8							0.02	0.002	0.004		0.18	0.0003	<0.001	4.06	80.30	<0.05	0.002	2.32	<0.0001	<0.001	1.160	<0.01	0.044	<0.001	<0.01	0.53
Feb 2023 Week 2																																						
Feb 2023 Week 3																																						
Feb 2023 Week 4																																						
March 2023 Week 1																																						
August 2023 Week 1											1.7							0.02	0.005	0.016		0.14	<0.0001	<0.001	0.01	0.01	<0.05	<0.001	0.03	<0.0001	0.008	0.002	<0.01	0.058	<0.001	<0.01	0.03
August 2023 Week 2																																						
November 2023 Week 2		-	-	-	-	-	-	-	-	-	4.0	-	-	-	-	-	-	0.02	0.001	0.010	-	0.20	0.0003	<0.001	2.14	31.40	<0.05	0.002	1.43	<0.0001	<0.001	0.510	<0.01	0.082	<0.001	<0.01	0.53
16/10/22 Final Tail DS																																						
16/10/22 Final Tail NS																																						
23/10/22 Final Tail DS																																						
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19/2/23 Final Tail DS																																						
19/2/23 Final Tail NS																																						
ANZG, 2023: Draft Livestock Drinking Water Guidelines (Cattle)		-	-	4,000	-	-	-	-	500	-	-	1,000	400	-	-	-	-	<5	-	<0.025	-	<5	<0.01	(ii) <0.05	<1	<1	-	<0.1	<10	<0.002	-	<1	<0.02	-	<0.2	<0.1	<20

ENGENY

29METALS

Capricorn Copper Mine

Sampling and Analysis Plan

QC1022_016-RPT-001-0

9 NOVEMBER 2023

DISCLAIMER

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	9/11/2023	Initial Issue	Rebecca Malaj	Travis Warren	Rebecca Malaj	Travis Warren
Signatures:						

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1. INTRODUCTION

29Metals (29M) are seeking to recommence sub-aqueous tailings deposition into EPit following exhaustion of the capacity of the current Esperanza tailings storage facility (ETSF) at the Capricorn Copper Mine (CCM).

Limited geochemical characterisation of the tailings at CCM has been undertaken to date, although it is understood the tailings are categorised as potential acid forming (PAF) materials.

All sulfide-containing material has the potential, when exposed to water and air, to produce run-off and/or leachate with increased concentrations of solutes. The key questions to be addressed are the extent to which this may occur and whether the risk to the environment is of a magnitude that needs to be mitigated to produce an acceptable outcome.

This sampling and analysis quality plan aims to ensure a contemporary understanding of the geochemical characteristics of the tailings to inform the risks associated with placement within the Esperanza Pit. Engeny understand that 29M have previously deposited up to 6.6Mt of tailings into EPit, from approximately July 2017 to January 2022.

A view of the site is presented in Figure 1.1.

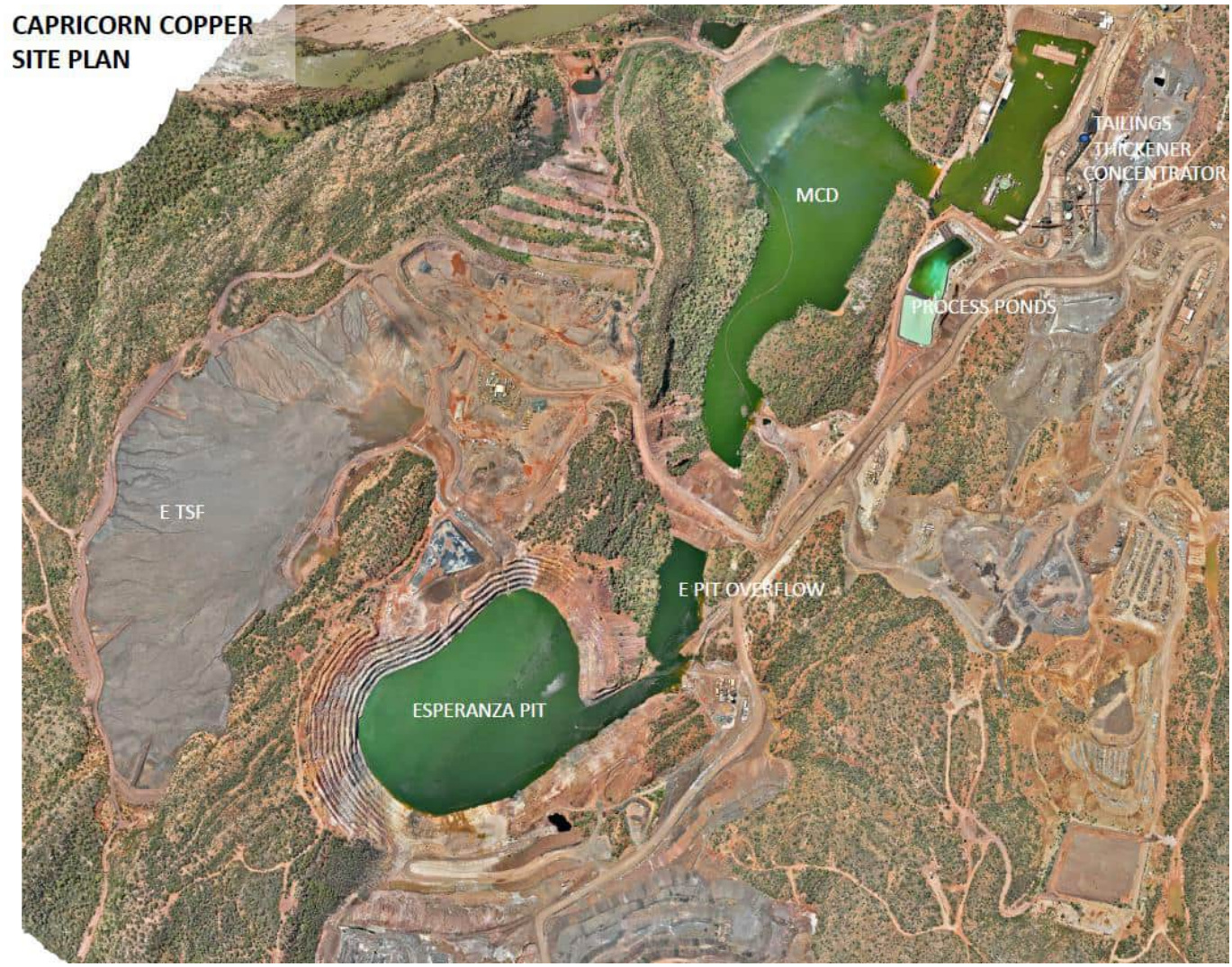


Figure 1.1:Site Plan

1.1 Objective

The objective of the Sampling and Analysis Plan (SAP) for the characterisation of tailings on the site is to complete a geochemical assessment of representative samples of mining waste materials in accordance with relevant legislation, guidelines and policies and with a level of rigour consistent with the Queensland approvals processes. Specifically, to document the tailings geochemistry and assess whether these characteristics have the potential to lead to seepage impacts to groundwater.

1.2 Scope of Works

To achieve the objective of the SAQP, the following scope of works is required:

- Review of available geochemical and geological data associated with the Project.
- Design of a geochemical assessment program, including sampling for and testing of representative tailings materials within the Project boundary. The program will:
  - Identify sampling locations.
  - Provide guidance on sample collection, storage, preservation, transport, and laboratory submission.
  - Specify a laboratory testing program suitable to address:
    - AMD (acid and metalliferous drainage) potential;
    - Other deleterious environmental risks (i.e., cyanide / nitrate);
    - pH and salinity; and
    - Elemental enrichment.

1.3 Guidelines and Legislation

The SAP has been developed with reference to the following documents:

- *Preventing Acid and Metalliferous Drainage Leading Practice Sustainable Development Program for the Mining Industry Commonwealth of Australia, September 2016 (CoA, 2016).*
- *State of Queensland (1994) Environmental Protection Act 1994 (EP Act).*
- *Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water).*
- *ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines (ANZG, 2018).*

2. BACKGROUND

Capricorn Copper Pty Ltd (CCPL) recommenced operations at their Capricorn Copper Mine (CCM) in 2018, with a planned Life of Mine of 9.5 years, generating approximately 14 Mt of tailings. The plan for tailings management over the first 4 years was to utilise the Esperanza Pit (EPit) for the initial mine development phase in conjunction with paste backfill of underground voids. Several options for ongoing tailings management were identified in the Tailings Management Plan (GHD, 2017) for the Project.

Currently the site is progressing with design of the TSF 3 facility, and this project will be used in support of the design and associated approvals for TSF 3.

2.1 Geology and Mineralisation

Mineralisation is structurally controlled, and sediment hosted, and occurs in the Western Fold Belt of the Mount Isa.

Inlier (Early to Mid-Proterozoic rocks). Capricorn Copper Mine consists of five known copper deposits – Mammoth, Greenstone, Esperanza South, Esperanza and Pluto, of which underground mining is currently active at Mammoth and Esperanza South. The Mammoth Deposit is hosted by the Whitworth Quartzite, part of the Myally sub-group, which was deposited in a shallow marine environment. The Whitworth Quartzite is a massive pink feldspathic, medium to coarse grained, poorly bedded and homogenous quartzite which formed by the silicification of the original arenite. The Mammoth Deposit occurs at the intersection of the SE-dipping Mammoth Fault and the moderate W-dipping Portal Fault, with the main mineralisation in the footwall of the steep south dipping Mammoth Fault and the hanging wall of the west dipping Portal Fault. The copper sulphide mineralisation is mainly a mix of chalcocite, bornite and chalcopyrite, with pyrite most likely associated with bornite and chalcopyrite. There is less pyrite at Mammoth than Esperanza South.

Mineralisation is found in 3 styles:

- Massive mineralisation occurs adjacent to the Mammoth and/or Portal Faults and contains minor host rock fragments.
- Brecciated mineralisation occurs farther away from the major faults and consist of angular and sometimes fragmented clasts.
- Veined mineralisation is the most distal Mineralisation style from the faults, occurring in the quartzite's, sandstone and siltstone of the Myally Subgroup. These rocks have been fractured allowing fluids to enter these weaker bedding or broken planes, resulting in vein-like patterns.

The Mammoth decline and development drives sit within the host Whitworth Quartzite, with a halo of variable sulphide content leading into the ore zone.

Esperanza South Deposit is shear hosted occurring in graphitic shales of the Esperanza Formation. Mineralisation is largely restricted to this unit, preferentially in sheared and silicified zones, with some minor incursion into the adjoining Paradise Creek Formation, a dolomitic siltstone largely devoid of sulphide. Copper sulphides are dominated by chalcocite with lesser bornite in the upper parts of the deposit, with chalcopyrite dominating at depth associated with pyrite. Sulphides can be massive and semi-massive.

The Esperanza South Deposit decline and a significant portion of the development drives are within the mainly barren Paradise Creek Formation and are expected to be mainly devoid of sulphide.

2.2 Environmental Authority

The Environmental Authority (EPML000911413) (EA) for CCM has the following relevant conditions for tailings management:

(E4-1) A tailings management procedure must be developed and implemented. These procedures must include provisions for:

(a) Containment of tailings in accordance with best practice environmental management;

(b) The management of seepage or leachate during operation and post-closure;

(c) The control of fugitive emissions to air;

(d) Characterisation of tailings to identify the potential to generate contaminated seepage or leachate must be undertaken at a minimum frequency of once every month during tailings deposition. Characterisation must include:

  (i) Determining the acid producing potential through calculating both the 'Net Acid Producing Potential' and the 'Net Acid Generation test'.

(ii) Determining the level of aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, lead, manganese, nickel, uranium and zinc.

(iii) Where the acid producing potential of tailings material has not been conclusively determined, tailings material must be considered as acid forming unless further geochemical testing demonstrates otherwise.

(e) Reducing the exposure of potentially acid producing tailings to oxidizing conditions;

(f) A rehabilitation strategy which meets the rehabilitation objectives specified in Schedule F – Land of this environmental authority; and

(g) Monitoring of rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of tailings, including the prevention and management of acid drainage, erosion minimisation and establishment of vegetation cover.

This plan has considered the relevant EA requirements for ongoing sampling.

2.3 Tailings Management Plan

GHD prepared a Tailings Management Plan for tailings management from recommencement of operations in 2018 for a period of approximately 4 years. The plan utilised the EPit for the initial mine development phase in conjunction with paste backfill of underground voids. The tailings management plan details previous testing of tailings undertaken on the site.

Geotechnical testing of the historic tailings was undertaken by Maunsell in mid-2008 (Maunsell, 2008). Additional tailings sampling and testing was undertaken by GHD in 2008 and 2009. Results from the testing was summarised in Table 4 of the GHD report, presented in Figure 2.1.

Table 4 Tailings Geotechnical Test Results - Classification

Test	1 Maunsell 2008	2 Maunsell 2008	3 Maunsell 2008	4 GHD 2008	5 GHD 2009	6 GHD 2009	7 GHD 2009
Linear Shrinkage (%)	3	3	2		3.5	3.5	4
LL (%)	22	21	21	32	25	22	26
PL (%)	17	15	18	28	16	13	16
PI (%)	5	6	3	8	9	9	10
% passing 75 micron					64	62.5	60.2
Emerson Class	4	4	4				
Friction Angle (deg)	43	NA	44				
Cohesion (kPa)	1	NA	0				
Hydraulic conductivity (m/sec)				2×10^{-8}			

Figure 2.1:Tailings Classification

The results presented in Figure 2.1 indicate that the tailings:

- Comprise sandy silty clay with low to moderate plasticity.
- Have dried on the surface of Esperanza TSF to a density of 1.4 to 1.6 t/m3 which is approximately 78%-87% maximum dry density, indicating further density would be achievable with compaction. This is noted to be in contrast to previous historic data which showed that density has been as low as 0.7 t/m3 when excessive surface water had been stored on the TSF.
- Hydraulic conductivity is low.

2.3.1 Geochemistry and Options for Modifying

Past geochemical testing (Environmental Earth Scientists 2012, EMM 2015, GHD 2018) has shown that the historic tailings exhibit high concentrations of total S and sulfide-S, hence have a high Maximum Potential Acidity (MPA), with limited Acid Neutralising Capacity (ANC).

This correlates to strongly positive Net Acid Production Potential (NAPP) values indicating a high probability of being acid-forming. This suggestion is further supported by low Net Acid Generation (NAG) pH test results.

Multi-element testing indicates that tailings samples are significantly enriched (Geochemical Abundance Indices (GAI) of 3 or greater) in silver (Ag), arsenic (As), bismuth, (Bi), copper (Cu), lead (Pb), antimony (Sb) and thallium (TI) (Environmental Earth Scientists, 2012).

2.4 Existing Reports

2.4.1 Geocompute (2001)

Geocompute completed an evaluation of the tailings dam at the site in response to a request from a previous operator (Western Metals Copper Limited) to assess the potential for contaminant bearing fluids to escape from the ETSF, the EPit. This report notes additional contaminant input into the water due to a high rainfall event in the wet season of 2000-2001.

The Geocompute assessment estimates the pyrite content of Esperanza tailings at 70% and the Mammoth tailings at 50%.

2.4.2 EMM (2015)

EMM carried out excavation of 10 test pits through the Old TSF (Pit A, B, B1-B6, C and D), which showed the tailings cover comprised a plant growth medium of around 60cm, with a 30 to 40 cm lower permeability layer or a 20cm coarse layer below, which was most likely used to help support equipment during placement of the cover. EMM submitted 40 samples to ALS Brisbane for standard geochemical characterisation of cover materials and underlying tailings. There were issues with the EMM assessment of the data (they did not convert SO4 ppm to S% and used NAPP values instead of ANC to determine the ARD potential), and it was incorrectly concluded that the tailings were non-acid forming (NAF). Total S of the tailings were generally over 1% and acid neutralising capacity was generally 0 kg H2SO4/t, indicating the tailings are potentially acid forming (PAF) with no lag, consistent with the low pH of less than 4 in water extracts. The only two samples from the coarse layer (in Pit B) also had S greater than 1%, indicating PAF waste rock may have been used for the construction platform.

2.4.3 GHD (2018)

GHD carried out excavation of 10 test pits (TP01 to TP10) on the Old TSF through the cover system into the tailings and drilled six boreholes (BH01 to BH06) to the full depth of the TSF and into natural ground, except for BH05, which terminated in very wet tailings at a depth of 24m. Observations were consistent with EMM (2015), and showed the cover thickness was generally around 90cm, but could be up to 2m. The tailings were damp or wet at 10m below ground surface. Intermittent tailings samples were selected for standard geochemical characterisation by GHD, but no cover materials. Geochemical results confirmed all tailings had high total S greater than 1%, had negligible ANC of generally less than 10 kg H2SO4/t, and were PAF. Samples in test pits and closer to surface generally had total S values of 1% to 1.5%, compared to much higher S at depth in the drillholes of 2.5% to 5.8%, reflecting either variable tailings sources over time or the effects of extended leaching of the near surface tailings materials over the 40 years since deposition ceased. Sulphate S results account for 20% to 50% of the total S, even at depth, indicating sulphide oxidation and generation of ARD salts throughout the tailings pile. Multi-element data shows the tailings solids still contain high metal contents:

- Ag 2-10ppm.
- Co 60 to 380ppm.
- Cu 0.1 to 1.2%.

Geochemical test results confirm the high residual ARD potential of the Old TSF, the presence of ARD oxidation products that will be readily mobilised, and high metal concentrations readily liberated under acid conditions.

2.4.4 Capricorn Copper Definitive Feasibility Report (not dated)

Chapter 7 of the Capricorn Copper *Definitive Feasibility Report* (CC DFR) presents *Net Acid Production Potential (NAPP) and Net Acid Generation (NAG) tests performed on the rougher tailings samples to characterise the Acid Forming Potential (AFP) of the rougher tailings of each Metallurgical Domain to identify potential ore zones that may be used to cap regulated storage facilities. The Rougher Tailings from Greenstone (GRN) is a nett-acid consumer and is likely that this processing stream can be used as an inert cap for rehabilitation activities. Tailings from Mammoth Chalcocite also have low sulphur content and may be blended with GRN ores to increase the volume of capping material present. The other domains will likely require a subsequent flotation stage to further remove pyrite if they are to be neutral or net-acid consumers* (CC DFR).

Table 34 Preliminary AFP results of rougher tailings

Test	Units	ESS Hm	MM Cc	ESS Coarse	ESS Fine Cc	MM Bn	GRN	ESP HG
Nett acid producing potential								
NAPP	kg H_2SO_4/t	27.2	1.7	26.4	34.7	24.2	-53.1	45.4
Nett acid generation								
pH (OX)	pH unit	2.8	3.6	3.1	2.9	2.8	9.3	2.7
NAG (pH 4.5)	kg H_2SO_4/t	14.1	1.4	5.0	23.0	15.9	<0.1	13.5
NAG (pH 7.0)	kg H_2SO_4/t	18.9	2.6	9.2	26.7	19.7	<0.1	30.3
Acid neutralising capacity								
ANC as H_2SO_4	kg H_2SO_4 equiv./t	<0.5	4.4	1.7	0.8	4.9	54.0	7.2
ANC as $CaCO_3$	%$CaCO_3$	<0.1	0.4	0.2	<0.1	0.5	5.5	0.7
Fizz Rating	Fizz unit	0	0	0	0	0	2	1
Total sulphur by LECO								
Total S	%	0.89	0.20	0.92	1.16	0.95	0.03	1.72

Figure 2.2: Rougher Tailings Acid Forming Potential (extract from Chapter 7: Definitive Feasibility Report)

Recommendations for further work included AFP testing *on the higher sulphur domains to reduce their AFP. Suggested works include an additional pyrite flotation stage after roughing to reduce the sulphur content as low as possible.*

2.4.5 Earth Systems (2020)

Earth Systems (ES, 2020) was engaged to co-ordinate Quantitative X-Ray Diffraction (QXRD) analyses of 28 tailings samples to identify the presence of iron-oxide phases (e.g., goethite, hematite) that may facilitate sulfate removal from process water in the EPit via bacterially induced pyrite precipitation.

The dominant mineral in the tailing's samples analysed is quartz, with smaller proportions of pyrite, muscovite, kaolinite and siderite. The Maximum Potential Acidity (MPA) calculated from the mineralogy is elevated (16-109 kg H_2SO_4 per tonne) due to the presence of pyrite (0.8-6.5 wt.%). The calculated ANC is generally low (<6.2 kg H_2SO_4 per tonne). Therefore, the Net Acid Production Potential (NAPP; NAPP = MPA - ANC) of these samples ranges from 14 to 104 kg H_2SO_4 per tonne of tailings, and hence all samples are classified as Potentially Acid Forming (PAF).

2.4.6 Laboratory Report

Supplied laboratory results (ALS reference BR23079597) from recent tailings testing conducted between 16/10/2022 and 19/02/2023, presented in Table 2.1, report all tailings as potentially acid forming, with reported pH following oxidation ranging between 2.2 and 3.0 and calculated MPA elevated between 57-356 kg H_2SO_4 per tonne.

TABLE 2.1: LABORATORY RESULTS (BR23079597)

SAMPLE	S	NAG @ pH 4.5	NAG @ pH 7.0	pH	Calc. MPA 30.6 x %S = MPA
UNIT	%	kg/t	kg/t	pH Unit	kgH_2SO_4/t
16/10/22 Final Tail DS	2.98	49.4	64.8	2.5	91.188
16/10/22 Final Tail NS	4.32	79.3	96.3	2.2	132.192
23/10/22 Final Tail DS	3.55	57.6	69.6	2.5	108.63
23/10/22 Final Tail NS	4.22	66.9	83.9	2.4	129.132
30/10/22 Final Tail DS	2.82	44.3	60.9	2.6	86.292
30/10/22 Final Tail NS	4.24	74.4	94.1	2.4	129.744
6/11/22 Final Tail DS	3.3	61.5	96	2.5	100.98

SAMPLE	S	NAG @ pH 4.5	NAG @ pH 7.0	pH	Calc. MPA 30.6 x %S = MPA
UNIT	%	kg/t	kg/t	pH Unit	kgH_2SO_4/t
6/11/22 Final Tail NS	1.88	31.5	54.2	2.8	57.528
13/11/22 Final Tail DS	4.65	77.9	96.8	2.5	142.29
13/11/22 Final Tail NS	4.03	61.3	78.2	2.3	123.318
20/11/22 Final Tail DS	6.51	90.6	119	2.4	199.206
27/11/22 Final Tail DS	4.02	70.5	89.8	2.5	123.012
27/11/22 Final Tail NS	11.65	82.2	126	2.4	356.49
4/12/22 Final Tail DS	2.74	51	66.8	2.8	83.844
4/12/22 Final Tail NS	2.45	26.9	55.3	3	74.97
18/12/22 Final Tail DS	4.06	71.6	91.4	2.4	124.236
18/12/22 Final Tail NS	4.27	76.1	97	2.4	130.662
25/12/22 Final Tail DS	3.04	57.4	77.3	2.6	93.024
25/12/22 Final Tail NS	2.78	38.8	51.2	2.7	85.068
1/01/23 Final Tail DS	7	114	142	2.4	214.2
1/01/23 Final Tail NS	6.12	98	120	2.4	187.272
15/1/23 Final Tail DS	3.62	71.2	85.4	2.4	110.772
15/1/23 Final Tail NS	3.76	73.6	90.6	2.4	115.056
12/2/23 Final Tail DS	5.9	98.5	127	2.3	180.54
12/2/23 Final Tail NS	5.54	86.7	113	2.3	169.524
19/2/23 Final Tail DS	4.17	67.6	95.9	2.4	127.602
19/2/23 Final Tail NS	4.29	77.5	95.4	2.4	131.274
Mean Results	**4.36**	**68.75**	**90.29**	**2.47**	**133.63**
Min Results	**1.88**	**26.9**	**51.2**	**2.2**	**57.528**
Max Results	**11.65**	**114**	**142**	**3**	**356.49**

2.5 Data Gaps

Data gaps identified relevant to this SAP include:

- Comprehensive tailings assessment has not been completed. Minimal static test data is available.
- No kinetic testing has been conducted to determine long-term leachate properties.
- All samples tested indicate potential acid forming material with pyrite confirmed as being present within the waste rock material.

More broadly comprehensive analysis and sampling of ore and waste rock, and the development of block models has not been undertaken. Undertaking this work would be very beneficial in characterising the future ore and waste materials, and associated tailings streams, and informing environmental risk across the site during operations and closure.

3. ASSESSMENT CRITERIA

3.1 Acid Generation and Prediction

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 S content or assuming that all sulfur does not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O = Fe\ (OH)_3 + 2\ H_2SO_4$$

According to this reaction, the maximum potential acidity (MPA) of a sample containing 1%S 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.

3.1.1 Net Acid Producing Potential

The net acid producing potential (NAPP) is used as an indicator of materials that may be of concern with respect to acid generation. The NAPP calculation represents the balance between the maximum potential acidity (MPA) of a sample, which is derived from the sulfide sulfur content, and the acid neutralising capacity (ANC) of the material, which is determined experimentally. By convention, the NAPP result is expressed in units of kg H_2SO_4/t sample. If the capacity of the solids to neutralise acid (ANC) exceeds their capacity to generate acid (MPA), then the NAPP of the material is negative. Conversely, if the MPA exceeds the ANC, the NAPP of the material is positive. A NAPP assessment involves a series of analytical tests that include:

3.1.1.1 Determination of pH and EC

pH and EC measured on 1:5 w/w water extract. This gives an indication of the inherent acidity and salinity of the waste material when initially exposed in a waste emplacement area.

3.1.1.2 Total sulfur content and Maximum Potential Acidity (MPA)

$$\text{Acidity generated } (\text{KgH}_2\text{SO}_4/\text{t}) = \frac{\text{S w\%} \times 10 \times 2\ (\text{moles H}_2\text{SO}_4) \times 98.07(\text{g/mol})}{2(\text{moles S}) \times 32.06(\text{g/mol})} = \text{S w\%} \times 30.6 \quad (9)$$

Total sulfur content is determined by the Leco high temperature combustion method. The total sulfur content is then used to calculate the MPA, which is based on the assumption that the entire sulfur content is present as reactive pyrite. Direct determination of the pyritic sulfur content can provide a more accurate estimate of the MPA.

3.1.1.3 Acid neutralising capacity (ANC)

By addition of acid to a known weight of sample, then titration with NaOH to determine the amount of residual acid. The ANC measures the capacity of a sample to react with and neutralise acid. The ANC can be further evaluated by slow acid titration to a set endpoint in the Acid Buffering Characteristic Curve (ABCC) test through calculation of the amount of acid consumed and evaluation of the resultant titration curve.

3.1.1.4 Net acid producing potential (NAPP)

Calculated from the MPA and ANC results. The NAPP represents the balance between a sample's inherent capacities to generate and neutralise acid. If the MPA is greater than the ANC, then the NAPP is positive. If the MPA is less than the ANC, then the NAPP is negative.

3.1.1.5 Net Acid Generation (NAG)

The net acid generation (NAG) test involves the addition of hydrogen peroxide to a sample of mine rock or process residue to oxidise reactive sulfide, then measurement of pH and titration of any net acidity produced by the acid generation and neutralisation reactions occurring in the sample. A significant NAG result (i.e., final NAGpH < 4.5) indicates that the sample is potentially acid forming (PAF), and the test provides

a direct measure of the net amount of acid remaining in the sample after all acid generating and acid neutralising reactions have taken place. A NAGpH > 4.5 indicates that the sample is non-acid forming (NAF). The NAG test provides a direct assessment of the potential for a material to produce acid after a period of exposure and weathering and is used to refine the results of the theoretical NAPP predictions. The NAG test can be used as a stand-alone test but is recommended that this only be considered after site specific calibration work is carried out.

3.2 Assessment of Element Enrichment and Solubility

In mineralised areas it is common to find a suite of enriched elements that have resulted from natural geological processes. Multi-element scans are carried out to identify any elements that are present in a material (or readily leachable from a material) at concentrations that may be of environmental concern with respect to surface water quality, revegetation and public health. The samples are generally analysed for the following elements:

Major elements: Al, Ca, Fe, K, Mg, Na and S.

Minor elements: As, B, Cd, Co, Cr, Cu, F, Hg, Mn, Mo, Ni, Pb, Sb, Se and Zn.

The concentration of these elements in samples can be directly compared with relevant state or national environmental and health-based concentration guideline criteria to determine the level of significance. Water extracts are used to determine the immediate element solubilities under the existing sample pH conditions of the sample. The following tests are normally carried out:

3.2.1 Multi-element composition of solids

Multi-element composition of solid samples determined using a combination of ICP-mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

3.2.2 Multi-element composition of water extracts

Multi-element composition of water extracts from solid samples determined using a combination of ICP mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

Under some conditions (e.g., low pH) the solubility and mobility of common environmentally important elements can increase significantly. If element mobility under initial pH conditions is deemed likely and/or subsequent low pH conditions may occur, kinetic leach column test work may be completed on representative samples.

3.3 Kinetic Leach Column Tests

Kinetic leach column (KLC) tests can be used to provide information on the reaction kinetics of mining 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; and
- Assess treatment options such as addition of alkaline materials.

The KLC tests simulate the weathering process that leads to acid and base generation and reaction under laboratory controlled or site conditions. 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.

In KLC tests, water is added to a sample and the mixture allowed to leach products and by-products of acid producing and consuming reactions. Samples of leachate are then collected and analysed. Intermittent water application is applied to simulate rainfall and heat lamps are used to simulate sunshine. These tests provide real-time information and may have to continue for months or years. Monitoring includes trends in pH, sulfate, acidity or alkalinity, and metals, for example. The pH of the collected leachate simulates the acid drainage process, acidity or alkalinity levels indicate the rate of acid production and acid neutralisation, and sulfate production can be related to the rate of Loch-Wilkinson oxidation. Metal concentration data provides an assessment of metal solubility and leaching behaviour.

3.4 Assessment of Element Enrichment

The total concentration result for each element will be compared to average element abundance in soil in the earth's crust to measure how the total elemental concentrations in the tailings compare against average elemental concentrations in soil (worldwide). Such a comparison is undertaken to identify samples that contain what may be regarded as 'elevated' concentrations of metals and metalloids to assess any potential concerns related to disposal and rehabilitation. However, enrichment in any metals/metalloids in the solids does not translate to enhanced leachability or mobilisation of that specific element.

From the comparison with average crustal abundance in rocks a geochemical abundance index (GAI) was calculated. The GAI quantifies an assay result for a particular element in terms of the average abundance for that element (in sedimentary rocks). The index, based on a log 2 scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times average crustal abundance, as shown in Table 3.1.

As a general rule, a GAI greater than or equal to three indicates enrichment to a level that potentially warrants further investigation or provides an indication of which elements may potentially be problematic with respect to environmental impacts.

TABLE 3.1: GEOCHEMICAL ABUNDANCE INDEX (GAI)

GAI	Enrichment factor
0	Less than 3-fold enrichment
1	3 to 6-fold enrichment
2	6 to 12-fold enrichment
3	12 to 24-fold enrichment
4	24 to 48-fold enrichment
5	48 to 96-fold enrichment
6	Greater than 96-fold enrichment

3.5 Acid Classification Criteria

Sample classification of mineral waste material follows some general rules. Samples will be classified, with respect to acid generation, using NAPP (and NAG data, where available) into three broad categories:

- NAF: Non-acid Forming.
- Uncertain: Those samples with inconclusive results, leading to a degree of uncertainty about their ability to generate acid.
- PAF: Potentially Acid Forming.

Within these three broad categories the sample classification will be further refined with the aid of Total S data in accordance with Table 3.2, as follows:

- NAF (NAF).
- NAF-Sulfur (NAF-S).
- PAF – Low Capacity (PAF-LC).
- PAF.
- Uncertain.

Heterogeneity is a characteristic of natural geological (soil and rock) material. Sometimes an analytical result for a rock sample can vary to that which may be expected based on the known rock type (from information contained in the lithological logs). In this case, a degree of conservatism is applied to the result (i.e., the precautionary principle prevails) and the sample is classified as 'Uncertain' until further information becomes available.

TABLE 3.2: GEOCHEMICAL CLASSIFICATION CRITERIA FOR MINING WASTE MATERIALS

Geochemical Classification	Total Sulfur (%)	NAG pH	NAPP (kg H_2SO_4/t)	NAG at pH 4.5
NAF	≤1 %	≥4.5	<0	-
NAF-Sulphur	>1 %	≥4.5	<0	-
PAF – Low Capacity	-	<4.5	≥0 and <10	≤5
PAF	-	<4.5	≥10	>5
Uncertain	Any result outside of the above criteria, or results that appear to significantly conflict with the expected result based on lithology or mineralogy.			

4. PROPOSED SAMPLING PROGRAM

4.1 Sample Numbers

Geochemical sample density is a critical parameter to ensure that a statistically significant data set has been captured, such that the AMD risk assessment is based on sound mineral waste characterisation. There is arguably no 'right' number of samples that should be collected for geochemical characterisation, rather, demonstrating a level of confidence for the stated purpose statistically is the preferred method. In that regard, several publications provide guidance toward obtaining a representative sampling density. For example, Price (1997), Miller (1997) and the (then) Queensland Department of Mines and Energy (DME) (1995) have provided guidance on geochemical sampling numbers / density. The correct number, however, relates to a level of statistical significance for which the AMD risk becomes acceptable based on the proposed development.

For the purposes of this assessment, the sampling density has been informed by Table 4.1 (MEND 2009).

TABLE 4.1: SUGGESTED PHASE 1 CHARACTERISATION SAMPLING FREQUENCY BASED ON TONNAGE (MEND 2009)

Tonnes of Disturbed Rock	Minimum Number of Samples
<10,000	3
<100,000	3-8
<1,000,000	8-26
<10,000,000	26-80
> 10,000,000	Few hundred

Engeny understand that mining is ongoing in Mammoth and Esperanza South mines. Engeny do not have clarity on the blend of the ore and therefore if a homogenous tailings stream is expected. The assumed rate of deposition of tailings is 100,000t per month. This would equate to 2.5 samples per month. Initially Engeny recommends sampling up to five (5) samples a month (1 per day for five days) for up to three months to build a site-specific data set.

It is assumed representative samples can be taken from the tailing's thickener directly.

Where varying ore blending strategies are in place, additional sampling should be undertaken to ensure variability in tailings streams is analysed.

Engeny note the requirement for monthly sampling has been considered in deriving the tailings sampling densities. Sampling of the full analysis in Section 4.2 below should be undertaken on at least one representative sample each month.

4.2 Laboratory Analysis

Screening of all samples will be conducted for:

- Description of ore feed and photo.
- XRF.
- pH (1:5 w:v).
- Electrical conductivity (EC) (1:5 w:v).
- Total sulfur [Leco method] (LoR: 0.0005wt%).

- Sulfate-S.
- Net Acid Production Potential (NAPP, ASS-1).
- NAG at pH4.5 and 7.0.
- Sulphur speciation.
- Acid buffering characteristics curves.
- Sulfide (chromium reducible sulfur – Scr) [AS 4969.7-2008 method].
- Total metals/metalloids (Al, As, B, Cd, Cr, Co, Cu, Fe, P, Pb, Mn, Ni, Sb, Se and Zn) in solids [HCl and HNO3 acid digest followed by ICP-AES/MS].
- Total cations (Ca, Mg, Na and K) [HCl and HNO3 acid digest followed by ICP-AES].
- Leachable metals/metalloids (TCLP at pH 5) (Al, As, B, Cd, Cr, Co, Cu, Fe, P, Pb, Mn, Mo, Ni, Sb, Se, Si, V and Zn) [ICP/AES (1:5 w:v water extracts)].
- Leachable metals/metalloids (ASLP at pH 7) (Al, As, B, Cd, Cr, Co, Cu, Fe, P, Pb, Mn, Mo, Ni, Sb, Se, Si, V and Zn) [ICP/MS (1:5 w:v water extracts)].
- Major cations (Ca, Mg, Na and K) [ICP-AES/MS (1:5 w:v water extracts)].
- Major anions (Cl, F, and SO4) [ICP-AES/MS and PC Titrator (1:5 w:v water extracts)].
- Exchangeable cations [ICP-AES] (Calcium [Ca], Magnesium [Mg], Sodium [Na], Potassium [K]) (with pre-treatment for salinity).
- Total Inorganic Carbon and Total Organic Carbon.
- Emerson Class testing [in accordance with AS1289-3.8.1].
- Bulk density.

Following receipt and interpretation of the static geochemical test results, Kinetic Leach Column (KLC) tests may be required. The KLC tests will require a period of up to six months to complete under a monthly watering and leaching cycle.

All leachate samples collected from the KLC tests will be analysed for:

- pH and EC.
- Acidity and alkalinity [Automatic titrator].
- Dissolved metals/metalloids (Al, As, B, Cd, Cr, Co, Cu, F, Fe, Pb, Mn, Mo, Ni, Sb, Se, Si, V and Zn) [ICP-AES].
- Dissolved major cations (Ca, Mg, Na and K) [ICP-AES].
- Dissolved major anions (Cl, SO_4) [ICP-AES].

5. REPORTING REQUIREMENTS

The deliverables from the work will include:

- Technical memo summarising the classification of the tailing's streams sampled, and recommendation of mitigation measures to prevent environmental harm from acid generation where required.
- Results can be used to inform subsequent update of the tailings management plan and monthly sampling requirements.

6. REFERENCES

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MEND (2009) Report 1.20.1: Prediction Manual for drainage chemistry from sulphidic geologic materials).

7. GLOSSARY

Acid Base Accounting (ABA)

ABA is a series of chemical analyses and calculated values that provide a preliminary evaluation of the amounts, and relative balance, of the acid generation potential and acid-neutralisation potential of a sample. The calculated values are used to make preliminary projections about whether a sample will produce acid drainage. ABA includes the most common static tests used in the prediction of Acid Rock Drainage (ARD). The potential acid production is commonly determined by analysis for sulfur species. ARD prediction and ABA data interpretation requires an understanding of the analytical procedures, the future physical and geochemical conditions and the identity, location and reactivity of the contributing minerals. Kinetic tests, mineral identification and detailed material characterisation are required to provide this information.

Acid Neutralisation Capacity (ANC)

ANC is a general term for a sample's or a material's capability to neutralise acidity. ANC can be measured using different laboratory acid neutralisation procedures. The objective of ANC analysis is usually to determine the ARD potential. The objective is to predict the capacity of mine site waste materials to maintain a pH 6.0 or above. Assessment of the best static-test ANC requires a knowledge of future physical and geochemical conditions, the rate of acid generation and the identity, exposure and reactivity of the minerals with ANC and an understanding of the various analytical procedures.

Acid Rock Drainage (ARD)

ARD is acidic water discharge (i.e., pH <5.0), usually rich in iron, sulfate and other metals/metalloids. ARD usually forms under natural conditions when geological materials containing oxidisable forms of sulfur (i.e., pyrite) are exposed to atmospheric conditions or oxidising environments. ARD is produced when the neutralising potential is no longer capable of maintaining neutral pH conditions. In the context of mining, ARD may also be referred to as Acid Mine Drainage (AMD).

Base of oxidation (BoX)

The Box is the zone below which oxidation of (in this case) sulfur as sulfide species will not occur.

Maximum Potential Acidity (MPA) MPA refers to the maximum amount of sulfuric acid (H2 SO4) that is produced from complete oxidation of sulfide minerals (namely pyrite and pyrrotite) present in the rock material. The MPA is given as kgH2 SO4 /tonne and determined by multiplying the sulfide-S value (%) by 30.591 (or 623.7 moles/H+). This value is based on the stoichiometry of this chemical reaction which accounts for the maximum amount of acid that could be produced by material(s) containing 1% S.

Non-acid Forming (NAF)

NAF rock is material which is highly unlikely to produce acid when exposed to atmospheric oxygen and water and where the Acid Potential Ratio (APR) (defined as ANC/MPA) is ≥ 2.

Potentially Acid Forming (PAF)

PAF is defined as the potential for acid generation from a particular sample. The calculation of PAF is an integral part of ABA. Knowledge of sample chemistry (especially pH), sulfur mineralogy and sulfide mineral chemistry is required for an accurate assessment. Total sulfur may be substituted for sulfide sulfur if there is no sulfate or organic sulfur. Accurate data interpretation requires an understanding of the analytical procedures, the physical and geochemical conditions the material will be subjected to and the identity, location and reactivity of the contributing minerals. Sulfides differ in their PAF, and a correction may be required to the PAF calculation where non-pyrite sulfide minerals occur in significant amounts. A mineralogical assessment will be required to determine the sulfide mineralogy. The concentration of common sulfide metals like copper, molybdenum, lead and zinc can be used to estimate the concentration of non-iron sulfides.

8. 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.

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APPENDIX E: GROUNDWATER MONITORING AND MANAGEMENT PLAN

ENGENY

29 METALS

Groundwater Monitoring & Management Plan

TSF3

QC1022_018-REP-007-0

29 JULY 2025

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1. INTRODUCTION

1.1 Site background and overview

Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29Metals Limited (29Metals), owns and operates the Capricorn Copper Mine (CCM), and have engaged Engeny Australia Pty Ltd (Engeny) to develop the Groundwater Monitoring and Management Plan (GMMP) for the proposed tailings storage facility 3 (TSF3) at the CCM.

The CCM is located in northwest Queensland, Australia, approximately 140 kilometres (km) north of Mount Isa and 2.5 km northwest of the settlement of Gunpowder. Gunpowder Creek, a tributary to the Leichhardt River which flanks the mine to the north and west. The mine is bordered to the east by Lake Waggaboonya. The site is an underground mine, with an exhausted open cut void, and other significant structures related to mining as shown in Figure 1.1.

The purpose of the GMMP is to provide a structured and robust framework to protect and manage groundwater resources potentially impacted by the proposed or existing activity. In Queensland, the GMMP supports compliance with the *Environmental Protection Act 1994* and relevant environmental authorities (EAs) and is aligned with the requirements of the *Model Conditions for Environmental Authorities – Mining Activities (EM1128)* and the *Water Act 2000* where applicable.

The GMMP outlines the groundwater monitoring and sampling that would be conducted at the site during mining operations.

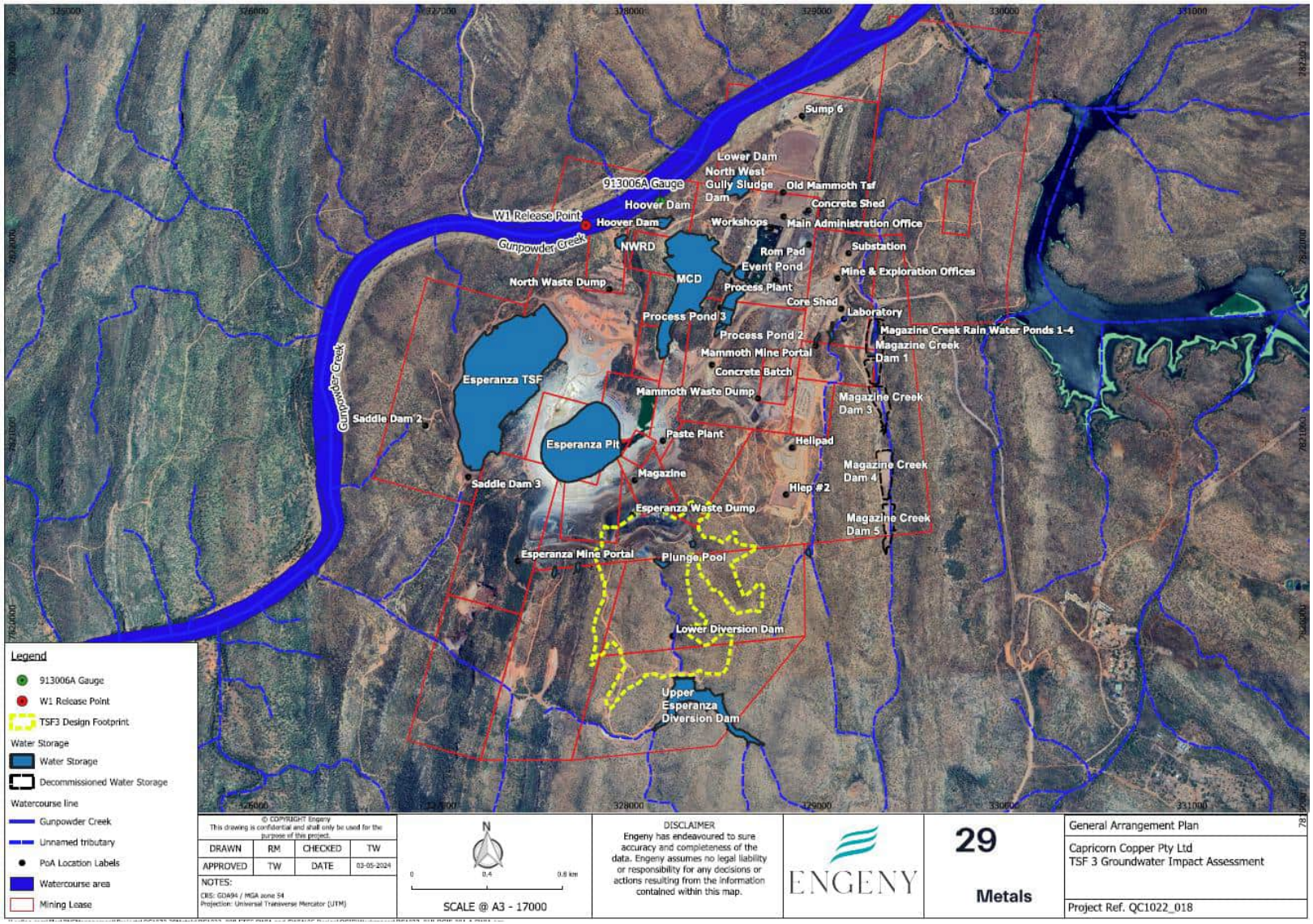


Figure 1.1: General Arrangement Plan (Engeny, 2025a)

1.2 TSF3 Design

TSF3 is proposed to be located between the EWRD and UEDD and bound by the surrounding ridges. The site topography consists of roughly north-south striking undulating ridges which are incised by a main drainage line which forms the UEV and is bound by the EWRD in the north and by the UEDD in the south. The proposed TSF3 preliminary design is shown in Figure 1.2.

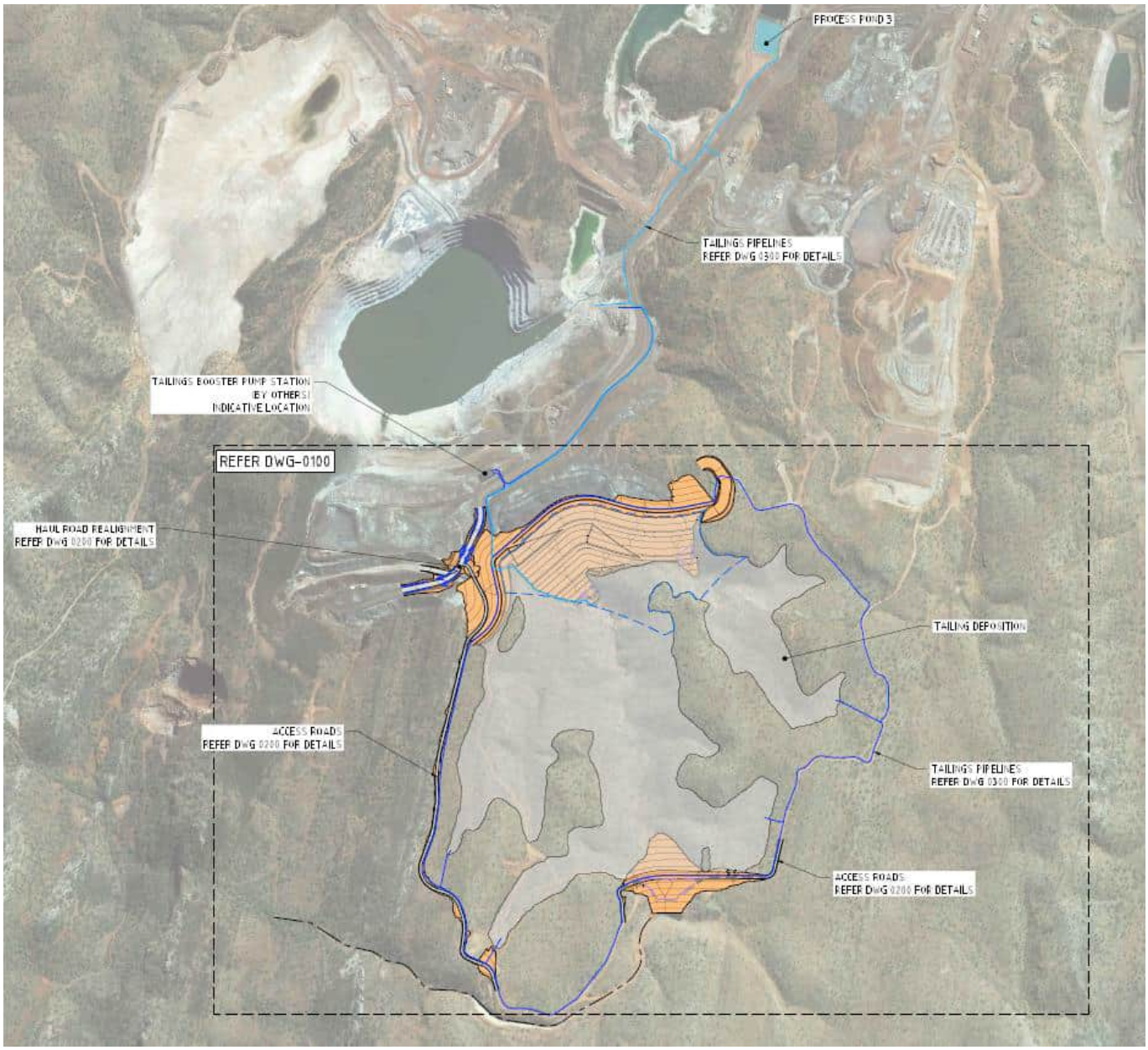


Figure 1.2: TSF3 Preliminary Design (Extract from Drawing QC1022-018-DWG-0010)

Construction activities will primarily be at the northern and southern embankments, as described below.

1.2.1 Northern Embankment Design

The typical design for the northern embankment is shown in Figure 1.3.

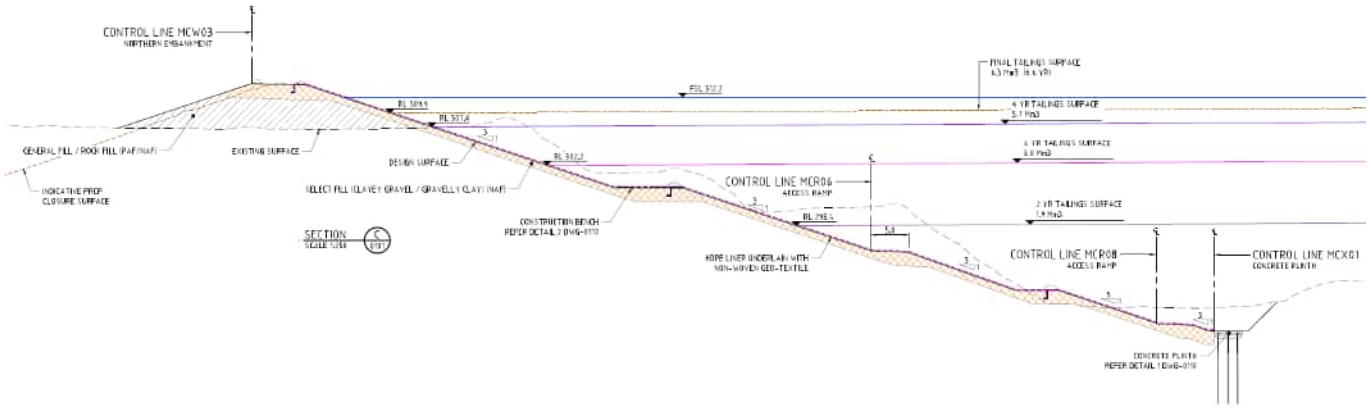


Figure 1.3: Tailings Deposition – Rate of Rise (Northern Embankment)

The provisional construction sequence is as follows:

1. Undertake bulk earthworks using NAF/PAF General Fill / Rock Fill to form the northern embankment and reprofile the upstream batter. Areas of the northern embankment which may drain to a clean catchment (e.g. Upper Snakeskin Valley) to be constructed from NAF General Fill / Rock Fill.
2. Construct geomembrane liner cushion layer using Select Fill (Clayey GRAVEL / Gravelly CLAY). The preliminary design allows for a typically 3m wide (1m thick) Select Fill layer, thickened to 2m thick at the batter benches to facilitate anchoring of the geomembrane liner. Where required the Select Fill layer may be separated into two material types to transition from the existing rock fill to the cushion layer to prevent loss of fines in the cushion layer during operation.
3. Construct concrete plinth and grout curtain and install geomembrane liner.

1.2.2 Southern Embankment Design

The typical design for the southern embankment is shown in Figure 1.4.

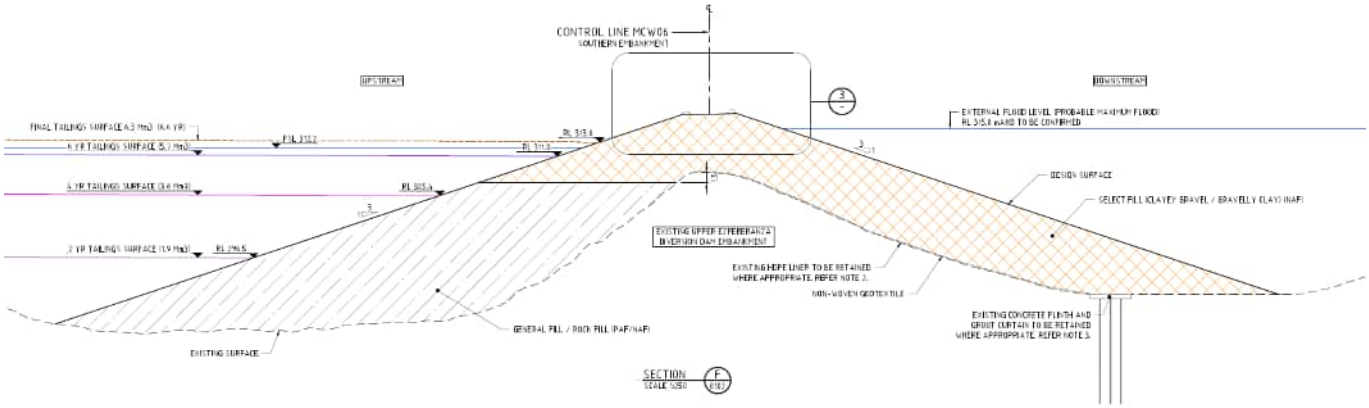


Figure 1.4: Tailings Deposition – Rate of Rise (Southern Embankment)

The provisional construction sequence is as follows:

1. Verify adequacy of existing grout curtain (e.g. through conformation grouting) and HDPE geomembrane liner (e.g through inspection and testing) and repair / replace / remediate where required. Extend grout curtain and concrete plinth to accommodate centreline raise.
2. Undertake centreline raise using NAF/PAF General Fill / Rock Fill (internal batter) and Select Fill (Clayey Gravel / Gravelly Clay) (crest and external batter). Tie low permeability Select Fill into concrete plinth / grout curtain extension. Existing HDPE liner to be protected by non-woven geotextile or similar prior to Select Fill placement.

1.3 EWRD Construction

Construction of the EWRD occurred sometime after the commencement of mining at Esperanza Pit (EPit), circa 1997. The EWRD appears to have infilled drainage lines that previously drained waters to the north. The EWRD is known to contain PAF waste rock and general waste deposits from the previous operator, Birla Mount Gordon, as described in the Esperanza WRD Waste Disposal Management Plan (BMG, 2014).

1.4 UEDD Construction and Repairs

The Upper Esperanza Diversion Dam (UEDD) was constructed as part of ongoing water management control measures at Birla's Mount Gordon mine during the 2009 dry season. During the 2009-2010 wet season, seepage was observed at the downstream toe of the dam. This was controlled by installation of a pump to return seepage to the diversion channel. Back analysis of seepage data in conjunction with onsite observations and knowledge of the construction methods indicated that the seepage was most likely passing through the dam foundations and not due to a fault in the GCL membrane (GHD, 2010).

The foundation investigations carried out by GHD found the underlying geology to be highly jointed, with many of the joints being randomly oriented. Recurring joints included those that struck and dipped along the bedding plane (i.e. approximately 10 to 30 degrees strike, and between 55 and 65 degrees west dip), as well as a set that struck in the same direction as the bedding plane, but dipped between 30 and 60 degrees east (GHD, 2010).

The UEDD repair works consisted of general earthworks and slope corrections, grout curtain installation, plinth construction, and installation of a HDPE liner. The objective of the works was to minimise seepage through the foundations by the use of a grout curtain, and through the embankment (and therefore through the foundations on the downstream side of the plinth) by the use of a HDPE liner.

CCM are currently progressing preliminary investigations to determine the cause of apparent ingress of clean water through the UEDD to the north including dewatering of the UEDD while monitoring seepage at the v-notch weir and piezometric levels in the UEDD piezometer during dewatering, and inspection of the liner and liner – grout curtain connection.

The current design of TSF3 incorporates a number of controls to reduce seepage through the southern embankment including:

- Verification of the adequacy of the existing grout curtain via conformation grouting, and extension of the grout curtain to enable the centreline raise of the UEDD.
- Verification of the adequacy of the existing HDPE liner including inspection and testing, and where inadequate repair or replacement as appropriate.
- Decant pond remote from the UEDD embankment.
- Low permeability tailings deposited against the internal embankment.
- UEDD continued to be dewatered via pumping.
- Remote and convoluted drainage path from TSF3 to Gunpowder Creek.

1.5 TSF 3 Topography

The UEV runs roughly south-east / north-west, and drains waters to the north toward E-Pit. The base of the UEV beneath the Upper UEDD occurs at approximately RL 287 mAHD and drops to RL 249 mAHD beneath the EWRD, falling at a grade of approximately 5%. Valley sides which form the abutments of the TSF3 and UEDD rise at approximately 37% and 20% [grade] respectively. Valley sides in the tributary lines either side of the UEV (denoted by blue arrows in Figure 1.5) have similar properties to the UEV. The topography in the UEV and adjacent valleys present difficulty for LV access and the ability to build access tracks.

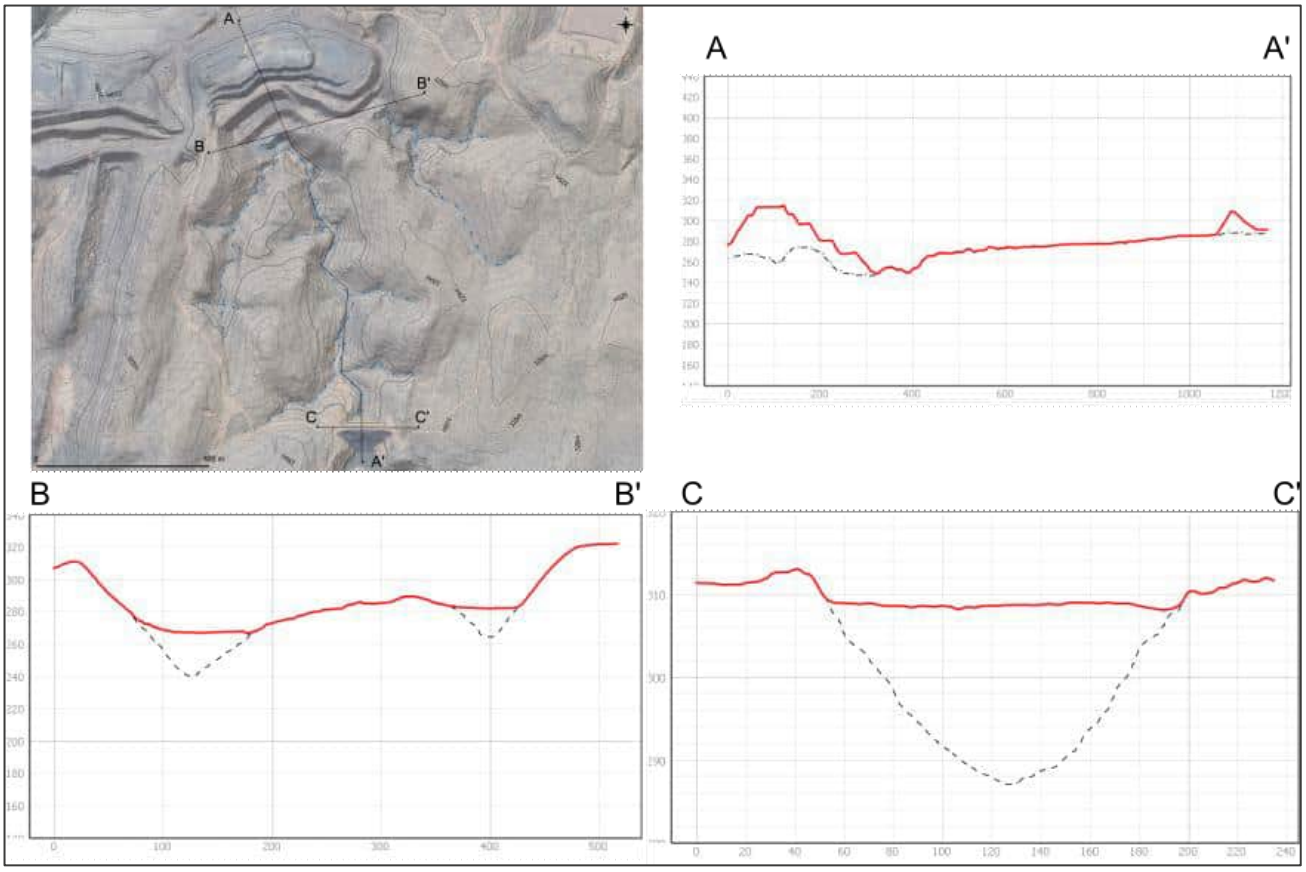


Figure 1.5: Topographical Sections Through The UEV

Note: Inferred ground surface beneath the embankments based on historical imagery are shown in dashed black above.

1.6 Geological Setting

CCM sits within the Western Fold Belt of the Mount Isa Inlier. Mineralisation in the area is associated with faults relating to the Mount Gordon Fault Zone (outcrops to the west of CCM), which generally separates gently folded McNamara Group rocks of the Lawn Hill Platform to the west from older tightly folded rocks of the Haslingden Group to the east. Mineralisation at CCM is hosted by Proterozoic units at various stratigraphic levels, ranging from Haslington Group rocks at the Mammoth deposit (at EPit), to McNamara Group units at Esperanza.

The detailed surface geology of the area around the TSF3 is shown Figure 1.6. A geophysical assessment undertaken by Southern Geoscience Consultants (SGC) in 2023 indicates the potential for unmapped faults to be present within the UEV, these interpreted faults are shown in Figure 1.6.

1.7 Hydrogeological setting

The hydrogeology at CCM is characterised by highly fractured rocks of relatively low permeability and high secondary porosity. The surface soils and Quaternary sands and gravels along Gunpowder Creek valley are thin and mostly unsaturated. The deposits are not considered as significant aquifers, with saturation only occurring after significant rainfall events, and from seepage near mine water bodies (Engeny, 2024a).

Groundwater within the extent of the Upper Esperanza Valley (UEV) is expected within the shallow aquifer system and the deep fractured rock aquifer system. The extent of the shallow aquifer is limited to the extent of the Tertiary colluvium present on the valley floor and sides. In the vicinity of CCM, soils are thin over most areas including valley floors, and this is expected to also occur within the extent of the UEV.

Groundwater within the colluvium is localised and recharged from direct rainfall. Due to the ridges surrounding the extent of the UEV, the shallow aquifer is not expected to be hydraulically connected to any other surficial aquifers at CCM (ATC Williams, 2023a) and (ACT Williams, 2023b). The UEV is located within the Whitworth Quartzite, which is considered to be a relatively impermeable aquitards due to re-crystallisation during regional metamorphism which resulted in little to no primary porosity in the quartzite.

The hydraulic conductivity of the quartzite is low (in the order of 10^{-7} m/sec), with areas of higher permeability present in the secondary porosity associated with fractures (ACT Williams, 2023b). The near-surface zone of higher permeability in the fractured rock aquifer (associated with delaminating siltstones and shales) is not likely to be present due to the absence of any mapped siltstone or shale (ACT Williams, 2023b).

Five hydrostratigraphic units are present, shown in Table 1.1.

TABLE 1.1: HYDROSTRATIGRAPHIC UNITS WITH LITHOLOGIES (ENGENY, 2024A)

Hydrostratigraphic Unit	Formation	Aquifer type
Porous alluvial sediments	Quaternary Alluvium.	Unconfined (where saturated).
Fractured arenaceous rocks	Alsace Quartzite, Whitworth Quartzite, Torpedo Creek Quartzite and Mount Oxide Chert Members.	Unconfined/semi confined.
Fractured argillaceous rocks	Bortala Formation; Lochness Formation; Surprise Creek Formation and Gunpowder Creek Formation.	Semi Confined.
Fractured dolomitic rocks	Paradise Creek Formation; Esperanza Formation.	Semi Confined.
Fractured metabasalts	Pickwick Metabasalt Member.	Semi Confined.

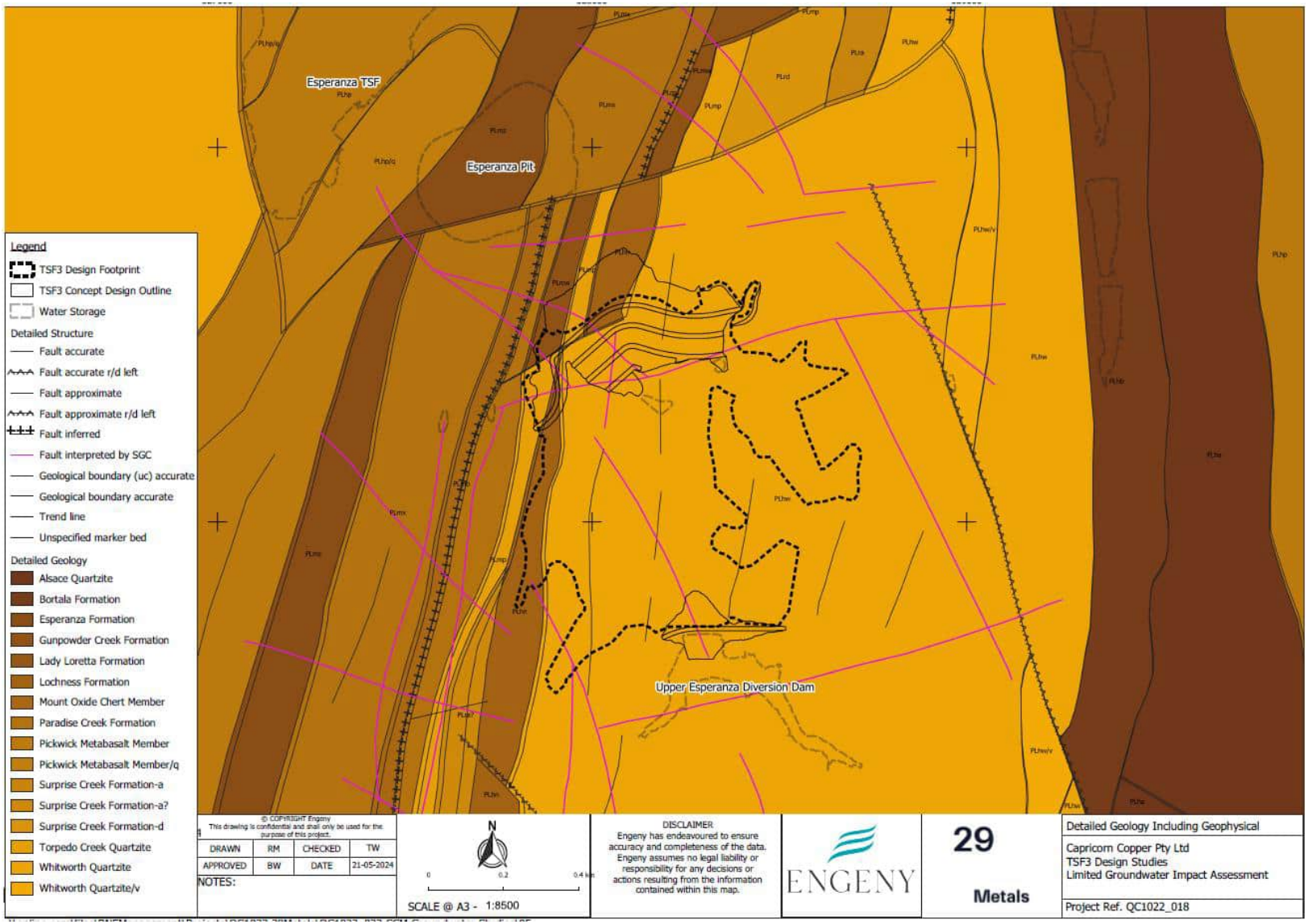


Figure 1.6: Detailed Geology Including SGC Geophysical Interpretation (Engeny, 2025a)

1.7.1 Groundwater Levels and Flow Direction

Five (5) groundwater monitoring bores have recently been installed in the area surrounding the proposed TSF3 footprint (GWMB78, GWMB79, GWMB80, GWMB81 and GWMB82).

Figure 1.7 presents inferred groundwater contours calculated from the average standing water levels obtained across the site between 23 February 2023 and 1 May 2024, inclusive of the newly installed bores. The direction of flow of groundwater is generally to the north. Groundwater levels mostly mimic a subdued version of the surface elevation. Elevated groundwater is noted surrounding GWMB21 and GWMB22 and at GWMB75.

Groundwater contours generated in the absence of groundwater observation data from the TSF3 footprint and using surface topography suggests that groundwater may flow to the west from TSF3. This is currently being tested with the development of the transient groundwater model and may require additional groundwater monitoring locations to be installed and monitored to confirm. A key assumption to the design of TSF3 is that all potential seepage from the TSF will be captured in EPit.

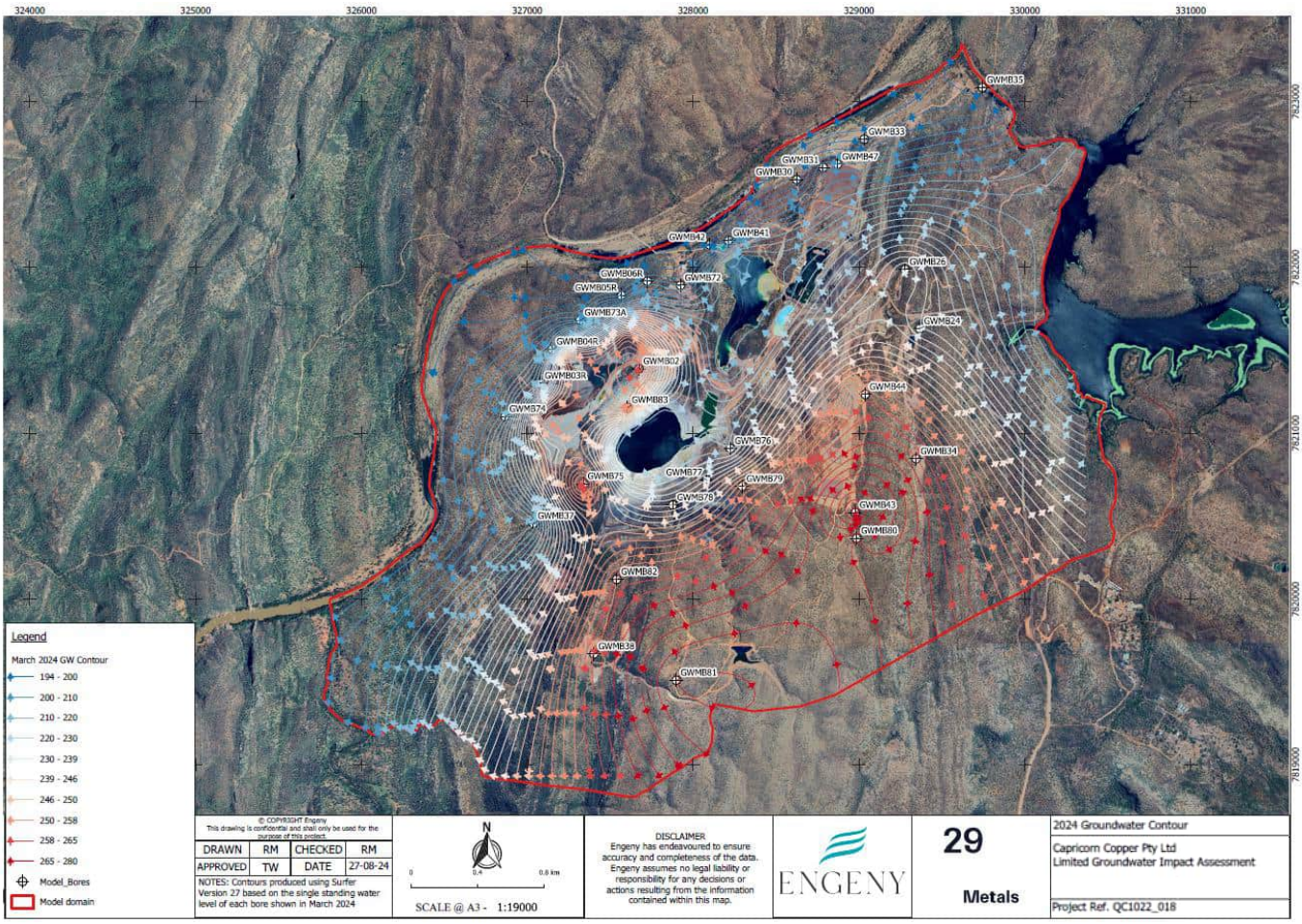


Figure 1.7: Groundwater Contours

1.8 Potential Project Impacts

A summary of the potential project impacts is provided below, detailed impacts are included in:

- *Groundwater Impact Assessment – Capricorn Copper Pty Ltd, Capricorn Copper Mine TSF3 EA Amendment*. Report No. QC1022_018-REP-004-1, prepared for Capricorn Copper Pty Ltd, 15 May 2025 (Engeny, 2025a).
- Groundwater seepage

- Potential seepage pathways beneath the TSF3 embankments and through the TSF3 impoundment via geological faults (and inferred geological faults) identified by SGC.
- The geology underlying the extent of the UEV (the Whitworth Quartzite) is considered to have a low hydraulic conductivity. This is expected to limit the rate of groundwater movement away from the UEV (ACT Williams, 2023b).
- Groundwater contours indicate the groundwater flow is in the direction of the Esperanza Pit (EPit). Any seepage associated with water storage within the UEV is expected to ultimately discharge into the pit. Any potential seepage through the UEV surrounding faults will also be intercepted by the EPit.

- Groundwater flow changes
  - A water balance assessment (Engeny, 2025a) has shown that the proposed TSF3 does not increase the likelihood of uncontrolled discharges of mine affected water to Gunpowder Creek; hence the proposed TSF3 is not anticipated to impact surface water flow (quantity and quality) in Gunpowder Creek.
  - Groundwater quality is not expected to be severely impacted by the proposed TSF3, provided the liner is installed and the base of the structure is demonstrated to have low hydraulic conductivity. Any overflows from the proposed TSF3 are designed to flow into the existing mine water management system and are not expected to impact groundwater quality.
- Impact on sensitive receptors
  - A portion of the total site is mapped as a moderate potential terrestrial groundwater dependent ecosystem (GDE), the bed of Gunpowder Creek is mapped as high potential terrestrial GDE and Gunpowder Creek is mapped as low-moderate potential aquatic GDE.
  - Three (3) active bores were identified as present outside of the mining lease boundaries, with an additional bore list as abandoned and destroyed. Bore 146737 is listed for the role of mine monitoring, the other two (2) existing bores (146236 and 163777) do not have a role listed, however, water quality was noted as potable in both bore reports, indicating potential for beneficial reuse. The bores are located east and north of the site, with 163777 located north of Gunpowder Creek.
- Impact of downstream users
  - Based on a review of the site data, the predicted increase in seepage rates to EPit and the seepage management systems in place at the CCM site, no additional discharge of mine affected water will be required to Gunpowder Creek because of the proposed TSF3. Therefore, TSF3 will have no additional impact on downstream users.
  - The review of provided data for the proposed TSF3 indicates that the risk to the receiving environment as a result of the additional tailings storage is low to medium.
  - This GMMP plan includes targeted water level and quality monitoring, early warning thresholds, and adaptive management protocols to respond to unexpected changes.

2. GROUNDWATER MONITORING AND MANAGEMENT PLAN

2.1 Monitoring Network

The groundwater monitoring network at the CCM consists of fifty-nine (59) bores at various depths across six (6) precincts. Seven (7) bores have been proposed as groundwater monitoring bores for the TSF3. The details of these proposed groundwater monitoring bores are described below in **Table 2.1** and locations presented in Figure 2.1. Background bores are proposed to be monitored monthly to obtain baseline concentrations and quarterly for compliance bores.

This GMMP has been developed with consideration of:

- Implementation of the GMMP within three months of receiving the modified Environmental Authority (EA).
- Groundwater level and quality monitoring will be completed quarterly.
- Replacement of destroyed monitoring bores as needed.
- Annual reporting and improvement of the monitoring program.

2.2 Objectives

The objectives of the GMMP are to:

- Detect potential impacts to groundwater quality due to the authorised activities.
- Detect changes to groundwater level due to the authorised activities.
- Ensure compliance with the EA.
- Continuously improve hydrogeological understanding of the hydrogeological conditions at the site.

2.3 Scope and Frequency of Monitoring

The scope and frequency of monitoring is summarised as:

- Groundwater monitoring of water level and water quality will be conducted quarterly (every three months).
- Three (3) bores have been selected for baseline assessment as detailed in Section 2.4.
- The scope of the monitoring program is defined as this ML boundary.
- Pit water samples will be collected when free water is present. The water level elevation of the pit will be monitored monthly.
- Table 3.2 identifies the parameters for sample analysis. The analytes outlined for sample analysis are based on the contaminants of potential concern and analytes to protect aquatic ecosystem Environmental Values (based on the aquatic ecosystem ANZECC 95%).

Table 2.1: Proposed TSF3 Monitoring Bores

Bore ID	Easting (GDA 94)	Northing (GDA 94)	Elevation (mAHD) at ground	Total Depth (m)	Screen Depth (mbgl)	Screened Geology	Compliance / Background Bore	Purpose/reasons	Monitoring Frequency
GWMB76	328,214	7,820,910	240.62	42.5	30-36	Whitworth Quartzite	Compliance	Targeting seepage pathway between TSF3 and EPit.	Quarterly
GWMB77	328,047	7,820,726	265.70	42.5	28-34	Lochness Formation	Compliance	Targeting seepage pathway between TSF3 and EPit.	Quarterly
GWMB78	327,856	7,820,608	288.05	42.5	45.4-48.4	Paradise Creek Formation	Compliance	Targeting seepage pathway between TSF3 and EPit.	Quarterly
GWMB79	328,296	7,820,679	302.22	50.0	47-50	Whitworth Quartzite	Compliance	Targeting seepage pathway between TSF3 and EPit.	Quarterly
GWMB80	328,986	7,820,366	303.66	47.0	38-47	Whitworth Quartzite	Background	Baseline groundwater conditions associated with proposed TSF3.	Monthly
GWMB81	327,899	7,819,510	322.48	42.5	47-50	Whitworth Quartzite	Background	Baseline groundwater conditions associated with proposed TSF3.	Monthly
GWMB82	327,539	7,820,119	271.93	42.5	18.5-21.5	Paradise Creek Formation	Background	Background to EPit located in the Paradise Creek Formation. To assess spatial and temporal changes in water quality. Understand the spatial and temporal extent of water quality impacts. Assess potential impacts on groundwater quality.	Monthly



Figure 2.1: TSF3 Groundwater Monitoring Locations (ENGENY, 2025A)

2.4 Monitoring Frequency and Parameters

The monitoring program using the site monitoring bore network would provide a sufficient spatial and temporal sampling regime to detect the presence or absence of impacts and contamination on the groundwater regime down gradient of any potential source of contamination. Contaminants of potential concern have been characterising during the design stages and are included in the list of analytes.

Details of monitoring frequency and measurements are outlined in Table 2.2 and Table 2.3. All field measurements during construction and occupancy will be recorded in a logbook kept current by the EA holder.

TABLE 2.2: GROUNDWATER MONITORING – GROUNDWATER LEVELS

Bore ID	Method	Frequency	Timetable
GWMB76, GWMB77, GWMB78, GWMB79, GWMB80, GWMB81, GWMB82	Measured using dip meter (or similar method)	Quarterly In the event of an exceedance or a complaint, additional monitoring would occur.	• January • April • July • October

TABLE 2.3: GROUNDWATER MONITORING – GROUNDWATER QUALITY

Item	Parameters	Frequency	Timetable
GWMB76, GWMB77, GWMB78, GWMB79, GWMB80, GWMB81, GWMB82	**Physiochemical parameters** pH, temperature, redox and Electrical conductivity, Total Dissolved Solids, including observations such as odour, colour **Major ions** Chloride, Sulphate, Calcium, Magnesium, Potassium, Sodium, Alkalinity, Fluoride **Dissolved metals** Aluminium, Arsenic, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Uranium, Vanadium and Zinc	Quarterly In the event of an exceedance or a complaint, additional monitoring would occur.	• January • April • July • October (synchronised with water level monitoring)

2.5 Monitoring Methods

2.5.1 Groundwater Levels

Groundwater levels will be measured with an electronic water level meter (dip-meter) to an accuracy of 1 centimetre (cm). The water level reference point will be the top of the PVC casing within the steel monument cover.

Pit water levels will be surveyed to a vertical accuracy of 0.1 metre (m) or better. Pit inflows will be measured through methods described in DNRME (2020) *Quantifying the volume of associated water taken under a mining lease or mineral development licence*.

2.5.2 Groundwater Quality

Field water quality (electrical conductivity (EC), pH, temperature) will be measured at the time of sample collection using a calibrated portable water quality meter. The portable water quality meter will be calibrated at the beginning of each sampling event in accordance with the manufacturer's specification. Meter calibration will be recorded on an appropriate form.

Samples will be collected by suitably qualified and trained personnel and in accordance with: Groundwater monitoring will be conducted in accordance with the latest edition of the *Queensland Monitoring and Sampling Manual*, AS/NZS 5667:11:1998 *Water Sampling Guidelines – Part 11: Guidance on Sampling Groundwater*, and the Australian Government's *Groundwater Sampling and Analysis – A Field Guide* (2009:27 GeoCat #6890.1), or any relevant updates to these guidelines.

- The Queensland Government's Monitoring and Sampling Manual 2018,
- Geoscience Australia (2009) Groundwater Sampling and Analysis – A Field Guide,
- AS/NZS 5667.11:1998 Water Quality – Sampling – Guidance on sampling of groundwaters,
- The specific sampling method(s) will be determined following bore installation and will be dependent on the permeability of the screened formation.

Metals/metalloids will be analysed as the dissolved fractions only. Samples for these parameters will be field filtered using new, disposable 0.45 micrometre (µm) filters. Metals/metalloid analysis will be performed by Inductively Coupled Plasma Mass Spectrometry (ICP/MS) to ensure the trigger threshold concentrations are achieved.

Samples will be:

- Collected in new, laboratory supplied sample containers, with appropriate preservatives,
- Labelled with the bore identification, date and time of collection. This will be recorded on the field form,
- Stored in a chilled esky and/or refrigerator prior to delivery to the laboratory,
- Submitted under chain-of-custody protocols,
- Submitted to a laboratory accredited with the national association of testing authorities (nata) for the analyses to be conducted,
- If no nata-accredited laboratory is available for a particular analyte or substance, duplicate samples will be sent to at least two separate laboratories for independent testing or evaluation to ensure reliability and accuracy of results.

The following samples will be collected for quality assurance/quality control purposes:

- Field blind duplicates will be collected at a frequency of 1 in 20 primary samples, the duplicates will be submitted to the primary laboratory, duplicate samples will be assessed against the primary through the calculation and comparison of the relative percentage difference, and
- One rinsate sample will be collected per sampling campaign.

Field monitoring records will be documented and included in the annual report.

2.5.3 Groundwater Modelling

Groundwater modelling for TSF3 has been conducted to assess potential impacts on the receiving environment, focusing on seepage rates, flow paths, and quality changes. Initial modelling, as detailed in the Limited Groundwater Impact Assessment (GWIA; QC1022_018-REP-004-1, Engeny, 2025), utilized a 2D steady-state approach to evaluate baseline conditions and predict seepage under operational and closure scenarios. Key assumptions included low-permeability Whitworth Quartzite foundations (10^{-6}–10^{-7} m/s), defect-controlled flow paths, and controls like upstream geomembrane liners and grout curtains, resulting in estimated seepage of ~39 m^3/day directed to Esperanza Pit (EPit) as a sink, representing an 84% reduction from uncontrolled scenarios. This modelling confirmed low risks to Environmental Values (EVs) and informed design refinements.

To provide a comprehensive understanding of the hydrogeological conditions and inform the detailed design of TSF3, a transient numerical groundwater model is being developed for the entire CCM site, including TSF3. This 3D model, scheduled for completion in September 2025, will incorporate time-variable factors (e.g., seasonal rainfall, tailings consolidation, cover performance) and refine predictions of long-term seepage and quality migration, informing an updated GWIA for the project.

2.5.4 Management Measures

Seepage control is a critical aspect of TSF3 design and operation to minimise environmental risks, such as groundwater contamination from potentially acid-forming (PAF) tailings and ensure compliance with the Environmental Authority (EA) EPML00911413 and Progressive Rehabilitation and Closure Plan (PRCP) requirements. The controls are informed by the Limited Groundwater Impact Assessment (GWIA; QC1022_018-REP-004-1, Engeny, 2025), which predicts ~39 m^3/day seepage directed to Esperanza Pit (EPit) with mitigation, representing an 84% reduction from uncontrolled scenarios. These measures incorporate engineered barriers (e.g., liners, grout curtains) and operational practices (e.g., decant minimization) to limit infiltration, and are summarised in Table 2.4.

TABLE 2.4: MANAGEMENT MEASURES

Seepage Control Measure	Description	Purpose	Management/Monitoring Measures
Upstream Geomembrane Liner (Northern Embankment)	Reprofiled Esperanza Waste Rock Dump (EWRD) with HDPE geomembrane liner on upstream face, anchored by concrete plinth.	Reduces infiltration through the embankment; acts as primary barrier to horizontal seepage.	• Regular inspections for integrity during operations • Post-closure monitoring via piezometers; repair any defects identified • Integrate with GWIA monitoring bores for early detection
Grout Curtain (Both Embankments)	Curtain grouting along northern (EWRD) and southern (UEDD) embankments; depth 5–25 m (average 10 m), 3 rows at 1.5 m spacing.	Seals fractures in low-permeability Whitworth Quartzite foundations (10^{-6}–10^{-7} m/s); provides bi-directional control.	• Verification grouting during construction (permeability ≤10^{-9} m/s) • Quarterly piezometer readings for pore pressure; annual review by RPEQ.
Retained Existing Liners (Southern Embankment)	Centreline raise of Upper Esperanza Diversion Dam (UEDD) retaining existing geomembrane liners.	Maintains operational seepage barrier; prevents southward flow.	• Inspect during raise for damage; certify post-construction. • Monitor downstream bores.
Enhanced Store-and-Release Cover System	Multi-layer closure cover: Working cover (NAF rockfill 0.5–1 m), capillary break (gravel/sand 0.3–0.5 m), barrier (compacted clay ≥0.5 m, K ≤10^{-7} m/s or BGM), rock cover (0.5 m), growth media (0.3 m ameliorated).	Limits net percolation (<1% rainfall ~5 mm/yr); reduces oxygen ingress and AMD generation from PAF tailings.	• Trials for material optimization (clay deficit 100–150k m³) • Post-installation permeability tests • Annual surface inspections for cracking/erosion • Vegetation monitoring to ensure >70% cover Year 1 (erosion <5 t/ha/yr)
Decant Pond Management	Maintain decant pond at ~1 m depth; pump supernatant for reuse in processing (200 L/s capacity).	Minimizes pond extent and head pressure; reduces seepage driving force.	• Continuous level monitoring; pump to EPit/MCD if >1 m • Maximize reuse to limit raw water • Closure: Dewater fully and monitor for residual ponding prior to capping.
Spillway and Diversion Channels	Eastern rock-cut spillway (PMF capacity) directing overflows to EPit; diversion channels around facility.	Prevents ponding/erosion; contains flows within Integrated Containment System (no uncontrolled releases to Gunpowder Creek).	• Inspect quarterly for blockages/erosion/integrity • Flow gauging at spillway; integrate with REMP for downstream quality.
Seepage Monitoring Network	Piezometers, v-notch weirs, sentinel bores (GWMB76–82 per GWIA); quarterly sampling.	Early detection of seepage; assess quality/volume trends.	• - Parameters: Volume, pH, EC, metals (Cu, Zn per EA Table 6), sulfate. - Triggers: >39 m³/day or quality exceedances prompt root cause analysis/adaptive actions (e.g., liner repair). - Annual reports to DESI; integrate with groundwater model (3D transient, September 2025).

3. COMPLIANCE

3.1 Groundwater Level

For groundwater level, the compliance limits and triggers for groundwater levels will be determined following finalisation of the numerical groundwater model for any relevant water supply bore. Given the TSF3 is not dewatering groundwater, water supply bores are not proposed to be affected.

3.2 Groundwater Quality

The compliance approaches recommended in (DES, 2021) *Using monitoring data to assess groundwater quality and potential environmental impacts* for groundwater quality assessment are based on comparing a number of consecutive sample tests at compliance bores to a limit based on percentile calculations. This approach is aimed at reducing the probability of a false positive, or what is referred to as a false non-compliance in regard to regulation while ensure approaches are sufficiently sensitive to detect potential impacts. The approach is based on combining ANZECC 2000 methodology, adapted control charting approaches, and statistics around applying one or two limit types (or trigger).

Trigger level and contaminant limit values have been determined by Engeny in the *2024 Annual Groundwater Repor*t (Engeny, 2025b). These limits are 'interim' limits. Interim limits would be updated following additional groundwater sampling of the background monitoring bores to determine the baseline groundwater conditions for TSF3.

Monitoring locations and frequency are outlined in Table 2.3. The compliance limits and triggers are presented in Table 3.1.

TABLE 3.1: COMPLIANCE LIMITS AND TRIGGERS

Limit	Trigger
Limit A – 80th Percentile[2]	5 consecutive test samples exceeding the limit
Limit B – 95th Percentile[2]	3 consecutive test samples exceeding the limit

[1] If toxicant default guideline (ANZG 2018) is adopted, it should be applied as a Limit B not Limit A.

3.2.1 Site-Specific WQO Considerations

Site-specific Water Quality Objectives (WQO) have been proposed based on the 80th percentile of the baseline data. For water quality parameters where the baseline data is less than, or there is no historic data, the limit to protect aquatic ecosystem EVs (based on the aquatic ecosystem ANZECC 95%), the default ANZECC 95% limit has been adopted.

Table 3.2 outlines the proposed WQO for the Project.

TABLE 3.2: TRIGGER VALUES AND COMPLIANCE LIMITS FOR 2024 (ENGENY, 2025B)

Parameter	Aquatic ecosystems (ANZECC 95%)	Limit A (80th Percentile)	Limit B (95th Percentile)	WQO	Adopted from
pH (field)	6.0-8.5	7.8	8.2	7.8	Site specific data
Electrical Conductivity (µS/cm)	435	913	925	913	Site specific data
Sulfate SO_4 (mg/L)	250	36	50.6	250	Aquatic ecosystems (ANZECC 95%)
Fluoride (mg/L)	80th %	0.3	0.4	0.3	Site specific data
Dissolved Aluminium (mg/L)	0.055	0.005	0.02	0.055	Aquatic ecosystems (ANZECC 95%)
Dissolved Arsenic (mg/L)	0.013	0.002	0.002	0.013	Aquatic ecosystems (ANZECC 95%)
Dissolved Boron (mg/L)	0.37	0.03	0.06	0.37	Aquatic ecosystems (ANZECC 95%)
Dissolved Cadmium (mg/L)	0.0002	0.00005	0.0001	0.0002	Aquatic ecosystems (ANZECC 95%)
Dissolved Chromium (mg/L)	0.001	0.0005	0.0005	0.001	Aquatic ecosystems (ANZECC 95%)
Dissolved Cobalt (mg/L)	80th %	0.005	0.013	0.005	Site specific data
Dissolved Copper (mg/L)	0.0014	0.06	0.16	0.0014	Aquatic ecosystems (ANZECC 95%)
Dissolved Lead (mg/L)	0.0034	0.0005	0.0005	0.0034	Aquatic ecosystems (ANZECC 95%)
Dissolved Manganese (mg/L)	1.9	0.43	0.59	1.9	Aquatic ecosystems (ANZECC 95%)
Dissolved Nickel (mg/L)	0.011	0.003	0.007	0.011	Aquatic ecosystems (ANZECC 95%)
Dissolved Uranium (mg/L)	80th %	0.0018	0.002	0.0018	Site specific data
Dissolved Zinc (mg/L)	0.008	0.02	0.09	0.02	Site specific data

4. REVIEW AND IMPROVEMENT

4.1 Exceedance Investigation

Groundwater quality monitoring during the operational phase of TSF3 is critical to detect early signs of seepage or contamination from) tailings, ensuring protection of environmental values EVs aligns with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018), which provide a risk-based framework for water quality management, including trigger values, investigation levels, and response protocols. It also complies with Environmental Authority (EA) EPML00911413 (Schedule C for groundwater triggers) and the Preliminary Design Report (QC1022_018-REP-005-1) for operational controls.

Exceedances are defined as values above site-specific WQO) derived from baseline data or ANZG default guideline values (DGVs) for 95% species protection in slightly-moderately disturbed systems as shown in Table 3.1..

The investigation process follows a tiered approach: confirmation, root cause analysis, risk assessment, corrective actions, and reporting. It is triggered by any exceedance in routine monitoring. All steps are documented by an appropriately qualified persons (AQP) and integrated with surface water monitoring (REMP) for holistic EV assessment.

The process for exceedance investigation is summarised below:

- Trigger and Confirmation Sampling
  - Trigger: Exceedance of WQOs (Table 3.2).
  - Confirmation: Immediate re-sampling within 48 hours at the affected bore and upstream/downstream controls. Analyse for full suite (pH, EC, dissolved metals, sulfate, acidity/alkalinity per ANZG). If confirmed, notify DESI within 24 hours.
  - Enhance monitoring frequency if trends indicate rising risks.
- Root Cause Analysis
  - Conduct desktop review: Compare to historical data (baseline from 2018–2024 REMP/GWIA), operational logs (e.g., decant levels <1 m, deposition rates), and modelling.
  - Field investigation: Inspect for sources (e.g., liner defects, excessive ponding >1 m, water impounded against embankment).
  - Statistical tests (e.g., trend analysis per ANZG) to distinguish operational impacts from natural variability.
  - Identify potential causes.
- Corrective Actions
  - Implement corrective actions which are likely to include short term and long term measures, and could include: Isolate source (e.g., reduce decant via pumping 200 L/s to EPit), suspend deposition, seepage interception and return to water management system, Repair/upgrade infrastructure,
- Reporting and Review
  - Internal: Root cause report within 30 days; update risk register and operations plan.
  - External: Notify DETSI within 24 hours; quarterly EA reports include trends/exceedances.
  - Review: Annual per EA A4-5 or as per GMMP.

4.2 Annual Report

An annual report will be produced to present and assess results of the GMMP from the previous year. The report will include:

- The current monitoring locations and scope.
- Any changes since the previous year (e.g. Bores destroyed, replaced, and new bores) will be identified.
- A complete history of groundwater monitoring data over the life of the CCM project.
- A detailed analysis of trends in groundwater quality and levels, and their impacts on water resources, the environment, and other users.

- A comparison of water quality results with triggers.
- A review of the suitability of the monitoring program, and the associated monitoring rationale and strategy.
- An analysis and a statement regarding whether there has been a material change in the information or predictions used to determine the areas included.
- Details of any non-compliances with the obligations listed in the obligations register.
- Provide any recommendations for improvements for the next reporting period.
- Provide feedback for improvement to management measures.

The report will be prepared by an appropriately qualified person possessing appropriate qualifications and experience in hydrogeology and groundwater monitoring.

The Annual Report will be issued in June each year.

4.3 Model Validation

A transient numerical groundwater model for CCM has been developed encompassing the proposed TSF3. The model is proposed to be finalised in September 2025 at which point the TSF3 GWIA will be updated with the outcomes of the numerical modelling and used to support the Environmental Authority Amendment Application .

Subsequent model updates and verification of predications are proposed during the following milestones/timeframes:

- After one year following the finalistion of the TSF3 GWIA (nominally September 2026) to consider additional monitoring data.
- After additional monitoring data and investigations are finalsied in conjunction with the detailed design of TSF3.
- Where a significant design change occurs.
- As an outcome of a peer review.

This model validation will be reported on as per Section 4.1.

4.4 Monitoring Plan Review

This GMMP will be reviewed each year and updated accordingly. The review is to be completed by an appropriately qualified person. Changes would be made to the monitoring groundwater monitoring network that are suitable to detect potential pollution to groundwater associated with the mine site.

5. REFERENCES

ACT Williams. (2023b, August 15). Capricorn Copper, Temporary Water Storage Options Assessment: Hydrogeological Risk And Impact Assessment. Newmarket, QLD, Australia: ACT Williams Pty Ltd.

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Engeny. (2024a). *Capricorn Copper Pty Ltd Progressive Rehabilitation and Closure Plan.*

Engeny. (2025a). *Groundwater Impact Assessment TSF3 EA Amendment.* Brisbane: Engeny Australia Pty Ltd.

Engeny. (2025b). *Capricorn Copper Pty Ltd 2024 Annual Groundwater Report.* Engeny Australia Pty Ltd.

GSQ. (2025, June 1). *Queensland geology series - REST Service*. (Geological Survey of Queensland) Retrieved from Queensland Government Open Data Portal: https://spatial-gis.information.qld.gov.au/arcgis/rest/services/GeoscientificInformation

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.

(c) 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.

(d) 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.

(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.

APPENDIX K: BILL OF QUANTITIES AND CLASS 5 COST ESTIMATE

TSF3 Cost Estimate - Stage 1

Item	Description of Work	Estimated Qty	Unit	Fixed Rate A$	Sub-Total A$
S1.0 CLEARING AND PREPARATION					
S1.0.1	Clear and grub basin area (all stages) and access roads and haul up to 1 km to stockpile (no offset)	100,000	m2	$ 1.00	$100,000.00
S1.0.2	Strip topsoil basin area (all stages) (nominal 200 mm) and haul up to 1 km to stockpile (including 20m offset from toe)	20,000	m3	$ 6.00	$120,000.00
S1.0.3	Scarify, condition and compact in situ subgrade	30,000	m2	$ 1.00	$30,000.00
S1.0.4	Excavate unsuitable material haul to <2km (nominal allowance)	10,000	BCM	$ 15.00	$150,000.00
				Total S1.0	**$400,000.00**
S2.0 EMBANKMENT FOUNDATION WORKS					
S2.0.1	Foundation dental / slush Grouting - Northern embankment	1,205	CCM	$ 850.00	$1,024,250.00
S2.0.2	Reinforced Concrete Plinth - Northern Embankment	2,405	CCM	$ 2,000.00	$4,810,000.00
S2.0.3	Foundation Grouting - Northern Embankment	10,060	LM	$ 900.00	$9,054,000.00
S2.0.4	Foundation dental / slush Grouting - Southern embankment	260	CCM	$ 850.00	$221,000.00
S2.0.5	Reinforced Concrete Plinth - Southern Embankment	515	CCM	$ 2,000.00	$1,030,000.00
S2.0.6	Foundation Grouting - Southern Embankment	2,130	LM	$ 900.00	$1,917,000.00
				Total S2.0	**$18,056,250.00**
S3.0 EMBANKMENT CONSTRUCTION					
S3.0.1	Excavate northen embankment, load, haul, spread, moisture condition and compact as General Fill in north embankment	95,600	CCM	$ 20.00	$1,912,000.00
S3.0.2	Excavate Spillway (inc D&B), load, haul, spread, moisture condition and compact as General Fill in north embankment	31,900	CCM	$ 28.00	$893,200.00
S3.0.3	Drill and Blast to borrow General Fill material, load, haul, spread, moisture condition and compact in North embankment (<2 km haul)	206,300	CCM	$ 20.00	$4,126,000.00
S3.0.4	Borrow Select Fill material, load, haul, spread, moisture condition and compact in North embankment (<5 km haul)	99,900	CCM	$ 20.00	$1,998,000.00
S3.0.5	Drill and Blast to borrow erosion Protection material, load, haul and spread on north embankment upstream face (<2 km haul)	9,000	CCM	$ 38.00	$342,000.00
S3.0.6	Drill and Blast to borrow General Fill material, load, haul, spread, moisture condition and compact in Southern embankment (<2 km haul)	55,100	CCM	$ 28.00	$1,542,800.00
S3.0.7	Borrow Select Fill material, load, haul, spread, moisture condition and compact in Southern embankment (<5 km haul)	106,500	CCM	$ 20.00	$2,130,000.00
S3.0.8	Drill and Blast to borrow erosion Protection material, load, haul and spread on southern embankment upstream face (<2 km haul)	3,000	CCM	$ 38.00	$114,000.00
S3.0.9	Borrow General Fill material, load, haul, construct safety bunds (Heavy Vehicle) (<2 km haul)	750	LM	$ 160.00	$120,000.00
S3.0.10	Borrow General Fill material, load, haul, construct safety bunds (Medium Vehicle) (<2 km haul)	1,650	LM	$ 100.00	$165,000.00
S3.0.11	Borrow General Fill material, load, haul, construct safety bunds (Light Vehicle) (<2 km haul)	2,650	LM	$ 100.00	$265,000.00
				Total S3.0	**$13,608,000.00**
S4.0 EMBANKMENT LINING WORKS					
S4.0.1	Non-woven geotextile	130,500	m2	$ 10.00	$1,305,000.00
S4.0.2	HDPE	87,000	m2	$ 20.00	$1,740,000.00
				Total S4.0	**$3,045,000.00**
S5.0 MONIOTORING AND INSTRUIMENTATION					
S5.0.1	Piezometers - VWP	10	Ea	$ 50,000.00	$500,000.00
S5.0.2	Survey Instrumentation	15	Ea	$ 2,000.00	$30,000.00
				Total S6.0	**$530,000.00**
S6.0 SPILLWAY					
S6.0.1	Reinforced Concrete - Grade S50 - Spillway Sill	15	m3	$ 2,350.00	$35,250.00
S6.0.2	D50 - 750 mm Dumped Rock - Spillway	31,900	m3	$ 80.00	$2,552,000.00
				Total S73.0	**$2,587,250.00**
S7.0 ACCESS AND HAUL ROADS					
S7.0.1	Excavate haul road alignment, load, haul, spread, moisture condition and compact as General Fill in road alignment	16,000	CCM	$ 20.00	$320,000.00
S7.0.2	Drill and Blast to borrow General Fill material, load, haul, spread, moisture condition and compact on haul road alignments (<2 km haul)	8,300	CCM	$ 28.00	$232,400.00
S7.0.3	Borrow wearing course material, load, haul, spread, moisture condition and compact on haul roads (<5 km haul)	4,300	CCM	$ 20.00	$86,000.00
S7.0.4	Borrow wearing course material, load, haul, spread, moisture condition and compact on access roads (<5 km haul)	2,600	CCM	$ 20.00	$52,000.00
				6	**$690,400.00**
S8.0 PIPING					
S8.0.1	Supply and install steel tailings delivery pipework (including all fixtures and fittings) (250NB)	1,000	LM	$ 650.00	$650,000.00
S8.0.2	Supply and install HDPE tailings delivery pipework (including all fixtures and fittings) (250OD PN20)	3,000	LM	$ 190.00	$570,000.00
S8.0.3	Supply and install spigot droppers and tees to northern embankment	12	no.	$ 15,000.00	$180,000.00
S8.0.4	Booster station.	1	LS	$ 5,000,000.00	$5,000,000.00
S8.0.5	Supply and install decant pump and starter panel	1	LS	$ 500,000.00	$500,000.00
S8.0.6	Supply and install HDPE decant return pipework (including all fixtures and fittings) (315 OD PN16)	2,000	LM	$ 100.00	$200,000.00
S8.0.7	Supply and install HV Powerline to Decant Area?	1,500	LM	$ 250.00	$375,000.00
				Total S9.0	**$7,100,000.00**
				TOTAL DIRECTS	**$46,016,900.00**
				INDIRECT COSTS (35% of Direct Costs)	**$16,105,915.00**
				TOTAL DIRECT AND INDIRECTS	**$62,122,815.00**
				Contingency (30%)	**$18,636,844.50**
				Owners Costs (7.5%)	**$4,659,211.13**
				TOTAL CAPITAL COST	**$85,418,870.63**

APPENDIX L: DESIGN RISK ASSESSMENT

Engeny Project Risk Register - TSF3 Preliminary Design

Rev2

Project Name : QC1022_018 TSF3 Design and Studies

Job No.: QC1022_018
Risk Framework: 29 Metals - 20211216-HO-POL-APPROVED Risk Evaluation Matrix

Project Manager: Brendan Wallace
Project Director: Travis Warren

Client: 29 Metals - Capricorn Copper Mine
Client Contact: Michael Gunner

ENGENY

Item No.	Type	Asset Location	Design Life Cycle Phase	Risk	Hazard	Likelihood	Consequences	Risk Rating and Score	Existing Controls	Residual Likelihood	Residual Consequences	Residual Risk Rating and Score	Control Rating	Further Control Suggestions	Action	Responsibility (Risk Owner)
1	Production	TSF3	Operation	• Tailings beach properties different from expected.	• Storage capacity / design life less than expected. •Approx $2M/month.	C. Possible	4. Major	18 - High	•Tailings rehology testing completed (ATCW) •Existing TSF (ETSF) to estimate beaching slopes. •Sensitivity analysis based on various beaching angles / tailings rheology / settled density / water balance performance. •LoM tailings strategy developed to identify future facilities and planning requirements •Independent Techniocal Review of design	B. Unlikely	3. Moderate	9 - Medium	1. Effective	•Staged TSF3 with initial deposition to confirm beach slopes. •Operational controls. •Operational monitoring (to confirm operating as per design intent).	•Further sensitivity analysis on beach slopes / density etc to be undertaken in detailed design phase.	•Engeny / CCM
2	Enviornment / Community	TSF3	Design / Approvals	• No clear closure plan for TSF3 / mine. •No clear closure plan for E-Pit and EWRD.	• Tailings deposition stratergy and TSF3 design not optimised for closure stratergy. •Potential ongoing seepage / AMD to E-Pit through EWRD. •Ammendment application submitted prior to PRCP approved. High level of detail required for ammendment application.	C. Possible	4. Major	18 - High	•PRCP Application •Concept TSF3 Closure Landform Design. •Stage 1 geotechnical and borrow investigation •Independent Techniocal Review of design	B. Unlikely	4. Major	14 - High	2. Partially Effective	• Workshop potential closure scenarios and surface water flow paths e.g. Option 1 - E-Pit approved for tailings storage. Option 2 - E-Pit not approved for tailings storage. •Assess scenarios using water balance model. •Confirm and assess E-pit, WRD closure strategy. •Consider having detailed closure design to support ammendment application. •Proposed Stage 2 site wide borrow investigation (on lease / off lease). •Proposed capping trials to reduce material requirements for closure. •Additional pre-lodgement meeting with DES regarding PRCP and requirements to achieve properly made.	•Progress site wide borrow investigation. •Refine cap design (2D modelling). •Update design with EWRD closure landform.	•Engeny / CCM
3	Enviornment / Community	TSF3	Design / Approvals	• Insufficient material to close and rehabilitate TSF3 (NAF/Clay Fill / Capillary Break Layer / Topsoil)	• Poor closure performance, extended care and maintenance, and delayed EA relinquishment. •Approvals not granted. •Increased ERC liability.	D. Likely	4. Major	21 - Extreme	•PRCP (Currently assessed as not properly made). •Design to support closure strategy •Integration of TSF3 design into site wide PRCP •Stage 1 geotechnical and borrow investigation •Independent Techniocal Review of design	C. Possible	4. Major	18 - High	2. Partially Effective	• Use of geomembranes (e.g BGM/GCL/HDPE) where appropriate to reduce earthfill material quantities. •Proposed Stage 2 site wide borrow investigation (on lease / off lease) •Proposed capping trials to reduce material requirements for closure. •Additional pre-lodgement meeting with DES regarding PRCP and requirements to achieve properly made.	•Progress site wide borrow investigation. •Refine cap design (2D modelling).	•Engeny / CCM
4	Enviornment / Community	TSF3	Operation	• Incorporation of PAF into perimeter embankments due to poor practices / lack of available NAF.	• Poor quality surface water / seepage reporting to environment.	C. Possible	3. Moderate	13 - Medium	•Selective borrowing / placement. •Stage 1 geotechnical and borrow investigation •CQC/CQA including assessment of sulphur content and acid-base accounting. •No direct surface water pathway to Gunpowder Creek. •Groundwater and surface water monitoring program. •Independent Techniocal Review of design	B. Unlikely	2. Minor	5 - Low	1. Effective			
5	Production	TSF3	Construction	• Insufficient suitable material to construction perimeter embankments (NAF / Clay Fill / Fine Rock Fill / Coarse Rock Fill / Riprap / Topsoil)	• Reduced storage capacity / design life than expected. • Delays to construction completion. •Increased construction costs. •Impacts to production.	C. Possible	3. Moderate	13 - Medium	• Geotechnical investigation of potential borrow areas including geochemistry / soil suitability testing. • Civil modelling of design to be undertaken to inform quantities with quantity contingency to be included. •Proposed site wide borrow investigation (on lease / off lease) •LoM tailings strategy developed to identify future facilities and planning requirements •Independent Techniocal Review of design	B. Unlikely	3. Moderate	9 - Medium	2. Partially Effective	• Use of geomembranes (e.g BGM/GCL/HDPE) where appropriate to reduce earthfill material quantities. •Proposed Stage 2 site wide borrow investigation (on lease / off lease).		
6	Enviornment / Community	TSF3	Design / Approvals	• Seepage through northern embankments / existing waste rock dump / natural topography and dam floor.	• Poor quality surface water / seepage reporting to E Pit and environment. • Potential serviceability impacts to haul road. •Interaction of PAF tailings and potentially acidic seepage with PAF waste rock in EWRD embankment. •Potential chemical reactions leading to clogging of rockfill embankments. •Longer term poor water quality seepage through EWRD delays final closure of TSF3.	D. Likely	3. Moderate	17 - High	•Preliminary 2D seepage model completed. •Geological setting indicates TSF3 sited in stable low permeability setting. •Embankment design to incorporate controls to reduce seepage where appropriate including EWRD grout curtain and geomembrane liner to seperate tailings and PAF EWRD. •Decant size to be minimised through appropriate operational procedures. •Site wide seepage interception project. •Independent Techniocal Review of design	B. Unlikely	3. Moderate	9 - Medium	2. Partially Effective	• Update of existing site groundwater and surface water monitoring programs to incorporate TSF3. •Additional active seepage management (i.e. pumped dewatering of seepage interception wells / sumps). •Decant location away from perimiter embankments. (Modify deposition methodology). • Site wide numerical groundwater model to quanitify change in groundwater flows / groundwater quality. •Geotechnical investigation for TSF3 embankments proposed for detailed design. •Operational controls.		
7	Enviornment / Community	TSF3	Design / Approvals	• Seepage through southern embankments / / natural topography and dam floor.	• Poor quality surface water / seepage reporting to environment. •Potential chemical reactions leading to clogging of rockfill embankments.	C. Possible	4. Major	18 - High	•Preliminary 2D seepage model completed. •Geological setting indicates TSF3 sited in stable low permeability setting. •Embankment design to incorporate controls to reduce seepage where appropriate including incorporation and extension of UEDD grout curtain (including replacement / repair / verification of adequacy of existing UEDD grout curtain and HDPE liner to separate tailings and from UEDD clean catchment). •Decant size to be minimised through appropriate operational procedures. •Independent Techniocal Review of design	B. Unlikely	4. Major	14 - High	2. Partially Effective	• Update of existing site groundwater and surface water monitoring programs to incorporate TSF3. •Additional active seepage management (i.e. pumped dewatering of seepage interception wells / sumps). •Decant location away from perimiter embankments. (Modify deposition methodology). • Site wide numerical groundwater model during detailed design to quanitify change in groundwater flows / groundwater quality. •Geotechnical investigation for TSF3 embankments proposed for detailed design. •Operational controls. •Verification of effectiveness of existing UEDD seepage controls through dewatering and inspection		
8	Approvals	TSF3	Design / Approvals	•EA Ammendment Rejected by DETSI	• Cessation of production / Extended Care and Maintenance Period.	C. Possible	4. Major	18 - High	• Early engagement with DETSI / Pre-lodgement meetins. •PRCP •DETSI Concerns Register •Limited GWIA, SWIA and Ecological Assessments undertaken for approvals •Independent Techniocal Review of design	B. Unlikely	4. Major	14 - High	2. Partially Effective	• Detailed GWIA / SWIA to be undertaken during detailed design. • Use of geomembranes (e.g BGM/GCL/HDPE) where appropriate to reduce earthfill material quantities. •Proposed site wide borrow investigation (on lease / off lease) •Proposed capping trials to reduce material requirements for closure. •Additional pre-lodgement meeting with DES regarding PRCP and requirements to achieve properly made.	•Review and update approvals risk register.	•Engeny / CCM
9	Enviornment / Community	TSF3	Operation	•Dam Overflow / Spill Event	• Release of stored contents off-site. •Breach of regulations / fines / penalties. •Adverse reputational impacts.	C. Possible	3. Moderate	13 - Medium	•Site Water Balance Model (DSA/ESS) - SWIA modelling did not show overflows from site under any scenario P99). • TSF3 Monitoring Instrumentation • Suitable Freeboard to be maintained (ESS ~180 ML prior to spill at final tailings deposition surface). • No direct overflow path to Gunpowder Creek. •Spillway to overflow to E pit. •Independent Techniocal Review of design	B. Unlikely	3. Moderate	9 - Medium	1. Effective	• OMS Manual to be developed / updated. •Water treatment plant and management plan. •Diversions and emergency pumping. •Mechanical evaporators. •Proposed release criteria for EA.		
10	Multiple	TSF3	Operation	•Dam Break (potentially non-credible for failures reaching off site)	• Release of stored contents off-site • Release of stored contents on-site •Potential impacts to persons / enviornment / property / social licence.	A. Rare	5. Catastrophic	15 - High	• Design to industry recommended guidelines. • Site specific seizmic hazard assessment completed. •Preliminary CCAs completed (DESI/ANCOLD) •Large landform embankment (EWRD). •Independent Techniocal Review of design	A. Rare	5. Catastrophic	15 - High	2. Partially Effective	•Remove upstream raise methodology from UEDD embankment. • OMS Manual / TARPs to be developed / updated. • Routine Surveillance Inspections • TSF Monitoring Instrumentation. • Emergency Response Plan to be developed / updated. •Detailed CCAs including FIA (if required) (DESI/ANCOLD/GISTM =) to be undertaken during detailed design. •Geotechnical Investigation to be completed as part of detailed design. •Overbuild of northern embankment sections to demonstrate non-credible failure	•Undertake works to determine if embankment dam break is a credible failure mode during detailed design.	•Engeny / CCM

11	Multiple	TSF3	Design / Approvals	•Insufficient available data (seepage risk as main driver)	• Design performance uncertainty. • Overly conservative design resulting in increased costs.	C. Possible	3. Moderate	13 - Medium	• Review of available data. • Investigations / assessments undertaken to address data gaps. • Modify design or undertake more conservative design where data gaps cannot be addressed or uncertianty remains. •Preliminary 2D seepage model completed. •Independent Techniocal Review of design	B. Unlikely	3. Moderate	9 - Medium	2. Partially Effective	• Additional investigations / assessments to be undertaken to address data gaps.I. •Third party review of groundwater modelling and GWIA.		•CCM
12	Multiple	TSF3	Design / Approvals	• Design not optimised or fatal flaw in design. • Poor Design Practices	• Redesign required resulting in delay to approvals / construction / operation.	B. Unlikely	4. Major	14 - High	•Independent Techniocal Review of design •Suitably qualified consultant. • High level concept design review to be undertaken.	A. Rare	4. Major	10 - Medium	1. Effective			
13	Production	TSF3	Construction	• Poor / inadequate construction practices.	• Design performance intent not achieved.	C. Possible	4. Major	18 - High	• Construction Quality Assuance / Construction Quality Control Program to be implemented. • Construction oversight by independent suitably qualified engineer. •Competent contractor selection. •Sufficient construction schedule.	B. Unlikely	4. Major	14 - High	1. Effective			
14	Enviornment / Community	TSF3	Operation	• Change to downstream enviornment / PAR / PLL.	• Material change in CCA and required upgrade to TSF3 design performance.	B. Unlikely	4. Major	14 - High	• CCM Change Management Procedures. • Ongoing review of TSF3 risks and mitigation requirements.	B. Unlikely	3. Moderate	9 - Medium	1. Effective	•Annual review / updates of operational documents (OMS, TARP, ERP) to confirm. •Annual audits. • Establish consistent EOR for CCM.		
15	Enviornment / Community	TSF3	Operation	• Poor Operational Practices / TSF3 Maintenance	• Reduction in TSF3 perforcmance	A. Rare	4. Major	10 - Medium	•Dedicated TSF operators. •Existing Environmental Management System / Policy, Procedures. •Annual inspections. •Regular flyover surveys.	A. Rare	4. Major	10 - Medium	2. Partially Effective	• Establish consistent EOR for TSF3. • OMS Manual to be developed / updated. • Routine and intependent surveillance inspections. • Develop training program for operational personnel resoponsible for TSF3 Operation / Management		
16	Multiple	TSF3	Design / Approvals	• Key risks not identified or changes.	• Unknown, unquantified, and uncontrolled risk/s	C. Possible	4. Major	18 - High	• Preliminary design risk assessment. • Develop and maintain a risk register. • CCM Change Management Procedures. • Independent Third Party Review	A. Rare	4. Major	10 - Medium	1. Effective	• Detailed Failure Modes and Effects Analysis to be undertaken during detailed design.		
17	Approvals	TSF3	Design / Approvals	•Grout curtain not able to be constructed as per design intent.	• Potential fatal flaw for approvals. •Grout curtain does not perform as intended (increased seepage through EWRD).	C. Possible	5. Catastrophic	22 - Extreme	•Low permeability tailings will reduce seepage rates. •Early engagement with grouting contractor to confirm feasibility •Independent Techniocal Review of design	B. Unlikely	5. Catastrophic	19 - High	2. Partially Effective	•Decant location away from perimiter embankments. (Modify deposition methodology). • Early contrator engagement to undertake constructability review. •Independent third party review. •Review of requirement of grout curtain based on groundwater modelling		
18	Enviornment / Community	TSF3	Design / Approvals	•Settlement of EWRD leading to damage to liner, particularly at liner - grout curtain connection.	•Grout curtain does not perform as intended (increased seepage through EWRD).	C. Possible	4. Major	18 - High	• Early contrator engagement to undertake constructability review. •Compaction of reprofiled fill for EWRD. •Liner to prevent saturation of EWRD. •Low permeability tailings will reduce seepage rates. •Independent Techniocal Review of design	C. Possible	4. Major	18 - High	2. Partially Effective	•Decant location away from perimiter embankments. (Modify deposition methodology). •Settlement modelling. •Defensive design e.g. (incorporating slack in liner to accommodate settlement, use of LLDPE (higher elongation).		

APPENDIX M: TSF3 REHABILITATION AND CLOSURE PLAN

ENGENY

29 METALS

TSF3 Project

Rehabilitation and Closure Plan

QC1022_018-REP-006-01022_018-REP-006-0

29 JULY 2025

DISCLAIMER

This Report has been prepared on behalf of and for the exclusive use of 29 Metals and is subject to and issued in accordance with 29 Metals instruction to Engeny Australia Pty Ltd (Engeny). The content of this Report was based on previous information and studies supplied by 29 Metals.

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1. INTRODUCTION

1.1 Background and Site Context

Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29 Metals Limited (29M), has engaged Engeny Australia (Engeny) to undertake the preliminary design of the proposed Tailings Storage Facility 3 (TSF3) located at Capricorn Copper Mine (CCM) in north-west Queensland. CCM is operated under Environmental Authority EMPL 00911413 (EA) as in effect on 6 December 2023. This Closure and Rehabilitation report is provided to support a major EA amendment for the approval of TSF3. Based on the preliminary design, the design life of TSF3 is expected to be approximately 6.5 – 7.5 years.

1.2 Site History

CCM has been subject to mining activities dating back to 1927, with mining effort varied over the life of the mine. Mining activity included active underground mining within the Mammoth and Esperanza South underground mines up until January 2009. CCM was placed in care and maintenance in February 2009 until February 2011, with underground mining recommencing in May 2011. Operations then continued until April 2013, when the site was again returned to care and maintenance. CCPL acquired the site in 2015 and successfully recommenced operations in 2017.

Due to multiple extreme wet weather events during both the 2022 and 2023 wet seasons, and exhaustion of the existing tailings storage facility (TSF), Esperanza TSF (ETSF) in March 2024, mining and ore processing activities ceased and the site entered a period of suspended operations. The extreme wet weather events resulted in the loss of critical infrastructure (flooding of the Esperanza Underground Mine, loss of the existing reverse osmosis water treatment plant (WTP), workshops and warehouse area) as well as significant increases to the mine affected water (MAW) inventory which is primarily contained within Esperanza Pit (EPit).

In addition to the proposed TSF3, CCPL have initiated a program of water management system (WMS) improvements aimed at reducing the use of raw water, minimising the generation of MAW, increasing the utilisation of existing EA conditions to release more treated water to Gunpowder Creek and increasing the rate of water destruction through mechanical evaporators.

1.3 Purpose

The purpose of this Closure and Rehabilitation Plan for TSF3 is to establish a structured, risk-based framework for the safe, environmentally responsible, and sustainable closure and rehabilitation of the facility at the end of its operational life. This plan integrates closure considerations into the whole lifecycle of TSF 3, ensuring compliance with regulatory requirements, minimizing long-term liabilities, and facilitating post-closure land uses that align with stakeholder expectations and environmental values. By addressing potential physical, chemical, and ecological risks, the plan aims to transform the site into a stable, self-sustaining landscape that requires minimal ongoing maintenance while protecting public health and the environment.

Key objectives of the plan include:

- Achieving long-term geotechnical and geochemical stability of the TSF to prevent failures, erosion, or contaminant releases, including the implementation of engineered covers to limit water infiltration, oxygen diffusion, and acid generation.
- Redirecting surface water runoff and managing seepage to avoid accumulation on the facility, and minimize impacts on groundwater and surface water quality, ensuring no unacceptable off-site effects on receptors.
- Progressively rehabilitating disturbed areas during operations to reduce residual risks at closure, such as dust generation or habitat disruption, and to restore natural drainage patterns and vegetation consistent with surrounding landforms.
- Ensuring the site meets or exceeds environmental standards for air, soil, and water quality post-closure, with specific criteria for radiation levels (if applicable), pest control, and ecological recolonization.
- Conducting comprehensive post-closure monitoring and maintenance for a defined period (e.g., 20 years) to verify the achievement of closure criteria, identify any emerging issues, and demonstrate that the rehabilitated site poses acceptably low risks in perpetuity.

- Engaging stakeholders, including regulatory authorities, local communities, and Traditional Owners, throughout the planning and execution phases to incorporate diverse perspectives and support sustainable post-mining outcomes.

1.4 Scope

This scope of this plan comprises:

- Closure objectives and design criteria.
- Rehabilitation methods, including cover systems and landform reshaping.
- Monitoring, maintenance, and contingency measures.
- Risk management and stakeholder engagement.
- Implementation schedule and cost estimates.

Exclusions include detailed engineering for ancillary infrastructure (e.g., tailings delivery systems) and site-wide PRCP integration, which will be addressed in future updates.

1.5 Key Data Sources

A summary of key reports report and data used on in development of this plan is summarised below in Table 1.1.

TABLE 1.1: SUPPORTING INFORAMTATION

Data Source/Document Name	Reference/Code	Key Content/Use in Report	Date/Author
Preliminary Design Report	QC1022_018-REP-005-1	Provides conceptual closure strategy, geotechnical investigations, borrow material assessments, and design criteria for TSF3 stability and closure. Used for basis of design (BOD), landform reshaping, and stability FoS requirements.	2025 / Engeny
Limited Surface Water Impact Assessment (SWIA)	QC1022_018-REP-003-2	Assesses surface water flows, quality impacts, and risks from TSF3; informs water management, no material flow changes to Gunpowder Creek, and erosion controls. Used for SWIA integration in monitoring and stability.	2025 / Engeny
Limited Groundwater Impact Assessment (GWIA)	QC1022_018-REP-004-1	Evaluates groundwater seepage, and quality triggers; informs seepage controls, GDE protection, and monitoring bores. Used for GWIA baseline in decommissioning and stability.	2025 / Engeny
Soil Mapping Report	QC1022_020-REP-009-A	Desktop and field soils investigation; classifies soils (e.g., Um1.43/Rudosol), assesses suitability for rehab (low fertility, acidic), and borrow sources. Used for soil properties, amelioration, and revegetation strategy.	2025 / Engeny
TSF3 Soil Data	29M_TSF3_SoilData.xlsx	Laboratory results from TSF3 footprint sampling (e.g., pH 3.98–4.95, ECEC 1.36–1.72 cmol/kg, nutrients low); informs soil quality parameters and rehab challenges. Used for site-specific soil tables and revegetation amendments.	2024 / Engeny (sampling), ALS Laboratories (analysis)

Data Source/Document Name	Reference/Code	Key Content/Use in Report	Date/Author
CCM Rehabilitation Monitoring Procedure	QC1022_020-REP-007-0	Outlines monitoring methodology (BioCondition, remote sensing); analogue sites, scorecards, and adaptive management. Adapted for TSF3 monitoring section.	2025 / Engeny
Environmental Authority	EPML00911413	Regulatory conditions for CCM operations, rehab monitoring (e.g., Schedule C water quality, F4-1 program), and EVs protection. Used for compliance in all sections.	2025 Queensland Department of Environment, Science and Innovation (DESI)
Progressive Rehabilitation and Closure Plan Guideline	ESR/2019/4963, Version 1.01	Guidance on PRCP schedule, milestones, PMLUs, NUMAs, and monitoring. Used for PRCP Schedule development and rehab strategy.	2024 / DETSI
ANCOLD Guidelines on Tailings Dams	-	Standards for stability FoS (e.g., ≥1.5 drained), closure design, and risk management. Used for stability criteria and monitoring.	2012 (with 2019 Addendum) / Australian National Committee on Large Dams (ANCOLD)
GHD 2019 Borrow Areas Report	-	Field investigations of growth medium/clay borrows (e.g., NWRD 350,000 m^3). Used for material sources and volumes.	2019 / GHD
EMM 2015 Borrow Assessment	-	Potential quarries (e.g., North Rock Quarry). Used for borrow suitability and Non-Acid Forming (NAF) confirmation.	2015 / EMM
Engeny 2023 Soils Investigation	QC1022_018-MEM-005-0	TSF3 footprint sampling (e.g., rock-mantled, acidic). Used for site-specific properties.	2023 / Engeny
Engeny 2024 Geological Mapping	QC1022_018-REP-001-1	Borrow sources (e.g., Cromwell Metabasalt clay). Used for material availability.	2024 / Engeny
Northwest Highlands Bioregion Expert Panel Report	-	RE descriptions and benchmarks. Used for revegetation targets.	2018 / Queensland Government

1.6 Legislative Framework

1.6.1 PRCP Framework and Guidelines Requirements

The Progressive Rehabilitation and Closure Plan (PRCP) framework is a key regulatory mechanism in Queensland designed to ensure that mining activities, including the operation and closure of tailings storage facilities (TSFs) like TSF3 at CCM, are conducted in a manner that minimizes long-term environmental risks and facilitates the timely return of land to a stable, productive state. This overview summarizes the underpinning legislation, the purpose and structure of the PRCP Guideline, and its specific relevance to TSF closure, drawing from the Queensland Department of Environment, Tourism, Science and Innovation's (DETSI) Progressive Rehabilitation and Closure Plan Guideline (Version 1.0, effective under the Environmental Protection Act 1994 (EP Act) and Mineral and Energy Resources (Financial Provisioning) Act 2018 (MERFP Act)).

The PRCP framework is established under two primary pieces of legislation:

- **Environmental Protection Act 1994 (EP Act)**: This Act provides the overarching environmental protection regime in Queensland, emphasizing the prevention and minimization of environmental harm from resource projects. Key provisions relevant to PRCPs include:
  - Section 126C: Requires the submission of a proposed PRC Plan for site-specific environmental authorities (EAs), outlining rehabilitation planning, risk assessments, community engagement, and methodologies to achieve a stable condition.
  - Section 126D: Mandates the inclusion of a PRCP schedule with enforceable milestones for rehabilitation to post-mining land uses (PMLUs) or management of non-use management areas (NUMAs). It prohibits NUMAs in flood plains unless rehabilitated to a stable condition and requires justification for NUMAs based on greater environmental harm or public interest.
  - Section 111A: Defines a "stable condition" as safe, structurally stable, causing no environmental harm, and sustainable for the proposed PMLU without ongoing management.
  - Transitional provisions (e.g., Section 754): Apply to existing EAs like CCM's EPML00911413, allowing the transition of pre-existing rehabilitation outcomes into the PRCP schedule.
- **Mineral and Energy Resources (Financial Provisioning) Act 2018 (MERFP Act**): This Act complements the EP Act by addressing financial assurance for rehabilitation. It requires PRCPs to estimate costs for closure activities (e.g., via the Estimated Rehabilitation Cost (ERC) Guideline) and enables progressive certification to reduce assurance as milestones are met. The MERFP Act ensures that closure liabilities are adequately provisioned, linking to the EP Act's surrender process.

1.6.2 Purpose of the PRCP Guideline

The Progressive Rehabilitation and Closure Plan Guideline (ESR2019/4957, Version 3.01) provides practical guidance for preparing and implementing PRCPs, ensuring consistency across resource projects. Its primary purposes are:

- To maximize progressive rehabilitation, reducing the extent of disturbed land and residual risks at surrender.
- To achieve a "stable condition" that protects environmental values (EVs) like aquatic ecosystems and groundwater (per Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP)), while supporting viable PMLUs (e.g., native bushland for TSF3).
- To separate residual risk management (handled at surrender) from progressive planning, focusing on enforceable milestones.
- To facilitate community and stakeholder input, ensuring transparency and alignment with public interest.
- For TSFs like TSF3, the guideline emphasizes early closure planning to address unique challenges such as Potentially Acid Forming (PAF) tailings, seepage and long-term stability.

For TSFs, the PRCP Guideline highlights tailored requirements (Section 3.6.2):

- **Characterisation**: Tailings geochemistry (e.g., PAF potential), rheology, and geotechnical parameters (e.g., shear strength, consolidation per Preliminary Design Report lab tests).
- **Design Elements**: Liners, leak detection, seepage collection, and spillways (e.g., TSF3's eastern spillway to EPit, designed for PMF per SWIA).
- **Risk Management**: NUMAs justified if rehab harms more (e.g., for persistent seepage risks per GWIA); best-practice management including monitoring.
- **Flooding and Hydrogeology**: Assess voids/flood plains (TSF3 not in flood plain; PMF modeling required); integrate groundwater modeling (e.g., GWIA's 2D SEEP/W, recommending 3D transient updates).
- **Cover Design**: Risk-based (e.g., store-and-release for TSF3 to limit infiltration into PAF tailings).
- **Milestones**: Include TSF-specific (e.g., decommissioning, capping).

Non-compliance with the schedule is enforceable (Section 4.3), with audits and annual returns required (Section 5.6). For TSF3, this ensures progressive actions (e.g., early dewatering) reduce residual risks.

1.7 Guidelines and References

This Closure and Rehabilitation Plan has been compiled with reference to the following legislation and best practice guidance, with key requirements and report sections summarised in Table 1.2 :

- ESR/2015/1839 Application Requirements for Activities with Impacts to Land (DESI, 2024).
- Tailings Management Leading Practice Sustainable Development Program for the Mining Industry (DFAT, 2016).
- Preventing Acid and Metalliferous Drainage Leading Practice Sustainable Development Program for the Mining Industry (DFAT, 2016).

TABLE 1.2:BEST PRACTICE REQUIREMENTS

Reference	Key Requirements	Report Section
ESR/2015/1839 – Application Requirements for Activities with Impacts to Land (DESI, 2024)	• Demonstrate minimisation of land disturbance • Include progressive rehabilitation and final land use plans • Address AMD risk and mitigation • Prevent environmental harm from tailings/mine-affected water • Detail monitoring and maintenance measures.	• Sections 2.1, 2.8, 3, 4, 7 and 8
Tailings Management Leading Practice Sustainable Development Program (DFAT, 2016)	• Apply risk-based TSF design, operation and closure • Plan progressive rehabilitation from outset • Ensure TSF stability, seepage control, water management • Implement surveillance, monitoring, reviews • Stakeholder engagement on tailings management	• Sections 3, 4, 5, 6 and 8
Preventing Acid and Metalliferous Drainage Leading Practice (DFAT, 2016)	• Early geochemical characterisation of mine materials • Design covers to limit oxygen and water ingress • AMD prevention/control strategies • Long-term monitoring of seepage, water quality, cover performance • Integrate AMD control into closure planning.	• Sections 2.8, 5.3 and 8

1.7.1 ESR/2015/1839 Application Requirements for Activities with Impacts to Land

The *DES Guideline Application Requirements for Activities with Impacts to Land (ESR/2015/1839*) details the information to be provided to support an Environmental Authority Application (EAA) with impacts to land. This document has been considered during the development of this Plan.

The requirements for Tailings Management specified in Section 5.1 are shown in Table 1.3, and where they are addressed in this Plan.

TABLE 1.3: GUIDELINE REQUIREMENTS FOR ACTIVITIES WITH IMPACTS TO LAND

Section 5.1 Tailings Management	Report Section
Consideration for the manual for dams containing hazardous waste.	Section 2.1
Liners and basement preparations for any structure.	Section 2.1
How capillary rise in tailings storage facility will be managed (operationally and post closure e.g., capillary breaks).	Sections 3, 5 and 8
Proposed leak detection systems.	Section 8
Structural geology below dams and geotechnical and seepage implications.	Section 2.1 and 3

Section 5.1 Tailings Management	Report Section
Fracturing and springs and potential to cause increase into structures and lift liners.	Section 2
Design storage allowance and design standard being adopted.	Section 2.1
Heap leach pads and carbon in pulp/leach treatment, and how the highly contaminated waters will be managed (i.e., cyanide and acid leach issues).	N/A
Pregnant/barren ponds management and risk of cascading water quality from these facilities impacting mildly contaminated dams	N/A
Proposed capping and closure design.	Section 5
Co-disposal options and risks.	N/A
Geochemical characterisation	Sections 2.9 and 8.4
Restriction of access of cattle and wildlife to contaminated waters in structures.	Section 7.1
Spillway location.	Section 2.1
Chemical storage on site (including explosives).	N/A
Perimeter spigot—central discharge and coarse grind towards closure.	N/A
Potential radionuclides and implications for environment and public health regarding radiation risks.	N/A

2. SITE SETTING

TSF3 is located within Mining Leases ML90180, ML90181, and ML90812 at CCM, approximately 130 km north of Mount Isa. The facility occupies about 79 ha in the Upper Esperanza Valley (UEV), with a total disturbance footprint of approximately 136 ha including borrow areas and access tracks. The geology comprises Whitworth Quartzite, Lochness Formation, and Torpedo Creek Quartzite, characterized by low permeability rock units with defect-controlled seepage pathways. Surrounding features include the Esperanza Waste Rock Dump (EWRD) (northern boundary), UEDD (southern boundary), Esperanza Pit (EPit) to the north, and Gunpowder Creek as the primary receiving water body.

TSF3 will store tailings from copper processing, with deposition in a down-valley manner from the southern embankment, beaching northward toward the EWRD. Key design elements include:

- Northern embankment: Reprofiled EWRD with upstream geomembrane liner, concrete plinth, and grout curtain for seepage control.
- Southern embankment: Centreline raise of UEDD, retaining existing liners and grout curtain.
- Spillway: Eastern rock-cut emergency overflow directing flows to EPit.
- Water management: Decant Pond maintained at ~1 m depth, with ESS capacity of 171.4 ML.

Tailings are expected to be potentially acid forming (PAF), requiring geochemical management during closure.

2.1 TSF3 Construction

TSF3 is proposed to be located between the EWRD and UEDD and bound by the surrounding ridges. The site topography consists of roughly north-south striking undulating ridges which are incised by a main drainage line which forms the UEV and is bound by the EWRD in the north and by the UEDD in the south. The proposed TSF3 preliminary design is shown in Figure 2.1.

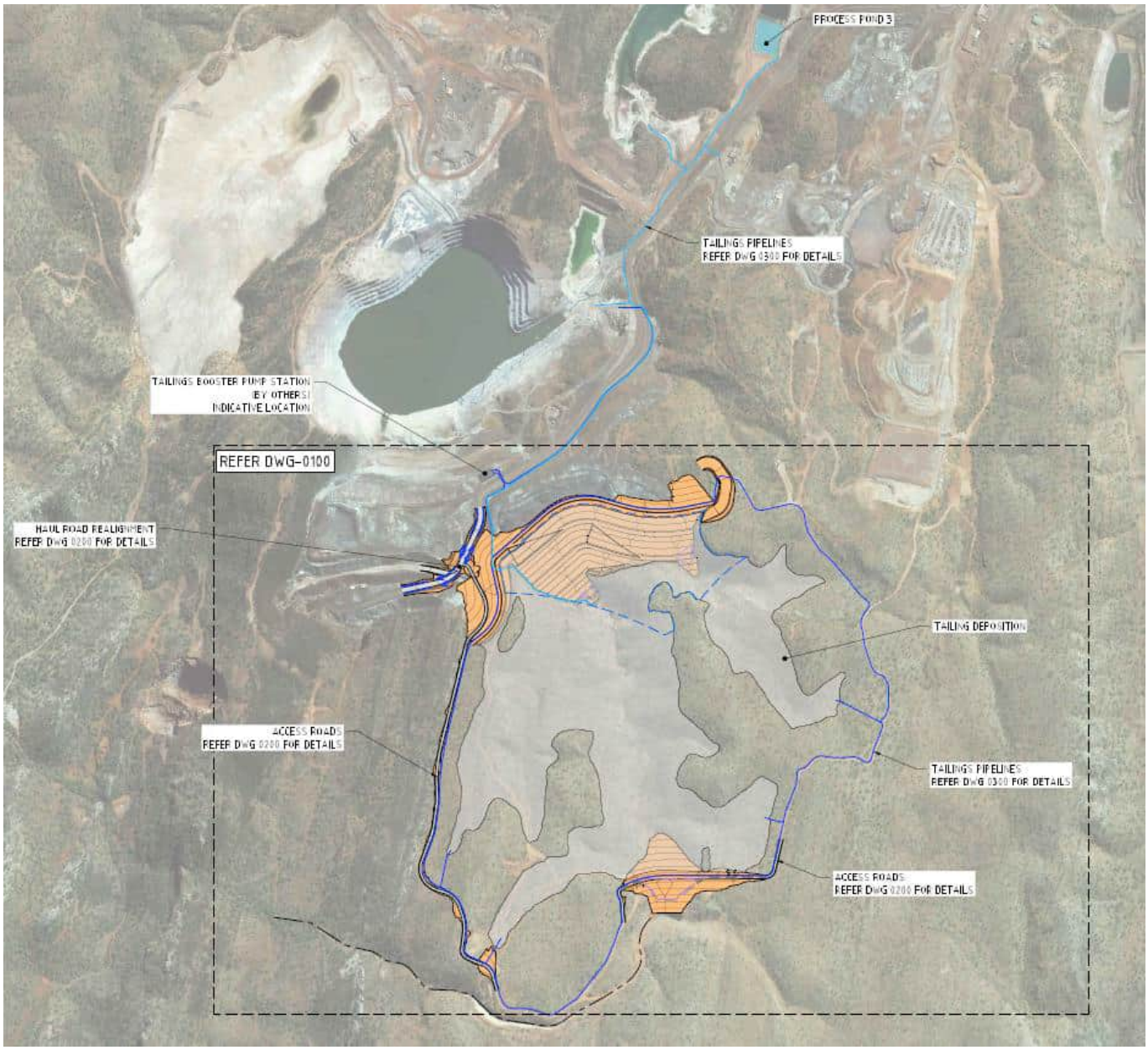


Figure 2.1: TSF3 Preliminary Design (Extract from Drawing QC1022-018-DWG-0010)

Construction activities will primarily be at the northern and southern embankments, as described below.

2.1.1 Northern Embankment Design

The typical design for the northern embankment is shown in Figure 2.2.

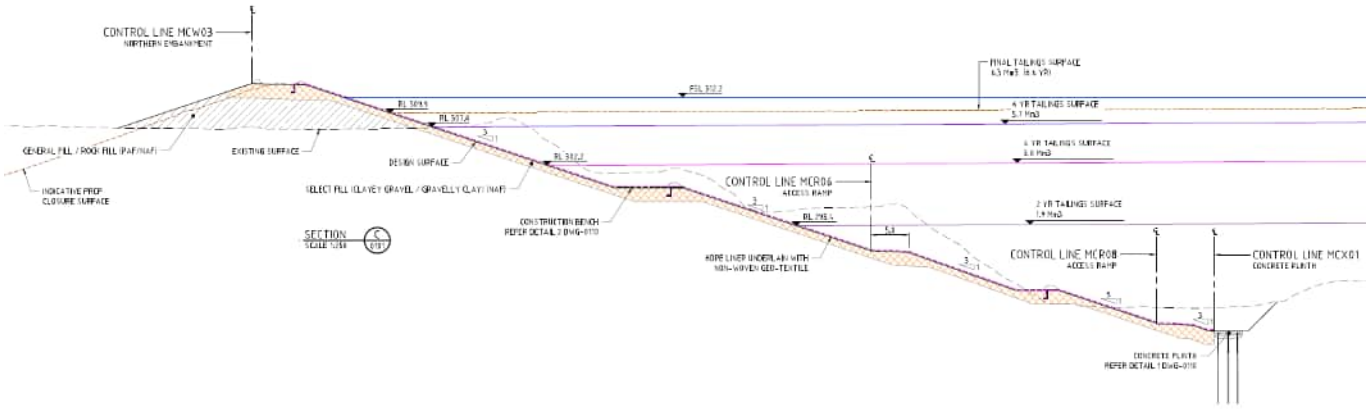


Figure 2.2: Tailings Deposition – Rate of Rise (Northern Embankment)

The provisional construction sequence is as follows:

(1) Undertake bulk earthworks using NAF/PAF General Fill / Rock Fill to form the northern embankment and reprofile the upstream batter. Areas of the northern embankment which may drain to a clean catchment (e.g. Upper Snakeskin Valley) to be constructed from NAF General Fill / Rock Fill.

(2) Construct geomembrane liner cushion layer using Select Fill (Clayey GRAVEL / Gravelly CLAY). The preliminary design allows for a typically 3m wide (1m thick) Select Fill layer, thickened to 2m thick at the batter benches to facilitate anchoring of the geomembrane liner. Where required the Select Fill layer may be separated into two material types to transition from the existing rock fill to the cushion layer to prevent loss of fines in the cushion layer during operation.

(3) Construct concrete plinth and grout curtain and install geomembrane liner.

2.1.2 Southern Embankment Design

The typical design for the southern embankment is shown in Figure 2.3.

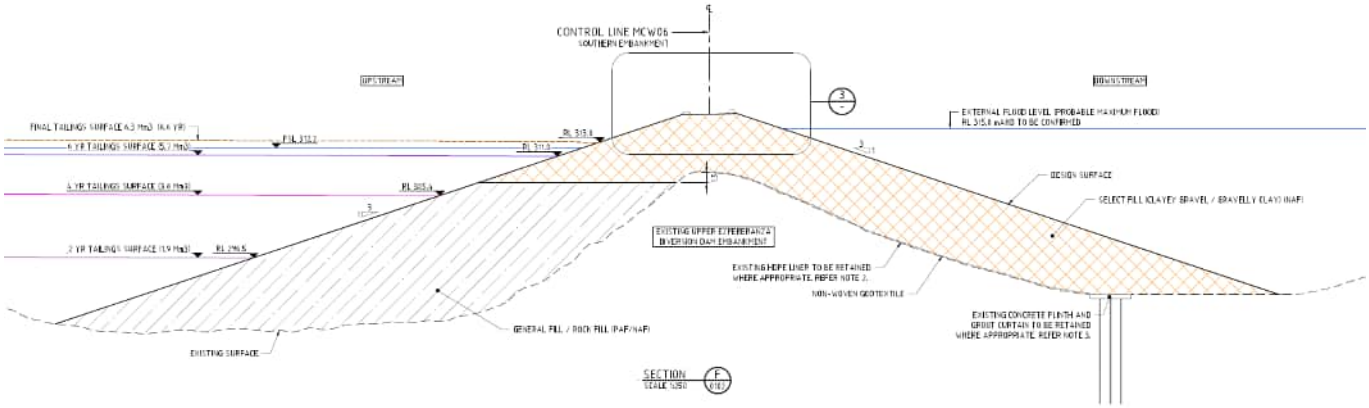


Figure 2.3: Tailings Deposition – Rate of Rise (Southern Embankment)

The provisional construction sequence is as follows:

(1) Verify adequacy of existing grout curtain (e.g. through conformation grouting) and HDPE geomembrane liner (e.g through inspection and testing) and repair / replace / remediate where required. Extend grout curtain and concrete plinth to accommodate centreline raise.

(2) Undertake centreline raise using NAF/PAF General Fill / Rock Fill (internal batter) and Select Fill (Clayey Gravel / Gravelly Clay) (crest and external batter). Tie low permeability Select Fill into concrete plinth / grout curtain extension. Existing HDPE liner to be protected by non-woven geotextile or similar prior to Select Fill placement.

2.2 EWRD Construction

Construction of the EWRD occurred sometime after the commencement of mining at Esperanza Pit (EPit), circa 1997. The EWRD appears to have infilled drainage lines that previously drained waters to the north. The EWRD is known to contain PAF waste rock and general waste deposits from the previous operator, Birla Mount Gordon, as described in the Esperanza WRD Waste Disposal Management Plan (BMG, 2014).

2.3 UEDD Construction and Repairs

The Upper Esperanza Diversion Dam (UEDD) was constructed as part of ongoing water management control measures at Birla's Mount Gordon mine during the 2009 dry season. During the 2009-2010 wet season, seepage was observed at the downstream toe of the dam. This was controlled by installation of a pump to return seepage to the diversion channel. Back analysis of seepage data in conjunction with onsite observations and knowledge of the construction methods indicated that the seepage was most likely passing through the dam foundations and not due to a fault in the GCL membrane (GHD, 2010).

The foundation investigations carried out by GHD found the underlying geology to be highly jointed, with many of the joints being randomly oriented. Recurring joints included those that struck and dipped along the bedding plane (i.e. approximately 10 to 30 degrees strike, and between 55- and 65-degrees west dip), as well as a set that struck in the same direction as the bedding plane, but dipped between 30 and 60 degrees east (GHD, 2010).

The UEDD repair works consisted of general earthworks and slope corrections, grout curtain installation, plinth construction, and installation of a HDPE liner. The objective of the works was to minimise seepage through the foundations using a grout curtain, and through the embankment (and therefore through the foundations on the downstream side of the plinth) by the use of a HDPE liner.

CCM are currently progressing preliminary investigations to determine the cause of apparent ingress of clean water through the UEDD to the north including dewatering of the UEDD while monitoring seepage at the v-notch weir and piezometric levels in the UEDD piezometer during dewatering, and inspection of the liner and liner – grout curtain connection.

The current design of TSF3 incorporates a number of controls to reduce seepage through the southern embankment including:

- Verification of the adequacy of the existing grout curtain via conformation grouting, and extension of the grout curtain to enable the centreline raise of the UEDD.
- Verification of the adequacy of the existing HDPE liner including inspection and testing, and where inadequate repair or replacement as appropriate.
- Decant pond remote from the UEDD embankment.
- Low permeability tailings deposited against the internal embankment.
- UEDD continued to be dewatered via pumping.
- Remote and convoluted drainage path from TSF3 to Gunpowder Creek.

2.4 TSF 3 Topography

The UEV runs roughly south-east / north-west and drains waters to the north toward E-Pit. The base of the UEV beneath the Upper UEDD occurs at approximately RL 287 mAHD and drops to RL 249 mAHD beneath the EWRD, falling at a grade of approximately 5%. Valley sides which form the abutments of the TSF3 and UEDD rise at approximately 37% and 20% [grade] respectively. Valley sides in the tributary lines either side of the UEV (denoted by blue arrows in Figure 2.4) have similar properties to the UEV. The topography in the UEV and adjacent valleys present difficulty for LV access and the ability to build access tracks.

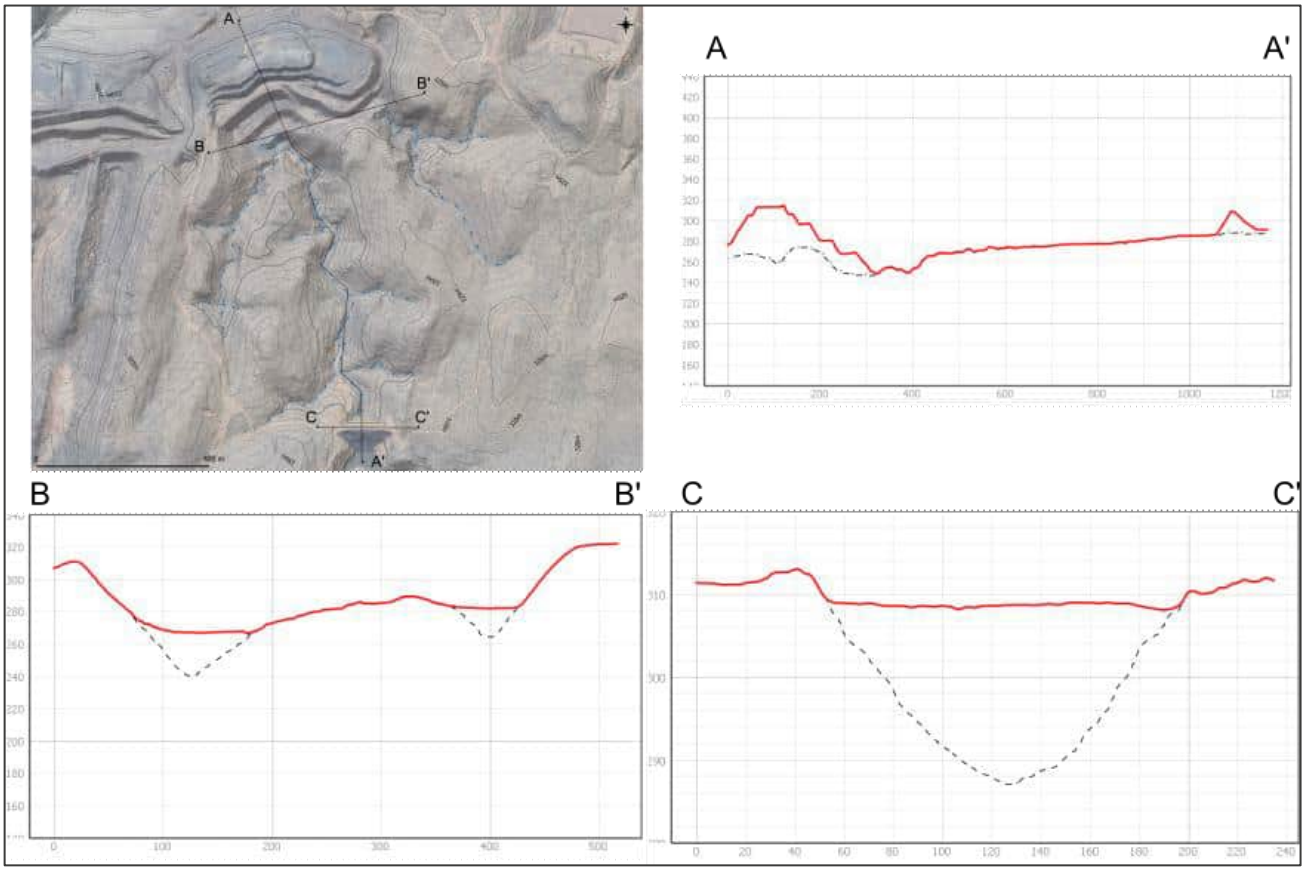


Figure 2.4: Topographical Sections Through The UEV

Note: Inferred ground surface beneath the embankments based on historical imagery are shown in dashed black above.

2.5 Regional Catchments and Drainage

The Project is in the Leichhardt River drainage sub-basin area in the Leichhardt Drainage Basin. The Leichhardt drainage basin has a total catchment area of 32,882.2 km1.

The Leichhardt River rises in the Selwyn Ranges, 40 kilometres southeast of Mount Isa. It flows in a northerly direction, through the city of Mount Isa and Lake Moondarra, before passing through Julius Dam. It is joined by its major tributary, Gunpowder Creek, 15 kilometres downstream of Kamilaroi homestead. Another major tributary, Fiery Creek, joins the river 70 kilometres downstream of Lorraine. The Alexandra River enters the river from the east, just below Floraville, before the Leichhardt River finally passes through a vast coastal plain and enters the Gulf of Carpentaria 30 kilometres northeast of Burketown2. The location of the project site in relation to the catchment is presented in Figure 2.5.

The Project is located east of Gunpowder Creek (Figure 2.6). Run-off from CCM flows into Gunpowder Creek, which also receives licensed releases of treated mine-affected water that enters the creek system at the EA-nominated release point (W1, Figure 2.6). Magazine Creek flows into Greenstone Creek, which flows into Gunpowder Creek downstream of the mining activities. Gunpowder Creek flows into Leichhardt River, approximately 100 km north-east of CCM.

[1] *https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/basin-leichhardt/*

[2] *http://www.bom.gov.au/qld/flood/brochures/leichhardt/leichhardt.pdf*

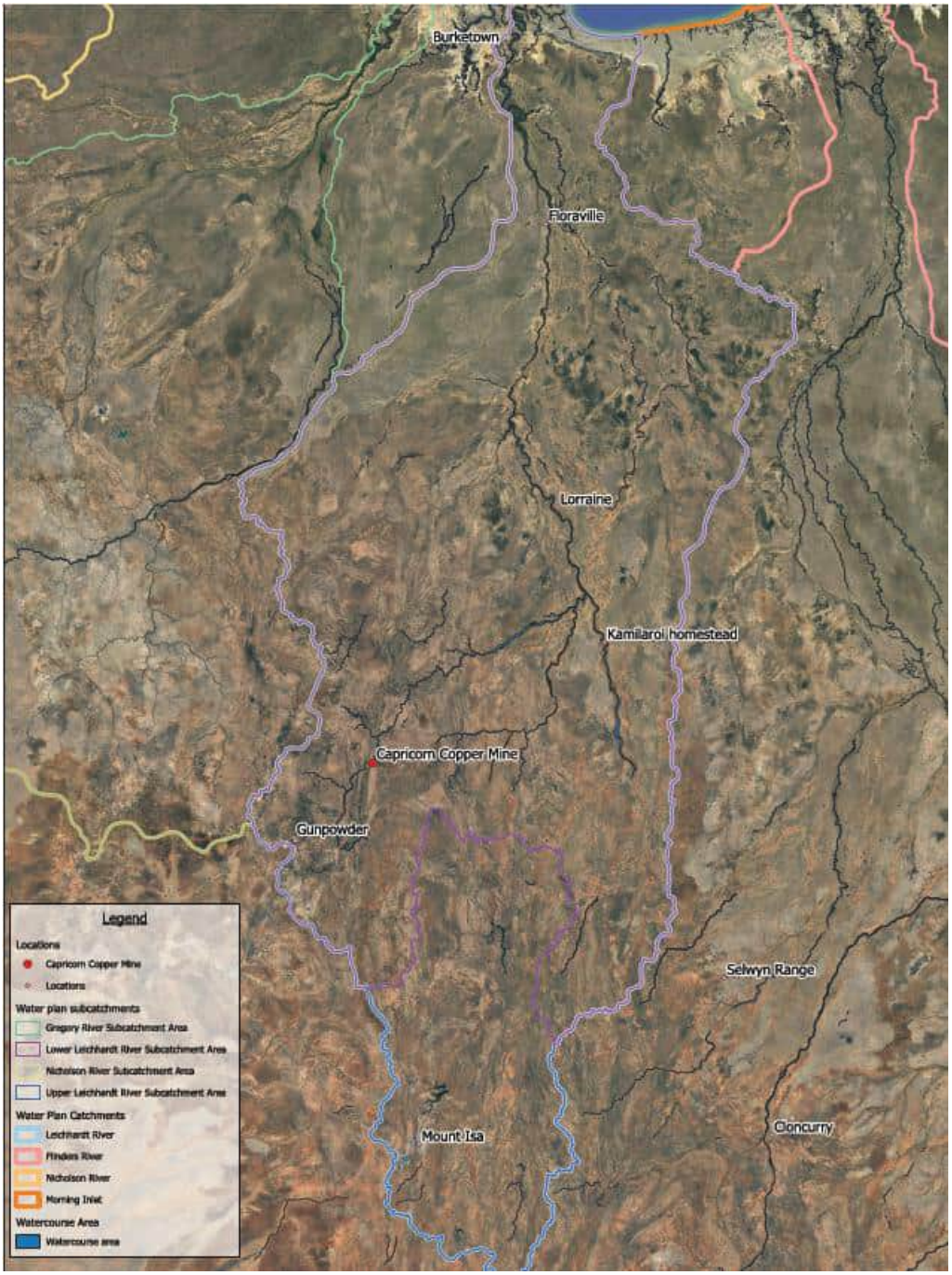


FIGURE 2.5: REGIONAL CATCHMENTS AND DRAINAGE

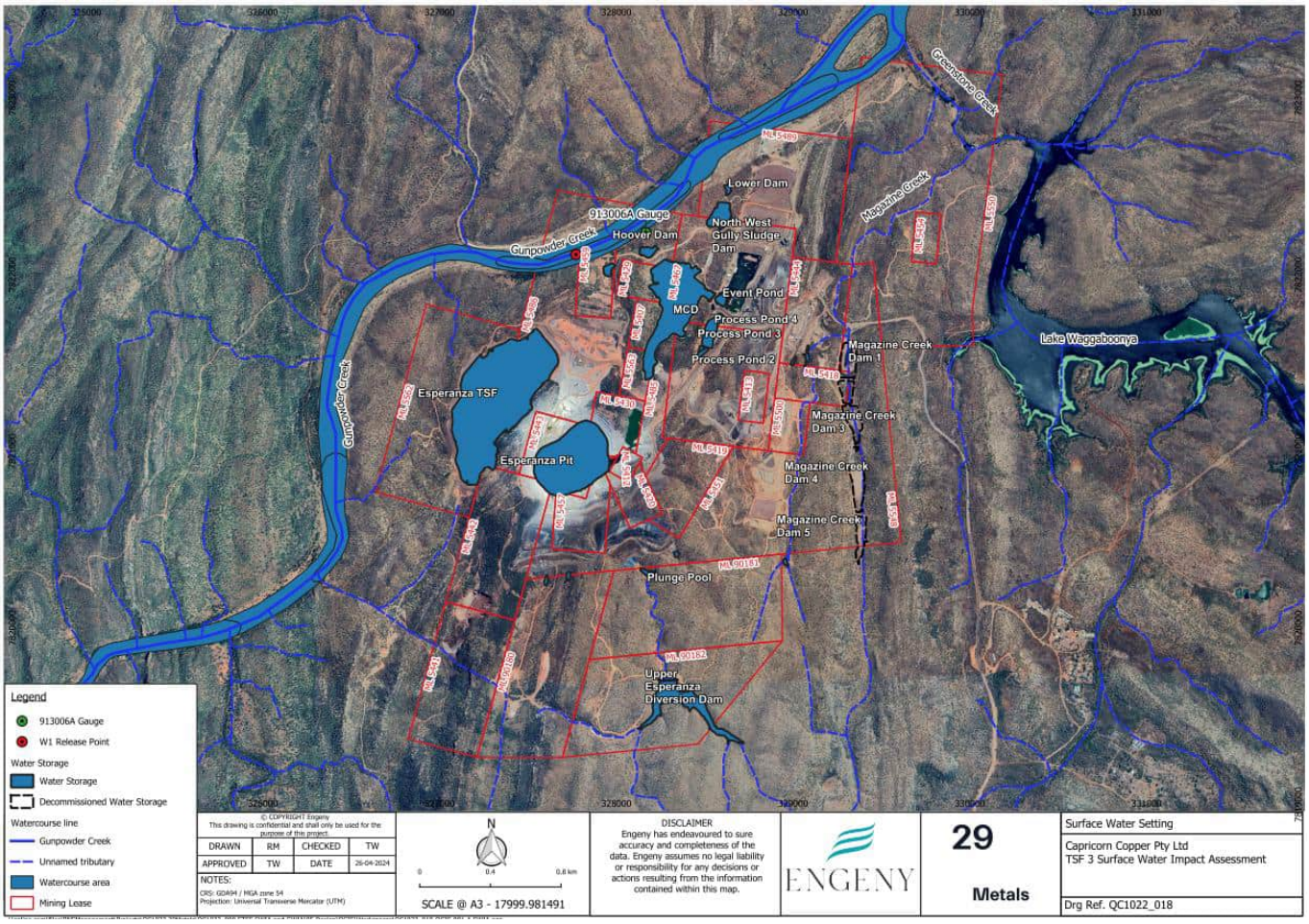


FIGURE 2.6: SURFACE WATER SETTING

2.5.1 Gunpowder Creek

Gunpowder Creek is the receiving waterway for any water discharged from site operations. Gunpowder Creek joins the Leichardt River approximately 100 km north-east of the mine and is located within the Leichardt River drainage sub-basin area in the Leichardt Drainage Basin.

Gunpowder Creek (adjacent to CCM) has been classified as a highly disturbed aquatic ecosystem and is considered moderately disturbed downstream of the mine (NRA 2022). Gunpowder Creek is utilised for primary industries (livestock drinking water) and mining activities. Recreational uses have been identified as visual recreational use and downstream of CCM, secondary recreation only e.g. boating and fishing with no swimming.

CCM generally drains to the north towards Mill Creek Dam (MCD) which provides for water supply to site operations and pumped releases to Gunpowder Creek. Seepage and overflows from MCD are intercepted by Hoover Dam and pumped back to EPit which is the main bulk water storage for mine affected water at CCM.

The authorised release point is located west of the Hoover Dam on Gunpowder Creek (W1 Release Point, shown in Figure 2.6), approximately 2 km upstream of the confluence between Gunpowder Creek and Greenstone Creek. Releases of treated mine affected water to Gunpowder Creek is only allowed in accordance with the conditions in Schedule C of the EA, or previously in accordance with Environmental Protection Order E100127175.

2.5.2 Greenstone Creek

Greenstone Creek is located to the east of CCM and has a confluence with Gunpowder Creek approximately 2km downstream of the authorised release point (refer to Figure 2.6 above). The Creek has been classified as a highly disturbed aquatic ecosystem utilised for primary industries (livestock drinking water), mining and visual recreational use (NRA 2022). Greenstone Creek is impounded by Greenstone Creek Dam (Lake Waggaboonya) which is located to the east of CCM and has a capacity of 14,000 ML. Lake Waggaboonya was constructed in the 1960s to supply raw water to CCM and other nearby by mining operations (Lady Annie mine, located approximately 25 km west of CCM).

2.5.3 Magazine Creek

Magazine Creek, a tributary of Greenstone Creek is located to the east of CCM and enters Greenstone Creek approximate 300m downstream of the Greenstone Creek Dam. The Creek is utilised for primary industries (livestock drinking water) and mining (NRA 2022). Magazine Creek previously contained five (5) stormwater ponds which retained stormwater following the wet season and was historically used to supply raw water to the mine. These ponds have since been decommissioned (refer to Figure 2.6), with no ongoing impoundment or pumping of water for use as raw water.

2.6 Climate

CCM is located within the grassland Köppen major climate zone and experiences hot humid summers, summer dominant rainfall and winter drought. Long term climate data for the site has been obtained from the Scientific Information for Landowners (SILO) climate database facility hosted by DETSI using a Data Drill extracted for the site location (Lat, Long -19.70 139.35 (decimal degrees)). The SILO climate data record produces 136 years of daily climatic data (1889-2025) at the site location based on interpolation of historical nearby weather station data. The following sections provide further description of rainfall, evaporation and temperature for the site.

2.6.1 Rainfall

CCM is in a region of North Queensland that can experience significant, cyclonically influenced rainfall events during summer and is predominantly dry in winter. Table 2.1 and Figure 2.7 below show monthly and annual rainfall for CCM:

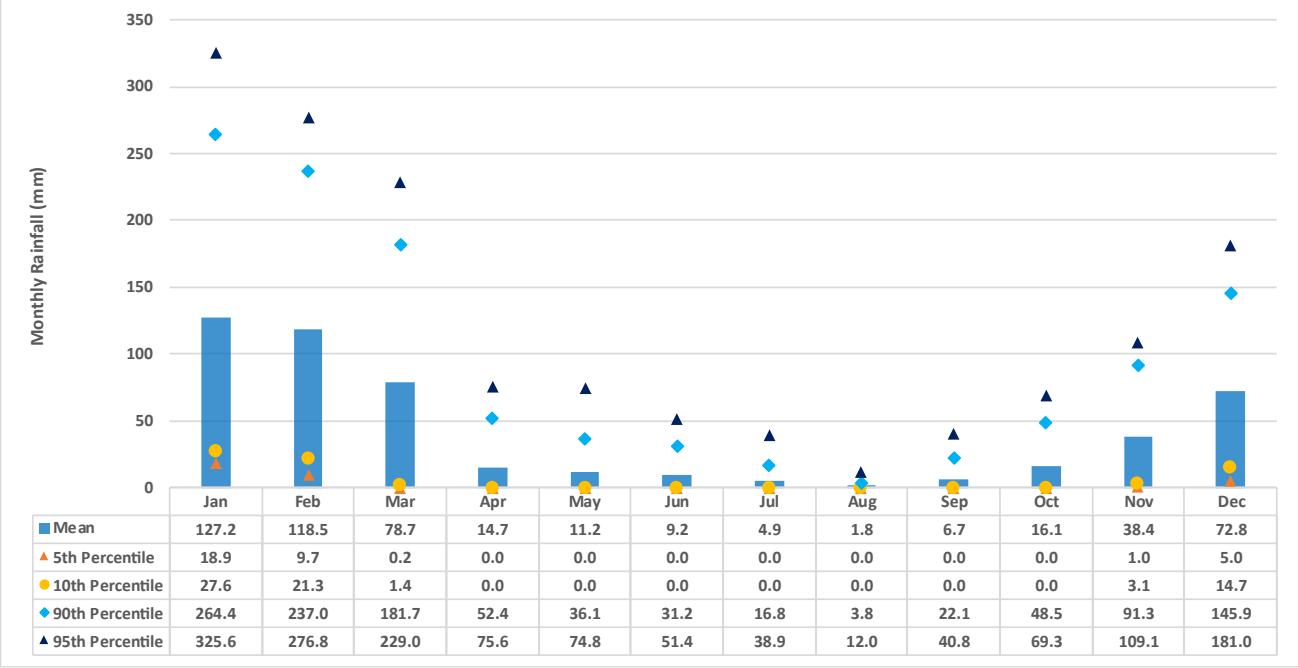
- Mean annual rainfall is 498.9 mm (Table 2.1) and subject to a strong seasonal distributed with 87% of the mean monthly rainfall occurring within the wet season months of November through March (Figure 2.7).
  - Mean monthly wet season rainfall ranges from 38.4 mm in November to 127.2 mm in January.

- A winter dry season extends from April through October where mean monthly rainfall ranges from 16.1 mm in October to 1.8 mm in August.
- From Table 2.1 annual rainfall is subject to significant variability indicating potential for:
  - prolonged drought – a 5% likelihood that annual rainfall will be 202 mm or less which represents only 40% of the mean annual total.
  - significant wet season rainfall – a 5% likelihood that annual rainfall will be 953 mm or more which is 191% of the mean annual total.
- Potential for significant wet season variability is similarly demonstrated in Figure 2.7 where there is significant variation from the mean. For example, the 5th percentile result for January is 18.9 mm (15% of the mean of 126.3 mm) and the 95th percentile result for January of 325.6 mm is 259% of the mean.

In summary, rainfall at CCM is subject to a strong seasonal distribution with a majority of rainfall occurring during a wet season extending from November through March. However, wet season rainfall is also likely to be subject to significant variability with potential for periods of extended drought and intense flooding rainfall.

TABLE 2.1: ANNUAL RAINFALL STATISTICS (SILO DATA DRILL, 1889-2025)

Statistic	Annual Rainfall (mm)
5th Percentile	202
10th Percentile	251
Median	460
Mean	498.9
90th Percentile	813
95th Percentile	**953**

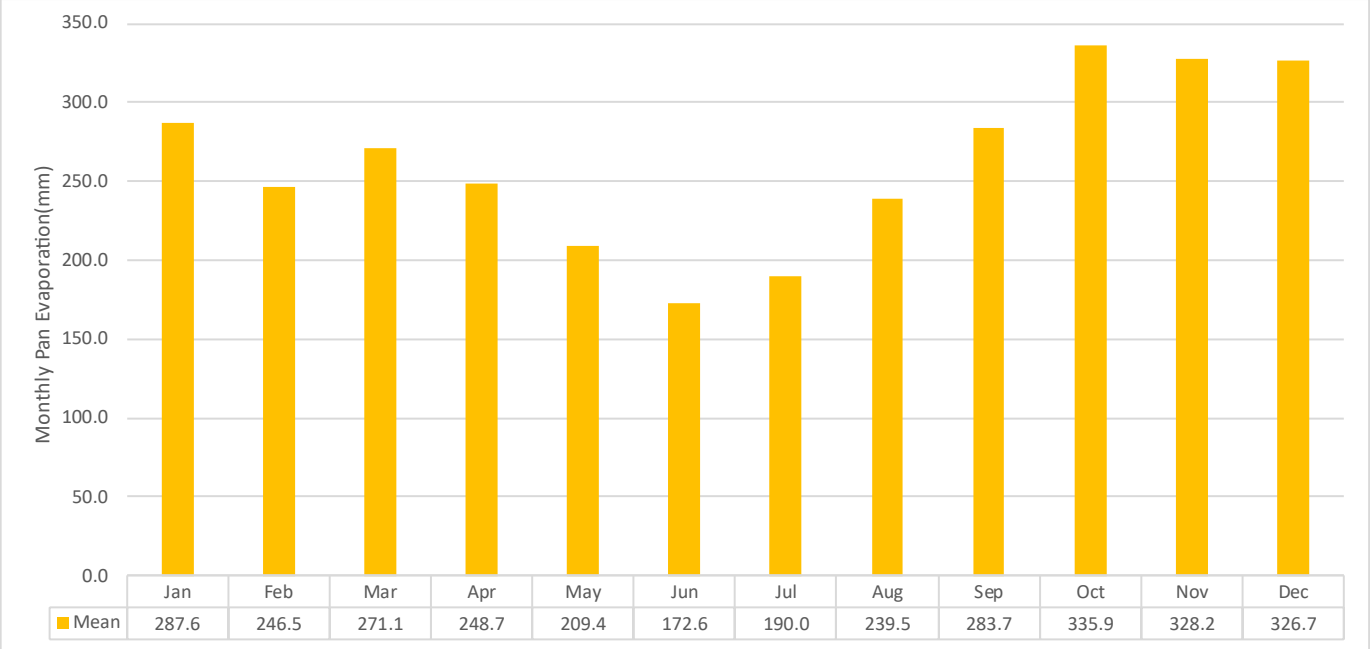


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	127.2	118.5	78.7	14.7	11.2	9.2	4.9	1.8	6.7	16.1	38.4	72.8
5th Percentile	18.9	9.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	5.0
10th Percentile	27.6	21.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	14.7
90th Percentile	264.4	237.0	181.7	52.4	36.1	31.2	16.8	3.8	22.1	48.5	91.3	145.9
95th Percentile	325.6	276.8	229.0	75.6	74.8	51.4	38.9	12.0	40.8	69.3	109.1	181.0

FIGURE 2.7: MONTHLY RAINFALL (SILO DATA DRILL, 1889-2025)

2.6.2 Evaporation

Figure 2.8 below shows mean monthly pan evaporation for CCM. From the figure it can be see that under average conditions evaporation is significantly in excess of mean rainfall (Figure 2.7). Mean monthly evaporation is seasonally distributed with rates highest from October through March and lowest from April through September.

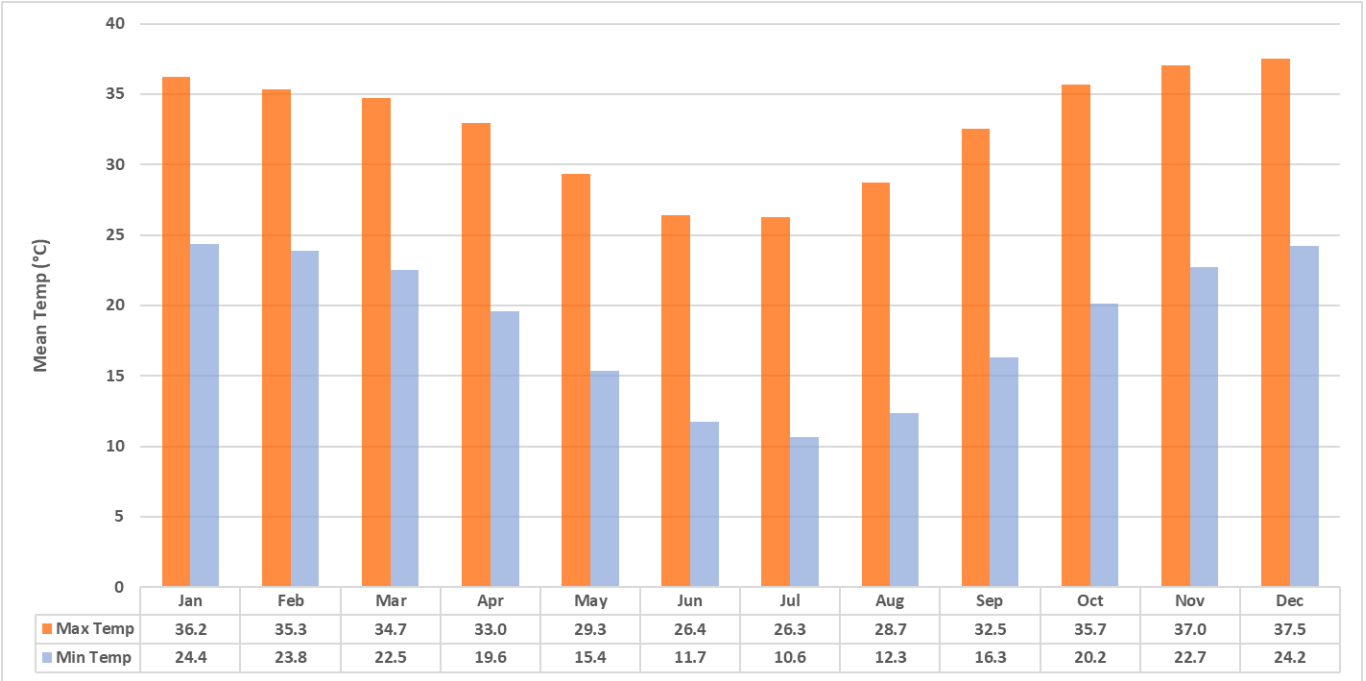


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	287.6	246.5	271.1	248.7	209.4	172.6	190.0	239.5	283.7	335.9	328.2	326.7

FIGURE 2.8: MONTHLY PAN EVAPORATION (SILO DATA DRILL, 1970-2024)

2.6.3 Temperature

Mean monthly maximum and minimum temperatures are shown below in Figure 2.9 and indicate an extended hot summer period where mean temperatures exceed 35°C from October through February and a mild winter where mean maximum temperature remain above 25° for all months. Mean minimum temperature ranges from a maximum of 24.4°C in January to a minimum of 10.6°C in July.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max Temp	36.2	35.3	34.7	33.0	29.3	26.4	26.3	28.7	32.5	35.7	37.0	37.5
Min Temp	24.4	23.8	22.5	19.6	15.4	11.7	10.6	12.3	16.3	20.2	22.7	24.2

FIGURE 2.9: MEAN MONTHLY TEMPERATURE (SILO DATA DRILL, 1970-2024)

2.7 Upper Esperanza Valley Geology

The Queensland detailed solid geological mapping indicates that the UEV is located within the Whitworth Quartzite, which is comprised of massive medium to coarse-grained feldspathic to quartzose sandstone, fine purple sandstone and mud flake conglomerate. The valley is covered with a thin layer of colluvium, with scree located on the upper slopes of the surrounding ridges (refer to Figure 2.10).

2.7.1 Geophysical Assessments

Interpretation of airborne geophysical datasets was completed by Southern Geoscience Consultants (SGC) in 2023 to identify structural settings, domains, and fault distribution. SGC used freely available [open source and State Government] aeromagnetic (AMAG), radiometric (RAD), and airborne EM (AEM) surveys to inform the geophysical interpretations against existing or known faults derived from the Geological Survey of Queensland (GSQ) 1:250,000 scale Camooweal and 1:100,000 scale Mammoth geology maps.

All faults identified by SGC consultants are presented in Figure 2.10 below. SGC noted that their structural interpretation of the magnetic data improves the understanding of the geological structures in the area, refines the geometry of certain known faults and potentially identifies local, subtle faults that may not have been previously recognised.

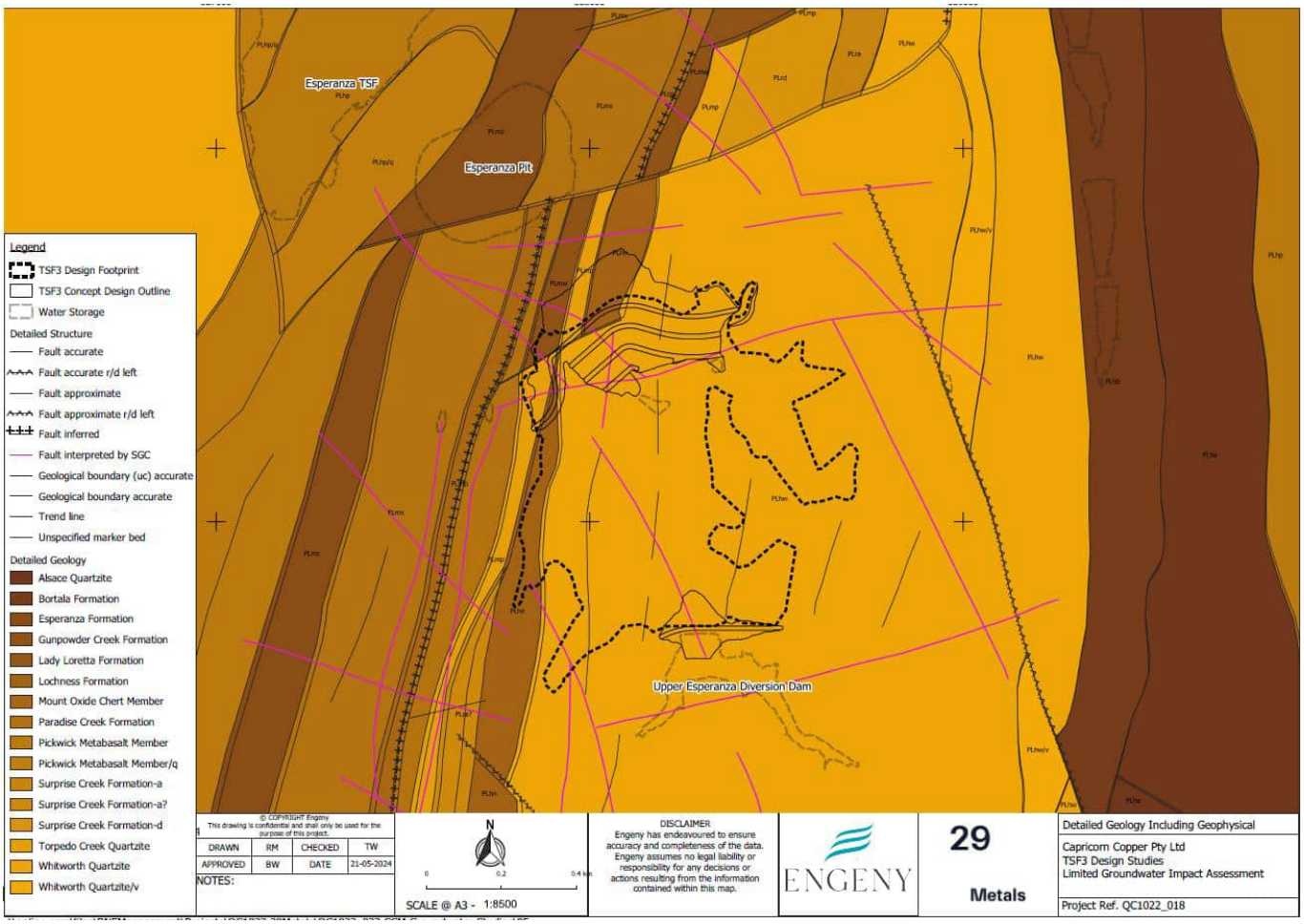


Figure 2.10: Detailed Geology Including SGC Geophysical Interpretation

2.8 Hydrogeology

Groundwater within the extent of the UEV is expected within the shallow perched aquifer system and the deep fractured rock aquifer system. The extent of the shallow aquifer is limited to the extent of the colluvium present on the valley floor and sides. Soils at the CCM site are thin over most areas including valley floors, this is expected to also occur within the extent of the UEV.

Groundwater within the colluvium is localised and recharged from direct rainfall. Due to the ridges surrounding the extent of the UEV, the shallow aquifer is not expected to be hydraulically connected to any other surficial aquifers at CCM (ATC Williams (2023a)and (2023b)). The UEV is located within the Whitworth Quartzite, which is considered to be a relatively impermeable aquitards due to re-crystallisation during regional metamorphism which resulted in little to no primary porosity in the quartzite (Engeny, 2025).

The hydraulic conductivity of the quartzite is low (in the order of 10-7 m/sec), with areas of higher permeability present in the secondary porosity associated with fractures (ATC Williams, 2023b). The near-surface zone of higher permeability in the fractured rock aquifer (associated with delaminating siltstones and shales) is not likely to be present due to the absence of any mapped siltstone or shale within the extent of the UEV (ATC Williams, 2023b). The recent geophysical assessment indicates the potential for unmapped faults to be present within the UEV (refer to Figure 2.10).

2.8.1 Groundwater Levels and Flow Direction

Five (5) groundwater monitoring bores have recently been installed in the area surrounding the proposed TSF3 footprint (GWMB78, GWMB79, GWMB80, GWMB81 and GWMB82). Bore installation details, including average standing water levels for the wells obtained between January and December 2024, are presented in Table 2.2.

Figure 2.11 presents inferred groundwater contours calculated from the average standing water levels obtained across the site between 23 February 2023 and 1 May 2024, inclusive of the newly installed bores (refer to Table 2.3Table 2.3). The direction of flow of groundwater is generally to the north. Groundwater levels mostly mimic a subdued version of the surface elevation. Elevated groundwater is noted surrounding GWMB21 and GWMB22 and at GWMB75.

Groundwater contours generated in the absence of groundwater observation data from the TSF3 footprint and using surface topography suggests that groundwater may flow to the west from TSF3. This is currently being tested with the development of the transient groundwater model and may require additional groundwater monitoring locations to be installed and monitored to confirm. A key assumption to the design of TSF3 is that all potential seepage from the TSF will be captured in EPit.

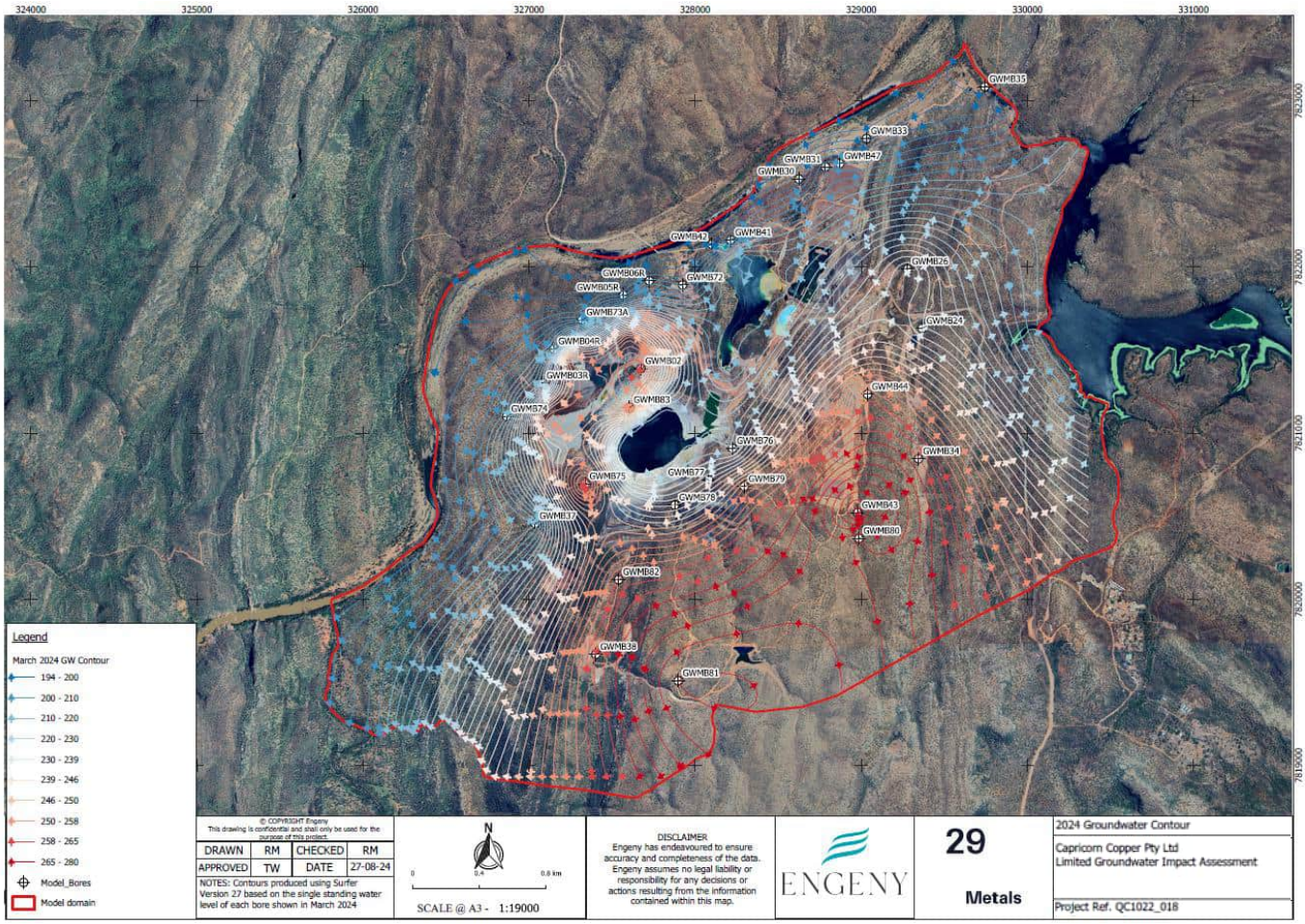


Figure 2.11: Groundwater Contours

TABLE 2.2: TSF3 GROUNDWATER MONITORING NETWORK

Bore ID	Date Installed	Easting (GDA 94)	Northing (GDA 94)	Depth	Screened Interval	SWL at installation	Surface RL (mAHD)	Average SWL (mbTOC)	RL at TOC (mAHD)	Average SWL (mAHD)
GWMB78	19/03/24	327877	7820567	42.5	36.5-42.5	Dry	288.05	48.815	288.905	240.09
GWMB79	01/02/24	328295.65	7820679.127	50	47-50	Dry	302.218	51.40	302.886	251.486
GWMB80	06/01/24	328986.223	7820366.201	48.41	38-47	46.7	303.664	33.849	304.593	270.744
GWMB81	01/02/24	327898.608	7819510.11	50	47-50	49.81	322.479	48.968	323.217	274.249
GWMB82	04/02/24	327539.28	7820118.859	21.7	18.5-21.5	6.53	271.933	14.839	272.538	257.699

TABLE 2.3: CCM GROUNDWATER MONITORING NETWORK

Bore ID	Purpose	Easting	Northing	Average SWL (mbTOC)	mAHD (toc)	SWL (mAHD)
GWMB02	Esperanza TSF	327673.066	7821388.541	18.660	278.695	260.035
GWMB03R	Esperanza TSF	327078	7821301	56.675	277.21	220.535
GWMB04R	Esperanza TSF	327150.055	7821506.754	61.180	288.017	226.837
GWMB05R	Esperanza TSF	327567.392	7821831.145	83.641	285.288	201.647
GWMB06R	Esperanza TSF	327723.676	7821917.018	88.126	291.575	203.448
GWMB08	Old TSF	328723.194	7822122.067	1.580	215.717	214.137
GWMB11	Old SX Tanks / Mill Creek Dam	328719.031	7822011.25	0.480	215.869	215.389

Bore ID	Purpose	Easting	Northing	Average SWL (mbTOC)	mAHD (toc)	SWL (mAHD)
GWMB12	Old SX Tanks / Mill Creek Dam	328664.925	7821976.584	0.320	215.134	214.814
GWMB13	Old SX Tanks / Mill Creek Dam	328656.04	7821925.297	0.580	215.179	214.599
GWMB18	North WRD	328026.512	7822135.585	2.752	199.926	197.174
GWMB19	North WRD	327956.192	7822064.673	3.890	201.713	197.823
GWMB21	Heap Leach Pads	328789.403	7820685.798	3.600	314.163	310.563
GWMB22	Heap Leach Pads	328914.288	7820651.477	4.751	311.614	306.863
GWMB24	Magazine Creek Raw Water Dams	329365.988	7821630.302	26.182	260.966	234.784
GWMB26	Heap Leach Pads / Magazine Creek	329279.06	7821987.436	7.401	244.421	237.02
GWMB30	Northwest Gully Dam	328624.361	7822529.577	5.029	202.485	197.456
GWMB31	Old TSF / Gunpowder Creek	328783.714	7822601.379	18.854	222.951	204.097
GWMB32	Old TSF / Gunpowder Creek	328884.085	7822707.373	4.360	199.078	194.718
GWMB33	Old TSF / Gunpowder Creek	329031.715	7822772.548	6.673	200.042	193.368
GWMB34	Magazine Creek Raw Water Dams	329345.095	7820845.594	8.380	266.396	258.016

Bore ID	Purpose	Easting	Northing	Average SWL (mbTOC)	mAHD (toc)	SWL (mAHD)
GWMB35	Gunpowder Creek	329744.666	7823085.36	3.435	196.607	193.172
GWMB37	Esperanza South	327037.005	7820456.172	20.161	231.73	211.569
GWMB38	Esperanza South	327402.509	7819668.854	3.604	262.909	259.304
GWMB41	North WRD / Mill Creek	328213.926	7822162.012	6.618	206.869	200.251
GWMB42	North WRD / Mill Creek	328100.284	7822136.061	3.467	201.51	198.043
GWMB43	Old Heap Leach / Magazine Creek	328977.235	7820520.98	16.184	296.185	280.001
GWMB44	Old Heap Leach / Magazine Creek	329037.779	7821233.901	27.146	285.833	258.687
GWMB45	Esperanza Pit	328143.204	7821159.397	1.690	227.462	225.772
GWMB47	Esperanza Pit	328871.816	7822621.668	19.050	223.223	204.173
GWMB48	Old TSF	328775.9	7822505	20.691	Surface RL 228.503	207.812
GWMB63	North WRD	327797.84	7821816.07	40.620	Surface RL 227.46	225.38
GWMB64	North WRD	328306	7821421	9.119	Surface RL 223.22	188.081
GWMB65	North WRD	327917.4	7822109	6.726	Surface RL 228.503	194.173
GWMB66	North WRD	327954.3	7822093	5.760	Surface RL 266	192.34
GWMB72	Esperanza TSF	327924.065	7821891.359	28.915	231.87	202.955

Bore ID	Purpose	Easting	Northing	Average SWL (mbTOC)	mAHD (toc)	SWL (mAHD)
GWMB73	Esperanza TSF	327315.515	7821675.018	84.235	286.612	202.377
GWMB74	Esperanza TSF / Gunpowder Creek	326866.272	7821100.527	18.570	232.473	213.903
GWMB75	Esperanza TSF / Gunpowder Creek	327337.62	7820694.87	70.260	334.266	264.006
GWMB76	Esperanza Pit	328225	7820908	13.460	241.46	228
GWMB77	Esperanza Pit	328082	7820717	28.250	266.518	238.268
GWMB78	Esperanza Pit / TSF3	327877	7820567	48.990	288.905	239.915
GWMB79	Esperanza Pit / TSF3	328295.65	7820679.127	50.847	302.886	252.039
GWMB80	TSF 3	328986.223	7820366.201	34.718	304.593	269.874
GWMB81	TSF 3	327898.608	7819510.11	48.670	323.217	274.547
GWMB82	TSF 3	327539.28	7820118.859	11.420	272.538	261.118
GWMB83	Esperanza Pit	327604	7821155	24.875	283.387	258.512

2.9 Waste Characteristics

Engeny (Engeny, 2024) presents a summary of the characterisation of waste at the CCM site and is summarised below. A total of 356,698 assays from 7,127 exploration bores, including sulfur content, have been obtained of the mined material to date, the results of which have been used to develop block models for all deposits across the site. Based on review of the block models, the following observations are relevant:

- The ESS underground generally has high sulphur (>5.0) in the majority of the assessed materials to be mined, increasing with depth.
- The MAM underground generally has high sulphur (>5.0) in the majority of the assessed materials to be mined, with increasing sulphur along the strike of the ore body.
- The GST underground mine generally has lower sulphur (<2.0), increasing with depth.
- The PTO underground mine generally has moderate sulphur (<3.0), increasing with depth.

Significant risk of AMD has been identified within:

- The waste rock across the site.
- Tailings which classify as PAF coupled with geochemical enrichment and an increased risk of leaching of these metals with a reduction in pH.

2.9.1 Waste Rock

Sampling and analysis of waste rock materials from three (3) bores drilled during geotechnical investigations surrounding the Esperanza Waste Rock Dump (EWRD) report:

- Total Sulfur between 0.1% and 15.6 % averaging 4.4 %.
- ANC between 3.3 and 35.0 kgH_2SO_4/t averaging 18.1 kgH_2SO_4/t.
- NAPP values between -15.6 and 477.0 kgH_2SO_4/t averaging 125.6 kgH_2SO_4/t.

Because of relatively little ANC and large NAP values, 3 samples from bores 2 and 5 classify as NAF, the remaining 14 samples classify as PAF.

- Total metals arsenic, cobalt, copper and manganese were enriched (GAI >3), in addition to elevated levels of cadmium, lead, mercury, nickel and zinc.
- Leachable metals include cobalt (between 0.1 and 11.7 mg/L), copper (between 0.1 and 263 mg/L), manganese (between 0.4 and 41.4 mg/L), nickel (between 0.4 and 0.6 mg/L) and zinc (between 0.4 and 8.8 mg/L).

2.9.2 Tailings

A summary of the relevant characteristics for tailings includes:

- The tailings generally comprise sandy silty clay with low to moderate plasticity. The USCS classification of the tailing would be silty-clay/clayey-silt.
- Tailings average settled density of 1.40 dmt/m^3.
- The permeability of the tailings is low, and with consolidation, tailings permeability decreases.

Past geochemical testing (Environmental Earth Scientists 2012, EMM 2015, GHD 2018) has shown that the historic tailings exhibit high concentrations of total S and sulfide-S, hence have a high Maximum Potential Acidity (MPA), with limited Acid Neutralising Capacity (ANC). This correlates to strongly positive Net Acid Production Potential (NAPP) values indicating a high probability of being acid-forming. This suggestion is further supported by low Net Acid Generation (NAG) pH test results.

Multi-element testing indicates that tailings samples are significantly enriched (Geochemical Abundance Indices (GAI) of 3 or greater) in silver (Ag), arsenic (As), bismuth, (Bi), copper (Cu), lead (Pb), antimony (Sb) and thallium (TI) (Environmental Earth Scientists, 2012).

2.9.2.1 Static Testing

Recent sampling and analysis of 11 composite (necessitated due to the sizes of the samples) samples of tailings (a mixture of crushed and pulverized and raw ESS, MAM, GST ores) obtained between December 2022 and November 2023. These tailings materials were confirmed to classify as PAF with:

- Total Sulfur between 3.4 % and 7.2 % averaging 5.0 %.
- ANC between 1.3 and 17.0 kgH_2SO_4/t averaging 10.8 kgH_2SO_4/t.
- NAPP values between 90 and 280 kgH_2SO_4/t averaging 144 kgH_2SO_4/t.
- Total metals arsenic, cobalt and copper were enriched (GAI >3), in addition to elevated levels of lead and nickel.
- Leachable metals under acidic conditions include aluminium (between 0.5 and 1.3 mg/L), cobalt (between 1.4 and 3.7 mg/L), copper (between 17.0 and 70.9 mg/L), manganese (between 1.4 and 2.0 mg/L), nickel (between 0.4 and 1.1 mg/L) and zinc (between 0.6 and 0.8 mg/L).
- Leachable metals under neutral conditions include aluminium (between 0.02 and 0.03 mg/L), arsenic (between 0.004 and 0.04 mg/L), cobalt (between 0.01 and 4.06 mg/L), copper (between 0.01 and 31.4 mg/L), manganese (between 0.03 and 2.32 mg/L), nickel (between 0.004 and 1.16 mg/L) and zinc (between 0.03 and 0.53 mg/L).

2.9.2.2 Kinetic Testing

A single composite kinetic leach column (KLC) is currently under analysis at ALS laboratory in Brisbane and is yet to be officially reported. Preliminary assessments and observations following 261 days of leach testing include (Figure 2.12):

- pH is rapidly decreasing as sulphate and EC increase indicating substantial mobility of solute elements. EC and sulphate are steadily decreasing over time as pH appears to stabilise at 2.27.
- Major cations, following an increased concentration, decreased to low levels, particularly in the cases of potassium and sodium. Magnesium shows a delayed rapid decrease in concentrations whereas calcium is increasing indicating high reactivity and mobility of calcium base elements.
- Sulphide oxidation ratios (SOR) following a steady decrease is increasing as the reactivity of sulphides are increasing.
- Metals (particularly copper, nickel and zinc) concentrations are observed to peak between day 90-120 of the kinetic leach program, with a rapid decline observed following the peak. Steady increases are noted for iron and arsenic associated with reduced pH between days 131 and 222, with a declining trend in the final three leaches from day 235 to 261.
- Dissolved oxygen remains relatively constant throughout the program, reported between 7.2 and 9.9 mg/L.

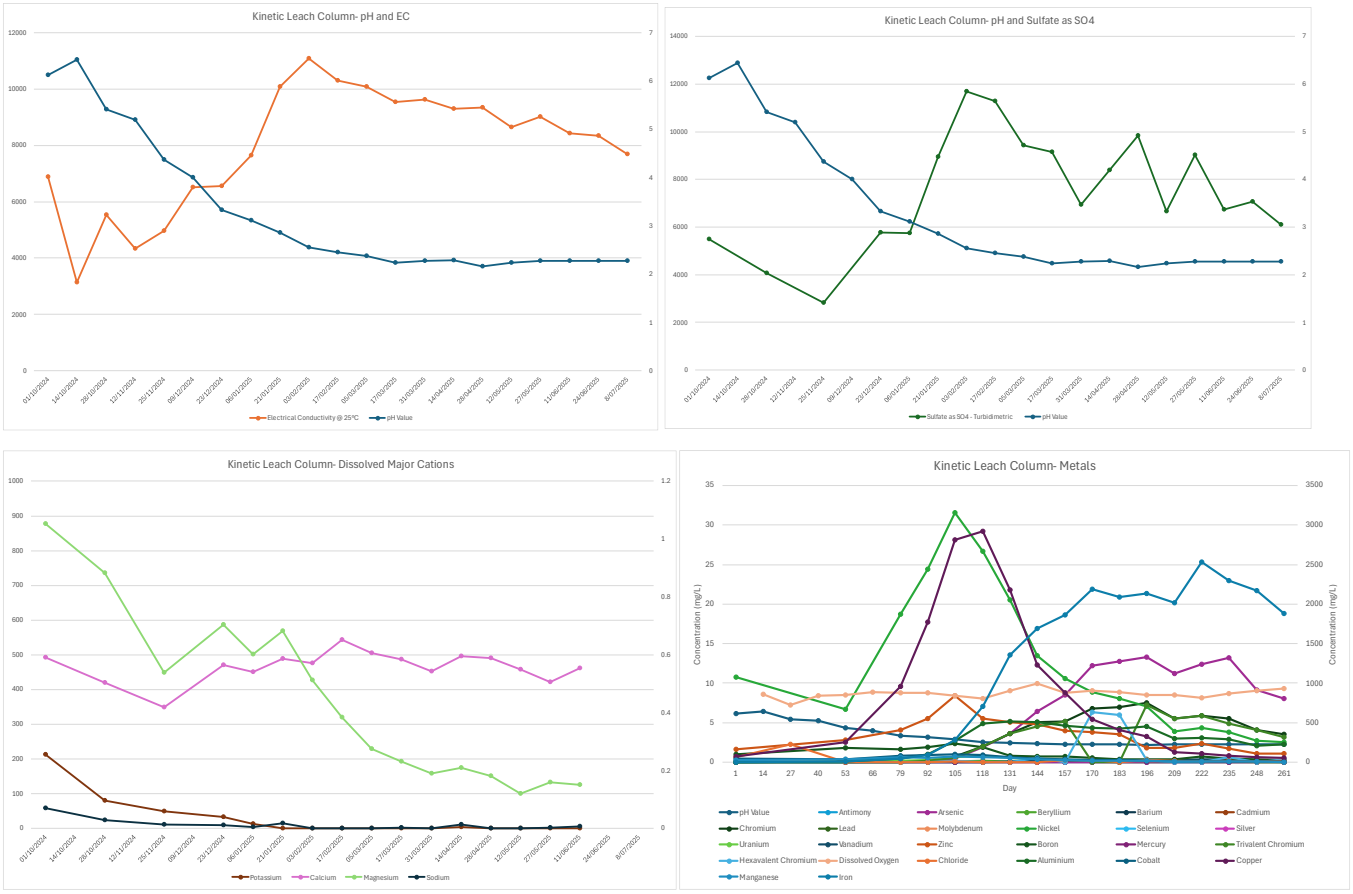


Figure 2.12: Tailings Kinetic Leach Column.

3. CLOSURE RISK ASSESSMENT

3.1 Methodology

The purpose of this closure risk assessment is to identify and mitigate risks that could compromise closure objectives, including geotechnical stability, contaminant control, environmental protection and long-term achievement of the PMLU. The scope covers the closure phase (estimated 2032–2037) and post-closure perpetuity, focusing on ~79 ha footprint plus ~57 ha ancillary areas. It draws on site-specific data from the Preliminary Design Report (QC1022_018-REP-005-1), geotechnical investigations, soils assessments (QC1022_020-REP-009-A), and stakeholder input (e.g., Kalkadoon Native Title Aboriginal Corporation).

This report follows the ISO 31000 process: establishing internal/external context, identifying risks through workshops and data reviews, analysing likelihood/consequence, evaluating against tolerance criteria, proposing treatments, and outlining monitoring/communication. Risks are qualitatively assessed using a likelihood-consequence matrix, with quantitative elements (e.g., seepage modeling) where data allows.

3.2 Risk Identification

The risk assessment process undertaken for this plan is designed to systematically identify, evaluate, and mitigate the environmental risks associated with the closure and rehabilitation of TSF3. The assessment aligns with the principles of AS/NZS ISO 31000:2018 Risk Management – Guidelines (Standards Australia, 2018) and focuses on minimising the potential for acid and metalliferous drainage (AMD) generation and associated environmental harm.

The consequence table (Table 3.1) defines the potential severity of environmental, operational, or regulatory impacts that could result from mine waste management risks. Consequence categories have been developed in accordance with AS/NZS ISO 31000:2018 Risk Management – Guidelines and reflect the significance of outcomes in relation to environmental harm, regulatory compliance, and closure objectives. These levels guide consistent risk evaluation across all identified hazards in the RMP.

TABLE 3.1: CONSEQUENCE DESCRIPTION

Consequence	Description
Insignificant (1)	No environmental or operational impact, no reporting required.
Minor (2)	Localised, reversible impact; minor cost/time overruns.
Moderate (3)	Localised environmental harm requires intervention or corrective work.
Major (4)	Significant impact; regulatory breach; major cost/time overrun.
Severe/Catastrophic (5)	Irreversible impact; major regulatory breach; long-term cost or loss of licence.

The likelihood table (Table 3.2) provides qualitative descriptors of how probable it is that a given risk scenario will occur during the life of mine or closure phases. Likelihood levels are consistent with the ISO 31000 framework and have been adapted to account for site-specific operational, geotechnical, and environmental conditions relevant to mine waste management. This enables a structured and transparent assessment of risk probability for each identified hazard.

TABLE 3.2:LIKELIHOOD DESCRIPTION

Likelihood	Description
Rare (1)	May occur only in exceptional circumstances.
Unlikely (2)	Could occur at some time but not expected.
Possible (3)	Might occur at some time.
Likely (4)	Will probably occur at some time.
Almost Certain (5)	Expected to occur in most circumstances.

The risk matrix table (Table 3.3) combines the assessed consequence and likelihood of each risk to derive an overall risk rating. This rating determines the priority for risk mitigation, monitoring, and management actions. The matrix is based on the AS/NZS ISO 31000:2018 risk management standard and provides a framework for ensuring that risks are managed in a way that protects the environment, meets regulatory requirements, and supports progressive rehabilitation and closure objectives.

TABLE 3.3: RISK DESCRIPTION

Risk Level	Interpretation
Low (1-3)	Acceptable with routine management.
Moderate (4-6)	Monitor and manage with controls.
High (8-12)	Requires detailed management planning.
Extreme (15-25)	Immediate action required; intolerable risk.

3.3 Risk Analysis and Quantification

Risks were evaluated by assessing the consequence of potential environmental impacts in combination with the likelihood of occurrence, producing a risk rating through a structured risk matrix.

The process incorporated input from geotechnical, geological, environmental, and operational specialists, with consideration of site-specific conditions and regulatory requirements. The approach reflects best practice guidance as outlined in the Preventing Acid and Metalliferous Drainage: Leading Practice Sustainable Development Program for the Mining Industry (Department of Industry, Tourism and Resources, 2007), the Queensland Environmental Protection Act 1994, and the Preparing a Progressive Rehabilitation and Closure Plan (PRCP) Guideline (Department of Environment and Science, 2019). Identified risks have been documented in the risk register shown in Table 3.4 with appropriate mitigation and forward works strategies proposed to ensure ongoing environmental protection and compliance.

TABLE 3.4: TSF3 RISK ANALYSIS

Risk ID	Risk Description	Likelihood	Consequence	Inherent Level	Controls/Treatment	Likelihood	Consequence	Residual Level
GEO-01	Geotechnical failure (e.g., embankment slope instability post-reshape)	Unlikely (2)	Major (4)	High (8)	Reshape to 1V:3H with benches; compact to 95% (AS 1289); monitor settlement (<50 mm/year).	Rare (1)	Moderate (3)	Low (3)
GEO-02	Subsidence from tailings consolidation	Possible (3)	Moderate (3)	High (9)	Allow post-deposition settlement; backfill voids with NAF fill; verify via piezometers.	Unlikely (2)	Insignificant (1)	Low (2)
ENV-01	Seepage/groundwater contamination (e.g., AMD from PAF tailings)	Possible (3)	Major (4)	High (12)	Install bi-directional covers (clay/geomembrane ≤10^{-7} m/s); extend grout curtain; monitor bores	Unlikely (2)	Moderate (3)	Moderate (6)
ENV-02	Surface erosion/failure (e.g., during wet seasons)	Likely (4)	Moderate (3)	High (12)	Rock armoring on embankment; drainage to EPit (PMF capacity per SWIA); revegetation for cover (>70% Year 1).	Possible (3)	Minor (2)	Moderate (6)
ENV-03	Vegetation failure (e.g., poor establishment due to low-fertility soils)	Possible (3)	Moderate (3)	High (9)	Ameliorate with lime/organics (per soils data: pH 3.98–4.95, OC 0.3–0.8%); use adapted seed mix; trials for >80% cover Year 5.	Unlikely (2)	Minor (2)	Moderate (4)
ENV-04	Biodiversity loss/GDE impacts	Unlikely (2)	Major (4)	High (8)	Ground-truth GDEs (per GWIA); no off-site seepage (SWIA confirmation); monitor riparian RE 1.3.7.	Unlikely (2)	Minor (2)	Moderate (4)
OPS-01	Delays in decommissioning (e.g., weather, material shortages)	Likely (4)	Minor (2)	High (8)	Contingency planning (e.g., off-lease borrow for 100–150k m^3 deficit); phased scheduling.	Possible (3)	Insignificant (1)	Low (3)

Risk ID	Risk Description	Likelihood	Consequence	Inherent Level	Controls/Treatment	Likelihood	Consequence	Residual Level
REG-01	Non-compliance with EA/PRCP (e.g., missed milestones)	Unlikely (2)	Major (4)	High (8)	Annual audits; adaptive management per ISO 31000.	Unlikely (2)	Minor (2)	Moderate (4)
SOC-01	Cultural heritage disturbance (e.g., during reshaping)	Rare (1)	Moderate (3)	Low (3)	Pre-works surveys (sites outside footprint per Preliminary Report); Kalkadoon monitoring.	Rare (1)	Moderate (3)	Low (3)

4. REHABILITATION PLANNING

4.1 Closure Objectives

The closure objectives for TSF3 are designed to ensure the facility achieves a safe, stable, and sustainable post-closure state that minimizes environmental risks and supports relinquishment of the site. These objectives are aligned with the requirements of Queensland's PRCP framework under the Environmental Protection Act 1994, which mandates the development of closure goals, rehabilitation milestones, and completion criteria to facilitate progressive certification and eventual site relinquishment. They also comply with the Australian National Committee on Large Dams (ANCOLD) Guidelines on Tailings Dams (2012, with 2019 Addendum), emphasizing risk-based design for long-term stability and environmental protection. Integration of findings from the Limited Surface Water Impact Assessment (SWIA) and Limited Groundwater Impact Assessment (GWIA) ensures that objectives address potential impacts to water resources, ecosystems, and groundwater-dependent features.

The objectives are structured to support the overall PRCP for CCM, incorporating stakeholder input (e.g., from DETSI, Kalkadoon Native Title Aboriginal Corporation, and local communities) and adaptive management based on monitoring data. They focus on transforming TSF3 into a self-sustaining landform compatible with the surrounding arid environment, while meeting Environmental Authority (EA) EMPL00911413 conditions for water quality, seepage control, and rehabilitation success.

Key closure objectives include:

- **Stability**: Achieve long-term geotechnical and geochemical stability to prevent structural failures, erosion, or contaminant mobilization. This includes designing the final landform with factors of safety ≥1.5 under static conditions and ≥1.0 under seismic loading (as per ANCOLD guidelines for "Significant" consequence category facilities). Geochemical stability will be ensured through cover systems that limit acid mine drainage (AMD) from potentially acid-forming (PAF) tailings and waste rock, informed by geochemical testing (e.g., acid-base accounting). PRCP compliance is met by incorporating progressive stability assessments during operations and post-closure, with milestones for certification of embankment integrity and landform reshaping.
- **Contaminant Control**: Minimize the release of contaminants to protect environmental values, limiting net percolation through the cover system to <1% of mean annual rainfall (~5 mm/year, based on site-specific climate data). Engineered barriers, such as compacted clay layers (hydraulic conductivity $\leq 10^{-7}$ m/s) or geomembranes, will restrict water infiltration and oxygen ingress, preventing AMD generation and metal leaching (e.g., Cu, Zn from tailings). Seepage controls (e.g., liners and grout curtains) will be retained to maintain low seepage rates (~0.05 m^3/day/m to EPit, as modeled in GWIA). This aligns with PRCP requirements for risk-based contaminant management and EA limits on groundwater triggers. Milestones include geochemical monitoring during progressive rehabilitation to confirm no off-site migration.
- **Water Management**: Restore natural drainage patterns and manage surface water and groundwater to prevent uncontrolled releases post-closure, ensuring compliance with the Environmental requirements. Surface runoff will be directed via the retained spillway to EPit, avoiding ponding and erosion, while MAW will be contained within the ICS to protect Gunpowder Creek. Groundwater flow alterations (e.g., potential divide from TSF3) will be mitigated through design adjustments informed by the 3D transient groundwater model.
- **Rehabilitation**: Establish a self-sustaining ecosystem (native bushland) through progressive and final rehabilitation, minimizing erosion, dust, and habitat disruption. Disturbed areas will be reshaped to stable slopes (1–3%), covered with an enhanced store-and-release cover system, and revegetated with native species adapted to the site's arid conditions and low-quality soils (Class VII land). Erosion controls (e.g., rock armoring) and dust suppression (e.g., early seeding) will be implemented. This supports PRCP goals for progressive rehabilitation.
- **Post-Mining Land Use (PMLU)**: Transition the site to native bushland, consistent with surrounding landforms and stakeholder expectations, excluding grazing or other intensive uses initially (e.g., 10–20 years) to allow vegetation establishment and ecosystem recovery. This PMLU is compatible with the site's low carrying capacity and existing land use.
- **Performance Criteria**: Define measurable indicators for closure success, including meeting EA water quality limits (e.g., no exceedances in groundwater bores per Schedule C, Table 6), achieving vegetation cover and species diversity within 5 years (monitored annually), and confirming no adverse impacts to EVs (e.g., aquatic ecosystems in Gunpowder Creek per REMP). Criteria also include seepage rates below modeled thresholds and landform stability via geotechnical inspections.
- **Sustainability**: Design for minimal long-term maintenance, with passive systems (e.g., self-sustaining covers) ensuring the site poses low residual risks in perpetuity. Relinquishment criteria will be demonstrated after 20 years of monitoring (e.g., no trigger exceedances, stable vegetation), allowing handover to the state or Traditional Owners. This meets PRCP sustainability principles, incorporating adaptive management from SWIA/GWIA data and stakeholder engagement for ongoing refinements.

4.2 Identification and Evaluation of PMLUs

In accordance with the PRCP Guideline and the EP Act, sections 126A–126D, a comprehensive evaluation of potential PMLUs for TSF3 has been conducted. The PRCP requires that all disturbed areas be rehabilitated to a stable, self-sustaining condition that supports a defined PMLU or, where rehabilitation would cause greater environmental harm, managed as a Non-Use Management Area (NUMA). PMLUs must be identified in the PRCP schedule, including a final site design map, and justified through a multi-criteria assessment (MCA) that considers viability, consistency with pre-mining conditions, environmental benefits, costs/benefits, constraints, risks, and stakeholder input. The evaluation ensures the PMLU is compatible with regulatory land use plans (e.g., Gulf Water Plan 2007), protects environmental values (EVs) such as aquatic ecosystems, livestock drinking water, and visual recreation (per SWIA), and aligns with community expectations (e.g., Kalkadoon Native Title Aboriginal Corporation feedback).

Potential PMLUs were identified based on:

- **Pre-Mining Land Use and Surrounding Context**: The UEV site was historically undisturbed native vegetation within the Whitworth Quartzite formation, supporting sparse grassland and shrubland ecosystems typical of the Mount Isa Inlier. Surrounding land uses include mining (CCM operations), low intensity grazing on adjacent pastoral leases, and natural conservation areas. No high-value agricultural or urban uses are present. The site's location is remote from Gunpowder Creek and sensitive receptors (e.g., mapped moderate-potential groundwater-dependent ecosystems (GDEs) per GWIA) support low-intensity PMLUs.
- **Regulatory and Planning Constraints**: Alignment with existing land outcome documents (e.g., EA EPML00911413) and regional plans (e.g., Gulf Water Plan 2007) prioritizes EVs such as aquatic ecosystems, livestock drinking water, and visual recreation. PMLUs must comply with EP Act section 111A (stable condition: safe, no harm, sustainable) and avoid conflicts with cultural heritage.

Options were evaluated using a MCA framework, adapted from the site selection MCA in the Preliminary Design Report (Section 3) and informed by ANCOLD Guidelines on Tailings Dams (2012, 2019 Addendum). Criteria were weighted considering the PRCP Guideline requirements, drawing on site-specific data including:

- **Viability and Sustainability**: Assessed via soil capability (low fertility, Class VII) geochemical stability (PAF risks from tailings) hydrological modeling, hydrogeological modelling and long-term self-sustenance without intervention (e.g., passive cover systems).
- **Consistency with Pre-Mining Use**: Preference for restoring native vegetation over new uses, aligning with pre-mining bushland and regional pastoral/grazing constraints (e.g., arid climate, low carrying capacity).
- **Environmental Values**: Maximize protection of EVs (e.g., no impact to aquatic ecosystems), minimize harm.
- **Costs and Benefits**: Economic analysis includes capital and ongoing costs, benefits encompass social (e.g., visual amenity for recreation, cultural values) and environmental (e.g., biodiversity enhancement).
- **Constraints and Risks**: Ensuring that residual risks are minimised upon closure and relinquishment.

The MCA scored options on a qualitative scale (Low/Medium/High viability), prioritizing those that were feasible and provided the most benefit.

Potential PMLUs considered:

- Native ecosystem restoration (bushland/shrubland).
- Low-intensity grazing.
- Non-use management (NUMA).
- Industrial retention (e.g., water storage).

A detailed analysis of possible PMLUs was undertaken, evaluating four options against the criteria. Native Bushland emerged as preferred, consistent with pre-mining ecosystem, low risks, and was feasible with a higher likelihood for success. Results are summarized in Table 4.1, with justifications tied to site data and PRCP compliance.

TABLE 4.1: PMLU ASSESSMENT SUMMARY

PMLU Option	Opportunities	Risks	Viability Score	Justification/Additional Notes
Native Bushland (Preferred PMLU)	• Aligns with pre-mining ecosystem and surrounding native vegetation, supporting PRCP consistency requirements. • Low maintenance and self-sustaining post-establishment, with passive cover systems (e.g., store-and-release) ensuring long-term stability without intervention (ANCOLD alignment). • Protects EVs such as aquatic ecosystems and GDEs, enhancing biodiversity. • Feasible with enhanced covers managing PAF risks and low soil quality. • Provides visual amenity for recreational and cultural/spiritual values (e.g., Kalkadoon heritage). • Negligible ongoing risks with seepage controls.	• Limited topsoil availability and quality (Class VII, low recovery value, requiring amelioration. • Potential delays in vegetation establishment due to arid climate and material shortages. • Requires monitoring for success and period of ongoing maintenance.	High	Selected as preferred due to site constraints, environmental benefits, reduces erosion, supports cover system and regulatory alignment (EP Act s.111A stable condition; Gulf Water Plan compatibility). Cost-effective, supports progressive certification (e.g., cover installation milestones) and relinquishment after 20 years.
Low-Intensity Grazing	• Potential economic benefit for landholders through pastoral use, aligning with regional practices (e.g., adjacent leases). • Could integrate with broader land management, providing minor social benefits (e.g., employment in monitoring). • Low infrastructure needs post-rehabilitation, with existing access tracks reusable.	• Incompatible with low soil capability and carrying capacity (Class VII land per topsoil assessment; negligible stocking rates due to poor fertility and aridity). • Risks from PAF materials (AMD affecting livestock health via contaminated water/soil. • Higher erosion potential from grazing, requiring exclusion fencing and ongoing management (conflicts with self-sustaining PRCP goal).	Low	Not recommended; site not suitable for cultivation or grazing (low productivity, PAF risks per geochemical data); better suited to non-intensive uses.
NUMA (No Rehabilitation)	• Avoids potential greater environmental harm from disturbing PAF materials during rehab. • Reduces short-term costs by minimizing earthworks and covers. • Allows focus on containment (e.g., ongoing monitoring of seepage to EPit).	• Requires long-term management • Needs PIE and qualified person report to justify • Conflicts with progressive rehabilitation and may not align with community expectations	Medium	Not suitable or consistent with stakeholder expectations.

PMLU Option	Opportunities	Risks	Viability Score	Justification/Additional Notes
Industrial Retention (e.g., Water Storage)	• Potential reuse for site water management or future mining (e.g., storing treated MAW per ICS). • Leverages existing infrastructure (e.g., liners, spillways for flood control).	• Inconsistent with closure goals (ongoing operational liability; not self-sustaining). • Increased seepage risks to EPit with no cover system. • Increase risks for stability and seepage. • Regulatory hurdles (EA amendments; not aligned with EVs like recreation per EPP). • Conflicts with PMLU no-harm post-surrender (EP Act).	Low	Incompatible with relinquishment (ongoing maintenance needed) and residual risk.

4.2.1 Final Landform

Upon finalisation of the preferred PMLU, the final landform design was undertaken. The overarching objective of the rehabilitation and closure of the TSF3 is to demonstrate that once closed, the site is able to be rehabilitated to a safe, stable, non-polluting condition which is suitable for its approved PMLU. To support this objective, the primary goals for the final landform design include:

- **Safety and Stability**: The landform must be geotechnically and erosionally stable.
- **Drainage and Ponding**: The design should achieve free-draining conditions and limit surface water ponding where possible.
- **Post-Mining Land Use**: The TSF landforms are to meet the requirements of its proposed PMLU of native bushland.
- **Compliance with Regulations**: The design must comply with legal and regulatory requirements set by relevant authorities (e.g., retained within the approved mining lease boundary, disturbance footprints, etc).

The proposed final landform inclusive of the rehabilitated TSFs are shown below in Figure 4.1.

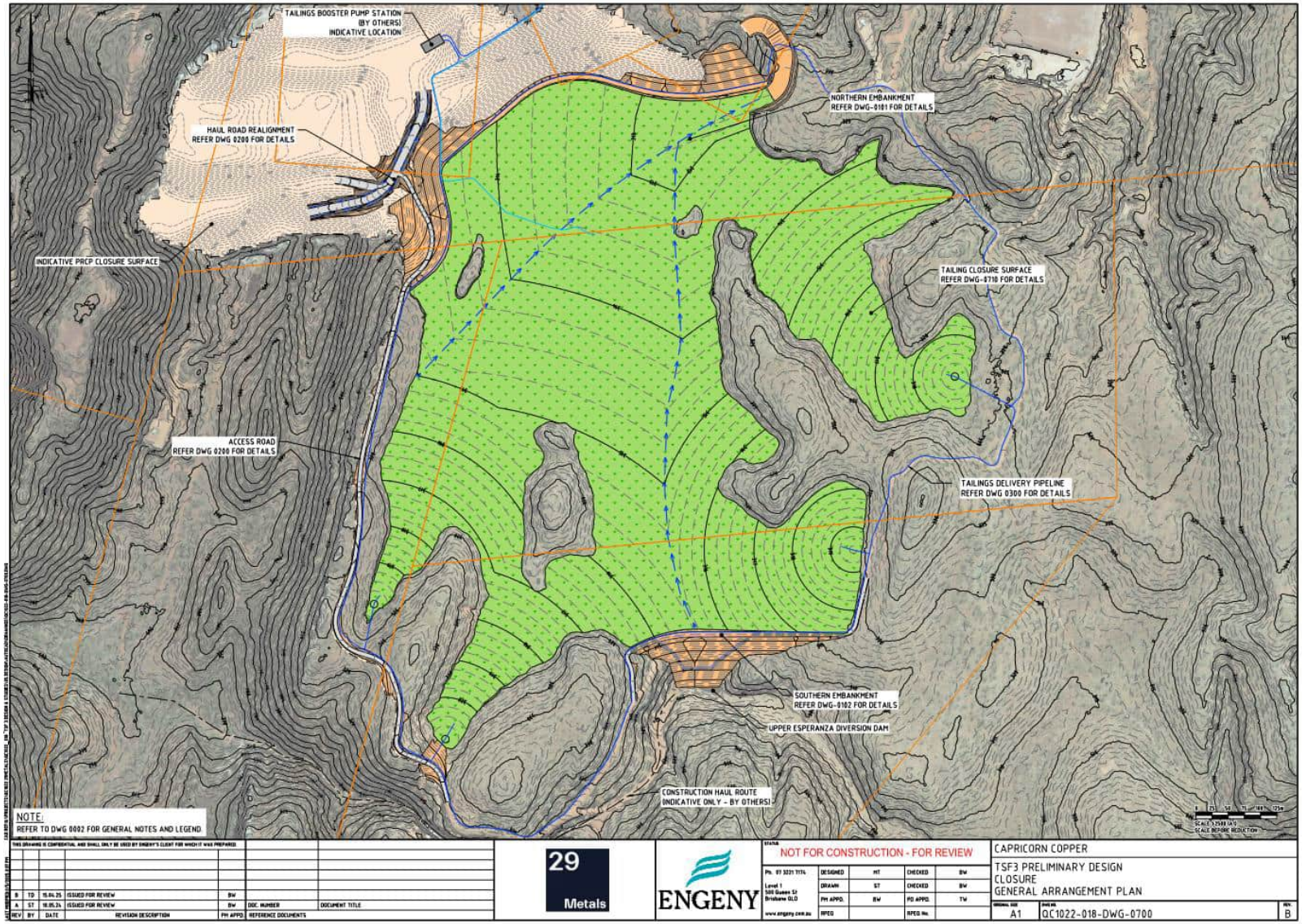


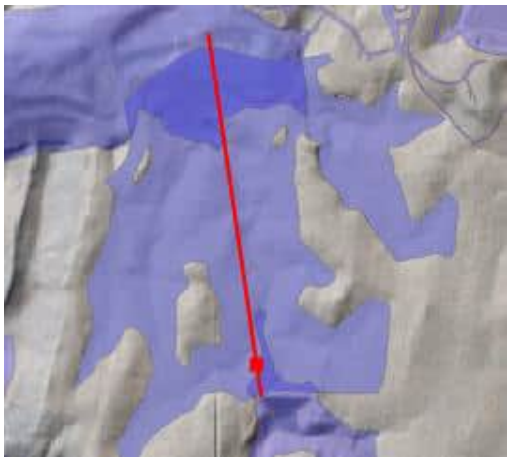
Figure 4.1: Final Landform Layout

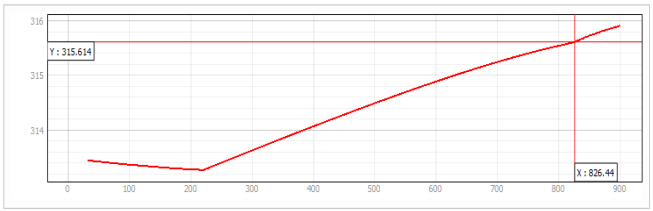
4.2.2 Erosional Stability

An assessment of the erosional stability of the final landforms at CCM has been undertaken and is documented in the CCM PRCP Landform Stability Assessment (QC1022_020-REP-003-1) (**Appendix A**).

The landform erosion assessment for TSF3 evaluates the long-term stability of the rehabilitated facility against erosional processes, ensuring compliance with PRCP requirements and industry best practice. This assessment focuses on achieving a stable condition by predicting average annual soil loss rates (t/ha/yr) over 100 years, using the Water Erosion Prediction Project (WEPP) model. Two representative profiles have been assessed in WEPP as shown in Figure 4.2

A – TSF3 SURFACE

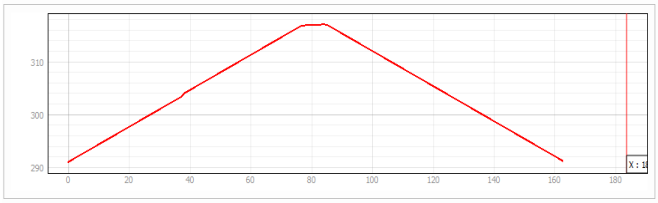




3m high, 687m long, ~1% gradient

B – TSF3 BATTER





26m high, 78m long, 33% gradient

FIGURE 4.2: CROSS SECTIONS AND PROFILE OF TSF3 FINAL LANDFORM

The soils data to inform the LEM model was based on the previously mapped unit Fz29 (Figure 4.3) form the UEV described as low hilly to hilly lands with extensive rock outcropping and steep slopes, along with narrow undulating valleys. The dominant soil type is a very shallow gravelly loam corresponding to Um1.43 using the Northcote classification. This soil is described as a uniform medium textured soil showing little, if any, pedological organisation beyond possibly some accumulation of organic matter in the surface 2.5-3cm, are non-calcareous, and are Group 5 in the value/chroma colour scheme.

The soil encountered on site from nine test pits were very uniform, and the material was sand to loamy sand, acidic, low nutrient, low organic matter, low CEC soil with an abundant stone content throughout. The main difference from the previously mapped information was the coarse texture, as opposed to medium texture.



Figure 4.3: Soil Mapping for UEV

The CCM LEM model was run over a simulation period of 100-years, to enable assessment of long-term stability of each final landform. To enable complete assessment of long-term stability of the landforms (in particular during high-risk periods such as vegetation establishment), model was run with scenarios of increasing vegetation cover.

WEPP provides a range of outputs dependent to the model parameters being investigated, which align with the selected measures within the basis of assessment and are compared against the selected Target Erosion Rates.

The slopes with the longest slope lengths and the highest elevations related to the TSF3 were selected (highest risk slopes). Slope length and height is widely viewed as a key driver in erosion.

4.2.2.1 Model Results

Analysis has been undertaken for the long-term erosion rates (100 years) in the prevailing climate to determine if the average and localised maximum adopted soil loss rates of 5 and 10 t/ha/yr respectively are met for the final landforms.

To assess average slope stability, the annual average soil loss rate calculated by WEPP (Table 4.2) was reviewed for the modelled landforms. The average target erosion is met at 0% vegetation cover.

TABLE 4.2: WEPP ANNUAL AVERAGE MEAN SOIL LOSS RATE (T/HA/YR) FOR 0/30/60% VEGETATION COVER.

Landform/Scenario ID	Landform Height, Horizontal Footprint, And Average Gradient	Average Soil Loss (t/ha/yr)
A: TSF3 Surface	3m high, 687m long, ~1% gradient	0.08
B: TSF3 Batter	26m high, 78m long, 33% gradient	1.79

The WEPP modelling results for the final landforms are representative of regional undisturbed landforms, given the CSIRO's National Assessment of Soil Erosion for representative slopes in the region ranged between 1-7t/ha/yr.

It's also important to note that the CSIRO estimates represent regional slopes that are much steeper than those simulated in the LEM report.

The relationship between increased rock cover and reduced erosion rates is well established which supports the findings of this assessment for a soil material high in rock content. Studies comparing rock clad rehabilitated slopes with conventionally topsoiled rehab showed that erosion was comparable to undisturbed sites. Rock cladding can not only reduce erosion but also help create conditions to establish native ecosystems.

4.2.3 Slope Stability

The stability of TSF3 has been designed in accordance with the Basis of Design (BOD) outlined in the Preliminary Design Report (QC1022_018-REP-005-1), ensuring compliance with ANCOLD guidelines for "Significant" consequence category facilities and PRCP requirements for long-term geotechnical integrity. During operations, TSF3 meets the following minimum factors of safety (FoS) under various loading conditions:

- Long-term drained: ≥1.5 (accounts for consolidated tailings and steady-state seepage).
- Short-term undrained (no potential loss of containment): ≥1.3 (for rapid loading scenarios, e.g., during deposition).
- Post-seismic: ≥1.0–1.2 (for earthquake-induced liquefaction risks, based on site-specific seismic assessments).

These criteria incorporate conservative assumptions, such as tailings densities from rheology testing (e.g., settled density increasing over time) and seepage controls (e.g., upstream geomembrane liner reducing flows by 84% per GWIA modelling).

Following closure, the stability of the rehabilitated landform is expected to increase beyond operational levels through progressive physical and hydrological changes, supporting closure objectives for a safe, stable condition with no ongoing risks to EVs. Key mechanisms include:

- **Tailings Consolidation**: The tailings will continue to settle and consolidate post-deposition, increasing settled density. This enhances shear strength and reduces liquefaction potential, improving FoS under drained and seismic conditions.
- **Reduced Infiltration**: Construction of the engineered store-and-release cover system (e.g., compacted clay or geomembrane with $K \leq 10^{-7}$ m/s) will limit net percolation to <1% of annual rainfall (~5 mm/year), minimizing phreatic surface buildup and pore pressures. This aligns with GWIA recommendations for seepage control, further elevating long-term drained FoS.
- **Free-Draining and Vegetated Surface**: The reshaped landform (1–3% slopes) will be free-draining via the retained spillway and diversion channels, preventing ponding and erosion. Established vegetation (e.g., native bushland mix per revegetation strategy) will enhance root reinforcement, evapotranspiration (~4x rainfall), and surface stability, reducing runoff and improving post-seismic FoS through natural armoring.

Geotechnical inspections and piezometer data will verify performance against rehabilitation milestones.

4.2.4 Regional Ecosystem Mapping

Regional ecosystem (RE) mapping provides understanding of the pre-mining vegetation communities and ecological attributes at the proposed TSF3 site, enabling informed decisions on PMLU selection and rehabilitation strategies. Detailed RE mapping and flora/fauna assessments were completed in 2023–2025 (KG Environmental 2025; Williams 2023), aligning with Queensland Herbarium standards and the Queensland Government's Regional Ecosystem Description Database (REDD). This mapping supports the PRCP by identifying benchmark

communities for rehabilitation success criteria, ensuring compatibility with EVs such as biodiversity. The assessment confirms that native bushland is the most viable PMLU for TSF3, given the site's arid, rocky, low-fertility conditions that naturally support sparse, resilient woodlands and grasslands.

Three REs were recorded and mapped within the TSF3 footprint (~79 ha) during dry and wet season surveys (KG Environmental 2025) as shown in Figure 4.4, reflecting a landscape dominated by low open eucalypt woodlands on hills and rocky outcrops, with limited riparian elements. The predominant RE is RE 1.7.7a, consistent with the site's skeletal soils (e.g., Um1.43/Rudosol) and arid conditions. The REs are all Least Concern under the Vegetation Management Act 1999 (VM Act) and have No Concern biodiversity status, indicating resilience suitable for bushland rehabilitation. Descriptions follow KG Environmental (2025) and Williams (2023):

- **RE 1.3.7b (Northern Swamp Box gully)**: Riparian woodland along ephemeral gullies, with Lophostemon grandiflorus (Northern Swamp Box) dominating the tree layer. Shrub layer includes scattered wattles (e.g., Acacia spp.); ground layer features sparse grasses and herbs. Weeds like Calotropis procera (Calotrope) are present along edges. This RE occupies minor drainage lines in the footprint, providing habitat for aquatic-dependent species but with low GDE potential due to ephemeral flows.
- **RE 1.7.7a (Small-fruited Ghost Gum hills)**: Predominant RE in the TSF3 footprint, characterised as open woodland on silcrete duricrust hills. Tree layer dominated by Corymbia capricornia (Small-fruited Ghost Gum), with occasional Eucalyptus leucophloia (Snappy Gum) near boundaries. Shrub layer includes wattles (e.g., Acacia hammondii, Acacia retivenea, Petalostigma quadriloculare) and whips (Triumfetta micrantha, Triumfetta plumigera). Ground layer dominated by Triodia pungens (Soft Spinifex), with scattered herbs (e.g., Bulbostylis barbata). A patch of near-threatened Ipomoea antonschmidii occurs along a track edge in the center (protected plant survey required per KG Environmental 2025). Weeds limited to scattered Calotropis procera along tracks.
- **RE 1.11.2a (Snappy Gum hills)**: Mapped along the western boundary and patchily on the eastern side, as open woodland on metamorphic hills. Tree layer dominated by Eucalyptus leucophloia, with Corymbia capricornia occasional. Shrub layer similar to RE 1.7.7a (wattles, Grevillea spp., Jacksonia lanicarica). Ground layer dominated by Triodia pungens, with annual grasses (e.g., Schizachyrium fragile, Erachne ciliata). No significant weeds beyond Calotropis procera on edges.

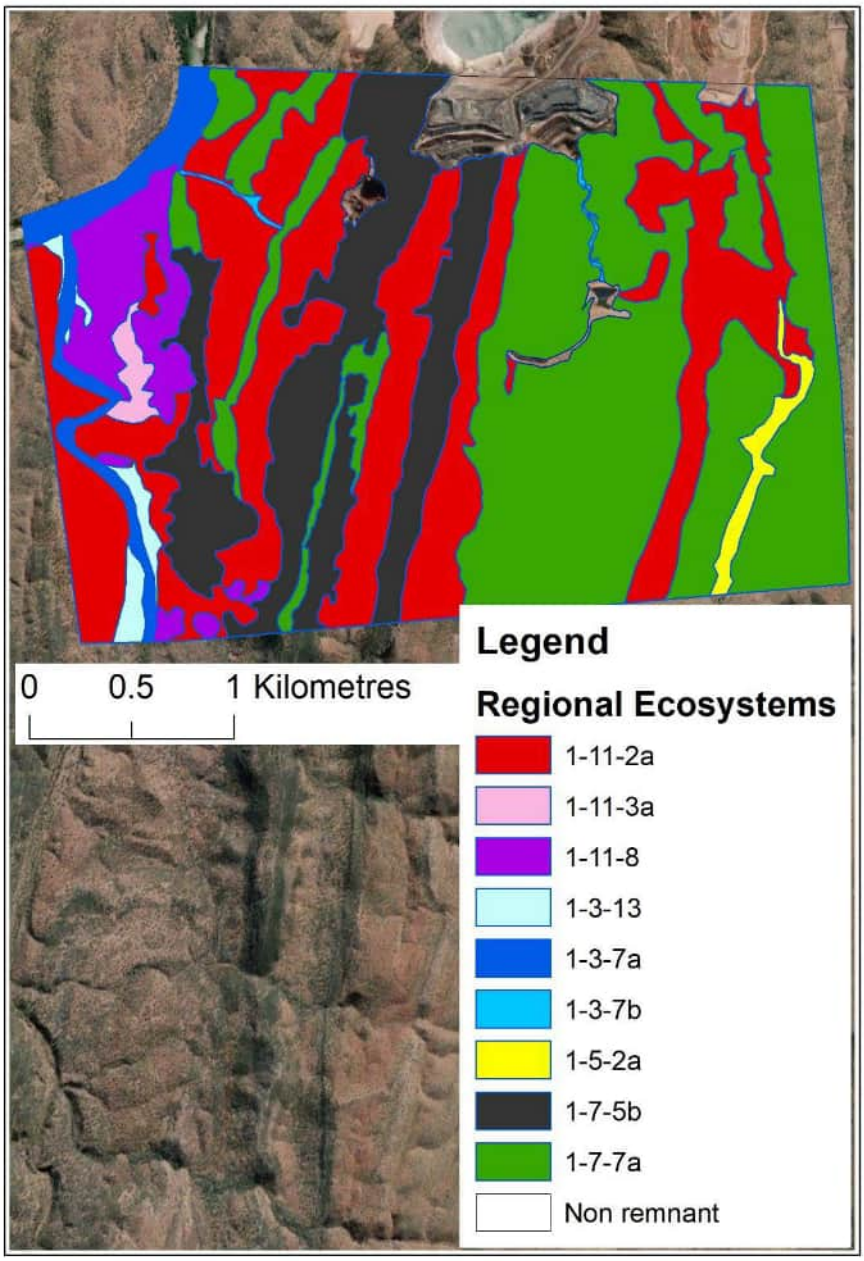


Figure 4.4: Regional Ecosystem Mapping (Williams, 2023)

This RE mapping directly supports the selection of native bushland as the preferred PMLU for TSF3. The dominant REs (1.7.7a and 1.11.2a) are adapted to low-fertility, rocky soils (Class VII land per soils report; skeletal with 10–50% coarse fragments) and arid conditions, mirroring the post-closure landform (reshaped 1–3% slopes, store-and-release cover). Their sparse, resilient vegetation (e.g., spinifex-dominated ground layer, drought-tolerant eucalypts) aligns with closure objectives for self-sustaining ecosystems, minimizing maintenance and erosion risks. Habitat features (low open woodlands, rocky walls, ephemeral creeks) indicate limited fauna refuge but suitability for bushland conservation.

The mapping informs rehabilitation strategies (Section 5), such as seed mixes emphasizing Triodia spp., Corymbia capricornia, and Acacia spp. (per revegetation table), and monitoring benchmarks (Section 7; e.g., >70% ground cover by Year 1 matching analogue REs).

4.3 Soils and Growth Media

4.3.1 Overview

This section provides a detailed summary of the soil conditions at TSF3 based on desktop assessments, field investigations, laboratory testing, and national datasets (Soil and Landscape Grid of Australia (SLGA) and Southern Gulf Water Resource Assessment (SGWRA)). The analysis draws from the CCM Soil Mapping Report (QC1022_020-REP-009-A, Engeny, 2025) and evaluates soil suitability for rehabilitation activities, such as topsoil stripping, stockpiling, and re-use in cover systems or revegetation. Soil is critical for achieving PRCP milestones. However, the site's low-productivity soils pose challenges, with limited potential for intensive uses like grazing and a focus on engineered analogues for closure covers.

Queensland soil mapping (1:100,000 scale) identifies dominant units as shallow gravelly loams (Um1.43/Rudosol under Australian Soil Classification: uniform medium-textured, non-calcareous, little pedological organization). Key units include:

- Fz25: Low hilly with rock outcrop; dominant Um1.43/K-Um1.43 (gravelly shallow loams); associated Um4.1/Um4.22 on slopes.
- Bz19: High sandstone plateaux; shallow gravelly sands (Uc1.23); associated Uc4.12/Uc4.22.
- Fz29: Hilly with rock outcrop; shallow gravelly loams (Um1.43/K-Um1.43); associated Um5.51 on slopes.
- Qa19: Undulating hilly; gravelly-surfaced loamy red duplex (Dr2.12).

4.3.2 Previous and Current Soil Assessments

Multiple investigations inform TSF3 soils:

- **Engeny, 2023**: TSF3 footprint (south-east EWRD, Snake Skin Valley): Extremely acidic (pH 3.98–4.5), coarse-textured skeletal soils (90% sand, loamy sand; rapid infiltration 60–120 mm/hr); very low nutrients (P <5–16 mg/kg; N 1.26–4.32 mg/kg); low ECEC (~1.5 meq/100g); non-saline/non-sodic. Classified Uc1.43/Rudosol/Lithosol; low fertility, Al toxicity risk.
- **GHD, 2019**: 51 test pits across borrow sites (e.g., Old Magazine Road: 40,000 m³ silty gravel, NAF; NWRD: 350,000 m³ gravelly silt/clay, suitable growth medium; Gilberts Quarry: 33,000 m³ gravelly sand, NAF). Volumes viable for covers/rehab.
- **EMM, 2015**: Potential quarries (e.g., North Rock Quarry: ample NAF borrow/clay; mildly acidic pH 4.5–6.5; low EC; non-dispersive; CEC Ca/Mg-dominated).
- **Engeny, 2024 (Ongoing)**: 6 borrow areas (e.g., Borrow Area 2: Arenite/dolomitic siltstone, viable clay ~30,000 m³ near Mill Creek; Borrow Area 6: Thin silty clay over gabbro). Confirms NAF but testing underway for closure suitability.

4.3.3 Soil Suitability

This evaluation focuses on the potential for soils to support the proposed PMLU (native bushland).

Soils at CCM are predominantly skeletal, stony, and derived from the Mt Isa land system, characterized by rugged, hilly terrain with extensive rock outcrops. Desktop data from sources like the Soil and Landscape Grid of Australia (SLGA) and Southern Gulf Water Resource Assessment (SGWRA) indicate rocky surfaces (coarse fragments >20-50% in top 30 cm), shallow depths (topsoil ~0.15-0.17 m, regolith 1.4-2 m), sand-dominated textures (sandy loam, ~70-77% sand), moderate acidity (pH CaCl2 5.8-6.0 at surface, trending to 6.0-6.5 at depth), low nutrient levels (e.g., available P 19-27 mg/kg at surface, declining sharply), and low effective cation exchange capacity (ECEC ~10-12 meq/100g). These properties support sparse vegetation typical of the region, such as Snappy Gum (Eucalyptus brevifolia) woodlands with spinifex understories.

Field sampling and laboratory results from nine locations in the TSF3 footprint confirm these characteristics, and are summarised as:

- **Physical Properties**: Soils are coarse-textured (90% sand fraction, loamy sand to coarse sand), with high gravel content (>2 mm fraction 7-31%) and extensive stone mantling, classifying as Uc1.43/Rudosol/Lithosol/Skeletal soils. Bulk density is moderate (1.4-1.5 g/cm³), but low water-holding capacity (rapid infiltration ~60-120 mm/hr) limits plant establishment. Rockiness and steep slopes (>20% in ~64% of areas) restrict machinery access for stripping/stockpiling, potentially limiting recoverable topsoil to ~36% of disturbed areas.
- **Chemical Properties**: Very strongly acidic (pH CaCl2 3.98-4.95, mean 4.5), non-saline (EC <0.02 dS/m), non-sodic (ESP <6%), with very low ECEC (1.36-1.72 cmol/kg) and nutrient status (organic C 0.3-0.8%, extractable N 1.26-4.32 mg/kg, available P <5-16 mg/kg, S 3.93-5.53

mg/kg). Trace elements are low (e.g., Cu 1.62-14.1 mg/kg, Zn <0.2-0.4 mg/kg), and exchangeable cations are imbalanced (Ca-dominant ~55-71%, Al 2-23%, Ca:Mg ratio 2.76-4.65).

The assessment links soil properties to target REs for the PMLU, emphasizing compatibility with arid, low-nutrient environments supporting sparse Snappy Gum (Eucalyptus brevifolia) woodlands and spinifex. Overall agricultural capability is low (Class VII; ALC C3; GLM SG11, carrying capacity 35–146 ha/AE), limiting intensive uses and favoring native restoration.

Key soil types/units, their properties, uses, limitations, and recommendations are summarized in Table 4.3, informed by site-specific data and analogue RE profiles.

TABLE 4.3: SUITABILITY OF SOILS FOR REHABILITATION

Soil Type/Unit	Key Physical Properties	Key Chemical Properties	Potential Uses in Rehabilitation	Limitations/Challenges	Recommendations for Use
Shallow Gravelly Loam (Um1.43/Rudosol) (Dominant in Fz25, Fz29; e.g., TSF3 footprint, slopes)	• Texture: Sandy loam (76–90% sand, uniform to depth). • Depth: Shallow topsoil (15–17 mm; regolith 1.4–2 m). • Structure: Skeletal, stone-mantled; common-many coarse fragments (10–50% gravel/cobbles). • Infiltration: Rapid (60–120 mm/hr); low water-holding (50–75 mm PAWC/1.2 m).	• pH: Strongly–very strongly acidic (3.98–4.5). • Salinity/Sodicity: Non-saline (low EC <0.02 dS/m); non-sodic (ESP <6%). • Nutrients: Very low (P 5–16 mg/kg; N 1–4 mg/kg; trace elements below medium). • OC: Low (0.3–0.8%). • CEC: Very low (1.4–1.7 meq/100g); Ca-dominant (~60%). • Geochem: NAF dominant; low AMD risk if covered.	• Growth media in covers (e.g., capillary break/drainage layer). • Surface preparation for revegetation (with amendments). • Opportunistic topsoil for native bushland PMLU.	• Low fertility/nutrient retention; acidity (Al toxicity). • Erodibility on slopes (high fragments); poor rooting depth. • Limited volume (thin/shallow); overestimation in national data (SLGA).	• Amend with lime (pH), organics (CEC/OC), nutrients for revegetation. • Screen for gravel in covers; trials for performance. • More sampling for depth variability; stockpile carefully to avoid contamination.
Gravelly Shallow Sands (Uc1.23/Uc4.12) (e.g., Bz19 plateaux, borrow sites like Gilberts Quarry)	• Texture: Gravelly sands (high gravel content; breaks down to silt/clay in testing). • Depth: Very shallow (<30 cm); extensive rock outcrop. • Structure: Non-dispersive (Emerson 4–6); high gravel throughout. • Bulk Density: 1.4–1.5 g/cm³ (uniform).	• pH: Mildly acidic (4.5–6.5 per borrow tests). • Salinity: Very low EC; non-saline. • Nutrients: Low (similar to loams; NAF). • CEC: Ca/Mg-dominated; suitable without toxicity. • Geochem: NAF; non-dispersive.	• Capillary break/bridging layer in covers. • Growth medium with screening/amendments. • Erosion control (gravel aids stability).	• High gravel reduces trafficability; low water-holding. • Limited fines for compaction; potential dispersion if unscreened. • Volume variability (e.g., 33,000 m³ at Gilberts; deficit overall).	• Screen to separate fines for clay use; blend with organics. • Geochem testing for all borrow; integrate with NWRD sources (350,000 m³). • Trials for cover drainage performance.
Gravelly-Surfaced Duplex (Dr2.12/Dr2.13) (e.g., Qa19 lower slopes; NWRD borrow)	• Texture: Loamy red duplex (gravelly surface; silt/clay subsoil). • Depth: Shallow–moderate (up to 4.3 m in test pits).	• pH: Acidic (site-specific low). • Salinity/Sodicity: Non-saline/non-sodic.	• Low-permeability layer in covers (clay content). • Topsoil/growth medium (with amendments).	• Gravelly surface crusting; acidity limits uptake. • Erodibility on slopes; variable depth.	• Ameliorate for pH/nutrients; compact for barriers (≤10^{-7} m/s).

Soil Type/Unit	Key Physical Properties	Key Chemical Properties	Potential Uses in Rehabilitation	Limitations/Challenges	Recommendations for Use
	• Structure: Gravelly silt/clay with sand; cemented clay breaks down. • Infiltration: Moderate; non-dispersive.	• Nutrients: Low; NAF suitable for covers. • CEC: Moderate; stable ratios. • Geochem: Low AMD; suitable growth medium.	• Suitable for revegetation base.	• Borrow deficit (100–150k m^3 overall).	• Blend with sands for drainage; additional off-lease if needed. • Monitor for dispersion in wet conditions.
Colluvium/Alluvium (Silty Gravel/Clay) (e.g., Valley floors, borrow like Old Magazine Road)	• Texture: Silty gravel/clay (breaks to fines); colluvial mantles. • Depth: Thin (~1 m over dolerite; up to 2.7 m alluvium). • Structure: Angular gravel; medium plasticity. • Bulk Density: ~1.4 g/cm^3.	• pH: Strongly acidic (~4). - Salinity: Non-saline. - Nutrients: Very low (P/N low). • CEC: Low (~1.5 meq/100g). • Geochem: NAF/PAF variable (e.g., low-capacity PAF in some).	• Clay for barrier layers (reduced permeability). • Growth medium if amended/stockpiled. • Suitable for water management (e.g., liners).	• Thin/limited volume (e.g., 210,000 m^3 at Airport; PAF in some). • Acidity/toxicity; low fertility. • Dispersion risk if sodic (though non-dispersive per tests).	• Test for PAF; amend heavily (lime/organics). • Stockpile from viable areas (e.g., 40,000 m^3 Magazine Road). • Use in engineered covers; trials for PMLU support.
Overall Site Potential	• Rocky/skeletal; sandy loam dominant; low depth. • High erosion on slopes; rapid drainage.	• Acidic (3.98–6.5); low nutrients/OC/CEC. • NAF mostly; low salinity/sodicity.	• Engineered covers (capillary/barrier layers). • Revegetation with natives adapted to conditions. • Opportunistic topsoil for bushland PMLU.	• Low agricultural capability (Class VII; ALC C3; GLM SG11 low carrying ~4–19 head/650 ha). • Data gaps (SLGA overestimates fertility); material shortages. • PAF/erosion risks limit uses.	• Expand sampling (subsurface, borrow); trials for amendments/covers. • Focus on bushland PMLU; geomembranes if clay scarce. • Monitor integration with GWIA/SWIA for no-harm.

Local soils are moderately suitable for native bushland PMLUs without significant amendment, as they mirror the skeletal, low-fertility conditions supporting target REs (e.g., sparse Snappy Gum/Spinifex communities). Rockiness provides erosion resistance, and low nutrient levels favor hardy natives over invasives. However, acidity and low ECEC may limit establishment; trials recommend pH adjustment (e.g., lime addition) and organic amendments to achieve >70% vegetation cover by Year 1 and 80-90% by Year 5, per rehabilitation milestones. Borrow sources like North Waste Rock Dump (NAF gravelly silt/clay) or Gilberts Quarry (NAF gravelly sand) can supplement limited topsoil (~40,000-350,000 m^3 available).

CCM soils pose challenges for rehabilitation due to acidity, rockiness, and low fertility, but are compatible with low-intensity PMLUs including the proposed PMLU of native bushland. Agricultural capability is limited (Class VII/C3), precluding intensive uses.

5. REHABILITATION STRATEGY

This specification provides detailed technical requirements, procedures, materials, quality assurance/quality control (QA/QC) measures, and monitoring for undertaking the specific closure steps at TSF3. It ensures compliance with the PRCP Guideline (ESR/2019/4963, Version 1.01, DESI, 2019), EA, ANCOLD Guidelines on Tailings Dams (2012, with 2019 Addendum), and site-specific assessments from the Preliminary Design Report (QC1022_018-REP-005-1), Limited Groundwater Impact Assessment (GWIA; QC1022_018-REP-004-1), and Limited Surface Water Impact Assessment (SWIA; QC1022_018-REP-003-2). All activities must be certified by appropriately qualified people and align with AS ISO 31000:2018 for risk management, incorporating stakeholder input (e.g., Kalkadoon Native Title Aboriginal Corporation) and adaptive measures based on monitoring.

Closure activities commence post-deposition cessation (estimated 2032) and span 4–5 years, divided into five sequential steps:

- Decommissioning.
- Landform Reshaping and Stabilization.
- Cover System Installation.
- Revegetation.
- Monitoring and maintenance.

A detailed summary of each phase is provided below.

5.1 Decommissioning

Decommissioning is the initial phase of TSF3 closure, transitioning the facility from operational to inactive status while ensuring immediate risks are mitigated and the site is prepared for subsequent rehabilitation steps. It addresses potential hazards identified in site assessments, such as ponding leading to seepage and erosion from exposed surfaces. Activities will be overseen by an Appropriately Qualified Person (AQP) and integrated with stakeholder consultations. This is expected to take 3–6 months post-deposition cessation allowing for tailings settlement and weather-dependent access.

The primary objectives are to cease all operational activities, safely remove or secure infrastructure, and implement interim controls to prevent environmental harm or safety risks during the transition to reshaping. This includes dewatering the decant pond, dismantling non-essential structures, and stabilizing exposed areas to avoid immediate issues like uncontrolled seepage, dust generation, or erosion. No active hazards (e.g., ponding >1 m depth, unstable embankments) must remain, with the site assessed as safe for heavy machinery access in later phases. The scope excludes final landform works but ensures compatibility (e.g., preserving grout curtains/liners for bi-directional seepage control per Preliminary Design Report). Environmental protection focuses on containing any residual MAW within the integrated containment system and protecting EV's.

Decommissioning follows a sequential, risk-assessed process, starting with operational shutdown and ending with approval for the subsequent rehabilitation phase. All steps incorporate PRCP adaptive management, with routine inspections for compliance. The key activities in this phase include:

(1) **Cease Tailings Deposition**: Confirm cessation via topographic survey (integrate LiDAR for accuracy); monitor tailings beach consolidation. Allow natural settling for 1–2 months, maintaining decant pond at ≤1 m depth to minimize pore pressures and hydraulic gradient.

(2) **Dewater**: Pump supernatant to EPit/MCD using existing 200 L/s capacity pumps; route via pipelines to avoid spills. Treat if quality exceeds EA limits (Schedule C, Table 6; e.g., metals like Cu <0.005 mg/L). Monitor volumes and cease if ICS levels approach maximum operating level (MOL).

(3) **Remove Infrastructure**: Dismantle pipelines, pumps, decant systems, and access tracks using controlled demolition; salvage reusable components (e.g., pumps for site reuse). Excavate contaminated areas (if identified via testing) and backfill with NAF fill.

(4) **Install Temporary Controls**: Place erosion barriers along embankments and exposed beaches; apply interim seeding to stabilize surfaces (focus on pioneer species for rapid cover). Install monitoring instruments as required.

(5) **Inspection and Approval**: Conduct geotechnical survey (stability analysis per ANCOLD FoS >1.3 undrained); integrate GWIA baseline data (e.g., no active seepage pathways). Approval by SQP that the site is hazard-free and ready for reshaping, and that the tailings beach is trafficable.

5.2 Landform Reshaping and Stabilisation

Landform reshaping and stabilisation is a critical phase in the closure of TSF3, focusing on transforming the operational topography into a safe, stable, and erosion-resistant landform that integrates with the surrounding environment and supports subsequent installation of the engineered cover and revegetation. This phase builds on the decommissioning works, ensuring the facility meets long-term geotechnical criteria while addressing potential risks such as settlement, erosion, and seepage-induced instability. Activities will be supervised by an AQP and incorporate adaptive risk management per AS ISO 31000:2018, with input from stakeholders (e.g., Kalkadoon Native Title Aboriginal Corporation for landform compatibility with cultural values). The expected duration of this phase is 6–12 months, allowing for seasonal access and iterative stability verification.

The scope encompasses reshaping the TSF3 surface and embankments to achieve geotechnical stability, preventing subsidence, erosion, or failure modes that could compromise closure objectives. This includes reshaping embankments (where needed), shaping the tailings beach to achieve a gentle and uniform profile, and preparing a uniform base for the cover system, ensuring the landform aligns with the native bushland PMLU (e.g., gentle slopes for vegetation establishment). Informed by geotechnical the works address risks like seismic loading (FoS ≥1.0–1.2 post-seismic per BOD) and potential groundwater flow alterations.

Reshaping follows a systematic, sequenced approach, starting with surveys and ending with stability verification, to minimize risks and ensure integration with downstream phases (e.g., cover tie-ins). The key activities in this phase include:

(1) **Survey**: Conduct pre- and post-works 3D topographic mapping using LiDAR or drone surveys for precision (±10 cm accuracy); establish benchmarks for monitoring settlement.

(2) **Treat Highwalls and Voids**: Reduce highwall slopes to 1–3% for drainage; backfill voids/depressions with compacted NAF fill to prevent ponding or subsidence; scarify surfaces for bonding with covers.

(3) **Reshape Tailings Beach**: undertake reshaping of the tailings beach as required to ensure the surface is ready for installation of the cover system, and that slopes are in accordance with the final closure design. This may also include the establishment of a working layer as needed,

(4) **Compaction**: Place fill in layered lifts (300 mm max), compact to 95% standard Proctor density (AS 1289); moisture condition per optimal range (OMC ±2%).

5.3 Cover System Installation

5.3.1 Cover Design

For semi-arid or seasonally dry climates in Queensland, a store and release cover is appropriate for tailings facilities typically comprising a nominal 0.5 m thick reduced permeability layer (RPL) overlain by a loose 1.5 to 2 m thick rocky soil mulch growth medium, giving a total thickness for this relatively simple two-layer cover of 2 to 2.5 m (Williams, 2022). Attention should focus on climatic extremes, the waste materials, and the design, materials selection, and the construction of such store and release covers to ensure that they restrict the net percolation of rainfall where AMD may occur.

Store and release cover systems are also recommended by GARD Guide for long-term management in climate regions where evapotranspiration dominates, such as the semi-arid region where CGM is located as shown in Figure 5.1.

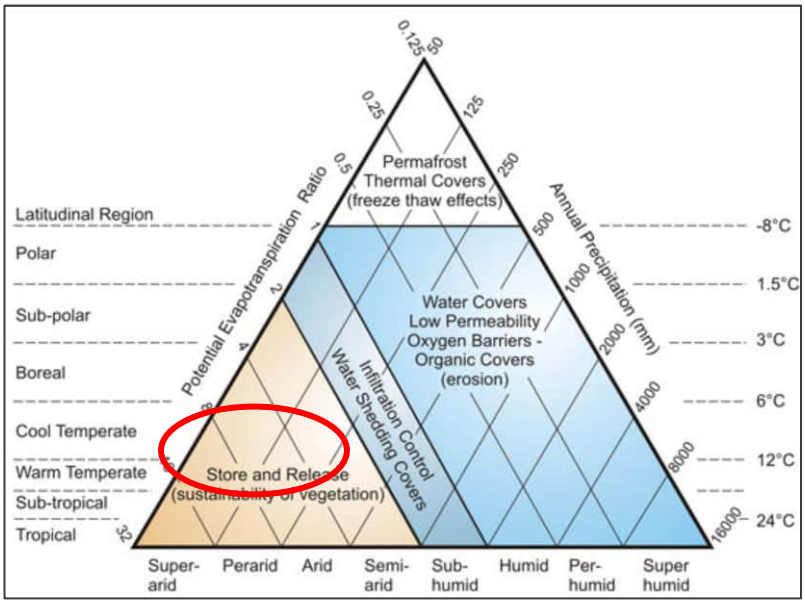


Figure 5.1: Cover Systems and Climate Types (INAP, 2011)

The cover systems adopted for waste structures at CCM follows the prescribed risk categories defined in the Queensland Government's Guideline: Estimated rehabilitation cost under the Environmental Protection Act 1994 (ESR/2018/4425, V6.0) (ERC Guideline). Under the ERC Guideline, and as part of Progressive Rehabilitation and Closure Planning (PRCP), the design objectives of covers installed over waste landforms is driven by the need to:

- Support vegetation consistent with the proposed Post-Mining Land Use (currently assumed to be Native Bushland).
- Promote infiltration and storage of rainfall within the upper cover layers during the wet season.
- Reduce rainfall infiltration and oxygen ingress into underlying waste.
- Prevent upward migration of contaminants.
- Support plant and equipment constructing the cover.

For the preliminary design of TSF3, an enhanced store and release cover system has been adopted. Due to the expected limited inventory of materials to undertake closure of TSF3, CCM propose to undertake cover trials to optimise the cover design where possible. This may include the incorporation of geomembranes where appropriate. As such the cover design presented herein is considered provisional.

The adopted cover layers for TSF3 are presented in Figure 5.2.

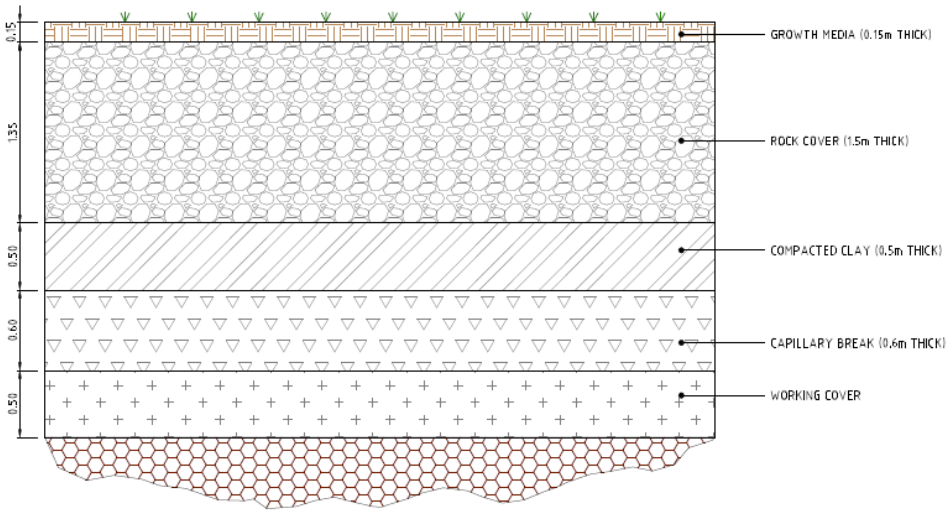


FIGURE 5.2: TSF3 COVER LAYERS

The TSF3 northern embankment comprises the EWRD. Following cessation of tailings deposition, the remaining exposed EWRD surface will also require installation of a cover system. All layers except the working cover are required over the EWRD.

5.3.2 Working Cover

A working cover is required to facilitate earthworks on soft to very soft tailings deposits, to maintain factors of safety against engulfment and undesired movement. Material for this layer will be comprised of NAF material won from existing stockpiles or borrow areas and will be pushed directly over the tailings beach surface with a low ground bearing pressure dozer (e.g. D6 / D7 Low Ground Pressure (LGP) of similar).

5.3.3 Capillary Break

The intent of a capillary break layer is twofold. It increases negative pore-water pressure within the cover, allowing the overlying compacted clay layer to maintain a higher water content, whilst preventing upward rise of underlying pore water within the tailings.

5.3.4 Compacted Clay

The compacted clay layer will act as a low hydraulic conductivity layer to limit ingress of rainfall and atmospheric oxygen. Clay materials should be compacted to achieve an in-situ saturated hydraulic conductivity of 1 x 10-7 cm/s or lower (INAP, 2017). Selection of the overlying rock material and growth media should be such so that the clay is not subject to excessive wetting and drying cycles, causing desiccation and ultimately increasing potential for infiltration to the waste material. The grade of the clay layer is such that any excess water stored in the overlying layers can be shed, rather than further increasing hydraulic head and risking percolation through to the capillary layer.

In the event that there is an absence of suitable clay material, geosynthetic membranes can be adopted. Modelling undertaken by GHD (2018) for Old TSF and HLP#2 demonstrated that a bituminous geomembrane (BGM) could be substituted to achieve the same decrease in net percolation through to the tailings material as a compacted clay layer.

5.3.5 Rock Cover and Growth Media

The rock cover and growth media layers are intended to promote infiltration and storage of rainfall until atmospheric and biotic demands can remove the water through evaporation and transpiration.

5.3.6 Material Availability & Cover Trials

Unavailability of materials available for rehabilitation has been identified as a major risk to success of the closure strategy at CCM. Rehabilitation trials are planned to identify potential materials within the lease areas, as well as engineered strategies such as design optimisation of the cover system through adoption of geosynthetics in replace of compacted clay layers.

5.3.7 Revegetation Strategy

The revegetation strategy for TSF3 is tailored to the proposed native bushland PMLU drawing on site-specific soils data from the Soil Mapping Report (QC1022_020-REP-009-A) and TSF3 soil sampling. These assessments, combined with regional ecosystem (RE) mappings and biodiversity studies (e.g., Northwest Highlands Bioregion Expert Panel Report, Queensland Government, 2018; Mount Isa Biodiversity Strategy 2023–2033), highlight soils that are sandy to sandy loam in texture, strongly acidic, skeletal with high coarse fragments (7–50%), low fertility and low effective cation exchange capacity. While these conditions present challenges such as poor nutrient retention, limited water-holding capacity (~50–75 mm PAWC/1.2 m), and potential aluminum toxicity, they align with arid, rocky rangelands supporting sparse Snappy Gum (Eucalyptus brevifolia) woodlands, spinifex grasslands, and shrublands typical of REs 1.7.5b, 1.7.7, and 1.11.8.

These studies identified that the site's soils can be suitably ameliorated to support the establishment of native bushland species consistent with the proposed PMLU. The strategy emphasizes resilient, drought-tolerant species adapted to low-nutrient, rocky environments, promoting self-sustaining ecosystems that protect EVs and aquatic habitats in Gunpowder Creek.

To achieve a stable, self-sustaining landform capable of supporting native bushland, a targeted soil amelioration program will be implemented as part of rehabilitation works. Indicative amelioration measures include:

- Lime application (2–6 t/ha) to address soil acidity and improve nutrient availability, applied where pH ($CaCl_2$) is below 5.0, reducing aluminum toxicity and enhancing microbial activity.
- Gypsum application (1–4 t/ha) if dispersive attributes emerge (though non-sodic per tests; ESP <6%), to improve soil structure, flocculation, and infiltration on clayey subsoils.
- Organic matter addition (30–60 t/ha) in the form of compost, mulch, or biosolids (NAF-compliant), to increase soil organic carbon, boost water-holding capacity, and stimulate soil biology.
- Starter fertiliser application (N: 10–20 kg/ha; P: 10–20 kg/ha; K: 15–30 kg/ha) to supply essential nutrients for initial establishment, with rates refined based on soil testing and avoiding over-fertilization to prevent weed invasion in natives.

These ameliorants will be incorporated into the upper soil profile (0–30 cm) during final landform shaping, using borrow materials blended with organics for uniform distribution and optimal conditions for revegetation.

5.3.8 Seed Mix

The revegetation strategy will focus on establishing a species mix that is:

- Compatible with regional REs and pre-mining bushland (e.g., spinifex-dominated grasslands on rocky hills).
- Suited to the rehabilitated soil conditions and arid climate (mean rainfall 498.9 mm, summer-dominant; low fertility).
- Capable of providing adequate groundcover (>70% by Year 1, >80% by Year 5) to limit erosion, enhance biodiversity, and support wildlife (e.g., for moderate-potential GDEs).

The seed mix targets species tolerant of sandy, acidic, low-nutrient soils (e.g., Triodia spp. for skeletal profiles, Acacia spp. for nitrogen fixation). Amendments (lime 2–6 t/ha, organic matter 30–60 t/ha) address acidity and fertility, as detailed in the revegetation strategy. Flat surfaces of the TSF are proposed to be seeded with grass species such as spinifex and other deep-rooted tussock species that bind unconsolidated slopes, reduce surface runoff and trap sediment, along with shrubs and forbs to provide a diverse mid-story to rebuild habitat complexity for fauna and increase rooting depth diversity. Rehabilitation of TSF embankments seeks to recreate the structure and species composition of Regional Ecosystems (REs) 1.11.2a (Eucalyptus leucophloia woodland) and 1.7.7a (Corymbia capricornia woodland).

The proposed seed mix is provided below in Table 5.1.

An overview of the rationale for revegetation and the native bushland seed mix is summarised below:

- Total Seeding Rate: ~8 kg/ha (adjustable based on trial outcomes and local conditions).
- Application methods: Broadcast seeding post-amelioration, with hydro-seeding on erosion-prone slopes (>20% gradient).
- Sourcing: Local provenance seeds from nurseries (e.g., Mount Isa region, Bush Heritage Australia guidelines) to ensure adaptability and compliance with biodiversity goals.
- Monitoring: Assess cover (>70% by Year 1, >80% by Year 5) and diversity metrics in consideration of approved rehabilitation milestones.

TABLE 5.1: NATIVE BUSHLAND SEED MIX

Functional Group	Scientific Name	Common Name	Application Rate*	Timing
Ground-layer grasses and spinifex (slope-binding)	*Heteropogon contortus*	Black speargrass	20% of grass mix	
	Themeda triandra	Kangaroo grass	20%	
	Cymbopogon bombycinus	Lemon grass	10%	
	Eulalia aurea	Silky brown-top	10%	
	Enneapogon lindleyanus	Bottle-washer grass	10%	
	Sporobolus australasicus	Fairy grass	10%	
	Triodia longiceps	Giant grey spinifex	10%	
	Triodia pungens	(Soft) spinifex	5%	
	Enteropogon acicularis	Curly windmill grass	2.5%	
	Paspalidium jubiflorum	Warrego summer grass	2.5%	
Nitrogen-fixing wattles	*Acacia orthocarpa*	Needle-leaf wattle	~0.05 kg per ha	Wet-season onset seeding window (November to early December)
	Acacia phlebocarpa	Velvet-leaf wattle		
	Acacia retivenea	Silky wattle		
Mid-storey shrubs/forbs	*Cullen balsamicum*	Balsam cullen	~0.05 kg per ha	
	Ipomoea antonschmidii	—		
	Polycarpaea spirostylis	Copper bush		
	Senna notabilis	Cockroach bush		
	Triumfetta plumigera	Native burr		
	Grevillea wickhamii	Holly-leaved grevillea		
Canopy trees (reference RE 1.11.2a & 1.7.7a)	*Eucalyptus leucophloia*	Snappy gum	~0.5 kg per ha	
	Eucalyptus leucophylla	Cloncurry box		
	Corymbia dallachiana	Dallachy's gum		
	Corymbia aperrerinja	North-west ghost gum		

Functional Group	Scientific Name	Common Name	Application Rate*	Timing
	Corymbia capricornia	Small-fruited ghost gum		
	Corymbia gummifera	Red bloodwood		
	Corymbia terminalis	Desert bloodwood		

The successful implementation of the revegetation strategy for native bushland requires careful planning, execution, and adaptive management to address the site's challenging soil conditions (e.g., very strongly acidic pH 3.98–4.95, low fertility, and skeletal profiles with 7–50% coarse fragments) and arid climate. Detailed guidance on timing, trials, maintenance, and iterative adjustments is summarised below:

- **Revegetation Timing:** Seeding should occur pre-wet season to maximize natural soil moisture and germination success, capitalizing on the site's summer-dominant rainfall pattern (November–March, ~87% of annual total). Optimal windows are November-December prior to wet season runoff that enhances infiltration in sandy loam textures. This timing reduces drought stress on seedlings, aligns with native species' natural cycles (e.g., Triodia spp. post-rain establishment), and minimizes erosion risks on reshaped slopes. Pre-seeding preparations (e.g., ameliorant incorporation 1–2 months prior) should coincide with dry periods (April–October) for machinery access. Delays due to extreme events will be managed via contingency seeding in April-May if moisture persists, informed by site-specific monitoring.
- **Revegetation Trials:** Conduct comprehensive field trials to refine seed rates, species viability, and amelioration efficacy, ensuring long-term self-sustaining ecosystems. Trials (e.g., 0.5–1 ha plots on representative landforms like TSF3 embankments) will test variables such as seeding density (6–10 kg/ha variations), mix compositions (e.g., higher Triodia spp. for rocky areas), and amendments (lime 2–6 t/ha for pH; organics 30–60 t/ha for organic C boost from 0.3–0.8%). Monitor metrics like germination (>50% within 6 months), survival (>70% after first dry season), and cover (>50% by Year 1) using quadrats. Trials will inform adaptive adjustments (e.g., species swaps if <30% survival).
- **Maintenance:** Post-seeding maintenance will prioritize ecosystem establishment, excluding disturbances for 5–10 years to allow root development in low water-holding soils (~50–75 mm PAWC/1.2 m) and prevent erosion/AMD from PAF materials. Exclude grazing via temporary fencing and pest control. Annual rehabilitation monitoring will assess PRCP compliance, with adaptive interventions like reseeding (<50% cover) or supplementary watering during droughts. Integrate groundwater/surface water monitoring (per GWIA/SWIA) to verify no-harm to EVs. Long-term (Years 11–20) shifts to passive management, demonstrating relinquishment criteria (e.g., self-sustaining cover >80%, no ongoing inputs).
- **Iterative Adjustments:** This seed mix provides a starting point, with adjustments based on ongoing sampling (e.g., RE analogue soils for cover analogs) and trials to optimize revegetation success for CCM's native bushland PMLU. Annual reviews will incorporate new data and feedback (e.g., Kalkadoon for cultural species), ensuring >90% alignment with target REs (e.g., Snappy Gum/spinifex dominance). If trials show <60% survival (e.g., due to acidity), escalate amendments. This adaptive approach supports long-term stability (no seepage impacts per GWIA/SWIA), facilitating site relinquishment.

6. COMMUNITY ENGAGEMENT PLAN

Stakeholder engagement for TSF3 closure is integral to achieving transparent, inclusive, and sustainable outcomes, in accordance with the PRCP Guidelines and GISTM. The process ensures diverse perspectives are incorporated, risks are mitigated, and closure aligns with community expectations for a native bushland PMLU. Key stakeholders include the Kalkadoon Native Title Aboriginal Corporation (Traditional Owners of the Calton Hills pastoral lease), local landholders (e.g., adjacent pastoralists Carlton Hill), regulatory authorities (e.g., Department of Environment, Science and Innovation (DESI)), and the broader Mount Isa community. Engagement commenced during PRCP development (2023–2025) and will continue through closure (2032–2037) and post-closure monitoring (up to 20 years for relinquishment).

6.1 Scope

The scope encompasses consultation on closure planning, PMLU selection risk management and monitoring/rehabilitation outcomes. It addresses EP Act s.126D requirements for PMLU consistency with stakeholder values, focusing on cultural significance (Kalkadoon heritage surveys 2016; no sites in footprint), land use compatibility and environmental protection. Engagement is ongoing, with regular meetings and adaptive feedback loops to refine strategies (e.g., revegetation seed mix incorporating Kalkadoon input).

6.2 Methods

Engagement follows a structured plan aligned with the PRCP Guideline:

1. **Identification**: Stakeholders identified via desktop review and initial consultations.
2. **Consultation Activities**: Annual meetings, site visits and detailed sessions where views can be shared and considered.
3. **Information Sharing**: Provide accessible materials and information to enhance understanding.
4. **Feedback Integration**: Incorporate input into updates and communicate actions.

6.3 Outcomes and Implementation

A series of consultation events were undertaken as specified below in

TABLE 6.1:COMMUNITY ENGAGAMENT SESSION

Stakeholders	Session Timing	Description
Community Consultative Committee (landholders, Traditional Owners, DETSI, Mount Isa City Council, Southern Gulf Natural Resource Management)	October 2023	Initial Discussion of TSF3 location and design
Community Consultative Committee	February, March, April 2024	Follow up Presentations of TSF3 Progress and feedback
Community Consultative Committee	September, November, December 2024	Presentation of TSF3 Preliminary Design and further feedback
Community Consultative Committee	April 2025	Follow up Presentation of TSF3 Preliminary Design with changes to incorporate feedback and concerns

7. REHABILITATION MILESTONES

7.1 PRCP Schedule and Rehabilitation Milestones

The PRCP Schedule is a key component of the PRCP, as required under section 126D of the EP Act. It outlines the time-based milestones for achieving rehabilitation to a stable condition for PMLU areas or sufficient improvement for NUMAs. For TSF3, the schedule must cover a suitable horizon from the plan's commencement to relinquishment, with milestones developed to be SMART (Specific, Measurable, Achievable, Relevant, Time-bound) and supported by criteria that demonstrate progress toward closure objectives (e.g., structural stability, no environmental harm, and sustainability per EP Act s.111A).

The schedule development follows a structured process aligned with the PRC Plan Guideline (Section 4.1) including development of appropriate rehabilitation milestones (RMs):

1. **Final Site Design Integration**: Use 3D models and maps from the rehabilitation strategy (Section 5) to delineate TSF3 into rehabilitation areas (RA). For the purpose of this plan, the TSF3 area is a single RA, RA1.
2. **Division into PMLU and NUMA Areas**: A single PMLU is proposed, native bushland for TSF3.
3. **Land Availability Determination**: Set dates when land becomes available for rehab understanding operational constraints and in line with the rehabilitation strategy.
4. **Milestone Development**: Identify sequential milestones from closure steps (Section 5.3), ensuring they address risks. Milestones are progressive, with criteria verifiable by AQP.
5. **Milestone Criteria**: Define measurable outcomes, drawing on site data.
6. **Commencement and Completion Dates**: Nominate dates for commencement and completion of milestones.

The following table provides proposed milestones for TSF3 (RA1). Milestones are SMART, with criteria informed by site-specific assessments. Completion dates assume tailings deposition commence in June 2026 for a period of 7.5 years until exhaustion.

TABLE 7.1:PROPOSED REHABILITATION MILESTONES AND CRITERIA

.	Rehabilitation Milestone	Milestone Criteria
RM4	Design & Installation of cover system/capping	(1) Source and investigation of cover materials consistent with design requirements. (2) Design and implementation of cover trials. (3) Performance monitoring of cover trials. (4) Design of cover system (5) Construction of cover in accordance with design specifications, with construction quality assurance undertaken by an AQP. (6) Preparation of as-constructed report, including preparation of monitoring procedure to assess performance of cover. (7) Certification by an AQP that cover is installed in accordance with design criteria and intent, including: 1. Prevents upward migration of contaminants 2. Reduces seepage volumes 3. Captures and conveys surface water to maintain surface stability 4. Instrumentation installed to monitor performance against performance monitoring plan.
RM5	Surface preparation	(1) Soils assessed by an AQP, and a recommendation made for required soil ameliorant and nutrients to sustain target PMLU vegetation.

		(2)	Growth media placed and spread to thickness as specified by AQP to achieve PMLU.
		(3)	Soil ameliorants and nutrients applied as recommended.
		(4)	Ripping/ surface roughening of rehabilitation area to encourage water capture and retain growth media (where placed).
RM6	Revegetation	(1)	Seeding/planting of the target species for relevant PMLU specified.
RM7	Achievement of surface requirements for PMLU	(1)	No bare areas exceeding 100 m² on all rehabilitated areas.
		(2)	Average total ground cover (all ground cover categories aggregated) is no less than the 15th percentile of equivalent reference site.
		(3)	A minimum of 70% of target species as per the revegetation plan have been established.
		(4)	Erosion gullies are less than or equal to 1m deep.
		(5)	Certification by an AQP that revegetation is comparable to reference sites, erosion and drainage is acceptable and weeds and pest species are in densities no greater than at reference sites.
		(6)	Receiving water quality and groundwater quality monitoring results do not exceed water quality objectives specified in EA, and surface water quality is on trajectory to support livestock drinking water quality limits for cattle (ANZECC).
RM8	Achievement of PMLU	(1)	Revegetation is comparable to reference sites and supports the proposed PMLU.
		(2)	Weeds and pest species are in densities no greater than at reference sites as certified by an AQP.
		(3)	The rehabilitated landforms have erosion consistent with reference sites with gullies less than or equal to 1m as certified by an AQP.
		(4)	Evidence that fauna is not compromising the integrity of the cover system when assessed by an AQP.
		(5)	Receiving water quality and groundwater quality monitoring results do not exceed livestock drinking water quality limits for cattle (ANZECC 2000) or the 80th percentile of reference whichever is higher.
		(6)	Safe to humans and wildlife - Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use.
		(7)	Stable - rehabilitation is geotechnically stable.

The proposed schedule for the RMs for TSf3 is shown below inTable 7.2.

TABLE 7.2: REHABILITATION SCHEDULE

Post-Mining Land Uses (PMLU)	
Rehabilitation area	RA1
Relevant activities	Tailings Storage Facilities (TSF3)
Total rehabilitation area size (ha)	79
Commencement of first milestone: RM4	10/12/2034

Post-Mining Land Uses (PMLU)				
PMLU				Native Bushland
Date area is available	10/12/34			
Cumulative area available (ha)	79	79	79	
Milestone completed by	10/12/37	10/12/42	10/12/52	

Milestone Reference	Cumulative Area Achieved (ha)
RM4	79
RM5	79
RM6	79
RM7	79
RM8	79

8. MONITORING

8.1 Rehabilitation Monitoring

The monitoring and maintenance program for TSF3 closure and rehabilitation is designed to systematically evaluate progress toward achieving a stable, self-sustaining native bushland PMLU. Monitoring integrates remote sensing (hyperspectral and LiDAR) with field assessments using an adapted BioCondition framework, benchmarked against analogue sites representing pre-mining regional ecosystems (REs, e.g., RE 1.11.2a for native bushland). The program supports PRCP milestones (e.g., RM6 Revegetation, RM7 Surface Stability, RM8 PMLU Achievement), with annual reviews by AQPs.

8.1.1 Scope

The scope covers all TSF3 rehabilitation areas and ancillary disturbances, starting post the Rehabilitation Milestone of Revegetation. Monitoring tracks KPIs against PRCP RMs and provides benchmarks for low-fertility, arid-adapted ecosystems (e.g., Snappy Gum woodlands).

8.1.2 Monitoring Objectives

The objectives for rehabilitation monitoring at CCM as outlined in the CCM Rehabilitation Monitoring Procedure (QC1022_020-REP-007-0), are focused on ensuring long-term ecological resilience and productive land use post-mining. Specifically, the procedure aims to:

- **Support Sustainable Productivity**: Ensure the transformed landscape supports designated post-mining land uses (PMLUs) such as low-density grazing, native bushland conservation, and water management.
- **Achieve Stable Landforms**: Restore and stabilize landforms to prevent erosion, maintain hydrological function, and integrate harmoniously with surrounding ecosystems.
- **Maintain Ecological Integrity**: Reinstate native vegetation and biodiversity levels that are sustainable over the long term, using regional ecosystem (RE)-based benchmarks to guide progress toward a stable, self-sustaining ecosystem.

These objectives align with the PRCP requirements, emphasizing measurable key performance indicators (KPIs), periodic evaluations, and adaptive management to meet regulatory standards and community

8.1.3 Monitoring Methods

Monitoring combines annual remote sensing for landscape-scale trends with field assessments in milestone years (3,5,7,10 post-revegetation) for detailed validation. Frequency aligns with EA F4-2 (annual minimum). The timing for monitoring is the dry season (April–May) to minimize cloud cover and access issues.

The rehabilitation monitoring methods include both a field based and remote sensing components.

8.1.3.1 Field-Based Assessment

The field-based assessment for TSF3 rehabilitation monitoring employs an adapted BioCondition framework (Eyre et al. 2015; Neldner & Ngugi 2014), a standardized vegetation condition assessment tool developed by the Queensland Herbarium for terrestrial biodiversity in Queensland. This framework has been modified to evaluate not only vegetation attributes but also soil quality, erosion and landform stability, and water parameters at rehabilitation monitoring (RM) sites and analogue sites, ensuring alignment with PRCP milestones for ecological integrity and landform stability. Assessments are conducted by qualified ecologists with experience in arid rangeland ecosystems, using fixed 50 m × 10 m plots supplemented by 100 m transects for canopy measurements, allowing for consistent, repeatable data collection across the ~79 ha TSF3 area. Plots are established using high-accuracy GPS for geospatial integration, with transects oriented to capture topographic variability (e.g., along slopes for erosion analysis). This setup supports detailed ground-truthing of remote sensing data and verification of progress toward self-sustaining native bushland PMLU, with benchmarks derived from pre-mining REs (e.g., RE 1.11.2a for Snappy Gum woodlands).

Vegetation parameters are measured to assess structure, diversity, and health, directly informing PRCP RM6 (Revegetation) criteria. Canopy height and cover are quantified using laser rangefinders for precise height measurements (to nearest 0.1 m) and densiometers or visual estimates for percentage cover (averaged across 10 points per transect), targeting gradual increases (e.g., >1.0 m height and >2.5% cover by Year 3). Species richness is recorded for trees, shrubs, grasses, and forbs through exhaustive surveys within plots, identifying to species level using field guides and apps (e.g., Queensland Flora Census), with counts aiming for ≥2 tree species and ≥6 shrubs by Year 3 to match analogue diversity. Ground cover is evaluated in 1 m² quadrats (5–10 per plot) for percentage native perennial grass (target >10% Year 3), litter (>10% Year 3), and non-native plants (<20% Year 3), while woody debris is quantified along transects (fallen logs/branches >10 cm diameter) to assess habitat complexity (target >50 m/ha by Year 5). Recruitment percentage (seedlings/saplings of canopy species) is counted in subplots (e.g., 50 m × 4 m), targeting >5% by Year 3 to indicate natural regeneration.

Soil quality sampling focuses on the top 0–15 cm horizon, collected from multiple points per plot (composite samples) and analyzed in-field (pH, salinity) or lab (organic matter, exchangeable cations) to verify suitability for native species establishment. pH is targeted at 4.0–5.0 initially (matching site acidity; adjusted via lime if <4.0 for Al toxicity reduction), salinity via EC <1.0 dS/m (non-saline threshold), organic matter >1.0% by Year 3 (to boost from baseline 0.3–0.8%), and exchangeable cations (e.g., Ca-dominant >60%) to ensure nutrient retention in low-ECEC soils (1.36–1.72 cmol/kg). Samples are tested per AS 1289 standards, with results informing amelioration (e.g., organics 30–60 t/ha if OC low).

Erosion and landform stability are assessed along 50 m transects, recording erosion type (e.g., rills, gullies) and extent (depth/width/length measurements; <5 t/ha/year rate per guideline thresholds), with stabilizing vegetation noted to evaluate control effectiveness. This supports PRCP RM7 (Surface Stability), ensuring slopes (1–3%) and reshaped areas (e.g., EWRD batters) meet <8 mm erosion by Year 8.

For waterways/storage areas (if applicable near spillways), in-situ water quality is measured using portable probes for pH (6.5–8.5 target), turbidity (<50 NTU), dissolved oxygen (>80% saturation), and salinity (EC <1.0 dS/m), meeting EA Schedule C limits to protect Gunpowder Creek EVs (per SWIA; no flow changes).

All data are recorded digitally on handheld devices with standardized forms (e.g., adapted BioCondition scorecards), including photos and GPS tags, and uploaded in real-time to the geospatial platform for integration with remote sensing (e.g., NDVI correlation for cover validation). This ensures traceability, QA/QC (e.g., duplicate samples 10% rate), and adaptive adjustments, with annual reviews per EA A4-5.

8.1.3.2 Remote Sensing Assessment

The remote sensing assessment component of the TSF3 rehabilitation monitoring program uses aerial technologies to provide high-resolution data on vegetation health, landform stability, and erosion risks, complementing the detailed but localised monitoring from field-based BioCondition evaluations. This approach aligns with the PRCP Guideline requirements for comprehensive, verifiable monitoring of rehabilitation progress, as well as Environmental Authority (EA) EPML00911413 conditions (e.g., F4-2 for annual monitoring with spatial replication) and ANCOLD Guidelines on Tailings Dams (2012, with 2019 Addendum) for long-term stability verification.

By using hyperspectral imagery with LiDAR, the assessment is designed to capture landscape-scale trends across the TSF3 area and analogue sites, enabling early detection of issues like erosion or vegetation stress that could impact PRCP milestones. Surveys are conducted annually by a commercial operator with expertise in mining rehabilitation timed for the dry season (April–May) to minimise cloud interference and align with field assessments for cross-validation.

The scope encompasses annual coverage of all rehabilitation monitoring (RM) sites, analogue sites, and the broader TSF3 footprint focusing on metrics that proxy BioCondition parameters while addressing TSF-specific risks. Hyperspectral sensors capture multi-band reflectance data (e.g., 400–2500 nm resolution) for vegetation indices, while LiDAR provides point clouds (>10 points/m² density) for topographic and structural models. This non-invasive method supports PRCP adaptive management by identifying trends (e.g., NDVI declines signaling drought stress in low-water-holding soils ~50–75 mm PAWC) and verifying no-harm to EVs.

Surveys are executed using fixed-wing or drone platforms equipped with calibrated sensors, flown at ~150–300 m altitude for ~1–2 cm ground resolution. Raw data is processed using software like ENVI (hyperspectral) and LAStools (LiDAR) to generate orthomosaics, digital elevation models (DEMs), and derived metrics. Processing includes atmospheric correction, georeferencing (to <0.5 m accuracy), and classification algorithms (e.g., machine learning for vegetation density). Metrics are calculated as follows, with targets benchmarked against analogues (e.g., RE 1.11.2a for native bushland):

- **Terrain Stability**: Terrain Ruggedness Index (TRI) quantifies surface variability from LiDAR DEMs (low target: <0.5, indicating smooth, stable post-reshape landforms); slope mean derived from DEM gradients (<3° target per design to minimize erosion on 1–3% contoured surfaces).
- **Vegetation Health/Structure**: NDVI mean calculated from hyperspectral bands (NIR-Red)/(NIR+Red) (>0.3 Year 3, increasing to >0.7 Year 10 for healthy bushland); canopy height from LiDAR canopy height models (CHM; ≥1.0 m Year 3); foliage projective cover (FPC >15% Year 3 via classified imagery); height ranges (% distribution: e.g., 0–0.5 m for groundcover, 1–5 m for shrubs, tracked against analogue profiles).
- **Ground Cover/Erosion**: Bare earth percentage from multispectral classification (<10% Year 3 to reduce exposure in skeletal soils); vegetation density categorized (sparse <30%, moderate 30–70%, dense >70% cover); erosion risk score as composite (TRI + bare earth + slope; low target <2 on 0–10 scale, calibrated to <5 t/ha/year guideline threshold).

Processed data is uploaded to the cloud-based geospatial platform (e.g., ArcGIS Online or similar) for querying, comparison (e.g., overlay with field plots), and visualization (e.g., dashboards showing NDVI trends). Annual calibration against field data ensures >80% correlation (e.g., NDVI vs. cover). Contingencies: Backup surveys if weather delays; integration with GWIA piezometers for seepage-correlated erosion risks.

This remote sensing approach provides scalable, cost-effective monitoring, supporting PRCP adaptive management and relinquishment after 20 years by demonstrating sustained stability and vegetation health.

8.1.4 Monitoring Parameters and KPIs

The rehabilitation program uses two complementary scoring systems to monitor progress: (1) field-based assessments evaluating vegetation condition, erosion control, and soil parameters; and (2) remote sensing analysis measuring NDVI, canopy cover, and bare ground. Adaptive management actions are required when either assessment falls below 80% of its expected benchmark score for that monitoring year

Monitoring parameters and relevant KPIs are included in Table 8.1 for the field based monitoring, and Table 8.2 for remote sensing.

TABLE 8.1: FIELD-BASED ADAPTED BIOCONDITION SCORECARD

Parameter	Units	Year 3 Target	Year 5 Target	Year 7 Target	Year 10 Target	Max Score
Vegetation Structure						
Tree Canopy Height	m	≥1.0	≥1.5	≥2.0	≥3.0	5
Tree Canopy Cover	%	≥2.5	≥5	≥7.5	≥10	5
Shrub Layer Cover	%	≥1.0	≥2.0	≥3.0	≥5.0	5
Species Richness						
Tree Species Richness	No.	≥2	≥2	≥2	≥2	5
Shrub Species Richness	No.	≥6	≥6	≥6	≥6	5
Grass Species Richness	No.	≥4	≥4	≥4	≥4	5
Forb Species Richness	No.	≥2	≥3	≥4	≥5	5
Native Perennial Grass Cover	%	≥10	≥20	≥30	≥35	5
Litter Cover	%	≥10	≥20	≥30	≥40	5
Non-Native Plant Cover	%	≤20	≤15	≤10	≤5	10
Subplot Metrics						

Parameter	Units	Year 3 Target	Year 5 Target	Year 7 Target	Year 10 Target	Max Score
Tree Density (>1m)	stems/ha	≥5	≥10	≥20	≥50	5
Sapling Density (0.5–1m)	stems/ha	≥20	≥50	≥100	≥200	5
Seedling Recruitment	stems/ha	≥5	≥20	≥50	≥100	5
Soil Quality						
Soil pH	units	5.5–7.5	5.5–7.5	5.5–7.5	5.5–7.5	5
Salinity	dS/m	<2.0	<1.5	<1.0	<1.0	5
Organic Matter	%	≥1.0	≥2.0	≥3.0	≥4.0	5
Erosion/Landform						
Erosion Type/Extent	Desc.	Stable	Minimal	Minimal	Minimal	5
Water Quality (if appl.)		TBA	TBA	TBA	TBA	TBA

TABLE 8.2: REMOTE SENSING SCORECARD

Parameter	Units	Year 3 Target	Year 5 Target	Year 7 Target	Year 10 Target	Max Score
Terrain Ruggedness Index	Ratio	Low	Low	Low	Low	5
Slope Mean	°	<3	<3	<3	<3	5
NDVI Mean	Ratio	≥0.3	≥0.5	≥0.6	≥0.7	50
Erosion Risk Score	-	Low	Low	Low	Low	5
Bare Earth	%	≤10	≤9	≤8	≤5	5
Sparse Vegetation	%	As per RE	As per RE	As per RE	As per RE	-
Moderate Vegetation	%	As per RE	As per RE	As per RE	As per RE	-
Dense Vegetation	%	As per RE	As per RE	As per RE	As per RE	-
Vegetation Cover (Surface)	%	≥15	≥20	≥25	≥30	5
Canopy Height Mean	m	≥1.0	≥1.5	≥2.0	≥3.0	30
Canopy Height Ranges (%)	%	Distribution as per analogues (e.g., 0–0.5m, 0.5–1m, etc.)				-
FPC Mean	%	≥15	≥20	≥25	≥30	5

8.2 Operational Phase Monitoring

8.2.1.1 Performance Data

Effective performance monitoring is essential to verify that the TSF3 closure design, including the engineered cover system, is functioning as intended, ensuring long-term containment of PAF tailings and protection of the receiving environment. This section outlines the proposed monitoring framework to assess the physical and geochemical stability of the rehabilitated landform over time.

The Monitoring Objectives include:

- Confirm the cover system is effectively isolating PAF tailings from water infiltration and oxygen ingress.
- Detect any seepage, erosion, or surface water ponding that may compromise landform integrity.
- Monitor geochemical stability by assessing groundwater, surface water, and potential leachate quality.
- Support validation of final landform performance against rehabilitation milestones and closure criteria (e.g., RM7 Surface Stability, RM8 PMLU Achievement).

The monitoring parameters include:

- **Surface Inspections**: Quarterly inspections of the TSF3 surface areas (e.g., beach, embankments) should be undertaken during the initial post-closure period (Years 1–5). Inspections will transition to biannual in Years 6–20. The following should be included:
  - Evidence of erosion, cracking, or slumping on the cover surface.
  - Vegetation establishment and health (e.g., cover >70% by Year 1 per RM6).
  - Ponding or drainage issues (e.g., spillway functionality).
  - Damage from animals, vehicles, or weather events.
- **Seepage or Leachate Monitoring**: Seepage monitoring should be undertaken from piezometers and sentinel bores around TSF3. Parameters will be measured quarterly:
  - Volume of seepage (continuous monitoring via flow meters on dewatering pipes or weirs).
  - pH, electrical conductivity (EC).
  - Acidity, alkalinity, sulfate, and dissolved metals (e.g., Cu, Zn per EA Schedule C). Seepage quality modeling should be undertaken at least six-monthly, using updated 3D transient groundwater models (per GWIA) to predict long-term flows.

Monitoring data will be evaluated against the following performance benchmarks, as specified in the rehabilitation milestone criteria.

The following reporting and review processes will be in place:

- Monitoring results will be compiled into annual performance reports, with improvement actions identified.
- Data will be used to support progressive certification applications and eventual relinquishment of the landform, subject to satisfying rehabilitation milestones in the PRCP.

8.3 Groundwater Monitoring

The details of the proposed groundwater monitoring bores for TSF3 are described below in Table 8.3 and locations presented in Figure 8.1. Background bores are proposed to be monitored monthly to obtain baseline concentrations and quarterly for compliance bores.

TABLE 8.3: PROPOSED TSF3 MONITORING BORES

Bore ID	Compliance / Background Bore	Purpose/reasons	Monitoring Frequency
GWMB81	Background	Baseline groundwater conditions associated with proposed TSF 3.	Monthly
GWMB80	Background	Baseline groundwater conditions associated with proposed TSF 3.	Monthly
GWMB76	Compliance	Targeting seepage pathway between TSF 3 and EPit.	Quarterly
GWMB77	Compliance	Targeting seepage pathway between TSF 3 and EPit.	Quarterly
GWMB78	Compliance	Targeting seepage pathway between TSF 3 and EPit.	Quarterly
GWMB79	Compliance	Targeting seepage pathway between TSF 3 and EPit.	Quarterly
GWMB79A	Compliance	Targeting seepage pathway between TSF 3 and EPit.	Quarterly
GWMB82	Background	Background to EPit located in the Paradise Creek Formation. To assess spatial and temporal changes in water quality. Understand the spatial and temporal extent of water quality impacts. Assess potential impacts on groundwater quality.	Monthly



Figure 8.1: TSF3 Monitoring Locations

8.4 Surface Water Monitoring

The surface water monitoring program should continue to be consistent with the TSF3 Surface Water Impact Assessment (QC1022_018-REP-003-2. **The Objectives of the surface water monitoring include:**

- Detect any uncontrolled discharges or ponding that could compromise closure stability.
- Assess water quality trends to ensure no adverse impacts from residual seepage or erosion.
- Validate hydrological performance (e.g., spillway flows to EPit; no accumulation per water balance modeling in SWIA Section 6).
- Support PRCP milestones (e.g., RM7 Surface Stability: erosion <5 t/ha/yr; RM9 PMLU for Waterways: WQOs met) and relinquishment after 20 years (no exceedances).

Monitoring integrates with the CCM REMP (annual macroinvertebrate/water quality assessments) and TSF-specific parameters. Sites include upstream (GWUS) and downstream (GWDS) in Gunpowder Creek, TSF3 spillway, and potential ponding areas. The frequency of monitoring is quarterly for surface water monitoring, and annual for REMP.

8.5 Geochemical Monitoring

Characterisation of tailings to identify the potential to generate contaminated seepage or leachate will be undertaken at a minimum frequency of once every month during tailings deposition. Characterisation will include:

- Determining the acid producing potential through calculating both the 'Net Acid Producing Potential' and the 'Net Acid Generation test'.
- Determining the concentrations of aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, lead, manganese, nickel, uranium and zinc.
- Where the acid producing potential of tailings material has not been conclusively determined, tailings material must be considered as acid forming unless further geochemical testing demonstrates otherwise.

In addition to the above monitoring requirements from the EA, the following geochemical testing is recommended on the same monthly frequency:

- Total Sulfur (S).
- Total Sulfate (SO4).
- Chromium Reducible Sulfur (Scr).
- Total alkalinity.
- 1:5 pH and EC.
- 1:5 Soluble major cations (Ca, Mg, Na, K).
- 1:5 Soluble major anions (Cl, SO_4).
- 1:5 Water-soluble metals (15 metals).

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APPENDIX A: LEM REPORT

ENGENY

29 METALS

Capricorn Copper PRCP

Landform Stability Assessment

QC1022_020-REP-003-0

30 July 2025

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1. INTRODUCTION

1.1 Background

Engeny has been engaged by 29 Metals (29M) to undertake Landform Evolution Modelling (LEM) in support of the development of a Progressive Rehabilitation and Closure Plan (PRCP) for the Capricorn Copper Mine (CCM). This report presents the assessment undertaken to determine the rehabilitation activities required to produce safe, stable, and sustainable rehabilitation of the Final Landform, with particular focus on Waste Rock Dumps (WRDs).

1.2 Context

In 2018, the Queensland *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act) amended the Queensland *Environmental Protection Act 1994* (EP Act) to introduce new requirements for the progressive rehabilitation and closure of mined land. These changes include the development of a PRCP for existing and future site-specific Environmental Authority (EA) holders for mining activities. A PRCP requires the EA holder to plan for how and where activities will be carried out on land, in a way that maximises the progressive rehabilitation of the land to a stable condition.

This assessment has been developed to support the CCM PRCP submission as it relates to the landform component. The goal of the landform is that it is fundamentally safe, stable, non-polluting, self-sustaining in the long term. The PRCP submission must include all supporting information required by the Department of Environment, Science, and Innovation (DESI) to reach a decision on the soundness of the rehabilitation strategies planned to meet the approved Post Mining Land Use (PMLU) outcomes.

TABLE 1.1: PRCP LANDFORM ASSESSMENT CRITERIA

Assessment Criteria	Example of satisfactory outcomes
Safe	The landform is geotechnically safe and not at risk of mass movement or slumping failure
Stable	The landform is erosionally stable and does not have active rill or gully features
Non-polluting	The landform is not contributing pollutants (e.g., acid/saline drainage, metals, sediment)
Self-sustaining	The landform can sustain the PMLU from a vegetation perspective without ongoing maintenance

To comply with the PRCP guideline requirements for final landform assessment shown in Table 1.1, the guideline states that the assessment must include:

(1) 3D design plans developed for the final landform.

(2) Method of determining landform design.

(3) Modelling predicting the long-term stability of the final landform design.

(4) Method of construction.

(5) Quality Assurance / Quality Control (QA/QC) requirements.

(6) Trial methodology to verify the predicted success of the final landform design.

(7) Limitations and assumptions of the landform design.

This report captures the requirements of point 3 on the proposed WRDs at the CCM through Landform Evolution Modelling (LEM). Inputs to the assessment are based on information supplied by CCM in terms of the location, volume and type of waste requiring rehabilitation.

1.3 Rehabilitation Requirements & Landform Configuration

CCM is committed to compliance with their EA (EPML0011413), which under Schedule F states the disturbed land is to be rehabilitated to the goals specified in the Queensland guideline for mine site rehabilitation[1]. The goals of the guideline are that the disturbed land is to be safe (geotechnically), non-polluting, stable (erosionally), and able to sustain the post mining landuse. The current CCM guidance documents refer to the detail of PMLUs to be defined as part of this current PRCP process for the detail of the rehabilitation objectives, indicators, and the completion criteria.

The current landform designs shown in Figure 1.1 were optimised to reduce slope angles as much as possible along with minimising the movement of waste materials. The landform will serve as the basis of erosion model runs in terms of the slope height and gradients.

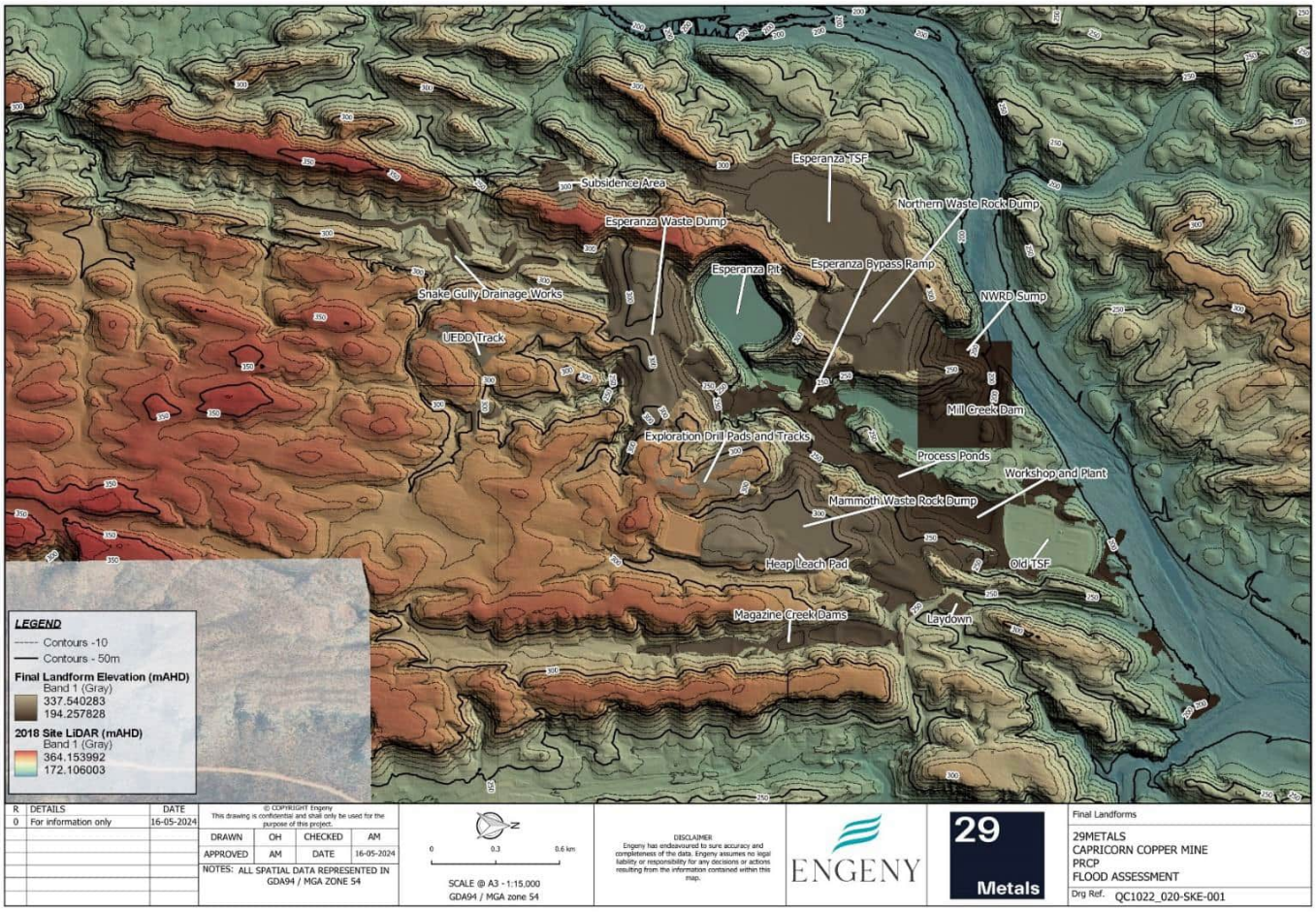


FIGURE 1.1: FINAL LANDFORMS OF THE CAPRICORN COPPER MINE

[1] DES. 2014. Guideline: Resource Activities – Rehabilitation requirements for mining resource activities. ERS/2016/1875 V 2.01. Queensland Department of Environment and Science..

2. METHODOLOGY

2.1 Assumptions

It can be expected that waste landforms, when rehabilitated, will be re-shaped, capped with an engineered cover, sheeted with a growth media, and then revegetated. Assuming that spoil does not act as an impeding layer for infiltration, and that they are not prone to tunneling, the stability of the rehabilitated waste landform will depend largely on the erosion characteristics of the growth media/topsoil applied in rehabilitation.

2.2 Basis of Assessment

The long-term stability of the site's landforms will be influenced the by soil and water interaction, in particular the landform shape, the chemical and physical characteristics of the topsoil and spoil, the final surface treatment outcomes (such as vegetation), and the landforms watershed catchments and resultant potential for the concentration of runoff causing erosion.

Typically, landform erosional stability is measured as tonnes of sediment lost per hectare per year (t/ha/yr) (i.e., the amount of sediment expected to detach from the landform). The assessment methodology has therefore been developed to enable evaluation of these factors. The measure of sediment loss used for the assessment methodology is Average Slope Stability. This is the annual average mean soil loss rate (in t/ha/yr) expected over the total length of the slope. The average slope stability (mean) has been used as the primary assessment tool, to enable evaluation of failure which may occur on a constant grade slope.

2.3 Landform Evaluation Model (LEM) Selection

The Water Erosion Prediction Project (WEPP) erosion model has been utilised to determine long-term landform stability. WEPP is a two-dimensional hillslope analysis model developed by the United States Department of Agriculture (USDA), initially for agricultural land to predict runoff, erosion, deposition for hillslopes and catchments. The model has been previously applied to Australian waste rock dumps to validate the model against measures erosion observations. After the USLE and RUSLE equations, WEPP is the most widely applied erosion model to assess soil loss from water[2].

WEPP requires inputs in six main categories for computation: climate generation, hydrology, plant growth, hillslope, soils, and management. These elements are assessed over a timestep (typically daily) are used to determine erodibility, with multiple iterations of the model run back-to-back to predict long term change. During model simulations rainfall is evaluated against plant and soil characteristics, to determine the presence of runoff, sediment detachment, and transport. The WEPP model's evaluates soil erodibility, using the following analytical processes:

- Interrill erodibility (Ki) – describes the detachment of sediment in interrill areas of the landform slope.
- Rill erodibility (Kr) – describes the detachment from rills and rill formations down landform the slope.
- Critical shear stress (Tc) – describes the critical shear stress required for rill initiation.
- Hydraulic conductivity (Ke) – critical in determining losses, and subsequent runoff.

The CCM LEM WEPP model was run over a simulation period of 100-years, to enable assessment of long-term stability of each final landform. To enable complete assessment of long-term stability of the landforms (in particular during high-risk periods such as vegetation establishment), model was run with scenarios of increasing vegetation cover.

WEPP provides a range of outputs dependent to the model parameters being investigated, which align with the selected measures within the basis of assessment and are compared against the selected Target Erosion Rates.

[2] Borrelli, P. et. al. 2021. Soil erosion modelling: A global review and statistical analysis. Science of the Total Environment. v780, pp146-194.

2.4 Target Erosion Rate Selection

Any assessment of landform stability requires a determination of an acceptable erosion rate to inform landform design. CSIRO conducted a national assessment of soil erosion using the revised universal soil loss equation (RUSLE). The grid is an estimate of the six RUSLE inputs for rainfall erosivity factor (R), soil erodibility (K), slope length and steepness (LS), cover management (C), and conservation practice (P). The grid for the CCM site (Figure 2.1: National Assessment Grid of Annual Erosion Rate for the Surrounding Area of Capricorn Copper Mine

shows erosion rates between 1-2t/ha/yr. This rate can be attributed to the high rock content of the regional soils, as well as the sandy texture resulting in higher rainfall infiltration rates. There are some areas of 5t/ha/yr, with some higher rates in the north east in excess of 10t/ha/yr.

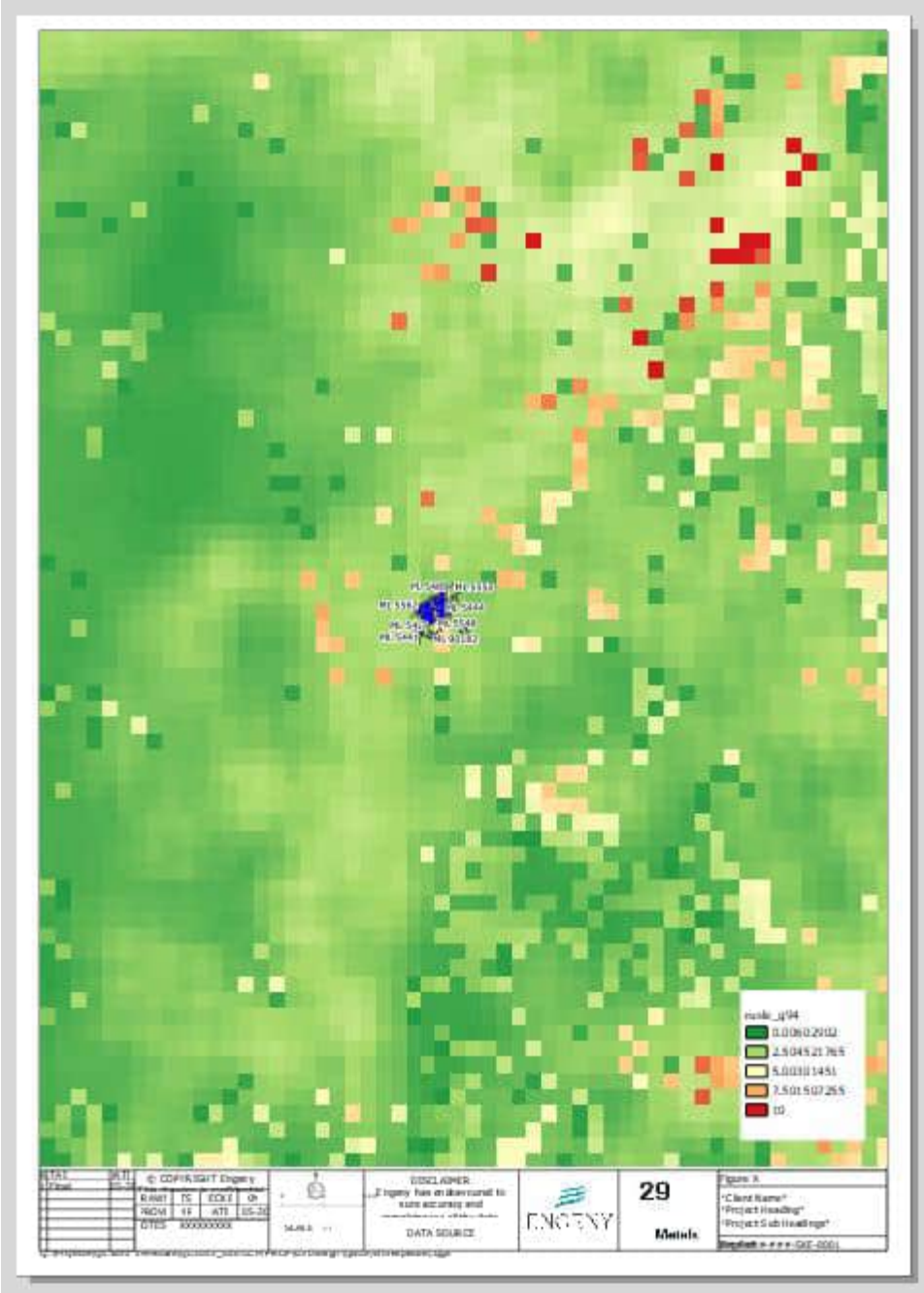


FIGURE 2.1: NATIONAL ASSESSMENT GRID OF ANNUAL EROSION RATE FOR THE SURROUNDING AREA OF CAPRICORN COPPER MINE

There are many definitions of an acceptable or tolerable soil loss rate of which the most environmentally sound would be that soil loss would match soil creation for an equilibrium state. This is impractical from a mine site perspective, as the equilibrium assumes an undisturbed soil profile where pedological and biological processes are functioning, and not a newly created soil cover on a highly disturbed waste landform.

Reviewing regularly refenced industry targets determined that a range of values has typically been adopted, such as:

- Historically, Mining industry Environmental Management Overview Strategies (EMOS) often included conditions requiring sites to target soil erosion loss rates for post mining land use. Typical ranges identified within these studies ranged between 12 t/ha/yr and 40 t/ha/yr[3]. Environmental Management Plans (EMPlans) which replaced the EMOS frameworks and then Environmental Authorities have remained silent on providing guidance to sites on acceptable soil loss rates, favouring general conditions to achieve 'stable' landforms.
- An Australia wide study undertaken in 2001 *The Prediction of Sheet and Rill Erosion Over the Australian Continent, Incorporating Monthly Soil Loss Distribution* used remote sensing to determine erosion rates on a national scale[4]. Erosions rates were then broken down into land uses, with the relevant rates identified as residual / native pastures (7.96 t/ha/yr) and national parks (10.30 t/ha/yr).
- Similarly, the *Leading Practice Sustainable Development Program for the Mining Industry*, published by the Department of Industry, Sciences and Resources references the work of early erosional models, suggesting a loss rate of 12.6 t/ha/yr for maintenance of the fertility of cropland is an applicable target[5].
- The Soil Conservation Measures Design Manual for Queensland (2004) states that a historically accepted limit, roughly representing 1mm of soil loss nominates, would result in approximately 12.5 t/ha/yr as an acceptable soil loss rate.
- Actual studies of erosion rates using rainfall simulators on Central Queensland mine sites estimated topsoil losses under pasture at 10% gradients as 6.7, 2.2, 8.3, and 3.5t/ha/yr. The same study estimated soil loss for 20% gradient pasture as 10.8, 50.7, 15.7, 18.7, 27.1t/ha/yr[6].
- Erosion rate estimates for cultivated Vertosols in Theresa Creek catchment (south of Clermont) on low relief gradients (<3%) at 4t/ha/yr[7].
- The author is aware of a long-term rehabilitation trial (~20 years) in Central Queensland on a WRD between 25-40% gradient. There was no topsoil used on the WRD, nor berms or rock spine drains. The current state of the trial is that there is no visible erosion, and the area is self-sustaining a woodland habitat without maintenance or inputs of fertiliser or soil amendments. The erosion rates during the early establishment as measured by direct sediment capture were 44.5t/ha/yr in the first two years, and then 89t/ha/yr in the following 3 years.
- The USDA undertook a study that suggested tolerable soil loss rates for agricultural soil were between 4.5 and 11.2t/ha/yr[8].

Considering the above, a target rate of 5t/ha/yr has been adopted for CCM Landforms and is considered a conservative value.

[3] Welsh, D., et. al. 1994. Coal mining on target with environmental planning. Queensland Government Mining Journal. v2, pp19-22.

[4] Lu, Hua. 2001. Prediction of sheet and rill erosion over the Australian continent, incorporating monthly soil loss distribution. CSIRO Land and Water, phhp://nla.gov.au/nla.arc-13482

[5] Wischmeier, W.H., and Smith, D.D. 1978. Predicting rainfall erosion losses: a guide to conservation planning, US Department of Agriculture handbook no. 537. US Government Printing Office, Washington DC.

[6] So, H.B. et. al. 2018. MINErosion 3: Using measurements on a tilting flume-rainfall simulator facility to predict erosion rates from post-mining landscapes in Central Queensland, Australia. PLoS One. v28, n13, pp1-21.

[7] Hughes, A.O., *et. al.* 2008. Sediment sources ina dry-tropical catchment: central Queensland, Australia. Sediment Dynamics in Changing Environments (Proceedings of a symposium held in Christchurch, New Zealand, December 2008). IAHS Publ. 325, 2008.

[8] McCormack, D.E., et. al. 1982. Current criteria for determining soil loss tolerance. *in* Determinants of Soil Loss Tolerance. ASA Special Publication No. 45. American Society of Agronomy, Madison, WI. pp95-111.

3. MODEL BUILD

3.1 WEPP Input Files

To enable evaluation of landform stability in the establishment phase, the WEPP model allows for inputs to define conditions expected post construction. A typical landform erodibility potential is particularly high during the establishment period, as the residual ground conditions encountered (i.e., where vegetation coverage on landform slopes is limited). In the context of a reshaped mine WRD, key factors affecting residual ground conditions would include:

- Climatic conditions.
- Landform topography.
- Quality and quantity of growth media, and preparation of the surface (e.g., tillage, deep ripping, crop rill lines).
- Landform establishment (vegetation species selection and success).

3.2 Climate

WEPP generates a climate file using an internal stochastic weather generator, CLIGEN (version 5.1). CLIGEN has previously been validated for Australian climates, including western Queensland. For each CLIGEN simulation, ten daily parameters are required.

- Precipitation.
- Precipitation duration.
- Peak storm intensity.
- Time to storm peak.
- Average maximum temperature.
- Average minimum temperature.
- Dew point.
- Solar radiation.
- Wind speed.
- Wind direction.

To generate the appropriate climate file in the absence of long-term monitored site specific data, the SILO[9] data set was used. The SILO data drill contains information on the CCM site for daily rainfall, solar radiation, and temperature.

Using the data set above, the following WEPP parameter values were calculated:

- Mean daily precipitation on wet days for each month.
- Standard deviation and skewness of daily precipitation for each month.
- Probability of a wet day following a dry day for each month.
- Probability of a wet day following a dry day for each month.
- Mean daily maximum temperature for each month.
- Mean daily minimum temperature for each month.
- Standard deviation of maximum daily temperature for each month.

[9] Qld. Government. 2024. SILO – Australian climate data from 1889 to yesterday. Queensland Government. Accessed 09/05/2024. URL: https://www.longpaddock.qld.gov.au/silo/

- Standard deviation of minimum daily temperature for each month.
- Mean maximum 30-min rainfall intensity for each month.
- Mean dew point for each month.

Using the calculated parameters, a CLIGEN parameter file was created for the site and a subsequent 100-year climate file was generated using CLIGEN (5.1). The standard WEPP approach of using Priestley-Taylor's method for estimating the potential evaporation was also adopted.

3.3 CLIGEN Validation

For validation of the CLIGEN climate file, statistical comparison was undertaken against the SILO drill data set. The annual average annual rainfall for the SILO Drill data set was approximately 496mm, while the CILGEN model produced an annual average of 457mm. Figure 3.1 compares the monthly average rainfall for the both the SILO data drill and CLIGEN 100-year climate data sets.

The frequency of occurrence of the maximum daily rainfall was compared using a Log Pearson III distribution for both data sets. Figure 3.2 displays the corresponding daily rainfall to recurrence interval for the data sets. Given the variability in the region's rainfall, the recurrence interval for daily rainfall matches well for both data sets.

The 100-year synthetic CLIGEN generated data set, correlates closely with the SILO Drill data set for the CCM region. This correlation validates the use of the CLIGEN climate file within the WEPP program to simulate runoff conditions expected on the landform.

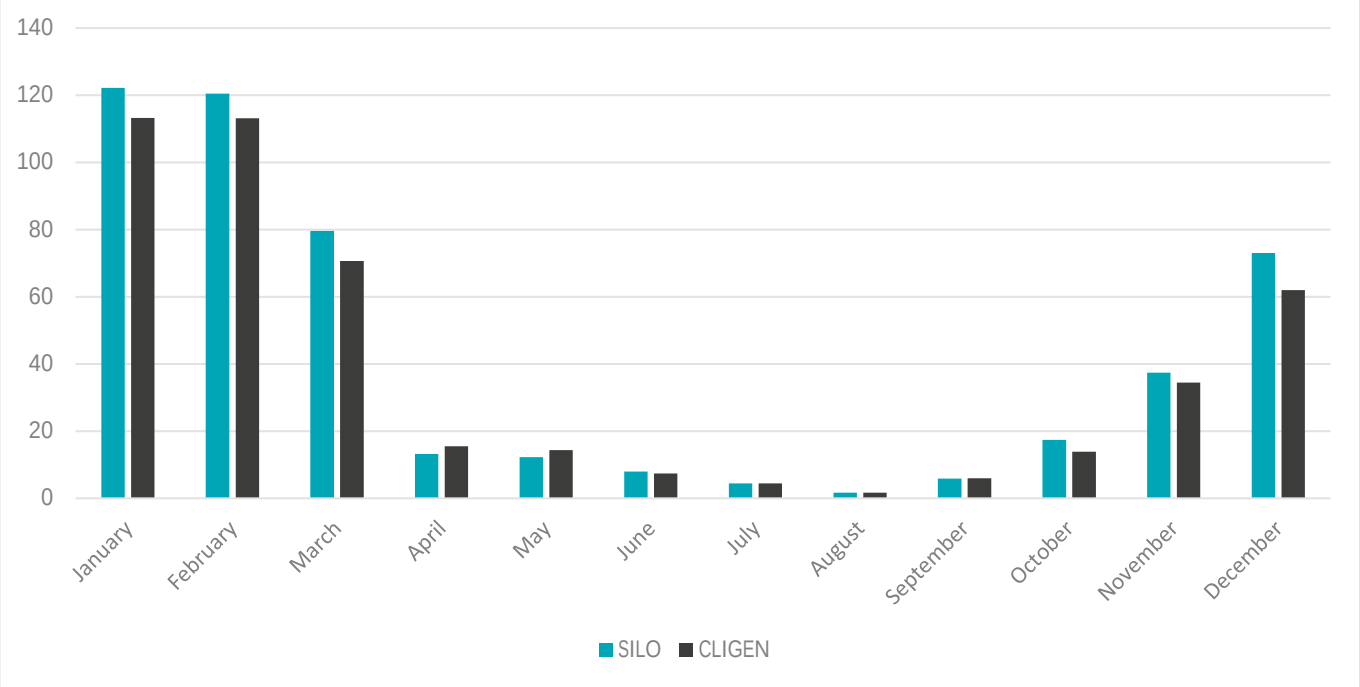


FIGURE 3.1: CLIGEN AND SILO DATA DRILL MONTHLY RAINFALL (MM) COMPARISON

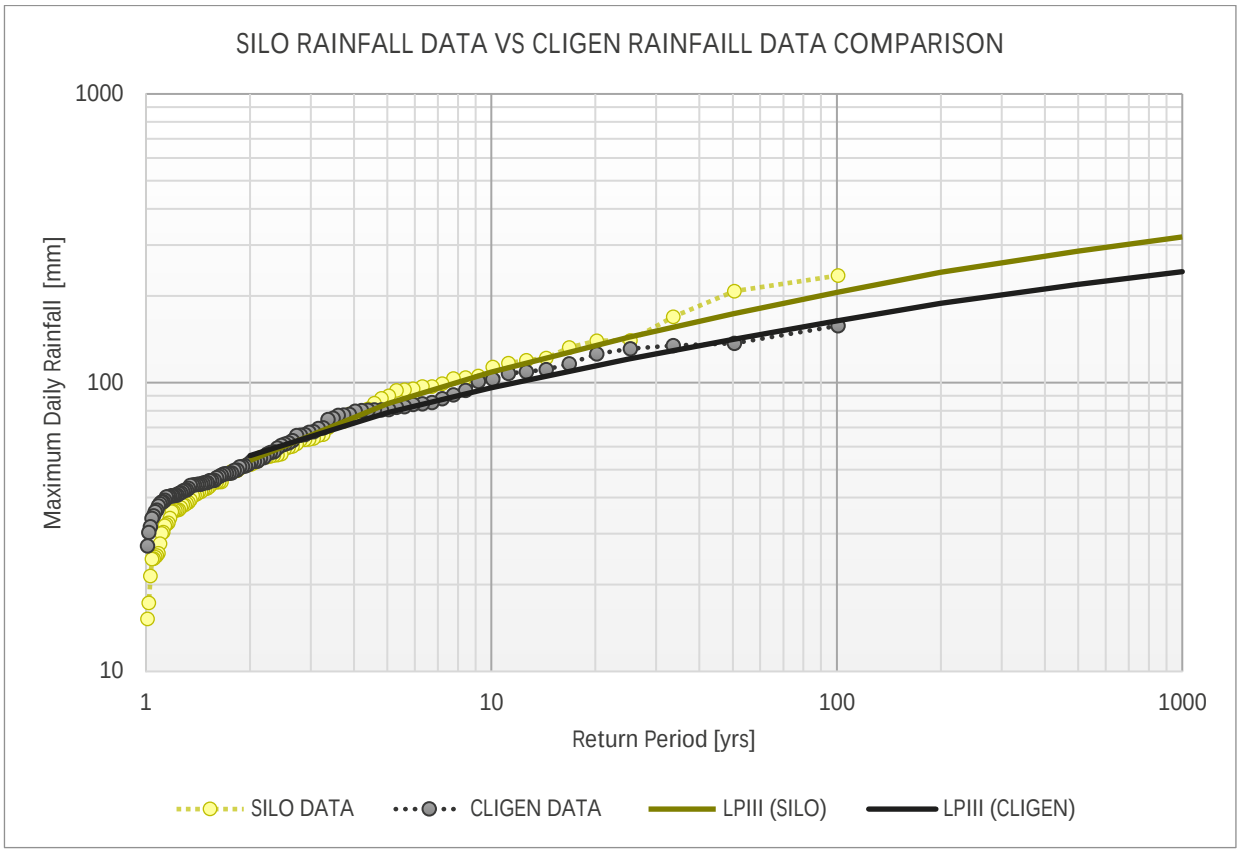


FIGURE 3.2: CLIGEN AND SILO DATA DRILL FREQUENCY OF OCCURRENCE COMPARISON

3.4 Landform Soil

WEPP requires a material file of the proposed landform growth media/topsoil. The main input requirements for the material file are:

- Particle size distribution (%) (clay, sand, rock).
- Organic matter (%).
- Cation Exchange Capacity (CEC) (meq/100g).

The area has been previously mapped[10] as a unit Fz29 (Figure 3.3) described as low hilly to hilly lands with extensive rock outcropping and steep slopes, along with narrow undulating valleys. The dominant soil type is a very shallow gravelly loam corresponding to Um1.43 using the Northcote classification[11]. This soil is described as a uniform medium textured soil showing little, if any, pedological organisation beyond possibly some accumulation of organic matter in the surface 2.5-3cm, are non-calcareous, and are Group 5 in the value/chroma colour scheme.

The soil encountered on site from nine test pits were very uniform, and the material was sand to loamy sand, acidic, low nutrient, low organic matter, low CEC soil with an abundant stone content throughout. The main difference from the previously mapped information was the coarse texture, as opposed to medium texture.

[10] McKenzie, N.J.; Jacquier, D.W.; Ashton, L.J.; Cresswell, H.P. 2002. Estimation of soil properties using the Atlas of Australian Soils. 2000-02. legacy:889. http://hdl.handle.net/102.100.100/205546?index=1

[11] Northcote, K.H. 1979. A factual key for the recognition of Australian soils. Fourth Edition. Rellim Technical Press.



FIGURE 3.3: SOIL MAPPING OF THE CCM SITE SOUTH OF THE ESPERANZA PIT AND ESPERANZA WASTE ROCK DUMP SHOWING THE UNIFORMITY OF THE MATERIAL



FIGURE 3.4: EXAMPLE SOIL SAMPLING SITE WITHIN THE TSF3 FOOTPRINT. NOTE: TROWEL BLADE IS 15CM FOR SCALE.

From the above information, the WEPP material file was written based on the TSF3 footprint soil samples for particle size (sand, silt, and clay), organic matter, and CEC as shown in Table 3.1.

TABLE 3.1: SOIL ATTRIBUTES USED FOR THE WEPP MATERIAL FILE

Attribute	CCM Soil
Sand %	90
Silt %	3
Clay %	7
Texture	Sand
Organic content %	0.60
CEC	1.50

A typical approach when using WEPP where the material parameters have not been experimentally derived, is to allow the model to calculate the rill, interrill, critical shear and effective hydraulic conductivity. In this case it is very apparent that the surface soils have an abundant stone content. To better characterise this attribute, a direct estimate of the critical shear (τ_c) value was made. In a review of rock sizing equations as they relate to D_{50} and D_{75} by various authors[12], it was shown that critical shear could be directly related to the simplified equation:

$$\tau_c(N/m^2) = 950 \times D_{50}(m) \qquad \textit{Equation 1}$$

Noting that critical shear in N/m^2 is equivalent to Pascals in SI units.

As exemplified in Figure 3.5 (and previously in Figure 3.4) there is a very high rock content of the soils which would not be reflected if the <2mm analysis was the only input into the material file. As such, it was estimated that the D50 of the soil material rock was 10mm and therefore a critical shear value of 95Pa was calculated. As a means of adding conservancy into the model inputs, the value was halved and a value of 47Pa was used in the WEPP model.

To enable representation of landform surface preparation, the following inputs were utilised, which are values considered standard in the construction of WRD's:

5 cm – initial ridge height and roughness.

5 m – rill spacing.

[12] Witheridge, G.M. 2023. Background to Rock Sizing and Rock Roughness Equations. V1, October 2023. Catchments and Creeks, Bargara, Queensland.



FIGURE 3.5: EXAMPLE ROCK CONTENT OF CCM UNDISTURBED SOILS

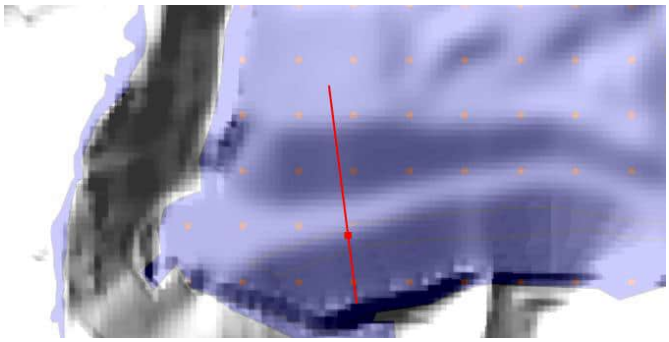
3.5 Rehabilitation Landform Slope Profiles

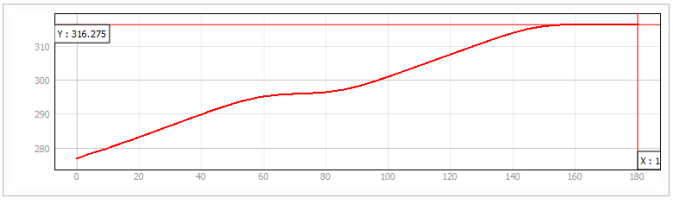
The rehabilitation landforms have been optimised based on site requirements for storage of waste materials, minimisation of waste handling, and as low a slope gradient as possible for factor of safety and erosional risk reduction. After the optimised reshaped surfaces had been completed by Engeny Closure engineers, the landform was interrogated to determine slope lengths and gradients. The aim was to find the highest risk slopes from an erosional perspective. That is, the slopes with the longest slope lengths and the highest elevations. Slope length and height is widely viewed as a key driver in erosion (e.g., RUSLE factors for slope length L and slope gradient S[13]). Representative landform cross sections in terms of height, horizontal footprint, and average gradient are shown in Figure 3.6 and summarised as:

a) Esperanza Waste Rock Dump (Southwest)- 39m high, 154m long, 25% gradient
b) Esperanza Waste Rock Dump (Southeast)- 38m high, 161m long, 24% gradient
c) Esperanza Waste Rock Dump (Northeast)- 47m high, 178m long, 27% gradient
d) Mammoth Valley and Mammoth Hill - 41m high, 199m long, 21% gradient
e) Mammoth Waste Rock Dump- 35m high, 100m long, 35% gradient
f) Old TSF - 11m high, 62m long, 17.7% gradient
g) TSF3 (surface) – 3m high, 687m long, ~1% gradient
h) TSF3 (batter) - 26m high, 78m long, 33% gradient

[13]USDA. 2014. "Revised Universal Soil Loss Equation (RUSLE) - Welcome to RUSLE 1 and RUSLE 2". URL: https://www.ars.usda.gov/southeast-area/oxford-ms/national-sedimentation-laboratory/watershed-physical-processes-research/docs/revised-universal-soil-loss-equation-rusle-welcome-to-rusle-1-and-rusle-2/ United States Department of Agriculture - Agricultural Research Service

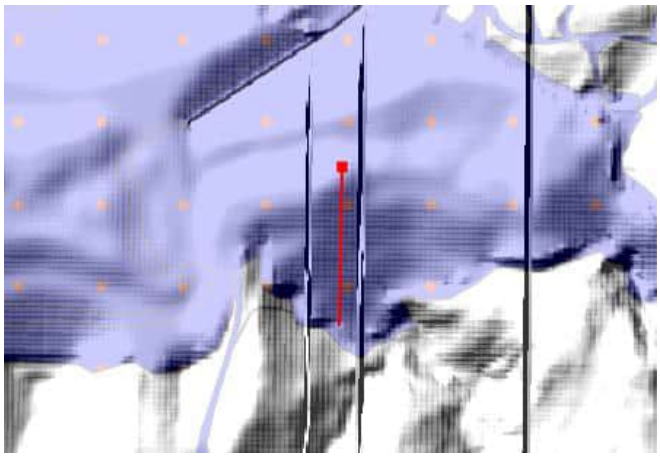
A – ESPERANZA WASTE ROCK DUMP (SOUTH WEST)

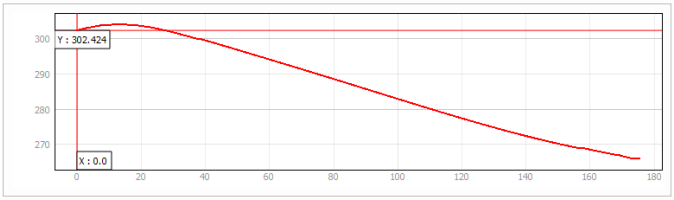




39m high, 154m long, 25.3% gradient

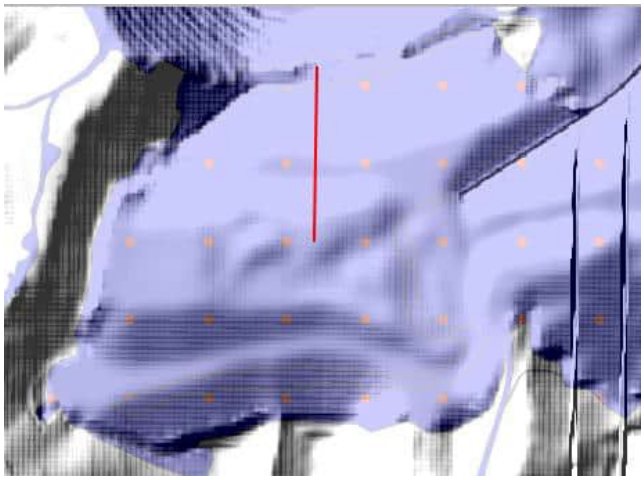
B - ESPERANZA WASTE ROCK DUMP (SOUTH EAST)

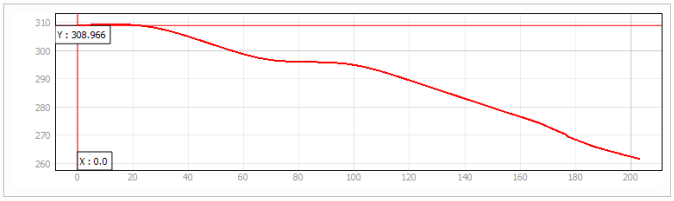




38m high, 161m long, 23.6% gradient

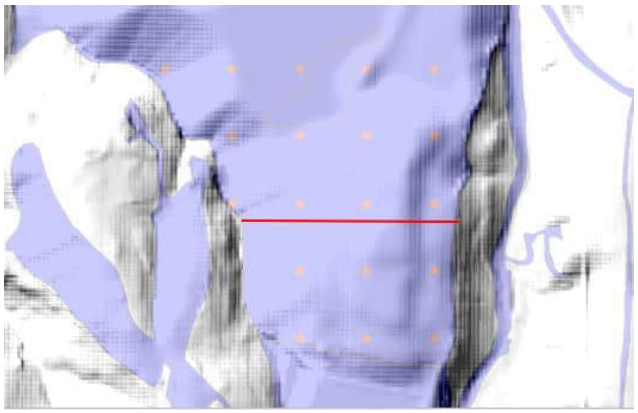
C- ESPERANZA WASTE ROCK DUMP (NORTH EAST)

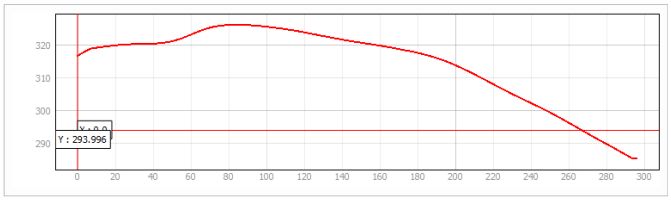




47m high, 178m long, 26.4% gradient

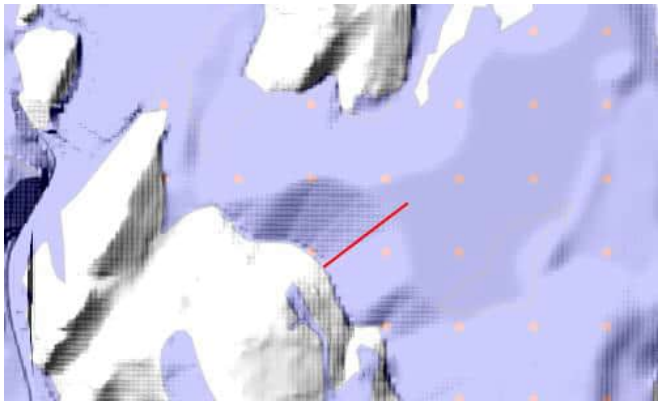
D- MAMMOTH VALLEY AND MAMMOTH HILL

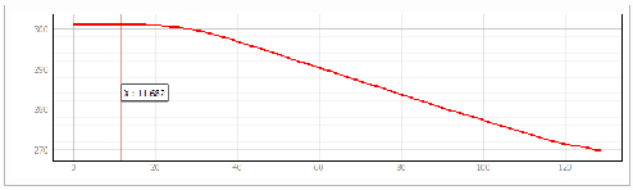




41m high, 199m long, 20.6% gradient

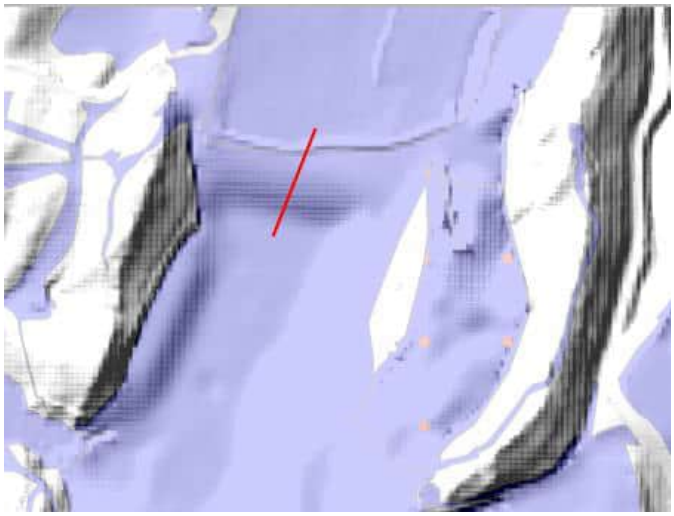
E- MAMMOTH WASTE ROCK DUMP

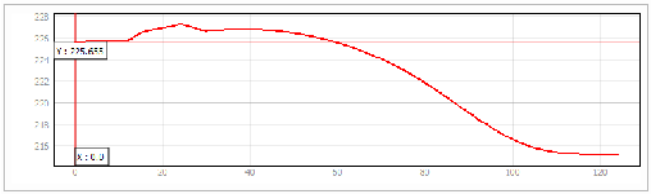




35m high, 100m long, 35% gradient

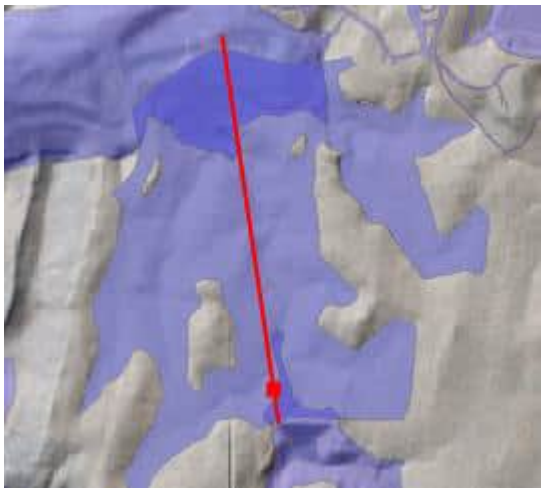
F – OLD TSF

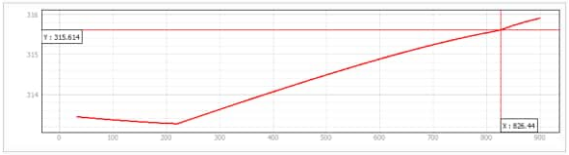




11m high, 62m long, 17.7% gradient

G – TSF3 SURFACE

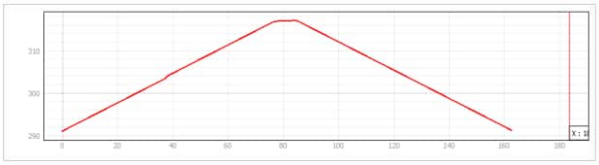




3m high, 687m long, ~1% gradient

H – TSF3 BATTER





26m high, 78m long, 33% gradient

FIGURE 3.6: CROSS SECTIONS AND PROFILE OF SELECTED CCM LANDFORMS

The WEPP model was run on the above slope scenarios for landform A to E and the results assessed against the target erosion rate. The scenarios were also modelled using varying rates of vegetation cover. Landform F was not simulated, as it is relatively low in height in comparison to the other landforms, and therefore low risk.

3.6 Vegetation Cover

The presence of vegetation provides resilience to erosion on all landform slopes. If erosion modelling results in exceedance of the target rate of 5t/ha/yr, vegetation will be added at an increasing cover rate of 30%, 60%, and 90% until the target is met. The initial model simulation for the duration period (i.e., 100 years) was done with no vegetation cover value (i.e. 0%).

4. MODEL RESULTS

Analysis has been undertaken for the long-term erosion rates (100 years) in the prevailing climate to determine if the average adopted soil loss rate of 5t/ha/yr is met for CCM Final Landforms. Landforms A to E detailed in Figure 3.6 were modelled, adopting relevant WEPP parameters for the soil described in Table 4.1. Comparison of model results for target rates of slope average provides an indication of future stability.

4.1 Average Slope Stability

To assess average slope stability, the annual average soil loss rate calculated by WEPP (Table 4.1). was reviewed for each landform. The most erodible landform was the northeast portion of Esperanza Waste Rock Dump at 3.44t/ha/yr. This landform has the highest profile at 47m and the second steepest gradient of 27%. However, all landform's achieved erosion results below the target erosion rate, without the use of vegetation cover.

TABLE 4.1: WEPP ANNUAL AVERAGE MEAN SOIL LOSS RATE OUTPUTS (T/HA/YR) FOR 0% VEGETATION COVER

Landform/Scenario ID	Landform Height, Horizontal Footprint, And Average Gradient	Average Soil Loss (t/ha/yr)
A: Esperanza Waste Rock Dump (Southwest)	39m high, 154m long, 25% gradient	2.51
B: Esperanza Waste Rock Dump (Southeast)	38m high, 161m long, 24% gradient	2.44
C: Esperanza Waste Rock Dump (Northeast)	47m high, 178m long, 27% gradient	3.44
D: Mammoth Valley and Mammoth Hill	41m high, 199m long, 21% gradient	2.31
E: Mammoth Waste Rock Dump	35m high, 100m long, 35% gradient	2.76
F: TSF3 Surface	3m high, 687m long, ~1% gradient	0.08
G: TSF3 Batter	26m high, 78m long, 33% gradient	1.79

5. DISCUSSION

The WEPP modelling results for the CCM final landforms are representative of regional undisturbed landforms, given the CSIRO's National Assessment of Soil Erosion for representative slopes in the region ranged between 1-7t/ha/yr (Figure 2.1Figure 5.1). It is also important to note that the CSIRO estimates represent regional slopes that are much steeper than those simulated in this report.

The relationship between increased rock cover and reduced erosion rates is well established[14] (Figure 5.1) which supports the findings of this report for a soil material high in rock content. Studies comparing rock clad rehabilitated slopes with conventionally topsoiled rehab showed that erosion was comparable to undisturbed sites (Figure 5.2). Rock cladding can not only reduce erosion, but also help create conditions to establish native ecosystems.

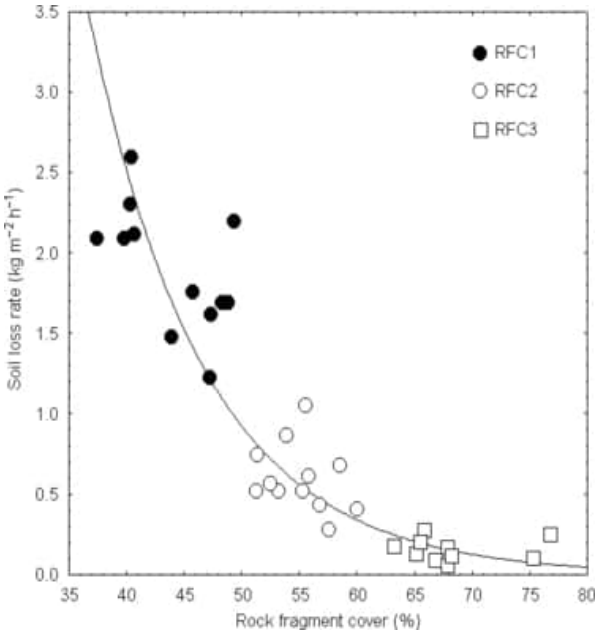


FIGURE 5.1: RELATIONSHIP BETWEEN INCREASING ROCK COVER & DECREASED SOIL LOSS

[14] Avala, L.M. and Jordan, A. 2010. Relationships between rock fragment cover and soil hydrological response in a Mediterranean environment. Soil Science and Plant Nutrition. v56, n1. pp 95-104.



FIGURE 5.2: COMPARISON OF UNMINED AND STABLE ANALOGUE SITES IN COMPARISON TO ROCK CLAD SITES FOR GULLY EROSION TYPE AND SEVERITY[15].

5.1 Model Sensitivity Analysis

To assess the results shown in Table 4.1, a number of adjustments were made within the WEPP model to assess the changes in the results. As the base case, the most erodible landform C- Esperanza Waste Rock Dump (Northeast) (47m high, 178m horizontal footprint, and 27% gradient) was used as the comparison (3.44t/ha/yr). Important WEPP input parameters were adjusted and rerun to compare against the base case. The altered input parameters were:

- A change in rill spacing from 5m to 2m.
- A doubling in the soil thickness from 300mm to 600mm
- A change in the climate file to increase rainfall by 100mm/year.
- A removal of the rock content of the soil (i.e., input of critical shear value) and allowing WEPP to calculate the value based on the <2mm particle size distribution of sand, silt, and clay.

The results of the analysis are shown in Table 5.1.

TABLE 5.1: SENSITIVITY RESULTS (SCENARIO C) FOR CHANGES TO VARIOUS WEPP PARAMETERS

Parameter	Average Soil Loss (t/ha/yr)
Rill spacing 5m ➔ 2m	1.66
Soil thickness 300mm ➔ 600mm	3.69
Climate file 450mm/yr ➔ 550mm/yr	24.09
Soil <2mm size fraction only/no rock	14.12

[15] Emmerton. B.R. 2018. Bowen Basin Coal Mine Spoil Classification for Improved Mine Rehabilitation Outcomes. Ph.D. thesis. The University of Queensland. Centre for Mined Land Rehabilitation, Sustainable Minerals Institute.

Rill spacing can have a major impact on erosion rates. Generally, the greater degree of flow concentration the more widely spaced the rill distance is. Typical rill spacing ranges are between 5m and 2m and this change only has a small change, and it is confirmed that the 5m spacing is the most conservative.

Soil thickness was assumed to be 300mm and the soil samples taken by Engeny were all from the surface. A doubling of the soil thickness also yielded only a small change.

The model was sensitive to a change in climate file. The climate file used was from Central Queensland where the rainfall pattern is summer storm dominant and was 100mm greater per year. This did increase soil erosion rates above target levels, and this showed the true effect of water erosion on the simulated material.

The soil material file was also sensitive to change. An estimate of the critical shear strength of the material due to its rock content was changed to allow the WEPP model to calculate it from its own equations using the <2mm particle size information for a sand textured material without rock. The 100 year simulation of this sandy soil showed that the average annual erosion rates were also above target rates.

6. CONCLUSIONS

The Landform Evolution Modelling assessment was undertaken on several final landform scenarios at the CCM. The slopes were selected to represent the 'worst case' (or highest risk of instability), considering slope height and length for the final landform. The soil file was constructed using soil information from the south of site, and an estimate of the critical shear values for a material dominated by rock with an approximate D_{50} of 10mm.

Of the slope combinations modelled, it was identified that each will achieve the defined average slope erosional stability without a vegetative cover. A sensitivity analysis showed that the model was not sensitive in this case to key inputs of rill spacing and soil thickness but are correctly responsive to increases in annual rainfall and the removal of rocks from the soil matrix.

The modelling and the direct soils sampling points to potential rehabilitation methods for CCM. The natural undisturbed country is comprised of steep stone rich material that has a sand texture and acidic pH that supports native Snappy Gum woodland communities. If stockpiled material is not available in adequate quantities, then sourcing of such materials for covers and growth media could be an option if supported by rehabilitation trials to prove up the concept and allow for testing of the optimum vegetation establishment techniques.

7. QUALIFICATIONS

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

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

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(g) This Report does not provide legal advice.

A.3 Life of Mine Tailings - Multi Criteria Analysis Decision Report, V1, Capricorn Copper

CAPRICORN COPPER
Life of Mine Tailings –
MULTI CRITERIA ANALYSIS DECISION REPORT

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APPENDICES

A – Report of Investigation into the Thickening of Capricorn Copper Tailings. FLSmidth (February 2023)
B - Report of Investigation into Filtration of Capricorn Copper Tailings. FLSmidth (February 2023)
C - Filtration Plant Cost Indication. Metso Australia (September 2024)
D – Tailings Storage Options Desktop Ecology Assessment. KG Environmental (August 2024)

1. OBJECTIVES AND PURPOSE

This report has been prepared to document the evaluation and selection process undertaken by 29Metals (29M) to determine the most appropriate long term tailings solution for Capricorn Copper Mine (CCM). The method for assessment of potential options was undertaken using a Multi-Criteria Analysis (MCA). As part of the MCA process 29M has considered options for employment of different technologies to mechanically alter and dewater the properties of tailings produced by the process plant which are discussed herein. Following a decision on the most appropriate tailings technology to be utilized, 29M has considered a range of options for the preferred tailings storage facility (TSF) location.

The objective of the MCA is to assess the options at a high level and eliminate the least favourable options; taking forward the preferred options to concept design stage and a preferred option to detailed design, in the process formalizing a Life of Mine (LoM) tailings strategy for CCM. This report details the steps of this MCA including the various options considered, the MCA evaluation and assessment criteria used, and associated weighting applied to each criterion.

2. CAPRICORN COPPER MINE OVERVIEW

CCM is located in Gunpowder, 120km north of Mt Isa, QLD. 29M manages 3 underground mines and processes up to 2.0 Mt of ore per annum producing copper -silver concentrate. The site is bordered by Gunpowder creek to the west and north. The Esperanza pit is located central to the mining operation.

CCM has been operated dis-continuously since 1927, including several major periods since the 1990s, where it was under care and maintenance. Periods of care and maintenance include 2001 –2003, 2009, 2010 – 2011, and 2013 – 2021. The site suspended operations in Q2 2024 to address water inventory issues and to determine a tailings strategy to support long term operation. For the purpose of the MCA, a long-term tailings strategy will support the current LoM plan of 10 years following restart. However, CCM are actively developing a robust tailings strategy which includes provision for storage beyond the current LoM.

Two tailings storage facilities (TSFs) exist on the site, the Old (or Mammoth) TSF and the Esperanza TSF (E TSF), with the Esperanza Pit (E Pit) also used as a previous tailings storage facility. The Old TSF is situated to the northeast of the Mill Creek Dam (MCD), and it has been capped and decommissioned. The E TSF was the only active storage prior to suspension of operations and is located in a steep-sided valley running roughly from south to north, with the northern end abutting the North Waste Rock Dump (NWRD). E TSF currently has approximately 2 months of residual tailings capacity available. Further raises to E TSF have been included as part of the MCA A Locality Plan is provided in Figure 2.1.

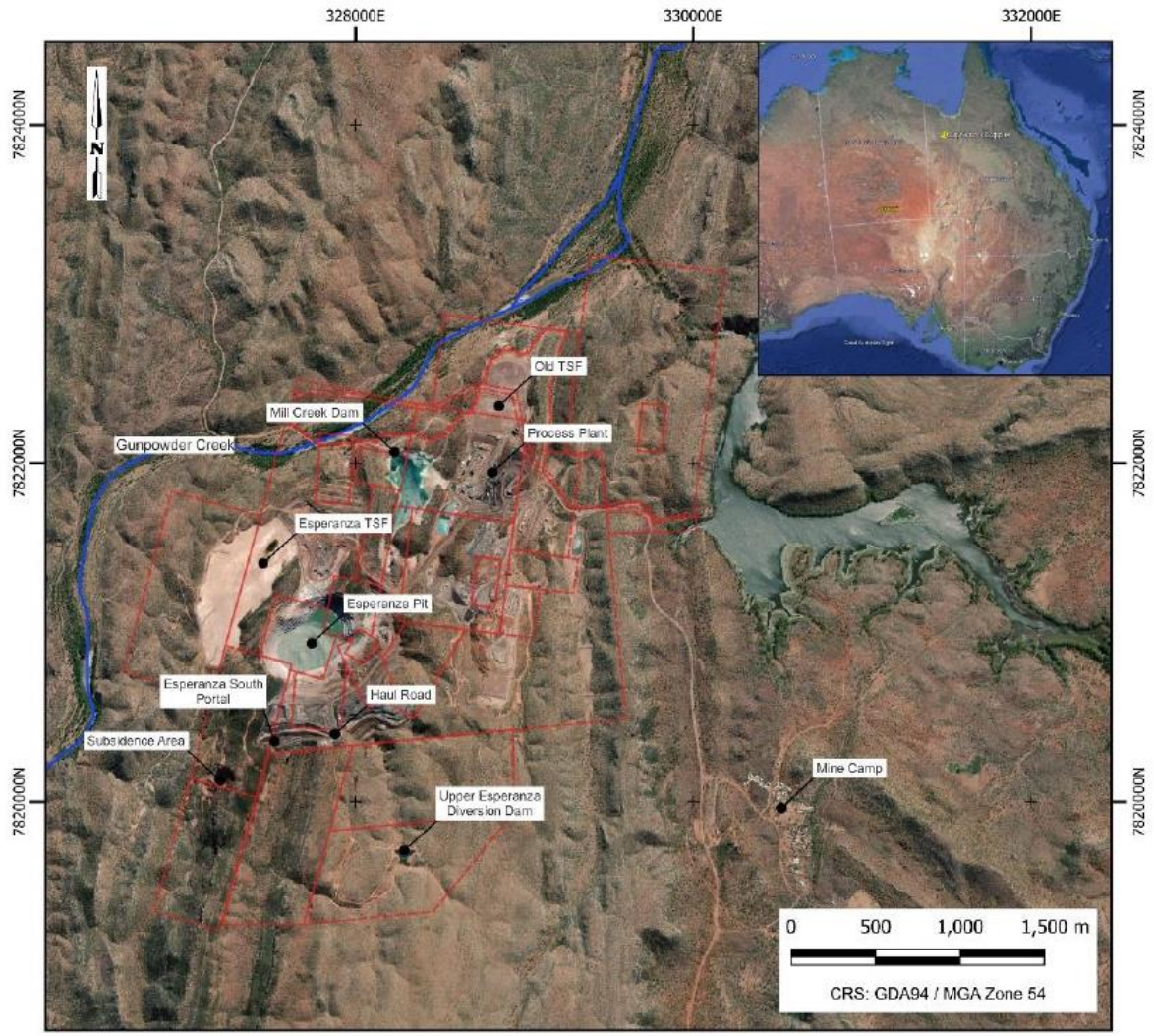


Figure 2.1: Locality Plan

Mill throughput upon recommencement of operations is progressing towards 2 Mtpa with an expected mine life of 10 years. During operations, tailings are thickened in a high-rate thickener and pumped to E TSF with a portion (approximately 13%) diverted to the paste plant located to the east of E Pit. The tailings are filtered and then mixed with a cement slurry at the paste plant before being pumped underground, with the residual tailings pumped to E TSF for storage.

Based on a 10-year LoM and tailings production (taking account of paste plant requirements) of 1.3 – 1.6 Mtpa with a total storage requirement of 16 Mt.

3. PREVIOUS LOM STRATEGY

A LoM tailings strategy was undertaken in 2022 which identified the preferred strategy as below.

1. Raise Esperanza TSF to provide short term storage capacity.
2. Conversion of E Pit to allow for storage of in-pit tailings through amendment of the Design Storage Allowance (DSA) for CCM
3. Design and construct a new TSF in the Upper Esperanza Valley with 5 year and 10 year options assessed (TSF and UE TSF)

The approach provided flexibility with multiple tailings options and a pathway for LoM tailings storage as well as supporting mine closure requirements. Developments at CCM following the completion of this strategy have necessitated the revision of the approach with a new strategy being developed in 2024, supported by this MCA.

4. MULTI-CRITERIA ANALYSIS

Multi-Criteria Analysis (MCA), also known as Multi-Criteria Decision Analysis (MCDA), is a structured approach used to evaluate and prioritize options when decisions need to consider multiple conflicting criteria. Unlike traditional analysis methods that might focus on a single objective (e.g., cost minimization), MCA takes a more holistic view, weighing various factors such as cost, quality, environmental impact, and social outcomes to provide a comprehensive assessment.

The process for development of an MCA include:

- **Define Objectives and Criteria**: Clearly identify the goals and list the criteria that are relevant to the decision (e.g., cost, efficiency, sustainability).
- **Assign Weights**: Establish the importance of each criterion relative to others. This often involves stakeholder input to reflect priorities.
- **Score Alternatives**: Rate each option against each criterion, either qualitatively or quantitatively.
- **Aggregate Scores**: Combine scores and weights to arrive at an overall ranking of alternatives.
- **Analyze Results**: Examine the rankings, possibly performing sensitivity analysis to understand how changes in weights or scores impact the outcome.

5. DESIGN AND ASSESSMENT APPROACH

29M approaches the design and assessment of new infrastructure generally in accordance with guidance from American Association of Cost Engineering (AACE). The general approach is summarised below:

1. **Pre-Feasibility Phase (Class 5 Estimate)**
   - **Data & Scope**: Early, limited data, representing 0-2% of the project definition. This may include broad geological surveys, general site assessments, and benchmarking against similar TSFs.
   - **Cost Estimate Accuracy**: A Class 5 estimate is a high-level, order-of-magnitude estimate with an accuracy range of -20% to -50% low and +30% to +100% high. This serves for initial investment considerations and strategic feasibility rather than precise budgeting.
2. **Preliminary Feasibility Phase (Class 4 Estimate)**
   - **Data & Scope**: Scope definition improves to around 1-15%, including conceptual layouts and initial geotechnical data.

- **Cost Estimate Accuracy**: Estimates fall within -15% to -30% low and +20% to +50% high. Cost models are created using parametric approaches and early assumptions, supporting decision-making on whether to proceed to the feasibility stage.

3. **Feasibility Phase (Class 3 Estimate)**
   - **Data & Scope**: With 10-40% project definition, more detailed geological data, preliminary environmental assessments, and design options are available.
   - **Cost Estimate Accuracy**: Class 3 estimates aim for -10% to -20% low and +10% to +30% high, supporting budget authorization decisions and detailed project feasibility studies.
4. **Definitive Phase (Class 2 Estimate)**
   - **Data & Scope**: At 30-75% project definition, the design includes final embankment layouts, seepage controls, and structural details, aligning with regulatory guidelines.
   - **Cost Estimate Accuracy**: A Class 2 estimate is within -5% to -15% low and +5% to +20% high, supporting contractor bidding and final budgeting.
5. **Execution Phase (Class 1 Estimate)**
   - **Data & Scope**: Full project definition (65-100%) with finalized engineering, procurement, and construction details.
   - **Cost Estimate Accuracy**: Class 1 estimates are the most accurate, falling within -3% to -10% low and +3% to +15% high. This phase enables precise control over construction and cost management, based on detailed unit costs and vendor quotes.

For the purposes of the MCA, information and estimates are generally equivalent to a **Class 5 estimate** and represents the earliest stage of cost estimation and is often used for strategic business planning or preliminary project feasibility studies. It is typically based on limited data, usually about 0-2% of total project definition. Class 5 estimates are essential for scoping the preliminary implications of a TSF project, helping to set early expectations and guide the allocation of resources for more refined project development given it is not feasible to undertake a full design process for all potential alternatives.

A summary of the approach to is included below:

1. **Data and Scope**
   - **Level of Definition**: A Class 5 estimate relies on minimal information. The data typically come from historical project data, high-level conceptual layouts, or analogous cost estimates based on similar facilities.
   - **Information Sources**: The estimate may use data like preliminary site assessments, regional geological surveys, environmental constraints, and benchmarking against comparable projects.
2. **Accuracy Range**
   - **Estimate Range**: Class 5 estimates have a broad accuracy range, typically falling between -20% to -50% on the low side and +30% to +100% on the high side. This variability is due to the limited project definition and the conceptual nature of the information.
   - **Purpose**: This early-phase estimate is useful for go/no-go decisions, initial investment considerations, or order-of-magnitude cost evaluations rather than detailed financial planning.
3. **Methodology**
   - **Estimation Techniques**: Class 5 estimates often employ parametric models, historical cost data, or capacity-factored methods, which extrapolate costs based on facility size, production rate, or other key characteristics.

- **Decision-Making**: While these estimates are approximate, they provide a high-level cost understanding to assess if further investment into detailed design and feasibility studies is justified.

6. TAILINGS TECHNOLOGY

6.1 Introduction

Tailings produced at CCM has historically been thickened to approximately 50-60% w/w using a high-rate thickener at the process plant and pumped to E TSF via a lined steel and HDPE pipeline. The tailings are then deposited into E TSF via spigots spaced at nominal 20 m centres on the perimeter embankment. Deposition spigots are rotated to ensure a beach is formed around the perimeter embankment and saddle dams and supernatant water reports to a centrally located decant.

The first stage of the MCA process is to assess the current deposition methodology along with alternative technological options available for tailings treatment, deposition and storage for the 10-year life of mine. This will allow the development of a tailings transportation and deposition plan which will describe how tailings will be transported and deposited in the chosen tailings facility and ensure that the selected facility location will have capacity of the life of the mine, either through initial construction or a staged construction methodology. This assessment was performed in 2022 and 2023 in consultation with Consulting Engineers, GHD (2022) and 2023 with ATC Williams (2023). These assessments form the basis of this MCA.

6.2 Options Considered

The MCA considered a number of options for tailings treatment and deposition which are summarized in the following sections.

6.2.1 Conventional Thickened Tailings

Thickened tailings disposal involves processing of the slurry tailings through a thickener, i.e. a large dewatering tank that uses the addition of flocculant along with mechanical agitation to aid settling and separation of the solids.

The slurry stream is introduced radially into the centre of the thickener at which point flocculant is added to the flow which causes the fine particles to coagulate and settle at a faster rate. As the solid particles settle, a thickener rake slowly rotates and moves material that has settled towards the central thickener underflow. At the same time, the clear liquid on the surface rises as more slurry enters the thickener, and eventually overflows a weir at the top of thickener and is collected in a storage tank for reuse in the process water circuit.

The solid particles that have settled in the centre of the thickener then flow out of the base through the thickener underflow with significantly less water than was in the slurry when it entered the thickener. The thickened slurry can then be transferred by conventional slurry pumps to the TSF.

The main advantage of thickeners is that a significant amount of water can be recycled, and the slurry properties have not been significantly altered beyond a point where conventional slurry pumps cannot be used for tailings transfer.

In the case of CCM, the use of the existing high-rate thickener producing tailings at a target solids concentration of 60% w/w has been used as the basis for the MCA. The existing pumping infrastructure has

been assumed as suitable, but a new storage facility would be required with in-line booster pumps, along with associated electrical infrastructure, required depending on the final deposition location.

6.2.2 High Density Thickened Tailings

High density thickened tailings are defined as tailings that have been significantly dewatered to a point where they will form a homogenous non-segregated mass when deposited from the end of a pipe. They are produced in a similar manner to conventional thickened tailings with the key difference being the thickener technology used. High -density thickeners are typically characterized by having a higher sidewall tank to provide enhanced compaction effects and a steeper floor slope to assist in moving the settled solids to the discharge underflow.

The solids particles will be of a high solids concentration than those produced by a conventional thickener, typically 60 – 70% w/w, but with a yield stress that will still allow for transfer to the deposition location using conventional slurry pumps and lined steel or HDPE piping networks.

A study has previously been undertaken on the feasibility of high-density thickened tailings at CCM by FLSmidth, this included bench scale testing, with the summary report included in Appendix A. This study recommended either a single 16 m diameter high density thickener or a single deep cone thickener of similar diameter, with testing indicating a thickener underflow in the range of 66 – 69% w/w. Therefore, for this MCA it has been assumed that this option will require the installation of a new thickener (either high density or deep cone) and likely upgraded tailings transfer pumps.

A new tailings storage facility would be required to store the high-density thickened tailings with the final deposition location determining whether new pipelines and in-line booster pumps are required.

6.2.3 Paste Tailings

Paste tailings are similar to thickened and high-density thickened tailings, except that the shape of the thickener tends to have a lower diameter to height ratio, and the removal of water is greater leaving a thicker slurry (typically > 70% w/w solids concentration), known as paste. Paste tailings are generally produced through a two-stage process, initially utilizing a conventional high-rate thickener and then pumped into a dedicated paste thickener to increase the solids concentration of tailings.

The increased viscosity of the tailings as a result of high dewatering requires the use of positive displacement pumps to transport the paste tailings and this in turn will limit the distance to which the paste can be economically transported without further pumping requirements.

For this MCA it has been assumed that the existing high-rate thickener can be used for the first stage of thickening with a new paste thickener required to further dewater the tailings. The new paste thickener will require new infrastructure including positive displacement pumps and lined steel pipes. A new tailings storage facility will also be required for a long-term solution using this option with new in-line booster pumps and pipelines required for each storage option.

The existing paste plant at CCM has not been considered as part of this MCA as the capacity is insufficient for use in the large scale production of paste tailings for storage. Additionally, the life of mine plan for the underground mines has established the backfill of voids with paste can account for 10-12% of the tailings solids produced by the ore processing. Esperanza south method of sub-level caving reduces opportunities for paste backfill and there is no ability / borehole to send paste underground. Increase of paste backfill quantities

is reviewed annually and an upgrade to the paste plant throughput is not expected in the medium term and will not replace the requirement for further tailings storage options.

6.2.4 Filtered Tailings

Filtered tailings or 'dry stacking' is the process where the slurry is filtered to a level that allows it to be stacked either by truck or by conveyor into a long-term suitable landform. Filtered tailings are generally produced using a two-stage process, initially utilizing a conventional high-rate thickener with thickened tailings pumped to a dedicated filtration plant.

The filtration plant consists of pressure filters which are used to dewater the tailings to a residual solids concentration of approximately 83-89% w/w. Due to the low moisture content the filtered tailings can no longer be transported by pipeline and normally transported either via an overland conveyor or trucks. The filtered product is deposited, spread and compacted to form an unsaturated tailings deposit usually requiring no retention bunding.

Filtered tailings requires the preparation of a suitable disposal areas with suitable surface contour management and underdrainage systems to prevent accumulation and easy removal of surface water and collection of seepage water and leachate from the stack. Upstream surface water diversion systems to prevent inundation of the dry stack facility will also be required.

A study has previously been undertaken on the feasibility of filtered tailings at CCM by FLSmidth, this included bench scale testing, with the summary report included in Appendix B. This study indicated that a thickened tailings stream of 50% w/w can be filtered to a filter cake moisture of approximately 15%. Following this, Metso were commissioned to undertake a feasibility study and high-level cost estimate for filter plant construction and materials handling requirements which could be applied to CCM. This report is included in Appendix C and indicates a capital cost of approximately $37 m for the filter plant and short distance radial stacker. This will allow the construction of a short-term stockpile which can then be hauled to the dedicated tailings stockpile area by a dedicated haul fleet.

For the purpose of the MCA, the existing high-rate thickener has been assumed as suitable for the first stage of tailings dewatering with the construction of a filtration plant required. Due to the topography at CCM, the use of an overland conveyor has not been deemed as viable with transportation of the filtered tailings undertaken by haul truck. The existing E TSF can be used to store some tailings, but a new area will be required to address the current life of mine tailings production requirements.

Costs associated with a dedicated load and haul fleet as well as stockpile management have not been included in the FLSmidth report. Based on the fleet requirement for both load and haul and filter stack management operating costs are estimated to be in the region of $10 – 15 million per annum as well as increased power requirements.

6.3 MCA Criteria

The tailings technology MCA assessment has been undertaken using weighted criteria determined based on various economic, technical, operational, social and environmental considerations. These were developed through consultation with various industry experts with experience in assessing tailings technology viability, including both GHD and ATC Williams. Table 6.1 provides a summary of this criteria along with associated weighting with the following sections providing further information.

Table 6.1: MCA Criteria and Weighting

Criteria	Applied Weighting
Capital Cost	20%
Operational Cost	15%
Timing and Availability	10%
Safety and Technical Risk	10%
Geotechnical Considerations	10%
Construction and Operational Complexity	5%
Water Management and Recovery	10%
Environmental Considerations	10%
Reclamation and Closure	10%
TOTAL	**100%**

For each MCA option the criteria have been scored using the qualitative system set out in Table 6.2.

Table 6.2: MCA Criteria and Weighting

Description	Score
Strong, positive impact for the criteria or measure	5
Moderate, positive impact for the criteria or measure	4
No significant positive or negative impact	3
Moderate, negative impact for the criteria or measure	2
Strong, negative impact for the criteria or measure	1

6.3.1 Capital Cost

This criterion considers the upfront cost associated with the capital purchase of the infrastructure associated with each technology option. This includes fixed plant requirements such as thickeners, pumping and piping, as well as other transportation requirements such as the purchase of trucks and stockpile management equipment for filtered tailings transportation. Any electrical infrastructure costs associated with fixed plant upgrades and installation of booster pumps are also included in this criterion.

6.3.2 Operational Cost

This considers the ongoing operational costs associated with the operation of the selected tailings technology and deposition system. This will include ongoing operation of the thickener(s) and filtration equipment and power costs. Consideration is also provided to additional manning to support the operation of multiple tailings dewatering plants as well as the ongoing maintenance requirements of these. For the filtered tailings solution this will also include for maintenance costs for mobile equipment as well as the diesel requirements.

6.3.3 Timing and Availability

This criterion considers the availability of the selected tailings technology to meet the operational requirements of CCM as well as the design and construction schedule to support the implementation of the solution. Consideration has been given to the planned restart date of Q1 2027.

6.3.4 Safety and Technical Risk

This takes into consideration the complexity in the design and safety risks associated with implementing the selected technology at CCM. It also considers the dam safety implications of implementing the proposed solution through a consideration of the potential consequence category in accordance with ANCOLD and DETSI requirements along with consideration of the requirements of the Global Industry Standard for Tailings Management (GISTM).

6.3.5 Geotechnical Considerations

Consideration of the overall geotechnical stability implications of the proposed solution through assessment of the implications to tailings facility water management, seepage control and liquefaction potential to any embankments.

6.3.6 Construction and Operational Complexity

This criterion considers the construction works associated with any new plant and pipeline requirements as well as changes to the site operational strategy associated with the updated processing requirements.

6.3.7 Water Management and Recovery

Consideration to the removal of water from the tailings prior to the deposition within a storage facility. This criterion focuses on the water removed and associated impacts to surface water management such as requirements to manage a decant pond or install a spillway as well as impacts on the overall site water balance.

6.3.8 Environmental Considerations

This wide-ranging criterion considers all impacts associated with the proposed technology and impacts to the tailings storage on site. This includes the disturbance footprint to construct a suitable storage area, impacts to the natural environment from groundwater seepage or acid rock drainage seepage from the tailings to the surrounding environment. Consideration is also given to dust management associated with high moisture recovery.

6.3.9 Reclamation and Closure

A consideration for the complexity and costs associated with closing any facility used to store tailings generated from each option. This includes the size of the area required for closure, typical cover and closure requirements and availability of material to implement the requirements. The timeframes associated with closure towards relinquishment are also considered.

6.4 MCA Summary

The MCA has been undertaken using the criteria and weighting provided in Section 6.3 with the results of the analysis provided in Figure 6.1.

Based on the outcome the preferred option to take forward as part of the analysis is that of conventional thickened tailings, i.e. tailings thickened to approximately 60% w/w and pumped to a new storage facility utilizing the existing process plant infrastructure but with the potential requirement for additional pumping infrastructure in the form of an in-line booster stations depending on the final location of the TSF and associated deposition infrastructure.

The MCA shows that increased dewatering of tailings has numerous advantages, particularly from a water management, environmental and closure perspective. However, the increased capital and operational costs associated with these options, along with the construction and operational complexity, means they are not a feasible solution. This will mean that the concerns highlighted in the analysis, particularly those associated with geotechnical and environmental considerations around seepage management will need to be accounted for as part of the tailings storage facility MCA with appropriate site selection and allowance for seepage mitigation measures built into each option.

Criteria	Weighting	Conventional Thickened Tailings	High Density Thickened Tailings (HDTT)	Paste Tailings	Filtered Tailings
CAPITAL COST	20.00	4 Existing thickener used for processing New tailings facility required along with water management infrastructure Potential booster pumps and electrical infrastructure	3 New thickener required for increased dewatering New tailings facility required along with water management infrastructure Potential booster pumps and electrical infrastructure	2 Existing thickener and pumps used but new paste thickener and PD pumps required. New tailings facility required along with water management infrastructure Potential booster pumps and electrical infrastructure	1 Existing thickener and pumps used but new filtration plant required. Purchase of materials handling infrastructure (dump trucks, dozers) E TSF suitable initially but new storage area required for LoM solution
OPERATIONAL COST	15.00	5 Maintenance of existing processing, pumping and piping infrastructure Power costs as existing Ongoing tailings management of conventional TSF	4 Operational costs similar to conventional solution once HD thickener constructed	2 Additional maintenance requirements of paste thickener and pumping infrastructure Additional power costs	1 Additional maintenance requirements of filter plant Additional power costs Ongoing materials handling costs for haulage, placement and stockpile management
TIMING AND AVAILABILITY	10.00	5 Can use current infrastructure for operation Potential additional infrastructure (electrical, booster pumps)	3 Purchase and installation of new High Density Thickener	2 Purchase and installation of new paste thickener and PD pumps	2 Purchase and installation of filtration plant and materials handling infrastructure
SAFETY AND TECHNICAL RISK	10.00	2 Risk of dam failure related to geotechnical stability, liquefaction and seepage	3 Risk of dam failure related to geotechnical stability, liquefaction and seepage, however reduced due to reduced tailings water content.	4 Low probability of dam failure due to low moisture content, however acid rock drainage concerns from paste tailings	3 Acid rock drainage concerns from filtered tailings run off Active management of stockpile of 'dry' tailings will result in increased exposure hours
GEOTECHNICAL CONSIDERATIONS	10.00	2 TSF stability Liquefaction Seepage	2 TSF stability Liquefaction Seepage	4 No major geotechnical risk	3 Potential for remobilisation of tailings in wet climate
CONSTRUCTION AND OPERATIONAL COMPLEXITY	5.00	4 Embankment construction and potential booster pumps No additional operational complexity	3 High density thickener and embankment construction plus potential booster pumps No additional operational complexity other than new equipment	2 Paste thickener and pumps along with suitable storage facility, although potentially reduced earthworks due to improved densities and water management Operational complexity associated with 2 stage tailings processing and new pumping infrastructure	1 Filtration plant construction Ongoing construction and maintenance of filtered tailings stack Operational complexity of new plant and change in operational methodology
WATER MANAGEMENT AND RECOVERY	10.00	1 Lowest water recovery Requires decant pond and water recycling infrastructure as well as addition to site water treatment philosophy Spillway required to manage flood risk	2 Low water recovery Requires decant pond (smaller than conventional thickened tailings) and water recycling infrastructure Spillway required to manage flood risk	4 Good water recovery No major decant pond and potentially no return infrastructure required	5 Best water recovery No major decant pond Stockpile management to collect filtered tailings leachate Storm water diversion infrastructure
ENVIRONMENTAL CONSIDERATIONS	10.00	2 Largest footprint TSF Low Acid Rock Drainage risk Seepage management infrastructure (liners, grout curtains, underdrainage etc.) may be required to prevent infiltration to groundwater	3 Large footprint TSF Low Acid Rock Drainage risk Seepage management infrastructure (liners, grout curtains, underdrainage etc.) may be required to prevent infiltration to groundwater	3 Potentially smaller footprint TSF Minimised risk of seepage to groundwater due to reduced moisture Acid Rock Drainage Risk may require cover	4 Removal of moisture results in limited seepage potential Disturbance of smaller area for filtered tailings stack construction Acid rock drainage risk may require cover system Collection and treatment of filtered tailings leachate Dust management requirements
RECLAMATION AND CLOSURE	10.00	1 Largest footprint and higher closure costs May require capillary break cover to prevent Acid Rock Drainage Limited opportunity for progressive closure and rehabilitation	2 Large footprint and higher closure costs May require capillary break cover to prevent Acid Rock Drainage Limited opportunity for progressive closure and rehabilitation	3 Lower TSF footprint May require capillary break cover to prevent Acid Rock Drainage	4 Lowest footprint May require capillary break cover to prevent Acid Rock Drainage Potential for progressive closure and rehab
Weighted Score	**100**	61.0	57.0	56.0	50.0

Figure6.1: Tailings Technology MCA

7. TAILINGS STORAGE FACILITY LOCATION

7.1 Introduction

Following a decision on the appropriate tailings processing and storage option to take forward an assessment on a suitable location to store the conventional thickened tailings is undertaken. The existing tailings facility at CCM, E TSF, has approximately 2 months of storage capacity available with limited options to extend without undertaking embankment raises.

The intention of this MCA is to identify a long-term storage option that will ideally provide a solution to store tailings up to the current life of mine, i.e. approximately 10 years or approximately 16 Mt of tailings.

7.2 Options Considered

The MCA considered a number of options for the location of a suitable tailings storage facility. An overall plan showing the various options, excluding E TSF, is provided as Figure 7.1 with each option summarized in the following sections.

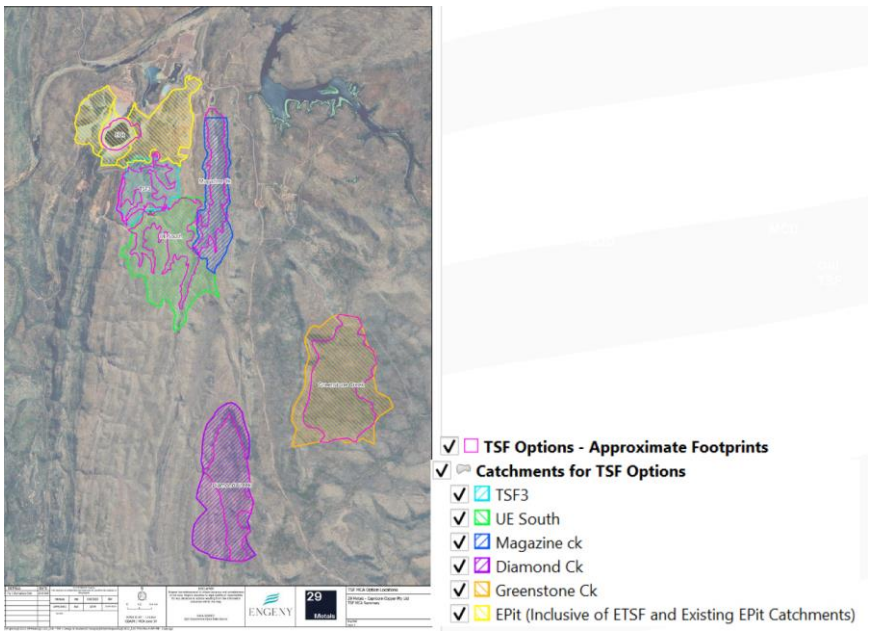


Figure 7.1: TSF Location Options

7.2.1 Upper Esperanza TSF3

Upper Esperanza TSF3 (TSF3) is located approximately 2.7 km south of the CCM process plant, immediately south of the existing Esperanza Waste Rock Dump (EWRD) and north of the existing Upper Esperanza Diversion Drain (UEDD) as shown in Figure 7.2 with key design criteria provided in Table 7.1.

Table 7.1: TSF3 Key Design Criteria

Storage Capacity	6.5 Mm^3
Operational Life	7 years
Distance from CCM Plant	2.7 km
Construction Materials	550,000 m^3
Disturbance Area	54 ha
Disturbance Ranking[1]	Low
Drainage catchment	80 ha
Total Cost (Capital and Operational)	$91,000,000
Storage Cost	$13.98 /$m^3$

[1] Disturbance ranking from Desktop Ecological Assessment (Appendix D)

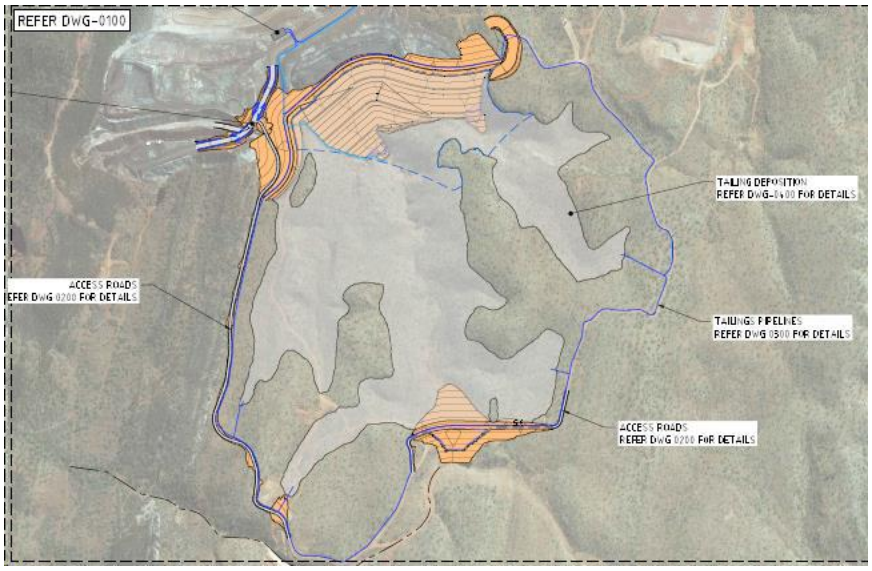


Figure 7.2: TSF3 Location Plan

Placement of a facility in this location will involve reshaping of the EWRD as well as placement of low permeability fill against the upstream face. On the southern side, the existing UEDD provides diversion of an 80 Ha catchment which is critical flood protection infrastructure for CCM and would also be required to form a similar function for TSF3. This embankment would need to be raised and modified to allow for the storage and containment of tailings to the north as well as storm water to the south.

The advantage of TSF3 is the use of EWRD to buttress the storage to the north minimising geotechnical stability concerns associated with TSF failure. However, EWRD contains mine waste material that is potentially acid forming (PAF) and therefore the inclusion of seepage management controls are critical to the design, construction and operation of this facility. Should supernatant water seep through the embankment and

EWRD, this would be captured in E Pit which will form part of the CCM mine affected water storage and treatment system.

TSF3 fully sits on existing CCM mining tenure and would require disturbance of approximately 54 Ha of land, initial ecological surveys have been undertaken which have identified possible presence of threatened species in the area, this would need to be confirmed through additional surveys. Local stakeholders, including landowners and Traditional Owner groups, are supportive of the location of TSF3 due to minimal disturbance and provided adequate seepage controls are included in the design. Additional comments were received regarding the presence of rubbish and contaminants in EWRD as well as geotechnical stability of the ground near the Esperanza underground portal, approximately 500 m from the TSF location. TSF3 could provide an opportunity to address these concerns. The facility provides approximately 7 years storage and would require construction of a second TSF to meet life of mine requirements.

A conceptual TSF cover design for closure as detailed in section 7.3.10 would be applied to facilitate the closure of TSF3 along with the reshaping of the UEDD embankment and EWRD closure. A closure spillway would also be required. Closure considerations are largely driven by the availability of cover material to cap the tailings beach and the costs associated with implementing this cover.

7.2.2 Greenstone Creek TSF

The Greenstone Creek TSF option is located approximately 7.9 km southeast of the CCM process plant and covers an area of approximately169 Ha of greenfield land. It is located in a natural depression with containment provided by a natural ridgeline to the west and a series of saddle embankments as shown in Figure 7.3 with key design criteria presented in Table 7.2.

Table7.2: Greenstone Creek TSF Key Design Criteria

Storage Capacity	13.9 Mm^3
Operational Life	15 years
Distance from CCM Plant	7.9 km
Construction Materials	175,000 m^3
Disturbance Area	169 ha
Disturbance Ranking[1]	High
Drainage catchment	240 ha
Total Cost (Capital and Operational)	$112,000,000
Storage Cost	$8.08 /$m^3$

[1] Disturbance ranking from Desktop Ecological Assessment (Appendix D)

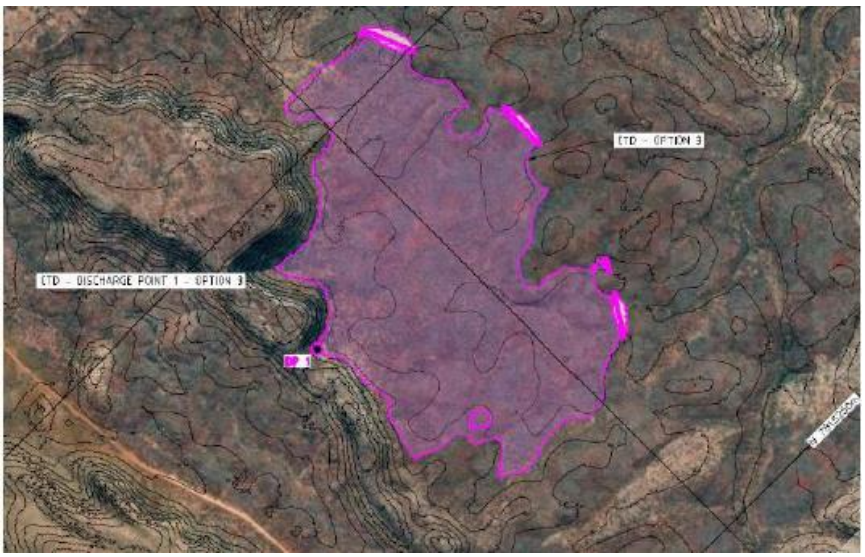


Figure 7.3: Greenstone Creek TSF Location Plan

Modelling indicates that Greenstone Creek TSF will provide approximately 15 years of tailings storage, more than meeting the current life of mine requirements. The impoundment area for Greenstone Creek TSF, approximately 169 Ha, is currently greenfield with no ecological surveys undertaken to assess potential impacts and sits outside of CCM mining tenure.

Greenstone Creek TSF is considered to represent a higher geotechnical risk with standalone engineered fill embankments required to support the containment. Material to construct these embankments, approximately 200,000 m^3, would also require sourcing of sufficient clean rock fill and clay construction materials. Should failure of the embankment occur it is also estimated that, as the facility is above both Greenstone Creek and Lake Waggaboonya, the runout could potentially impact any people in the vicinity and sensitive downstream receptors.

From a water management perspective, while Greenstone Creek has a large catchment, approximately 243 ha, it is not expected that any significant catchment diversion will be required to facilitate the TSF due to its elevation. This does present closure challenges of ensuring there is no residual impacts to the creek along with sourcing of larger volumes of suitable capping material compared to other options due to the facility size. Reprofiling of embankments and construction of a closure spillway will also be require for this option.

Engagement with local stakeholders around the Greenstone Creek TSF option has largely received negative sentiments, including from the owner of the tenure, due to the area being desirable agricultural land for grazing.

7.2.3 Diamond Creek TSF

The Diamond Creek TSF option is located approximately 10 km south of the CCM process plant and covers an area of approximately 96 Ha of greenfield land. It is located in a natural creek line, which forms part of the wider Greenstone Creek, and will require the construction of one large embankment along with a potential series of saddle embankments to support the required storage volume. An outline location of Diamond Creek TSF is provided in Figure 7.4 with key design criteria presented in Table 7.3.

Table 7.3: Diamond Creek TSF Key Design Criteria

Storage Capacity	12.6 Mm^3
Operational Life	14 years
Distance from CCM Plant	9.9 km
Construction Materials	101,000 m^3
Disturbance Area	96 ha
Disturbance Ranking[1]	Medium
Drainage catchment	200 ha
Total Cost (Capital and Operational)	$120,000,000
Storage Cost	\$9.52 /m^3

[1] Disturbance ranking from Desktop Ecological Assessment (Appendix D)

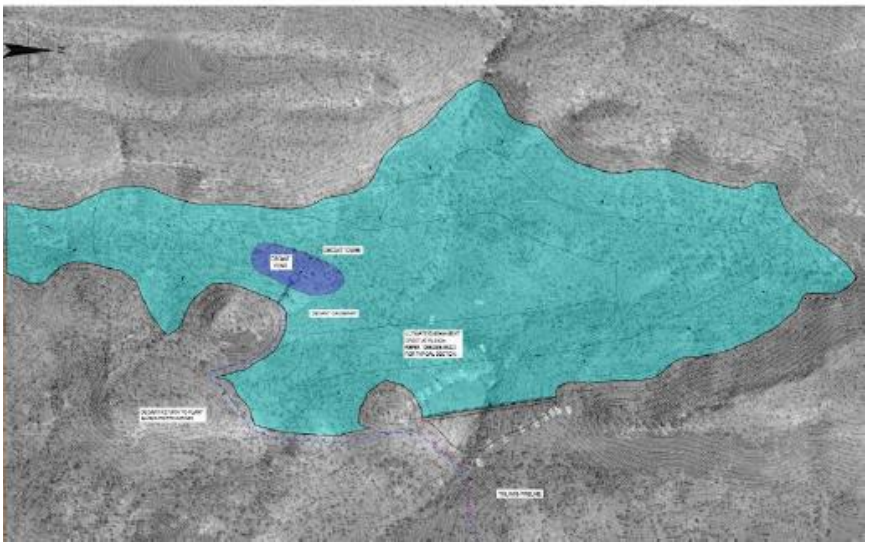


Figure 7.4: Diamond Creek TSF Location Plan

Diamond Creek TSF has been sized to meet life of mine requirements as well as tie into the natural topography and will provide approximately 14 years of tailings storage. Due to the topography embankment volumes are less than other options at approximately 100,000 m^3 with similar geotechnical challenges to other similar structures in that requires standalone engineered fill embankments with suitable clean rock fill and clay construction materials. Seepage controls have also been assumed to be required in the form of HDPE lining and a grout curtain along the embankment toe.

The TSF sits outside CCM mining tenure with an impoundment area of 96 Ha. The land is currently undisturbed with only desktop ecological surveys undertaken to assess potential impacts. The site also sits above

Gunpowder Road and Greenstone Creek which means potential impacts to people as well impacts to Greenstone Creek under facility failure scenarios.

Water management associated with Diamond Creek TSF is similar to that associated with the Greenstone Creek TSF option with the differentiation being that catchment diversion of the upstream creek, approximately 195 ha, may be required for operation and closure. This also presents similar closure challenges of ensuring no impacts to the creek post-closure along with sourcing a large volume of closure capping material and embankment reshaping. A closure spillway will also be required.

Engagement with local stakeholders identified that the landowner is not supportive of this option due to the undisturbed nature of the land and additional disturbance associated with the proximity from other CCM mining infrastructure.

7.2.4 Esperanza Pit TSF

This option considers the conversion of the existing Esperanza Pit (E Pit) from a water storage facility to a TSF. It will require the construction of a large embankment at the eastern side of the pit as shown in Figure 7.5 with key design criteria presented in Table 7.4.

Table 7.4: E Pit TSF Key Design Criteria

Storage Capacity	8.0 Mm^3
Operational Life	9 years
Distance from CCM Plant	1.0 km
Construction Materials	560,000 m^3
Disturbance Area	0 ha (pre-disturbed)
Disturbance Ranking[1]	N/A
Drainage catchment	180 ha
Total Cost (Capital and Operational)	$69,000,000 m
Storage Cost	\$8.55 /m^3

[1] Disturbance ranking from Desktop Ecological Assessment (Appendix D)

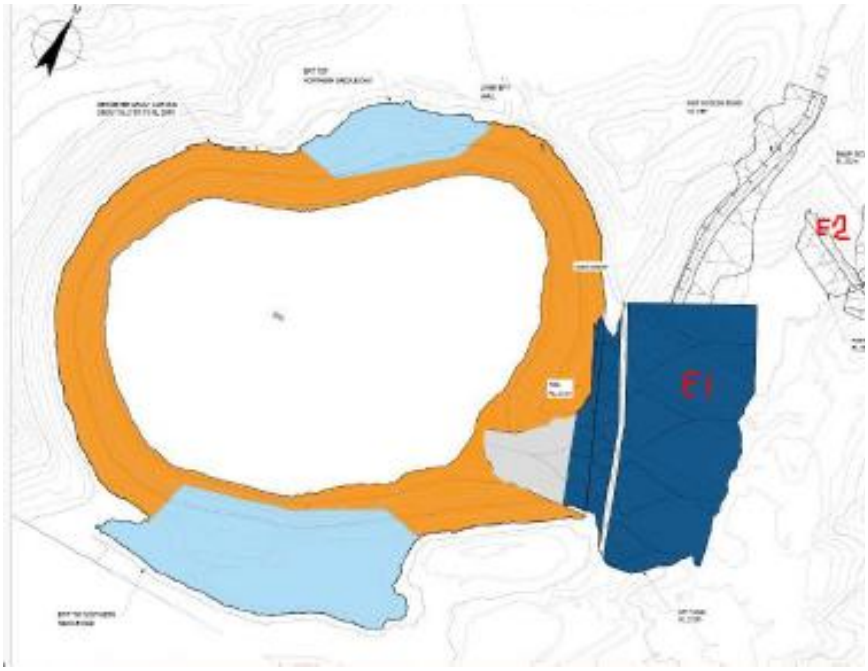


Figure 7.5: E Pit TSF Location Plan

E Pit is located approximately 1 km south of the CCM Process Plant and has previously been used to temporarily deposit tailings. The embankment construction associated with converting E Pit to a long-term viable storage option will require approximately 600,000 m^3 of clean rock fill and clay construction materials and will be approximately 48 m tall at its ultimate height. The construction of this embankment will also require the relocation of site infrastructure including vent rises and the underground paste fill plant. This embankment will allow E Pit to store approximately 9 years of tailings meaning that additional options will be required to meet the current life of mine commitments. It has also been assumed that seepage control measures will be required for the embankment in the form of a grout curtain and HDPE liner.

E Pit sits wholly on CCM mining tenure with no additional disturbance required with the major challenge being water management. E Pit is currently above the maximum operating level (MOL) (~RL229) and the use of this facility for water storage is critical to meet the site wet season storage requirements. If E Pit were to be utilised for tailings storage this would mean that an additional Mine Affected Water (MAW) storage would likely be required at CCM. Additionally, E Pit has a large catchment of up to 180 ha and includes E TSF and therefore significant catchment diversion works may be required as well as rerouting of E TSF spillway.

From a failure consequence perspective, once above the pit rim consideration will need to be given to underground workers at the Mammoth underground mine and also due cognisance to the cascade failure into Mill Creek Dam and the impacts that this would have on the site clean water release strategy and potential impacts to Gunpowder Creek.

Elimination of additional disturbance means that this option has closure benefits, including that a residual void would not be left at closure. Capping design would need to accommodate in-pit storage with additional time potentially being required for tailings consolidation prior to closure capping and shaping of the final profile to a water shedding landform. Local stakeholders are generally supportive of this option, they have however

highlighted the importance of water management and elimination of any seepage pathways from E Pit to Gunpowder Creek.

7.2.5 Magazine Creek TSF

Magazine Creek TSF is located approximately 3 km southeast of the CCM Process Plant and covers an area of approximately60 ha including embankments and impoundment. The area, shown in Figure 7.6, is partially disturbed and has historically been the location of water treatment ponds. These have been decommissioned. Magazine Creek TSF sits partially on CCM Mining Lease (ML) to the north, and on CCM Exploration Permit for Minerals (EPM) to the south. A small area at the far south extends of both CCM ML and EPM. Key design criteria for Magazine Creek TSF are presented in Table 7.5.

Table 7.5: Magazine Creek TSF Key Design Criteria

Storage Capacity	10.5 Mm^3
Operational Life	11.5 years
Distance from CCM Plant	3.2 km
Construction Materials	1,165,000 m^3
Disturbance Area	60 ha
Disturbance Ranking	Medium
Drainage catchment	104 ha
Total Cost (Capital and Operational)	$67,000,000 m
Storage Cost	$6.41 /$m^3$

[1] Disturbance ranking from Desktop Ecological Assessment (Appendix D)

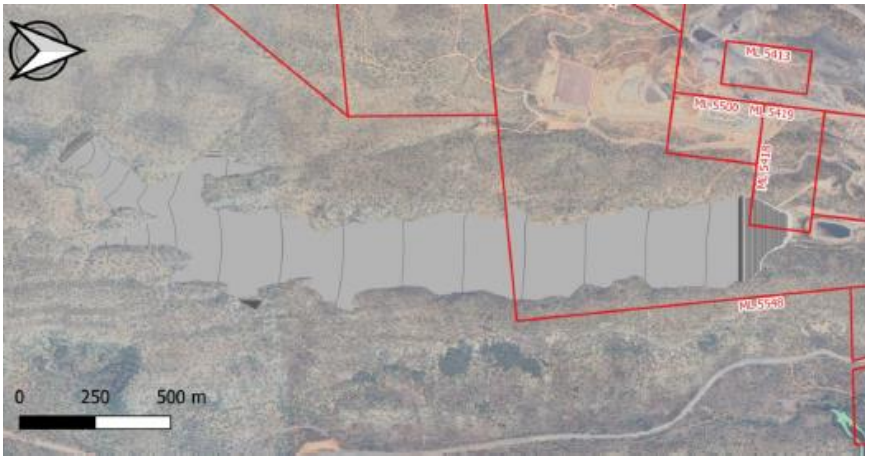


Figure 7.6: Magazine Creek TSF Location Plan

Magazine Creek TSF requires the construction of a large embankment to the north as well as an embankment to the south which will also double as a surface water diversion structure. Saddle embankments to the east and west will also be required taking the total embankment fill requirements to approximately 1,200,000 m^3, significantly higher than other options, making sourcing of suitable fill material of high importance. This will provide approximately 11 years of tailings storage, meeting current life of mine requirements. The embankments will be constructed from engineered fill with seepage mitigation measures employed similar to other TSF options. Downstream of Magazine Creek TSF includes Lake Waggaboonya, Gunpowder Creek and also the existing access road which all need to be considered as part of a failure consequence assessment.

Magazine Creek TSF is constructed on both disturbed and undisturbed land with some ecological survey information available indicating the potential presence of protected species. The facility sits on a large water catchment (approximately 104 ha), which will require minor diversion works at the southern extent and this will also represent some closure challenges to ensure there are no impacts to the creek system. A large capping volume, embankment reshaping, and closure spillway will also be required. Potential seepage pathways from the facility exist to Lake Waggaboonya and Gunpowder Creek that will need to be confirmed.

Consultation with local stakeholders around the Magazine Creek TSF option indicates that they are neutral to this solution.

7.2.6 Upper Esperanza TSF (Phase 2)

Upper Esperanza TSF Phase 2 (UE TSF) is an extension of TSF3 and is located approximately 4 km south of the CCM Process Plant. It requires the disturbance of approximately 44 ha of greenfield land as well as the construction of 3 no. embankments with associated seepage controls as well as utilizing the UEDD for tailings storage. A general arrangement of UE TSF is shown in Figure 7.7 along with key design criteria in Table 7.6. It should be noted that CCM are unlikely to utilize this option without first utilizing TSF3.

Table 7.6: UE TSF Creek TSF Key Design Criteria

Storage Capacity	5.2 Mm^3
Operational Life	6 years
Distance from CCM Plant	3.8 km
Construction Materials	460,000 m^3
Disturbance Area	44 ha
Disturbance Ranking	Medium
Drainage catchment	189 ha
Total Cost (Capital and Operational)	$60,000,000 m
Storage Cost	$11.58 /$m^3$

[1] Disturbance ranking from Desktop Ecological Assessment (Appendix D)

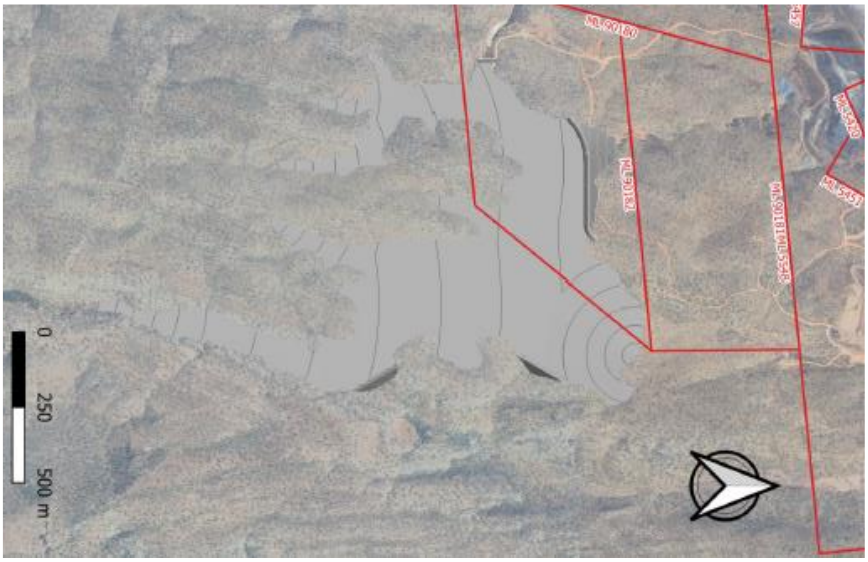


Figure 7.7: UE TSF Location Plan

UE TSF provides approximately 6 years of tailings storage and requires approximately 450,000 m^3 of embankment fill. The major challenge associated with UE TSF is the large water catchment (~189 ha) which will require diversion to facilitate the construction and operation of the TSF. This catchment is currently diverted around CCM by the UEDD, and a similar structure would be required upstream for the TSF to be viable.

Failure consequences associated with UE TSF are mainly related to impacts to the creek with any failure of this facility potentially resulting in a cascade failure into TSF3 and/or E Pit and onwards towards Gunpowder Creek. The UE TSF area is currently undisturbed with limited ecological information available to determine the impacts of this disturbance, however any groundwater seepage pathways would likely head towards either Gunpowder Creek or Magazine Creek.

Closure concepts for this option are similar to other embankment options (reshaping, capping, closure spillway), however the capping volume will be smaller as a function of the decreased footprint and storage capacity. Local stakeholders have indicated that they are neutral to this option with limited impacts identified.

7.2.7 Esperanza TSF Raise

The final option considered for additional tailings storage at CCM is a raise of E TSF to provide additional capacity. The facility currently has approximately 2 months of storage capacity before further embankment raises would be required. A general arrangement of E TSF, including the northern embankment and 4 saddle dams is provided in Figure 7.8.

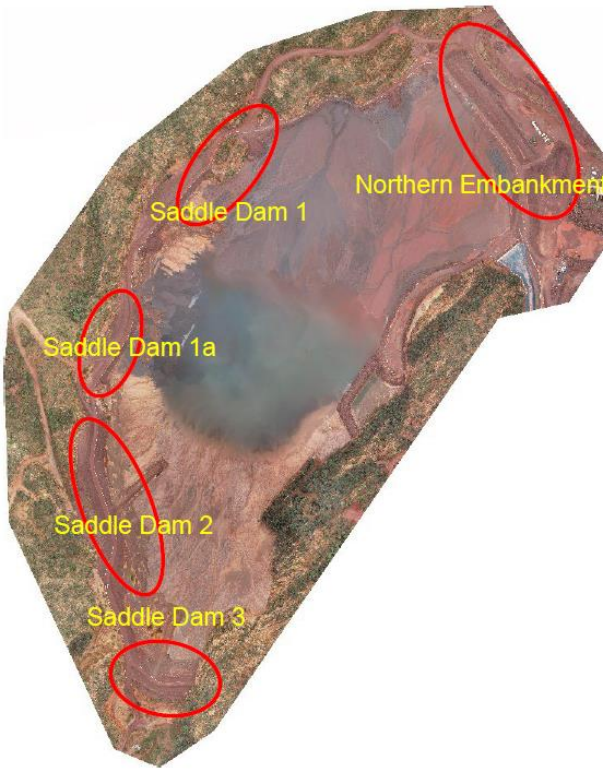


Figure 7.8: E TSF Location Plan

For the purpose of this MCA, it has been considered that a 3 m raise to the embankments, providing approximate 2 years of storage capacity is the maximum that can be achieved from E TSF based on previous study works undertaken by both GHD and ATC Williams. For this purpose, it has not been included as a life of mine solution but has been retained to provide context that all solutions have been considered.

Additional raises to E TSF have the advantage of minimising any additional disturbance at CCM, although some disturbance will be required to construct downstream buttresses to the saddle dams to ensure minimum design factor of safety requirements are met. Additionally closure commitments would only be an incremental minor increase on current requirements for E TSF.

Water management strategies would remain unchanged from those existing at CCM and seepage pathways from E TSF are reasonably well understood and have been addressed through seepage collection systems downstream of the saddle dams and at the NWRD. Similarly, failure consequences would likely remain unchanged from the existing facility with major consequences associated with impacts to Gunpowder Creek. An incremental increase associated with the increased height and storage volume is unlikely to impact the consequence category of the facility.

The major drawback to this option is the high cost associated with constructing embankment buttresses for relatively small increase in tailings storage capacity. Similarly, local stakeholders have previously expressed negative sentiment around the continued use of E TSF, mainly driven by historical water management issues that would need to be addressed.

7.3 MCA Criteria

The TSF location MCA assessment has been undertaken using weighted criteria determined based on various economic, technical, operational, social and environmental considerations. These have been developed though consultation with industry experts with experience in TSF location assessment. This included both GHD and ATC Williams as per the tailings technology MCA with more recent works supported by Design Consultants, Engeny, and environmental consultants, EPIC Environmental. Members of assessment team have a borad knowledge of the site, the region, the challenges of constructing and operating a tailings dam and mine closure responsibilities. The MCA criteria and weighting have been shared with local stakeholders and feedback was incorporated into the scoring.

Table 7.7 provides a summary of this criteria along with associated weighting with the following sections providing further information.

Table 7.7: TSF Location MCA Criteria and Weighting

Criteria	Applied Weighting
Storage Capacity	5%
Overall Cost	20%
Geotechnical Conditions	10%
Consequence of Failure	10%
Land Disturbance	10%
Seepage Pathways	10%
Water Management	10%
Tenure	5%
Local Stakeholder Support	10%
Closure	10%
TOTAL	**100%**

For each MCA option the criteria have been scored using the qualitative system set out in Table 7.8.

Table 7.8: TSF Location MCA Criteria and Weighting

Description	Score
Strong, positive impact for the criteria or measure	5
Moderate, positive impact for the criteria or measure	4
No significant positive or negative impact	3
Moderate, negative impact for the criteria or measure	2
Strong, negative impact for the criteria or measure	1

7.3.1 Storage Capacity

This criterion assesses the ability of the selected facility to meet the operational requirements for the predicted life of CCM, i.e. 10 years.

7.3.2 Overall Cost

The cost criterion takes account of the total capital and operational cost for the life of the facility to determine a storage cost in $/m^3. For the costing assessment, key assumptions have been made which are consistent to each option. This is based on the level of study work undertaken for the TSF3 option and applying the same assumptions across all options to provide an equitable comparison. These assumptions are provided to ensure sufficient conservatism in the design and operation of any TSF for comparison purposes only, the relevant of all or some of these will be validated during subsequent design and assessments as relevant. These assumptions are,

- A 10 m deep grout curtain is required for all embankments that are tailings containment structure has been assumed for the purpose of the MCA to ensure sufficient conservatism ahead of more detailed studies / design.
- All embankments with the potential for water stored against them (including decant ponds and extreme rainfall events) have included allowance for a liner system for MCA comparison purposes. This will be confirmed during detailed design for the preferred option.
- Embankments are assumed to comprise 95% General Fill (i.e. rockfill) and 5% Select Fill (i.e. clay).
- All embankments are downstream raised.
- Costs associated with haul roads, access roads and associated drainage have been excluded.
- Capital costs for mechanical items have been scaled based on distance from the CCM Process Plant with TSF3 used as the basis for comparison.
- Capital costs for power infrastructure are based on approximate distance from the CCM Process Plant to the furthest tailings discharge point at a rate of ~$2.3M/km.
- Operational costs for power and mechanical infrastructure have been scaled based on the distance to the CCM Process Plant with TSF3 used as the basis for comparison.
- Capital costs include a 30% contingency allowance.
- Operational costs have no contingency applied.
- Closure costs have not been included in the capex/opex costs but have been allowed for in the closure criterion.

7.3.3 Geotechnical Conditions

This criterion takes consideration of the engineering challenges associated with any embankment construction to meet industry guidelines in terms of stability factor of safety. For the purpose of this assessment, it has been assumed that all embankments are downstream raised and therefore no consideration has been given to the rate of rise of tailings and the potential for constructing on top of consolidated tailings. This criterion also considers the quantum of borrow material requirement and the risk associated with constructing the full embankment heights using clean rock fill and clay.

7.3.4 Consequence of Failure

A high-level assessment of the location of each TSF option has been undertaken to look at potential dam break scenarios and tailings run out areas to assess downstream receptors. This includes a population at risk

assessment for downstream users of infrastructure, creeks and the lake as well as mine workers at CCM. The importance of downstream receptors from an environmental and cultural heritage perspective has also been undertaken. A full dam break assessment to determine the severity of damage and loss has not been undertaken for this assessment.

7.3.5 Land Disturbance

This criterion assesses the total new disturbance required for each option as well as potential flora and fauna impacts for the area. Where surveys have been undertaken for the areas (i.e. those on or partially on the CCM ML) the impacts have been assessed. Where surveys have not yet been undertaken the unknowns associated with ecological impacts have been built into the assessment.

A desktop ecological assessment of all tailings storage options (excluding E Pit and E TSF raise) was undertaken by KG Environmental in 2024 which found no discernible difference between each option based on searches on matters or state (MSES) and national (MNES) environmental significance. The report recommended that, for the purpose of the MCA that each TSF option should be assessed based on disturbance footprint size, regulated vegetation, potential agricultural value and potential presence of threatened species. This report is included as Appendix D.

7.3.6 Seepage Pathways

A high-level assessment of the local geology has been undertaken to understand potential seepage pathways to downstream receptors. This criterion looks at potential impacts to these receptors without any mitigation measures in place, i.e. grout curtains or liner systems.

7.3.7 Water Management

This criterion assesses the surface water catchment area associated with each option and the potential for upstream diversion systems to be required to manage the TSF to ensure wet season storage allowance requirements can be maintained without the need for extensive embankment construction. Where applicable, the impacts to any proposed TSF option to existing water management systems at CCM have also been considered.

7.3.8 Tenure

This criterion addresses the Environmental Authority (EA) application process and the complexity associated with each option. Options that are fully on CCM ML have been rated higher than those that are on CCM EPM. Options that are off CCM leases (ML and EPM) have been rated the lowest due to the timeframe associated with negotiation on tenure with existing landholders.

7.3.9 Local Stakeholder Agreements

This criterion captures the sentiments of local stakeholders discussed during CCM community meetings held approximately 3 times per year. Tailings storage options have been discussed with local stakeholders with further information provided to stakeholders on request or additional workshops and targeted sessions facilitated.

Feedback from stakeholder sessions are that landholders are mostly concerned with the health of the creek systems and surrounding environment as this may adversely affect their cattle business. Greenstone and Diamon Creek TSF's in particular were not supported by the Calton Hills landholders due to favourable grazing land and perceived impacts further away from the mining operation. This feedback has been used to inform the assessment.

7.3.10 Closure

Closure of a new TSF's has been identified as a major constraint at CCM due to the availability of construction materials for closure, including clay and clean rockfill Investigations are required to be undertaken to source suitable materials locally with cost implications determined by haul distance requirements.

This criterion addresses the closure volumes associated with each option and a qualitative assessment of the associated costs with sourcing and placing the required capping volumes based on tailings surface area. This is mainly a function of the impoundment area and a typical cover system as provided in Figure 7.9.

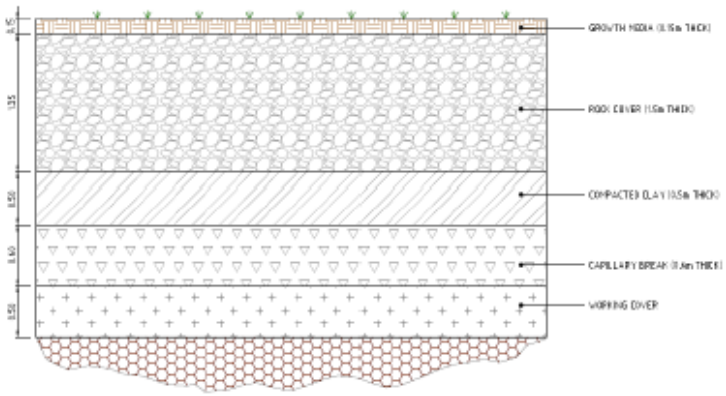


Figure 7.9: TSF Closure Cover Profile

Complexities associated with reshaping of embankment profiles and construction of closure spillways have also been included in this assessment. Assessment of residual closure risk with a view to relinquishment timeframes has also been undertaken, this is especially pertinent for any TSF option constructed on an existing creek line.

7.4 MCA Summary

The MCA has been undertaken using the criteria and weighting provided in Section 7.3 with the results of the analysis provided in Figure 7.10.

Based on the outcome both TSF3 and Magazine Creek have been identified as favourable solutions to undergo further design works and studies.

TSF3 is favourable in that it utilises the existing Esperanza Waste Dump as a buttress to the main tailings embankment, however seepage concerns and the feasibility of proposed seepage mitigation measures are crucial to determine the feasibility of this option. Additionally, TSF3 is on CCM ML and surveys have been previously undertaken to understand the ecological impacts associated with disturbance in this area. Surface

water diversions are currently in place but will require upgrade to meet tailings storage requirements and local stakeholders are generally supportive of the option as it minimises impacts. Storage capacity concerns need to be addressed as part of a CCM life of mine tailings strategy which could result in TSF3 being utilised in conjunction with a lift to E TSF and/or deposition of tailings in E Pit once water management concerns have been addressed.

Magazine Creek TSF provides life of mine storage and is the lowest cost option in terms of cost per m3 of storage. Concerns remain around the volume of fill required to construct the embankments which will need to be addressed through geotechnical investigations and similarly updated groundwater modelling and installation of monitoring bores will likely be required to further understand and mitigate against potential seepage pathways to Gunpowder Creek and Lake Waggaboonya.

The closure strategy for both options is contingent on locally sourcing suitable closure material, and this will also need to be addressed as studies progress.

Criteria	Weighting	1. UE TSF3 (Phase 1)	2. Greenstone Ck	3. Diamond Ck	4. Epit RL 270m	5. Magazine Creek	6. UE TSF - South of UEDD (Phase 2)	7. E TSF Raise
STORAGE CAPACITY Target 10 years	5.00	3	5	5	3	5	2	1
		7.2 years	15.3 years	13.8 Years	8.9 years	11.5 years	5.7 years	2 years
COST Capex Opex Complexity	20.00	2	4	3	4	5	3	1
		$13.98/m3	$8.08/m3	$9.52/m3	$8.55/m3	$6.41/m3	$11.58/m3	$20/m3
GEOTECHNICAL CONDITIONS Natural Topography Borrow Risk	10.00	5	3	5	4	3	4	3
		Steep sided valley. Waste dump with good stability.	Flat area, multiple embankments.	Steep sided valley, Small embankment.	Enclosed pit wall with small embankment volume.	Natural valley. Large main embankment volume	Steep sided valleys. Multiple embankments.	Raise on existing facility. Buttressing likely.
CONSEQUENCE OF FAILURE Downstream consequence	10.00	4	3	3	3	3	5	4
		On-site PAR at ESS underground. Above E Pit and UEDD	Indirect PAR, creek and lake users Above Greenstone Ck and Lake W.	Indirect PAR, Road users Above Greenstone Ck and Public Road.	On-site PAR at Mammoth underground. Above MCD	Indirect PAR, Road and Lake users Above Gunpowder Ck and Lake W and Public Road.	No PAR. Above Upper Esperanza, Magazine Ck and Snakeskin Valley.	No PAR. Above Gunpowder Creek
LAND DISTURBANCE Flora/Fauna impact	10.00	4	1	3	5	3	3	5
		Medium area. Surveys complete. Possible threatened Species	Largest area. Unknown species	Large area. Unknown species	No new disturbance or flora/fauna impact	Large area. Previous distubance. Unknown species	Medium area. Unknown species	No new disturbance or flora/fauna impact
SEEPAGE PATHWAY Geology / Faults (Before any new controls)	10.00	3	3	3	2	2	4	4
		500m to E Pit with PAF Waste Dump in pathway.. Interceptions at MCD and NWRD. 1.6km to Gunpowder Ck.	On Greenstone Ck tributary.	On Greenstone Ck tributary.	1km to Gunpowder Ck. Known seepage above 222RL. Interceptions at MCD and NWRD.	On Magazine Ck. 600m to Lake, 1.2km to Gunpowder Ck.	1.2km to Magazine Ck. 2km to Gunpowder Ck.	400m to Gunpowder Creek. Existing seepage capture systems at NWRD and saddle dams.
WATER MANAGEMENT Surface Water Diversions Catchment area	10.00	4	4	3	1	4	2	5
		Diversion already in place. Medium catchment (80 ha)	No diversion expected. Large catchment (243 ha, low accuracy – ELVIS publicly available data).	Possible diversion, Large catchment (195 ha, low accuracy – ELVIS publicly available data).	Requires additional site MAW storage capacity. Large existing catchment. Catchment area may range from 38 ha (contained by large embankment) to 80 ha (inclusive of ETSF) to 180 (total inclusive of existing EPit catchment + ETSF).	Minor diversion works. Medium catchment (104 ha).	Major diversion works required. Large Catchment (189 ha).	No change to surface water management
MINING TENURE Timing for applications	5.00	4	1	1	4	2	2	5
		On existing tenure	No mining lease or agreement.	No mining lease or agreement	On existing tenure	Partially on and off tenure	Partially on and off tenure	Existing tailings storage
LOCAL STAKEHOLDERS	10.00	4	2	2	3	3	3	2
		Generally supportive	Desirable Agricultural land. Owner not supportive.	Agrigultural land. Owner not supportive.	Generally supportive. Only if water is managed.	Neutral	Neutral	Some misconceptions about seepage and stability.
CLOSURE CONCEPT Closure volumes Residual Risk	10.00	4	3	4	3	3	4	5
		Large capping volume. Includes waste dump closure	Largest capping volume Residual risk to Greenstone creek	Large capping volume	Small capping volume. Water shedding option required.	Large capping volume. Water management during rehab.	Large capping volume	Small capping volume
Weighted Score	**100**	71	60	64	65	69	66	66

Figure 7.10: TSF Location MCA

Appendix A

Report of Investigation into the Thickening of Capricorn Copper Tailings
FLSmidth

REPORT OF INVESTIGATION

INTO THE

THICKENING

OF

CAPRICORN COPPER TAILINGS

FOR

29 METALS

by

Kim Nguyen
FLSmidth Pty Ltd
February 2023

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1.0 SUMMARY

FLSmidth Pty Ltd was commissioned by ATC Williams on behalf of 29 Metals to conduct a complete bench scale thickening test work study on one sample of Copper Tailings pertaining to the Capricorn Copper operations located in Queensland, Australia.

The following table summarises the expected performance outcomes and process parameters for a 16m Ø thickener to process the Capricorn Copper Tailings.

The Capricorn Copper Tailings feed solids and feed rates used to calculate the thickener design parameters were provided by ATC Williams;

1.0.1 16m Ø High Density & Deep Cone Thickener – Capricorn Copper Tailings Expected Performance

The ***Table 1.0.1.1*** displays the expected performance outcomes of the 16m Ø High Density and Deep Cone Thickener when processing Capricorn Copper Tailings.

1.0.1.1 Capricorn Copper Tailings Expected Performances - 16m Ø High Density & Deep Cone Thickeners

Parameters		Capricorn Copper Tailings 16m Ø Thickener	
		High Density	Deep Cone
Design Feed Tonnage	**(t/h)**	300	300
Feed Solids	**(% w/w)**	55.0	55.0
Feedwell Solids	**(% w/w)**	12.5	12.5
Flocculant Addition Rate	**(g/t)**	15	15
Unit Area	**(m^2/tpd)**	0.03	0.03
Solids Flux Rate	**(t/m^2h)**	1.49	1.49
Rise Rate (external)	**(m/h)**	0.58	0.64
Underflow Solids	**(% w/w)**	66 – 67	68 – 69
Underflow Yield Stress	**(Pa)**	44 – 77	129 – 235
Overflow Solids	**(mg/l)**	< 100	< 100
Thickener Diameter Ø	**(m)**	16	16
Number of Thickeners		1	1

2.0 INTRODUCTION

FLSmidth Pty Ltd was commissioned by ATC Williams on behalf of 29 Metals to conduct a complete bench scale thickening test work study on one sample of Copper Tailings pertaining to the Capricorn Copper operations located in Queensland, Australia.

The bench scale thickening testwork was conducted at the FLSmidth dewatering laboratory, located in Perth, Western Australia during February 2023.

The objectives of the thickening testwork on the 29 Metals – Capricorn Copper Tailings were to determine;

Thickening

- Optimum feedwell solids
- Optimum flocculant dosage
- Settling rate of the slurry solids thus determining the maximum operating thickener rise rate
- Optimal overflow clarities
- Achievable underflow solids densities
- Underflow slurry rheology

The thickening test work involved evaluating FLSmidth's High Density and Deep Cone Thickener technology.

This report discusses and summarises the test results achieved when processing the 29 Metals Capricorn Copper Tailings.

3.0 THICKENING PROCEDURES

3.0.1 Thickener Feed

One sample of Capricorn Copper Tailings feed slurry were received from 29 Metals for the thickening testwork.

Settling flux tests were conducted to determine the optimum feedwell solids concentration to achieve maximum settling performance.

For the slurries, the optimum feedwell solids concentration was found to be lower than the nominated solids content of the feed stream. This is a typical phenomenon as most slurries exhibit improved settling characteristics as the solids concentration is reduced.

The slurry samples were adjusted to the optimum solids concentration by adding process water and the dilution water pH has been increase to 10 as requested by the client.

3.0.2 Continuous Fill Deep Tube Settling Tests

The continuous fill settling test involved pumping slurry at the optimum settling flux concentration and flocculant at the settling flux addition rate into a 5-litre test cylinder containing a feedwell to mix and flocculate the slurry. The flocculated slurry then settled towards the bottom of the cylinder and the clear overflow is exited from the top of the cylinder.

The 5-litre cylinder was fitted with a slowly rotating rake to assist with the dewatering of the slurry the same way as the rake mechanism assists dewatering in the full-scale thickener.

The objectives of the continuous fill test were to:

- Confirm the optimum settling flux solids concentration determined in the static settling flux tests.
- Confirm the flocculant addition rate by conducting a series of rise rate tests over a range of flocculant addition rates.
- Determine the bed residence time required for the full-scale thickener to achieve maximum or target underflow solids levels.

Typical fill time for the continuous fill test is 20 – 30 minutes depending on the solids flux rate. The feed rate and flocculant addition rate were initially set to approximately 50% of the predicted solids flux rate and at 100% of the expected flocculant addition rate on a g/t basis.

After initial observations of floc structure and settling velocity the feed rate was increased to the expected maximum with a corresponding increase in flocculant addition rate to maintain the correct addition rate on a g/t basis. If any degradation in floc structure was observed the flocculant addition rate was increased to bring the parameter back to visual acceptance.

3.0.3 Flocculant

The preferred flocculant for the Capricorn Copper Tailings sample tested for bench-scale thickening tests was BASF Magnafloc 10.

BASF Magnaflocc 10 was selected for the testwork after a number of other BASF flocculants including M333, M155, M919 and M5250 were evaluated.

3.0.4 Underflow Rheology

The yield stresses for the Capricorn Copper Tailings slurries thickened to a range of solids densities was measured using a Haake Vane VT550 Viscometer.

3.0.5 Particle Size Distribution

The particle size distributions of Capricorn Copper Tailings slurries solids used in the thickener simulations was provided by ATC Williams.

4.0 THICKENING RESULTS

4.0.1 Solids Characterisation

4.0.1.1 Particle Size Distribution Table

Size (um)	Capricorn Copper Tailings
	% Passing
500	99.8
150	80.7
75	58.7
63	45.0
38	37.0

4.0.2 Specific Gravity & Test Conditions

4.0.2.1 Specific Gravities and Test Conditions

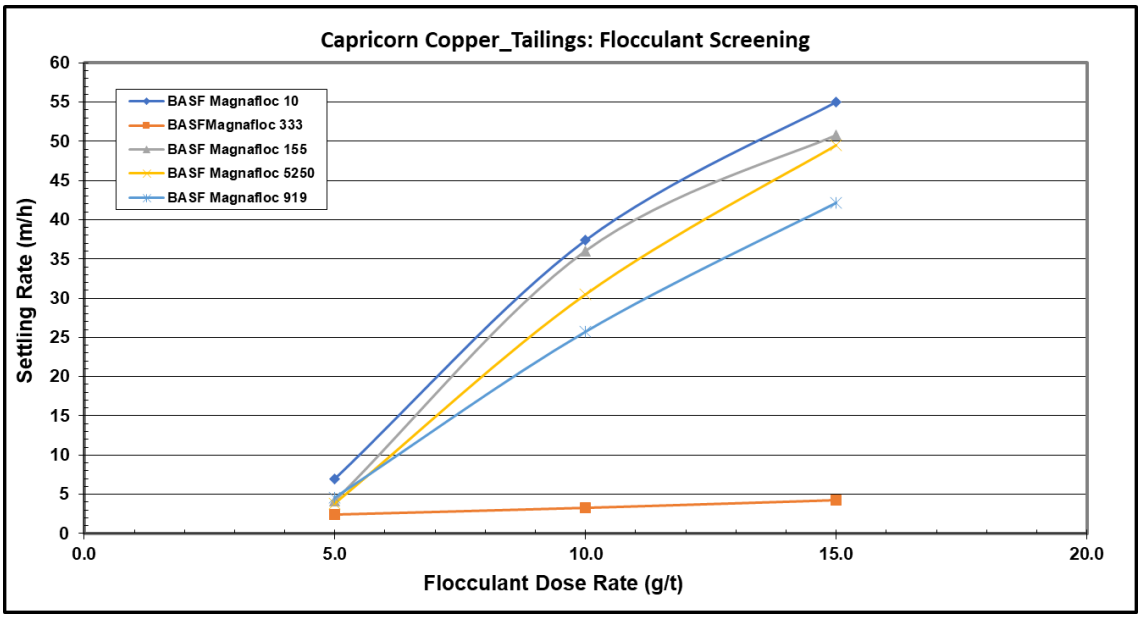
Parameters	Specific Gravities / Test Conditions
	Capricorn Copper Tailings
SG of Solids	2.82
SG of Water	1.00
Test Temperature	Ambient 23°C
pH	10*

Note:- pH of slurry was adjusted to 10 before testwork.

4.0.3 Flocculant Screening

The preferred flocculant used for the bench-scale thickening tests was BASF Magnafloc 10. BASF Magnafloc 10 was selected for the testwork after a comparison screen was performed between it and M333, M155, M919 and M5250. The results of the flocculant screening for the Capricorn Copper Tailings samples is shown on the following ***Graph 4.03.1.***

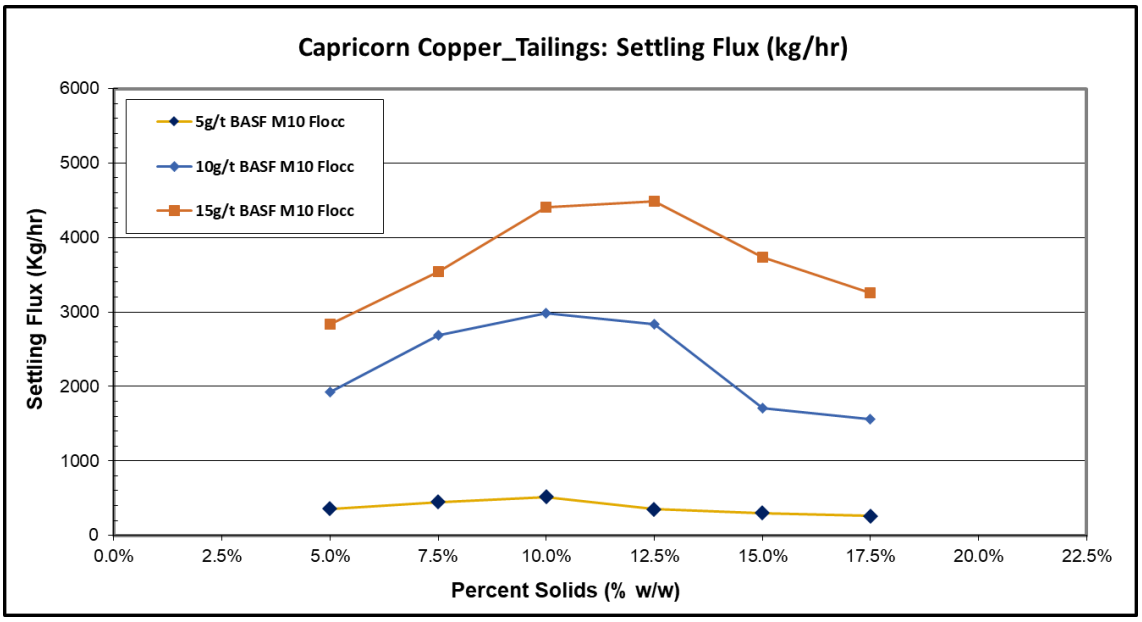
4.0.3.1 Flocculant Screening – Capricorn Copper Tailings



4.0.4 Effect of Feed Dilution

The settling flux curve, ***Graph 4.0.4.1*** indicates that the sample of Capricorn Copper Tailings exhibits optimum settling performance at feedwell solids concentrations of 12.5% w/w solids. Above the optimum feed solids concentration there is a deterioration in settling performance as the settling rate is adversely affected by hindered settling.

4.0.4.1 Settling Flux – Capricorn Copper Tailings



4.0.5 Continuous Fill Rise Rate vs Overflow Solids Tests

The objective of these dynamic tests was to evaluate the clarification performance of the **Capricorn Copper Tailings** at the nominated solids content of 12.5% w/w by measuring the overflow solids contents for various rises rates and various flocculant addition rates.

The following dynamic settling rise tests were conducted:

- A 2.5 m/h rise rate was evaluated at flocculant addition rates of 10 - 15 g/t.
- A 5.0 m/h rise rate was evaluated at flocculant addition rates of 10 - 15 g/t.
- A 7.5 m/h rise rate was evaluated at flocculant addition rates of 10 - 15 g/t.
- A 10.0 m/h rise rate was evaluated at flocculant addition rates of 15 - 20 g/t.
- A 12.5 m/h rise rate was evaluated at flocculant addition rate of 20 g/t.

The results of these dynamic settling tests are detailed in ***Tables 4.0.5.1*** below.

4.0.5.1 Continuous Fill Deep Tube Settling Test - Test Parameter Results
Capricorn Copper Tailings

Test ID	Rise Rate (m/h)	Feed Solids (% w/w)	Flocculant Dosage (g/t)	Clarity Wedge Measure (CW)	O/F Solids (mg/l)
1	2.5	12.5	10	46	22
2	2.5	12.5	15	46+	18
3	5.0	12.5	10	45	30
4	5.0	12.5	15	46	26
5	7.5	12.5	10	44	58
6	7.5	12.5	15	45	44
7	10.0	12.5	15	43	48
8	10.0	12.5	20	44	46
9	12.5	12.5	20	43	52

The above table indicates that the sample of Capricorn Copper Tailings exhibits the following dynamic settling characteristics:

- At 2.5 m/h rise rate and a flocculant addition rate of 10 g/t the overflow stream contained 22 mg/l solids. The overflow solids level decreased to 18 mg/l when the flocculant addition rate was increased to 15 g/t.
- At 5.0 m/h rise rate and a flocculant addition rate of 10 g/t the overflow stream contained 30 mg/l solids. The overflow solids level decreased to 26 mg/l when the flocculant addition rate was increased to 15 g/t.
- At 7.5 m/h rise rate and a flocculant addition rate of 10 g/t the overflow stream contained 58 mg/l solids. The overflow solids level decreased to 44 mg/l when the flocculant addition rate was increased to 15 g/t.
- At 10.0 m/h rise rate and a flocculant addition rate of 15 g/t the overflow stream contained 48 mg/l solids. The overflow solids level decreased to 46 mg/l when the flocculant addition rate was increased to 20 g/t.
- At 12.5 m/h rise rate and a flocculant addition rate of 20 g/t the overflow stream contained 52 mg/l solids.

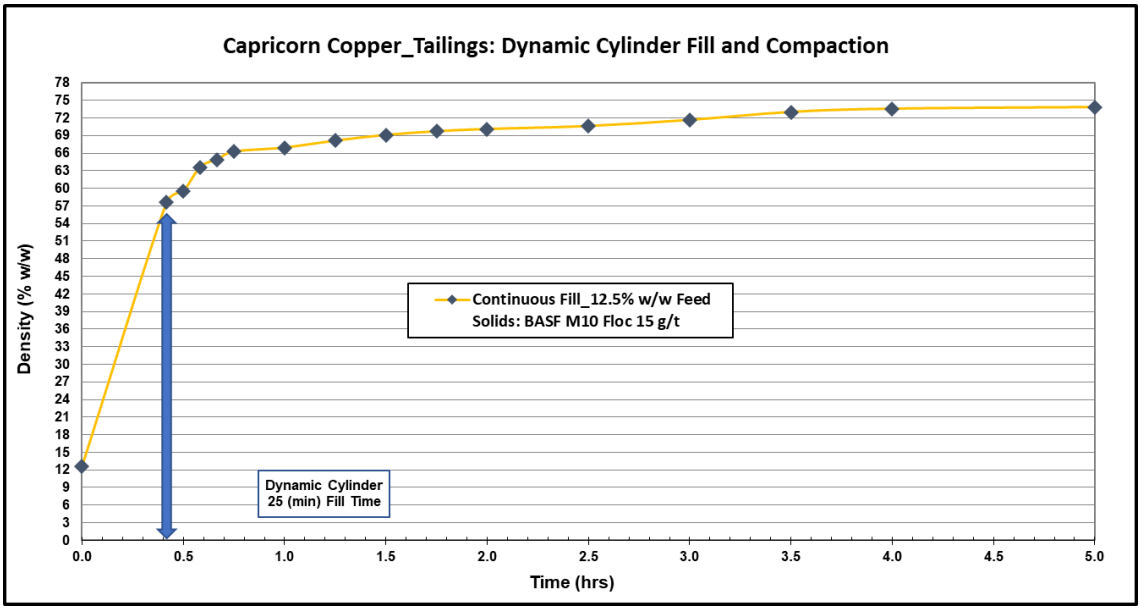
4.0.6 Continuous Fill Tube Settling Tests

The results of the continuous fill deep tube settling tests conducted on the sample of Capricorn Copper Tailings are summarised in ***Table 4.0.6.1*** and the raked compression ***Graph 4.0.6.1.***

4.0.6.1 Continuous Fill Deep Tube Compaction - Test Parameter and Results

Test Parameter	Capricorn Copper Tails
Test Feed Solids / *calculated solids* (% w/w)	12.5
Flocculant Type	BASF M10
Flocculant Addition (g/t)	15
Flux Rate (t/m^2h)	0.95
Unit Area (m^2/tpd)	0.04
Rise Rate (internal) (m/h)	7.5
Overflow Solids (mg/l)	<50
Bed Solids – 0.5 hr Residence Time (% w/w)	59.50
Bed Solids – 1 hr Residence Time (% w/w)	66.93
Bed Solids – 2 hr Residence Time (% w/w)	70.08
Bed Solids – 4 hr Residence Time (% w/w)	73.55
Bed Solids – 5 hr Residence Time (% w/w)	73.83

4.0.6.1 Continuous Fill Bed Compression Rate – Capricorn Copper Tailings



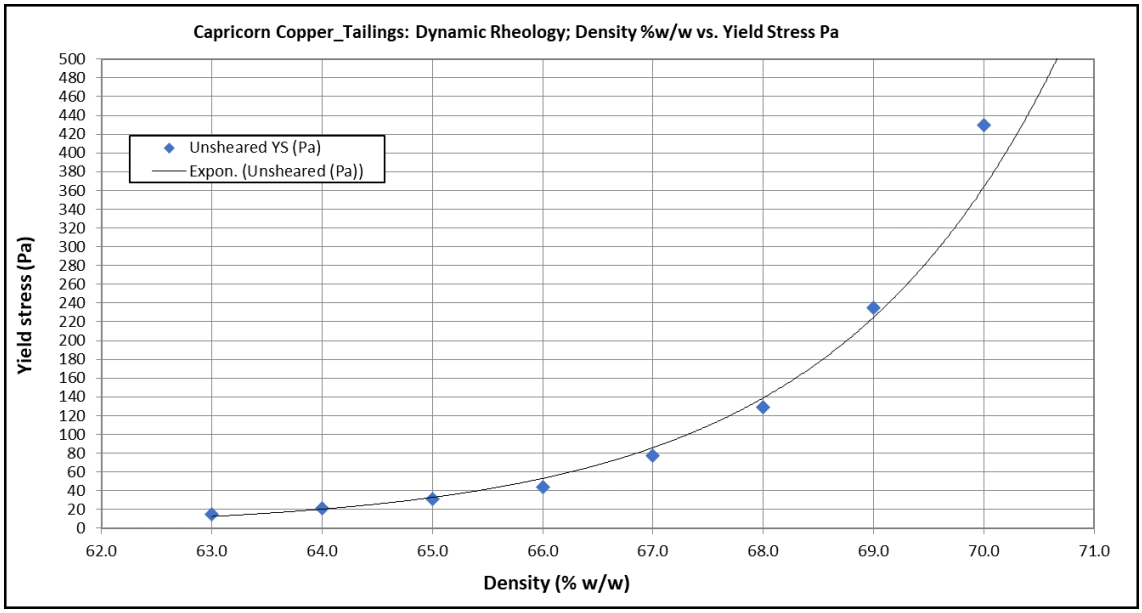
4.0.7 Underflow Rheology Tests

Underflow rheology yield stress data was obtained on the sample of Capricorn Copper Tailings over a range of solids densities using a Haake vane viscometer. The yield stress results are presented on ***Graph 4.0.7.2*** and are also summarised in the following ***Table 4.0.7.1***

4.0.7.1 Yield Stress Results

Capricorn Copper Tailings	
Underflow Solids (% w/w)	**Yield Stress (Pa)**
70	430
69	235
68	129
67	77
66	44
65	31
64	21
63	15

4.0.7.2 Yield Stress Results – Capricorn Copper Tailings



5.0 DISCUSSION

5.0.1 Feed Dilution

As detailed in section 4.0.4 the optimum solids settling flux for the Capricorn Copper Tailings slurry was found to be 12.5% w/w. As the feed stream to the Thickener is expected to have a typical feed solids concentration of 55.0% w/w for the thickener will require a feed dilution system.

An FLSmidth P-DUC® Feed System can dilute the feed stream to the desired level. The FLSmidth P-DUC® Feed System uses clarified liquor from within the thickener to dilute the incoming feed stream resulting in improved thickener performance through uniform feed dilution and improved flocculation of the feed stream.

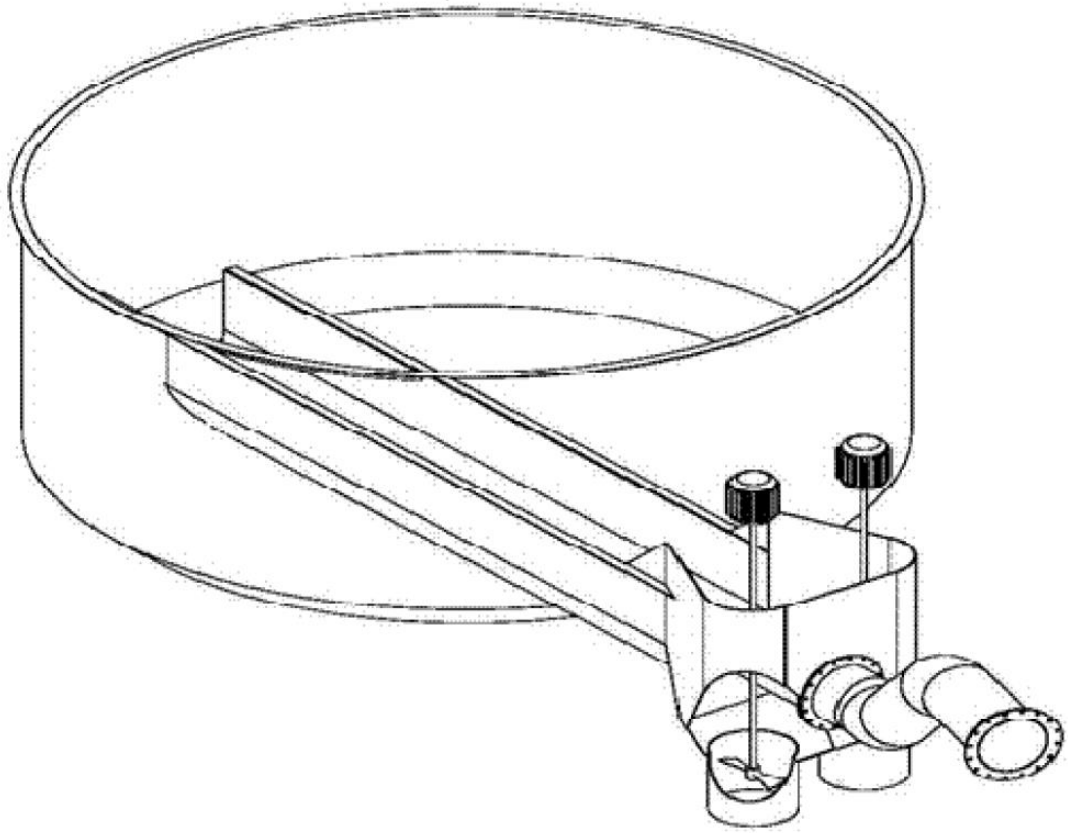


Figure 1 – FLSmidth P-DUC® Feed Dilution System

5.0.2 Recommended: High Density & Deep Cone Thickener Performance

Based on the static, dynamic settling and the underflow slurry yield stress results, the evaluated data for the 16m ϕ High Density and Deep Cone Thickeners to process the design feed tonnage of 300 t/h of Capricorn Copper Tailings solids has been calculated.

The recommended thickener technology design parameters are summarised in ***Table 5.0.2.1.***

5.0.2.1 Capricorn Copper Tailings Expected Performances – 16m ϕ High Density & Deep Cone Thickener

Parameters		Capricorn Copper Tailings 16m Ø Thickener	
		High Density	Deep Cone
Design Feed Tonnage	**(t/h)**	300	300
Feed Solids	**(% w/w)**	55.0	55.0
Feedwell Solids	**(% w/w)**	15.0	15.0
Flocculant Type		BASF M10	BASF M10
Flocculant Addition Rate	**(g/t)**	15	15
Unit Area	**(m^2/tpd)**	0.03	0.03
Solids Flux Rate	**(t/m^2h)**	1.49	1.49
Rise Rate (internal)	**(m/h)**	8.8	8.9
Rise Rate (external)	**(m/h)**	0.58	0.64
Underflow Solids	**(% w/w)**	66 – 67	68 – 69
Underflow Yield Stress	**(Pa)**	44 - 77	129 – 235
Overflow Solids	**(mg/l)**	< 100	< 100
Estimated Bed Residence Time/ BRT	**(hr)**	2.0	4.0
Thickener Diameter Ø	**(m)**	16	16
Sidewall Height	**(m)**	4	4.8
Number of Thickeners		1	1

Appendix B

Report of Investigation into Filtration of Capricorn Copper Tailings. FLSmidth

REPORT OF INVESTIGATION
INTO THE
FILTRATION

OF
CAPRICORN COPPER TAILINGS
FOR
29 METALS

by

Kim Nguyen
FLSmidth Pty Ltd
February 2023

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1.0 SUMMARY

FLSmidth Pty Ltd was commissioned by ATC Williams on behalf of 29 Metals to conduct a complete bench scale filtration test work study on one sample of Copper Tailings pertaining to the Capricorn Copper operations located in Queensland, Australia.

The objective of the pressure filtration testwork was to determine the filter size and operating conditions to process 250 t/h of Capricorn Copper Tailings to an optimal filter cake moisture content determined by the testwork.

1.1 Capricorn Copper Tailings Filtration

The testwork indicated that the Capricorn Copper Tailings solids can be pressure filtered to approximately 15.0% w/w cake moisture with AFP technology and an approximate filtration rate of 287 kg/m^2/hr.

The Table below summarises the expected performance of AFP technology when processing Capricorn Copper Tailings sample.

Table 1.1 – Expected Performance – Capricorn Copper Tailings - AFP® Pressure Filter

Parameter		Filter Sizing Data
Filter Feed Solids Rate	**(t/h)**	250
Feed Solids	**(% w/w)**	50
Total Cycle Time	**(min)**	8.26
Cake Thickness/Chamber Depth	**(mm)**	40
Filter Cake Moisture	**(% wt)**	15.0
Dry Cake Bulk Density	**(kg/m^3)**	2077
Chamber Area	**(m^2)**	12.41
Pressure Filter Model		**H2525-40mm x 110 Chambers**
Number of Filters		1
Filter Utilisation	**(%)**	77

The testwork results indicated that the Capricorn Copper Tailings stream with a feed rate of 250 t/h at feed solids of 50% w/w, can be filtered to a cake moisture of 15.0% wt with a dry cake thickness of 40mm in (1) x AFP® H2525-110 Pressure Filters.

2.0 INTRODUCTION

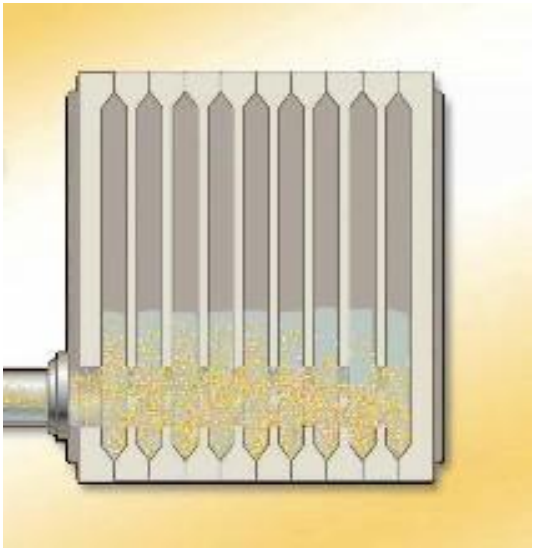
FLSmidth Pty Ltd was commissioned by ATC Williams on behalf of 29 Metals to conduct a complete bench scale filtration test work study on one sample of Copper Tailings pertaining to the Capricorn Copper operations located in Queensland, Australia.

The testing objectives included operating parameters and evaluation of pressure filtration technologies. FLSmidth have tested pressure filtration methods at the feed solids achieved from the thickener test work simulations. The test work data produces information used to size filter presses.

This report details the results of the bench scale filtration testwork conducted on the sample of Capricorn Copper Tailings slurry and discusses the rates and conditions required to process the target solids feed rates to achieve the lowest practicable cake moisture content.

2.1 Procedures – Pressure Filtration with AFP Technology

The following is a description of the full scale filtration process in an Automatic Filter Press. It is important to understand this process in order to simulate it on the bench scale.



1. Pumping Step: Filling Empty Chambers

- Chambers fill from lower centre, in parallel
- Minimal segregation of particles by size/mass due to filling against gravity

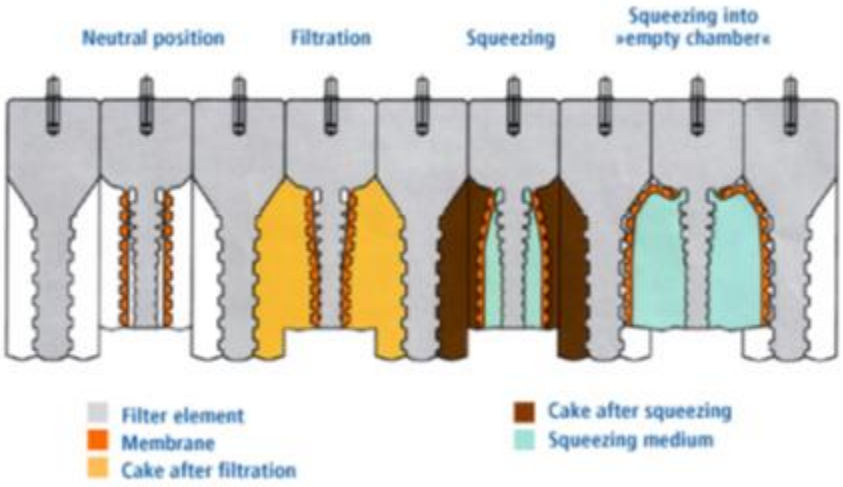


2. Pumping Step: Consolidating solids into a Cake

- Once chambers are full, the pump pressure forces water through the filter media and consolidates the solids
- Solids consolidate on filter cloth in layers, forming a homogenous cake
- Lower feed eye produces uniform pressure in every chamber, resulting in uniform cake density in every chamber

3. (Optional) Squeezing Step: Further cake consolidation

- After the pumping step is terminated, high pressure water is introduced behind the membranes, which squeezes the filter cakes
- Recessed chamber plates are alternated with membrane plates to form a “Mixed Plate Pack”
- Squeezing reduces cake thickness, which reduces the maximum mass of cake that can be discharged from the fixed volume of the plate pack



4. (Optional) Air Blowing

- After the pumping the chambers full of slurry and consolidating the filter cake, or after membrane squeezing, compressed air is introduced into the chambers to remove additional water from the filter cakes and to sweep filtrate from the piping.
- Alternatively, air blowing can be done simultaneously with squeezing.
- In some cases, saturated cakes are acceptable and air blowing is not required. Typically 30 sec of air blowing is used regardless, in order to sweep filtrate out of the piping to prevent dripping on the filter cakes.

5. Cake Discharge and Cloth Washing

- After air blowing, the cakes are ready for discharge. The hydraulic cylinders holding the plates closed are retracted and the cakes discharge mostly by gravity.
- Once the plate pack is fully opened, the high amplitude shaker system is activated and any remaining pieces of filter cake are discharged.
- After shaking, the cloth wash system is activated, flood washing any remaining sticky cake from the filter plates. Good cloth washing prevents leaking between plates.
- After cloth washing, the plates are closed and the cycle repeats.

FLSmidth uses a small pressure filtration cell to simulate the above process on the bench scale:

1. The as-received slurry is analysed for solids concentration and particle size distribution (PSD). If necessary, the solids concentration is adjusted, either by adding process water or by allowing the sample to settle and decanting liquid.
2. Once the solids concentration is correct, the sample is continuously agitated to ensure homogeneity, pH and temperature are recorded.
3. A sub-sample is poured into the feed tank, and the feed pump is turned on to re-circulate the slurry in the feed tank and maintain agitation.
4. The feed valve is opened, the timer started, and the re-circulation valve is closed. Slurry is now pumped into the filter chamber and filtration begins.
5. The pump pressure is slowly increased to simulate full scale filling of empty filter chambers. Filtration continues, under pump pressure, until the filtrate flow rate decreases to approximately 10% of the initial rate.
6. Optional: Pre-Squeeze of filter cake at 4bar, to reduce the void ratio and hence the moisture content of the filter cake. Air blowing can also be used during the pre-squeeze step.
7. Optional: Air Blowing of the filter cake at 7bar to remove filtrate from the voids of the filter cake and reduce the moisture content.
8. Optional: Final Squeeze of the filter cake at 16bar to further reduce the void ratio and hence the moisture content of the filter cake.
9. Steps 4-8 are repeated with various feed pressures, chamber depths, squeezing times and air blowing times to determine the optimum cycle time to produce a cake at the desired moisture content.

The pressure filter lab kit is pictured below:

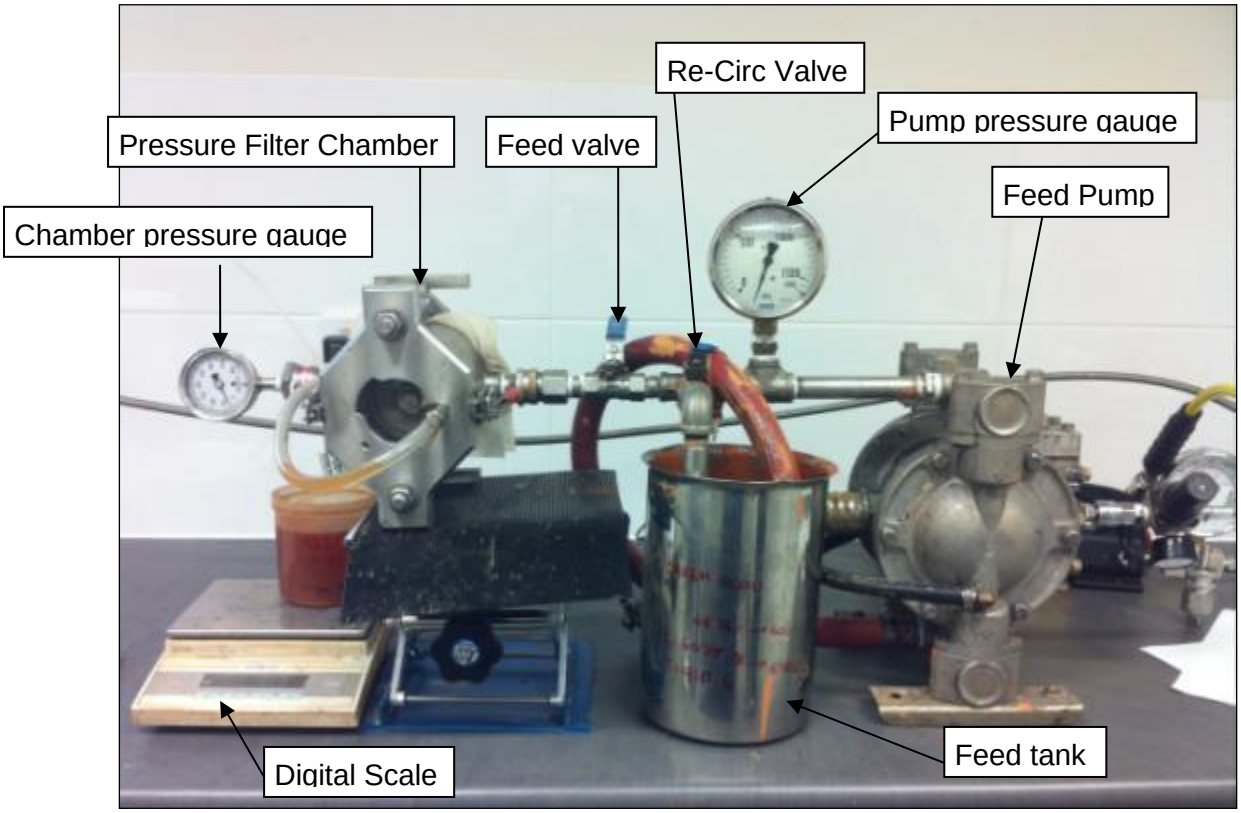


Table 2.2 – Lab filter characteristics

AFP Lab Filter	
Chamber Area m^2	0.00785
Number of Chambers	1
Chamber Thickness mm	25, 32, 40, 50
Chamber Volume $m^3 \times 10^{-3}$	1.96, 2.51, 3.93

The filtration media used in the filter simulations was Clear Edge 46.

3.0 Characterisations

3.1 Sample Characterisation

3.1.1 Sample Characteristic Summary

Parameter	Capricorn Copper Tailings
Feed Suspended Solids (wt %)	50
Solids Specific Gravity	2.82
Liquor Specific Gravity	1.0
Slurry Temp	24°C
pH	10*

3.2 Filter Cake



3.2.1 Filter Cake:

Displays a 32mm cake from Test 1; Final moisture 13.2% wt.



3.2.2 Filter Cake:

Displays a 32mm cake from Test 2; Final moisture 12.3% wt.



3.2.3 Filter Cake:

Displays a 40mm cake from Test 3; Final moisture 12.2% wt.

4.0 Test Results and Discussion

FLSmidth has conducted pressure filtration tests using a small single chamber bench-scale testing unit. The bench-scale testing unit simulates the recessed chamber plate configuration allowing for various feed solids concentrations, feed pressures, and cake thicknesses.

The filtration tests were conducted using a filter media with an air permeability of 0.6 m^3 of air volume per m^2 of filter area per minute at 125 kPa. This filter media is typically effective in similar processes and exhibited good performance based on filtration rate, filtrate clarity, cake release and resistance to blinding.

4.1 Capricorn Copper Tailings

4.1.1 Capricorn Copper Tailings

Table 4.1.2 presents a summary of the tested conditions.

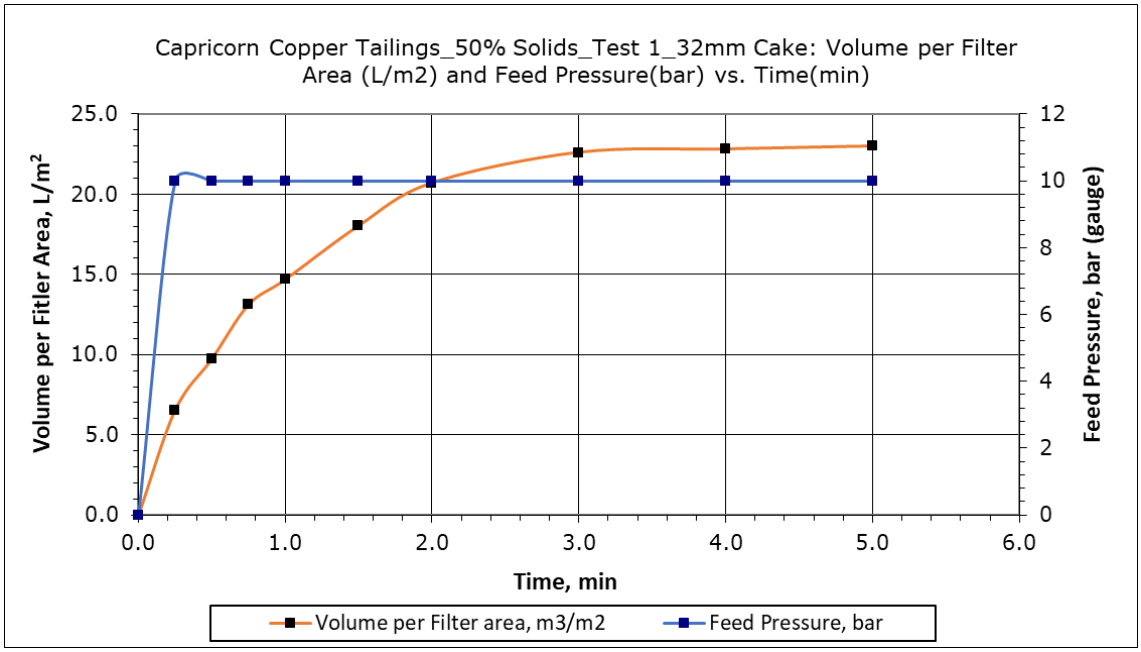
4.1.2 Summary of Pressure Filtration Test Results – Capricorn Copper Tailings

Test		1	2	3
Feed Solids	**% w/w**	50	50	50
Cake Thickness	**mm**	32	32	50
Maximum Feed Pressure	**bar**	10	13	13
Fill Time	**min**	5	3	3
Fill Time to Consolidate	**min**	3	2	2
Air Blow Pressure	**bar**	7.5	7.5	7.5
Air Blow Time	**min**	10	10	10
Dry Cake Density	**kg/m^3**	1947	2030	2077
Final Cake Moisture	**% w/w**	13.22	12.25	12.20

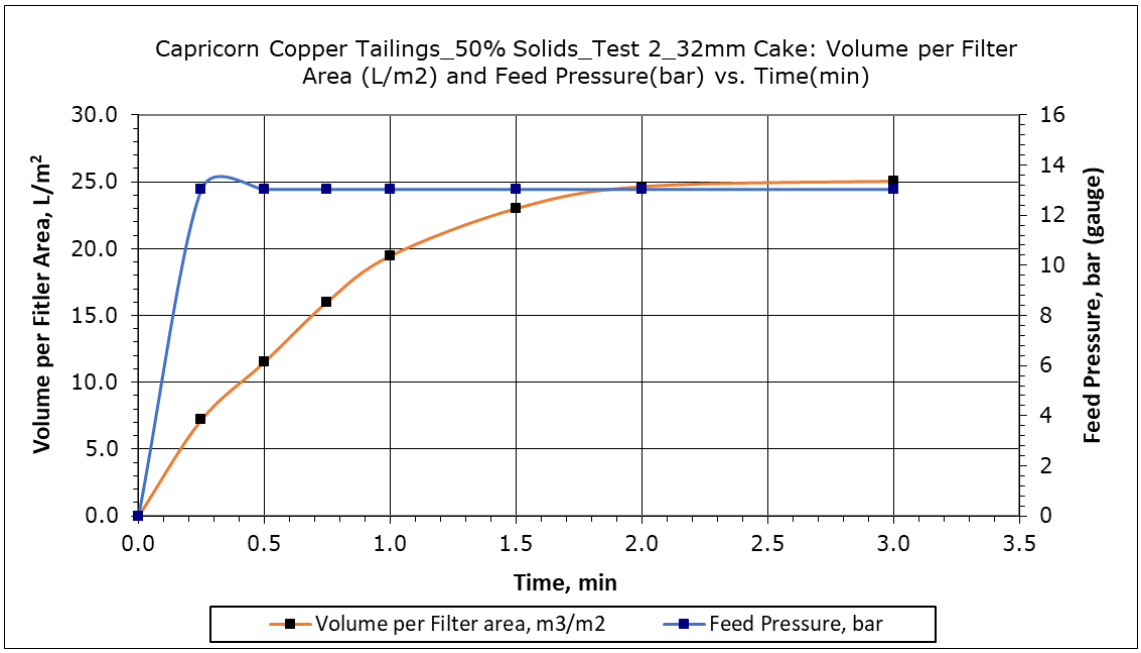
4.1.3 Pumping Time – Capricorn Copper Tailings

The table above shows that pumping at a pressure of 10 - 13 bar leads to 32 - 40mm cake in2 - 3 minutes. For filter presses, the cake form time is based on the time required to consolidate the filter cake. Pumping should be terminated as soon as the cake consolidates in order to minimize cycle time.

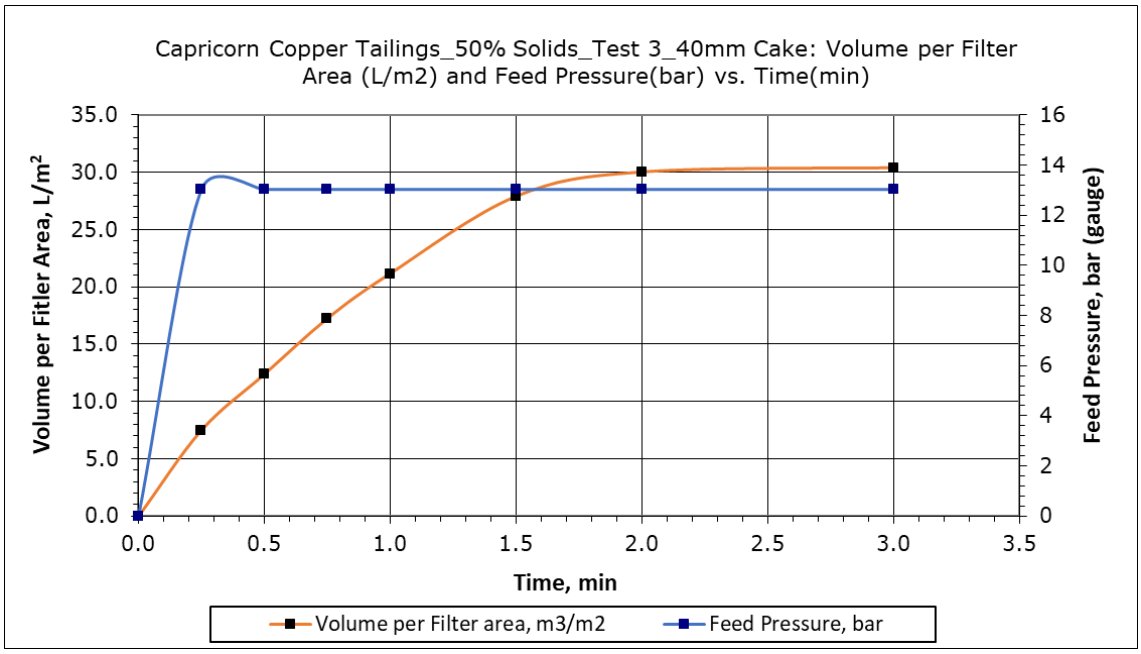
4.1.4 Capricorn Copper Tailings - Volume per Filter Area with Respect to Time - Test 1



4.1.5 Capricorn Copper Tailings - Volume per Filter Area with Respect to Time - Test 2



4.1.6 Capricorn Copper Tailings - Volume per Filter Area with Respect to Time - Test 3

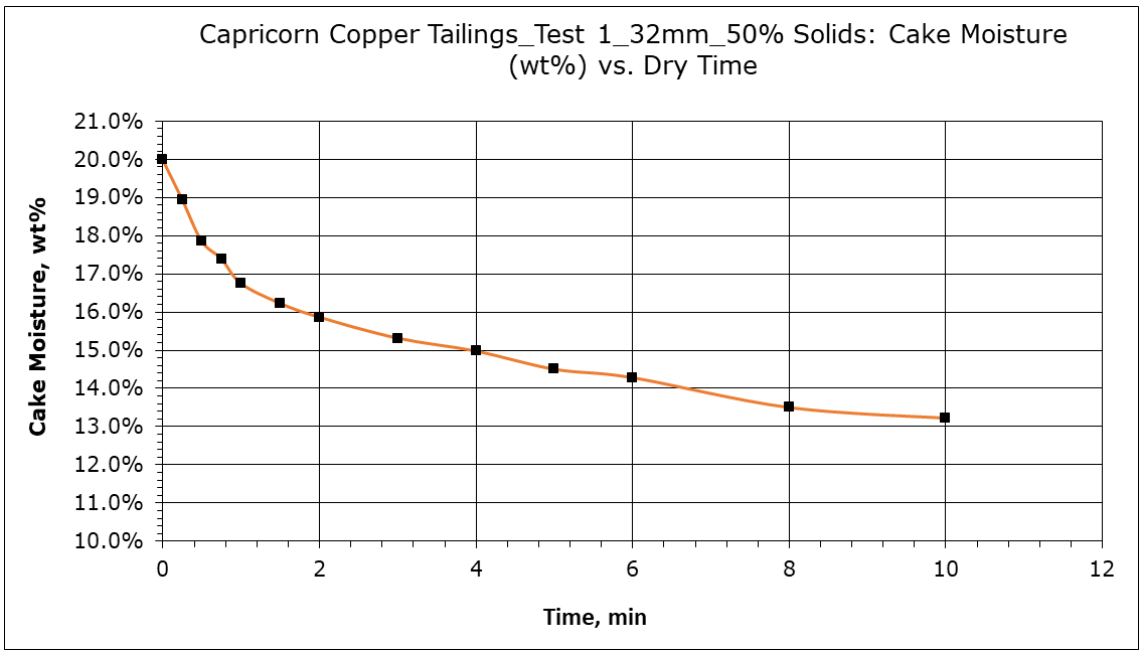


4.2.1 Cake Drying – Capricorn Copper Tailings

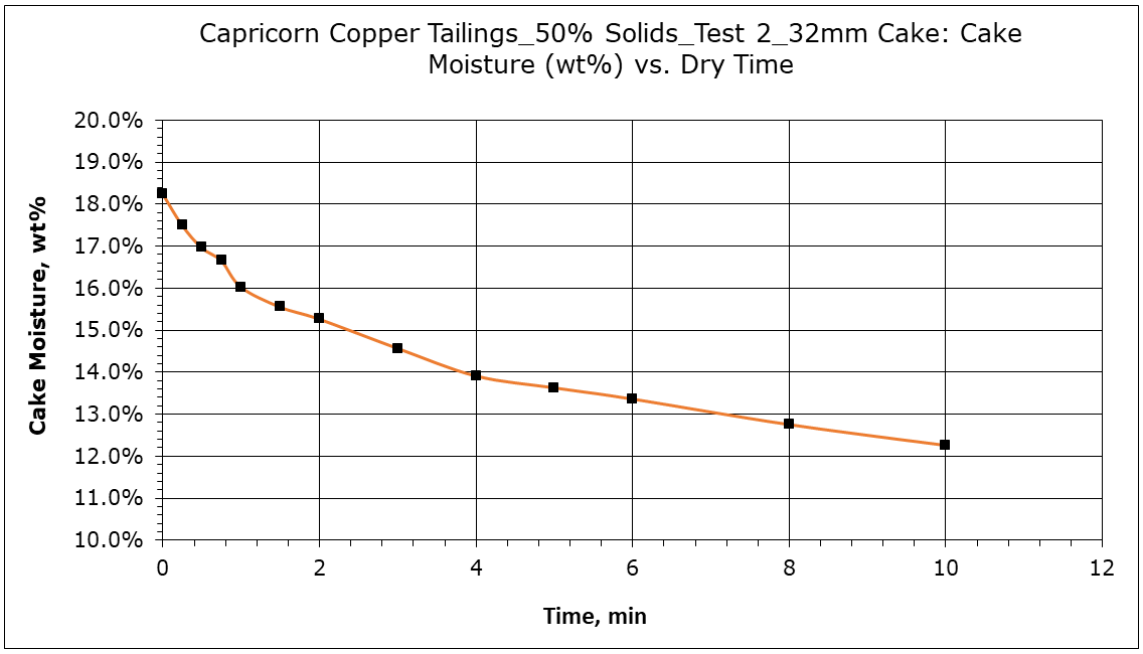
Cake drying in a filter press can consist of air blowing.

For AFP tests, the filtrate volume is captured at regular time intervals during the testing, allowing the moisture content of the filter cake to be back calculated at each time interval. The drying time can be selected based on the moisture content desired using the figures below.

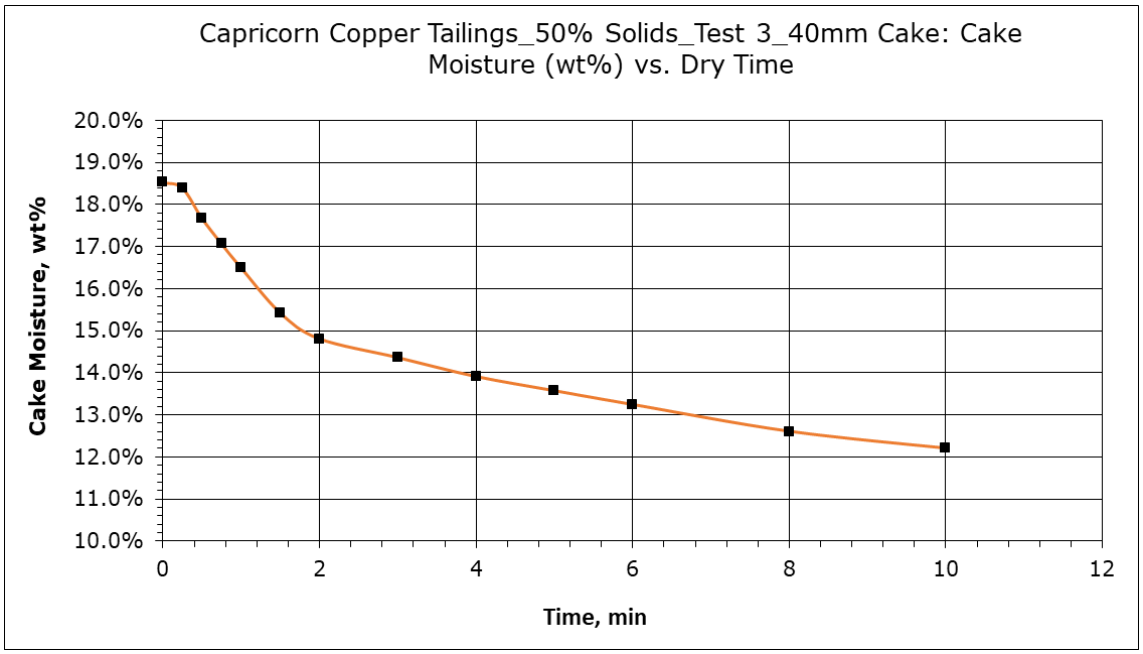
4.2.1 Capricorn Copper Tailings - Moisture content vs dewatering time – Test 1



4.2.2 Capricorn Copper Tailings - Moisture content vs dewatering time – Test 2



4.2.3 Capricorn Copper Tailings - Moisture content vs dewatering time – Test 3

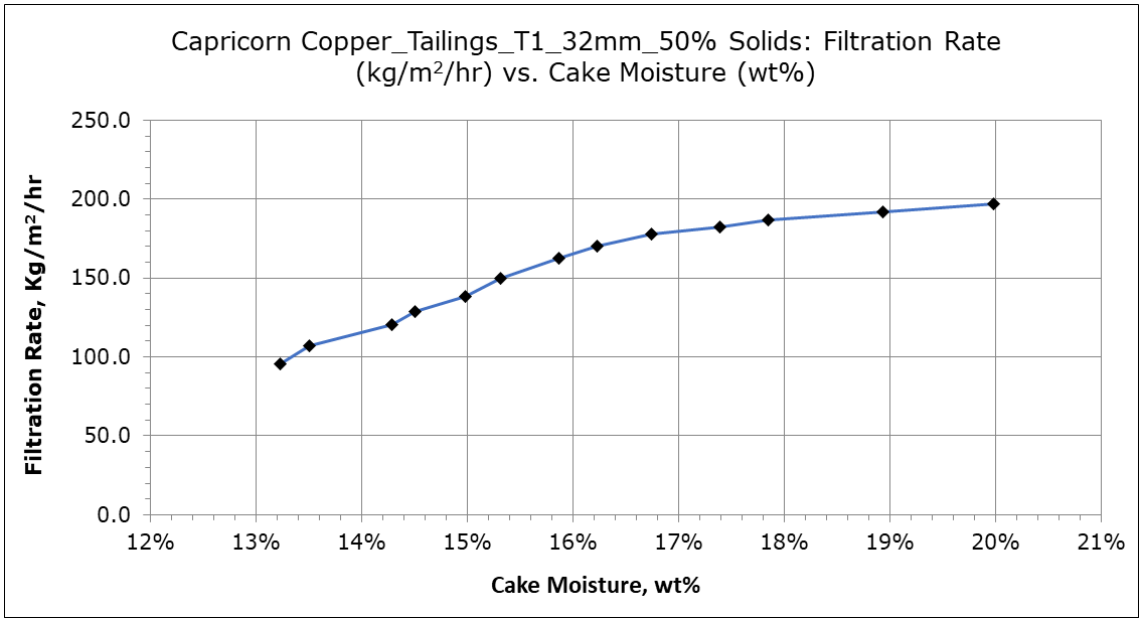


Filtration results indicate FLSmidth pressure filtration technology can be designed to achieve approximately 15.0-wt% cake moisture with a filtration rate of approximately 287 kg/m^2/hr for a 40mm chamber. The filtration rate stated is derived from the cake weight divided by the total filterable area, divided by total cycle time which consists of filtration time and air blow time.

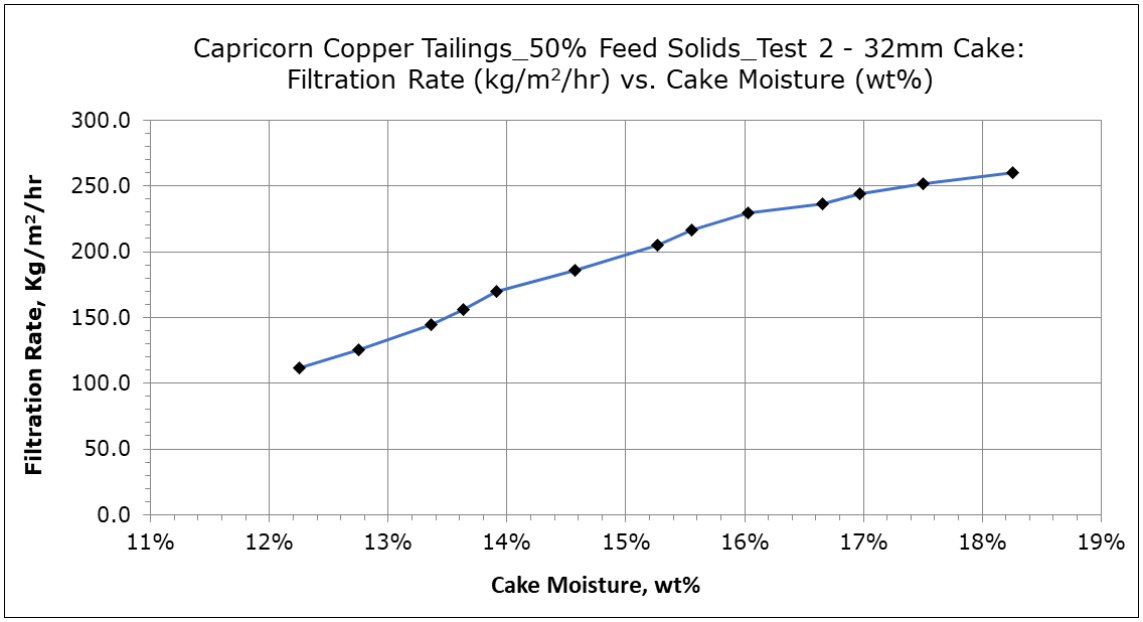
4.3.1 Filtration Rates – Capricorn Copper Tailings

The filtration rate (kg/m^2/hr) as a function of cake moisture (% wt.) has been calculated and plotted for each test on the graphs displayed below.

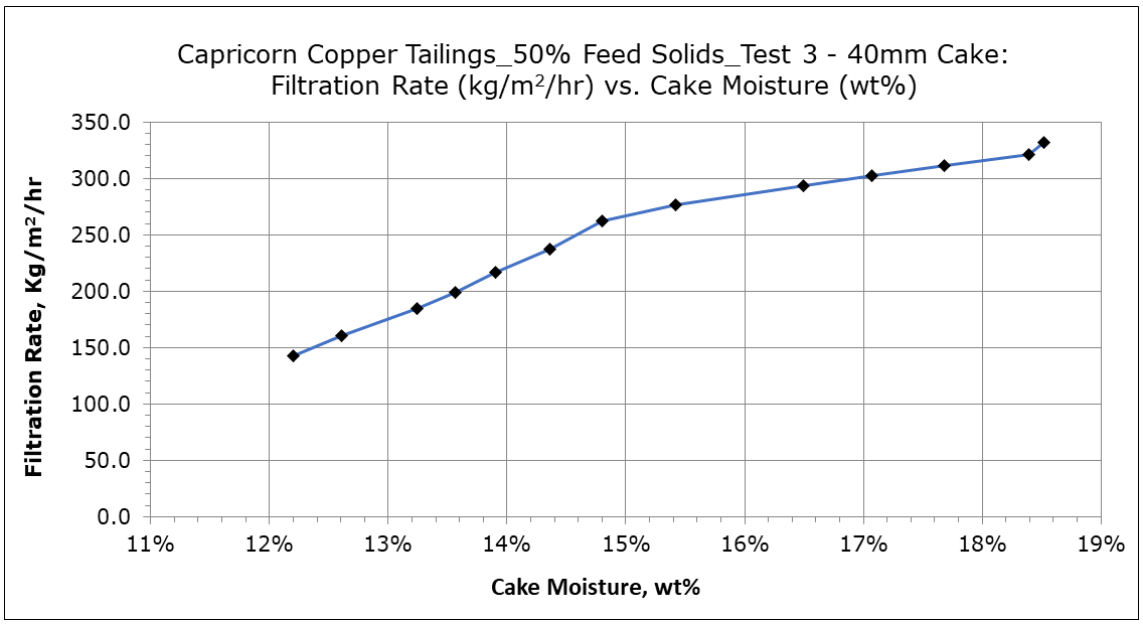
4.3.2 Capricorn Copper Tailings - Filtration Rate vs Cake Moisture – Test 1



4.3.3 Capricorn Copper Tailings - Filtration Rate vs Cake Moisture – Test 2



4.3.4 Capricorn Copper Tailings - Filtration Rate vs Cake Moisture – Test 3



5.0 Conclusions

5.1 Pressure Filtration

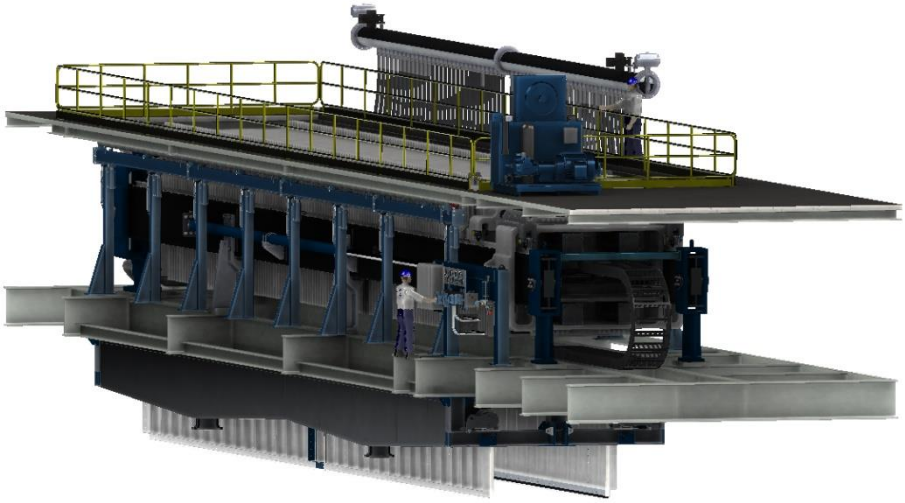
5.1.1 Capricorn Copper Tailings

Pressure technology filtration was evaluated to determine the cake moisture content achievable. Approximately 15.0 wt% cake moisture was achieved during the recessed chamber tests at a filtration rate of 287 kg/m^2/hr. The solids filtration rate stated is derived from the cake weight divided by the total filterable area, divided by total cycle time which consists of filtration time and air blow time.

Table 5.1 – Expected Performance
Capricorn Copper Tailings - AFP® Pressure Filter

Parameter		Filter Sizing Data
Filter Feed Solids Rate	**(t/h)**	250
Feed Solids	**(% w/w)**	50
Total Cycle Time	**(min)**	8.26
Cake Thickness/Chamber Depth	**(mm)**	40
Filter Cake Moisture	**(% wt)**	15.0
Dry Cake Bulk Density	**(kg/m^3)**	2077
Chamber Area	**(m^2)**	12.41
Pressure Filter Model		**H2525-40mm x 110 Chambers**
Number of Filters		1
Filter Utilisation	**(%)**	77

The testwork results indicated that the Capricorn Copper Tailings stream with a feed rate of 250 t/h at feed solids of 50% w/w, can be filtered to a cake moisture of 15.0% wt with a dry cake thickness of 40mm in (1) x AFP® H2525-110 Pressure Filters.



Appendix C

Filtration Plant Cost Indication
Metso Australia

Capricorn copper

Attn: Barry Shean

E-mail: barry.shean@29metals.com

Cost Indication Proposal for Capricorn copper

Dear Barry

We thank you for your interest in Metso's technology and we are pleased to present our price indication for a possible Capricorn tailings Plant. The scope and price is based on our understanding from our recent discussions with you.

The plant designs are based on the Metso modular process design, areas tailings There is a high percentage of Metso equipment in the scope, The process performance is not based on test data, and we would recommend testing to confirm the tailings filterability. While there is site operating data the implications of the tailings filtration rates are not defined.

Basis of estimation
The scope as broken down to a process island, the island included baseline equipment, automation, piping and structural steel. The equipment and automation are priced on Metso list price, the piping and structural steel on current bulk rates. Engineering, project management and contingency is estimated on a project including all the above scope and split to the process islands. Materials handling is not defined and we would need a plot plan of the area to estimate cake transport.

We trust this proposal contains all the information required and look forward to further collaboration in this project.

Should you need any additional information, please do not hesitate to contact myself

Yours truly,

On behalf of Metso Australia Ltd

Jason Palmer
Senior Director, Solutions Sales

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REVISION HISTORY

Revision No.	Revision date	Prepared	Revision text
0	**28-06-2024**	**J.Palmer**	**Cost Indication**
1	**10.08.24**	**J palmer**	**Materials handling added**

MIN-PSL-CI-TV2.40-CV221121-EN

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A. General

A.1. Executive Summary

Capricorn copper (later “Capricorn copper” or “Customer”) is planning to filter a portion of their tailings for storage. Based on the discussions with Capricorn copper, Metso Australia Ltd (Later “Metso”) provides herewith a Cost Indication for tailings dewatering plant. The Cost Indication cover Metso’s envisaged scope for engineering and supply.

The indicative price is provided in section B with technical background and assumptions in section C.

A.2. Metso in Brief

Metso is a frontrunner in providing sustainable technologies, end-to-end solutions and services for the aggregates, minerals processing and metals refining industries globally. By helping our customers increase their productivity, improve their energy and water efficiency and environmental performance with our process and product expertise, we are the partner for positive change.

Headquartered in Helsinki, Finland, Metso employs over 16,000 people in close to 50 countries and sales for 2022 were about EUR 5.3 billion. The company is listed on the Nasdaq Helsinki.

www.metso.com, www.x.com/metsoofficial

A.3. Introduction Technology

Metso’s Tailings Dewatering Plant Unit equipment is described in the following sections – for a complete list of all equipment, including 3rd party auxiliary equipment within Metso’s scope of supply, please refer to the Preliminary Equipment list in Annex D.2.1.

1. Metso Slurry Pumps

Slurry pumps offer the latest in wear technology with usage of high-performance materials resulting in excellent resistance to abrasion and erosion. Special emphasis has been placed on components that have to withstand exceptional wear from coarse heavy solids and flow turbulence. An oversized robust steel shaft and extra thick casings and liners are just some of the heavy-duty components equipped with the MD Series pumps.

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Metso slurry pump (demonstrative only)

2. Metso OKTOP® Agitation Technology

Metso OKTOP® Conditioners improve Filtration performance by providing stable feeds even in slurries with high solids content. The tank is designed to maximize availability while reducing operating and maintenance costs.

The innovative OKTOP® agitation technology ensures efficient solids suspension to prevent sanding in the tank and reduces energy consumption. It can be used to homogenize filter feeds and as a buffer and flow stabilization volume for continuous processes, or as a storage tank to enable batch operation in filtration processes.

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Metso OKTOP® Conditioner (demonstrative only)

FFP Tailings Filtration Plant Unit (Dewatering Plant Unit)

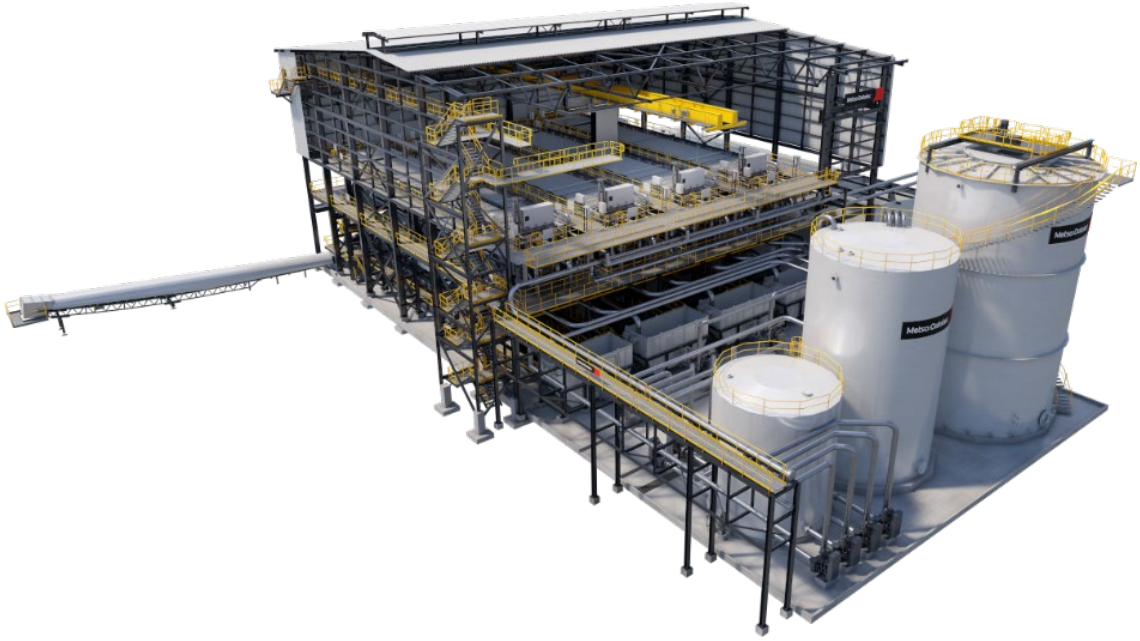
The Metso Dewatering Tailings Filtration Plant Unit has been developed utilizing decades of experience and lessons learned from global filtration operations. The portfolio of pre-designed, modular Thickener / Filtration Plant Units has been developed for the complete size range of the core Metso dewatering technology.

The benefits of the Dewatering Plant Unit are as follows:

- Single point performance assurance for the complete process area
- Pre-engineered, modular units ensuring the highest quality control and reduced engineering hours
- Best process layout practices
- Compact footprint and minimized elevation
- Optimal sizing, pumping distances, retention times and consumptions
- Ease of operation and maintenance built into the basic filtration plant unit design
- A comprehensive package with a consistent approach in engineering, fabrication, installation, commissioning and start-up

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Metso Larox®FFP Filtration Plant Unit (demonstrative only)

5. Metso LAROX® FFP Series Membrane Filter Press

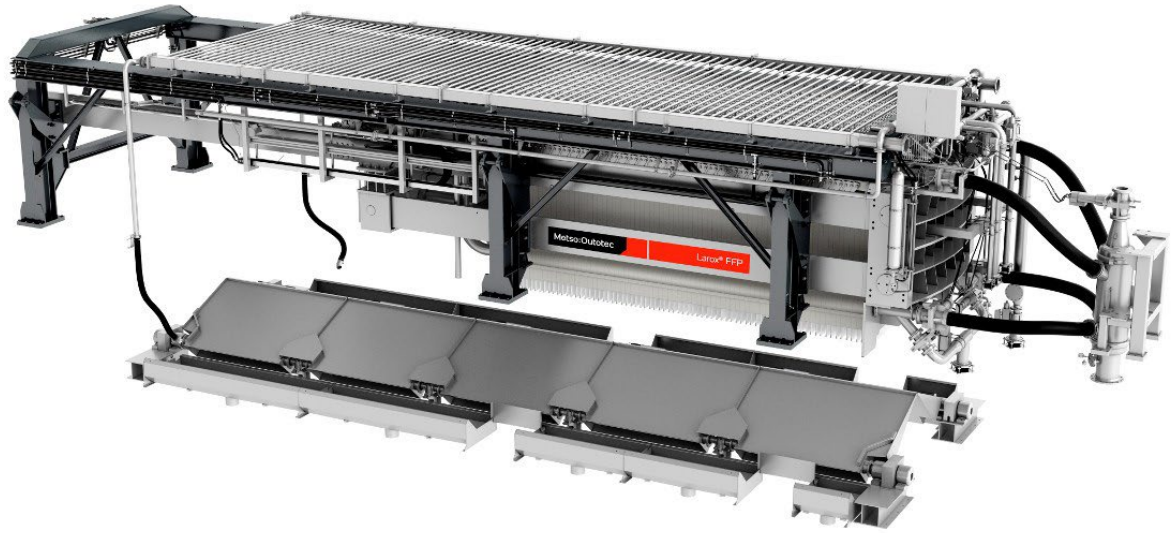
The Larox® FFP Fast opening Filter Press is a high-capacity pressure filter for industrial solid-liquid separation.
Filter press opening and closing is carried out in two stages. The plate pack is opened for cake discharge and closed again for the next filtration cycle, using long stroke quick action cylinders. The required sealing force is provided by large diameter sealing cylinders, which are mounted on the moving cross head.

The filter is equipped with cloth shaking and cloth flushing systems for improved cake discharge and reliability. Cloth flushing is applied after each cycle when the plate pack is open and cake discharge is complete. Flushing water is collected with swivel plates underneath the plate pack.

The operation of the filter is controlled automatically by the PLC control.

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Metso LAROX® FFP Filter Press (demonstrative only)

6. Process Control, Instrumentation and Electrification

Metso's delivery portfolio covers EIA. Metso has delivered several Mini PROSCON® process control systems and ACT® advanced process control solutions to run the plants with Metso process technology. In addition to control systems, Metso process electrification and field instrumentation engineering and supply capabilities constitute a solid basis for the process control.

The Customer secures several benefits by having a single supplier for process technology and process control. Most of the information to implement process control comes from the requirements of process and plant engineering and the main process equipment. With a single point supplier, there are fewer interfaces and the responsibility is clear allowing for simultaneous engineering of different disciplines to take place. This leads to cost and time savings in project implementation, reduced start up time and high performance of the running plant.

4. Metso's Key References

Please refer to several of Metso's recent Plant Solution References presented in the below Table. Metso has sold more than 2,000 Thickeners and more than 15,000 Filters globally.

Project, Site, Country	Scope	Year
Almalyk MOF-3, Uzbekistan	Flotation, Regrinding, Thickening, Filtration, Analyzers, Sampling system	2022
Karara, Australia	Larox® FFP3512 as primary filtration equipment, material handling conveyor systems and peripheral items. Additionally, spare parts and supervisory services will be supplied to support commissioning and plant ramp up.	2021
Cadia, Australia	Flotation, Regrinding, Thickening, Filtration, Analyzers, Sampling system	2021
Chernogorskaya, Russia	Grinding, Flotation, Separation, Electrification, Instrumentation, Automation	2021
Malmyzh, Russia	Crushing, Regrinding, Flotation, Thickening, Filtration, Instrumentation, Automation, Analyzers	2020

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Okvau Gold, Cambodia	Grinding, Flotation, Thickening	2020
Malmberget, Sweden	Flotation, Magnetic separation, Automation	2019
Madneuli, Georgia	Grinding, Flotation, Thickening, Filtration, Automation, Analyzers	2019
Prominent Hill, Australia	Complete Paste Backfill Plant	2019
Carrapateena, Australia	Grinding, Flotation, Thickening, Filtration, Automation	2019
Mansourah-Massarah, Saudi Arabia	Grinding, Flotation, Thickening, Filtration, POX, CCD, OKTOPs, ILR, Elution & Gold Room, Paste Thickening, Analysers, Samplers, Automation, Instrumentation	2019
Udokan, Russia	Basic and detail engineering of the concentrator and copper hydrometallurgical plant, procurement, delivery of main process equipment as well as installation supervision, training and start-up services.	2019
Kola, Russia	Flotation, Thickening, Filtration, Analysers	2018
Benete, Indonesia	Bulk material handling, Crushing, Grinding, Flotation, Thickening, Filtration, Reagent preparation, Electrification, Instrumentation, Automation, Analyzers	2018
Cobre Panama, Panama	Grinding, Flotation, Thickeners, Filtration, Automation	2018
Saucito II, Mexico	Grinding, Flotation, Thickening, Filtration, Automation, Analyzers	2018
Toquepala, Peru	Concentrate Filtration Plant	2017
Adiyaman, Turkey	Crushing, Grinding, Flotation, Thickening, Filtration, Reagent preparation	2017
Mutoshi, DRC	Grinding, Thickening, Filtration, Automation, Analyzers	2017
Woodlawn, Australia	Grinding, Flotation, Thickening, Tailings management	2017
Mibra, Brazil	Bulk material handling, Grinding, Magnetic separation, Flotation, Thickening, Filtration, Concentrate handling, Automation	2017
Kyzyl, Kazakhstan	Grinding, Flotation, Thickeners, Filters, Automation	2016

B. Technical

1. Design Basis

The Tailings Dewatering Plant Unit offered has been designed based on data received from the Customer and estimated filtration rates

Filter Sizing Data	t D.S./h
Plant throughput (max)	300
Plant throughput (nom)	200
Filter(s) utilization	85 %
Filtration capacity	250 kg D.S./m2h
Solids content in cake	85.0 % w/w

The process application is copper tailings dewatering. The design basis has been considered as follows:

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1. Design Limits

The scope of Metso's engineering set out in this proposal is for the plant within design limits defined as follows (if not otherwise specified it is assumed that design limits are located 1 m from plant / building perimeter):

Take-In Points (TIP)

TIP	Stream	Description
Feed Material		
1	Copper Tailings Feed tank	Copper tailings feed to Slurry Feed Tank SF01-RC101. inlet flange
Chemicals delivered via container or bags		
2	NA	
Water		
4	Fire-fighting water	At the plant boundary, fire-fighting system at client's scope
5	Sealing water	At the plant boundary
6	Wash water/Process water	At the plant boundary, intermittent used during start-up
7	Emergency shower water	At the plant boundary, emergency shower water system at client's scope
Gas		
6	NA	
Electrical energy		
7	Power Supply	Transformer primary tappings (see main single-line diagram)

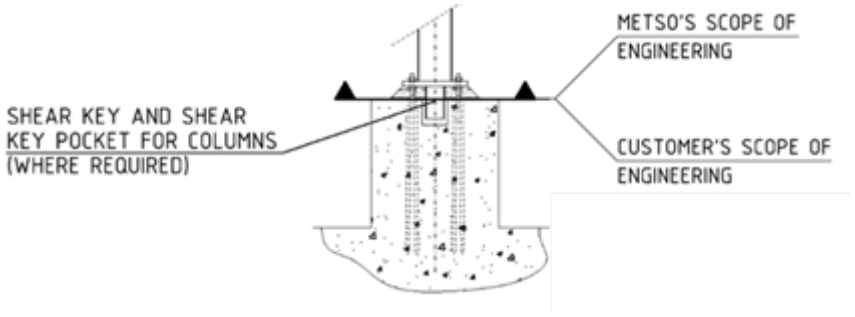
Take-out Points (TOP)

TOP	Stream	Description
Product / Residues		
1	Cake	Cake discharge point from the lip of the discharge conveyor
2	Filtrate tank out	Filtrate pump discharge flange

Design Limits for Civils and Structural Engineering

The structural engineering scope of Metso is from top of the concrete within the battery limits as defined in the below figure.

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2. Process and Plant Description

This is a general process description of the Metso Dewatering Plant Unit for Capricorn copper tailings dewatering. The dewatering plant is planned to dewater copper tailings according to the following table and is equipped two FFP3512 automated horizontal pressure filters and required auxiliary equipment.

Technology	Capacity, t D.S./h
2 x FFP3512 86/98 M45 2	300 (nominal)

The thickened slurry is pumped to the Slurry Feed Tank SF01-RC101 and filtered in the filtration plant for stockpiling and further transportation by trucks.
In this process description, the areas surrounding the filters and supplying the required streams to them (slurry handling, compressed air system, water handling, filtrate handling and water treatment) are called the auxiliary system.
The Larox® FFP Filtration Plant is equipped with two Larox® FFP3512 86/98 M45 automated pressure filters: SF01-FL101...102. The FFP (fast-opening filter press) filters are used to dewater copper tailings slurry to a residual moisture of <11 % w/w. The FFP filters have short cycle times (10-12min) and are hence considered as batch-wise operating units. Filter feed and cake discharge are intermittent, as well as the cloth and core washings. It is critically important to understand the stages of the pressure filtration cycle, and the relationship between average and instantaneous flows when sizing the overall operation to be able to optimize total throughput and size auxiliary equipment correctly.

B. Price Indication

The price for Metso's scope of supply and services as described in this proposal amounts to:

Item / Description	Tailings plant EUR AACE Class 5
Tailings Filtration capital equipment	15,000,000
Installed plant	6,000,000
Site construction & contingency	10,000,000
Total	31,000,000

The prices include equipment, engineering, plant and construction management excluding civils and earthwork.

Not included are any taxes, customs duties, dues, fees.

Notes:

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- Prices are based on:
    - Metso Standard Design and Deliverables. No Customer Specifications have been considered
- All Areas will require some engineering and additional testwork before a firm price can be developed.

ENVIRONMENTAL AND OPERATIONAL ISSUES TO CONSIDER ON DRY PLACEMENT

The Conceptual study have utilized database info to fulfil the requirements of this stage. Further work is needed to advance the project to feasibility and detail engineering, including:

- Transport behaviour evaluation.
- Variable moisture test work.
- Field compaction trial.
- Detailed strength testing (triaxial).

The target moisture content for the filtrate has been assumed though the degree of dewatering readily achievable depends on the FFP technology adopted. However, from an operational viewpoint, it is important to define placement conditions to expedite construction, maintaining structural integrity post-compaction and provide all the water management advantages that an appropriately developed dry stack exhibits in the given environmental conditions of Capricorn Copper.

Nevertheless, one of the most consistent “challenges” is filtration performance fluctuations not to mention the mechanical and human variability elements involved in transporting and placing/compacting those tailings. As a result, the filtrate’s character will vary and occasionally not meet the target moisture contents.

The solution proposed for addressing filtrate and climatic variation is to design and operate the dry stack with an emergency stack and/or off-spec internal stack. The material to be placed against the outer shell shall be meeting the target moistures to be compacted to its maximum density, the inner areas are assumed available for all specifications and shall be placed in as close as possible optimal conditions but subject to upset conditions, either equipment or environmental.

No geochemical issues have been built into the assessment though it is proposed that some form of zonation could be used to adequately manage placement of weathered rock within the dry stack, meaning providing an excellent oxygen barrier than a considerable thickness of unsaturated compacted tailings provides.

Further to placement, the management of surface water is of relevance. Surface water, particularly concentrated runoff, should not be permitted to be routed towards the dry stacking operation. As important, the catchment and routing of precipitation on the stack itself must be appropriately designed for. For the surface runoff within the overall catchment containing the dry stack, one (or more) of perimeter ditches, binds or under-stack flow through drains designed for an appropriate hydrological event(s) should be included in the design. A deeper assessment is required to secure routing of flows to armored channels with an allowance for a limiting slope lengths/gradients to keep erosion potential at a minimum.

Site development for a dry stack normally consists of the construction of surface and groundwater control systems. Two systems shall be incorporated:

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- An outer collection and diversion system. This system usually consists of ditches to divert surface runoff around the site and if necessary, a cut-off and drainage system usually combined with surface water diversion. The cut-off system can range from simple ditches to sophisticated cut-off walls depending upon site conditions and is believed to be part of the existing conventional tailings storage design. An inner interception and collection system for contact surface water and seepage from
  the dry stack. This system usually consists of an under-drainage system of finger drains, toe drains, drainage blankets and French drains, collection sumps and ponds. Water collected in the ponds and sumps is used in process or pumped to a water treatment plant depending upon the site water balance. No liners have been included but could be considered.

The concept design of the tailings dry stack is conceived as compatible with how the stack can be practically constructed using the selected stacking equipment with support from bulldozers on the outer areas near the external buttresses.

The main issue associated with the placement of the filtered tailings is usually trafficability. The filtered tailings are generally produced at or slightly above the optimum moisture content for compaction. The operating plan has been defined to avoid trafficability problems.

Finally, it is worth mentioning that the dry stack facility is conceived to be developed to consist of, or closely approximate, their desired closure configuration. There is negligible facility deformation post-placement versus the considerable consolidation settlement conventional tailings undergo over what can be a very long period. However, a closure capping has not been taken into consideration, unless those tailings on the outer shell and protected with the corresponding buttresses and the final surface cover along the slopes.

11.1 DRY STACKING INTRODUCTION

There are several options for stacking using continuous dumping systems. They can be divided into:

(1) Shiftable conveyor system.
(2) Truck transportation
(3) Combinations of (1) – (3)

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Shiftable conveyor system. Describes a system that mainly uses conveyor belts as main means of transport. The conveyors are relocatable and/or shiftable so that the conveyor routing can be altered. Normally the system operates with a tripper car to connect the material stream with a spreader system. If needed, connecting, mobile bridges may be added to extend the operating range and flexibility. Main disadvantage is the additional downtime of conveyor shifting and relocation. This must be assessed in more detailed planning work. Figure below provides a view of a typical conventional shiftable conveyor arrangement.



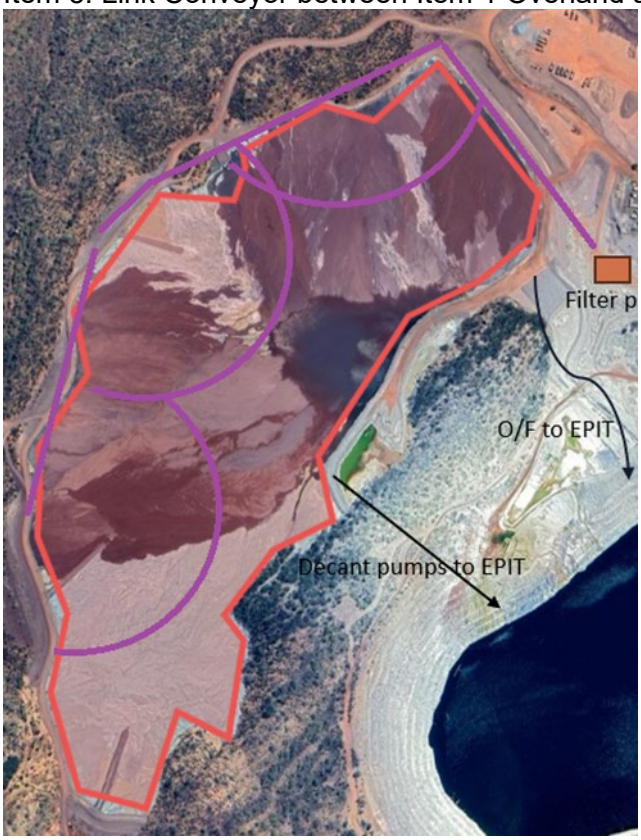
Shiftable Conveyor



Radial stacker

1. DRY STACKING CONCEPT Conveyor

As an overview the system consists of the following items:

- Item 1: Overland conveyor from filtration plant 3 x 400m
- Item 2: Overland/relocatable conveyor (for Phase 3) from item 1 to Track Shiftable
- Item 3: Track Shiftable for spreading
- Item 4: Tripper car and Spreader
- Item 5: Link Conveyor between Item 1 Overland and Item 3 Track Shiftable
- 

2. CONCEPT FOR DRY STACKING USING TRACK SHIFTABLE SPRADER

In detail this concept presents the dry spreading done with shiftable conveyor and spreader conveyor. The spreader is moving radial using the tripper car as pivot and parallel using the shiftable conveyor as a track. The shiftable conveyor can be shifted forward using e.g. dozer, as the spreading is advancing.

The radial spreader can be driven to opposite side of the shiftable conveyor in order to do a retrieving spread cake for e.g. building next start platform. This method can be repeated using link conveyors to move tailings from overland conveyors to the next levels where shiftable conveyor is moved.

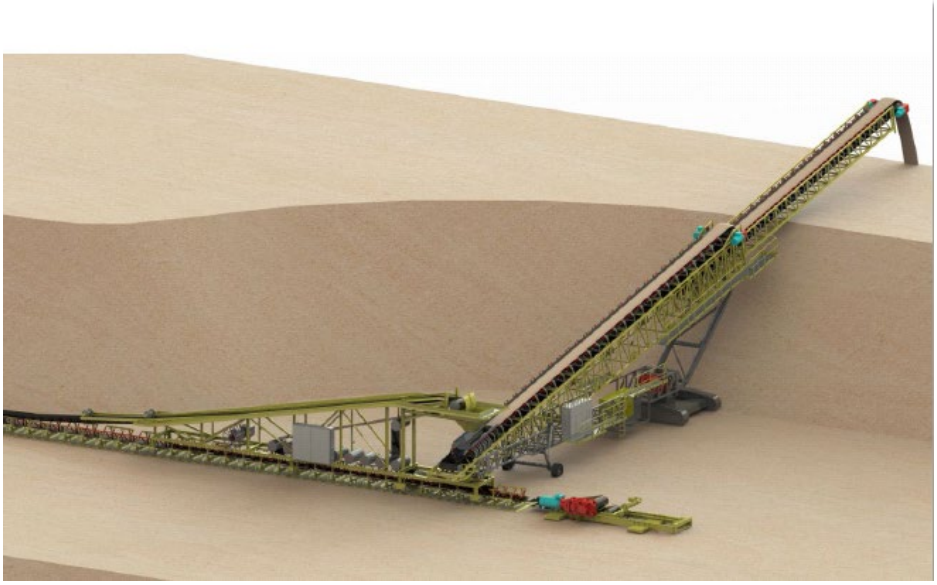


Figure: Concept picture of Track Shiftable and Radial Spreader

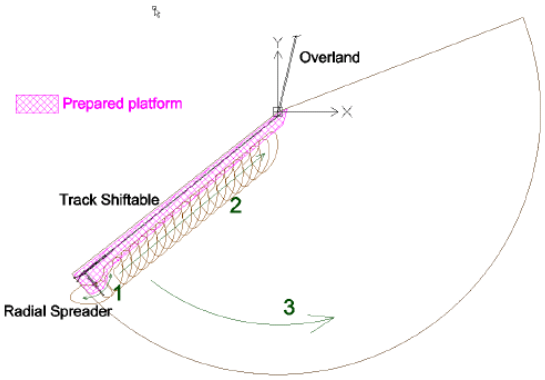


Figure 2: Track Shiftable and spreader in start position

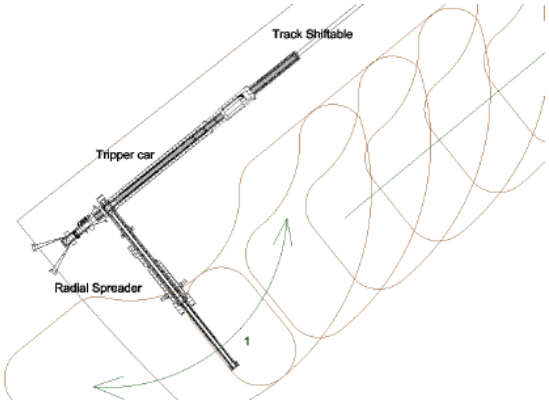


Figure 3: Detail view of the Tripper car

The critical parts of that system are shown in figure 2 with:

- Prepared platform from customer
- 1: Radial spreader starts with radial downcast spreading
- 2: Radial spreader advancing to Track Shiftable pivot with down cast spreading
- 3: Track Shiftable shifted to next radial positions

3. PHASE TIMES BETWEEN TRACK SHIFTS AND DOWN TIME

The usage of the system is done in phases with brief description here.

(All measures and calculations are assumptions and need further examinations when material and ground specifications become more accurate)

- Volume of first lift is 1,250 000 m3 (250 000 m2 @ 5m lift)

- Volume of each spread 250m radius is 125,000 m3 in ¼ to ½ arc
-
- With design capacity 300 t/h and assumed density of 1.7 t/m3 the time for the first spread is 700h
- Next spreads are approx. twice of the first spread as the shift movement is radial Track shiftable needs to be shifted after first 1400 hours.
- Shift time for Track Shiftable is approx. 6 hrs. (=down time)

4. REQUIREMENTS FOR RUNNING THE SYSTEM

(Requirements are not limited to these and are defined further when project develops)

- Compacted and levelled start platform.
- Dozer or equal for track shifting
- Concrete platform for Track Shiftable radial movement pivot
- 10% of tailings transported by truck during conveyor relocation times
- 10% of tailings moved by dozer for profiling and margin management

EQUIPMENT LIST

The following modifications are made to the equipment list (attached)

1. ITEM 1, OVERLAND CONVEYOR, 400 m 1 pcs
2. ITEM 2, OVERLAND CONVEYOR, 400 m 1 pcs
3. ITEM 3, OVERLAND CONVEYOR, 400 m 1 pcs
4. ITEM 4, TRACK SHIFTABLE CONVEYOR, 250 m 1 pcs
5. ITEM 5, SPREADER AND TRIPPER 1 pcs
6. ITEM 6, TRACK SHIFTING HEAD 1 pcs
7. ITEM 7, ELECTRIFICATION AND AUTOMATION 1 pcs
8. ITEM 8, OPTION, HIGH INCLINE LINK COVEYOR 1 pcs

5. Cost Impact

The budget estimate for the revised system is:

Tailings plant AUD AACE Class 5

ALTERNATE OFFER	OVERLAND
- Overland conveyor 1200m@$6670/m	8,000,000
- Grasshoppers + Radial Stacker	12,096,000
- Erection	5,033,000
- Civil Works	1,742,000
- Earth Works or road conservation	775,000
- Freight/Insurance, All Risk	1,242,000
- Engineering + Management	303,000
- Startup Site Services	436,000
TOTAL	**31,305,000**

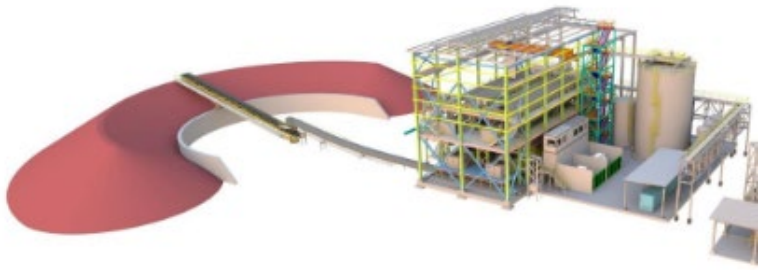
Conveyor system OPEX	$1.5/t at 2mta	$3,000,000 AUD/a

Alternative transportation

With truck transportation conveyors would still be required, feeder under the filters discharging to a short transfer conveyor and radial stacker to create a temporary stockpile. The stockpile should have sufficient storage for significant rain events and to allow decoupling between filtration and truck transportation. The conveyor equipment included would either be necessary in the conveyor option or could be repurposed.

In the first years of production trucking would allow significant flexibility and could be utilised as preparatory work for the later installation of a conveyor system once a stable and level surface has been established.

ALTERNATE OFFER	OVERLAND
- conveyor	3,500,000
- Erection	1,820,000
- Civil Works	630,000
- Earth Works or road conservation	280,000
- Freight/Insurance, All Risk	200,000
- Engineering + Management	303,000
- Startup Site Services	70,000
TOTAL	**6,803,000**



Typical temporary stockpile arrangement

Trucking OPEX

- CAPEX of trucking assumed included in OPEX
- 4 x 40 tonne articulated dump trucks = 22m3 per truck tight
- 1 x 980 loader at 4.5m3 per bucket x 3 buckets per load
- Stockpile management

Total per m3 $12.50m3 @ 1.5kms haul circuit, factorised to a 3km round trip

- 50% of tailings moved by dozer for profiling and margin management

$15.00 / m3 or $8.6/t $17,150,000/a

Liability

This Price Indication has been made in accordance with Metso's knowledge and experience in this kind of market and shall serve as an estimate, without prejudice. It is intended to provide an indication of the order of magnitude for the envisaged investment and is not intended as a binding offer, which we would be happy to provide if required. Due to the character of our price indication you will understand that we cannot accept liability for damages associated with this Price Indication, such as price accuracy or liability for the consequences of a decision to proceed, or not to proceed, with an investment based hereon.

Confidentiality and Intellectual Property

This Price Indication is made in confidence and on the understanding that it shall not be used for any purpose other than for your internal evaluation of the project and as a basis for further negotiations with us. It is made on the condition that it shall not be submitted to third parties without our prior consent, and shall specifically not be used, either partially or complete, as part of an invitation to third parties to bid for this or for similar projects.

Applicable Law

This Price indication shall be governed by and construed in accordance with the substantive laws of Finland excluding its choice of law provisions. The United Nations Convention on the International Sale of Goods (CISG) shall not apply.

Appendix D

Tailings Storage Options Desktop Ecology Assessment
KG Environmental

2024

Tailings Storage Options Desktop Ecology Assessment

29 METALS

CAPRICORN COPPER MINE

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Appendix B: Matters of State Environmental Significance Reports
Appendix C: Protected Plants Flora Survey Trigger Map (Lot 5 on CP865892)

1. INTRODUCTION

1.1 Overview

29 Metals is investigating options for future tailings storage at Capricorn Copper Mine (CCM). These options consist of deposition of tailings to EPit and potential new Tailings Storage Facilities (TSF) at five sites referred to as TSF3 Phase 1, TSF3 Phase 2 (also known as Upper Esperanza South), Magazine Creek, Diamond Creek and Greenstone. 29 Metals have commenced specialist studies of the TSF3 Phase 1 location, including wet and dry season ecological surveys.

This report presents ecological information available for each site for the purpose of identifying environmental values that may be impacted by construction and operation of a tailings storage facility.

1.2 Project Areas

The five potential TSF sites are in the Northwest Highlands bioregion and lie approximately 105 to 115 km north of Mount Isa. All are south of Gunpowder Creek in the vicinity of Capricorn Copper Mine (**Figure 1**).

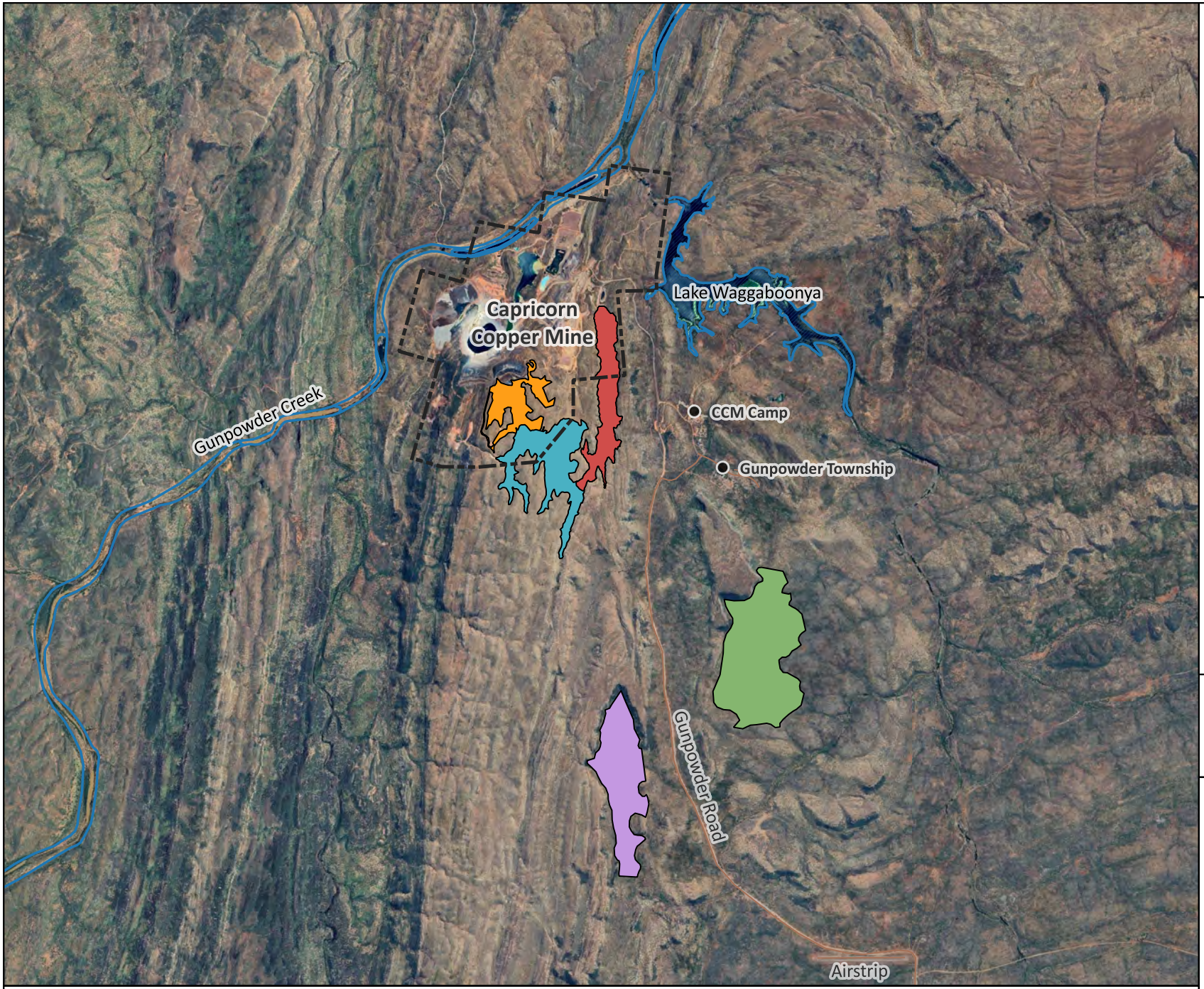
TSF3 Phase 1 and Phase 2 are located south of EPit and the Esperanza Waste Rock Dump (WRD). TSF3 Phase 1 covers 43 ha and is approximately 1.2 km (N-S) x 0.9 km (E-W). Phase 1 encompasses the plunge pools at the foot of the Esperanza WRD. TSF3 Phase 1 is within the boundary of existing approved Mining Leases (MLs) and is one of the closest sites to the current mining activities (approximately 2 km from the current processing plant).

TSF3 Phase 2 lies to the south and south-east of TSF3 Phase 1. The two sites are separated by the Upper Esperanza Diversion Drain (UEDD). Phase 2 covers 80 ha and is approximately 1.9 km (N-S) x 1.2 km (E-W). The site is approximately 3 km from the current processing plant. Other than the UEDD, no other mining disturbance is apparent from aerial imagery.

Magazine Creek site is located to the east and south-east of current mining operations. It covers 60 ha and is approximately 2.5 km (N-S) x 0.6 km (E-W). The Magazine Creek site is less than 1 km south-west of Lake Waggaboonya and less than 2 km south of Gunpowder Creek. It is the most northerly of the sites. The northern section of the site (within existing MLs) has been significantly disturbed by previous mining activities and contains a series of pools, currently used to supply water trucks with water for dust suppression. It is one of the closest sites to current mining activities (approximately 2 km from the current processing plant).

Diamond Creek is the most southerly site, on the western side of Gunpowder Road. It covers 96 ha and is approximately 2.6 km (N-S) x 0.8 km (E-W). No disturbance is apparent from aerial imagery. The site is located furthest from mining operations: over 7 km from the current processing plant.

Greenstone is south-east of CCM, between Gunpowder Road (0.7 km to the west) and Greenstone Creek (1.9 km to the east). The site is located less than 3 km south of Lake Waggaboonya and CCM Camp, and less than 2 km south of the old Gunpowder Township. It is by far the largest of the five sites, covering 169 ha and approximately 2.3 km (N-S) x 1.3 km (E-W). Greenstone site is approximately 6 km from the current processing plant. No disturbance is apparent from aerial imagery.



29 Metals Capricorn Copper Mine

Tailings Storage Options Desktop Ecology Assessment

LEGEND

- TSF3 Phase 1
- TSF3 Phase 2
- Magazine Creek
- Diamond Creek
- Greenstone
- ML permits granted - merged
- Gunpowder Creek
- Lake Waggaboonya

0 1 2 3 km

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Figure 1. CCM Tailings Storage Facility Site Options

2. METHODS

The scope of the desktop assessment was to identify and report potential ecological values relevant to the five sites using available online resources. Online sources included:

- Queensland Globe (Regional Ecosystem mapping, watercourse mapping, etc) (QG 2024b)
- Wildlife online database (QG 2024d)
- Protected Matters Search Tool (DCCEEW 2024)
- Queensland Government Environmental Reports portal (QG 2024a)
- Aerial imagery.

Approximate central locations were used to generate reports from the Queensland Government's Environmental Reports portal. It automatically assigns a search area of 2 km radius from the central point. In all five cases this buffer entirely encompassed the site. The specific areas contained within the site boundaries were unable to be searched.

Environmental Reports were generated from the following coordinates:

- Greenstone: latitude -19.736482, longitude 139.391134
- Diamond Creek: latitude -19.752392, longitude 139.374247
- Magazine Creek: latitude -19.706867, longitude 139.372552
- TSF3 Phase 1: latitude -19.707773, longitude 139.361044
- TSF3 Phase 2: latitude -19.716106, longitude 139.365471.

Environmental Reports were used to generate a list of Matters of State Environmental Significance (MSES), Biodiversity and Conservation Values and Regional Ecosystems (RE) mapped within a 2km radius search area overlaying each site. Items identified within the larger search area were then assessed within each site boundary to determine site-specific extents. This was completed using either direct measurements within the site boundaries in Queensland Globe (measurement tools) or extracted from Queensland Globe as spatial files to be analysed with Geographic Information System (GIS) software (QGIS). Results are presented for both the larger Environmental Report search area and the site-defined extents.

Regional Ecosystem (RE) mapping for the larger site was extracted from Queensland Globe and then clipped within QGIS to calculate RE areas within each site. RE mapping is often provided as a spatial polygon of mixed REs with a corresponding predicted percentage (e.g. 1.11.2a/1.11.8/1.7.5b, 80%/15%/5%). The area of each RE within mixed polygons was calculated by applying the relevant percent value to the total area of mixed RE polygon within the site boundary.

Protected Matters Reports were generated from the Protected Matters Search Tool (PMST) maintained by the Department of Climate Change, Energy, the Environment and Water by uploading spatial files of each site boundary. No buffer was applied as the PMST automatically extrapolates to habitats in the surrounding landscape that may not be within, or immediately adjacent to, the actual site.

The desktop assessment also incorporated the TSF3 Flora and Fauna Assessment (KG Environmental 2024) for TSF3 Phase 1 and the ground-truthed Regional Ecosystem mapping produced by Paul Williams in 2023.

3. RESULTS

3.1 Existing Land Use and Tenure

The five sites are mapped as a land use of 'grazing native vegetation', consistent with the greater region. The sites are located on Lot 5 on Plan CP865892 (Calton Hills), with a tenure of 'Lands Lease'. There is a small infringement on

adjoining Lot 1 of Plan TG38 (containing Gunpowder township and named 'Tourist Village') from the Magazine Creek and Greenstone site boundaries.

3.2 Topography

TSF3 Phase 1 and 2 consist of a connection of gullies and ridges with little flat area. Contour mapping shows the steepest sections within the northern portion of TSF3 Phase 1.

Magazine Creek contour mapping shows a gentle slope within the base of the primary gully, running south to north, with relatively steep slopes to the gully walls.

Diamond Creek site is contained by a ridgeline running along the western boundary and constricting the northern tip. The lower lying ground extends to the east and south of the site.

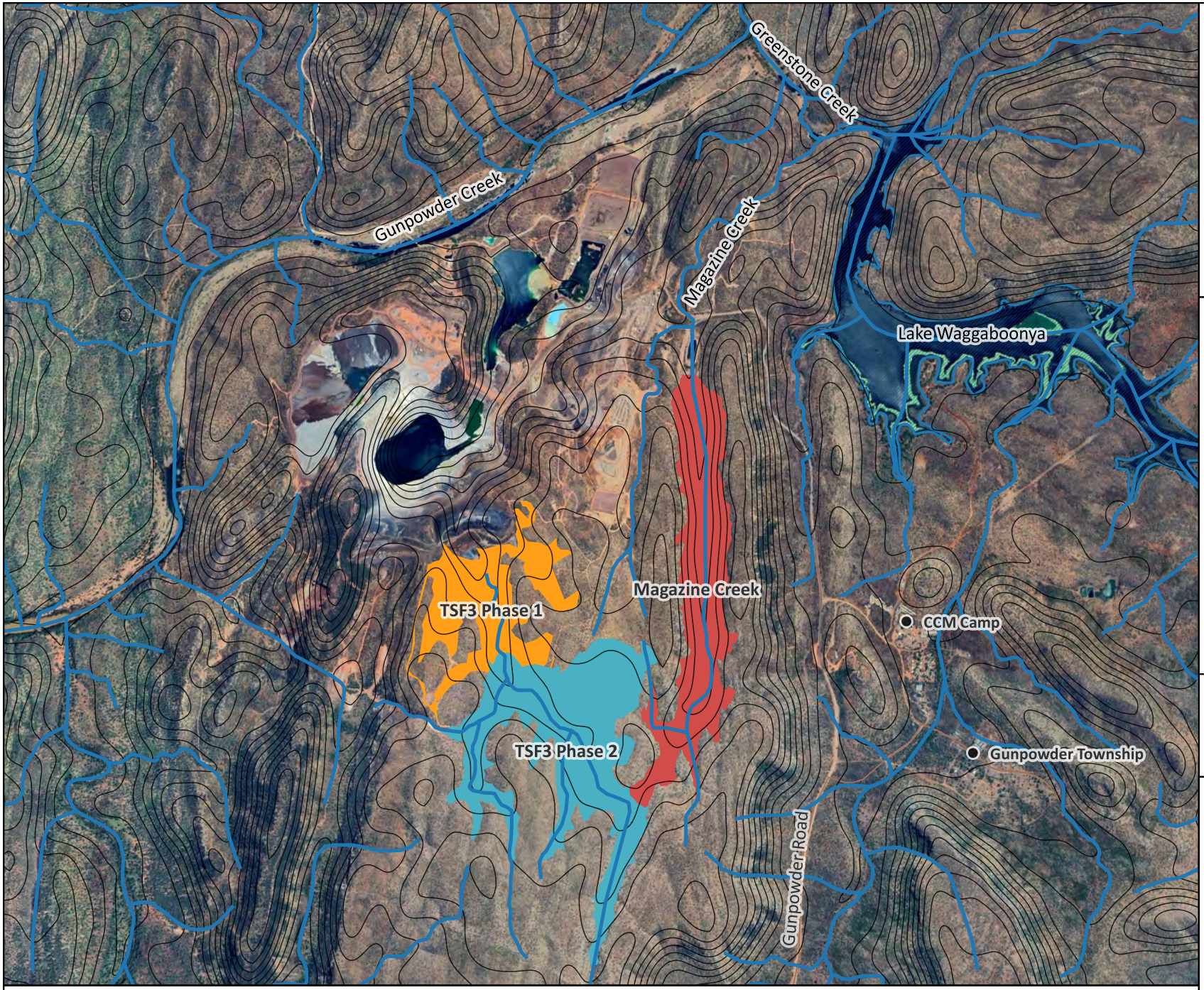
Greenstone site appears to be relatively flat, enclosed by a steep ridge on the northern boundary. It is assumed to be of higher agricultural value than the steeply sloped valleys of TSF3 Phase 1, TSF3 Phase 2 and Magazine Creek sites.

3.3 Waterways

Inland waters information derived from Queensland Globe is presented in **Table 1**, **Figure 2** and **Figure 3**.

Table 1. Waterways

Site	Water features	Drainage path
TSF3 Phase 1	There is an unnamed, stream order 2 waterway within the TSF3 Phase 1 site.	The site consists of three connected gullies, with the primary waterway located in the central gully. Overland flow within the site drains to the gullies which flow from north to south, terminating at the plunge pools. The unnamed waterway originally flowed to Gunpowder Creek but is no longer connected due to construction of the mine. The waterway is also disconnected from the upstream catchment via the Upper Esperanza Diversion Dam (UEDD).
TSF3 Phase 2	There is an unnamed, stream order 2 waterway within the TSF3 Phase 2 site. There are at least four stream order 1 channels feeding to the stream order 2 within the site.	TSF3 Phase 2 consists of one primary waterway: the upstream portion of the unnamed waterway within TSF3 Phase 1. The waterway commences as a stream order 1 in the south of TSF3 Phase 2 and upgrades to a stream order 2 as it encounters flows from adjoining gullies to the north and south. The waterway terminates at the UEDD. A single drainage line in the north-east of the site is mapped as draining away from the UEDD, towards Magazine Creek.
Magazine Creek	There are two stream order 1 watercourses within the Diamond Creek site, draining north to Lake Waggaboonya and Gunpowder Creek.	Within the Magazine Creek site, water drains from south to north, to the ponds located at the northern boundary of Magazine Creek site. The ponds overflow to Greenstone Creek, downstream of Lake Waggaboonya, which flows into Gunpowder Creek.
Diamond Creek	There are three stream order 1 waterways draining to a single stream order 2 within Diamond Creek site.	Waterway mapping in the south of Diamond Creek does not appear to match satellite imagery and may be of low reliability. The waterways across the central and northern portion of the site drain to the east, crossing Gunpowder Road, to Greenstone Creek upstream of Lake Waggaboonya, which flows into Gunpowder Creek.
Greenstone	There are five stream order 1 and one stream order 2 waterways within the Greenstone site.	The waterways drain to the east to Greenstone Creek upstream of Lake Waggaboonya, which flows into Gunpowder Creek.



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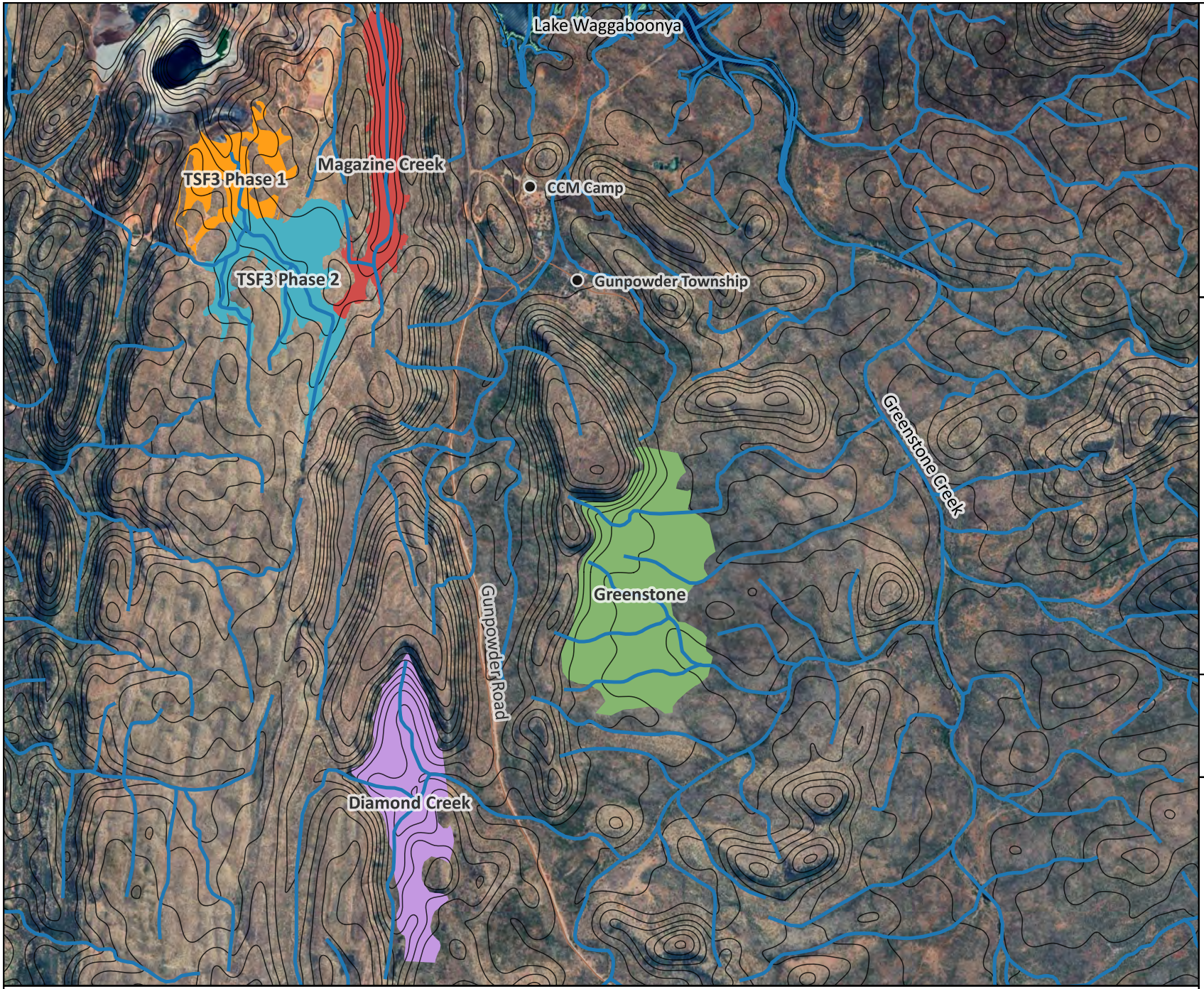
- TSF3 Phase 1
- TSF3 Phase 2
- Magazine Creek
- Lake Waggaboonya
- Watercourses
- Elevation Contours 10m interval

0 0.5 1 km

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Figure 2. CCM Waterways - TSF3 Phase 1, TSF3 Phase 2 and Magazine Creek



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Tailings Storage Options Desktop Ecology Assessment

LEGEND

- TSF3 Phase 1
- TSF3 Phase 2
- Magazine Creek
- Diamond Creek
- Greenstone
- Lake Waggaboonya
- Watercourses
- Elevation Contours 10m interval

0 1 2 km

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Figure 3. CCM Waterways - Diamond Creek and Greenstone

3.4 Matters of National Environmental Significance (MNES)

The Protected Matters Reports (PMRs) generated from the Protected Matters Search Tool (PMST) returned identical matters for TSF3 Phase 1, TSF3 Phase 2 (Upper Esperanza South), Magazine Creek, Diamond Creek and Greenstone sites. The PMRs reported:

- No results for World Heritage Properties
- No results for National Heritage Properties
- No results for Wetlands of International Importance (Ramsar)
- No results for Great Barrier Reef Marine Park
- No results for Commonwealth Marine Area
- No results for Listed Threatened Ecological Community
- 14 Listed Threatened Species
- 11 Listed Migratory Species.

The possible presence of Threatened or Migratory species is described as 'species or species habitat likely to occur, or may occur, within area'. Three of the Migratory species are also Threatened species. The Threatened species and their status under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC 1999) the *Nature Conservation Act 1992* (NC Act) are provided in **Table 2**.

Table 2. Threatened species predicted by the Protected Matters Search Tool for the five potential TSF sites

Scientific Name	Common Name	EPBC Act	NC Act
Macrotis lagotis	Greater Bilby	V	E
Macroderma gigas	Ghost Bat	V	E
Rostratula australis	Australian Painted Snipe	E	E
Calidris acuminata	Sharp-tailed Sandpiper	V, M	SL
Calidris ferruginea	Curlew Sandpiper	CE, M	CR
Erythrotriorchis radiatus	Red Goshawk	E	E
Falco hypoleucos	Grey Falcon	V	V
Amytornis dorotheae	Carpentarian Grasswren	E	E
Grantiella picta	Painted Honeyeater	V	V
Erythrura gouldiae	Gouldian Finch	E	E
Elseya lavarackorum	Gulf Snapping Turtle	E	V
Varanus mertensi	Mertens' Water Monitor	E	E
Acanthophis hawkei	Plains Death Adder	V	V
Pristis pristis	Freshwater Sawfish	V, M	LC

Abbreviations: CE = Critically Endangered, CR = Critically Endangered, E = Endangered, LC = Least Concern (Common), M = Migratory, SL = Special Least Concern, V = Vulnerable.

As the PMRs were identical for each of the five sites, only one example is provided in **Appendix A**.

3.5 Matters of State Environmental Significance (MSES)

The Environmental Reports for Matters of State Environmental Significance (MSES) generated from the Queensland Government's Environmental Report portal (**Appendix B**) returned nil results for the following MSES across all five sites:

- No results for Protected Areas
- No results for State Marine Parks
- No results for Fish Habitat Areas
- No results for Strategic Environmental Areas

- No results for High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values
- No results for High Ecological Value wetlands or waterways
- No results for special least concern animals, Koala habitat or sea turtle nesting areas
- No results for Regulated Vegetation - Endangered/Of concern in Category B (remnant)
- No results for Regulated Vegetation - Endangered/Of concern in Category C (regrowth)
- No results for Regulated Vegetation - Category R (GBR riverine regrowth)
- No results for Regulated Vegetation - Essential habitat
- No results for Regulated Vegetation - within 100 m of a Vegetation Management Wetland
- No results for Legally secured offset areas.

The remaining MSES Environmental Report results are presented in **Table 3** and **Appendix B** and described below.

Table 3. Threatened wildlife habitat and regulated vegetation for the five sites

Site	Regulated vegetation intersecting a watercourse within search area[1]	Regulated vegetation intersecting a watercourse with site boundary[2]	Threatened wildlife habitat within search area[1]	Threatened wildlife habitat within site boundary[2]
TSF3 Phase 1	18.1 km	0.6 km	0.2 ha	nil
TSF3 Phase 2	23.5 km	4.1 km	51.7 ha	nil
Magazine Creek	22.2 km	2.4 km	119.7 ha	nil
Diamond Creek	22.7 km	2.5 km	nil	nil
Greenstone	26.9 km	4.8 km	66.6 ha	nil

1. As identified by Environmental Reports for Matters of State Environmental Significance with a 2 km radius of a centre point of each site.
2. Measured from Queensland Globe within the site boundary.

The habitat suitability for thirty threatened flora and fauna species is modelled for each of the five areas, the same thirty species in all instances. None of the species is predicted to occur by the modelling in any of the five sites, despite Purple-necked Rock-Wallaby (*Petrogale purpureicollis*) being known from the area. Purple-necked Rock-Wallaby, listed as Vulnerable under the NC Act, was recorded in TSF3 Phase 1 in 2023 and 2024 (KG Environmental 2024). Although submitted to WildNet, an obligation under the relevant Research Permit, this record appears not yet to be available from the database. Based on known distribution, there is no likelihood of any of the other 29 species occurring in any of the five sites.

The threatened wildlife habitat contained within the 2 km radius of a centre point of Greenstone, Magazine Creek, TSF3 Phase 1 and TSF3 Phase 2 all refers to a single record of a single species, Carpentarian Grasswren *Amytornis dorotheae*, which is listed as Endangered under both the EPBC Act and NC Act. Although returned from the MSES Environmental Reports (2 km search radius), the threatened wildlife habitat layer is not mapped within any of the five sites.

Carpentarian Grasswren is a 'confidential' species (QG 2024c) and details such as exact location, date and observer are not publicly available, though the record is no earlier than 1980. Whilst the exact location of the record cannot be confirmed, it appears to be from within the old Gunpowder township.[1] Searches were also conducted of the *Atlas of Living Australia* (ALA 2024) and the Birdlife Australia *Birdata* database (Birdlife Australia 2024). Neither hold a record of the species within or in close proximity of any of the five sites.

[1] Threatened wildlife habitat MSES mapping often appears as a circle, which represents a 1.1 km buffer around an approximate threatened species record.

3.6 Regional Ecosystems

Regional ecosystem ground-truthing has been conducted in TSF3 Phase 1, TSF3 Phase 2 and part of Magazine Creek by Dr Paul Williams (Williams 2023a). For those sites, the ground-truthed regional ecosystems are provided. The regional ecosystem mapping for Diamond Creek, Greenstone and the remaining section of Magazine Creek has been extracted from Queensland Globe.

The Queensland *Vegetation Management Act 1999* (VM Act) status and Biodiversity status of each mapped regional ecosystem is provided.

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 percent of its pre-clearing extent across the bioregion; or 10-30 percent of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 percent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss, or
- 10-30 percent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare regional ecosystem subject to a threatening process.

"No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 percent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

Biodiversity status (which incorporates weed density and other health measures) is used for a range of planning and management applications including Biodiversity Planning Assessments and to determine environmentally sensitive areas that are used for regulation of the mining industry through provisions in the *Environmental Protection Act 1994*. Potential 'special values' of the mapped regional ecosystems are provided in **Table 4**.

Table 4. Regional Ecosystems (in hectares) within the five sites and their special values (NC Act)

Regional Ecosystem	TSF3 Phase 1	TSF3 Phase 2	Magazine Creek	Diamond Creek	Greenstone	Special Values
1.3.7b	0.9	0.1	0	0	0	Important seasonal water bird habitat; regional corridor for fauna.
1.5.2a	0	7.4	3.9	0	0	None
1.7.5b	0	0	2.1	11.6	1.1	None
1.7.7a	33.3	45.6	40.3	0	0	Potential habitat for *Ipomoea antonschmidii* (NT)
1.11.2a	6.9	23.4	10.4	60.3	127.6	Potential habitat for *Eucalyptus nudicaulis* (E), *Ipomoea antonschmidii* (NT), *Solanum carduiforme* (V) and *Trachymene glandulosa* (NT).
1.11.3a	0	0	0	20.6	0	Potential habitat for *Eucalyptus nudicaulis* (E).
1.11.3b	0	0	0	0	36.9	Potential habitat for *Eucalyptus nudicaulis* (E).
1.11.8	0	0	0	3.4	3.2	Potential habitat for *Eucalyptus nudicaulis* (E).

Abbreviations: E = Endangered, NT = Near Threatened, V = Vulnerable under the NC Act.



29 Metals Capricorn Copper Mine

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Ground-truthed Regional Ecosystems

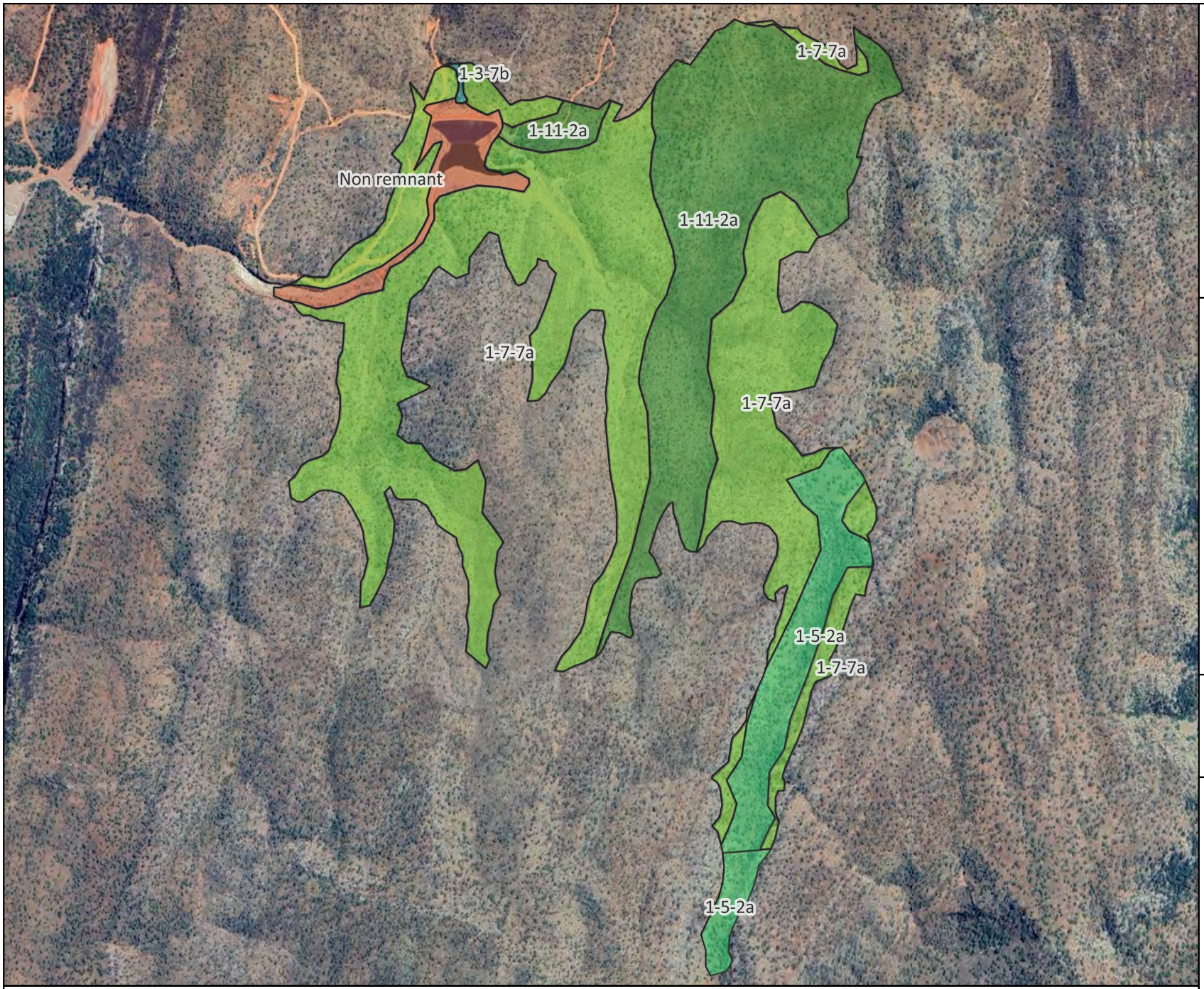
- 1-11-2a
- 1-3-7b
- 1-7-7a
- Non remnant

0 100 200 300 m

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Figure 4. TSF3 Phase 1 Ground-truthed Regional Ecosystems



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Ground-truthed Regional Ecosystems

- 1-11-2a
- 1-3-7b
- 1-5-2a
- 1-7-7a
- Non remnant

0 250 500 m

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Figure 5. TSF3 Phase 2 Ground-truthed Regional Ecosystems

3.6.1 Regional Ecosystems of TSF3 Phase 1

Regional ecosystem mapping of the TSF3 Phase 1 site consists of three regional ecosystems, RE 1.3.7b, RE 1.7.7a and RE 1.11.2a, and non-remnant areas (**Table 5**, **Figure 4**). These were ground-truthed by Dr Paul Williams (Williams 2023a).

Table 5. Regional Ecosystems ground-truthed within the TSF3 Phase 1 site

Regional Ecosystem	Description	VM Act Status	Biodiversity Status	Area (ha)
1.3.7b	*Eucalyptus camaldulensis* woodland on channels and levees	Least Concern	Endangered	0.9
1.7.7a	*Corymbia capricornia* +/- *Eucalyptus leucophloia* or *E. miniata* low open woodland on silcrete	Least Concern	No Concern at Present	33.3
1.11.2a	*Eucalyptus leucophloia* low open woodland	Least Concern	No Concern at Present	6.9
Non-remnant	Non-remnant/cleared	Non-remnant	NA	2.3

Most of the TSF3 Phase 1 site consists of low open eucalypt woodlands with a spinifex understorey.

RE 1.3.7b is noted as important seasonal waterbird habitat and regional corridor for fauna (**Table 4**). One ha of this regional ecosystem is known to occur in TSF3 Phase 1. However, the seasonal watercourse associated with this vegetation, and the vegetation itself, is disconnected. It spans a short distance between the Upper Esperanza Diversion Drain (UEDD) and the eastern plunge pools at the foot of the waste rock dump. The value of this vegetation and watercourse as waterbird habitat is significantly reduced. It also has very limited function as a corridor for fauna movement due to being disconnected.

RE 1.7.7a and 1.11.2a are noted as potential habitat for threatened flora species (**Table 4**). A protected plant survey conducted by Paul Williams in 2023 detected the presence of Near Threatened plant *Ipomoea antonschmidii* within TSF3 Phase 1 site. No other threatened plant species were recorded.

3.6.2 Regional Ecosystems of TSF3 Phase 2 (Upper Esperanza South)

Regional ecosystem mapping of the TSF3 Phase 2 site consists of four regional ecosystems, RE 1.3.7b, RE 1.5.2a, E 1.7.7a and RE 1.11.2a, and non-remnant areas (**Table 6**, **Figure 5**). These were ground-truthed by Dr Paul Williams (Williams 2023a).

Table 6. Regional Ecosystems ground-truthed within the TSF3 Phase 2 site

Regional Ecosystem	Description	VM Act Status	Biodiversity Status	Area (ha)
1.3.7b	*Eucalyptus camaldulensis* woodland on channels and levees	Least Concern	Endangered	0.1
1.5.2a	Low open woodland of mixed species which may include *Eucalyptus leucophloia*, *E. pruinosa*, *Corymbia grandifolia*, *C. terminalis* and *C. capricornia* with a variable shrub layer and ground layer mixed tussock grasses often with *Triodia pungens*	Least Concern	No Concern at Present	7.4
1.7.7a	*Corymbia capricornia* +/- *Eucalyptus leucophloia* or *E. miniata* low open woodland on silcrete[2]	Least Concern	No Concern at Present	45.6
1.11.2a	*Eucalyptus leucophloia* low open woodland[3]	Least Concern	No Concern at Present	23.4
Non-remnant	Non-remnant/cleared	Non-remnant	NA	3.2

RE 1.3.7b is noted as important seasonal waterbird habitat and regional corridor for fauna (**Table 4**).

RE 1.7.7a and 1.11.2a are noted as potential habitat for threatened flora species (**Table 4**). A protected plant survey conducted by Paul Williams in 2023 detected the presence of Near Threatened plant *Ipomoea antonschmidii* within TSF3 Phase 2 site. No other threatened plant species were recorded.

3.6.3 Regional Ecosystems of Magazine Creek

Regional ecosystem mapping of the Magazine Creek site consists of one regional ecosystem, RE 1.5.2a, one mixed regional ecosystem polygon, RE 1.7.7a/1.11.2a/1.7.5b, and non-remnant areas (**Table 7**, **Figure 6**). Some of the site was ground-truthed by Dr Paul Williams (Williams 2023a) but the majority of the mapping is taken from Queensland Globe.

Table 7. Regional Ecosystems mapped within the Magazine Creek site

Regional Ecosystem	Description	VM Act Status	Biodiversity Status	Area (ha)
1.5.2a	Low open woodland of mixed species which may include *Eucalyptus leucophloia*, *E. pruinosa*, *Corymbia grandifolia*, *C. terminalis* and *C. capricornia* with a variable shrub layer and ground layer mixed tussock grasses often with *Triodia pungens*	Least Concern	No Concern at Present	3.9
1.7.5b	*Acacia shirleyi* low woodland on lateritic scarps and hills	Least Concern	No Concern at Present	2.1
1.7.7a	*Corymbia capricornia* +/- *Eucalyptus leucophloia* or *E. miniata* low open woodland on silcrete	Least Concern	No Concern at Present	40.3
1.11.2a	*Eucalyptus leucophloia* low open woodland	Least Concern	No Concern at Present	10.4
Non-remnant	Non-remnant/cleared	Non-remnant	NA	3.3

Most of the Magazine Creek site is expected to consist of low open eucalypt woodlands with a spinifex understorey.

RE 1.7.7a and 1.11.2a are noted as potential habitat for threatened flora species (**Table 4**). A protected plant survey will be undertaken prior to any disturbance within Magazine Creek.

3.6.4 Regional Ecosystems of Diamond Creek

Regional ecosystem mapping of the Diamond Creek site consists of two mixed regional ecosystem polygons, RE 1.11.2a/1.11.3a/1.7.5b/1.11.8 and RE 1.11.2a/1.7.5b (**Table 8**, **Figure 7**).

Table 8. Regional Ecosystems mapped within the Diamond Creek site

Regional Ecosystem	Description	VM Act Status	Biodiversity Status	Area (ha)
1.7.5b	*Acacia shirleyi* low woodland on lateritic scarps and hills	Least Concern	No Concern at Present	11.6
1.11.2a	*Eucalyptus leucophloia* low open woodland	Least Concern	No Concern at Present	60.3
1.11.3a	*Corymbia terminalis* and/or *Eucalyptus leucophylla* low open woodland on metamorphics	Least Concern	No Concern at Present	20.6
1.11.8	*Terminalia aridicola* and/or *Corymbia aspera* low open woodland to low woodland, usually with vine-scrub species, on rock outcrops	Least Concern	No Concern at Present	3.4

Most of the Diamond Creek site is expected to consist of low open eucalypt woodlands with a spinifex understorey.

RE 1.7.7a, 1.11.2a and 1.11.8 are noted as potential habitat for threatened flora species (**Table 4**). A protected plant survey will be undertaken prior to any disturbance within Diamond Creek.

3.6.5 Regional Ecosystems of Greenstone

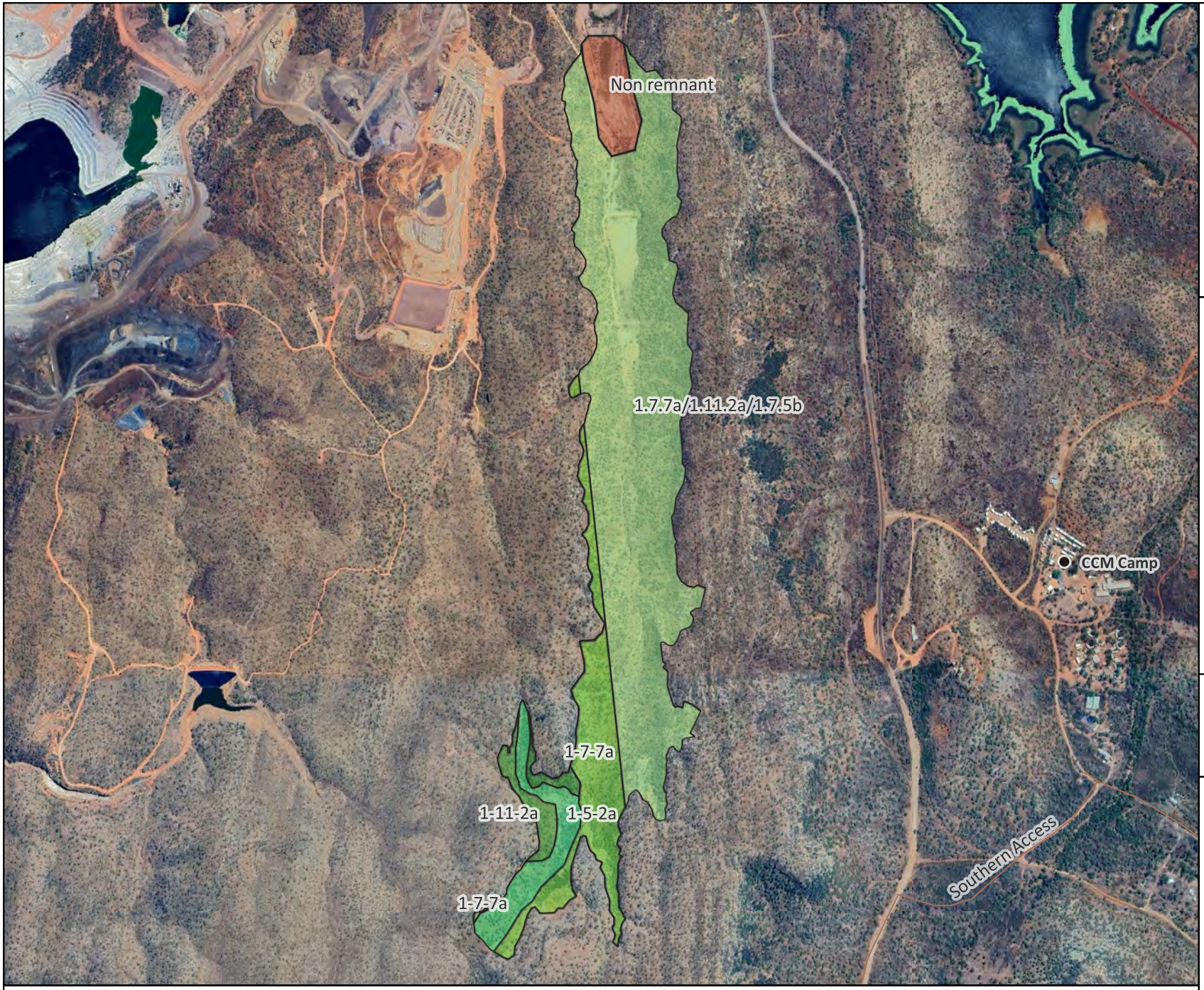
Regional ecosystem mapping of the Greenstone site consists of two mixed regional ecosystem polygons, RE 1.11.2a/1.11.3b and RE 1.11.2a/1.11.8/1.7.5b (**Table 9**, **Figure 8**).

Table 9. Regional Ecosystems mapped within the Greenstone site

Regional Ecosystem	Description	VM Act Status	Biodiversity Status	Area (ha)
1.7.5b	*Acacia shirleyi* low woodland on lateritic scarps and hills	Least Concern	No Concern at Present	1.1
1.11.2a	*Eucalyptus leucophloia* low open woodland	Least Concern	No Concern at Present	127.6
1.11.3b	*Corymbia terminalis* and/or *Eucalyptus leucophylla* low open woodland on metamorphics	Least Concern	No Concern at Present	36.9
1.11.8	*Terminalia aridicola* and/or *Corymbia aspera* low open woodland to low woodland, usually with vine-scrub species, on rock outcrops	Least Concern	No Concern at Present	3.2

Most of the Greenstone site is expected to consist of low open eucalypt woodlands with a spinifex understorey.

RE 1.11.2a, 1.11.3b and 1.11.8 are noted as potential habitat for threatened flora species (**Table 4**). A protected plant survey will be undertaken prior to any disturbance within Greenstone.



29 Metals Capricorn Copper Mine

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Ground-truthed Regional Ecosystems

- 1-11-2a
- 1-5-2a
- 1-7-7a

Regional Ecosystem Mapping

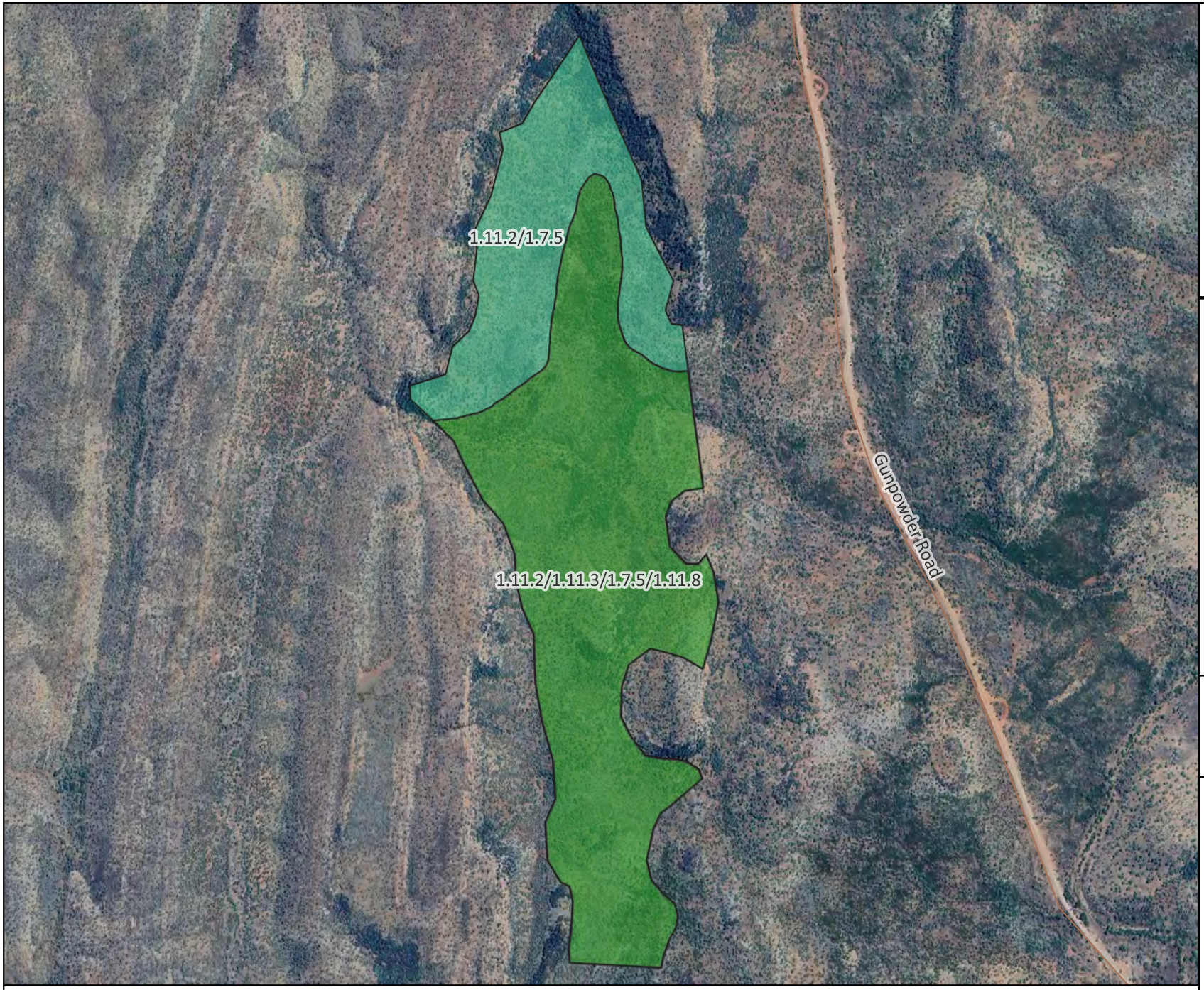
- 1.7.7a/1.11.2a/1.7.5b
- Non remnant

0 250 500 m

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Figure 6. Magazine Creek Ground-truthed and Mapped Regional Ecosystems



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Regional Ecosystem Mapping

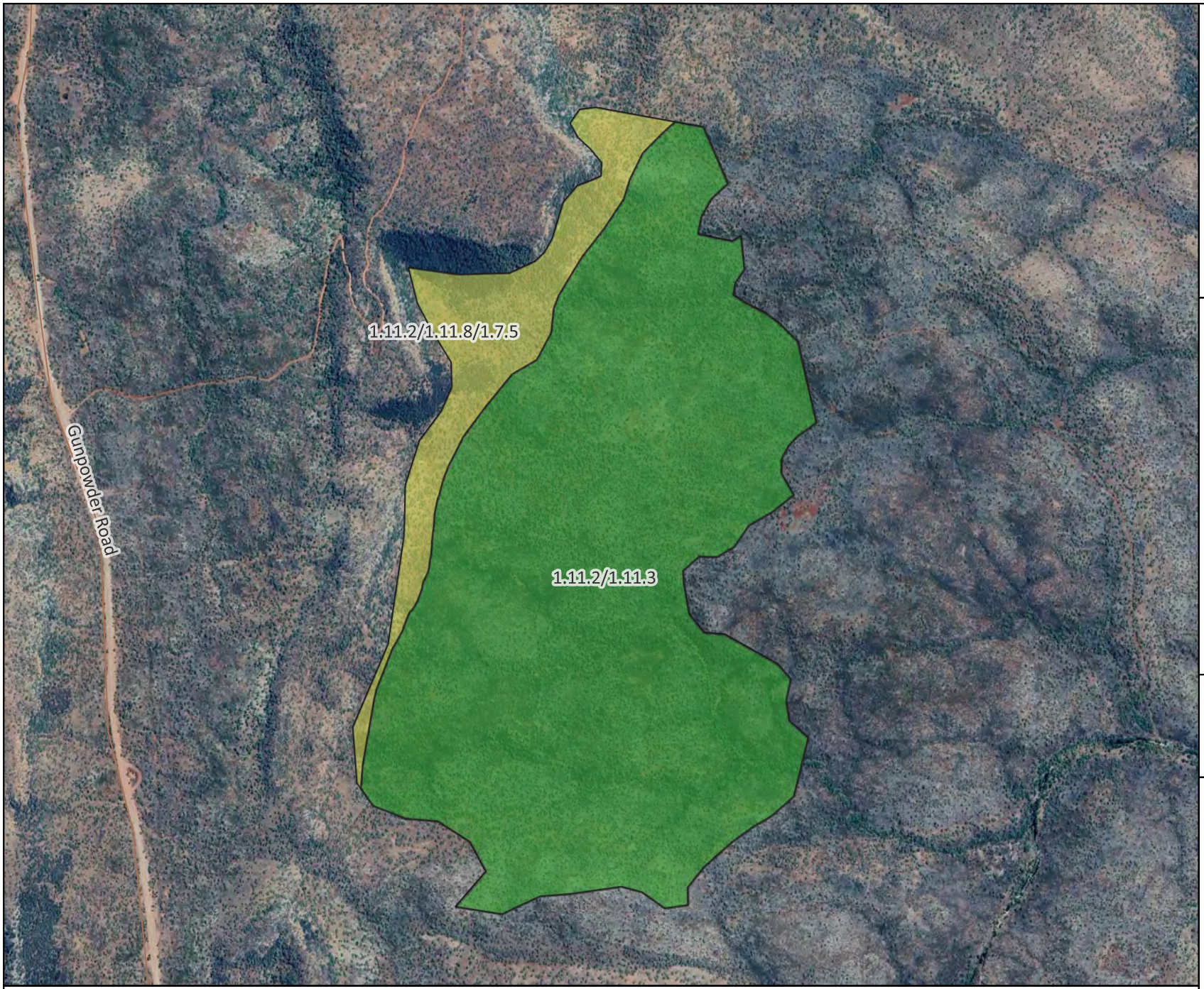
- 1.11.2/1.11.3/1.7.5/1.11.8
- 1.11.2/1.7.5

0 250 500 m

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Figure 7. Diamond Creek Regional Ecosystem Mapping



29 Metals Capricorn Copper Mine

Tailings Storage Options Desktop Ecology Assessment

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Regional Ecosystem Mapping

- 1.11.2/1.11.3
- 1.11.2/1.11.8/1.7.5

0 250 500 m

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Figure 8. Greenstone Regional Ecosystem Mapping

3.7 Flora

3.7.1 Protected Plants Flora Survey Trigger Map

The flora survey trigger map identifies high-risk areas where Threatened or Near Threatened native plants are present or are likely to be present. Areas that are within a 2 km radius of a validated record of a Threatened or Near Threatened plant and/or contain habitat highly likely to have one or more Critically Endangered or Endangered plant species, are included as high-risk areas on the flora survey trigger map.

There is no identified high-risk area in any of the five sites (**Appendix C**).

3.7.2 Conservation Significant Flora Species

No Threatened flora species is known from any of the five sites. One species listed as Near Threatened under the NC Act, *Ipomoea antonschmidii*, was recorded in TSF3 Phase 1 and TSF3 Phase 2 sites during a flora survey in 2023 (Williams 2023b) and during the 2024 fauna survey (KG Environmental 2024). These records were also returned from WildNet for the 2km radius search of the Magazine Creek site.

3.7.3 Introduced Flora Species

Calotrope (*Calotropis procera*) is present in TSF3 Phase 1 and Phase 2 sites (Williams 2023a). Williams (2023a) found the surrounds of Capricorn Copper Mine to be weed free except for along Gunpowder Creek, which is not relevant to the five sites. No introduced flora species was identified by searches of the WildNet or ALA databases for any of the five sites.

3.8 Fauna

3.8.1 Conservation Significant Fauna Species

Two conservation significant fauna species are known to occur in TSF3 Phase 1, Purple-necked Rock-wallaby and Orange Leaf-nosed Bat (*Rhinonicteris aurantia*), both of which are listed as Vulnerable under the NC Act and are not listed under the EPBC Act. Orange Leaf-nosed Bat was recorded during a fauna survey in 2023 (BEC 2023). Purple-necked Rock-wallaby was recorded in the 2023 survey and in 2024 by the report authors. The data from these surveys are not yet available from the WildNet database.

In Queensland, known Orange Leaf-nosed Bat roosts are in limestone caves, though elsewhere it uses sandstone and silcrete caves (Armstrong 2012). It also roosts in abandoned mines (Armstrong 2000) and occasionally buildings (Benda 2019). In the wet season it possibly becomes a tree-dweller while conditions are warm and humid, though this hasn't been confirmed (Churchill et al. 2008; Benda 2019). The species forages in rocky gorges containing water and lined with eucalypts or melaleuca, often over spinifex, and in open eucalypt woodland (Armstrong 2012). The species is known to forage up to 20 km from a roost (Cramer et al. 2016). All five sites contain eucalypt woodlands with a spinifex groundcover. Without knowing the location of the roost of the individual(s) recorded in TSF3 Phase 1 in 2023 it should be assumed that the species could forage in all the five sites.

Purple-necked Rock-wallaby occurs in rocky outcrops, boulder piles, cliffs and gorges associated with dry eucalypt and acacia woodland and spinifex grassland (Johnson 2003; Johnson & Eldridge 2008). Most large colonies have access to permanent fresh water (Johnson & Eldridge 2008). Based on land zones, the species could occur in all five sites though TSF3 Phase 2 appears to be least likely to contain suitable habitat. Purple-necked Rock-wallaby can persist in very small rocky outcrops whose occurrence may require field survey.

There is a 2011 WildNet record of Northern Blue-tongued Skink (*Tiliqua scincoides intermedia)* from approximately 6 km north of Capricorn Copper Mine (QG 2024b). This subspecies of Eastern Blue-tongued Skink is listed as Critically Endangered under both the EPBC Act and NC Act. The Conservation Advice (DCCEEW 2023) considers that this represents a persisting population.

Northern Blue-tongued Skink occurs in a wide variety of habitats including riparian habitats, floodplain, hills, ranges, gorges, spinifex and tussock grasslands, well-vegetated gardens and some modified areas (DCCEEW 2023). Most records have occurred near seasonal or permanent water. They spend much of their time in cool, moist sheltered locations with relatively dense vegetation or artificial material such as concrete and wood. Sites used generally have a high coverage of grass and leaf litter (Price-Rees et al. 2013a, b).

Habitats considered critical in the Conservation Advice (DCCEEW 2023) that occur or possibly occur in the five sites are well-vegetated creeks, gorges, drainage lines and shady thickets in rocky ranges. Of these, riparian forests and well-vegetated creeks are the only habitats that can be identified based on regional ecosystem. Land Zone 3 is defined as 'near-level alluvial plains with riverine patterns, wetlands and lakeside dunes' (Sattler & Williams 1999) and has been used to predict potential occurrence of suitable habitat at CCM. RE 1.3.7b is the only RE on Land Zone 3 that is mapped within the five sites, in TSF3 Phase 1 and Phase 2. However, other regional ecosystems may provide suitable conditions for the species.

Carpentarian Grasswren, Endangered under both the EPBC Act and NC Act, was recorded within the greater CCM site in 2024. The Conservation Advice for Carpentarian Grasswren (TSSC 2016) refers to mature spinifex clumps providing critical habitat for the species (Woinarski 2006). Critical habitat is not otherwise defined. This definition includes areas for where there is no Carpentarian Grasswren record and is considered of little value in habitat assessment. T. Reis has occasionally found the species on rocky ridges, but most frequently in areas of large 'hard' spinifex on flats, generally fringing a watercourse or at least a drainage line. Successful repeat surveys for the species over many years of his survey work in the Northwest Highlands bioregion have only been in such habitat. Based on regional ecosystem mapping, the five sites are likely to contain little optimal habitat for Carpentarian Grasswren. However, regulatory bodies are likely to consider any area of mature spinifex to be suitable, if not 'critical', habitat.

Regional Ecosystems and threatened species habitats will be ground-truthed prior to any disturbance.

3.8.2 Introduced Fauna Species

One introduced fauna species was identified by searches of WildNet for the five sites, House Sparrow (*Passer domesticus*), which has been recorded within the 2 km radius of centre points for Magazine and TSF3 Phase 2. There was no introduced species in ALA for any site.

The report authors recorded Dingo (*Canis familiaris dingo*) and Cane Toad (*Rhinella marina*) in TSF3 Phase 1 in January 2024. Cane Toad was common. Dingo was only recorded on two camera traps and no measure of abundance is possible. Data collected by the report authors were submitted to WildNet in March 2024 but are not yet available. Inclusion of data in searches can take up to 12 months from submission.

Four species are mapped as occurring in the general area by the Department of Agriculture and Fisheries (DAF 2024) (**Table 10**). Dingo is not differentiated from 'wild Dog' in the mapping. Unfortunately, the most recent map is 2013 and may not accurately represent the current status of the four species in the area encompassing the five sites. Cattle (*Bos taurus*, *B. indicus*) and Horses (*Equus caballus*) were not considered due to the difficulty of distinguishing domestic stock from feral animals. Of the four species, three are pest species listed under Schedule 2 of the *Biosecurity Act* 2014 as 'Restricted Matters'. Under the Biosecurity Act a person who has control over a 'Restricted Matter' must not do the following:

- Category 3: You must not distribute this restricted matter. This means it must not be given as a gift, sold, traded or released into the environment unless the distribution or disposal is authorised in a regulation or under a permit;

- Category 4: You must not move this restricted matter to ensure that it does not spread into other areas of the State; and
- Category 6: You must not feed this category of restricted matter. Feeding for the purpose of preparing for or undertaking a control program is exempted.

Table 10. Introduced fauna species identified by Department of Agriculture and Fisheries pest mapping

Scientific Name	Common Name	Biosecurity Act Categories	Density[1]	Distribution[1]
Canis familiaris	wild Dog	3, 4, 6	Common	Widespread
Felis catus	feral Cat	3, 4, 6	Common	Widespread
Sus scrofa	feral Pig	3, 4, 6	Occasional	Widespread
Rhinella marina	Cane Toad	-	Common	Widespread

1. Density and distribution taken from maps of pest animals (DAF 2024).

4. SUMMARY

In summary:

- The proposed disturbance footprints range from approximately 43 ha for TSF3 Phase 1 to 169 ha for Greenstone (**Table 11**).
- Greenstone may hold higher agricultural value than the other four options.
- There was no difference between the five sites identified from the MNES Protected Matters Report.
- MSES regulated vegetation (intersecting a watercourse) was identified in all five sites, with the greatest amount (4.8 km) contained within Greenstone (**Table 11**).
- There were no other differences between the five sites identified from the MSES report.
- Important Regional Ecosystems associated with waterways may be present at all sites and could be identified via ground-truthing, as occurred at TSF3. Therefore, RE value should be assessed as per the MSES regulated vegetation in **Table 11**.
- There was no significant difference in potential ecological values identified via desktop assessment of the five sites, other than the unlikely occurrence of threatened plants *Eucalyptus nudicaulis* and *Solanum carduiforme* within TSF3 Phase 1 and 2 (**Table 12**). Further field assessment would be required to provide a meaningful comparison.
- In the absence of field-verified ecological values, preliminary land disturbance ranking should be based on disturbance footprint size, regulated vegetation, potential agricultural value and potential presence of threatened plants (**Table 11**).

Table 11. Disturbance footprint, regulated vegetation and potential land disturbance ranking

Site	Approximate disturbance footprint (ha)	Regulated vegetation intersecting a watercourse with site boundary[1]	Potential disturbance ranking[2]
TSF3 Phase 1	43	0.6 km	Low
TSF3 Phase 2	80	4.1 km	Medium
Magazine Creek	60	2.4 km	Medium
Diamond Creek	96	2.5 km	Medium
Greenstone	169	4.8 km	High

1. Measured from Queensland Globe within the site boundary.
2. Ranking considers disturbance footprint size, presence of regulated vegetation, higher agricultural value of Greenstone and unlikely presence of threatened plants within TSF3 Phase 1 and Phase 2.

A comparison of potential ecology values identified for each of the five sites is provided in **Table 12**. It should be noted that a 'known' value within TSF3 Phase 1 or Phase 2 does not mean that the site holds a higher environmental value than other sites where the value is 'possible', only that the values at these sites have not been field-verified.

Table 12. Comparison of potential ecology values based on desktop assessment

Environmental Value	TSF3 Phase 1	TSF3 Phase 2	Magazine Creek	Diamond Creek	Greenstone
Carpentarian Grasswren (Endangered EPBC Act & NC Act)	Possible	Possible	Possible	Possible	Possible
Orange Leaf-nosed Bat (Vulnerable NC Act)	Known	Possible	Possible	Possible	Possible
Purple-necked Rock-wallaby (Vulnerable NC Act)	Known	Possible	Possible	Possible	Possible
RE 1.3.7b (Endangered Biodiversity Status)	Known	Known	Possible	Possible	Possible
Eucalyptus nudicaulis (Endangered NC Act)	Unlikely	Unlikely	Possible	Possible	Possible
Solanum carduiforme (Vulnerable NC Act)	Unlikely	Unlikely	Possible	Possible	Possible
Ipomoea antonschmidii (Near Threatened NC Act)	Known	Known	Possible	Possible	Possible
Trachymene glandulosa (Near Threatened NC Act)	Unlikely	Unlikely	Possible	Possible	Possible
Important seasonal water bird habitat	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Regional corridor for fauna	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

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Appendix A: Protected Matters Report

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 12-Jul-2024

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	14
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	1
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.		
Scientific Name	Threatened Category	Presence Text
BIRD		
Amytornis dorotheae Carpentarian Grasswren [558]	Endangered	Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
MAMMAL		

Scientific Name	Threatened Category	Presence Text
Macroderma gigas		
Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis		
Greater Bilby [282]	Vulnerable	Species or species habitat may occur within area
REPTILE		
Acanthophis hawkei		
Plains Death Adder [83821]	Vulnerable	Species or species habitat likely to occur within area
Elseya lavarackorum		
Gulf Snapping Turtle [67197]	Endangered	Species or species habitat may occur within area
Varanus mertensi		
Mertens' Water Monitor, Mertens's Water Monitor [1568]	Endangered	Species or species habitat likely to occur within area
SHARK		
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Marine Species		
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundo rustica		
Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum		
Oriental Pratincole [840]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat may occur within area overfly marine area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area overfly marine area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat likely to occur within area overfly marine area
[Rostratula australis as Rostratula benghalensis (sensu lato)](#) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area
Reptile		
[Crocodylus johnstoni](#) Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
CopperString Project	2010/5581	Controlled Action	Completed

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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Appendix B: Matters of State Environmental Significance Reports

Queensland Government

Department of Environment, Science and Innovation

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest

Longitude: 139.361044 Latitude: -19.707773 with 2 kilometre radius

TSF3 Phase 1

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and a field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@des.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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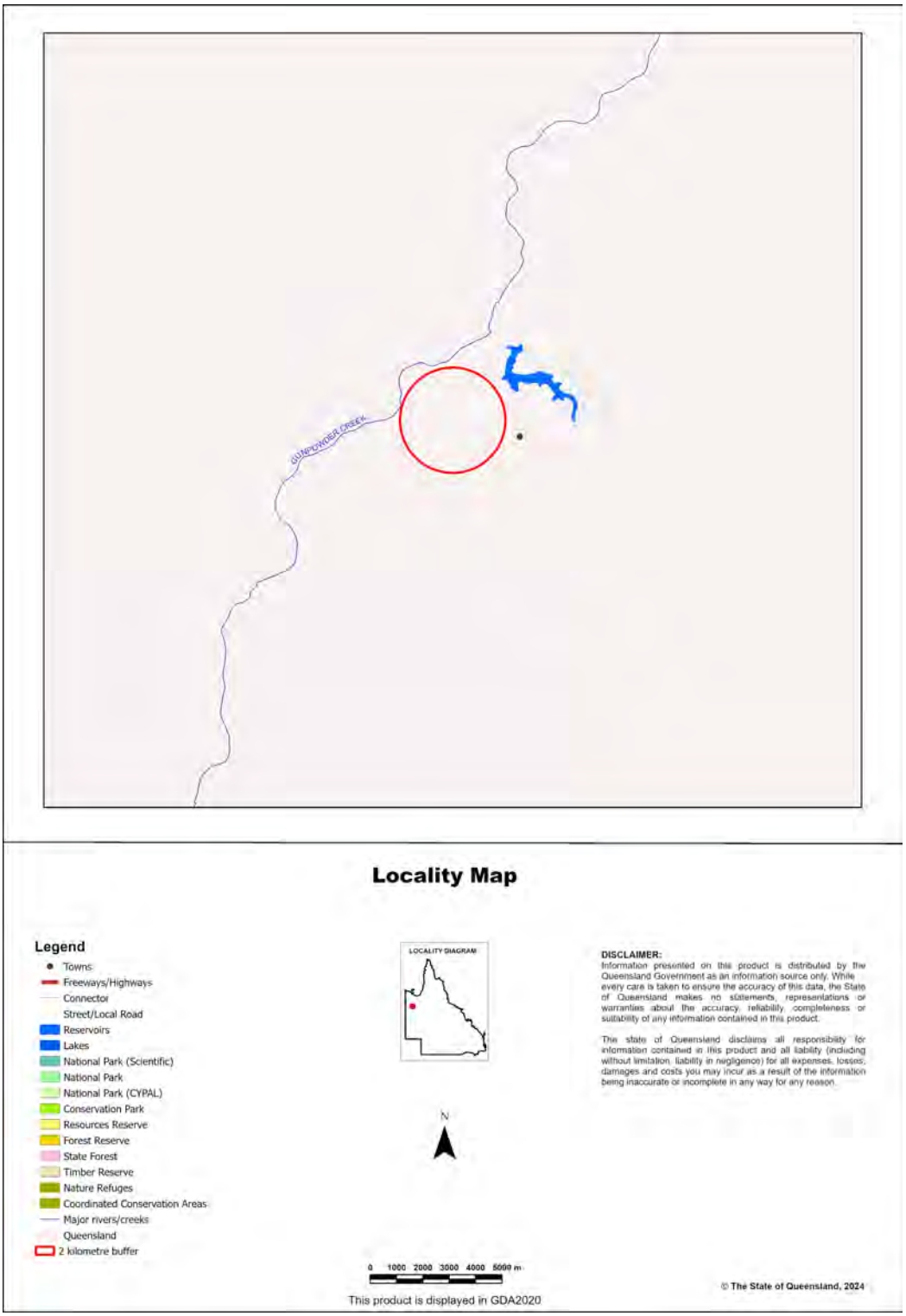
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI: Longitude: 139.361044 Latitude: -19.707773 with 2 kilometre radius, with area 1256.64 ha

Local Government(s)	Catchment(s)	Bioregion(s)	Subregion(s)
Mount Isa City	Leichhardt	Northwest Highlands	Mount Isa Inlier



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992;*

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the Marine Parks Act 2004 ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- *Threatened wildlife under the Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

  - Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;
  - Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;
  - Category R areas on the regulated vegetation management map;
  - Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;
  - Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Queensland Wetland Environmental Values under the Environment Protection Regulation 2019;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;
- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0 ha	0.0%
1b Protected Areas- nature refuges	0 ha	0.0%
1c Protected Areas- special wildlife reserves	0 ha	0.0%
2 State Marine Parks- highly protected zones	0 ha	0.0%
3 Fish habitat areas (A and B areas)	0 ha	0.0%
4 Strategic Environmental Areas (SEA)	0 ha	0.0%
5 High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values	0 ha	0.0%
6a High Ecological Value (HEV) wetlands	0 ha	0.0%
6b High Ecological Value (HEV) waterways	0 km	Not applicable
7a Threatened (endangered or vulnerable) wildlife	0.15 ha	0.0%
7b Special least concern animals	0 ha	0.0%
7c i Koala habitat area - core (SEQ)	0 ha	0.0%
7c ii Koala habitat area - locally refined (SEQ)	0 ha	0.0%
7d Sea turtle nesting areas	0 km	Not applicable
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0 ha	0.0%
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0 ha	0.0%
8c Regulated Vegetation - Category R (GBR riverine regrowth)	0 ha	0.0%
8d Regulated Vegetation - Essential habitat	0 ha	0.0%
8e Regulated Vegetation - intersecting a watercourse	18.1 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0 ha	0.0%
9a Legally secured offset areas- offset register areas	0 ha	0.0%
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0 ha	0.0%

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(No results)

1b. Protected Areas - nature refuges

(No results)

1c. Protected Areas - special wildlife reserves

(No results)

2. State Marine Parks - highly protected zones

(No results)

3. Fish habitat areas (A and B areas)

(No results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(No results)

5. High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values

(no results)

6a. Wetlands in High Ecological Value (HEV) waters

(no results)

6b. Waterways in High Ecological Value (HEV) waters

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7a. Threatened (endangered or vulnerable) wildlife

Values are present

7b. Special least concern animals

Not applicable

7c i. Koala habitat area - core (SEQ)

Not applicable

7c ii. Koala habitat area - locally refined (SEQ)

Not applicable

7d. Wildlife habitat (sea turtle nesting areas)

Not applicable

Threatened (endangered or vulnerable) wildlife habitat suitability models

Species	Common name	NCA status	Presence
Boronia keysii	Keys boronia	V	None
Calyptorhynchus lathami	Glossy black cockatoo	V	None
Casuarius casuarius johnsonii	Sthn population cassowary	E	None
Crinia tinnula	Wallum froglet	V	None
Denisonia maculata	Ornamental snake	V	None
Euastacus bindal	Mount Elliot crayfish	CR	None
Euastacus binzayedi		CR	None
Euastacus eungella		E	None
Euastacus hystricosus		E	None
Euastacus jagara	Jagara hairy crayfish	CR	None
Euastacus maidae		CR	None
Euastacus monteithorum		E	None
Euastacus robertsi		E	None
Taudactylus pleione	Kroombit tinkerfrog	E	None
Litoria freycineti	Wallum rocketfrog	V	None
Litoria olongburensis	Wallum sedgefrog	V	None
Macadamia integrifolia		V	None
Melaleuca irbyana	swamp tea-tree	E	None
Macadamia ternifolia		V	None
Macadamia tetraphylla	bopple nut	V	None
Petrogale penicillata	brush-tailed rock-wallaby	V	None
Petrogale coenensis	Cape York rock-wallaby	V	None
Petrogale purpureicollis	purple-necked rock-wallaby	V	None
Petrogale sharmani	Sharmans rock-wallaby	V	None
Petrogale xanthopus celeris	yellow-footed rock-wallaby (Qld subspecies)	V	None
Petaurus gracilis	Mahogany Glider	E	None
Petrogale persephone	Proserpine rock-wallaby	E	None
Phascolarctos cinereus	Koala - outside SEQ*	E	None
Pezoporus wallicus wallicus	Eastern ground parrot	V	None
Xeromys myoides	Water Mouse	V	None

*For koala model, this includes areas outside SEQ. Check 7c SEQ koala habitat for presence/absence.

Threatened (endangered or vulnerable) wildlife species records

Scientific name	Common name	NCA status	EPBC status	Migratory status
Amytornis dorotheae	Carpentarian grasswren	E	E	None

Special least concern animal species records

(No results)

Shorebird habitat (critically endangered/endangered/vulnerable)

Not applicable

Shorebird habitat (special least concern)

Not applicable

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

Migratory status (M) - China and Australia Migratory Bird Agreement (C), Japan and Australia Migratory Bird Agreement (J), Republic of Korea and Australia Migratory Bird Agreement (R), Bonn Migratory Convention (B), Eastern Flyway (E)

To request a species list for an area, or search for a species profile, access Wildlife Online at:

https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals** and **Map 3b - MSES - Species - Koala habitat area (SEQ)** and **Map 3c - MSES - Wildlife habitat (sea turtle nesting areas)** for an overview of the relevant MSES.

MSES - Regulated Vegetation

For further information relating to regional ecosystems in general, go to:

https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:

https://environment.ehp.qld.gov.au/regional-ecosystems/

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Not applicable

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

A vegetation management watercourse is mapped as present

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

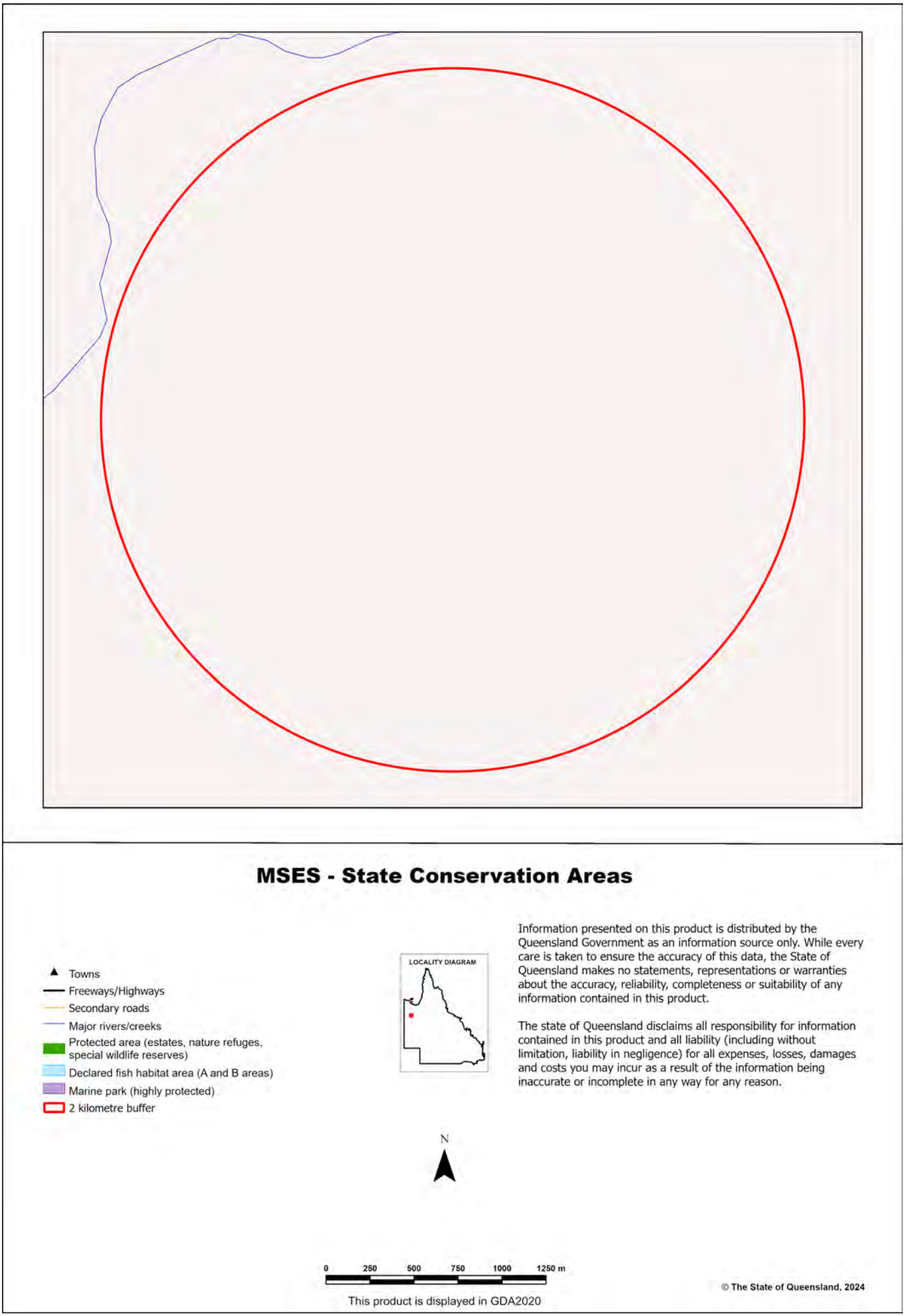
(No results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

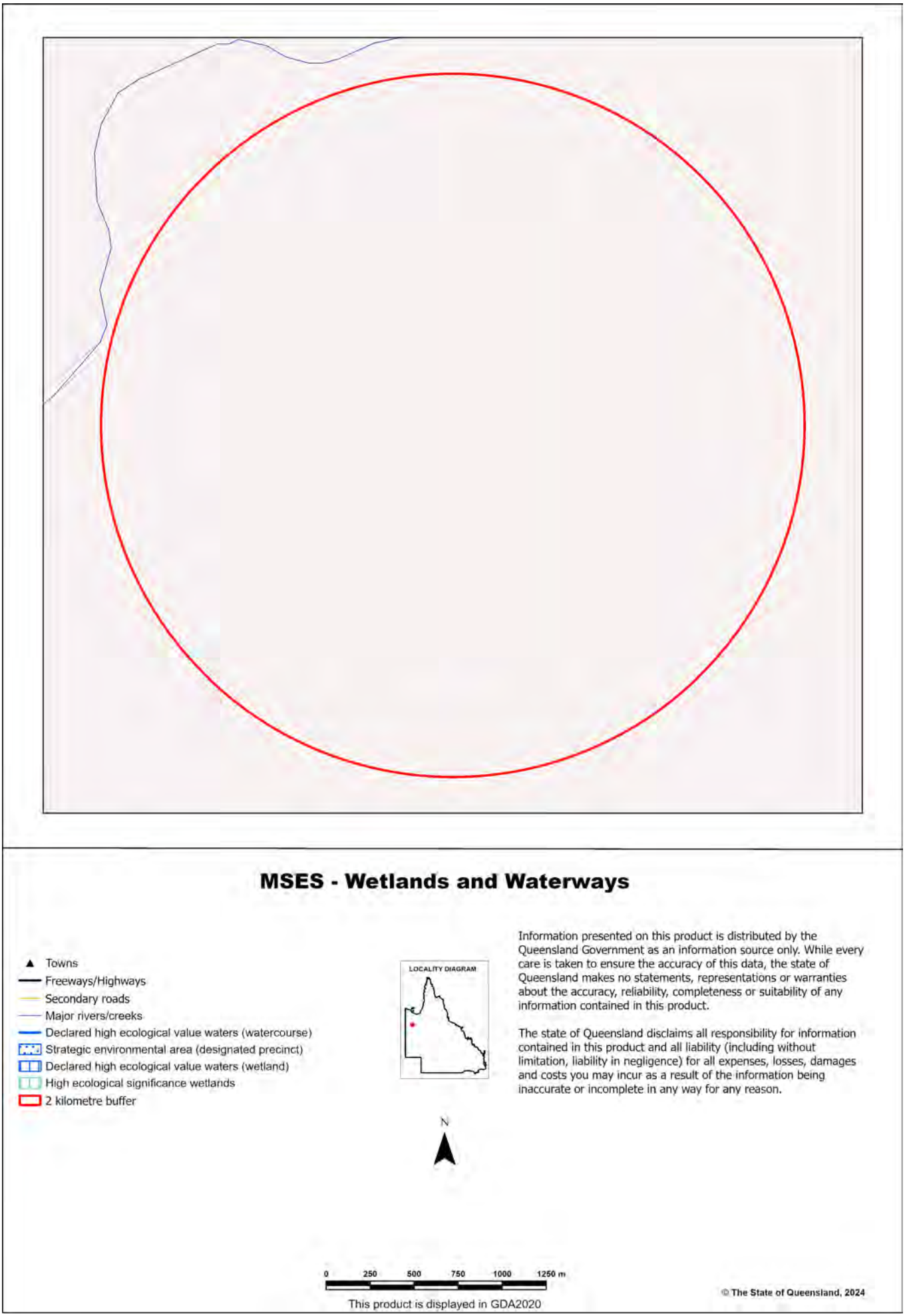
(No results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

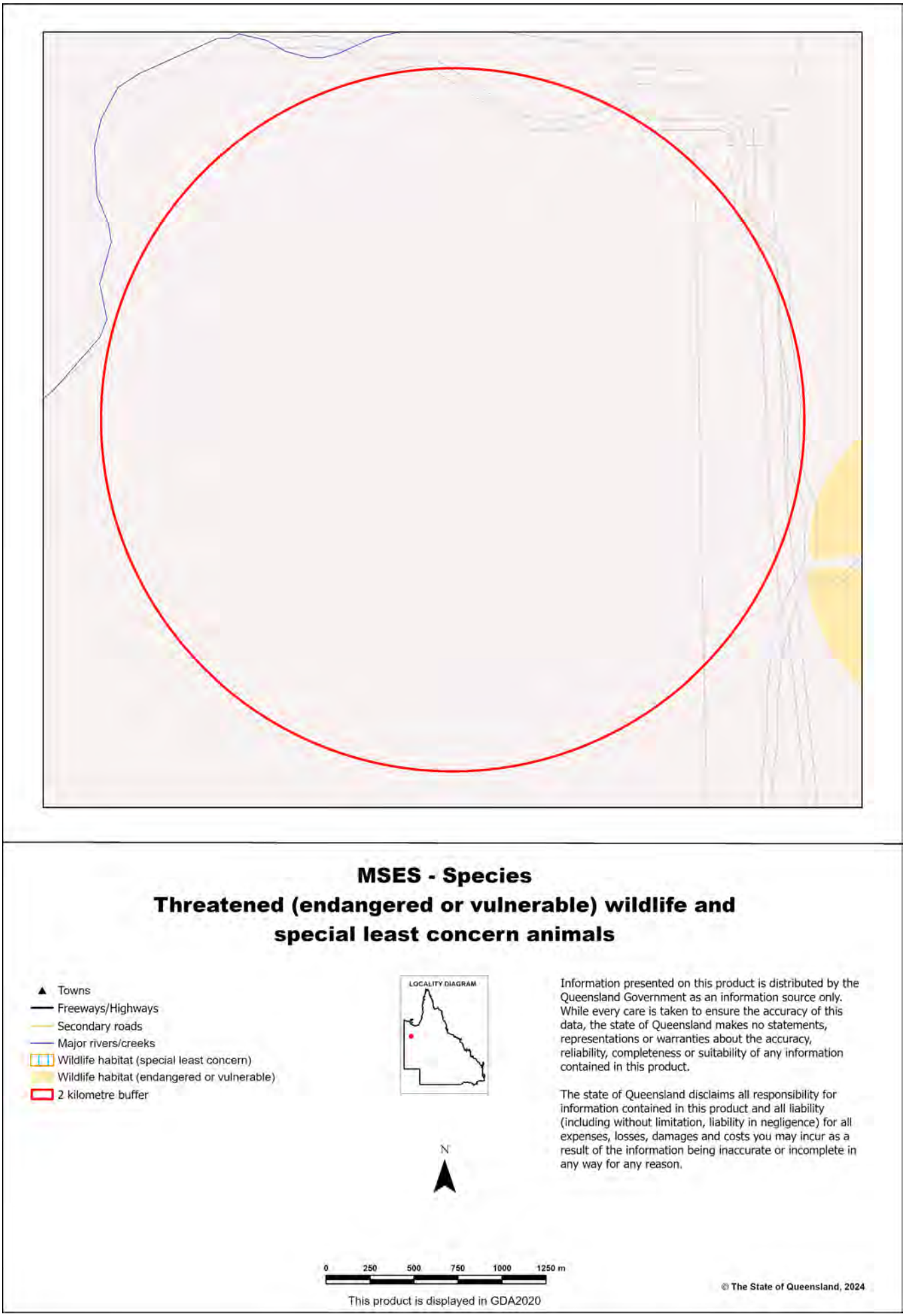
Map 1 - MSES - State Conservation Areas



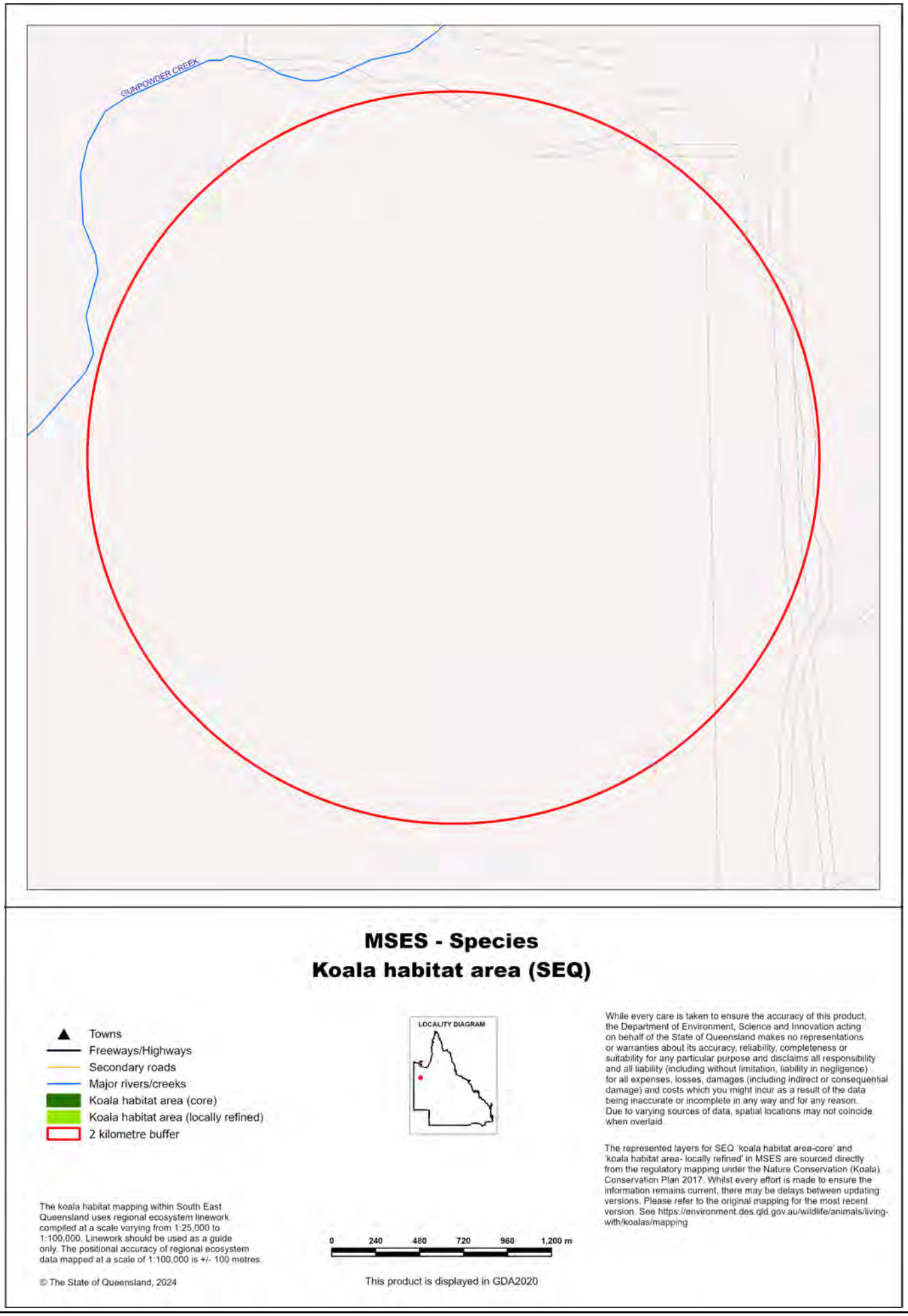
Map 2 - MSES - Wetlands and Waterways



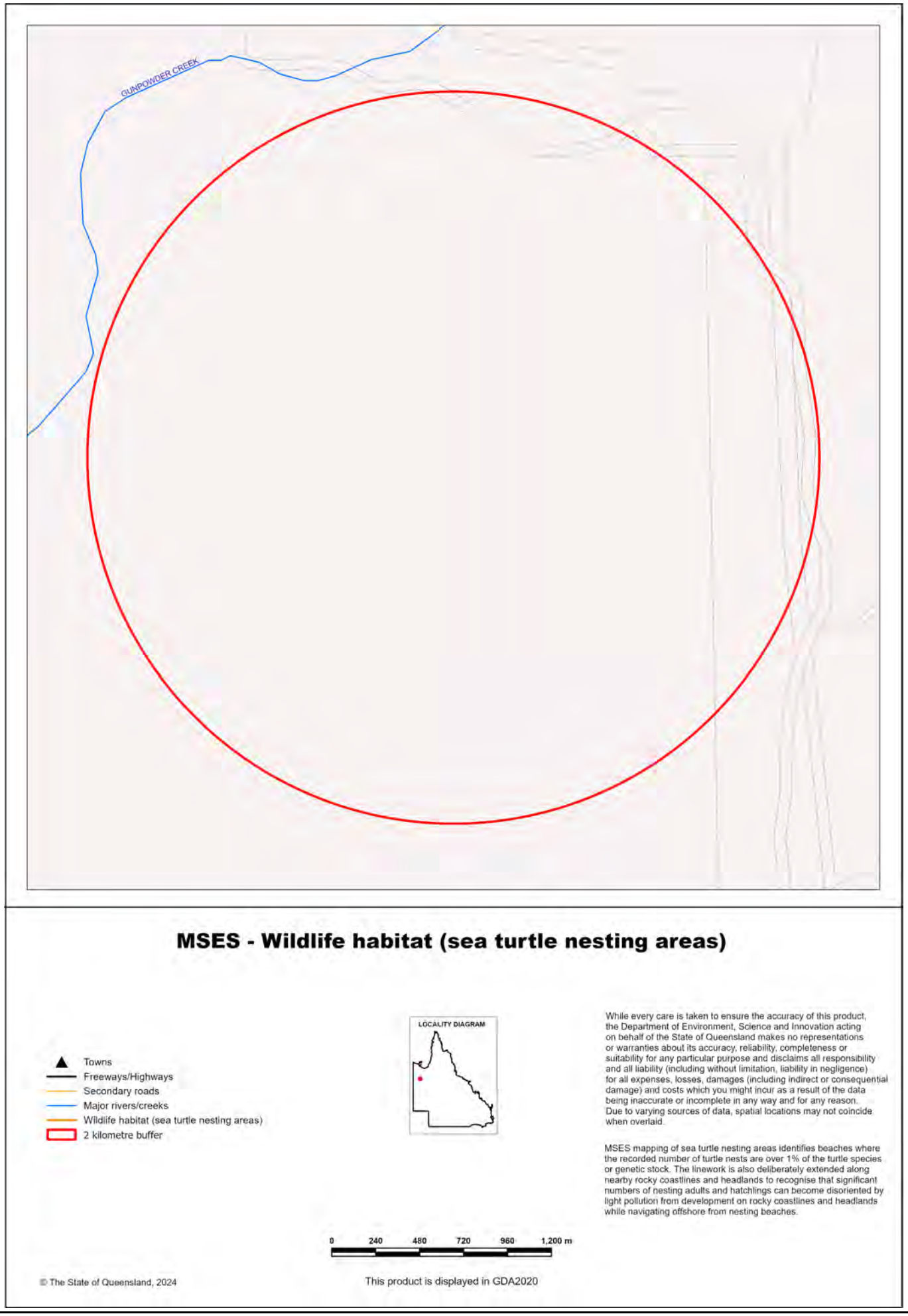
Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals



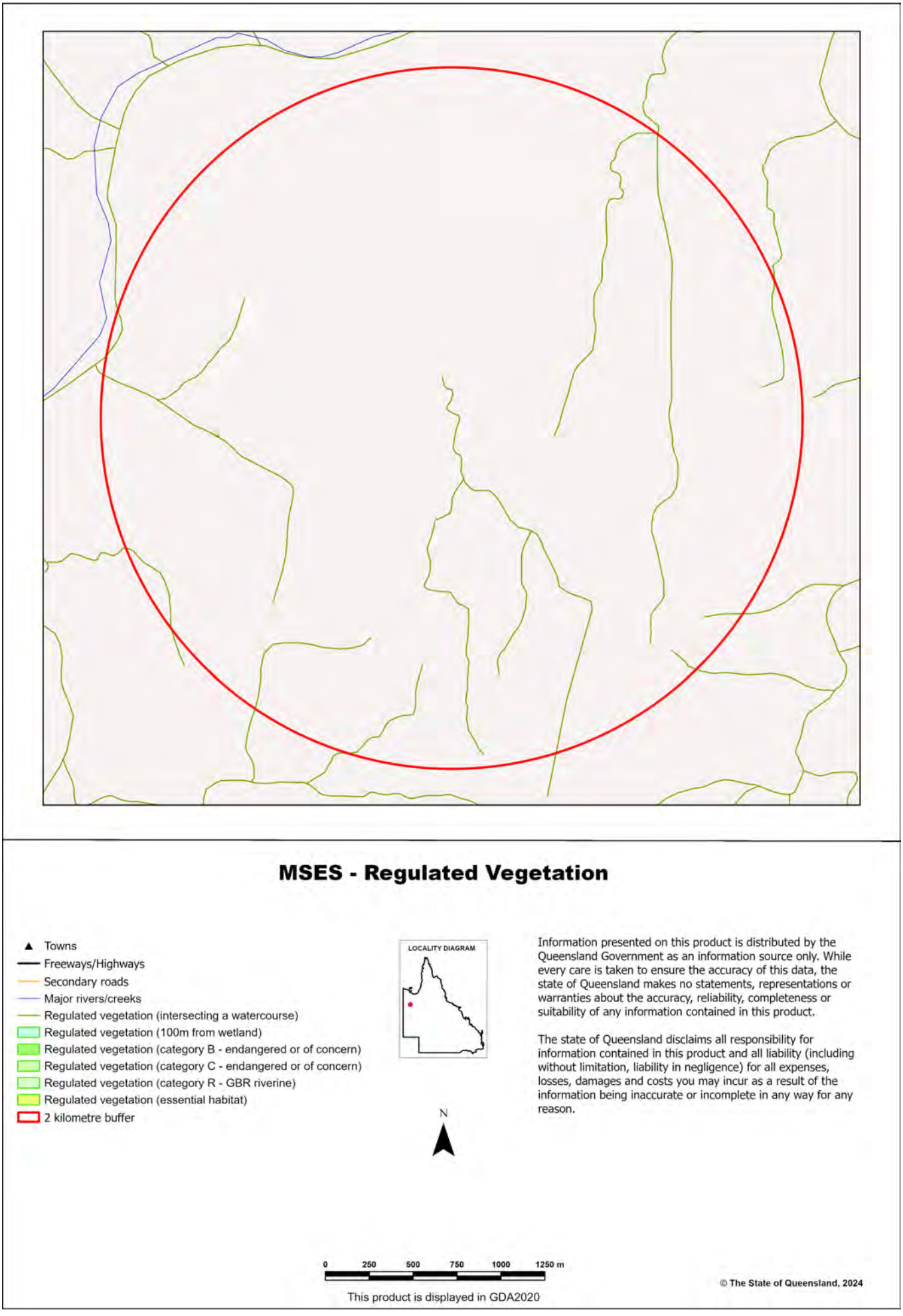
Map 3b - MSES - Species - Koala habitat area (SEQ)



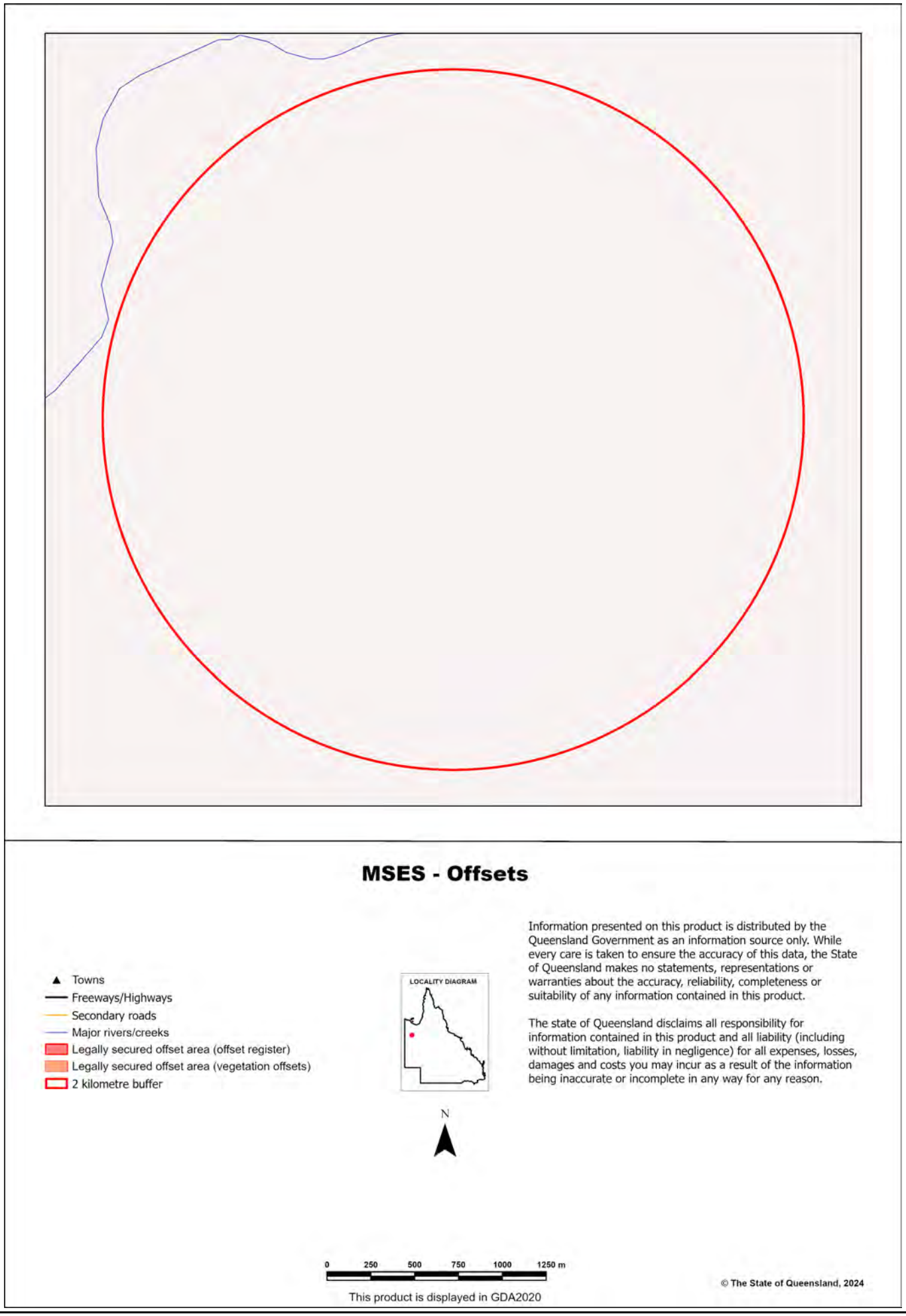
Map 3c - MSES - Species - Wildlife habitat (sea turtle nesting areas)



Map 4 - MSES - Regulated Vegetation



Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). Its primary purpose is to support implementation of the SPP biodiversity policy.

MSES mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

MSES mapping does not determine whether state or local development assessment is required. For state assessment triggers refer to the Development Assessment Mapping System (DAMS). For local assessment triggers, refer to the relevant local planning scheme.

The Queensland Government's "Method for mapping - matters of state environmental significance can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.information.qld.gov.au)**
Protected Areas-Estates, Nature Refuges, Special Wildlife Reserves	- Protected areas of Queensland - Nature Refuges - Queensland - Special Wildlife Reserves- Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Queensland Wetland Environmental Values
Wetlands in HEV waters	HEV waters: - EPP Water intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 5) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000)
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various) - SEQ koala habitat areas under the Koala Conservation Plan 2019
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map
VMA Essential Habitat	Vegetation management - essential habitat map
VMA Wetlands	Vegetation management wetlands map
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DES
Regulated Vegetation Map	Vegetation management - regulated vegetation management map

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DESI	- Department of Environment, Science and Innovation
EP Act	- Environmental Protection Act 1994
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- Nature Conservation Act 1992
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- Vegetation Management Act 1999

Queensland Government

Department of Environment, Science and Innovation

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest

Longitude: 139.365471 Latitude: -19.716106 with 2 kilometre radius

TSF3 Phase 2

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and a field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@des.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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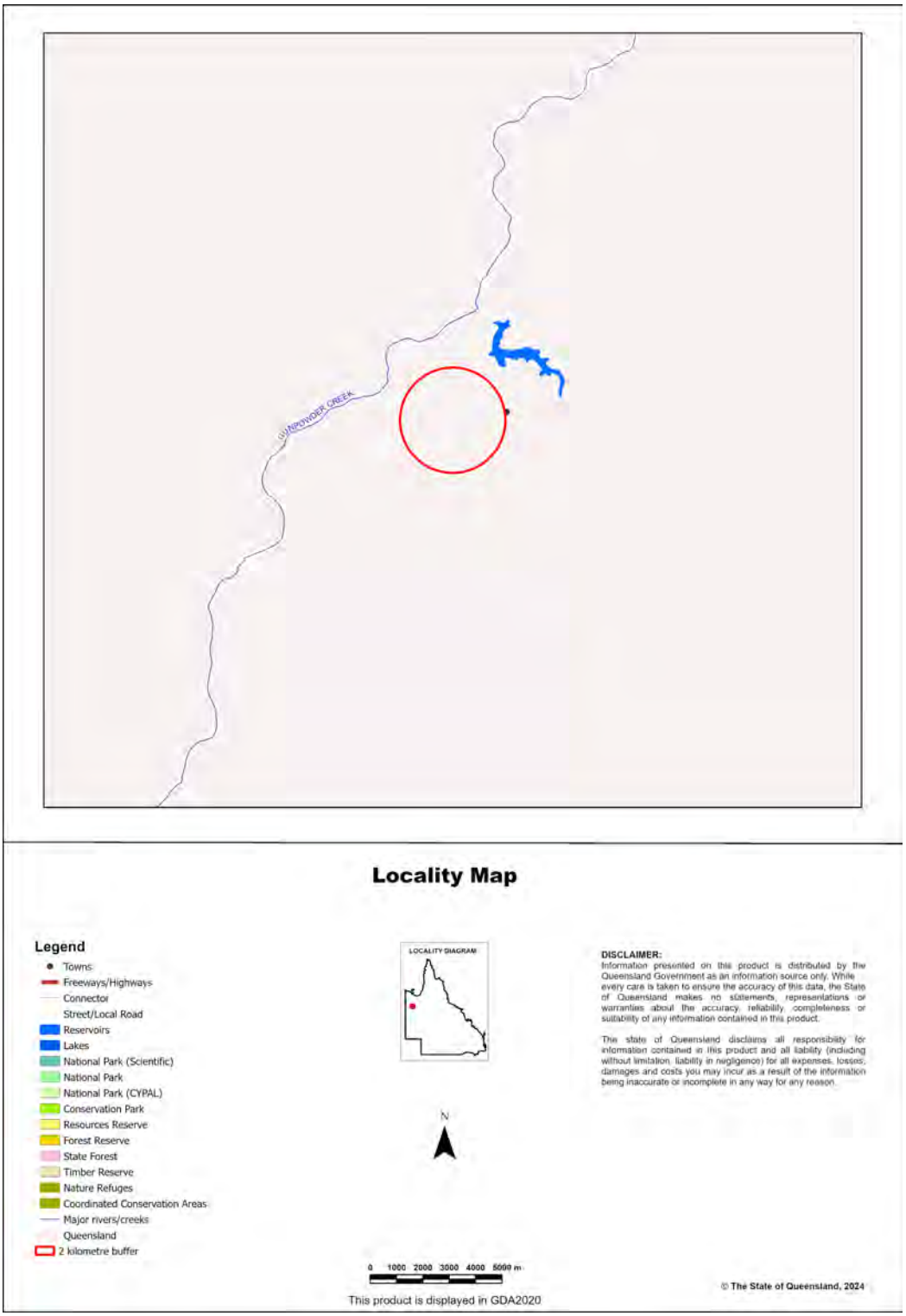
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI: Longitude: 139.365471 Latitude: -19.716106 with 2 kilometre radius, with area 1256.64 ha

Local Government(s)	Catchment(s)	Bioregion(s)	Subregion(s)
Mount Isa City	Leichhardt	Northwest Highlands	Mount Isa Inlier



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992;*

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the Marine Parks Act 2004 ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- *Threatened wildlife under the Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

  - Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;
  - Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;
  - Category R areas on the regulated vegetation management map;
  - Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;
  - Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Queensland Wetland Environmental Values under the Environment Protection Regulation 2019;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;
- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0 ha	0.0%
1b Protected Areas- nature refuges	0 ha	0.0%
1c Protected Areas- special wildlife reserves	0 ha	0.0%
2 State Marine Parks- highly protected zones	0 ha	0.0%
3 Fish habitat areas (A and B areas)	0 ha	0.0%
4 Strategic Environmental Areas (SEA)	0 ha	0.0%
5 High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values	0 ha	0.0%
6a High Ecological Value (HEV) wetlands	0 ha	0.0%
6b High Ecological Value (HEV) waterways	0 km	Not applicable
7a Threatened (endangered or vulnerable) wildlife	51.68 ha	4.1%
7b Special least concern animals	0 ha	0.0%
7c i Koala habitat area - core (SEQ)	0 ha	0.0%
7c ii Koala habitat area - locally refined (SEQ)	0 ha	0.0%
7d Sea turtle nesting areas	0 km	Not applicable
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0 ha	0.0%
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0 ha	0.0%
8c Regulated Vegetation - Category R (GBR riverine regrowth)	0 ha	0.0%
8d Regulated Vegetation - Essential habitat	0 ha	0.0%
8e Regulated Vegetation - intersecting a watercourse	23.5 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0 ha	0.0%
9a Legally secured offset areas- offset register areas	0 ha	0.0%
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0 ha	0.0%

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(No results)

1b. Protected Areas - nature refuges

(No results)

1c. Protected Areas - special wildlife reserves

(No results)

2. State Marine Parks - highly protected zones

(No results)

3. Fish habitat areas (A and B areas)

(No results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(No results)

5. High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values

(no results)

6a. Wetlands in High Ecological Value (HEV) waters

(no results)

6b. Waterways in High Ecological Value (HEV) waters

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7a. Threatened (endangered or vulnerable) wildlife

Values are present

7b. Special least concern animals

Not applicable

7c i. Koala habitat area - core (SEQ)

Not applicable

7c ii. Koala habitat area - locally refined (SEQ)

Not applicable

7d. Wildlife habitat (sea turtle nesting areas)

Not applicable

Threatened (endangered or vulnerable) wildlife habitat suitability models

Species	Common name	NCA status	Presence
Boronia keysii	Keys boronia	V	None
Calyptorhynchus lathami	Glossy black cockatoo	V	None
Casuarius casuarius johnsonii	Sthn population cassowary	E	None
Crinia tinnula	Wallum froglet	V	None
Denisonia maculata	Ornamental snake	V	None
Euastacus bindal	Mount Elliot crayfish	CR	None
Euastacus binzayedi		CR	None
Euastacus eungella		E	None
Euastacus hystricosus		E	None
Euastacus jagara	Jagara hairy crayfish	CR	None
Euastacus maidae		CR	None
Euastacus monteithorum		E	None
Euastacus robertsi		E	None
Taudactylus pleione	Kroombit tinkerfrog	E	None
Litoria freycineti	Wallum rocketfrog	V	None
Litoria olongburensis	Wallum sedgefrog	V	None
Macadamia integrifolia		V	None
Melaleuca irbyana	swamp tea-tree	E	None
Macadamia ternifolia		V	None
Macadamia tetraphylla	bopple nut	V	None
Petrogale penicillata	brush-tailed rock-wallaby	V	None
Petrogale coenensis	Cape York rock-wallaby	V	None
Petrogale purpureicollis	purple-necked rock-wallaby	V	None
Petrogale sharmani	Sharmans rock-wallaby	V	None
Petrogale xanthopus celeris	yellow-footed rock-wallaby (Qld subspecies)	V	None
Petaurus gracilis	Mahogany Glider	E	None
Petrogale persephone	Proserpine rock-wallaby	E	None
Phascolarctos cinereus	Koala - outside SEQ*	E	None
Pezoporus wallicus wallicus	Eastern ground parrot	V	None
Xeromys myoides	Water Mouse	V	None

*For koala model, this includes areas outside SEQ. Check 7c SEQ koala habitat for presence/absence.

Threatened (endangered or vulnerable) wildlife species records

Scientific name	Common name	NCA status	EPBC status	Migratory status
Amytornis dorotheae	Carpentarian grasswren	E	E	None

Special least concern animal species records

(No results)

Shorebird habitat (critically endangered/endangered/vulnerable)

Not applicable

Shorebird habitat (special least concern)

Not applicable

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

Migratory status (M) - China and Australia Migratory Bird Agreement (C), Japan and Australia Migratory Bird Agreement (J), Republic of Korea and Australia Migratory Bird Agreement (R), Bonn Migratory Convention (B), Eastern Flyway (E)

To request a species list for an area, or search for a species profile, access Wildlife Online at:

https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals** and **Map 3b - MSES - Species - Koala habitat area (SEQ)** and **Map 3c - MSES - Wildlife habitat (sea turtle nesting areas)** for an overview of the relevant MSES.

MSES - Regulated Vegetation

For further information relating to regional ecosystems in general, go to:

https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:

https://environment.ehp.qld.gov.au/regional-ecosystems/

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Not applicable

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

A vegetation management watercourse is mapped as present

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

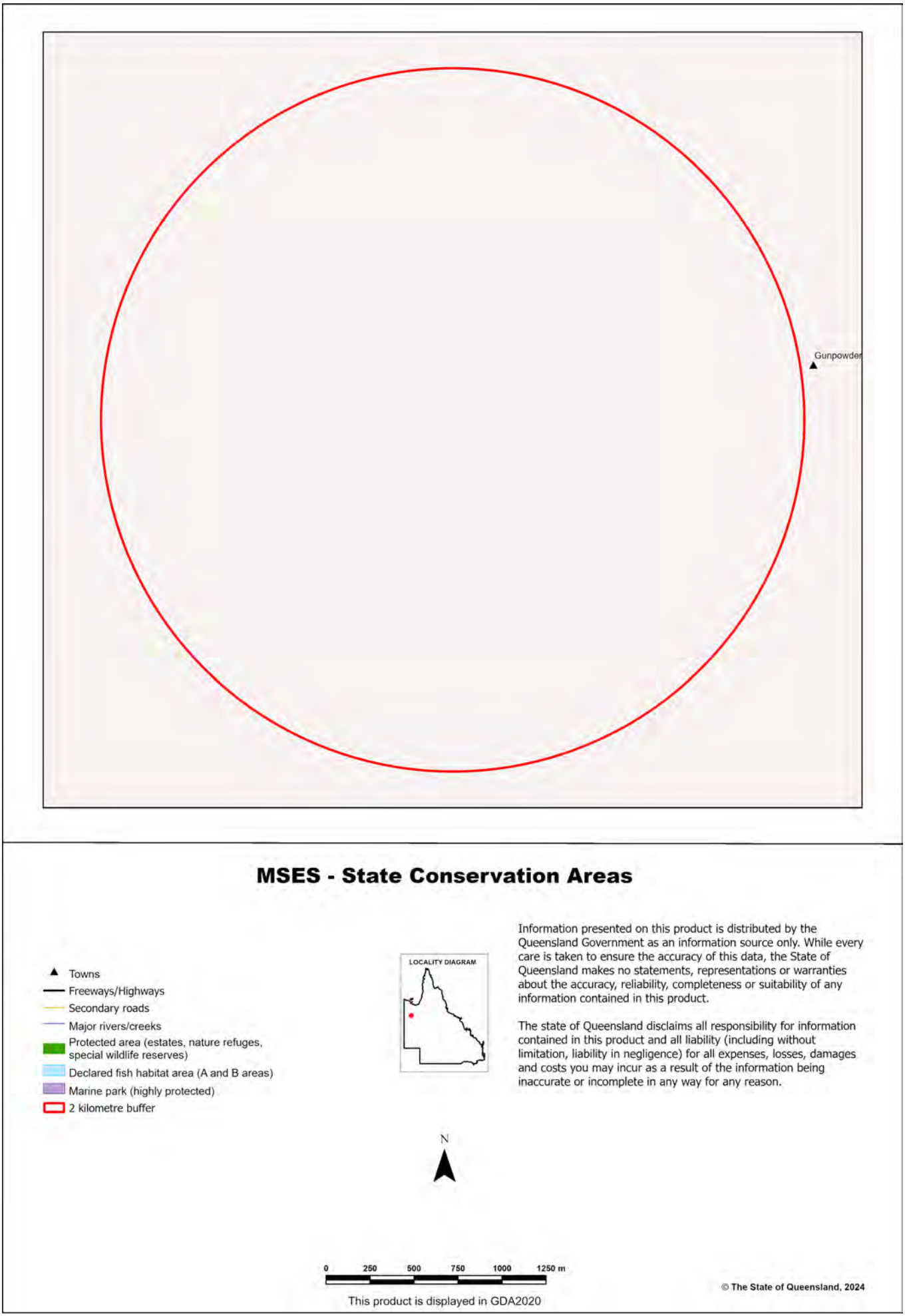
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9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

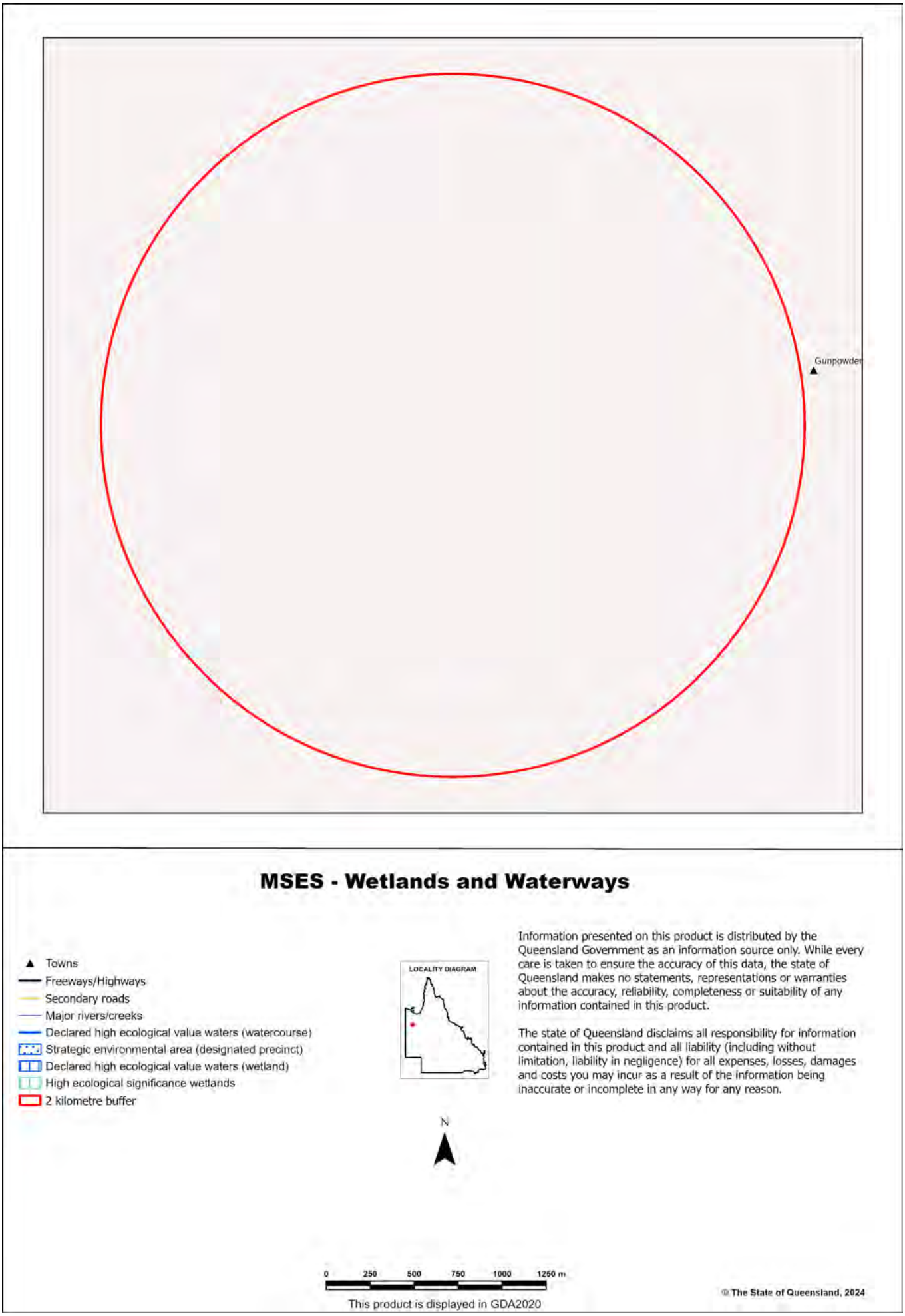
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Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

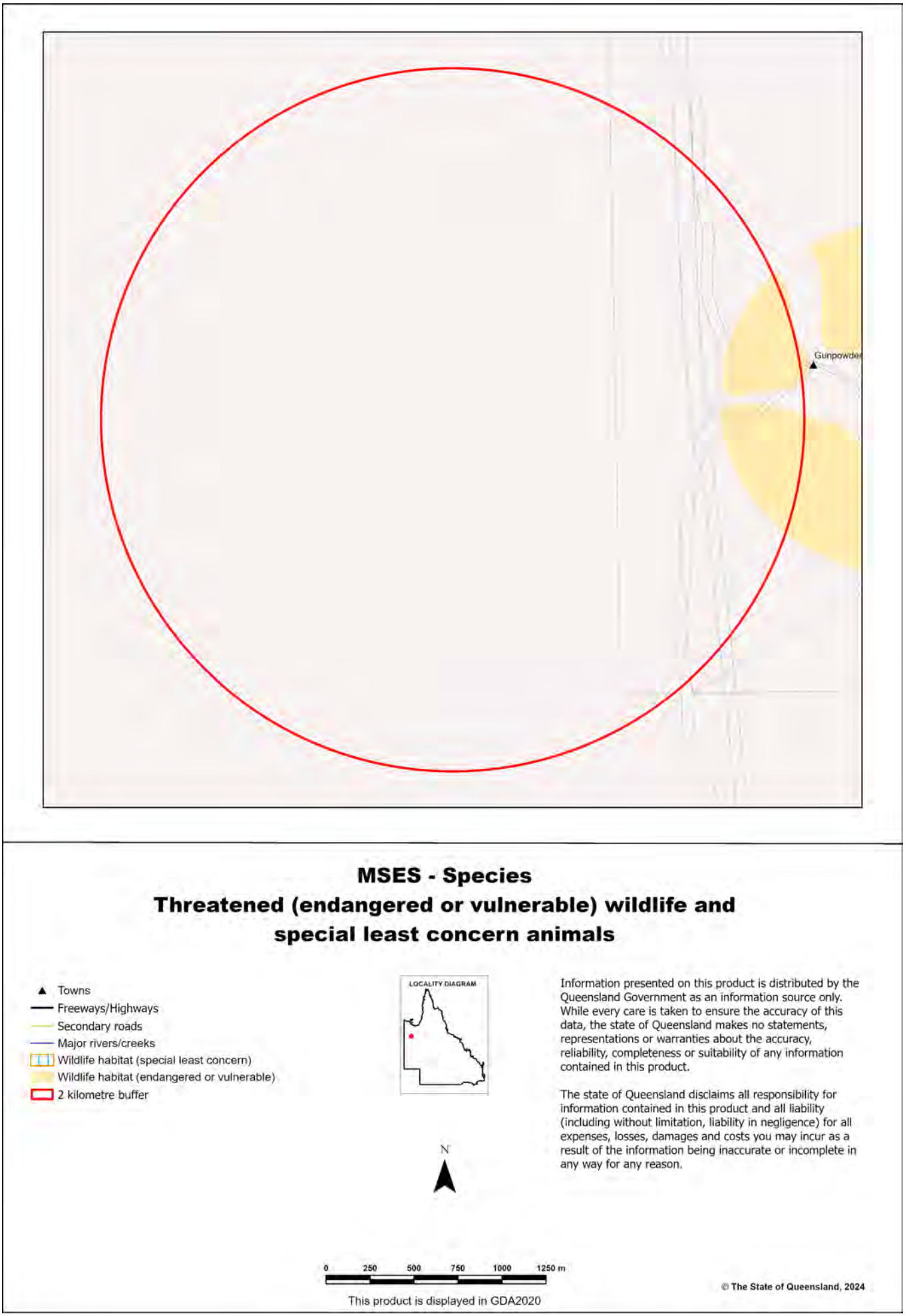
Map 1 - MSES - State Conservation Areas



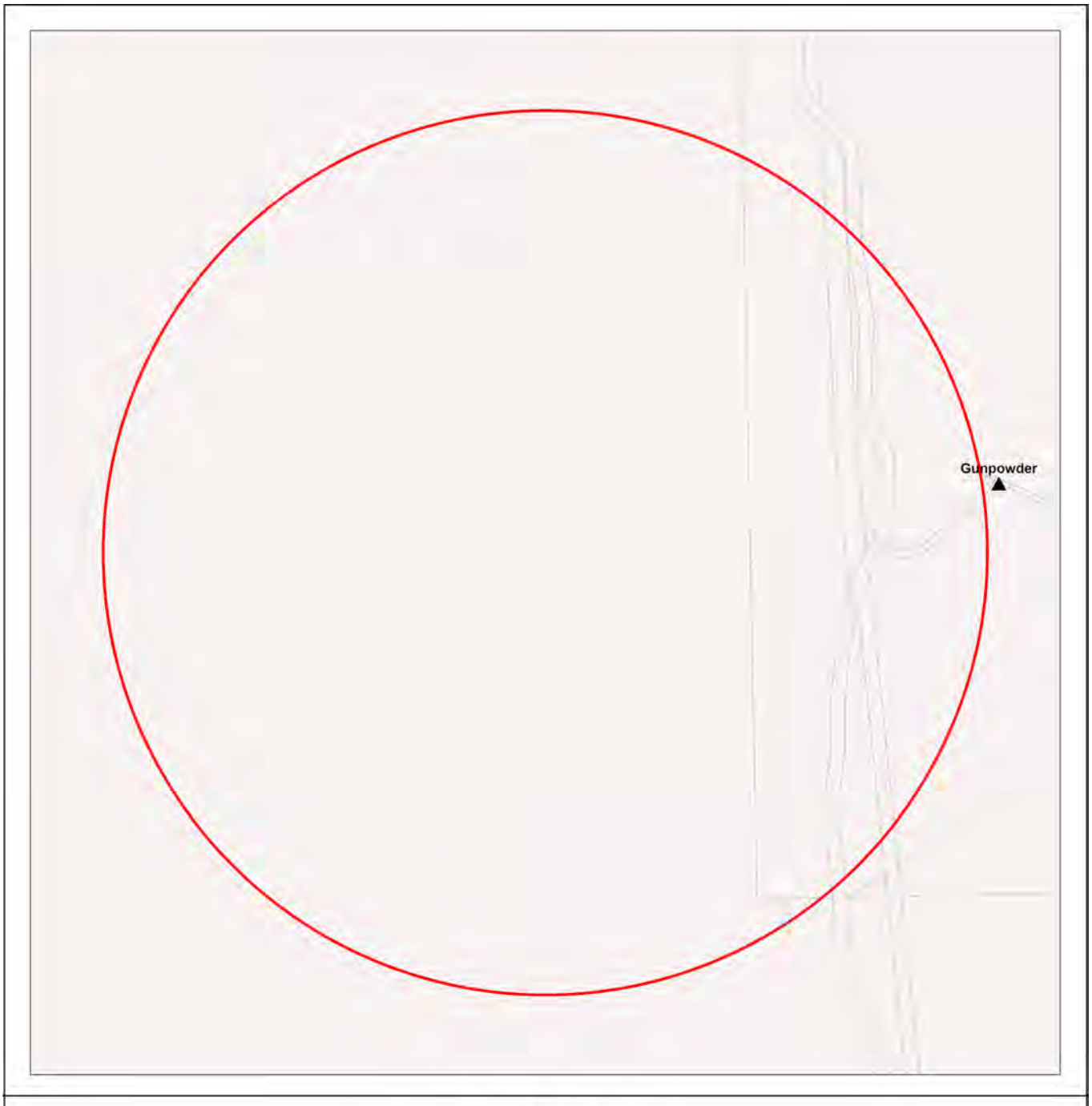
Map 2 - MSES - Wetlands and Waterways



Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals



Map 3b - MSES - Species - Koala habitat area (SEQ)



MSES - Species
Koala habitat area (SEQ)

- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Koala habitat area (core)
- Koala habitat area (locally refined)
- 2 kilometre buffer

LOCALITY DIAGRAM



0 240 480 720 960 1,200 m

This product is displayed in GDA2020

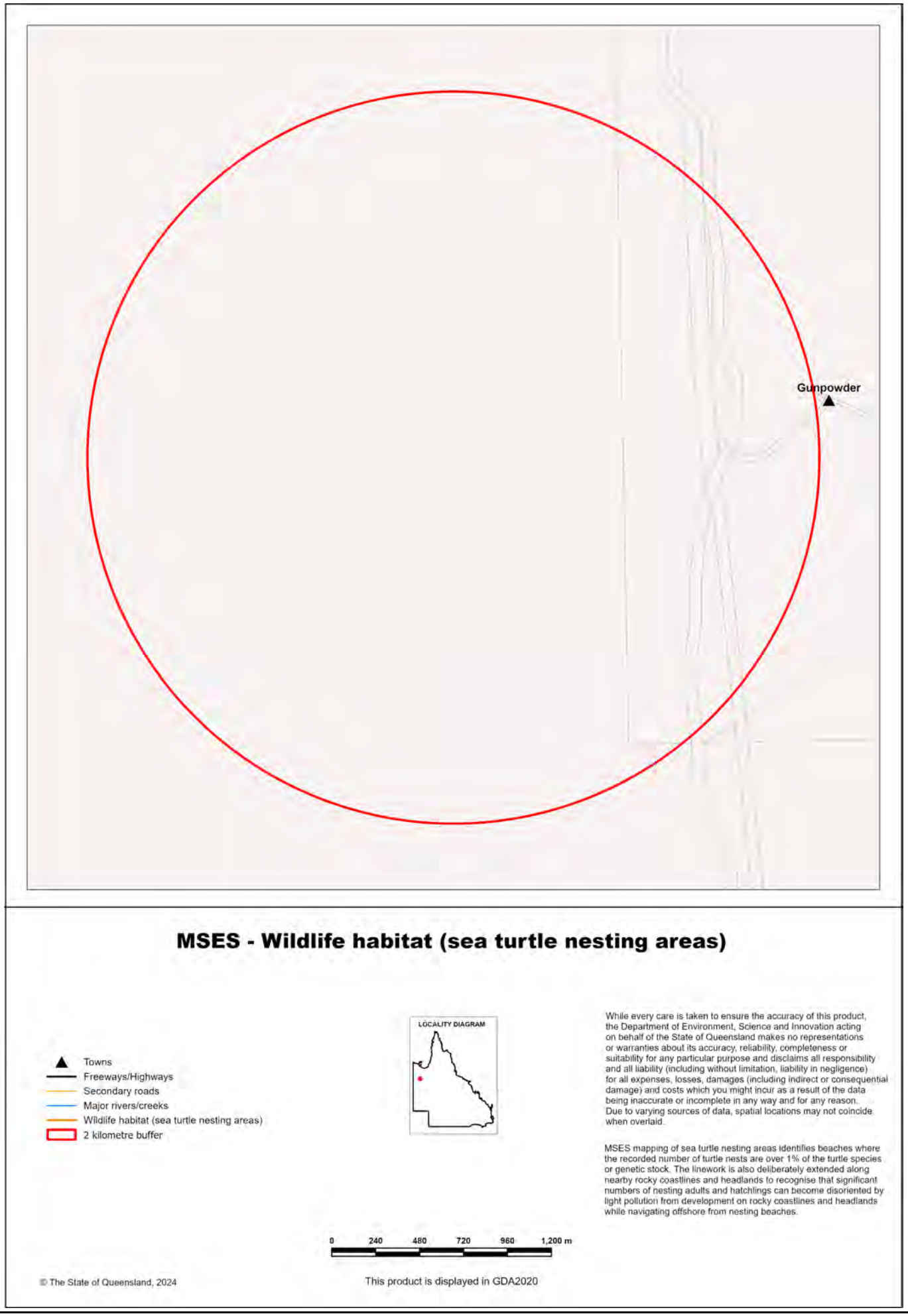
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The represented layers for SEQ 'koala habitat area-core' and 'koala habitat area- locally refined' in MSES are sourced directly from the regulatory mapping under the Nature Conservation (Koala) Conservation Plan 2017. Whilst every effort is made to ensure the information remains current, there may be delays between updating versions. Please refer to the original mapping for the most recent version. See https://environment.des.qld.gov.au/wildlife/animals/living-with/koalas/mapping

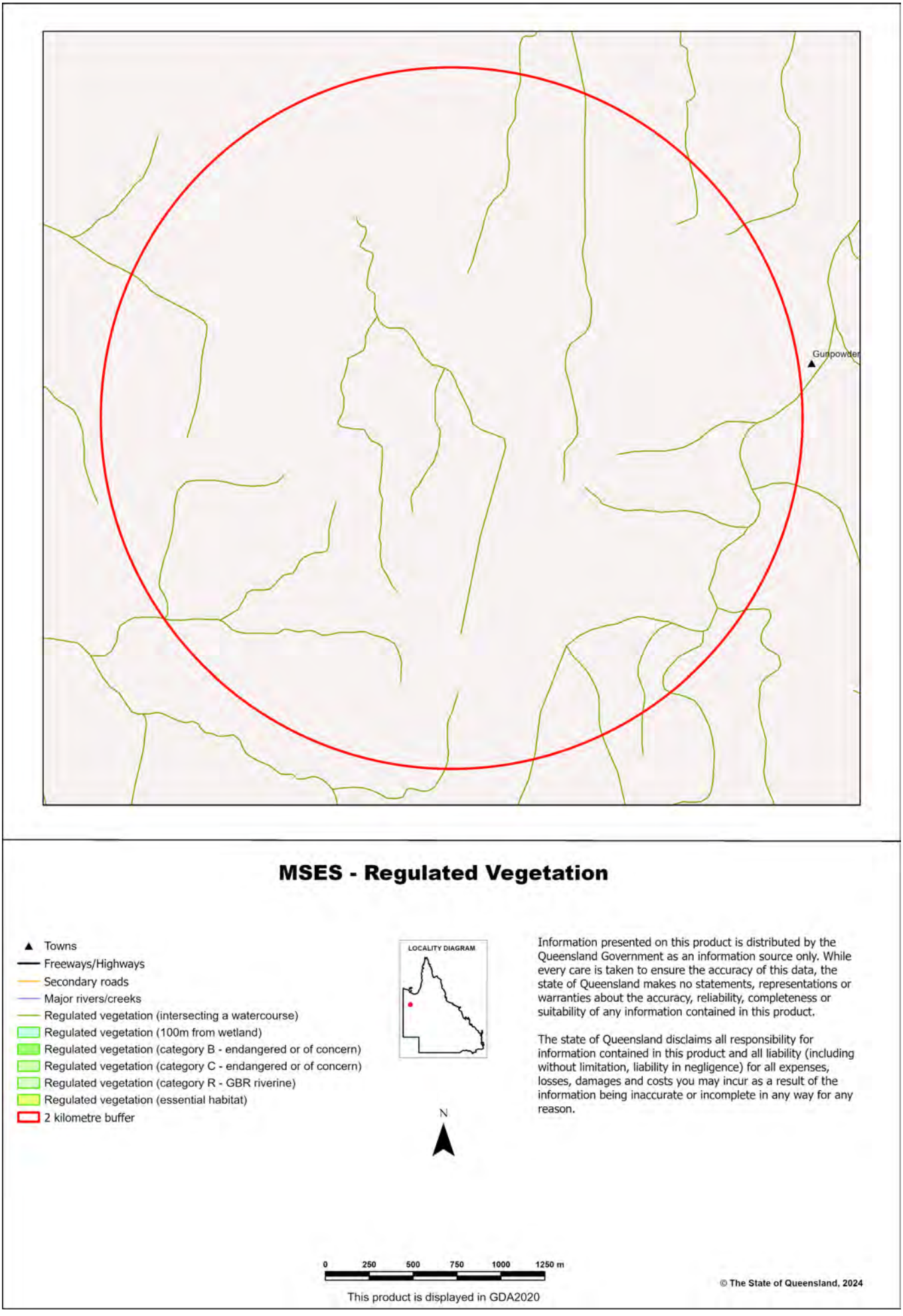
The koala habitat mapping within South East Queensland uses regional ecosystem linework compiled at a scale varying from 1:25,000 to 1:100,000. Linework should be used as a guide only. The positional accuracy of regional ecosystem data mapped at a scale of 1:100,000 is +/- 100 metres.

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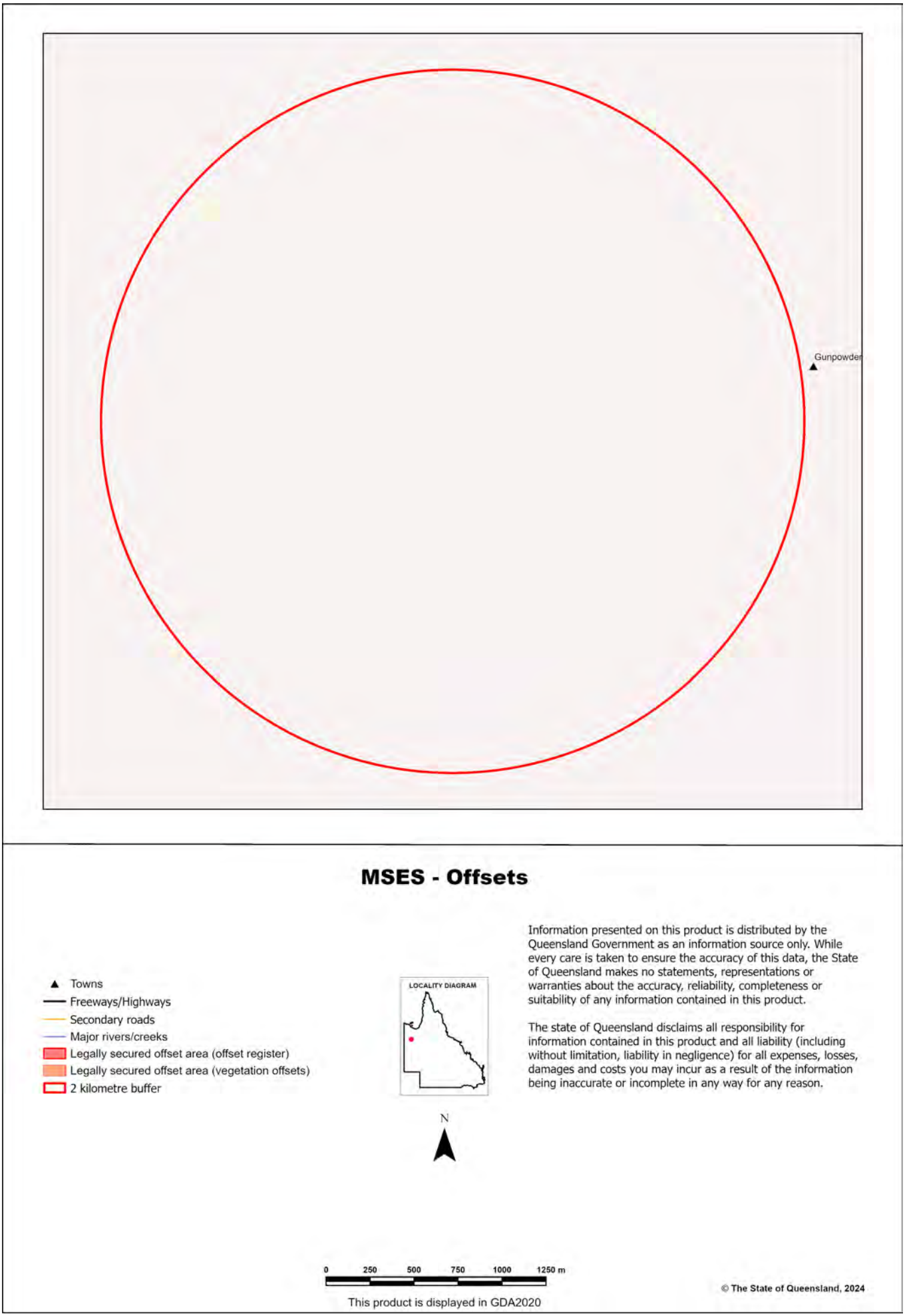
Map 3c - MSES - Species - Wildlife habitat (sea turtle nesting areas)



Map 4 - MSES - Regulated Vegetation



Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). Its primary purpose is to support implementation of the SPP biodiversity policy.

MSES mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

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The Queensland Government's "Method for mapping - matters of state environmental significance can be downloaded from:

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- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

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Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DES
Regulated Vegetation Map	Vegetation management - regulated vegetation management map

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DESI	- Department of Environment, Science and Innovation
EP Act	- Environmental Protection Act 1994
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- Nature Conservation Act 1992
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- Vegetation Management Act 1999

Queensland Government

Department of Environment, Science and Innovation

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest

Longitude: 139.372552 Latitude: -19.706867 with 2 kilometre radius

Magazine Creek

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

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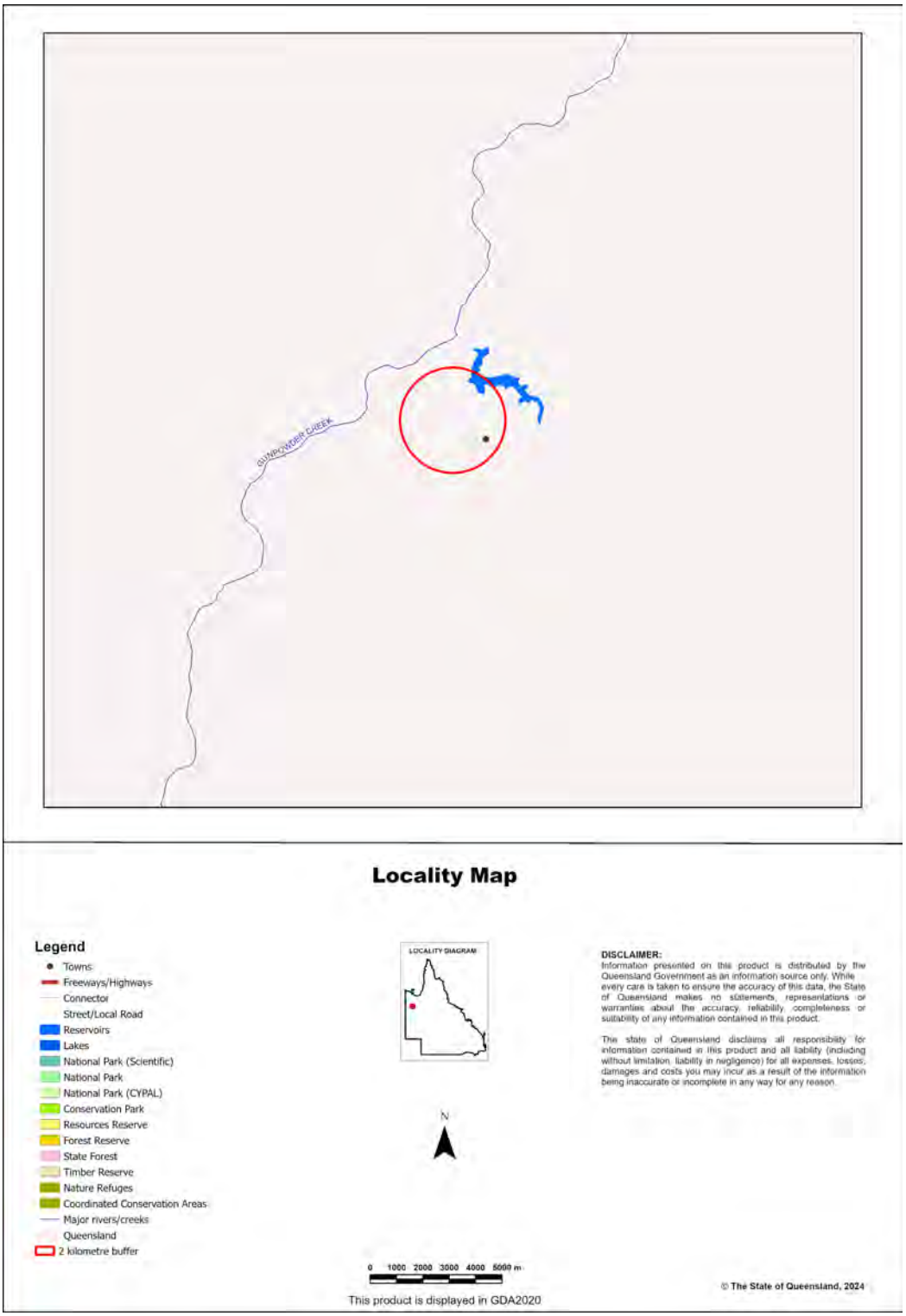
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI: Longitude: 139.372552 Latitude: -19.706867 with 2 kilometre radius, with area 1256.64 ha

Local Government(s)	Catchment(s)	Bioregion(s)	Subregion(s)
Mount Isa City	Leichhardt	Northwest Highlands	Mount Isa Inlier



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992;*

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the Marine Parks Act 2004 ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- *Threatened wildlife under the Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

  - Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;
  - Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;
  - Category R areas on the regulated vegetation management map;
  - Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;
  - Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Queensland Wetland Environmental Values under the Environment Protection Regulation 2019;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;
- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0 ha	0.0%
1b Protected Areas- nature refuges	0 ha	0.0%
1c Protected Areas- special wildlife reserves	0 ha	0.0%
2 State Marine Parks- highly protected zones	0 ha	0.0%
3 Fish habitat areas (A and B areas)	0 ha	0.0%
4 Strategic Environmental Areas (SEA)	0 ha	0.0%
5 High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values	0 ha	0.0%
6a High Ecological Value (HEV) wetlands	0 ha	0.0%
6b High Ecological Value (HEV) waterways	0 km	Not applicable
7a Threatened (endangered or vulnerable) wildlife	119.65 ha	9.5%
7b Special least concern animals	0 ha	0.0%
7c i Koala habitat area - core (SEQ)	0 ha	0.0%
7c ii Koala habitat area - locally refined (SEQ)	0 ha	0.0%
7d Sea turtle nesting areas	0 km	Not applicable
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0 ha	0.0%
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0 ha	0.0%
8c Regulated Vegetation - Category R (GBR riverine regrowth)	0 ha	0.0%
8d Regulated Vegetation - Essential habitat	0 ha	0.0%
8e Regulated Vegetation - intersecting a watercourse	22.2 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0 ha	0.0%
9a Legally secured offset areas- offset register areas	0 ha	0.0%
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0 ha	0.0%

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(No results)

1b. Protected Areas - nature refuges

(No results)

1c. Protected Areas - special wildlife reserves

(No results)

2. State Marine Parks - highly protected zones

(No results)

3. Fish habitat areas (A and B areas)

(No results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(No results)

5. High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values

(no results)

6a. Wetlands in High Ecological Value (HEV) waters

(no results)

6b. Waterways in High Ecological Value (HEV) waters

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7a. Threatened (endangered or vulnerable) wildlife

Values are present

7b. Special least concern animals

Not applicable

7c i. Koala habitat area - core (SEQ)

Not applicable

7c ii. Koala habitat area - locally refined (SEQ)

Not applicable

7d. Wildlife habitat (sea turtle nesting areas)

Not applicable

Threatened (endangered or vulnerable) wildlife habitat suitability models

Species	Common name	NCA status	Presence
Boronia keysii	Keys boronia	V	None
Calyptorhynchus lathami	Glossy black cockatoo	V	None
Casuarius casuarius johnsonii	Sthn population cassowary	E	None
Crinia tinnula	Wallum froglet	V	None
Denisonia maculata	Ornamental snake	V	None
Euastacus bindal	Mount Elliot crayfish	CR	None
Euastacus binzayedi		CR	None
Euastacus eungella		E	None
Euastacus hystricosus		E	None
Euastacus jagara	Jagara hairy crayfish	CR	None
Euastacus maidae		CR	None
Euastacus monteithorum		E	None
Euastacus robertsi		E	None
Taudactylus pleione	Kroombit tinkerfrog	E	None
Litoria freycineti	Wallum rocketfrog	V	None
Litoria olongburensis	Wallum sedgefrog	V	None
Macadamia integrifolia		V	None
Melaleuca irbyana	swamp tea-tree	E	None
Macadamia ternifolia		V	None
Macadamia tetraphylla	bopple nut	V	None
Petrogale penicillata	brush-tailed rock-wallaby	V	None
Petrogale coenensis	Cape York rock-wallaby	V	None
Petrogale purpureicollis	purple-necked rock-wallaby	V	None
Petrogale sharmani	Sharmans rock-wallaby	V	None
Petrogale xanthopus celeris	yellow-footed rock-wallaby (Qld subspecies)	V	None
Petaurus gracilis	Mahogany Glider	E	None
Petrogale persephone	Proserpine rock-wallaby	E	None
Phascolarctos cinereus	Koala - outside SEQ*	E	None
Pezoporus wallicus wallicus	Eastern ground parrot	V	None
Xeromys myoides	Water Mouse	V	None

*For koala model, this includes areas outside SEQ. Check 7c SEQ koala habitat for presence/absence.

Threatened (endangered or vulnerable) wildlife species records

Scientific name	Common name	NCA status	EPBC status	Migratory status
Amytornis dorotheae	Carpentarian grasswren	E	E	None

Special least concern animal species records

(No results)

Shorebird habitat (critically endangered/endangered/vulnerable)

Not applicable

Shorebird habitat (special least concern)

Not applicable

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

Migratory status (M) - China and Australia Migratory Bird Agreement (C), Japan and Australia Migratory Bird Agreement (J), Republic of Korea and Australia Migratory Bird Agreement (R), Bonn Migratory Convention (B), Eastern Flyway (E)

To request a species list for an area, or search for a species profile, access Wildlife Online at:

https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals** and **Map 3b - MSES - Species - Koala habitat area (SEQ)** and **Map 3c - MSES - Wildlife habitat (sea turtle nesting areas)** for an overview of the relevant MSES.

MSES - Regulated Vegetation

For further information relating to regional ecosystems in general, go to:

https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:

https://environment.ehp.qld.gov.au/regional-ecosystems/

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Not applicable

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

A vegetation management watercourse is mapped as present

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

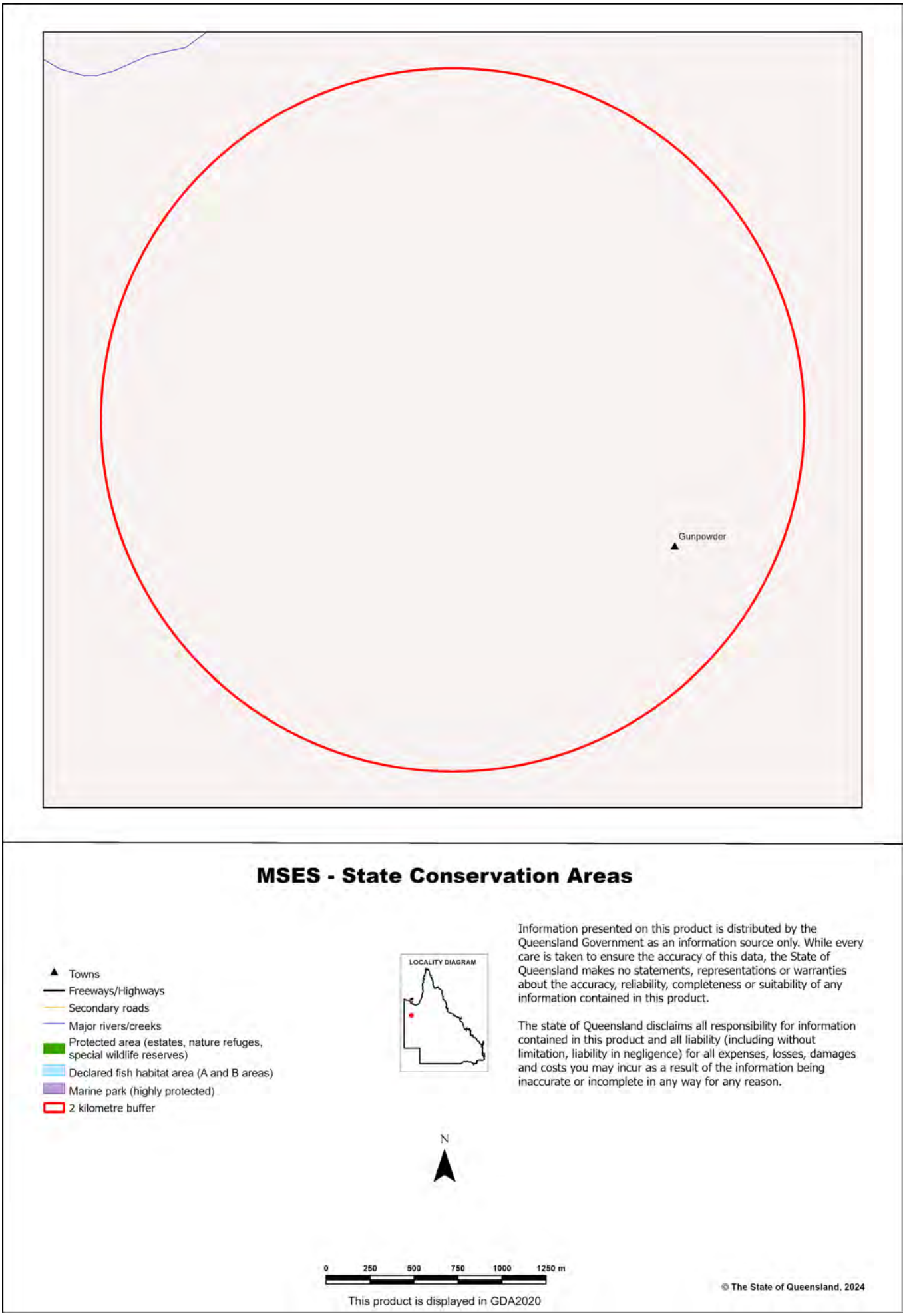
(No results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

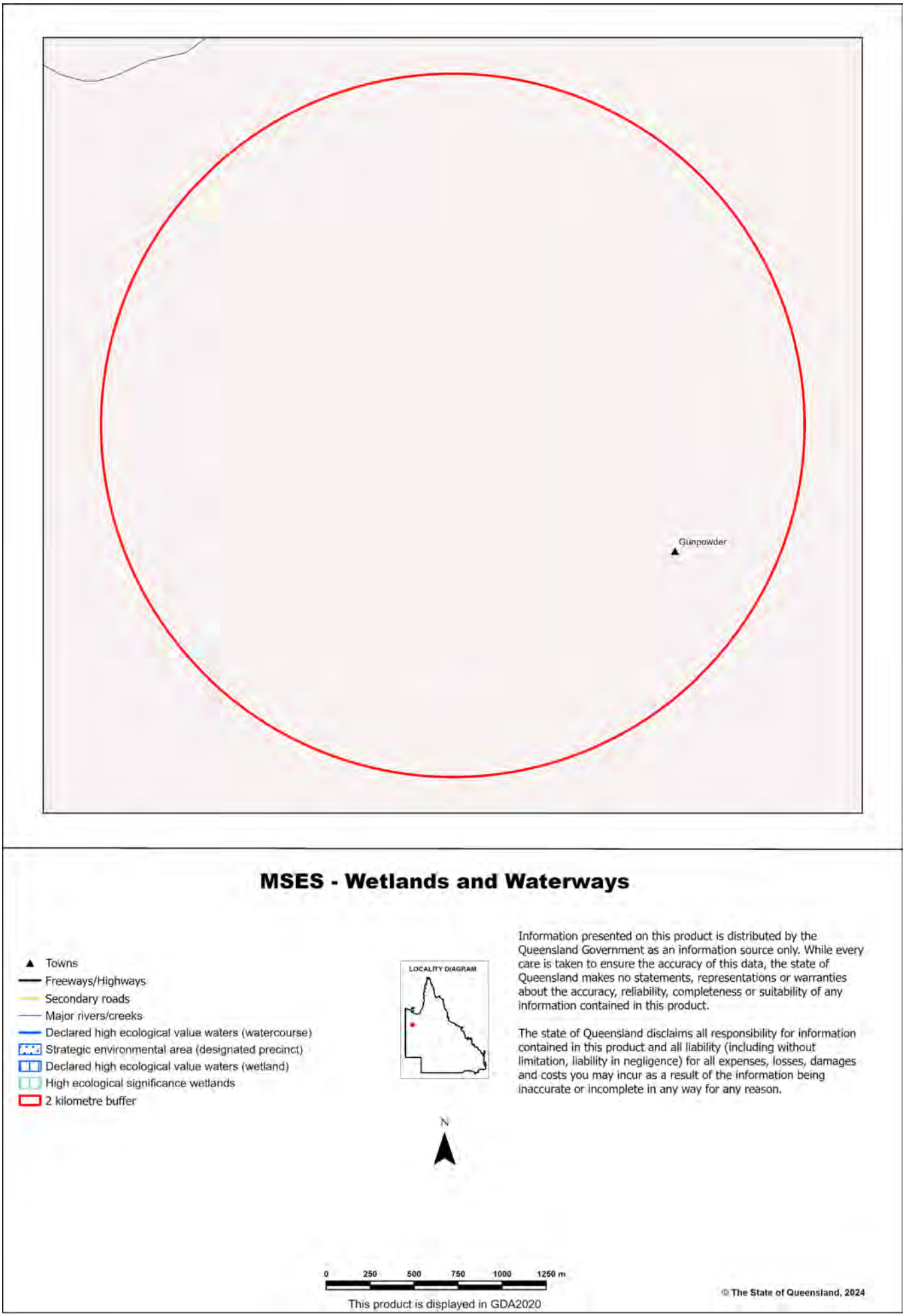
(No results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

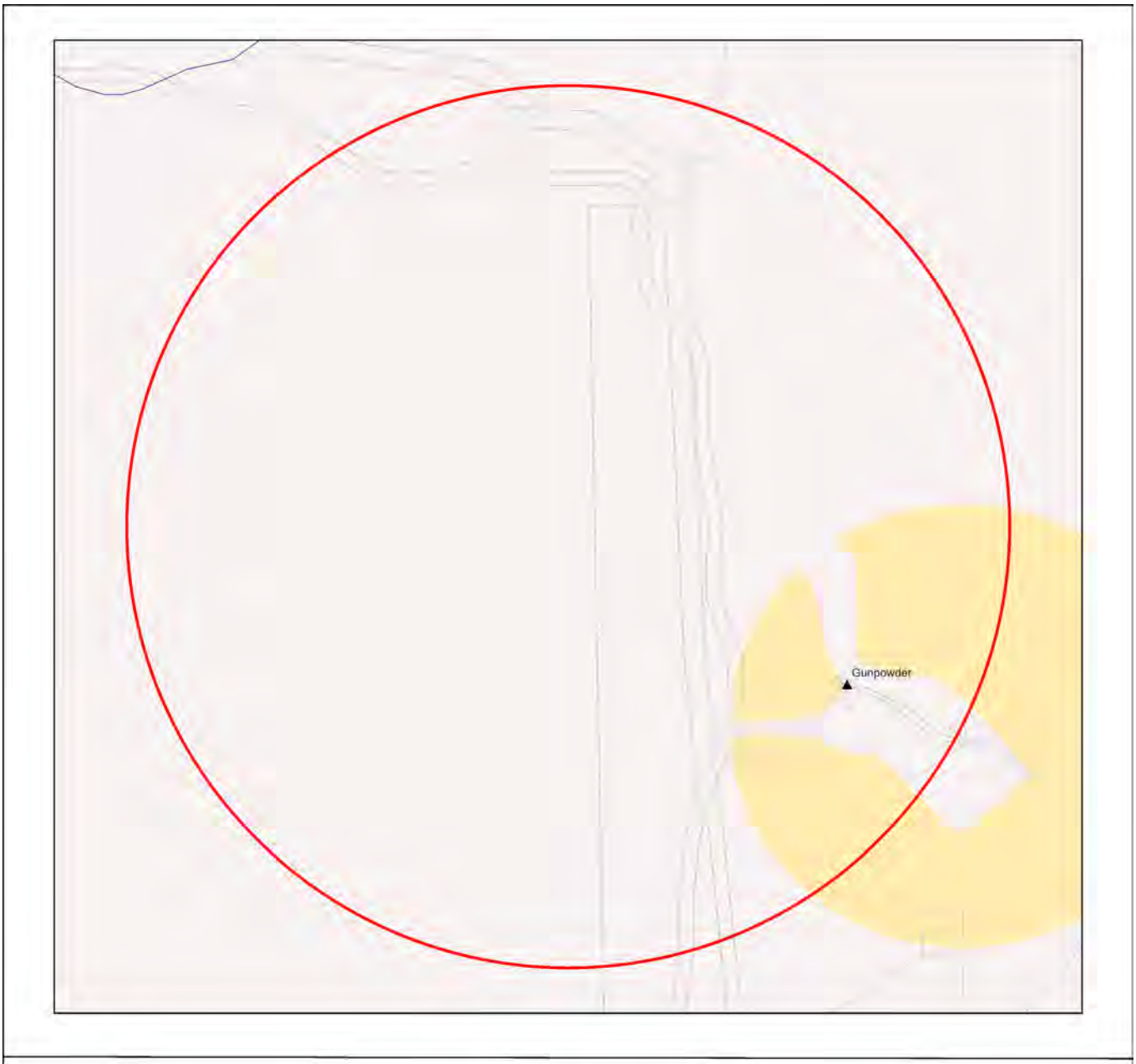
Map 1 - MSES - State Conservation Areas



Map 2 - MSES - Wetlands and Waterways



Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals



MSES - Species
Threatened (endangered or vulnerable) wildlife and special least concern animals

- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Wildlife habitat (special least concern)
- Wildlife habitat (endangered or vulnerable)
- 2 kilometre buffer

LOCALITY DIAGRAM



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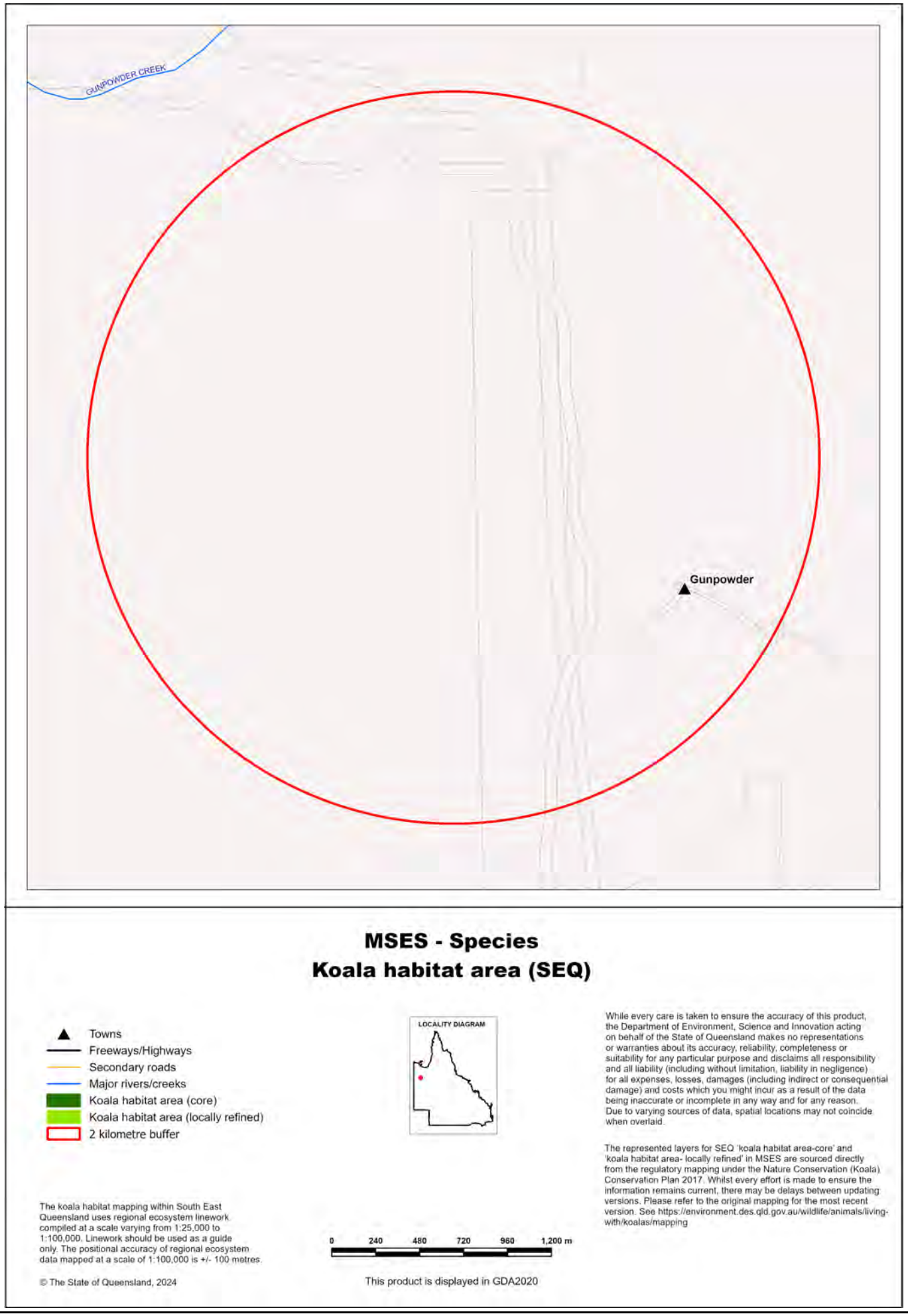
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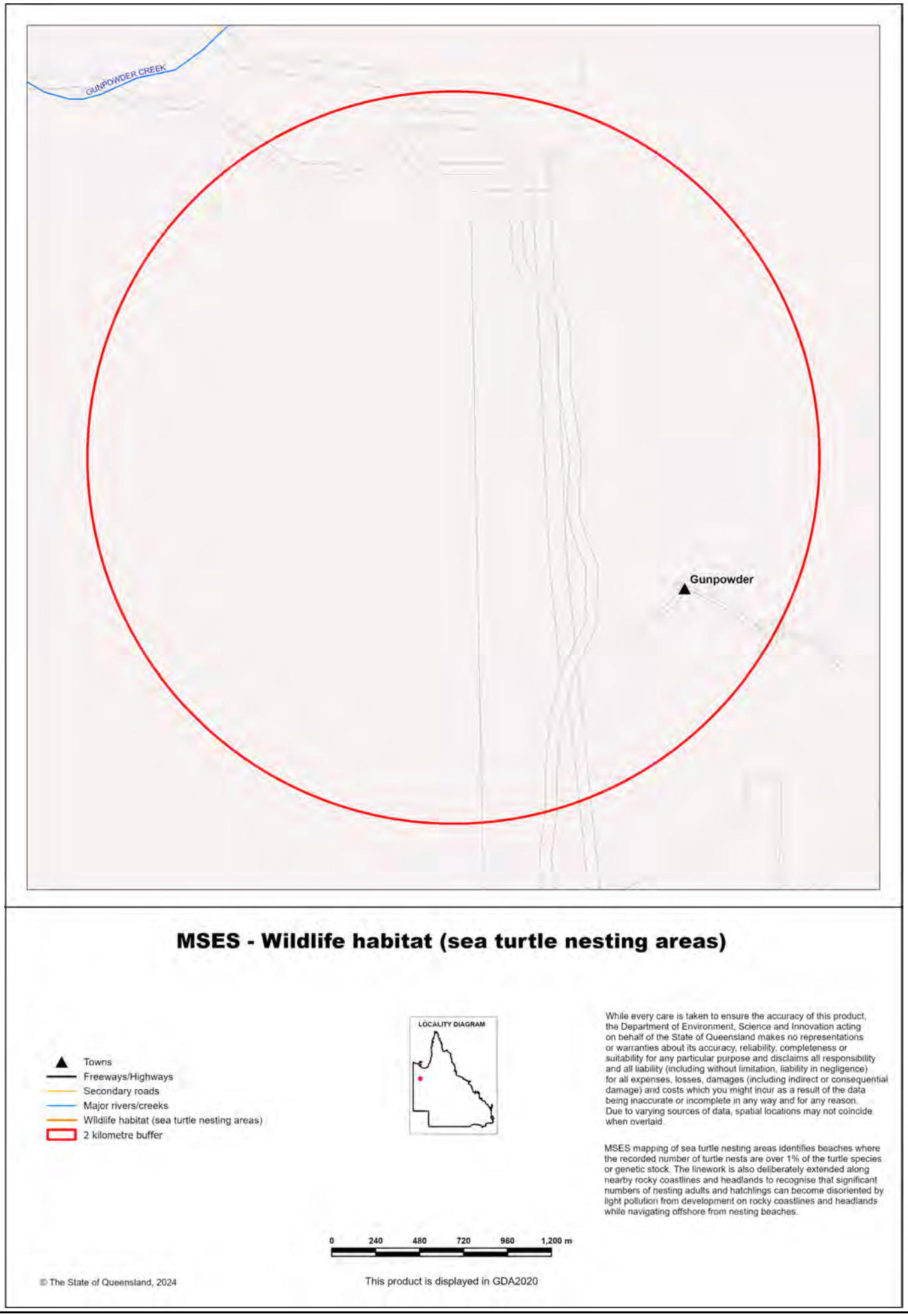
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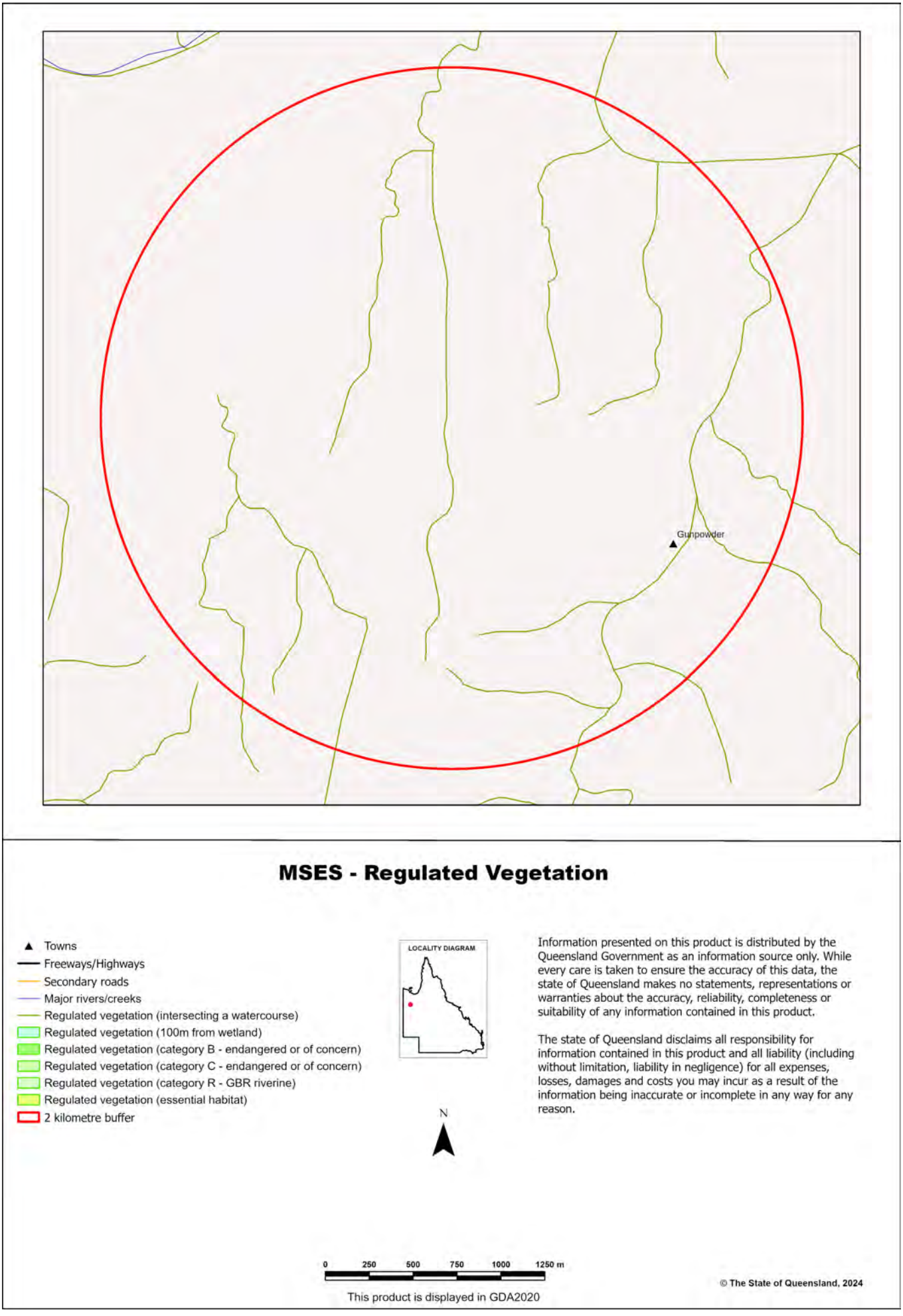
Map 3b - MSES - Species - Koala habitat area (SEQ)



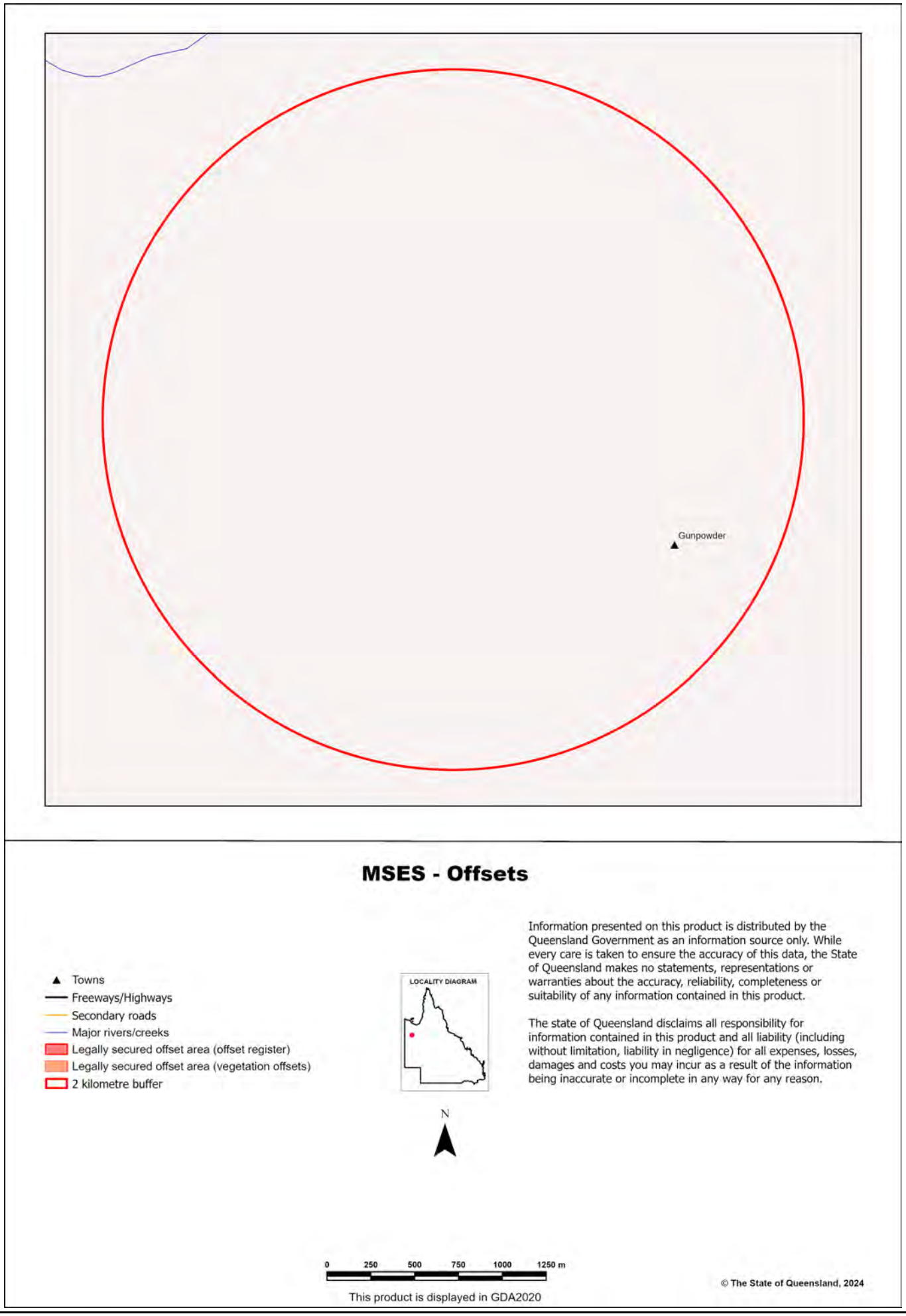
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Map 5 - MSES - Offset Areas



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Queensland Government

Department of Environment, Science and Innovation

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest

Longitude: 139.374247 Latitude: -19.752392 with 2 kilometre radius

Diamond Creek

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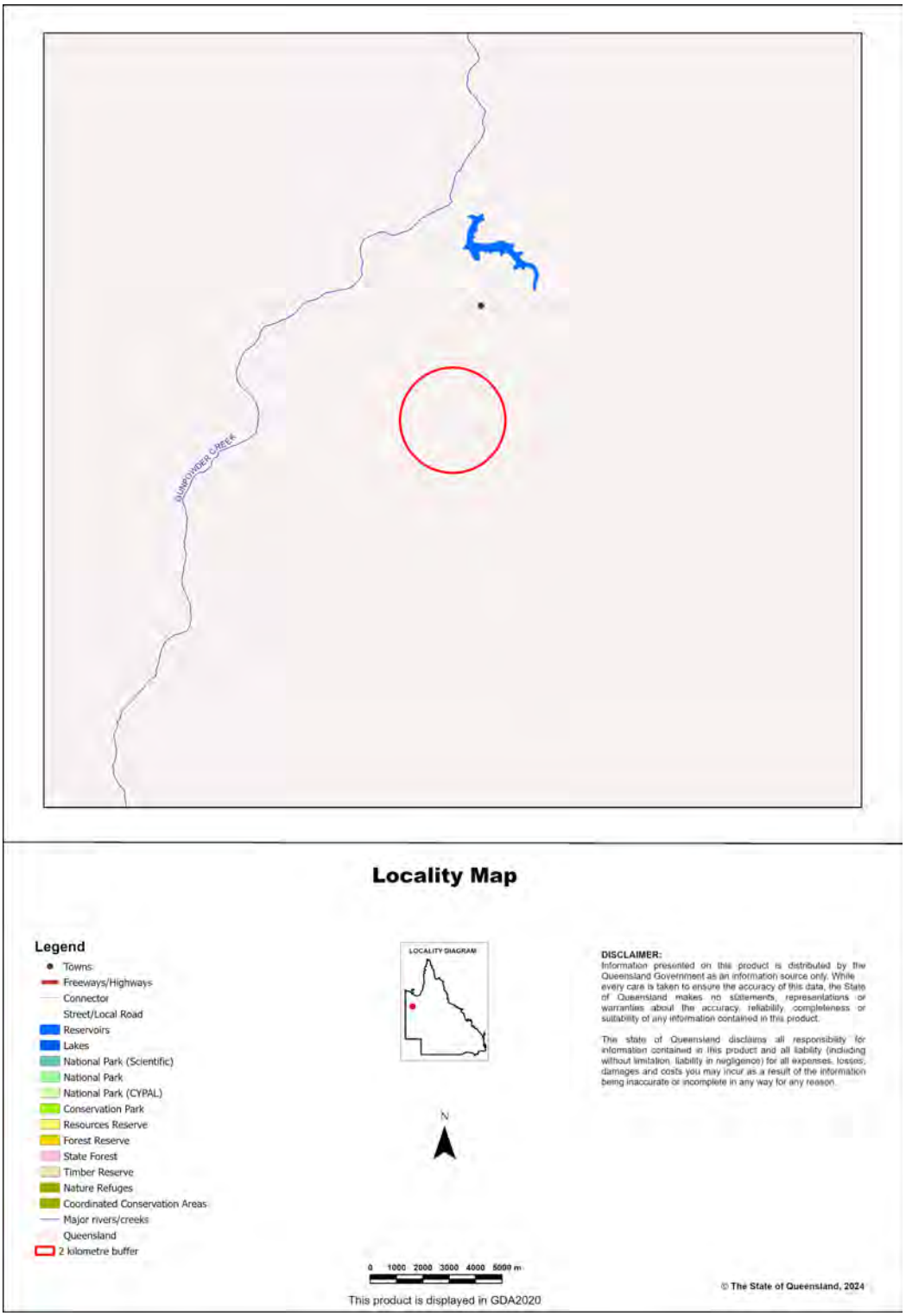
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI: Longitude: 139.374247 Latitude: -19.752392 with 2 kilometre radius, with area 1256.64 ha

Local Government(s)	Catchment(s)	Bioregion(s)	Subregion(s)
Mount Isa City	Leichhardt	Northwest Highlands	Mount Isa Inlier



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992;*

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the Marine Parks Act 2004 ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- *Threatened wildlife under the Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

  - Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;
  - Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;
  - Category R areas on the regulated vegetation management map;
  - Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;
  - Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Queensland Wetland Environmental Values under the Environment Protection Regulation 2019;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;
- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0 ha	0.0%
1b Protected Areas- nature refuges	0 ha	0.0%
1c Protected Areas- special wildlife reserves	0 ha	0.0%
2 State Marine Parks- highly protected zones	0 ha	0.0%
3 Fish habitat areas (A and B areas)	0 ha	0.0%
4 Strategic Environmental Areas (SEA)	0 ha	0.0%
5 High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values	0 ha	0.0%
6a High Ecological Value (HEV) wetlands	0 ha	0.0%
6b High Ecological Value (HEV) waterways	0 km	Not applicable
7a Threatened (endangered or vulnerable) wildlife	0 ha	0.0%
7b Special least concern animals	0 ha	0.0%
7c i Koala habitat area - core (SEQ)	0 ha	0.0%
7c ii Koala habitat area - locally refined (SEQ)	0 ha	0.0%
7d Sea turtle nesting areas	0 km	Not applicable
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0 ha	0.0%
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0 ha	0.0%
8c Regulated Vegetation - Category R (GBR riverine regrowth)	0 ha	0.0%
8d Regulated Vegetation - Essential habitat	0 ha	0.0%
8e Regulated Vegetation - intersecting a watercourse	22.7 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0 ha	0.0%
9a Legally secured offset areas- offset register areas	0 ha	0.0%
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0 ha	0.0%

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(No results)

1b. Protected Areas - nature refuges

(No results)

1c. Protected Areas - special wildlife reserves

(No results)

2. State Marine Parks - highly protected zones

(No results)

3. Fish habitat areas (A and B areas)

(No results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(No results)

5. High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values

(no results)

6a. Wetlands in High Ecological Value (HEV) waters

(no results)

6b. Waterways in High Ecological Value (HEV) waters

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7a. Threatened (endangered or vulnerable) wildlife

Not applicable

7b. Special least concern animals

Not applicable

7c i. Koala habitat area - core (SEQ)

Not applicable

7c ii. Koala habitat area - locally refined (SEQ)

Not applicable

7d. Wildlife habitat (sea turtle nesting areas)

Not applicable

Threatened (endangered or vulnerable) wildlife habitat suitability models

Species	Common name	NCA status	Presence
Boronia keysii	Keys boronia	V	None
Calyptorhynchus lathami	Glossy black cockatoo	V	None
Casuarius casuarius johnsonii	Sthn population cassowary	E	None
Crinia tinnula	Wallum froglet	V	None
Denisonia maculata	Ornamental snake	V	None
Euastacus bindal	Mount Elliot crayfish	CR	None
Euastacus binzayedi		CR	None
Euastacus eungella		E	None
Euastacus hystricosus		E	None
Euastacus jagara	Jagara hairy crayfish	CR	None
Euastacus maidae		CR	None
Euastacus monteithorum		E	None
Euastacus robertsi		E	None
Taudactylus pleione	Kroombit tinkerfrog	E	None
Litoria freycineti	Wallum rocketfrog	V	None
Litoria olongburensis	Wallum sedgefrog	V	None
Macadamia integrifolia		V	None
Melaleuca irbyana	swamp tea-tree	E	None
Macadamia ternifolia		V	None
Macadamia tetraphylla	bopple nut	V	None
Petrogale penicillata	brush-tailed rock-wallaby	V	None
Petrogale coenensis	Cape York rock-wallaby	V	None
Petrogale purpureicollis	purple-necked rock-wallaby	V	None
Petrogale sharmani	Sharmans rock-wallaby	V	None
Petrogale xanthopus celeris	yellow-footed rock-wallaby (Qld subspecies)	V	None
Petaurus gracilis	Mahogany Glider	E	None
Petrogale persephone	Proserpine rock-wallaby	E	None
Phascolarctos cinereus	Koala - outside SEQ*	E	None
Pezoporus wallicus wallicus	Eastern ground parrot	V	None
Xeromys myoides	Water Mouse	V	None

*For koala model, this includes areas outside SEQ. Check 7c SEQ koala habitat for presence/absence.

Threatened (endangered or vulnerable) wildlife species records

(No results)

Special least concern animal species records

(No results)

Shorebird habitat (critically endangered/endangered/vulnerable)

Not applicable

Shorebird habitat (special least concern)

Not applicable

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

Migratory status (M) - China and Australia Migratory Bird Agreement (C), Japan and Australia Migratory Bird Agreement (J), Republic of Korea and Australia Migratory Bird Agreement (R), Bonn Migratory Convention (B), Eastern Flyway (E)

To request a species list for an area, or search for a species profile, access Wildlife Online at:

https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals** and **Map 3b - MSES - Species - Koala habitat area (SEQ)** and **Map 3c - MSES - Wildlife habitat (sea turtle nesting areas)** for an overview of the relevant MSES.

MSES - Regulated Vegetation

For further information relating to regional ecosystems in general, go to:

https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:

https://environment.ehp.qld.gov.au/regional-ecosystems/

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Not applicable

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

A vegetation management watercourse is mapped as present

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

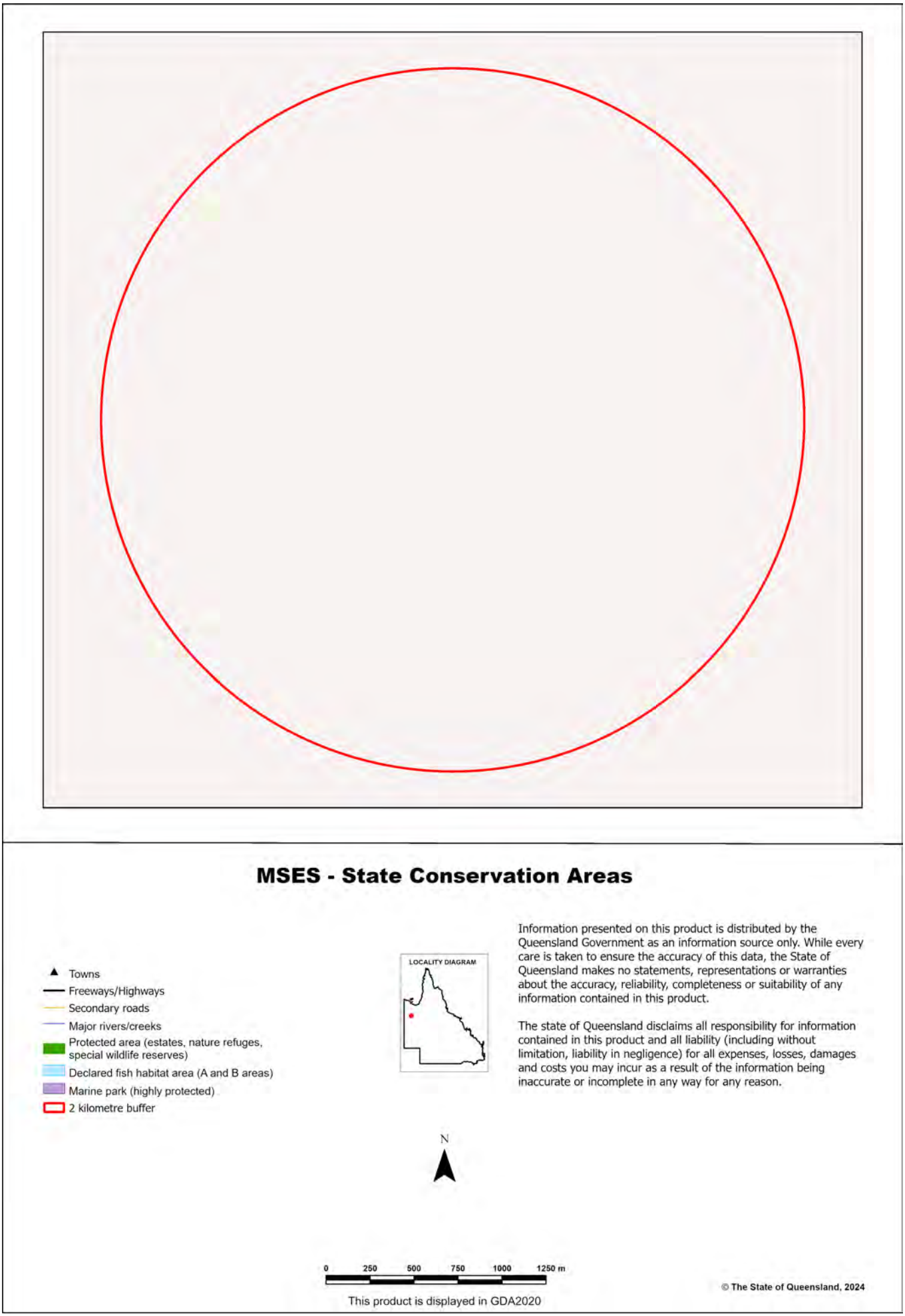
(No results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

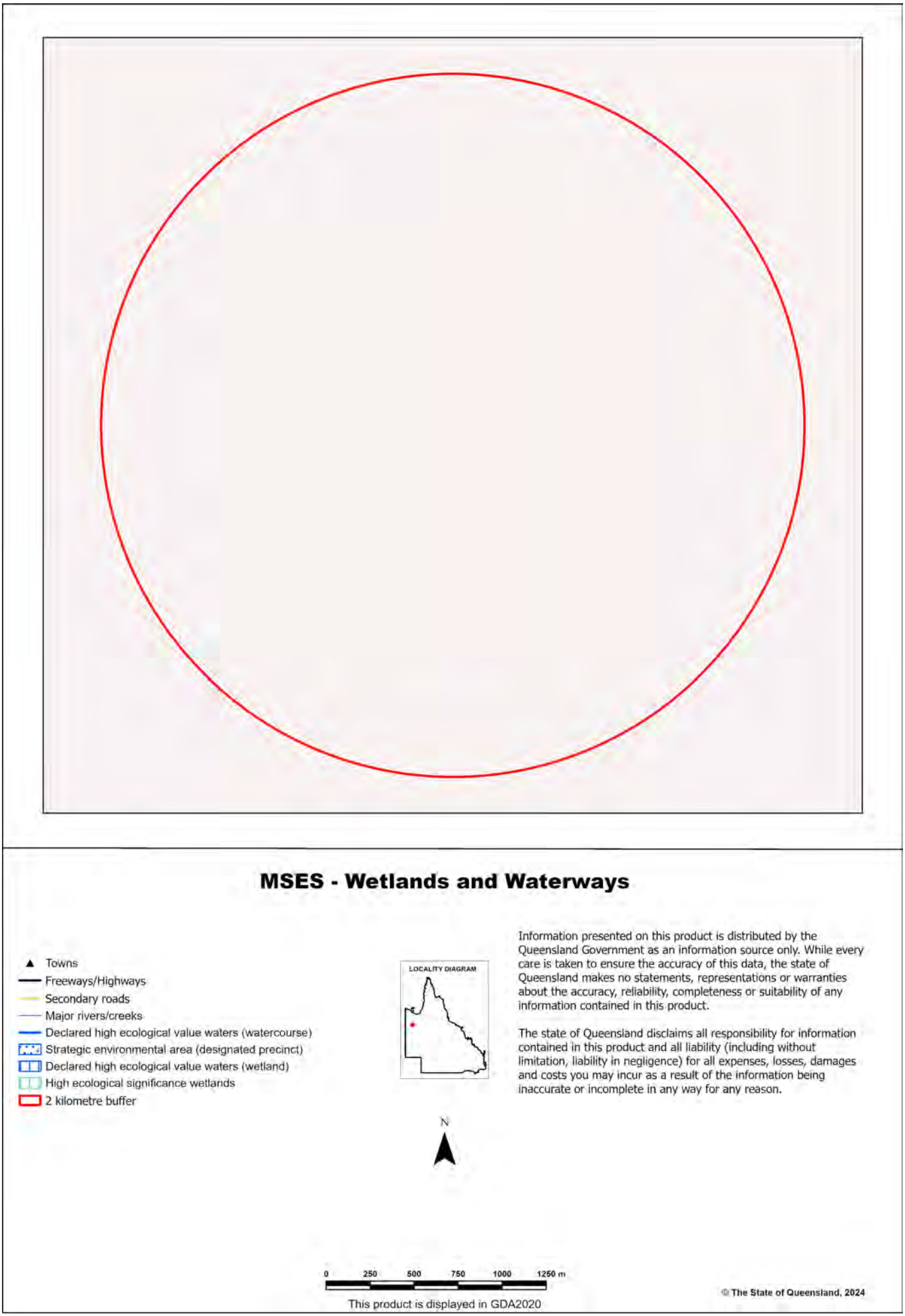
(No results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

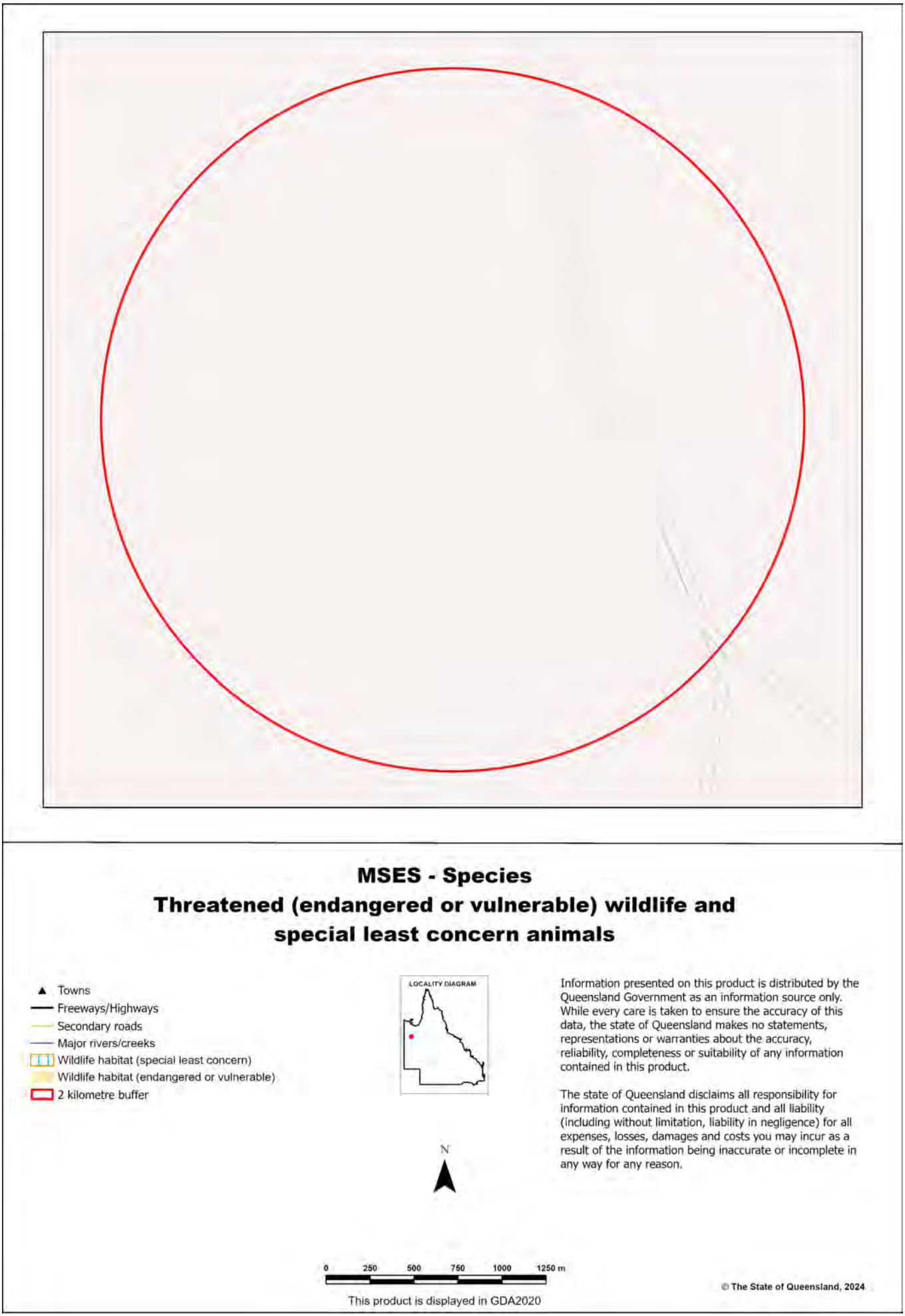
Map 1 - MSES - State Conservation Areas



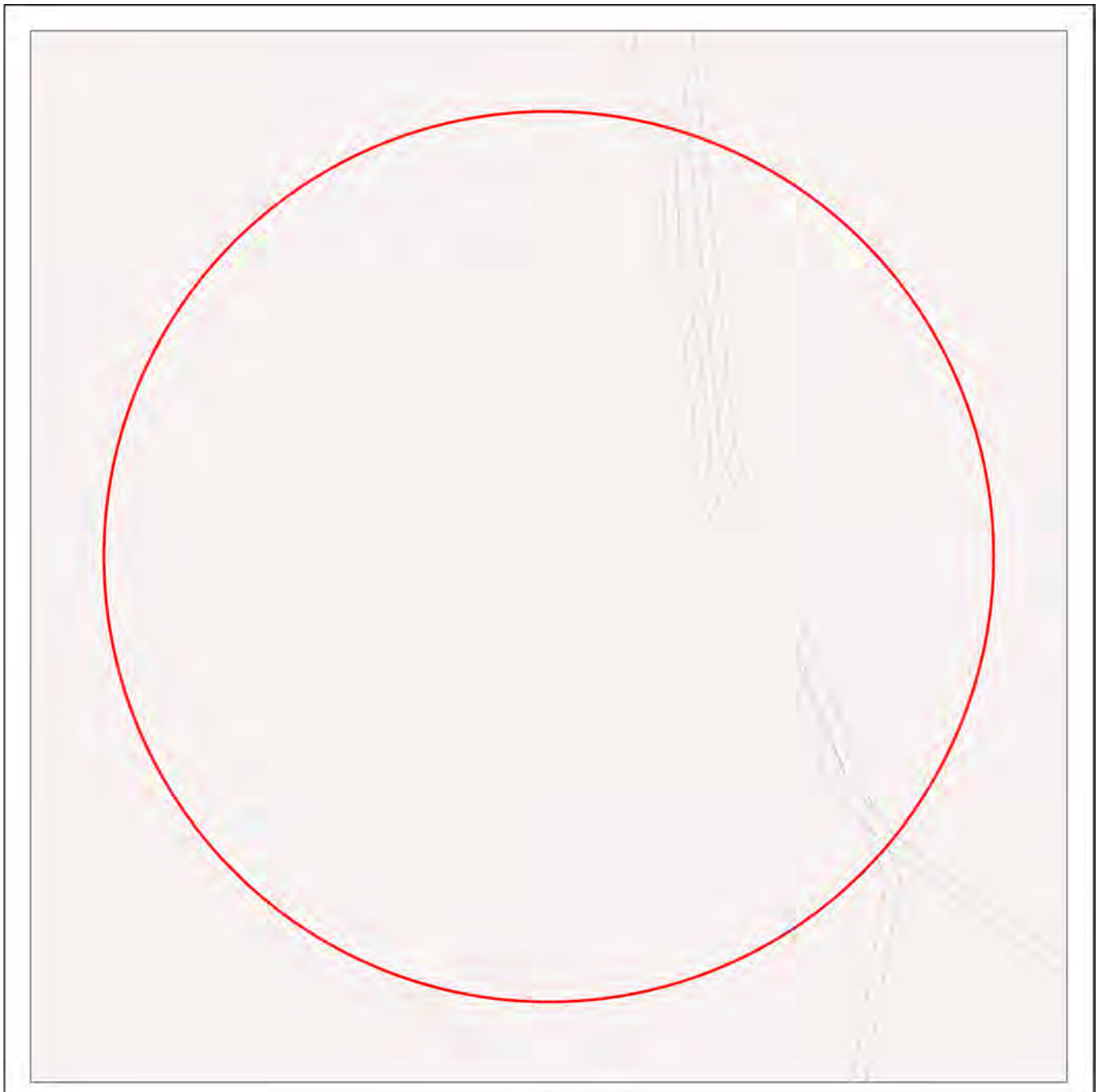
Map 2 - MSES - Wetlands and Waterways



Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals



Map 3b - MSES - Species - Koala habitat area (SEQ)



MSES - Species
Koala habitat area (SEQ)

- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Koala habitat area (core)
- Koala habitat area (locally refined)
- 2 kilometre buffer

LOCALITY DIAGRAM



While every care is taken to ensure the accuracy of this product, the Department of Environment, Science and Innovation acting on behalf of the State of Queensland makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which you might incur as a result of the data being inaccurate or incomplete in any way and for any reason. Due to varying sources of data, spatial locations may not coincide when overlaid.

The represented layers for SEQ 'koala habitat area-core' and 'koala habitat area- locally refined' in MSES are sourced directly from the regulatory mapping under the Nature Conservation (Koala) Conservation Plan 2017. Whilst every effort is made to ensure the information remains current, there may be delays between updating versions. Please refer to the original mapping for the most recent version. See https://environment.des.qld.gov.au/wildlife/animals/living-with/koalas/mapping

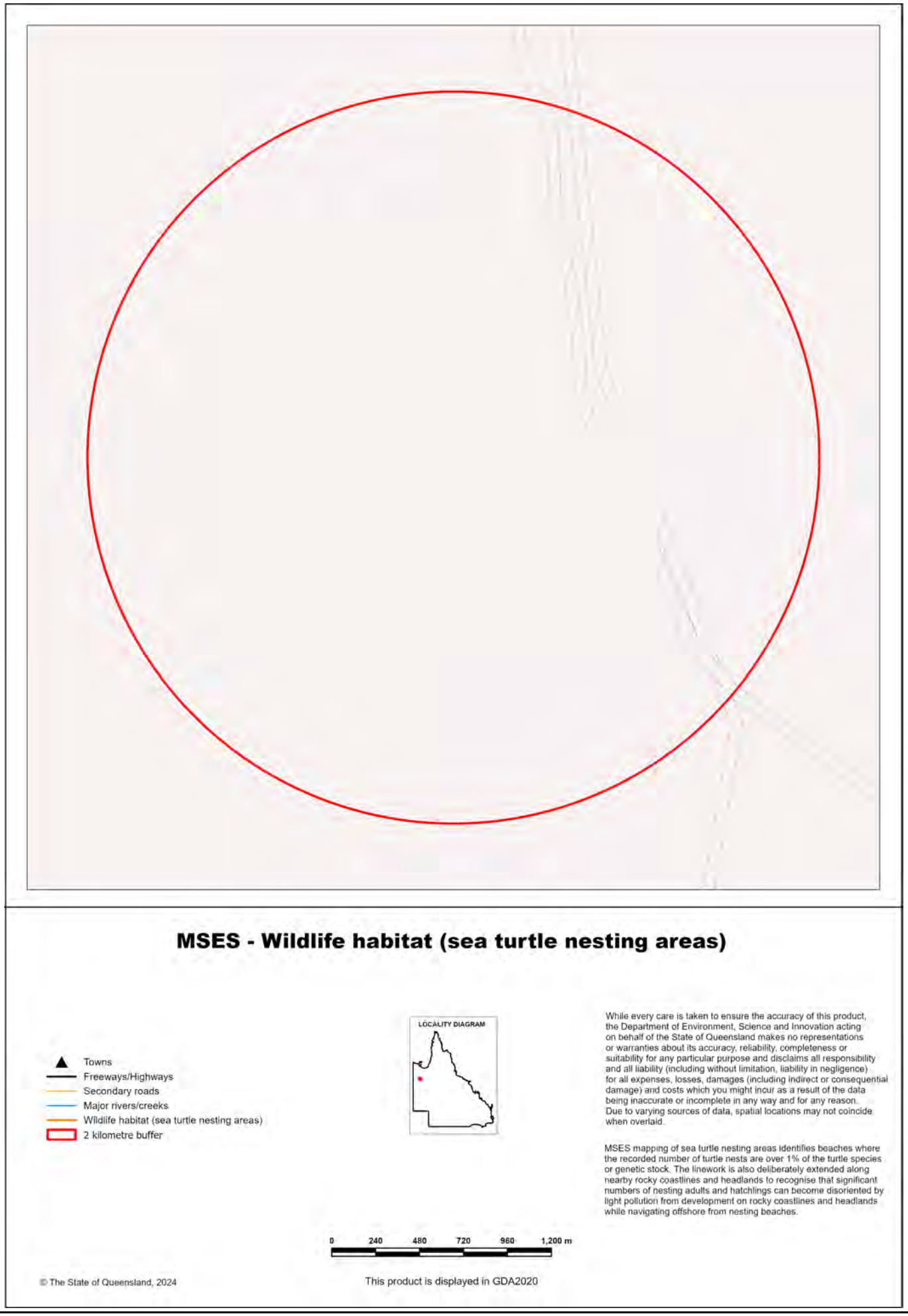
The koala habitat mapping within South East Queensland uses regional ecosystem linework compiled at a scale varying from 1:25,000 to 1:100,000. Linework should be used as a guide only. The positional accuracy of regional ecosystem data mapped at a scale of 1:100,000 is +/- 100 metres.

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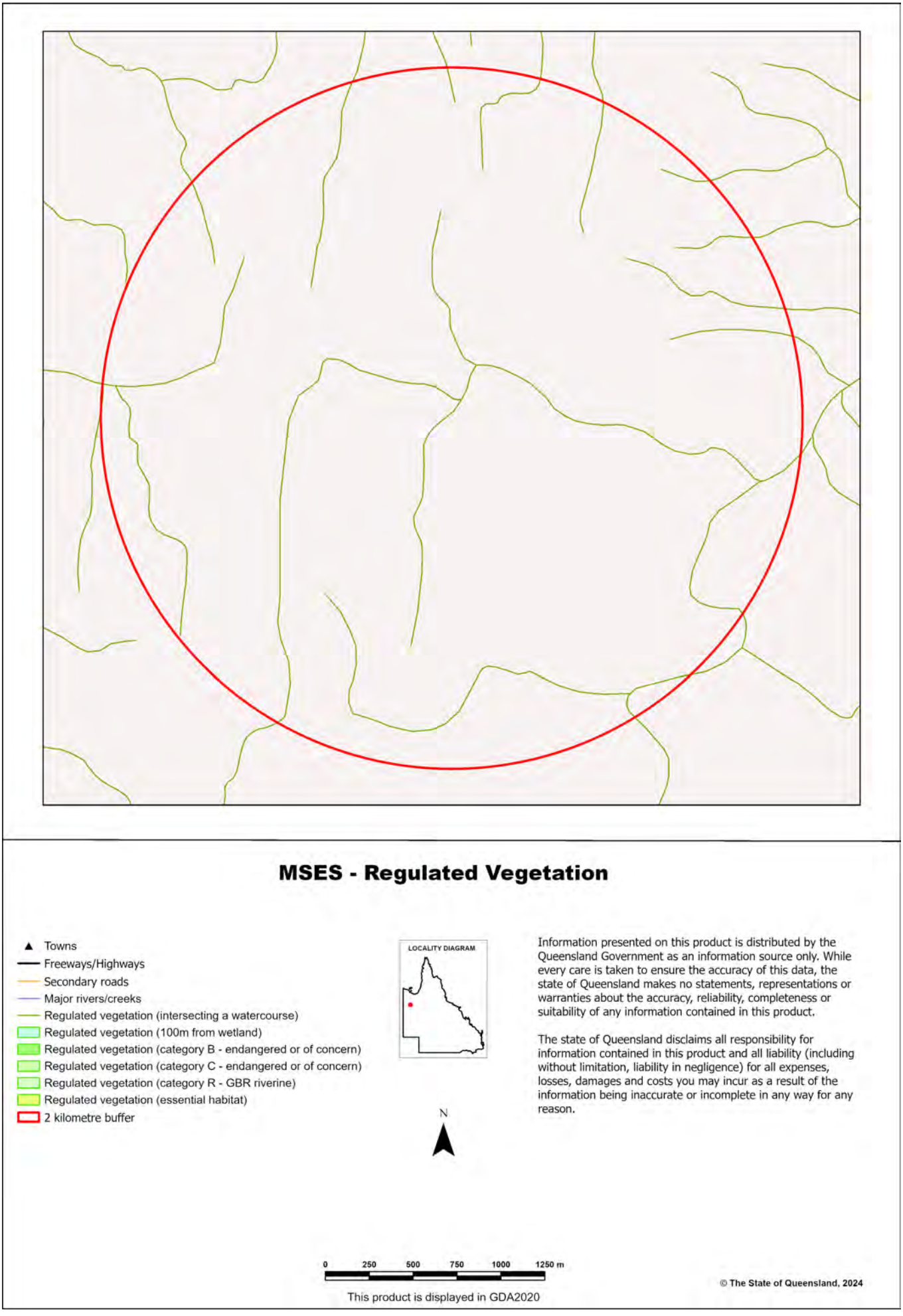
0 240 480 720 960 1,200 m

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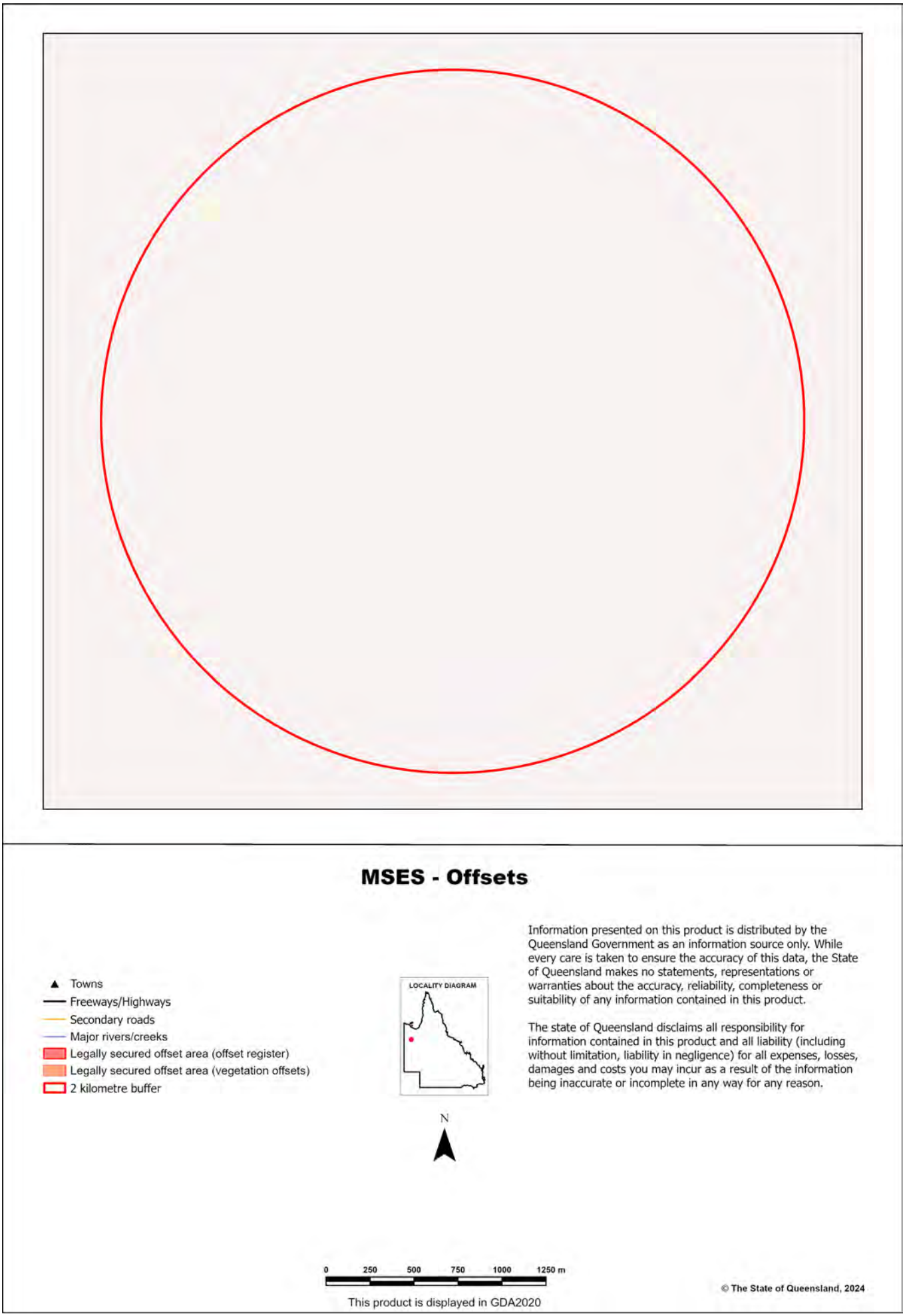
Map 3c - MSES - Species - Wildlife habitat (sea turtle nesting areas)



Map 4 - MSES - Regulated Vegetation



Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). Its primary purpose is to support implementation of the SPP biodiversity policy.

MSES mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

MSES mapping does not determine whether state or local development assessment is required. For state assessment triggers refer to the Development Assessment Mapping System (DAMS). For local assessment triggers, refer to the relevant local planning scheme.

The Queensland Government's "Method for mapping - matters of state environmental significance can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.information.qld.gov.au)**
Protected Areas-Estates, Nature Refuges, Special Wildlife Reserves	- Protected areas of Queensland - Nature Refuges - Queensland - Special Wildlife Reserves- Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Queensland Wetland Environmental Values
Wetlands in HEV waters	HEV waters: - EPP Water intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 5) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000)
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various) - SEQ koala habitat areas under the Koala Conservation Plan 2019
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map
VMA Essential Habitat	Vegetation management - essential habitat map
VMA Wetlands	Vegetation management wetlands map
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DES
Regulated Vegetation Map	Vegetation management - regulated vegetation management map

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DESI	- Department of Environment, Science and Innovation
EP Act	- Environmental Protection Act 1994
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- Nature Conservation Act 1992
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- Vegetation Management Act 1999

Queensland Government

Department of Environment, Science and Innovation

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest

Longitude: 139.391134 Latitude: -19.736482 with 2 kilometre radius

Greenstone

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and a field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@des.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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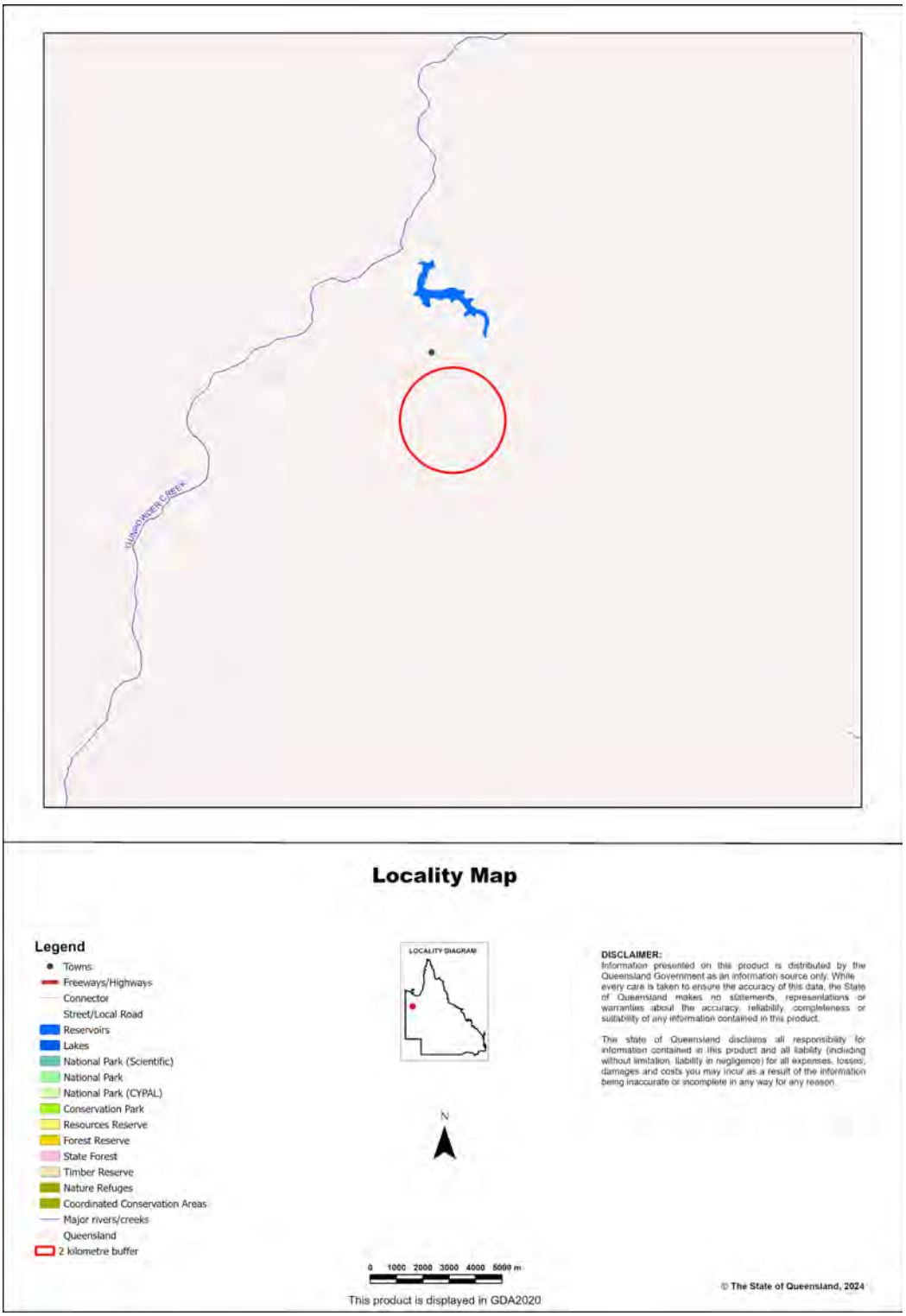
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Matters of State Environmental Significance (MSES)

MSES Categories

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  - Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;
  - Category R areas on the regulated vegetation management map;
  - Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;
  - Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Queensland Wetland Environmental Values under the Environment Protection Regulation 2019;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;
- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0 ha	0.0%
1b Protected Areas- nature refuges	0 ha	0.0%
1c Protected Areas- special wildlife reserves	0 ha	0.0%
2 State Marine Parks- highly protected zones	0 ha	0.0%
3 Fish habitat areas (A and B areas)	0 ha	0.0%
4 Strategic Environmental Areas (SEA)	0 ha	0.0%
5 High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values	0 ha	0.0%
6a High Ecological Value (HEV) wetlands	0 ha	0.0%
6b High Ecological Value (HEV) waterways	0 km	Not applicable
7a Threatened (endangered or vulnerable) wildlife	66.59 ha	5.3%
7b Special least concern animals	0 ha	0.0%
7c i Koala habitat area - core (SEQ)	0 ha	0.0%
7c ii Koala habitat area - locally refined (SEQ)	0 ha	0.0%
7d Sea turtle nesting areas	0 km	Not applicable
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0 ha	0.0%
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0 ha	0.0%
8c Regulated Vegetation - Category R (GBR riverine regrowth)	0 ha	0.0%
8d Regulated Vegetation - Essential habitat	0 ha	0.0%
8e Regulated Vegetation - intersecting a watercourse	26.9 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0 ha	0.0%
9a Legally secured offset areas- offset register areas	0 ha	0.0%
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0 ha	0.0%

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(No results)

1b. Protected Areas - nature refuges

(No results)

1c. Protected Areas - special wildlife reserves

(No results)

2. State Marine Parks - highly protected zones

(No results)

3. Fish habitat areas (A and B areas)

(No results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(No results)

5. High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values

(no results)

6a. Wetlands in High Ecological Value (HEV) waters

(no results)

6b. Waterways in High Ecological Value (HEV) waters

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7a. Threatened (endangered or vulnerable) wildlife

Values are present

7b. Special least concern animals

Not applicable

7c i. Koala habitat area - core (SEQ)

Not applicable

7c ii. Koala habitat area - locally refined (SEQ)

Not applicable

7d. Wildlife habitat (sea turtle nesting areas)

Not applicable

Threatened (endangered or vulnerable) wildlife habitat suitability models

Species	Common name	NCA status	Presence
Boronia keysii	Keys boronia	V	None
Calyptorhynchus lathami	Glossy black cockatoo	V	None
Casuarius casuarius johnsonii	Sthn population cassowary	E	None
Crinia tinnula	Wallum froglet	V	None
Denisonia maculata	Ornamental snake	V	None
Euastacus bindal	Mount Elliot crayfish	CR	None
Euastacus binzayedi		CR	None
Euastacus eungella		E	None
Euastacus hystricosus		E	None
Euastacus jagara	Jagara hairy crayfish	CR	None
Euastacus maidae		CR	None
Euastacus monteithorum		E	None
Euastacus robertsi		E	None
Taudactylus pleione	Kroombit tinkerfrog	E	None
Litoria freycineti	Wallum rocketfrog	V	None
Litoria olongburensis	Wallum sedgefrog	V	None
Macadamia integrifolia		V	None
Melaleuca irbyana	swamp tea-tree	E	None
Macadamia ternifolia		V	None
Macadamia tetraphylla	bopple nut	V	None
Petrogale penicillata	brush-tailed rock-wallaby	V	None
Petrogale coenensis	Cape York rock-wallaby	V	None
Petrogale purpureicollis	purple-necked rock-wallaby	V	None
Petrogale sharmani	Sharmans rock-wallaby	V	None
Petrogale xanthopus celeris	yellow-footed rock-wallaby (Qld subspecies)	V	None
Petaurus gracilis	Mahogany Glider	E	None
Petrogale persephone	Proserpine rock-wallaby	E	None
Phascolarctos cinereus	Koala - outside SEQ*	E	None
Pezoporus wallicus wallicus	Eastern ground parrot	V	None
Xeromys myoides	Water Mouse	V	None

*For koala model, this includes areas outside SEQ. Check 7c SEQ koala habitat for presence/absence.

Threatened (endangered or vulnerable) wildlife species records

Scientific name	Common name	NCA status	EPBC status	Migratory status
Amytornis dorotheae	Carpentarian grasswren	E	E	None

Special least concern animal species records

(No results)

Shorebird habitat (critically endangered/endangered/vulnerable)

Not applicable

Shorebird habitat (special least concern)

Not applicable

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

Migratory status (M) - China and Australia Migratory Bird Agreement (C), Japan and Australia Migratory Bird Agreement (J), Republic of Korea and Australia Migratory Bird Agreement (R), Bonn Migratory Convention (B), Eastern Flyway (E)

To request a species list for an area, or search for a species profile, access Wildlife Online at:

https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals** and **Map 3b - MSES - Species - Koala habitat area (SEQ)** and **Map 3c - MSES - Wildlife habitat (sea turtle nesting areas)** for an overview of the relevant MSES.

MSES - Regulated Vegetation

For further information relating to regional ecosystems in general, go to:

https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:

https://environment.ehp.qld.gov.au/regional-ecosystems/

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Not applicable

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

A vegetation management watercourse is mapped as present

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

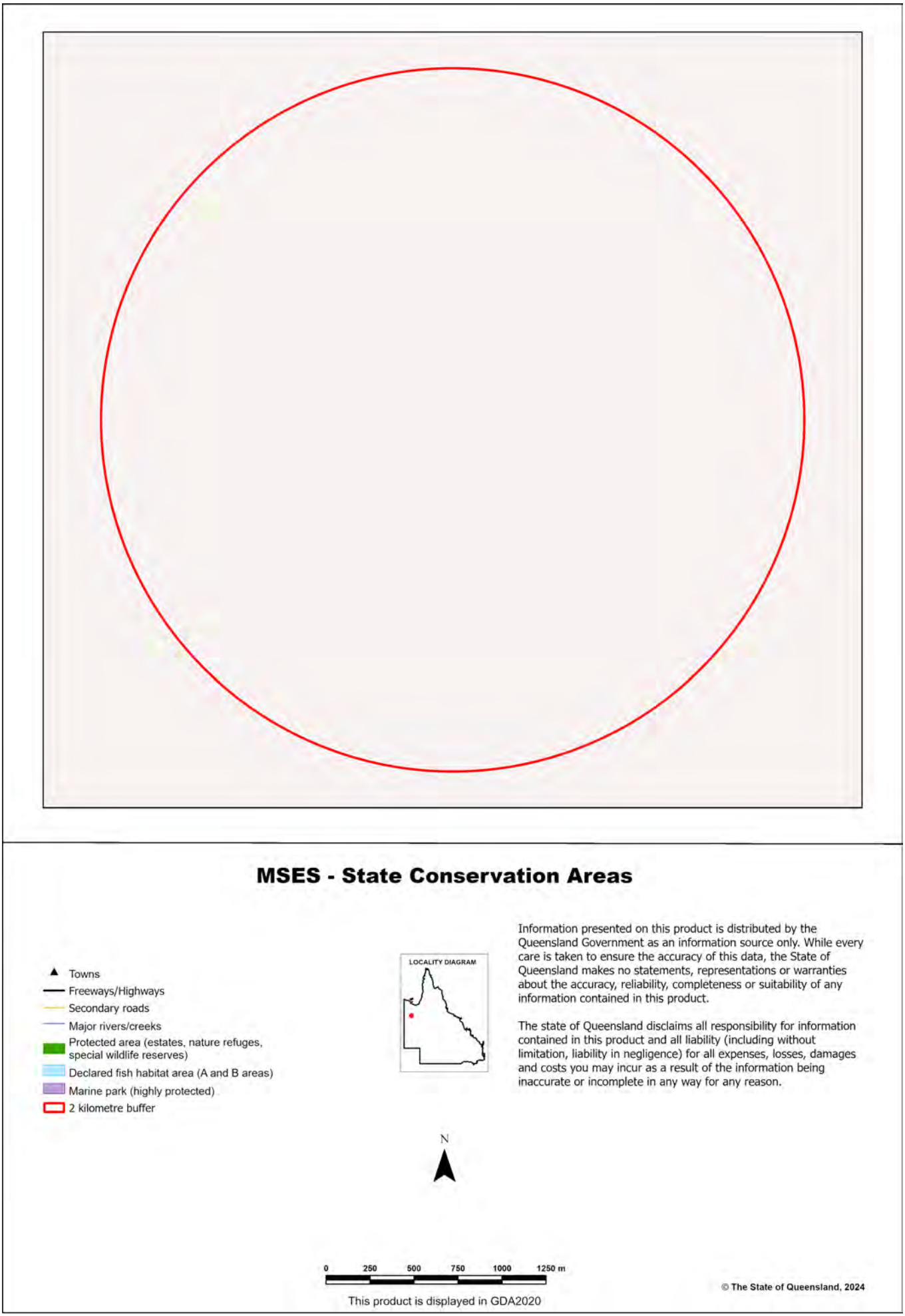
(No results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

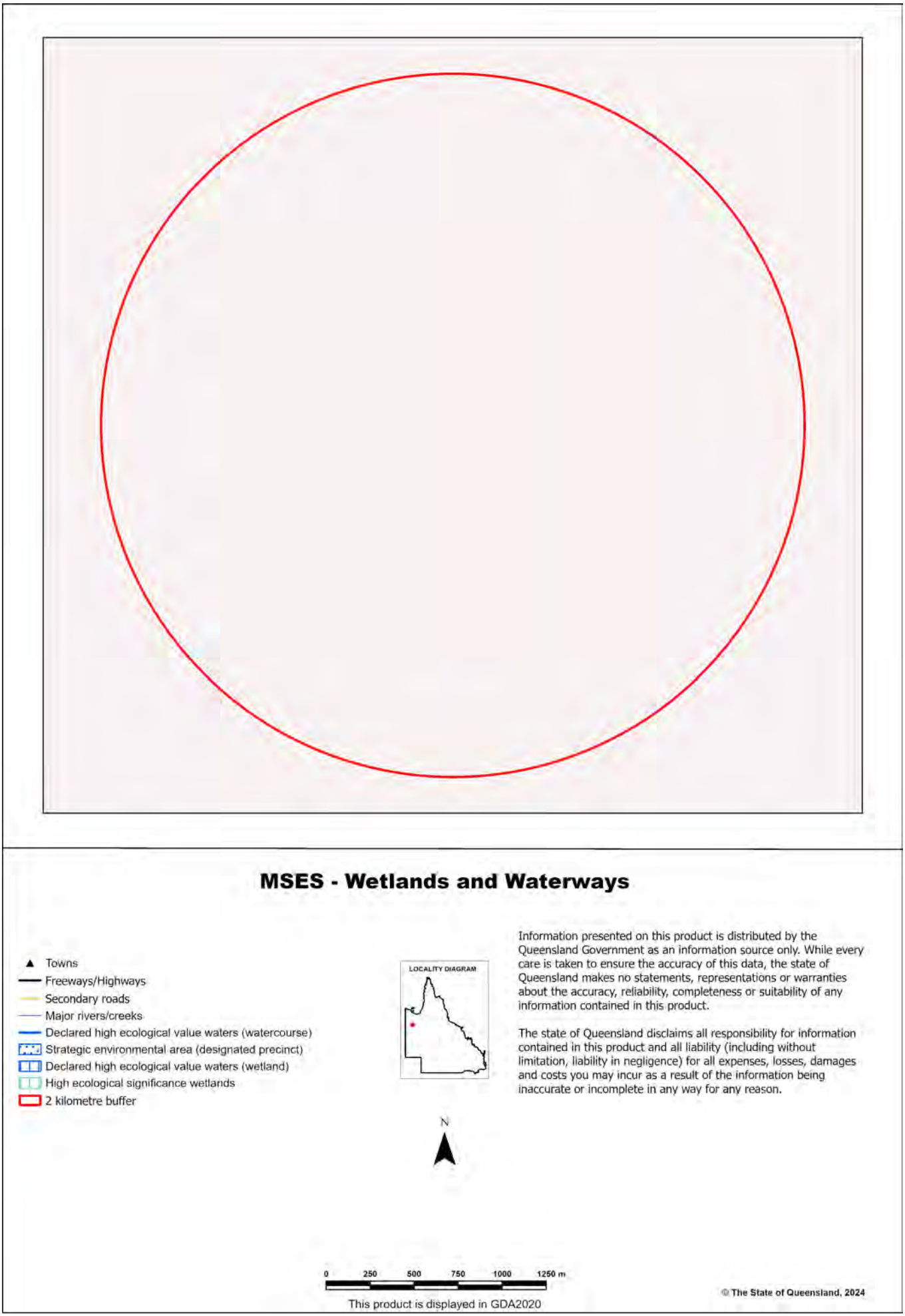
(No results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

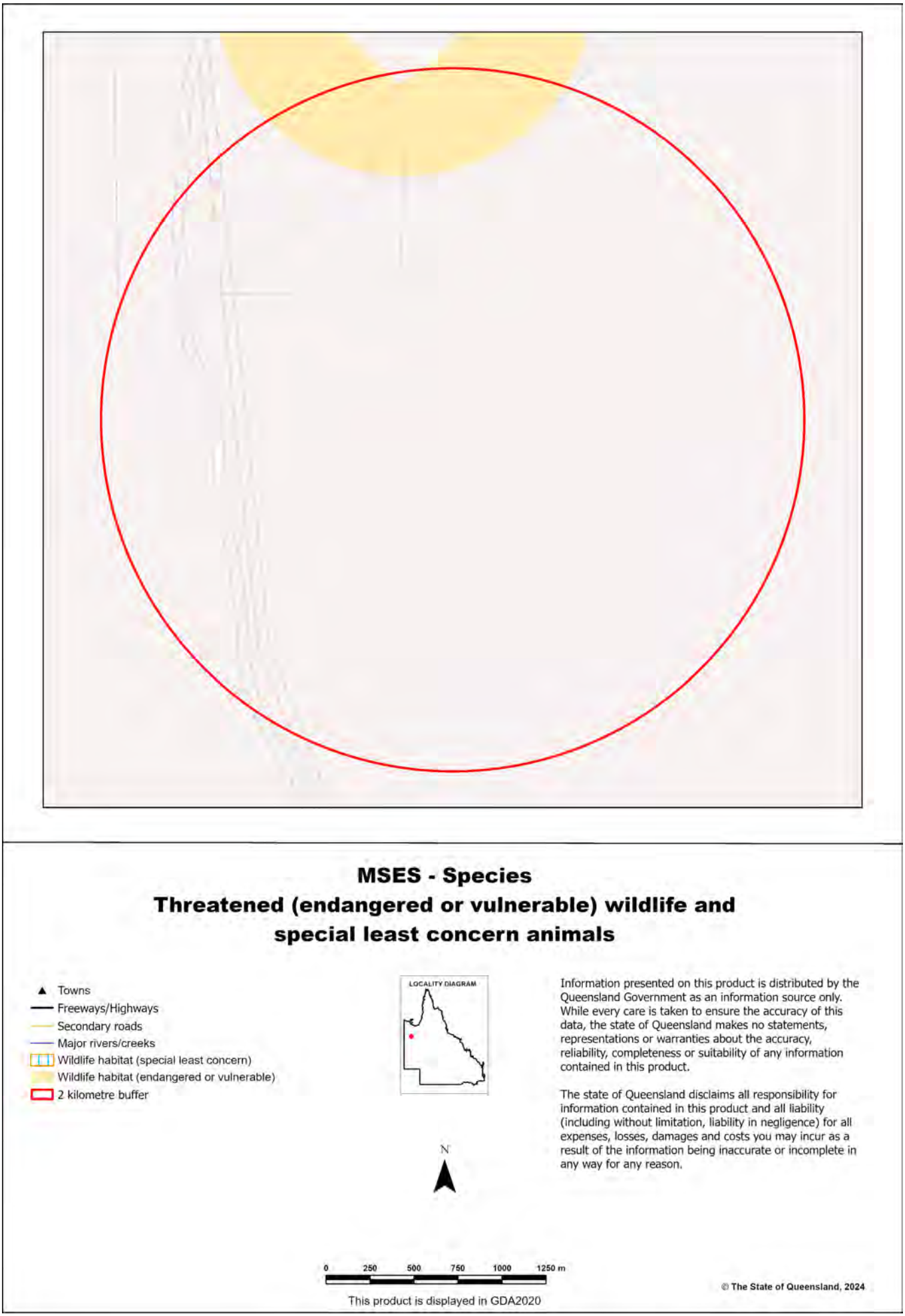
Map 1 - MSES - State Conservation Areas



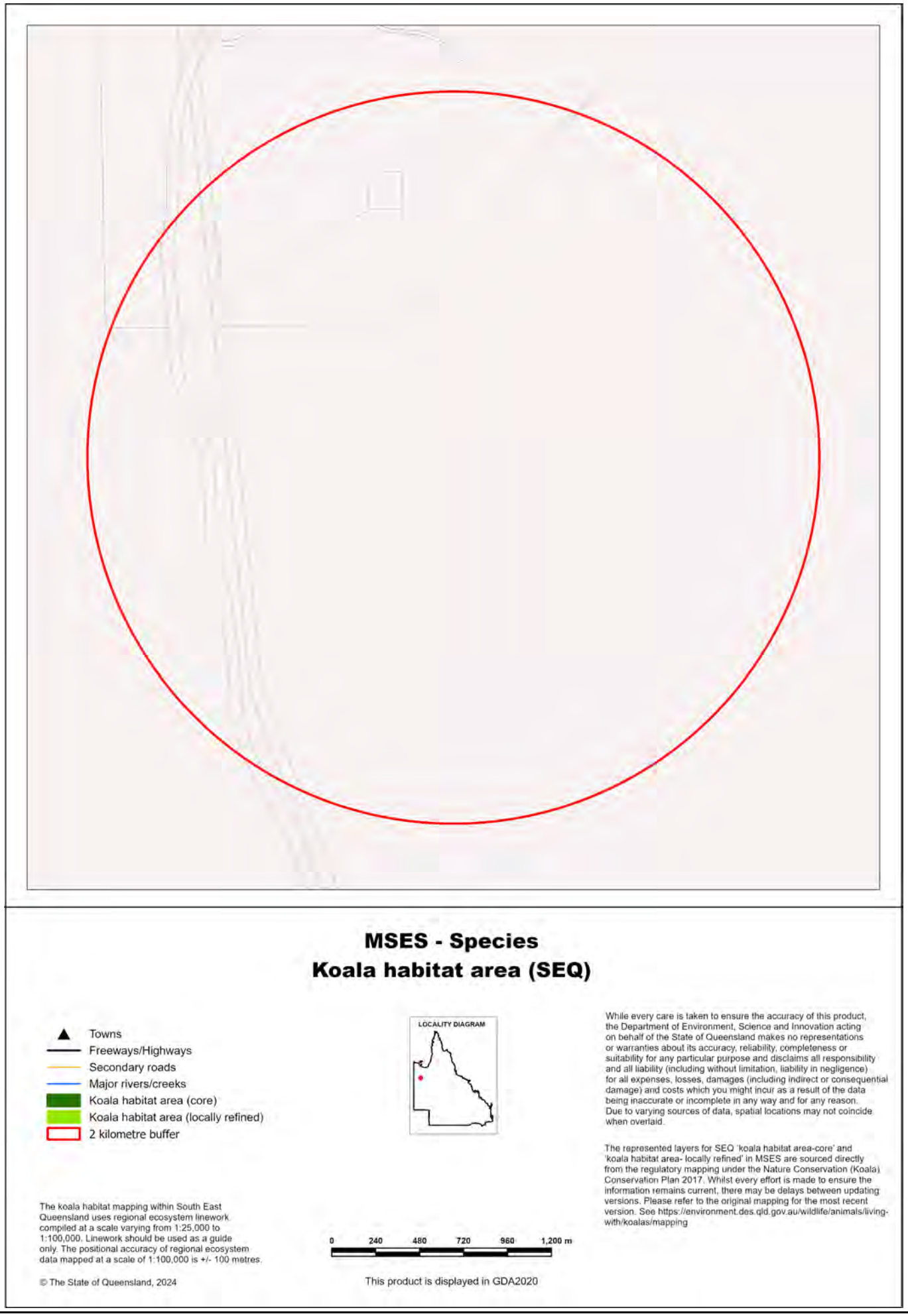
Map 2 - MSES - Wetlands and Waterways



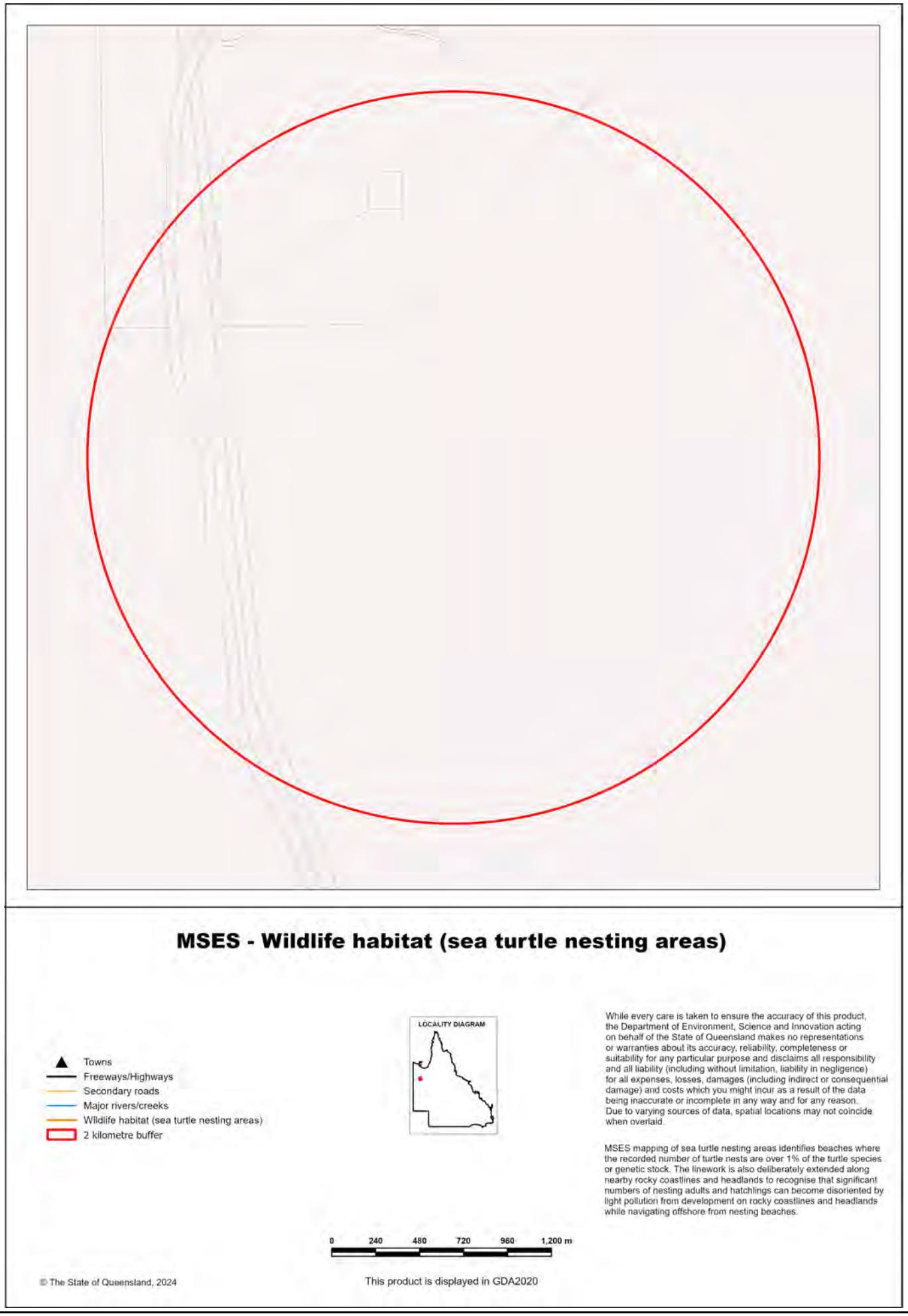
Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals



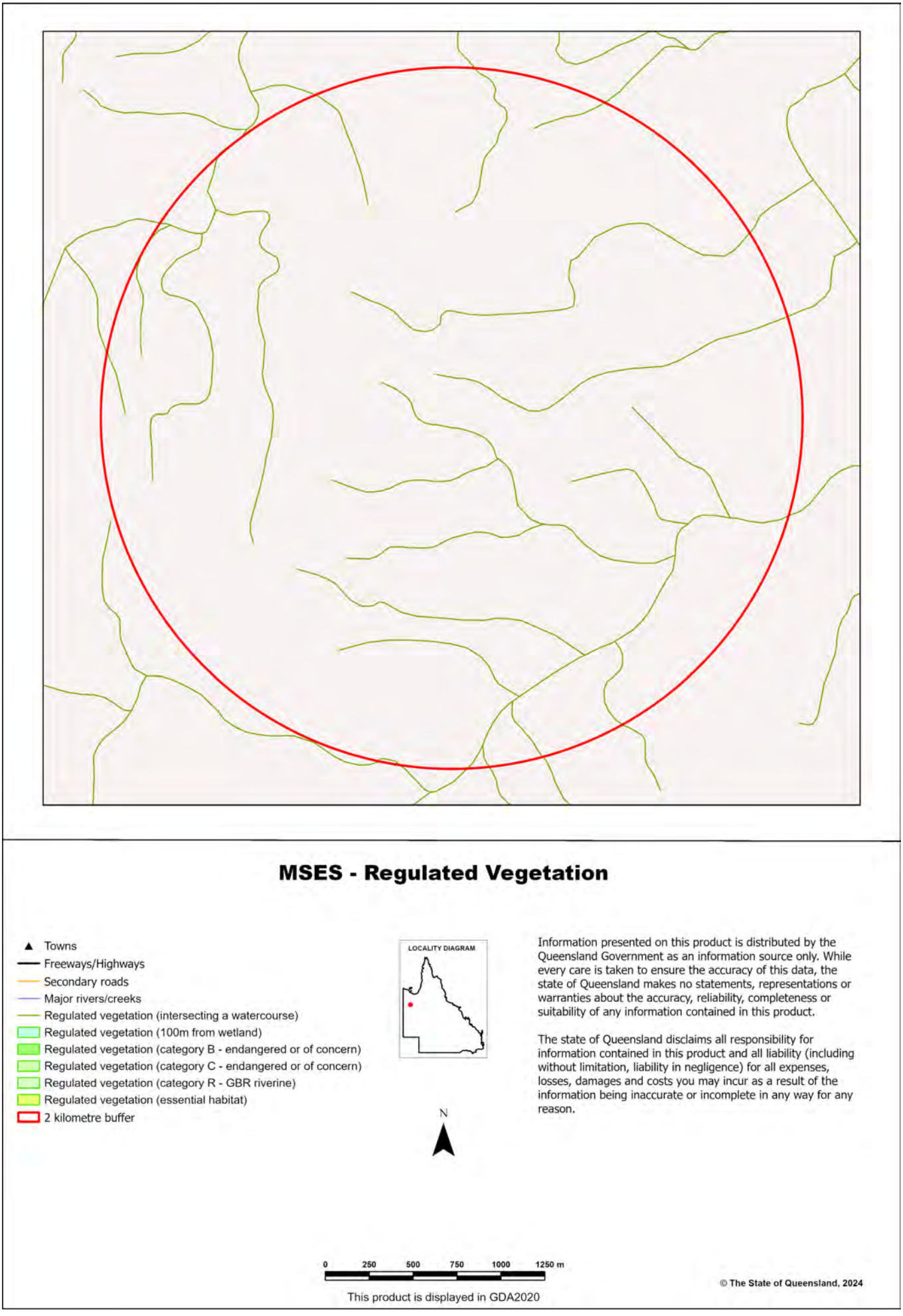
Map 3b - MSES - Species - Koala habitat area (SEQ)



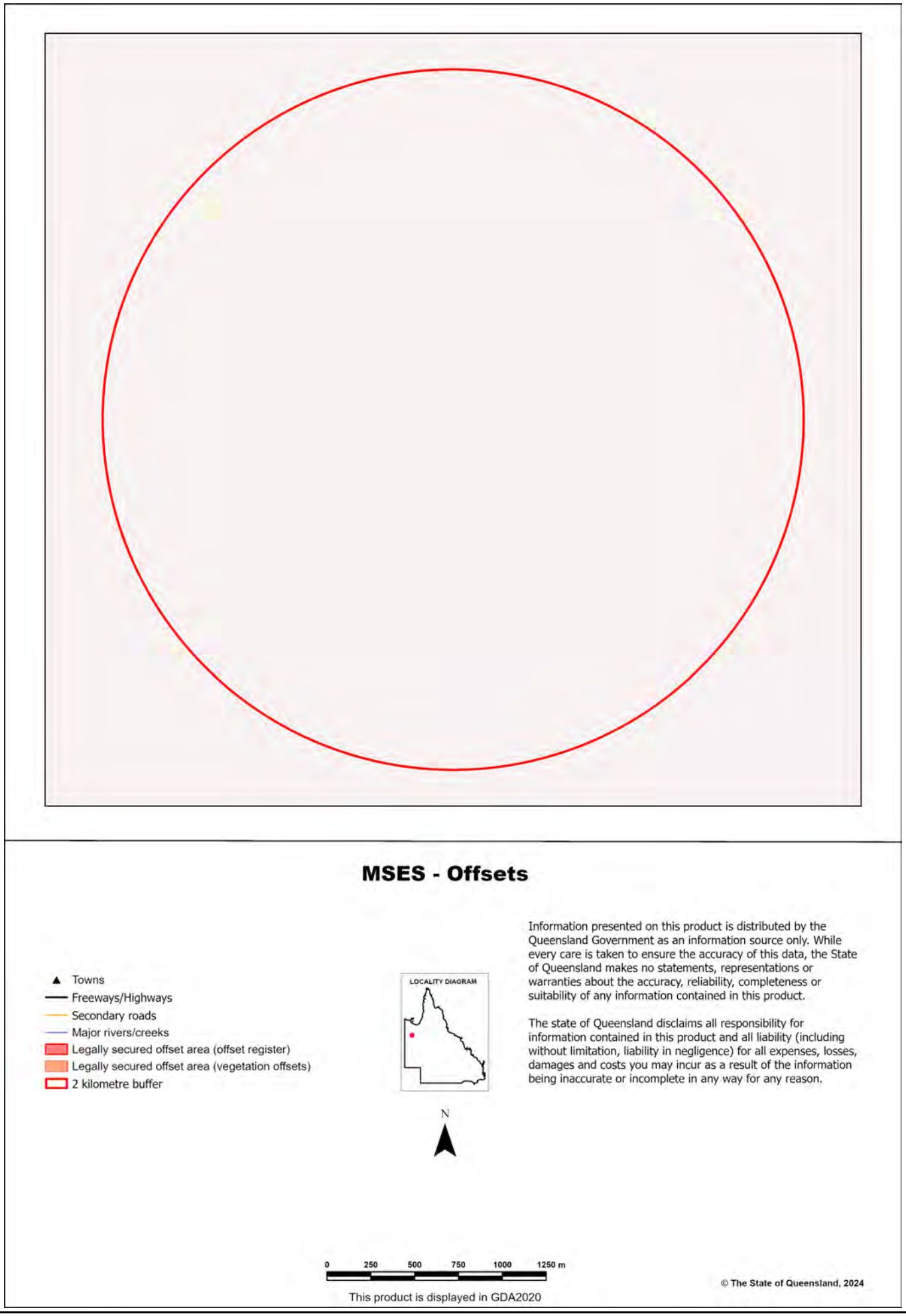
Map 3c - MSES - Species - Wildlife habitat (sea turtle nesting areas)



Map 4 - MSES - Regulated Vegetation



Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). Its primary purpose is to support implementation of the SPP biodiversity policy.

MSES mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

MSES mapping does not determine whether state or local development assessment is required. For state assessment triggers refer to the Development Assessment Mapping System (DAMS). For local assessment triggers, refer to the relevant local planning scheme.

The Queensland Government's "Method for mapping - matters of state environmental significance can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.information.qld.gov.au)**
Protected Areas-Estates, Nature Refuges, Special Wildlife Reserves	- Protected areas of Queensland - Nature Refuges - Queensland - Special Wildlife Reserves- Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Queensland Wetland Environmental Values
Wetlands in HEV waters	HEV waters: - EPP Water intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 5) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000)
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various) - SEQ koala habitat areas under the Koala Conservation Plan 2019
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map
VMA Essential Habitat	Vegetation management - essential habitat map
VMA Wetlands	Vegetation management wetlands map
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DES
Regulated Vegetation Map	Vegetation management - regulated vegetation management map

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DESI	- Department of Environment, Science and Innovation
EP Act	- Environmental Protection Act 1994
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- Nature Conservation Act 1992
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- Vegetation Management Act 1999

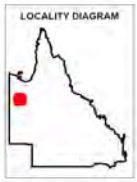
Appendix C: Protected Plants Flora Survey Trigger Map (Lot 5 on CP865892)



Protected Plants Flora Survey Trigger Map

High risk area
Other land parcel boundaries
Freeways / motorways / highways
Secondary roads / streets
Selected Lot and Plan

LOCALITY DIAGRAM



N

0 3,000 6,000 9,000 12,000 15,000 m

This product is displayed in: GDA2020

This map shows areas where particular provisions of the Nature Conservation Act 1992 apply to the clearing of protected plants.

Land parcel boundaries are provided as locational aid only.

This map is produced at a scale relevant to the size of the area selected and should be printed as A4 size in portrait orientation.

For further information or assistance with interpretation of this product, please contact the Department of Environment, Science and Innovation at palm@des.qld.gov.au

Disclaimer: While every care is taken to ensure the accuracy of the data used to generate this product, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaim all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damages) and costs which might be incurred as a consequence of reliance on the data, or as a result of the data being inaccurate or incomplete in any way and for any reason.

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Queensland Government

Protected plants flora survey trigger map

The protected plants flora survey trigger map identifies 'high risk areas' where endangered, vulnerable or near threatened plants are known to exist or are likely to exist. Under the *Nature Conservation Act 1992* (the Act) it is an offence to clear protected plants that are 'in the wild' unless you are authorised or the clearing is exempt, for more information see section 89 of the Act.

Please see the Department of Environment and Science webpage on the clearing of protected plants for information on what exemptions may apply in your circumstances, whether you may need to undertake a flora survey, and whether you may need a protected plants clearing permit.

Updates to the data informing the flora survey trigger map
The flora survey trigger map will be reviewed, and updated if necessary, at least every 12 months to ensure the map reflects the most up-to-date and accurate data available.

Species information
Please note that flora survey trigger maps do not identify species associated with 'high risk areas'. While some species information may be publicly available, for example via the Queensland Spatial Catalogue, the Department of Environment and Science does not provide species information on request. Regardless of whether species information is available for a particular high risk area, clearing plants in a high risk area may require a flora survey and/or clearing permit. Please see the Department of Environment and Science webpage on the clearing of protected plants for more information.

A.4 TSF3 Flora and Fauna Assessment, KG Environmental

2025

TSF3 Flora and Fauna Assessment

29 METALS

CAPRICORN COPPER MINE

Document Control				
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Appendix B: Fauna Species List (Wet Season Survey)

EXECUTIVE SUMMARY

29 Metals is currently undertaking studies to assess the location of a new Tailings Storage Facility 3 (TSF3) at Capricorn Copper Mine (CCM). An ecological assessment of the site was commissioned, comprising a dry season fauna, protected flora and regional ecosystem survey and a wet season fauna survey.

Three Regional Ecosystems were recorded and mapped within the TSF3 footprint: Small-fruited Ghost Gum hills, Snappy Gum hills and Northern Swamp Box gully. The vegetation is not listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and has a Least Concern status under the *Vegetation Management Act 1999*. The Northern Swamp Box gully has an Endangered Biodiversity status for the purpose of the *Environmental Protection Act 1994*.

No threatened plants were recorded within the TSF3 footprint. One flora species listed as Near Threatened under the *Nature Conservation Act 1992* (NC Act), *Ipomoea antonschmidii*, occurs within the TSF3 footprint. A Permit to Clear will need to be obtained prior to disturbing within 100 m of the plant.

Three threatened fauna species are known to occur in the TSF3 footprint: Purple-necked Rock-wallaby, Orange Leaf-nosed Bat and Grey Falcon. Both the rock-wallaby and bat species are listed as Vulnerable under the NC Act and are not listed under the EPBC Act. Grey Falcon is listed as Vulnerable under both acts. It is recommended that a Species Management Plan be prepared to manage potential impacts to the rock-wallaby species.

Five threatened fauna species may occur within the TSF3 footprint, although they were not recorded during the dry or wet season surveys. Five of the eight threatened species are listed under the EPBC Act and a self-assessment against the Significant Impact Guidelines is provided in this report. The significant impact criteria were triggered for two species: Endangered Carpentarian Grasswren and Critically Endangered Northern Blue-tongue Skink. Disturbance within the TSF3 footprint will adversely affect habitat that fits the definition of "critical habitat" for both species. Whilst a significant impact is not expected, it is recommended that EPBC Pre-referral advice is sought from DCCEEW due to scientific uncertainty pertaining to Northern Blue-tongue Skink.

It is also recommended that CCM continues to manage weeds, particularly Buffel Grass and Calotrope, and implement a fire management regime to reduce the risk of high intensity dry season fires.

1. INTRODUCTION

1.1 Project background

29 Metals has investigated options for future tailings storage at Capricorn Copper Mine (CCM) and is currently undertaking studies to assess the location of a new Tailings Storage Facility 3 (TSF3).

The proposed location of TSF3 is presented in **Figure 1**.

1.2 Dry Season Flora and Fauna Survey 2023

A baseline flora and fauna study was undertaken by Biosphere Environmental Consultants and Paul Williams in the dry season of 2023. The baseline study considered a large area of approximately 274 ha. The resulting report recommended a wet season fauna survey (to account for seasonal differences in distribution, habitat use, occurrence, etc.) and a targeted survey for Ghost Bat (*Macroderma gigas*) (if disturbance will affect escarpments, containing or potentially containing caves).

The TSF3 proposed disturbance footprint (approximately 47 ha) has been further defined since the dry season survey. This report presents the methods and results of the January 2024 wet season survey, as well as the findings of the 2023 dry season study relevant to the new footprint.

2. SURVEY METHODS

2.1 Desktop assessment

The dry season study included a desktop assessment to identify threatened, near-threatened and migratory fauna, or their habitats, and threatened and near-threatened plants, or their habitats, that have been recorded or are likely to occur in the vicinity of the larger project area. A list of resources is provided in BEC (2023).

2.2 Field surveys

The dry season vegetation survey was undertaken in June 2023. Satellite imagery, geology, topographic and the Queensland Herbarium's 1: 100,000 Regional Ecosystem (RE) map were examined to understand the likely range and distribution of vegetation and landforms across the larger site. REs were ground-truthed during the field survey following the standard methods the Queensland Herbarium recommends for RE mapping (Neldner et al. 2022). Further details are provided in Williams (2023a).

The dry season flora survey was undertaken in June 2023. The survey methods followed the timed meander approach outlined in 6.2.2 of the *Flora Survey Guidelines – Protected Plants* (QG 2020), as described and interpreted in Williams & Clouten (2021). Further details are provided in Williams (2023b).

The wet and/or dry season fauna surveys were conducted using size A Elliott traps (box traps), funnel traps, camera traps, ultrasonic microbat call detectors, diurnal bird surveys, call playback, diurnal active searches and nocturnal active searches (spotlighting). A summary of survey effort for the wet season fauna survey is provided below. Further details of the June 2023 dry season fauna survey methods are provided in BEC (2023).

The wet season fauna survey was undertaken over one day in November 2023 (reconnaissance) and five days in January 2024. Remote recording equipment was deployed in the field for a longer period of time, up to nine consecutive nights.

Wet season trap sites were located to represent the REs mapped by Paul Williams within the proposed disturbance footprint and target habitat features, such as escarpment and caves. Four general trap sites were set, composed of:

- Funnel traps – six per site
- Camera traps – one per site
- Anabat acoustic bat detectors – one per site.

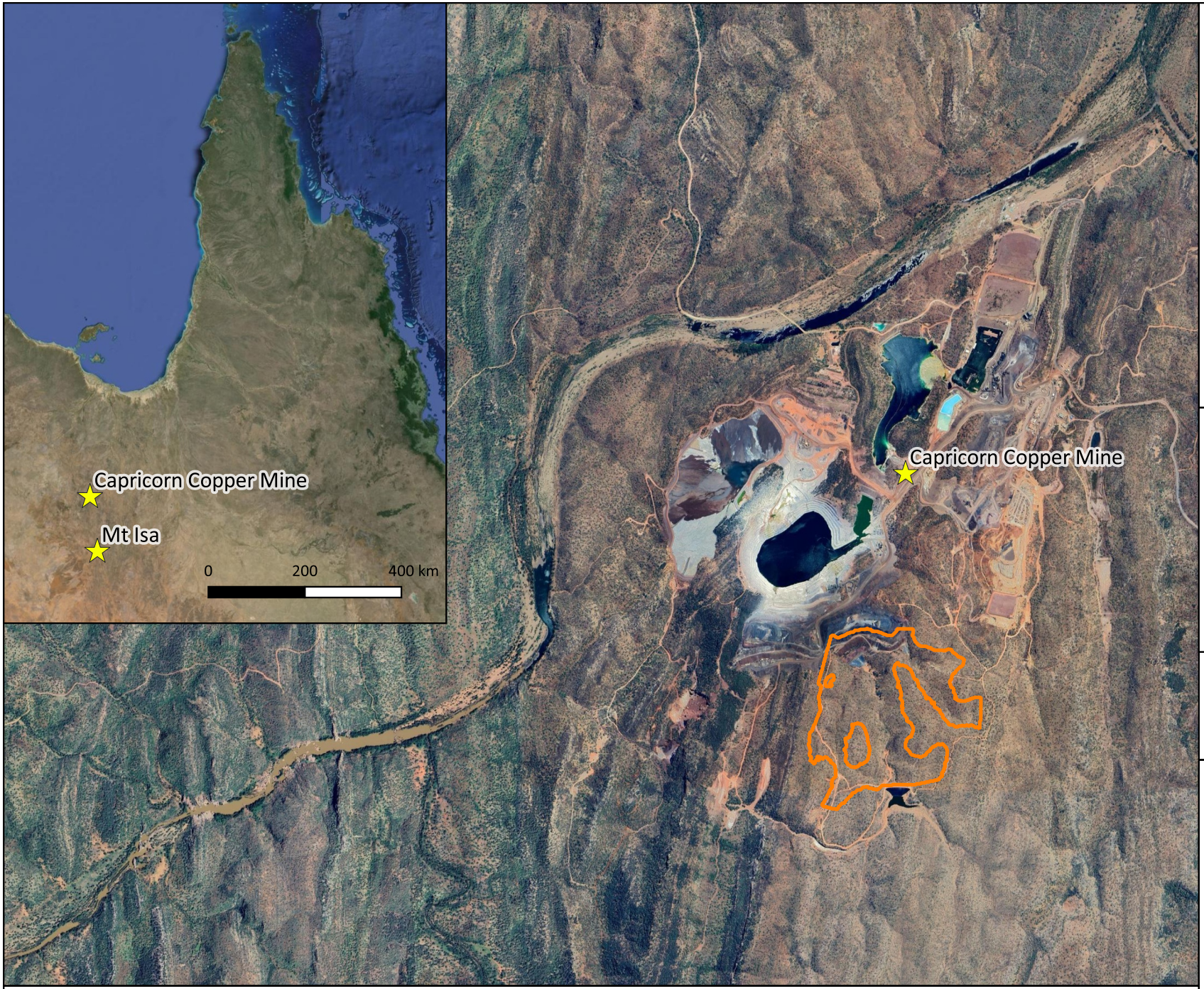
Elliott traps were not deployed during the wet season survey. Temperatures were forecast to exceed 40 degrees[1] Celsius every day of the field survey and could have posed serious health risks to captured fauna. The ecology team intended to monitor field temperatures on day 1 of the survey and decide whether Elliott box traps could be opened, however the box containing Elliott traps was delayed in transit and subsequently the traps were unavailable for the survey.

Targeted surveys for Ghost Bat were conducted at suitable roosting habitat in the northern part of the TSF3 disturbance footprint. A site reconnaissance survey was undertaken prior to the trapping survey to identify suitable survey locations, potential maternity roosts and safety and access issues associated with targeted surveys. The reconnaissance survey identified a single cave accessible by foot and two inaccessible rock walls with the potential to contain caves suitable for bat roosts. The wet season survey was undertaken during the breeding season and as such, survey methods such as harp trapping and mist netting that can cause distress and the dislodgement of young were excluded. A roost search was undertaken at the accessible cave, and acoustic detectors deployed at the accessible cave, along the gully and rock walls.

Targeted surveys for Purple-necked Rock-wallaby (*Petrogale purpureicollis*) were conducted across the TSF3 footprint as described in the *Targeted Species Survey Guidelines* for Purple-necked Rock-wallaby (Rowland 2012). Survey techniques included camera trapping, dawn and dusk observation surveys, and searches for signs such as scats, tracks and smooth worn rock ledges.

The wet season fauna survey also employed diurnal bird surveys, diurnal active searches and spotlighting. These techniques were employed at general trap sites and opportunistically across the disturbance footprint. Call playback was used at 30 sites across the TSF3 footprint to target Carpentarian Grasswren (*Amytornis dorotheae*). Dedicated searches for Gouldian Finch (*Erythrura gouldiae*) nesting trees were undertaken in suitable habitat. Northern Blue-tongue Skink (*Tiliqua scincoides intermedia*) was targeted during diurnal active searches and spotlighting.

[1] Site temperatures of up to 46 degrees Celsius were recorded on survey equipment during the wet season survey.



29 Metals Capricorn Copper Mine TSF3 Flora and Fauna Assessment

LEGEND

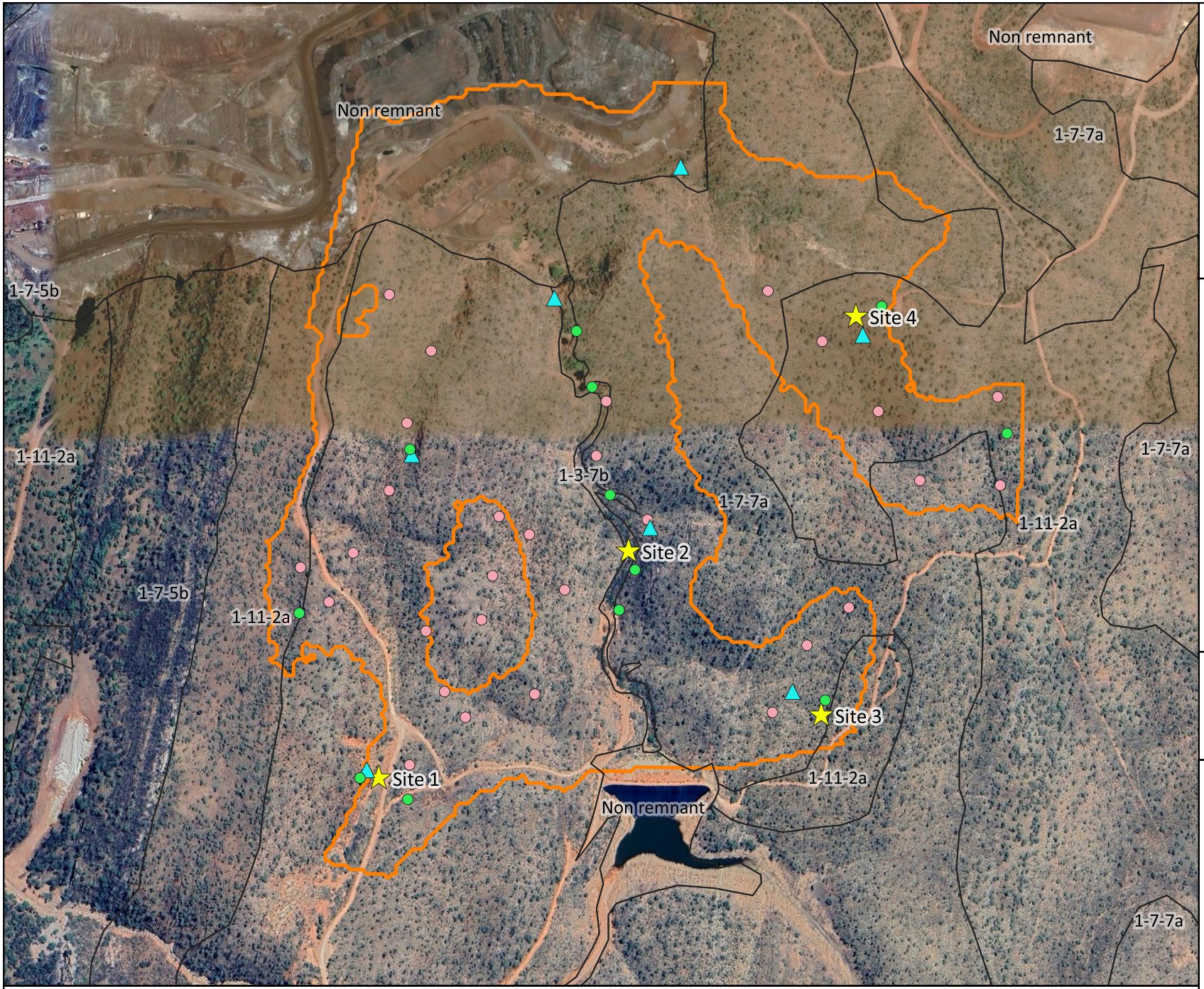
- TSF3 Disturbance Footprint
- Locality Names

0 0.5 1 km

KG ENVIRONMENTAL

KG Environmental
Creation Date: 28/02/2024

Figure 1. TSF3 Project Site



29 Metals Capricorn Copper Mine TSF3 Flora and Fauna Assessment

LEGEND

- TSF3 Disturbance Footprint
- General Trap Sites
- Anabat Survey Sites
- Carpentarian Grasswren Survey Sites
- Camera Trap Sites
- Regional Ecosystems (Paul Williams 2023)

0 100 200 300 m

KG ENVIRONMENTAL

KG Environmental
Creation Date: 22/02/2024

Figure 2. TSF3 Wet Season Fauna Survey Sites

3. RESULTS

3.1 Regional Ecosystems

The vegetation at CCM is consistent with the surrounding landscape in being dominated by common eucalypts of the district. It provides a good example of heathy north-west Queensland landscapes (Willams 2023a).

Other than the riparian vegetation along Gunpowder Creek and scattered *Calotropis procera* (Calotrope) along some tracks, the REs across the site on the southern side of CCM are basically weed free. This is a very significant feature for a landscape with a history of disturbance nearby (Williams 2023a).

Nine REs were documented and mapped across the larger dry season survey area. Of these, three occur within the TSF3 disturbance footprint (**Table 1**, **Figure 2**). The two predominant REs of the TSF3 footprint, both eucalypt woodlands, were also recorded as being the most widespread REs in the larger area.

Table 1. Regional Ecosystems present within the TSF3 footprint

Regional Ecosystem	Description	Area of Disturbance Footprint
1.3.7b	Northern Swamp Box gully	1 ha
1.7.7a	Small-fruited Ghost Gum hills	33 ha
1.11.2a	Snappy Gum hills	6 ha
NA	Non-remnant/cleared	7 ha
Total		47 ha

The three REs have a Least Concern *Vegetation Management Act 1999* (VM Act) status. Two have a No concern at present Biodiversity status (which incorporates weed density and other health measures). However, the riparian forest RE 1.3.7b has an Endangered Biodiversity status due to the extent of weeds and other degradation across the region.

Biodiversity status is used for a range of planning and management applications including Biodiversity Planning Assessments and to determine environmentally sensitive areas that are used for regulation of the mining industry through provisions in the *Environmental Protection Act 1994*.

Each RE is described below by Paul Williams (Williams 2023a) on the basis of Quaternary and transect data collected on site.

3.1.1 Regional Ecosystem 1.3.7b (Northern Swamp Box gully)

VM Act (Queensland) Status	Least Concern
Biodiversity Status	Endangered

Distribution within TSF3 footprint: along the drainage line from Upper Esperenza Diversion Dam (UEDD) to the plunge pool.



Plate 1. Northern Swamp box gully

Canopy height and crown cover: a relatively small canopy, averaging 5 m tall, though occasionally 10 m, with around 15 to 20% crown cover.

Tree layer: *Lophostemon grandiflorus* (Northern Swamp Box) dominates this seasonally dry water course (though a few rock waterholes are present near the mine).

Shrub layer: a diversity of shrubs are present, including *Acacia hammondii, Acacia holosericea, Calytrix brownii, Grevillea wickhamii* and *Terminalia canescens*.

Ground layer: the ground layer is bare rock in places, with sedges and the tall herb *Ludwigia octovalvis* common in places.

Weeds: *Calotropis procera* (Calotrope) is present in places.

3.1.2 Regional Ecosystem 1.7.7a (Small-fruited Ghost Gum hills)

VM Act (Queensland) Status	Least Concern

Biodiversity Status	No concern at present

Distribution within TSF3 footprint: the predominant RE of the TSF3 footprint, RE 1.7.7a makes up most of the vegetated areas of the site.



Plate 2. Small-fruited Ghost Gum hills

Canopy height and crown cover: Trees are typically 3 to 7 m tall, with a sparse crown cover of 7 to 15%.

Tree layer: *Corymbia capricornia* (Small-fruited Ghost Gum) dominates and is typically the only tree. However, *Eucalyptus leucophloia* (Snappy Gum) is sometimes present, especially near the boundary with RE 1.11.2a.

Shrub layer: a range of wattles, e.g. *Acacia hammondii, Acacia retivenea and Petalosigma quadriloculare* (Quinine) are common shrubs. The tall and whippy *Triumfetta micrantha* and *Triumfetta plumigera* are common in places.

Ground layer: *Triodia pungens* (Soft Spinifex) dominates the ground layer, with scattered herbs such as *Bulbostylis barbata*. A patch of the near threatened vine *Ipomoea antonschmidii* was found during the dry season survey along a track edge surrounded by this RE in the southwest of the TSF3 footprint (see associated protected plant survey report).

Weeds: only *Calotropis procera* (Calotrope) is present in a few spots along track edges.

3.1.3 Regional Ecosystem 1.11.2a (Snappy Gum hills)

VM Act (Queensland) Status	Least Concern
Biodiversity Status	No concern at present

Distribution within TSF3 footprint: mapped by Paul Williams (2023a) along the western boundary of the footprint, and patchily distributed on the eastern side of the footprint.



Plate 3. Snappy Gum hills

Canopy height and crown cover: a low canopy of 3 to 5 m has a crown cover of 10 to 35%.

Tree layer: *Eucalyptus leucophloia* (Snappy Gum) is the primary tree in this woodland, although *Corymbia capricornia* (Small-fruited Ghost Gum) also occurs in places.

Shrub layer: a diverse range of shrubs are present, including wattles, *Acacia acradenia, Acacia hammondii, Acacia retivenea, Grevillea dryandra, Grevillea wickhamii, Jacksonia lateritica* and *Petalosigma quadriloculare* (Quinine).

Ground layer: *Triodia pungens* (Soft Spinifex) dominates the ground layer, with a few annual grasses, *Schizachyrium fragile* and *Eriachne ciliata*.

Weeds: No weeds other than a few scattered *Calotropis procera* (Calotrope) along track edges.

3.2 Habitat

The habitat features of the TSF3 disturbance footprint consist of low open eucalypt woodland hills, rocky walls and an ephemeral creek. Overall, the site has limited habitat for fauna. The Soft Spinifex groundcover is formed in small clumps, offering lower refuge value than surrounding habitats. The riparian vegetation is very limited, only forming dense patches around waterholes at the very northern and southern ends of the gully. The ephemeral creek is short (approximately 440 m) and not connected to a larger watercourse. Rocky areas do not contain any observable significant caves, large overhangs or large boulders or fissures.

Surrounding habitats were briefly assessed, as the formal survey allowed, to gain an understanding of adjacent habitats and their function as source habitats for threatened and other fauna to move into the site, even if only sporadically, seasonally or in response to temporary food resources.

3.3 Threatened flora

No threatened flora species was recorded within the TSF3 disturbance footprint or greater survey area during the dry season flora survey (Williams 2023b).

One flora species listed as Near Threatened under the *Nature Conservation Act 1992* (NC Act) has been recorded onsite, including within the TSF3 footprint. *Ipomoea antonschmidii* was observed in two locations during the dry season survey. A total of two dozen *Ipomoea antonschmidii* plants were counted, with 14 plants spanning about 100 m in a northwestern location (within the TSF3 footprint) and 10 plants growing along about 30 m of track edge in a more eastern location in the larger survey area. This silver-hairy trailing vine was only observed growing on the edge of graded dirt tracks during the dry season (Williams 2023b).

The plant was observed in much higher numbers during the wet season survey, at the previously recorded location and along the central gully of the TSF3 footprint (**Figure 3**).

3.4 Threatened fauna

For this report, threatened fauna are those species listed as Critically Endangered, Endangered, Vulnerable or Near Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the NC Act.

The wet season survey recorded 67 species of terrestrial vertebrate in the site, comprised of 17 mammal (including 12 bat species), 31 bird, 12 reptile and seven frog species. One threatened fauna species was recorded, Purple-necked Rock-wallaby, which is listed as Vulnerable under the NC Act. Carpentarian Grasswren, Endangered under the EPBC Act and the NC Act, was recorded incidentally approximately 2.8 km north of the site (**Figure 4**).

The dry season survey recorded 67 species of terrestrial vertebrate in the larger survey area, comprised of 15 mammal (including 10 bat species), 44 bird, five reptile and three frog species. Two threatened fauna species were recorded, Purple-necked Rock-wallaby and Orange Leaf-nosed Bat (*Rhinonicteris aurantia*), which is also listed as Vulnerable under the NC Act. Both species were recorded within the TSF3 disturbance footprint (**Figure 3**).

Threatened fauna species that have the potential to occur within the TSF3 disturbance area based on the desktop review in BEC (2023) are listed in **Table 2**. The dry season survey assessed an area larger than the TSF3 footprint, with a greater range of habitats. The likelihood of occurrence of each species has been reassessed to consider habitats of the TSF3 footprint only, and results of the wet season fauna survey. The likelihood of occurrence categories assigned in this assessment are:

- **Known to occur**: recorded on site by direct observation, call, photograph and/or signs such as distinctive scats or tracks;
- **Likely**: core habitat and/or microhabitat, such as roost sites, maternity sites, shelter sites and important food resources are present, the species is known from the general area within recent decades and there is no barrier to movement;
- **May occur**: potentially suitable habitat is present, enough for at least sporadic occurrence or temporary/seasonal occurrence in response to a short-term resource (e.g., fruiting tree), core habitat is close enough for the species to move to the site, there is no barrier to movement and the species is known from the general area within recent decades;
- **Unlikely**: only marginal habitat is present and the site is substantially outside the known range of the species; the species, if sufficiently vagile, could only occur briefly in transit; and
- **Not expected**: no suitable habitat present and/or the site is substantially outside the known range of the species.

Three threatened species are known from the proposed TSF3 footprint. Five threatened fauna species may occur within the TSF3 footprint, although they were not recorded during the dry or wet season surveys. Five of these eight threatened species are listed under the EPBC Act and a self-assessment against the Significant Impact Guidelines is provided in **Section** Error! Reference source not found..

Table 2. Threatened fauna likelihood of occurrence within the TSF3 footprint

Common name	Scientific name	EPBC Act	NC Act	Distribution and habitat requirements	Habitat present in disturbance areas	Likelihood of occurrence within TSF3	EPBC Self-assessment required[1]
Mammals							
Greater Bilby	*Macrotis lagotis*	E	V	Occurs in three major vegetation types: open tussock grassland on uplands and hills, Mulga (*Acacia aneura*) woodland/shrubland on ridges and rises, and hummock grassland on sand plains and dunes, drainage systems, salt lake systems and other alluvial areas (Pavey 2006). The species formerly occurred over the southern half of Queensland in areas receiving <600 mm average annual rainfall. By the 1930s, Greater Bilbies were largely restricted to their current core range in south-western Queensland (Silcock et al. 2023). The species is considered extinct over nearly 99% of its former range in Queensland (McRae 2012).	None	Not expected	No
Purple-necked Rock-wallaby	*Petrogale purpureicollis*	-	V	Restricted to Queensland, from the Northern Territory border north-west of Lawn Hill, south to Dajarra and east to Winton (Johnson 2003). Occurs in rocky outcrops, boulder piles, cliffs and gorges associated with dry eucalypt and acacia woodland and spinifex grassland (Johnson 2003; Johnson & Eldridge 2008). Discussed in **Section 3.4.1**.	Yes	Known to occur	No
Ghost Bat	*Macroderma gigas*	V	E	Widespread but patchily distributed across northern Australia (Armstrong et al. 2023). Occurs in a broad range of habitats from arid spinifex hillsides to tropical rainforest (Churchill 2008; Richards et al. 2008). Its distribution is influenced by availability of suitable roost sites. Ghost Bats will roost in shallow caves and under boulders (Churchill 2008) but prefer deep caves, abandoned mines and deep rock fissures (Armstrong & Anstee 2000; Richards et al. 2008). They require particular structural and microclimatic features for permanent roosts and maternity sites. In the Top End, preferred roosting caves have microclimates of 27-29^{o}C and 80% relative humidity (Churchill 2008). The closest known record is from within 1 km of the site, given as Esperanza Mine. The dates provided are 1770 – 1989. More recently, there is a 2011 record from Chidna, approximately 25 km north of the	No roosting habitat known. Possible foraging habitat is present.	May occur	Yes

Common name	Scientific name	EPBC Act	NC Act	Distribution and habitat requirements	Habitat present in disturbance areas	Likelihood of occurrence within TSF3	EPBC Self-assessment required[1]
				site (QG 2024b). Recent studies show that Ghost Bats forage up to 12 km from their diurnal roost (Augusteyn 2018; Bullen 2021).			
Northern Leaf-nosed Bat	*Hipposideros stenotis*	-	V	Occurs in Western Australia and the Northern Territory with an isolated population near Mount Isa. Roosts in caves and deep cracks, under large boulders and in abandoned mines. Foraging habitat includes cliffs and gorges associated with waterholes bordered by paperbarks or mangroves (Milne et al. 2023). The species is slow-flying and forages in highly productive, cluttered environments (McKenzie & Bullen 2012). There are only around 100 records for the species, with almost half from offshore islands (Milne et al. 2023). There is only one publicly available WildNet (Wildlife Online) database record for the state. It is from approximately 120 km to the south of the site in 1990 (QG 2024a). The Atlas of Living Australia (ALA 2024c) has a second record, an Australian Museum specimen from 1934, also south of Mount Isa. Biosphere state that the species was recorded from approximately 30 km west of site (BEC 2023) and Brett Taylor (pers. comm.) also recorded the species from approximately 30 km west south-west of the site in 2012. Milne et al. (2023) state that it is rare and that known occurrences are highly isolated. Most targeted surveys have failed to detect it in apparently suitable habitat (Woinarski et al. 2014). It is considered that the species may occur within the TSF3 footprint but that an assessment of 'likely' is unsuitable given how poorly known the species is, that it is typically not recorded in areas of suitable habitat and that the extent of 'cluttered' foraging habitat on site is very small.	Some roosting habitat is present. The extent of preferred foraging habitat on site is apparently very small.	May occur	No
Orange Leaf-nosed Bat	*Rhinonicteris aurantia*	-	V	Occurs in Western Australia, the Northern Territory and north-western Queensland (Churchill et al. 2008). Roosts in caves and abandoned mines and forages in rocky gorges containing water and lined with eucalypts or melaleuca, often over spinifex, and in open eucalypt woodland (Armstrong 2000, 2012). Discussed in **Section 3.4.1**.	Some roosting habitat is present. Foraging habitat is widespread.	Known to occur	No

Common name	Scientific name	EPBC Act	NC Act	Distribution and habitat requirements	Habitat present in disturbance areas	Likelihood of occurrence within TSF3	EPBC Self-assessment required[1]
Australian Painted Snipe	*Rostratula australis*	E	E	Patchily distributed across much of Australia, largely absent of arid areas. Typically occurs in freshwater marshes. Breeding only occurs in swamps with temporary water regimes and complex shorelines forming islands, shallow water, exposed wet mud and dense low fringing vegetation (Rogers et al. 2005; Geering et al. 2007). During non-breeding periods they may be found in a wider range of habitats including dams, rice paddocks, waterlogged grasslands, roadside drains and even brackish waterways (Marchant & Higgins 1993). The only waterbodies on site are an ephemeral rocky stream that terminates in a mine 'plunge pool. Neither are suitable habitat. The site is very well-drained due to topography and substrate type.	None	Unlikely	No
Eastern Curlew	*Numenius madagascariensis*	CE, M	E	Occurs around the entire Australian coastline. Mostly confined to coastal habitats, particularly estuaries, harbours and coastal lagoons. Forages on open intertidal mudflats, sandflats and saltmarsh, often near mangroves, and occasionally on ocean beaches (Finn et al. 2008). Roosting occurs on sandy spits and islets, in mangroves and saltmarsh, and along high water mark on beaches (Pringle 1987; Higgins & Davies 1996).	None	Not expected	No
Curlew Sandpiper	*Calidris ferruginea*	CE, M	CR	Widespread on the coast, extending inland in places, mostly in Victoria and southern New South Wales (Lane 1987; Higgins & Davies 1996). In Queensland, inland records are sparsely scattered, mostly around Mt Isa (Higgins & Davies 1996). Occurrence across the inland is likely to be birds on passage to sites where it spends the Australian summer (Blakers et al. 1984). Mostly occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays and lagoons. It also uses swamps, lakes, saltworks and sewage ponds. Less often it is recorded inland, around lakes, dams and bore drains, usually with bare edges of mud or sand (Higgins & Davies 1996). The severe decline in this species (Garnett et al. 2011; Clemens et al. 2021) has dramatically reduced the number of inland records (T. Reis pers. obs.).	None	Unlikely	No

Common name	Scientific name	EPBC Act	NC Act	Distribution and habitat requirements	Habitat present in disturbance areas	Likelihood of occurrence within TSF3	EPBC Self-assessment required[1]
Red Goshawk	*Erythrotriorchis radiatus*	E	E	Patchily distributed in north-western, northern and eastern Australia, mostly in coastal and subcoastal areas (Debus & Czechura 1988; Marchant & Higgins 1993). Occurs in woodlands and forests, particularly tall forests in areas of high rainfall (Woinarski 2007), and ideally with intact forest or woodland, a mosaic of vegetation types and permanent water, particularly riverine forests, and a large and diverse bird population (prey species). The species avoids both very dense and very open habitats (Marchant & Higgins 1993; Czechura et al. 2010). Occasional records from western Queensland are mainly from gorges (Czechura 2012). The three closest publicly available WildNet and ALA records are between 75 and 86 km to the north-east of the site. The most recent is from pre-1974 (QG 2024e). NRA (2021) report a juvenile approximately 31 km west of the site in 2014. Misidentification of other reddish-brown raptors for Red Goshawks results in false positive records for the species (Debus 2017). The reliability of this record is unknown.	Very marginal habitat, without permanent water.	Unlikely	No
Grey Falcon	*Falco hypoleucos*	V	V	Confined to the arid and semi-arid zone (Schoenjahn et al. 2021), verified records outside of the arid zone are rare (Schoenjahn 2018). Occurs in semi-arid and arid woodlands, shrublands, grasslands and wooded watercourses, typically in areas of less than 500 mm annual rainfall (Olsen 1995; Debus 1998; Aumann 2001b). Some individuals may winter in tropical woodlands (Mooney 1998; T. Reis pers. obs.). Discussed in **Section 3.4.1**.	Foraging habitat for wintering adults and dispersing juveniles is present.	Known to occur	Yes
Night Parrot	*Pezoporus occidentalis*	E	E	Historically, Night Parrot occurred throughout arid and semi-arid Australia, mostly before the 1880s (Higgins 1999). The *Biodiversity Planning Assessment for the Northwest Highlands Bioregion* states that there are probable records just inside the southern edge of the bioregion (DES 2020). This is approximately 270 km south of the site. Occurs in open semi-arid grasslands, mostly with spinifex but also chenopods (Murphy et al. 2017; Leseberg et al. 2021b). All areas where long-term stable roost	Possible foraging habitat. No long-term roost habitat.	Unlikely	No

Common name	Scientific name	EPBC Act	NC Act	Distribution and habitat requirements	Habitat present in disturbance areas	Likelihood of occurrence within TSF3	EPBC Self-assessment required[1]
				sites have been detected in both Queensland and Western Australia have been practically treeless (Leseberg et al. 2021a).			
Carpentarian Grasswren	*Amytornis dorotheae*	E	E	Occurs in the Gulf of Carpentaria in the Northern Territory and north-west Queensland. In the south of its range, i.e. south of the Gregory River (Harrington & Murphy 2015) (which includes the site), it is found on siltstone ranges and undulating plains with rocky creeklines, typically with low open woodland dominated by Snappy Gum with spinifex (Higgins et al. 2001; Harris & Stewart 2009). The species can be found in almost flat areas (Harris & Stewart 2009; T. Reis pers. obs.). Contrary to some of the literature, T. Reis has recorded the species much more frequently in the south of its range in low-lying areas than on rocky ridges and outcrops. The species is often seemingly absent in areas of apparently suitable habitat (Harris & Stewart 2009; Harrington et al. 2011) and populations appear to be discrete for reasons that are unclear (Harrington & Murphy 2015). The species is highly cryptic (Harris & Stewart 2009; Harrington & Murphy 2015) and is the hardest of the grasswrens to find (Schodde 1982), a group that is secretive by nature (Menkhorst et al. 2017). One of the authors, T. Reis, has been conducting fauna surveys in the general study area for more than 15 years, including targeted Carpentarian Grasswren surveys. He is a member of Birds Queensland's Records Appraisal Committee. He has occasionally found the species on rocky ridges and even on a concrete path in a mining camp on a jump-up, but most frequently in areas of large 'hard' spinifex on flats, generally fringing a watercourse or at least a drainage line. Successful repeat surveys over years have only been in such habitat. Thirty call playback surveys were conducted in the site (**Figure 3**). Calls played included 'alarm' calls as it was assumed that January was not the ideal time for such surveys, with birds expected to be less responsive. There was no response within the TSF3 footprint, which contains small clumps of 'soft' spinifex. The survey team also conducted a call playback survey in	Habitat is present.	May occur	Yes

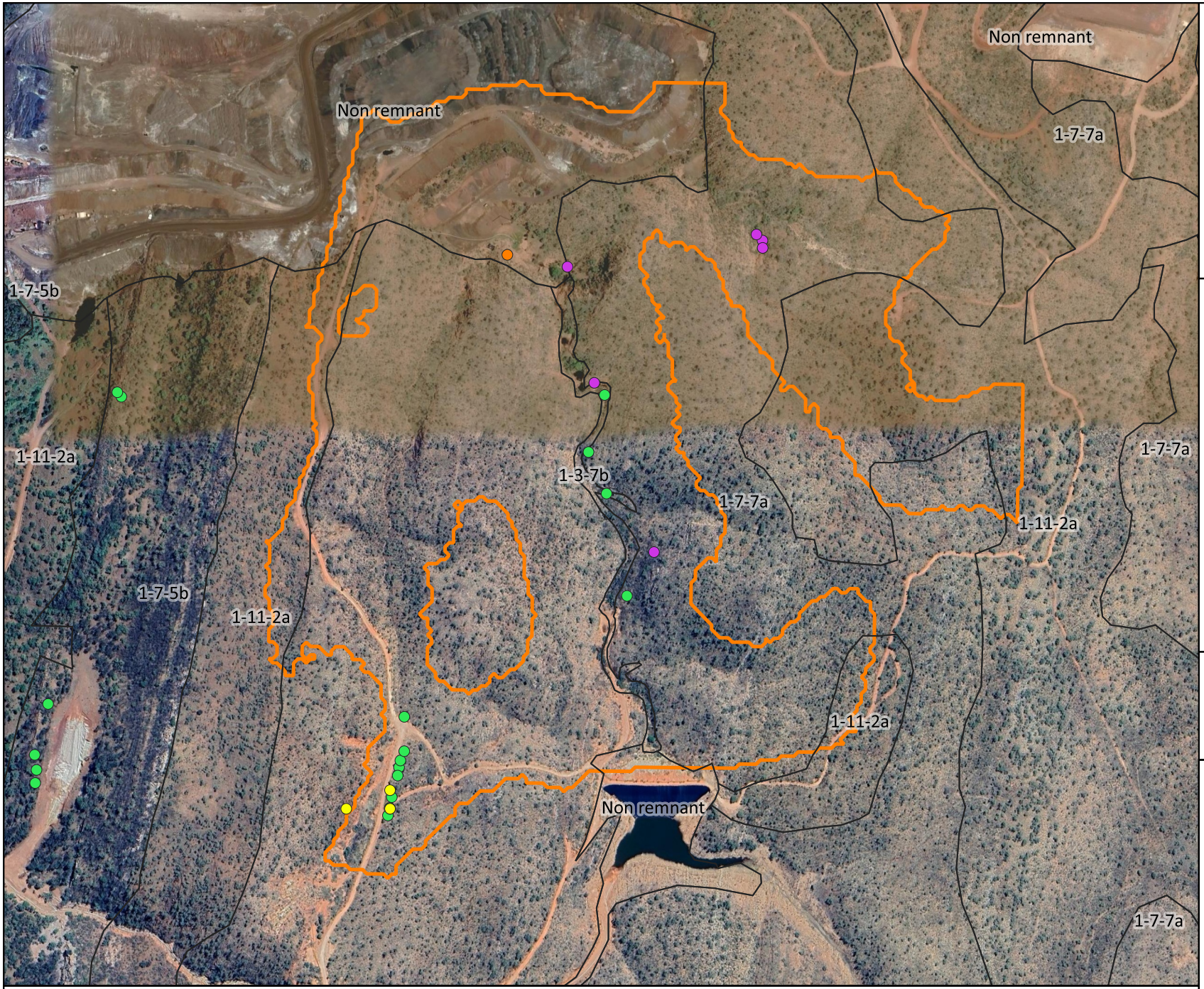
Common name	Scientific name	EPBC Act	NC Act	Distribution and habitat requirements	Habitat present in disturbance areas	Likelihood of occurrence within TSF3	EPBC Self-assessment required[1]
				hard spinifex close to a watercourse approximately 2.8 km north of the site. This site was chosen due to its apparent high suitability for the species. There was an immediate response to the alarm call, though the bird was not seen. Three birds were subsequently seen, heard and photographed in August 2024, approximately 700 m south-east of the site. This was also in an area of apparently more suitable habitat. It is considered that Carpentarian Grasswren may occur within the TSF3 footprint but that the habitat is not optimal.			
Painted Honeyeater	*Grantiella picta*	V	V	Occurs from south-eastern Australia to north-western Queensland and the eastern Northern Territory (Higgins et al. 2001). Almost all breeding records and the greatest concentrations of individuals occur south of 26ºS, i.e., south of the Roma area in Queensland (Higgins et al. 2001; Barrett et al. 2003). Breeding and north-south movements are closely aligned with fruiting mistletoes (Barea & Watson 2007), its primary food item (mostly *Amyema* species) (Garnett et al. 2011). In the absence of mistletoe fruit, nectar and insects are regularly taken (Higgins et al. 2001, Oliver et al. 2003). Painted Honeyeater is highly mobile and thinly spread over large areas (Watson 2012). The closest known record is from Gregory Downs in 2017, approximately 48 km to the north-west of the site (ALA 2024b). There are very few database records for the general area. Occurs mainly in dry open woodlands and forests with a strong association with mistletoe (Higgins et al. 2001). The species prefers woodlands with many mature trees, as these host more mistletoes (Oliver et al. 2003). Woodlands dominated by acacias (e.g., *Acacia harpophylla*, *A. pendula*, *A. aneura*) are particularly favoured, but the species also occurs in *Casuarina cristata*, *Allocasuarina luehmannii*, *Callitris glaucophylla* and riparian woodland of *Eucalyptus camaldulensis* (Barea & Watson 2007; Garnett et al. 2011; Watson 2012).	No mistletoe was observed on site and only two plants in the immediate surrounds. None of the favoured tree species is present.	Unlikely	No

Common name	Scientific name	EPBC Act	NC Act	Distribution and habitat requirements	Habitat present in disturbance areas	Likelihood of occurrence within TSF3	EPBC Self-assessment required[1]
Gouldian Finch	*Erythrura gouldiae*	E	E	Occurs in northern Australia on Cape York Peninsula, the Einasleigh Uplands and then continuously from north-west Queensland, through the Northern Territory to the Kimberleys in Western Australia (Legge et al. 2021). Occurs in open grassy woodlands, particularly on ridges and foothills. Their distribution appears closely allied to spear-grasses (*Sorghum* spp.). The species moves into flatter terrain with the onset of the wet season, where a variety of perennial grasses are favoured, such as *Alloteropsis semialata*, *Chrysopogon fallax*, *Themeda triandra*, *Heteropogon triticeus* (Dostine et al. 2001; Payne 2010), *Triodia bitextura* (Lewis 2007) and possibly *T. pungens*. The species nests in tree hollows. In Queensland it breeds in Snappy Gum (Higgins et al. 2006). Gouldian Finch prefers thicker, more robust hollows, in living tissue, with small entrances in larger trees (Brazil-Boast et al. 2010). Breeding has been anecdotally reported from various sites north of Mount Isa, and is documented for Chidna Nature Refuge (DES 2020), approximately 30 km north of the site. The species is increasing in numbers, possibly due to some natural process or adaptation, though at least some regional population increases are due to targeted management of fire and livestock grazing (Legge et al. 2015; Woinarski et al. 2023). The species was seen approximately 10 km north of Capricorn Copper Mine in 2023 (Brett Taylor pers. comm.) and there is an anecdotal record from Capricorn Copper Mine camp.	There are food species, *Themeda triandra* and *C. fallax* in the immediate surrounds. Snappy Gum is present. *Triodia pungens* dominates the ground cover on site. *T. bitextura* may be present but is not mentioned in the Regional Ecosystem report (Williams 2023a). It is uncertain as to food availability in the site. Ostensibly, the site includes suitable nesting habitat but all tree hollows observed were in dead wood, not living hollows.	May occur	Yes
Gulf Snapping Turtle	*Elseya lavarackorum*	E	V	Known only from rivers and creeks draining into the Gulf of Carpentaria including Lawn Hill Creek and Gregory, O'Shanassy and Nicholson Rivers. It lives in slow flowing sections, often lined with fig trees (*Ficus* spp.) (White 2012). Its occurrence is strongly linked to the presence of *Ficus racemosa* and Leichardt Trees (*Nauclea orientalis*) (Freeman 2010).	None	Not expected	No

Common name	Scientific name	EPBC Act	NC Act	Distribution and habitat requirements	Habitat present in disturbance areas	Likelihood of occurrence within TSF3	EPBC Self-assessment required[1]
Diamond Head Turtle	*Emydura subglobosa worrelli*	-	NT	Occurs from the Saxby River in Queensland west to the upper reaches of the Katherine River in the Northern Territory (Wilson & Swan 2021). It is often treated as a full species, Worrell's Turtle (*E. worrelli*) (Cann & Sadlier 2017; Wilson 2022). It occurs in large rivers and permanent lakes and lagoons (Cogger 2014).	None	Not expected	No
Northern Blue-tongue Skink	*Tiliqua scincoides intermedia*	CE	CR	Occurs across northern Australia from Western Australia, across the Top End of the Northern Territory, to approximately the Gregory Downs/Cloncurry area in western Queensland. It is not clear where the eastern limit of this subspecies' range occurs in north Qld due to a sampling gap (DCCEEW 2023a). There is a 2011 WildNet record from approximately 8 km north of the site (QG 2024c). Occurs in a wide variety of habitats including riparian forest and spinifex and tussock grassland. Most records have occurred near seasonal or permanent water. They spend much of their time in cool, moist sheltered locations with relatively dense vegetation or artificial material such as concrete and wood (Price-Rees et al. 2013). They are sedentary within a habitat and then move to another patch, where they remain sedentary (Christian et al. 2003; Price-Rees 2014).	Very small area of possibly suitable shelter habitat/sleeping site along an ephemeral rocky stream.	May occur	Yes
Mertens' Water Monitor	*Varanus mertensi*	E	E	Occurs across northern Australia, from the Kimberleys in Western Australia to Cape York Peninsula in Queensland (Wilson & Swan 2021). It is semi-aquatic and arboreal and occurs on watercourses, billabongs, lakes, irrigation channels and dams (Mayes et al. 2005). It seldom occurs away from water (Ward et al. 2007) and typically takes to the water when disturbed (Doody et al. 2014), where can remain submerged for considerable periods of time (Wilson & Swan 2021). It forages in water and Its diet is predominately freshwater crabs but also includes other crustaceans, frogs, fish, turtle eggs, invertebrates and carrion (Mayes et al. 2005; Ward et al. 2007). The closest known record is from approximately 15 km north of the site in 2011 with another record from the same year a further 16 km north (QG 2024d). The species was listed as Endangered under the NC Act in	Very small area along an ephemeral rocky stream. No habitat generally and no close habitat from which any individuals could temporarily colonise during suitable conditions.	Unlikely	No

Common name	Scientific name	EPBC Act	NC Act	Distribution and habitat requirements	Habitat present in disturbance areas	Likelihood of occurrence within TSF3	EPBC Self-assessment required[1]
				November 2022 (QG 2022) and under the EPBC Act in December 2023 (DCCEEW 2023b) due to significant declines. It does persist in the general area, an individual was seen by this report's authors in a creek along Gunpowder Road on 31/1/2024, approximately 47 km south of the site.			
Plains Death Adder	*Acanthophis hawkei*	V	V	Known only from the Barkly Tablelands of the Northern Territory and north-western Queensland around Camooweal, occurring on black soil plains with Mitchell Grass (*Astrebla* spp.) (Wells 2002; Cogger 2014). The species is found in flat, treeless and cracking soil riverine floodplain with tussock grassland. It shelters under debris and in earth fissures during the dry season (Chapple et al. 2019). Wüster et al. (2005) do not consider *hawkei* to be a separate species and Cogger (2014) states that this species remains undefined in distinguishing characteristics. No taxonomic work since Wüster et al. (2005) appears to have validated it as a species (Chapple et al. 2019). Wilson & Swan (2021) state that it is an 'ill-defined species' and indistinguishable on morphological characters but identifiable genetically. Assuming it is a valid species and its habitat is correctly identified then there is no habitat on site.	None	Not expected	No
Freshwater Sawfish	*Pristis pristis*	V, M	C	Freshwater Sawfish is a ray and potentially occurs in all large rivers of northern Australia from the Fitzroy River, Western Australia, to the western side of Cape York Peninsula, Queensland. It is mainly confined to the main channels of large rivers. It is actually a marine/estuarine species that spends its first 3-4 years in freshwater. Juveniles and sub-adults occur mostly in rivers and estuaries, while large mature animals tend to occur more often in coastal and offshore waters (Stevens et al. 2005; Thorburn et al. 2007).	None	Not expected	No

EPBC Act = *Environment Protection and Biodiversity Conservation Act* 1999
NC Act = Queensland's *Nature Conservation Act* 1992.
Status: CE = Critically Endangered, CR = Critically Endangered, E = Endangered, M = Migratory, NT = Near Threatened, V = Vulnerable.
[1] Only species listed under the EPBC Act have been considered eligible for self-assessment against the EPBC Act Significant Impact Guidelines.



29 Metals Capricorn Copper Mine TSF3 Flora and Fauna Assessment

LEGEND

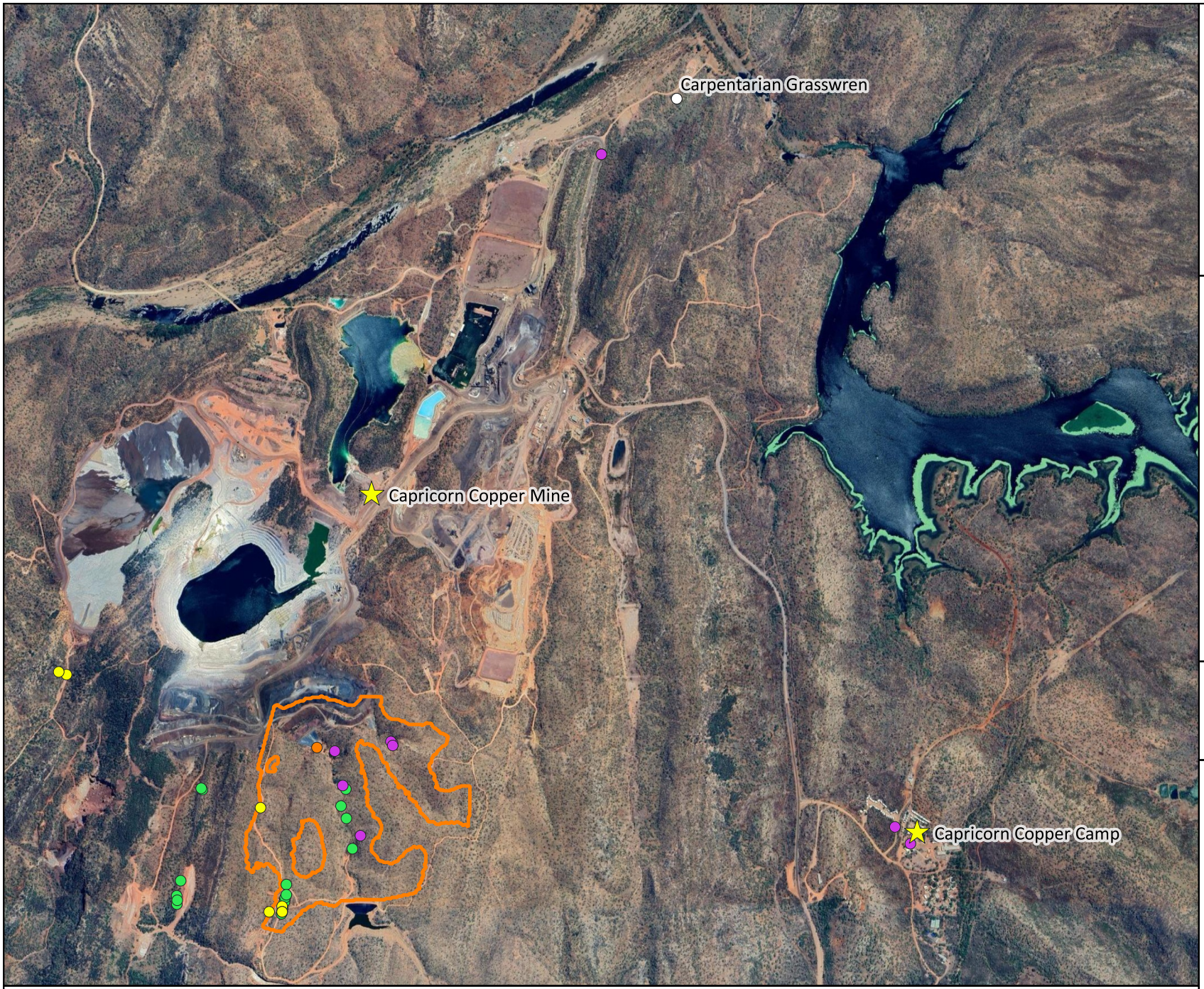
- TSF3 Disturbance Footprint
- Purple-necked Rock-wallaby record
- Orange Leaf-nosed Bat record
- *Ipomoea antonschmidii* Dry Season record
- *Ipomoea antonschmidii* Wet Season record
- Regional Ecosystems (Paul Williams 2023)

0 100 200 300 m

KG ENVIRONMENTAL

KG Environmental
Creation Date: 23/02/2024

Figure 3. TSF3 Threatened and Near Threatened Species Observations



29 Metals Capricorn Copper Mine TSF3 Flora and Fauna Assessment

LEGEND

- TSF3 Disturbance Footprint
- Purple-necked Rock-wallaby record
- Orange Leaf-nosed Bat record
- Carpentarian Grasswren record
- *Ipomoea antonschmidii* Dry Season record
- *Ipomoea antonschmidii* Wet Season record
- Regional Ecosystems (Paul Williams 2023)

0 0.5 1 km

KG ENVIRONMENTAL

KG Environmental
Creation Date: 28/02/2024

Figure 4. CCM Threatened and Near Threatened Species Observations

3.4.1 Threatened fauna species known to occur

Three threatened species are known to occur in the TSF3 footprint: Purple-necked Rock-wallaby, Orange Leaf-nosed Bat, more recently known as Orange Diamond-faced Bat, and Grey Falcon.

Purple-necked Rock-wallaby (*Petrogale purpureicollis*)

EPBC Act (Commonwealth) Listing Status	Not listed
NC Act (Queensland) Listing Status	Vulnerable
The *Action Plan for Australian Mammals* 2012	Near Threatened
Recovery Plan	There is no recovery plan for the species

Purple-necked Rock-wallaby is restricted to Queensland, from the Northern Territory border north-west of Lawn Hill, south to Dajarra and east to Winton (Johnson 2003). It is not known to occur in the adjacent Northern Territory (Johnson & Eldridge 2008), but its northern and western limits are uncertain (Eldridge & Coulson 2015). It is discontinuously distributed in preferred habitat (Johnson 2003), occurring in rocky outcrops, boulder piles, cliffs and gorges associated with dry eucalypt and acacia woodland and spinifex grassland (Johnson 2003; Johnson & Eldridge 2008). It generally lives in small groups, though up to 20 individuals may occur together (Johnson & Eldridge 2008; Eldridge 2012). Most large colonies have access to permanent fresh water and populations may die out during extended drought (Johnson & Eldridge 2008).

Johnson and Eldridge (2008) and Eldridge and Coulson (2015) state that Purple-necked Rock-wallaby is common around Mt Isa and Dajarra, but is much rarer to the north around Lawn Hill. However, White and Mason (2011) found it to be common and widespread in Boodjamullah (Lawn Hill) National Park. The species appears to have declined around Winton where feral Goats (*Capra hircus*) are common (Johnson & Eldridge 2008) and disappeared from nearby Bladensburg National Park in 1975 (Woinarski et al. 2014). Populations between Winton and McKinley have also been extirpated (Eldridge 2012).

The specialised habitat requirements of rock-wallabies present challenges to the conservation management of individual species. Rock-wallabies are threatened by vehicle strike, competition with introduced herbivores and habitat modification (Clancy & Close 1997). Causes of declines of Purple-necked Rock-wallaby are uncertain, though competition with, and habitat degradation by, Goats is likely in the south-east. Other threats include habitat degradation by livestock, changes in fire regimes, predation by feral Cats (*Felis catus*) (Eldridge 2012; Eldridge & Coulson 2015), invasion by weeds such as Buffel Grass (*Cenchrus ciliaris*) and localised habitat loss due to mining (Woinarski et al. 2014).

Five Purple-necked Rock-wallabies were observed within the TSF3 footprint (**Figure 3**), with scats seen in the immediate surrounds. The species is common north of, and within, Mount Isa wherever suitable habitat is present (T. Reis pers. obs.).

Orange Leaf-nosed Bat (*Rhinonicteris aurantia*)

The Pilbara form of *Rhinonicteris aurantia* is listed as Vulnerable under the EPBC Act (DCCEEW 2024b) but the Queensland population is not considered threatened at the Commonwealth level.

EPBC Act (Commonwealth) Listing Status	Not listed (Queensland population)
NC Act (Queensland) Listing Status	Vulnerable
The *Action Plan for Australian Mammals* 2012	Least Concern
Recovery Plan	There is no recovery plan for the species

Orange Leaf-nosed Bat occurs in Western Australia, the Northern Territory and north-western Queensland (Churchill et al. 2008; Armstrong 2012). In the dry season the species roosts in caves, in colonies from 20 to reportedly more than 20,000 individuals (Churchill et al. 2008), though such colonies haven't been confirmed and more typically colonies are up to several hundred individuals (Benda 2019). In Queensland, it is known from Camooweal Caves National Park and a relatively shallow cave in Lawn Hill Gorge National Park. Both known roost sites in Queensland are in limestone caves, though elsewhere it uses sandstone and silcrete caves (Armstrong 2012). It also roosts in abandoned mines (Armstrong 2000) and occasionally buildings (Benda 2019).

Outside of Queensland, colonies appear to be restricted to the deepest and most humid caves during dry conditions (Armstrong 2012). The species is exceptionally susceptible to cooling and desiccation (Churchill et al. 2008). In the wet season it is thought it becomes a tree-dweller while conditions are warm and humid (Churchill et al. 2008), though this hasn't been confirmed (Churchill et al. 2008; Benda 2019). The species forages in rocky gorges containing water and lined with eucalypts or melaleuca, often over spinifex, and in open eucalypt woodland (Armstrong 2012). In Western Australia, the species is known to forage up to 20 km from a roost (Cramer et al. 2016). Orange Leaf-nosed Bat seems to be limited by availability of roosts, rather than vegetation type (Benda 2019).

In Queensland, its status as Vulnerable probably reflects the few records and known colonies (Armstrong 2012). The species is threatened by destruction of roost sites, disturbance at roost sites and inappropriate fire regimes (Armstrong 2012; Woinarski et al. 2014). It will abandon roosts if sufficiently disturbed (Churchill 2008). Orange Leaf-nosed Bat is susceptible to collision with vehicles due to its low foraging height and attraction for lights (Armstrong 2012) and is heavily preyed on by Ghost Bat (Churchill et al. 2008).

Orange Leaf-nosed Bat was detected by call in rocky areas during the dry season survey (**Figure 3**). The species was not recorded during the wet season survey. It is unknown if the species roosts within the TSF3 footprint or roosts elsewhere and forages on site.

Grey Falcon (*Falco hypoleucos*)

EPBC Act (Commonwealth) Listing Status	Vulnerable
NC Act (Queensland) Listing Status	Vulnerable
The *Action Plan for Australian Birds* 2020	Vulnerable
Recovery Plan	There is no recovery plan for the species

Grey Falcon is confined to the arid and semi-arid zone (Schoenjahn et al. 2021). Recent genetic analysis substantiated that Grey Falcon consists of a single, freely interbreeding population (Mullin et al. 2020). The species occurs in semi-arid and arid woodlands, shrublands, grasslands and wooded watercourses, typically in areas of less than 500 mm annual rainfall. The species is reported to feed mainly on birds and mammals (Olsen 1995; Debus 1998; Aumann 2001b) and some invertebrates (Sutton 2010), though Schoenjahn (2013) considered it to specialise on birds, and predominantly on nomadic bird species.

Its breeding range has contracted since the 1950s and is now confined to the arid parts of its range (<250 mm annual rainfall) (Marchant & Higgins 1993; Debus 1998). In central Australia, Grey Falcons mostly nest in River Red Gums (*Eucalyptus camaldulensis*) that are taller, of greater girth and more foliated than other available trees on creeks (Aumann 2001a). The closest known breeding record (ALA 2025) is near Middleton, west of Winton, approximately 365 km south south-east of the site.

Grey Falcon occurs sparsely in the interior and the north of the Australian mainland (Marchant & Higgins 1993; Debus 1998). Mooney (1998) states that some individuals may winter in tropical woodlands. However, Schoenjahn et al. (2020) consider that some individuals appear to undertake movements that may best be interpreted as nomadic and that most other statements concerning movements of Grey Falcons are based on incidental sightings, short-term observations or unsubstantiated second-hand reports. Nomadism would be expected if it feeds mostly on nomadic birds.

Although it has experienced a decline and range contraction, there is no evidence that there have been recent declines in the arid zone. However, because the population is estimated to be fewer than 1,000 individuals the species is considered to be Vulnerable in *The Action Plan for Australian Birds 2010* (Garnett et al. 2011). Other raptor species are often misreported as Grey Falcon (Schoenjahn 2010) and records from coastal eastern and southern Australia are likely to be misidentified goshawks (Debus & Olsen 2001).

A Grey Falcon was seen in flight high above the site in August 2024 by this report's authors. It is the only known record in close proximity to Capricorn Copper Mine.

4. SIGNIFICANT IMPACT ASSESSMENT

4.1 Environmental Protection and Biodiversity Conservation Act 1999

In consideration of species/community profile information and the habitat features of the TSF3 proposed disturbance area, potential impacts to the following species have been assessed against the EPBC Act Significant Impact Guidelines 1.1 (AG 2013):

- Vulnerable Ghost Bat (*Macroderma gigas*)
- Vulnerable Grey Falcon (*Falco hypoleucos*)
- Endangered Carpentarian Grasswren (*Amytornis dorotheae*)
- Endangered Gouldian Finch (*Erythrura gouldiae*)
- Critically Endangered Northern Blue-tongue Skink (*Tiliqua scincoides intermedia*).

The purpose of the guidelines is to assist any person who proposes to take an action to decide whether or not they should submit a referral to the Australian Government for a decision (by the Australian Government Environment Minister) on whether assessment and approval is required under the EPBC Act.

Under the EPBC Act an action will require approval from the minister if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance.

The EPBC Significant Guidelines 1.1 set out 'significant impact criteria' for each matter of national environmental significance to assist in determining whether impacts of a proposed activity are likely to be significant impacts. Criteria relevant to the flora and fauna of the TSF3 proposed disturbance area are provided in **Table 3-7**. The criteria are intended to provide general guidance on the types of actions that will require approval and the types of actions that will not require approval. They are not intended to be exhaustive or definitive (AG 2013).

The self-assessment triggered significant impact criteria for Carpentarian Grasswren (**Table 5**) and Northern Blue-tongue Skink (**Table 7**). Disturbance within the TSF3 footprint will adversely affect habitat that fits the definition of "critical habitat" for both species. However, in context of the intensity and scale of the proposed project, a significant impact to these species is not expected.

The general test for significance is whether an impact is 'important, notable or of consequence, having regard to its context or intensity'. In regard to Carpentarian Grasswren, despite meeting a significant impact criterion, disturbance within the TSF3 footprint is not expected to have an impact on the species that is important, notable or of consequence. Whilst habitat within the TSF3 footprint is suitable for Carpentarian Grasswren, it is considered sub-optimal compared to habitat outside of the footprint (**Table 2**). Despite targeted survey effort (**Figure 2**), the species was not recorded within the TSF3 footprint during the dry or wet season surveys.

In regard to Northern Blue-tongue Skink, an EPBC Pre-referral meeting with the Department of Climate Change, Energy, the Environment and Water (DCCEEW) is recommended. The habitat available within TSF3 is very small in size (<1 ha) and considered sub-optimal for Northern Blue-tongue Skink, however, there is a lack of scientific evidence available to justify a decision that the action is not likely to have a significant impact. AG (2013) advises to apply the precautionary principle where there is scientific uncertainty about the impacts of an action and potential impacts are serious or irreversible.

Table 3. Assessment of potential impacts against EPBC Act significant impact criteria: Ghost Bat

Significant Impact Criteria	Assessment Response
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species	The closest known record is from within 1 km of the site, given as Esperanza Mine. The dates provided 1989. More recently, there is a 2011 record from Chidna, approximately 25 km north of the site (QG 202 no known suitable large cave site within or near the site that may serve as roost or maternity sites for the 'important population' is not defined but known roosts, especially maternity sites, would presumably 'important population'. Only 14 maternity sites are currently known (Worthington Wilmer 2012). In colonies are known only from eastern areas from Cape York Peninsula south to Mount Etna near R (Woinarski et al. 2014). As such, an 'important population' is not considered to occur within or adjacent footprint. Construction of TSF3 may result in the loss of up to 47 ha of potential foraging habitat (in remnant habitat) for the species (if it still occurs). The Project is considered very unlikely to lead to the long-term decrease in the size of an important popu
Reduce the area of occupancy of an important population	At this stage there is no evidence Ghost Bat or an 'important population' occurs in the site or its immediat The sole record in the immediate vicinity is more than 33 years old. The extent of occurrence is 2, (Woinarski et al. 2014), although the area of occupancy is much smaller, <10 km^2 (based on the limited a roost sites). The Project is not expected to lead to the long-term decrease in the size of an important population.
Fragment an existing important population into two or more populations	An 'important population' is not defined but known roosts, especially maternity sites, would presumably 'important population'. At this stage there is no evidence Ghost Bat or an 'important population' occurs i its immediate surrounds. The Project is not expected to fragment an important population.
Adversely affect habitat critical to the survival of a species	Ghost Bat occurs in a broad range of habitats from arid spinifex hillsides to tropical rainforest (Churchill 20 et al. 2008). Their distribution is influenced by availability of suitable roost sites. Ghost Bats will roost in sl and under boulders (Churchill 2008) but prefer deep caves, abandoned mines and deep rock fissures (A Anstee 2000; Richards et al. 2008). They require particular structural and microclimatic features for perm and maternity sites. There is no such habitat feature located within or adjacent to the site. The Project will impact potential foraging habitat for the species (if it occurs in the area) but will not adv habitat critical to the survival of the species.

Significant Impact Criteria	Assessment Response	Criterion impact
Disrupt the breeding cycle of an important population	There is no evidence Ghost Bat or an 'important population' of the species currently occurs in the site or its immediate surrounds. They require particular structural and microclimatic features for maternity roost sites. There is no such habitat feature known to occur within or adjacent to the site. While potential foraging habitat may be lost, the Project will not disrupt the breeding cycle of an important population.	Not expected
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There is no evidence Ghost Bat occurs in the site or its immediate surrounds. There is no known suitable large cave within the site that may serve as roost or maternity sites for the species. The species may predate on a range of vertebrates and larger invertebrates in a range of habitats. The Project may result in the loss of up to 47 ha of potential foraging habitat for the species (if it occurs). Given no potential roost or maternity site is known to occur the Project is considered unlikely to cause the species to decline.	Not expected
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The invasive species considered of threat, or potential threat, to Ghost Bat are Red Fox (*Vulpes vulpes*) (DCCEEW 2024a) and Cane Toad (*Rhinella marina*) (Francis 2019), though the species continues to occur in locations with Cane Toads (e.g., Gillieson & McDonald 2018). Cane Toad is already abundant in the site and surrounds and Red Fox is unlikely to occur this far north. Weed and pest control measures will be incorporated into the Project Construction and Operational Environmental Management Plans, as part of a Weed and Pest Management Plan. The plan will be implemented in particular to control the introduction and spread of weed species across the site. The Weed and Pest Management Plan will be in place for the life of the Project and will minimise the potential for weed invasion or pest proliferation. The Project is not expected to result in the establishment of a harmful invasive species.	Not expected
Introduce disease that may cause the species to decline	The Project Weed and Pest Management Plan will incorporate the management of invasive species and assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be suitably quarantined as required under State and Commonwealth legislation. The Project is not expected to introduce disease.	Not expected

Significant Impact Criteria	Assessment Response	Criterion impact
Interfere substantially with the recovery of the species	There is no recovery plan for the species. Management actions recommended in the Conservation advice for the species (TSSC 2016b) include: • protection of lands (roost sites and surrounding foraging area) with significant colonies • modification of barbed-wire fences in close proximity to roost sites • public education regarding disturbance of roost sites • minimise disturbance to known roost sites close to mining activities. The project will not interfere with any of these actions and is considered unlikely to interfere with the recovery of the species.	Not expected

Table 4. Assessment of potential impacts against EPBC Act significant impact criteria: Grey Falcon

Significant Impact Criteria	Assessment Response	Criterion impact
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:		
Lead to a long-term decrease in the size of an important population of a species	A Grey Falcon was seen in flight high above the site in August 2024 by this report's authors. It is the only known record in close proximity to Capricorn Copper Mine. The closest known database record is from approximately 45 km north of the site in 2010. It is an eBird record with a 2 km spatial error. Location provided is Chidna Station (ALA 2024a). WildNet records are not publicly available for this species. The species occurs as a single population sparsely distributed over a large expanse of inland Australia (Schoenjahn et al. 2021). There is no evidence a local population or an important population (or part thereof) would occur in the area. Grey Falcon would only be expected to occur as an irregular non-breeding winter visitor or as a dispersing juvenile. The closest known breeding record (ALA 2025) is near Middleton, west of Winton, approximately 365 km south south-east of the site. It is not considered that the Project would lead to a long-term decrease in the size of an important population of the species.	Not expected
Reduce the area of occupancy of an important population	There is no evidence a local population or an important population (or part thereof) would occur in the area. The extent of occurrence is estimated to be 2,500,00 km^2 and the area of occupancy estimated to be 1, 690,000 km^2 (Schoenjahn et al. 2021). The Project will result in the loss of 47 ha of lands (foraging may occur in non-remnant vegetation) located towards the margin of the species' occurrence in an area of possible seasonal foraging habitat. It is not considered that the Project will reduce the area of occupancy of an important population of the species.	Not expected

Significant Impact Criteria	Assessment Response	Criterion impact
Fragment an existing important population into two or more populations	The species occurs as a single population sparsely distributed over a large expanse of inland Australia (Schoenjahn et al. 2021). There is no evidence a local population or an important population (or part thereof) occurs in the area. The Project will result in the loss of 47 ha of lands located towards the margin of the species' occurrence in an area of possible seasonal foraging habitat. The Project will not fragment an important population.	Not expected
Adversely affect habitat critical to the survival of a species	Critical habitat is not defined. There is no evidence a local population or an important population (or part thereof) occurs in the area. The Project will result in the loss of 47 ha of lands located towards the margin of the species' occurrence in an area of possible seasonal foraging habitat. There is no evidence the Project would adversely affect critical habitat for Grey Falcon.	Not expected
Disrupt the breeding cycle of an important population	There is no evidence a local population or an important population (or part thereof) would occur in the area. Its breeding range has contracted since the 1950s and is now confined to the arid parts of its range (<250 mm annual rainfall) (Marchant & Higgins 1993; Debus 1998). In central Australia, Grey Falcons mostly nest in River Red Gums (*Eucalyptus camaldulensis*) that are taller, of greater girth and more foliated than other available trees on creeks (Aumann 2001a). The closest known breeding record (ALA 2025) is near Middleton, west of Winton, approximately 365 km south south-east of the site. It is not expected that the species would breed in the site, which lacks suitable trees, or in the general area. The Project will not disrupt the breeding cycle of an important population.	Not expected
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project will result in the loss of 47 ha of lands located towards the margin of the species' occurrence in an area of possible seasonal foraging habitat. It is not considered the Project will impact habitat for the species to the extent Grey Falcon will decline.	Not expected
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Grey Falcon is threatened by over-grazing by introduced herbivores including One-humped Camel (*Camelus dromedarius*). Cats are also a threat but that their impact is considered negligible (Schoenjahn et al. 2011). Weed and pest control measures will be incorporated into the Project Construction and Operational Environmental Management Plans, as part of a Weed and Pest Management Plan. The plan will be implemented in particular to control the introduction and spread of weed species across the Project site. The Weed Management Plan will be in place for the life of the Project and will minimise the potential for weed invasion or pest proliferation. The Project is not expected to result in the establishment of a harmful invasive species.	Not expected

Significant Impact Criteria	Assessment Response	Criterion impact
Introduce disease that may cause the species to decline	The Project Weed and Pest Management Plan will incorporate the management of invasive species and assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be suitably quarantined as required under State and Commonwealth legislation. The Project is not expected to introduce disease.	Not expected
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Approved Conservation advice for the species (TSSC 2020) identifies the following conservation and management priorities: • improved fire and grazing management where the species is known to occur • protect known nesting trees and support the establishment of replacement trees • retain artificial structures used as nest sites • control feral Cats and Camels where the species is known to nest/roost. The Project will not interfere with any of these priorities and will not interfere with the recovery of the species.	Not expected

Table 5. Assessment of potential impacts against EPBC Act significant impact criteria: Carpentarian Grasswren

Significant Impact Criteria	Assessment Response	Criterion impact
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:		
Lead to a long-term decrease in the size of a population	This report's authors recorded the species approximately 2.8 km north of the site during the survey, a location targeted as T. Reis identified it as highly suitable habitat based on his field experience with the species. Three birds were subsequently seen, heard and photographed in August 2024, approximately 700 m south-east of the site. This area, and much of the surrounding landscape was unintentionally burnt in October 2024, resulting in the loss of spinifex. Despite these records, at this stage there is no evidence that Carpentarian Grasswren occurs within the site (two fauna surveys have been conducted recently). The nearby habitats in which the species was recorded is ostensibly the same as much of the site but varies with regards to *Triodia* species and topography. Such proximity does not demonstrate that the species occurs on site. It is often seemingly absent in areas of apparently suitable habitat (Harris & Stewart 2009; Harrington et al. 2011). The largest remaining population of Carpentarian Grasswren exists in the Mount Isa region of Queensland (Harrington et al. 2009), encompassing the site, and 39 ha of potentially suitable habitat will be lost as a result of the Project. However, this is not expected to lead to a long-term decrease in the size of a population based on the small size of the Project.	Not expected
Reduce the area of occupancy of the species	The extent of occurrence is 50,000 km^2 and the area of occupancy is 11,000 km^2 (Stoetzel et al. 2021). The Project will result in the loss of 39 ha of potential habitat for the species, although it is unknown if the species frequents the site. The small size of the site means that the Project is considered unlikely to reduce the area of occupancy of the species.	Not expected
Fragment an existing population into two or more populations	The Project will result in the loss of 39 ha of potential habitat for the species, although it is uncertain to what extent the habitat is useful to the species. The site abuts an existing mine with no habitat for Carpentarian Grasswren and is sufficiently small that the Project is not expected to fragment an existing population (should one found to be present) into two or more populations.	Not expected
Adversely affect habitat critical to the survival of a species	The Conservation Advice (TSSC 2016a) refers to mature spinifex clumps that provide critical habitat for the Carpentarian Grasswren (Woinarski 2006). Critical habitat is not otherwise defined and Woinarski (2006) is no longer available as per the link provided in the Conservation Advice (see references). This definition includes areas for where there is no Carpentarian Grasswren record and although thought by this report to be of little value in determining critical habitat, its consideration means that the Project will adversely affect habitat critical to the survival of the species.	**Expected**

Significant Impact Criteria	Assessment Response	Criterion impact
Disrupt the breeding cycle of a population	The Project will result in the loss of 39 ha of potential habitat for the species. Breeding biology is very poorly known but active nests have been recorded in January and September (Higgins et al. 2001). Should the species occur, the Project may disrupt the breeding cycle of those individuals present.	**Possible**
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project will result in the loss of 39 ha of potential habitat for the species. Given the small size of the site, the Project is considered unlikely to affect the species habitat to the extent it is likely to decline.	Not expected
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The Conservation Advice (TSSC 2016a) identifies invasion by introduced pasture grasses, such as Buffel Grass, and feral Cats as a threat, and potential threat, respectively. Feral Cat is likely to be already present in the site or immediate surrounds (DAF 2024). Buffel Grass is not present. Weed and pest control measures will be incorporated into the Project Construction and Operational Environmental Management Plans, as part of a Weed and Pest Management Plan. The plan will be implemented in particular to control the introduction and spread of weed species across the Project site. Measure will ensure feral Cat does not use Project infrastructure for shelter sites or as a foraging source. The Weed and Pest Management Plan will be in place for the life of the Project and will minimise the potential for weed invasion or pest proliferation. The Project is not expected to result in the establishment of a harmful invasive species.	Not expected
Introduce disease that may cause the species to decline	The Project Weed Management Plan will incorporate the management of invasive species and assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be suitably quarantined as required under State and Commonwealth legislation. The Project is not expected to introduce disease.	Not expected

Significant Impact Criteria	Assessment Response	Criterion impact
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Conservation advice for the species (TSSC 2016a) identifies conservation and management actions for the species including: • Implementing fire management actions across the landscape the species occurs in • Plan and carry out translocation activities • Undertaking mapping and control of Buffel Grass where the species occurs • Implementing feral Cat controls where the species may be impacted • Ensure landholders and natural resources managers are aware of the species' occurrence and provide protection measures against potential threats such as vegetation clearing, mining and other resource extraction activities • Research into the effects of Buffel Grass and feral Cats on the species. The Project will result in the loss of 39 ha of potential habitat for the species. Given the small size of the site, the Project is considered unlikely to substantially interfere with the recovery of the species.	Not expected

Table 6. Assessment of potential impacts against EPBC Act significant impact criteria: Gouldian Finch

Significant Impact Criteria	Assessment Response	Criterion impact
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:		
Lead to a long-term decrease in the size of a population	By the early 2000s only scattered populations remained in north Queensland (Higgins et al. 2006). The 10 locations at which significant populations were known were all in Western Australia and the Northern Territory. In Queensland, records from 1980 to the early 2000s had been sporadic and rarely at the same place twice (O'Malley 2006a). There has been an increase of 36% in the known area of occupancy between 1999-2009 and 2010-2020, though it is uncertain if this simply reflects greater survey effort (Legge et al. 2021). Only two breeding populations are currently known in Queensland: Chidna Nature Refuge (150 km north of Mount Isa) (DES 2020), and another from the Einasleigh Uplands (BNQ 2019). It is not known if the site encompasses a population or if the nearby records are sporadic occurrences. For breeding, Gouldian Finch prefers thicker, more robust tree hollows, in living tissue, with small entrances in larger trees (Brazil-Boast et al. 2010). The Project will clear 40 ha of potential foraging habitat for the species, but no preferred nest site was observed despite targeted searches. The size of the area is considered sufficiently small that the loss of potential foraging habitat is unlikely to cause a long-term decrease in the size of a population, should one be present.	Not expected
Reduce the area of occupancy of the species	The area of occupancy is estimated at 10,000 km^2 and increasing, though this is a low-medium reliability estimate (Legge et al. 2021). The size of the area is considered sufficiently small that the loss of potential foraging habitat is unlikely to cause a long-term decrease in the area of occupancy, especially as the area of occupancy is apparently increasing.	Not expected
Fragment an existing population into two or more populations	The Project will clear 40 ha of potential foraging habitat for the species. Potential foraging habitat occurs in much of the surrounding landscape. The site abuts an existing mine with no habitat for Gouldian Finch and is sufficiently small that the Project is not expected to fragment an existing population (should one found to be present) into two or more populations.	Not expected
Adversely affect habitat critical to the survival of a species	Critical habitat is not defined. The Project will result in the loss of 40 ha of potential foraging habitat. In Queensland the species breeds in tree hollows in Snappy Gum (Higgins et al. 2006). Gouldian Finch prefers thicker, more robust hollows, in living tissue, with small entrances in larger trees (Brazil-Boast et al. 2010). Such hollows were not observed, despite targeted surveys. If breeding habitat is accepted as critical habitat, then there is no evidence the Project would adversely affect critical habitat for Gouldian Finch.	Not expected

Significant Impact Criteria	Assessment Response	Criterion impact
Disrupt the breeding cycle of a population	Only two breeding populations are currently known in Queensland: Chidna Nature Refuge (approximately 30 km north of the site) (DES 2020), and the Einasleigh Uplands (BNQ 2019). There is no breeding record for the site and immediate surrounds. There is no evidence that the Project will disrupt the breeding cycle of a population.	Not expected
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	For breeding, Gouldian Finch prefers thicker, more robust tree hollows, in living tissue, with small entrances in larger trees (Brazil-Boast et al. 2010). The Project will clear 40 ha of potential foraging habitat for the species, but no preferred nest site was observed despite targeted searches. The size of the area is considered sufficiently small that the loss of potential foraging habitat is unlikely to cause the species to decline.	Not expected
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Invasive species considered of threat to Gouldian Finch are feral Pig and some grasses. Pig is considered to be 'occasional and widespread' in the general area (DAF 2024). The five grasses listed in *Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses* (DSEWPC 2012), which is considered relevant to the species, are not present. Buffel Grass is also not present. It can alter fire regimes. Weed and pest control measures will be incorporated into the Project Construction and Operational Environmental Management Plans, as part of a Weed and Pest Management Plan. The plan will be implemented in particular to control the introduction and spread of weed species across the Project site. The Weed Management Plan will be in place for the life of the Project and will minimise the potential for weed invasion or pest proliferation. The Project is not expected to result in the establishment of a harmful invasive species.	Not expected
Introduce disease that may cause the species to decline	The Project Weed and Pest Management Plan will incorporate the management of invasive species and assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be suitably quarantined as required under State and Commonwealth legislation. The Project is not expected to introduce disease.	Not expected

Significant Impact Criteria	Assessment Response	Criterion impact
Interfere substantially with the recovery of the species	The overall objective of the *National recovery plan for the Gouldian finch (*Erythrura gouldiae*)* (O'Malley 2006b) is to improve the conservation status of the Gouldian Finch through population increases. Specific objectives to achieve the overall objective include: • SO1) Specific fire regimes aimed at improving Gouldian Finch population trends are implemented at key sites and their effectiveness tested. • SO2) Improved grazing, feral herbivore and fire management systems are in place at key off-reserve sites within Gouldian Finch range. • SO3) Trends in population and health indices for Gouldian Finches are stable or improving at key sites. • SO4) Reintroduction methodology and factors limiting Gouldian Finch survival are refined through trial reintroductions at Queensland sites. • SO5) The national recovery program is operating with high levels of community participation. Project activities are not expected to interfere with those specific objectives. The Project will not interfere with the recovery of the species.	Not expected

Table 7. Assessment of potential impacts against EPBC Act significant impact criteria: Northern Blue-tongue Skink

Significant Impact Criteria	Assessment Response	Criterion impact
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:		
Lead to a long-term decrease in the size of a population	Northern Blue-tongue Skink occurs across northern Australia from Western Australia, across the Top End of the Northern Territory, to approximately the Gregory Downs/Cloncurry area in western Queensland (DCCEEW 2023a). There is a 2011 WildNet record from approximately 8 km north of the site (QG 2024c). The Conservation Advice (DCCEEW 2023a) states that there is a 2011 record from Mount Gordon in the Atlas of Living Australia (ALA) (search dated 2022). That record is not currently held in ALA but probably refers the WildNet record provided above. DCCEEW (2023a) considers that this represents a persisting population. Given the record is 13 years old it is not known if the population does still exist, nor is it known if it extended south to the site. At this stage there is no evidence that the Project will lead to a long-term decrease in the size of a population.	Not expected
Reduce the area of occupancy of the species	The minimum area of occupancy is 704 km^2.The species occurs in remote areas and is rarely reported. It is likely to occur across a much larger area than recorded (DCCEEW 2023a). The Project will clear 40 ha of potential habitat for the species. Given the closest known population has a most recent record of 2011 and is 8 km to the north, there is no evidence the Project will reduce the area of occupancy for the species.	Not expected
Fragment an existing population into two or more populations	The Conservation Advice (DCCEEW 2023a) states that there is a 2011 record from Mount Gordon in the Atlas of Living Australia (ALA) (search dated 2022). That record is not currently held in ALA but probably refers the WildNet record provided above. DCCEEW (2023a) consider that this represents a persisting population. Given the record is 13 years old it is not known if the population does still exist, nor is it known if it extended south to the site. There is no evidence that the Project will lead to a long-term decrease in the size of a population.	Not expected
Adversely affect habitat critical to the survival of a species	*Areas of dense vegetation that provide cool and moist conditions within otherwise hot, dry, and flammable landscapes that are within the historical distribution of the northern blue-tongue skink are habitat critical to the survival of this species. …. Examples of habitat critical ….. include, but are not limited to:* • *Rainforests and vine thickets.* • *Riparian forests.* • *Well-vegetated creeks, gorges, and drainage lines.* • *Well-vegetated swamps, soaks, and springs.* • *Dense thickets within floodplains, grasslands, shrublands, savannas and woodlands.* • *Shady thickets in rocky ranges and gorges.* • *Well-watered and well-vegetated gardens.*	**Expected**

Significant Impact Criteria	Assessment Response	Criterion impact
	• *Non-vegetated areas that provide shelter from thermal extremes, fire, and predators are also habitat critical to the survival of the northern blue-tongue skink. These include areas with deep rocky crevices and underground burrows* (DCCEEW 2023a: 7). There is a very small area (<1 ha) of possibly suitable shelter habitat/sleeping site along an ephemeral rocky stream within the site. Individuals are sedentary within a habitat and then move to another patch, where they remain sedentary (Christian et al. 2003; Price-Rees 2014). The habitat in question is a well-vegetated ephemeral creek. No other similar patch or possibly critical habitat is known in or near the site. Based on this definition, the Project will result in the loss of <1 ha of critical habitat.	
Disrupt the breeding cycle of a population	The species is live-bearing (Cogger 2014). The Conservation Advice (DCCEEW 2023a) states that there is a 2011 record from Mount Gordon in ALA (search dated 2022). That record is not currently held in ALA but probably refers to a WildNet record. DCCEEW (2023a) consider that this represents a persisting population. Given the record is 13 years old it is not known if the population does still exist, nor is it known if it extended south to the site. There is a very small area (<1 ha) of possibly suitable shelter habitat/sleeping site along an ephemeral rocky stream within the site. There is no evidence the Project will disrupt the breeding cycle of a population.	Not expected
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There is a very small area (<1 ha) of possibly suitable shelter habitat/sleeping site along an ephemeral rocky stream within the site. It is not considered the Project will impact habitat for the species to the extent Northern Blue-tongue Skink will decline.	Not expected
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Invasive species considered of threat to Northern Blue-tongue Skink are Cane Toad, feral Pig, Swamp Buffalo (*Bubalus bubalis*) and Cattle (*Bos indicus*, *B. taurus*) (DCCEEW 2023a). Pig is considered to be 'occasional and widespread' in the general area (DAF 2024). Swamp Buffalo is not present in the area. Cattle are present in the surrounding landscape but there was no evidence of their presence on site. Weed and pest control measures will be incorporated into the Project Construction and Operational Environmental Management Plans, as part of a Weed and Pest Management Plan. The plan will be implemented in particular to control the introduction and spread of weed species across the Project site. The Weed Management Plan will be in place for the life of the Project and will minimise the potential for weed invasion or pest proliferation. The Project is not expected to result in the establishment of a harmful invasive species.	Not expected

Significant Impact Criteria	Assessment Response	Criterion impact
Introduce disease that may cause the species to decline	The Project Weed and Pest Management Plan will incorporate the management of invasive species and assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be suitably quarantined as required under State and Commonwealth legislation. The Project is not expected to introduce disease.	Not expected
Interfere substantially with the recovery of the species	There is no recovery plan for the species or subspecies. The primary conservation objectives in the Conservation Advice (DCCEEW 2024a) are to stabilise and then increase population size and area of occupancy by detecting subpopulations that are resilient to Cane Toads, supporting them to recover and by maintaining habitat integrity and connectivity among remnant subpopulations to support population expansion into temporarily unoccupied areas. Conservation and management priorities include inventory surveys to detect subpopulations resilient to Cane Toads, maintenance of effective Cane Toad quarantine, investigation of effective Cane Toad eradication, prioritisation of areas with habitat critical to the species' survival for fire and introduced species interventions, increased management intensity for introduced animals and prevention of illegal collection (DCCEEW 2024a). The Project is not expected to interfere with conservation objectives as outlined in the Conservation Advice.	Not expected

4.2 Queensland Environmental Offsets Policy

4.2.1 Regulated Vegetation

There is 0.9 ha of Endangered Biodiversity Status RE1.3.7b that will be disturbed by TSF3, which is overlayed by 0.6 km of regulated vegetation (intersecting a watercourse), associated with a stream order 2. Appendix 3 of the Queensland Environmental Offsets Policy nominates 25m distance from defining banks for stream order 1 and 2 within the non-coastal bioregions of Queensland. This calculates approximately 3 ha of regulated vegetation.

The Queensland Environmental Offsets Policy Significant Residual Impact Guideline provides a criteria of 2 ha of clearance within sparse regional ecosystems. According to the Queensland Environmental Offsets Policy Significant Residual Impact Guideline, the clearance of calculated regulated vegetation for this project (3 ha) exceeds the criteria and triggers consideration of an environmental offset. However, the actual extent of riparian vegetation as measured on-ground (0.9 ha) falls below the criteria of 2 ha.

Further site-specific matters for consideration include the disconnection of the TSF3 watercourse and the resulting value of the riparian vegetation as a wildlife corridor or aquatic ecosystem. The water course is disconnected from its upper tributaries by the UEDD, and disconnected from its natural flow downstream to Gunpowder Creek by the Esperanza Waste Rock Dump.

4.2.2 Threatened Species

In consideration of species/community profile information and the habitat features of the TSF3 proposed disturbance area, potential impacts to the following species have been assessed against the Queensland Environmental Offsets Policy Significant Residual Impact Guideline (QG 2014):

- Vulnerable Purple-necked Rock-wallaby (*Petrogale purpureicollis*)
- Vulnerable Orange Leaf-nosed Bat (*Rhinonicteris aurantia*).

Significant residual impact to the two vulnerable species is not expected, although the size and extent of the local Purple-necked Rock-wallaby has not been documented (**Table 8 and 9**).

Table 8. Assessment of potential impacts against Queensland significant residual impact criteria: Purple-necked Rock-wallaby

Significant Residual Impact Criteria	Assessment Response	Criterion impact
An action is likely to have a significant impact on endangered or vulnerable wildlife if the impact on the habitat is likely to:		
Lead to a long-term decrease in the size of local population	Five Purple-necked Rock-wallabies were observed within the TSF3 footprint, with scats also seen in the immediate surrounds. The species was observed in the mine in August 2024 and is commonly seen in Capricorn Copper Mine camp. The species occurs in rocky outcrops, boulder piles, cliffs and gorges associated with dry eucalypt and acacia woodland and spinifex grassland (Johnson 2003; Johnson & Eldridge 2008). Purple-necked Rock-wallaby is common around Mt Isa and Dajarra (Johnson & Eldridge (2008) and in Boodjamullah National Park further north (White & Mason 2011). It remains common on the outskirts of Mt Isa, including in built up areas close to rocky outcrops (T. Reis personal obs.). Construction of TSF3 may result in the loss of potential shelter sites and up to 39 ha of foraging habitat for the species. The size and extent of the local population is unknown. In consideration of the extensive occurrence of shelter and foraging habitat in and around Gunpowder, it is considered unlikely that the Project will lead to the long-term decrease in the size of a local population.	Unlikely
Reduce the extent of occurrence of the species	The extent of occurrence is 59,544 km^2 (Woinarski et al. 2014). The habitat to be lost as a result of the project is less than 0.01% of its extent of occurrence. The Project is not expected to reduce the extent of occurrence of the species.	Not expected
Fragment an existing population	The size and extent of the local population is unknown. The site is 1.2 km wide at its widest point. It abuts the existing mine to the north and habitat to the east, south and west can easily be traversed by the species. Given the species has been seen in the mine even this does not appear to be a barrier to movement. The Project is not expected to fragment a population.	Not expected
Result in genetically distinct populations forming as a result of habitat isolation	The site is 1.2 km wide at its widest point. It abuts the existing mine to the north and habitat to the east, south and west can easily be traversed by the species. Given the species has been seen in the mine even this does not appear to be a barrier to movement. The Project is not expected to isolate animals resulting in the formation of genetically distinct populations.	Not expected

Significant Residual Impact Criteria	Assessment Response	Criterion impact
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	The invasive species considered of threat, or potential threat, to Purple-necked Rock-wallaby are Goats, Cats (Eldridge 2012; Eldridge & Coulson 2015) and environmental weeds such as Buffel Grass (Woinarski et al. 2014). Feral Cat is likely to be already present in the site or immediate surrounds (DAF 2024). Goats and Buffel Grass are not present. Weed and pest control measures will be incorporated into the Project Construction and Operational Environmental Management Plans, as part of a Weed and Pest Management Plan. The plan will be implemented in particular to control the introduction and spread of weed species across the Project site. Measure will ensure feral Cat does not use Project infrastructure for shelter sites or as a foraging source. The Weed and Pest Management Plan will be in place for the life of the Project and will minimise the potential for weed invasion or pest proliferation. The Project is not expected to result in the establishment of a harmful invasive species.	Not expected
Introduce disease that may cause the population to decline	The Project Weed Management Plan will incorporate the management of invasive species and assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be suitably quarantined as required under State and Commonwealth legislation. The Project is not expected to introduce disease.	Not expected
Interfere with the recovery of the species	There is no recovery plan for the species. *The Action Plan for Australian Mammals 2012* (Woinarski et al. 2014) identifies management actions for the species including: • Implementing control mechanisms for non-native predators • Reducing impacts of non-native herbivores • Fire management actions that benefit the species • Reduce impacts of invasive weeds, particularly Buffel Grass • Developing conservation covenants on lands with high values for the species. The Project will not interfere with any of these actions and is considered unlikely to interfere with the recovery of the species.	Not expected
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species.	The site does not include sufficient shelter sites to be considered an ecologically significant location for the species.	Not expected

Table 9. Assessment of potential impacts against Queensland significant residual impact criteria: Orange Leaf-nosed Bat

Significant Residual Impact Criteria	Assessment Response	Criterion impact
An action is likely to have a significant impact on endangered or vulnerable wildlife if the impact on the habitat is likely to:		
Lead to a long-term decrease in the size of local population	Orange Leaf-nosed Bat was detected by call in rocky areas during the dry season survey. The species was not recorded during the wet season survey. It was also recorded in August 2024 in nearby areas, again only by call. It is unknown if the species roosts within the TSF3 footprint or roosts elsewhere and forages on site. The size and extent of the local population is unknown. Anabat data do not identify number of individuals if there are multiple calls. That the species has been twice recorded during dry season surveys and not during a wet season survey suggests that it may only occur seasonally on site but more data are required before that conclusion could be reached. No suitable roost site was identified in the site. Construction of TSF3 may result in the loss of up to 47 ha of potential foraging habitat, assuming it would also forage over non-remnant habitat. The Project is considered unlikely to lead to the long-term decrease in the size of a local population.	Not expected
Reduce the extent of occurrence of the species	The extent of occurrence is 1,162,011 km^2 (Woinarski et al. 2014). The habitat to be lost as a result of the project is less than 0.01% of its extent of occurrence. The Project is not expected to reduce the extent of occurrence of the species.	Not expected
Fragment an existing population	The size and extent of the local population is unknown. The site is 1.2 km wide at its widest point. The species is known to forage up to 20 km from a roost (Cramer et al. 2016). The Project will not be a barrier to its movement across the landscape. The Project is not expected to fragment a population.	Not expected
Result in genetically distinct populations forming as a result of habitat isolation	The site is 1.2 km wide at its widest point. The Project will not be a barrier to its movement across the landscape. The Project is not expected to isolate animals resulting in the formation of genetically distinct populations.	Not expected
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	Orange Leaf-nosed Bat is heavily preyed on by Ghost Bat (Churchill et al. 2008). There is no known threat to the species from an invasive species. The Project is not expected to result in the establishment of a harmful invasive species.	Not expected
Introduce disease that may cause the population to decline	The Project Weed Management Plan will incorporate the management of invasive species and assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be suitably quarantined as required under State and Commonwealth legislation. The Project is not expected to introduce disease.	Not expected

Significant Residual Impact Criteria	Assessment Response	Criterion impact
Interfere with the recovery of the species	There is no recovery plan for the species. *The Action Plan for Australian Mammals 2012* (Woinarski et al. 2014) identifies management actions for the species including: • Developing and implementing management and protection guidelines for roost sites • Fire management actions that benefit the species • Developing conservation covenants for important roost sites, particularly maternity sites. The action plan states that there is no specific management for the species across most of its range. The Project will not interfere with any of these actions and is considered unlikely to interfere with the recovery of the species.	Not expected
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species.	No roosting site has been found in the site, despite dedicated searches. It is possible that the records on site of these species are of individuals simply in transit though it is more likely that the species is foraging and/or drinking on site. However, there is no evidence that the site would to be considered an ecologically significant location for the species.	Not expected

5. RECOMMENDATIONS

The following recommendations are made, in order of the relevant sections of this report.

1. Obtain a Permit to Clear for *Ipomoea antonschmidii*. Flora survey results are valid for two years, so if a permit has not been obtained by June 2025 the protected plant survey will need to be repeated.
2. Implement the control of Buffel Grass, one of the most ecologically damaging weeds in the region, known to grow on the main road nearby and scattered along Gunpowder Creek.
3. Implement the control of Calotrope, prevalent at the site following the 2023 extreme rainfall event.
4. Reduce the risk of high intensity dry season fires by implementing patch burning during the wet season while the soil and spinifex is moist. This ensures spinifex fires are of low to moderate intensity (burning from April onwards ensures a high intensity spinifex fire), and the moist soil allows abundant post-fire recruitment of native herbs and grasses.
5. Develop a Species Management Plan for Purple-necked Rock-wallaby, known to occur within the TSF3 footprint.
6. Attend a pre-referral meeting with DCCEEW to discuss the requirement to submit an EPBC Referral based on the presence of habitat for Carpentarian Grasswren and Northern Blue-tongue Skink. This report identifies that a significant impact is not considered likely, however a precautionary approach may be required. The decision to refer the project is to be made by 29 Metals.
7. Develop a Project Construction and Operational Environmental Management Plan and Weed and Pest Management Plan.

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Appendix A: Photographs



Plate 4. Site 1 Trap Line



Plate 5. Western Plunge Pool from northern end of central gully



Plate 6 and Plate 7. Rock walls at northern end of central gully





Plate 8 and Plate 9. Central (top) and southern (bottom) segment of central gully





Plate 10 and Plate 11. Northern (top) and southern (bottom) segment of western gully





Plate 12. Typical rock wall habitat of the TSF3 footprint



Plate 13. Trap Site 4, eastern gully in background



Plate 14. Carpentarian Grasswren location, mature 'hard' spinifex outside of TSF3 footprint



Plate 15. *Litoria coplandi*



Plate 16. ***Litoria pallida***



Plate 17. ***Ctenophorus slateri***



Plate 18. Long-tailed Finch



Plate 19. Spinifex Pigeon

Appendix B: Fauna Species List (Wet Season Survey)

Scientific Name	Common Name	EPBC Act	NC Act	Site 1	Site 2	Site 3	Site 4	Borrow Pit	Inc.	Surrounds	Comments
Petrogale purpureicollis	Purpled-necked Rock-wallaby	-	V		x					x	One seen on site and another photographed at a camera trap site. Several seen nearby.
Osphranter robustus	Common Wallaroo	-	C	x	x					x	One animal was seen on site and scats were found in numerous places, though only on one trap site. Two camera trap images.
Pseudomys sp.									x		A small rodent was seen during spotlighting. Most likely Desert Mouse *P. desertor*.
rodent sp.									x		Camera trap images. Possibly *Rattus villosissimus*, though the habitat is unlikely except during a plague.
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	-	C	x	x		x				Also recorded at three targeted sites.
Taphozous sp.	Sheath-tailed bat sp. (most likely *T. georgianus*)*			x	x		x				Also recorded at three targeted sites.
Chaerephon jobensis	Greater Northern Free-tailed Bat	-	C	x	x		x				Also recorded at three targeted sites.
Ozimops lumsdenae	Northern Free-tailed Bat	-	C	x			x				
Myotis macropus	Large-footed Myotis	-	C		x						Also recorded at two targeted sites.
Chalinolobus gouldii	Gould's Wattled Bat	-	C	x	x		x				Also recorded at two targeted sites.
Chalinolobus nigrogriseus	Hoary Wattled Bat	-	C	x	x		x				Also recorded at three targeted sites.
Nyctophilus sp.	long-eared bat species (most likely *N. arnhemensis* or *N. geoffroyi*)			x	x		x				
Scotorepens balstoni	Inland Broad-nosed Bat	-	C				x				
Scotorepens greyii	Little Broad-nosed Bat	-	C	x	x		x				Also recorded at one targeted site.
Vespadelus caurinus	Northern Cave-bat	-	C	x	x						Also recorded at two targeted sites.
Vespadelus finlaysoni	Finlayson's Cave-bat	-	C	x	x		x				Also recorded at three targeted sites.
Canis familiaris dingo	Dingo	-	I		x						Camera trap image, also at a target site.
Synoicus ypsilophorus	Brown Quail	-	C							x	Heard only.
Tachybaptus novaehollandiae	Australasian Grebe	-	C							x	A pair were present on a waterbody adjacent to the site.

Scientific Name	Common Name	EPBC Act	NC Act	Site 1	Site 2	Site 3	Site 4	Borrow Pit	Inc.	Surrounds	Comments
Geophaps plumifera	Spinifex Pigeon	-	C	x						x	Common, mostly along roads.
Phaps chalcoptera	Common Bronzewing	-	C	x						x	Singletons seen occasionally.
Geopelia placida	Peaceful Dove	-	C	x		x	x			x	Reasonably common.
Geopelia humeralis	Bar-shouldered Dove	-	C							x	Uncommon.
Eurostopodus argus	Spotted Nightjar	-	C						x		One seen during spotlighting.
Centropus phasianinus	Pheasant Coucal	-	C						x	x	Heard occasionally.
Eudynamys orientalis	Eastern Koel	-	C							x	Heard twice.
Chalcites basalis	Horsfield's Bronze-Cuckoo	-	C				x			x	Seen once and heard occasionally.
Cacomantis variolosus	Brush Cuckoo	-	C						x	x	Heard occasionally.
Accipiter fasciatus	Brown Goshawk	-	C						x		Seen once.
Haliastur sphenurus	Whistling Kite	-	C		x					x	Present in small numbers.
Milvus migrans	Black Kite	-	C	x			x			x	Reasonably common.
Merops ornatus	Rainbow Bee-eater	-	C	x	x		x			x	Reasonably common, more so off site.
Todiramphus pyrrhopygius	Red-backed Kingfisher	-	C	x		x				x	Seen once, heard often.
Dacelo leachii	Blue-winged Kookaburra	-	C							x	Heard once.
Cacatua galerita	Sulphur-crested Cockatoo	-	C	x		x				x	Seen flying over the site occasionally.
Psitteuteles versicolor	Varied Lorikeet	-	C							x	Several flocks seen in at the mine camp and near Gunpowder Creek.
Melopsittacus undulatus	Budgerigar	-	C							x	Small flock seen once at the mine camp.
Aprosmictus erythropterus	Red-winged Parrot	-	C							x	Pair seen regularly at the mine camp.
Chlamydera nuchalis	Great Bowerbird	-	C		x					x	Pair seen on site in riparian habitat.
Climacteris melanurus	Black-tailed Treecreeper	-	C							x	One seen in nearby habitat.
Malurus assimilis	Purple-backed Fairy-wren	-	C							x	Seen near Gunpowder Creek.
Amytornis dorotheae	Carpentarian Grasswren	E	E							x	One heard near Gunpowder Creek.
Cissomela pectoralis	Banded Honeyeater	-	C							x	Several seen near Gunpowder Creek.
Lichmera indistincta	Brown Honeyeater	-	C		x					x	Uncommon on site, only in riparian habitat.

Scientific Name	Common Name	EPBC Act	NC Act	Site 1	Site 2	Site 3	Site 4	Borrow Pit	Inc.	Surrounds	Comments
Melithreptus laetior	Golden-backed Honeyeater	-	C	x	x			x		x	Common throughout.
Philemon citreogularis	Little Friarbird	-	C			x	x			x	Uncommon.
Philemon argenticeps	Silver-crowned Friarbird	-	C		x					x	Uncommon.
Conopophila rufogularis	Rufous-throated Honeyeater	-	C							x	Uncommon.
Stomiopera unicolor	White-gaped Honeyeater	-	C							x	One pair at the mining camp.
Ptilotula penicillata	White-plumed Honeyeater	-	C							x	Uncommon.
Ptilotula flavescens	Yellow-tinted Honeyeater	-	C							x	Common in the mine camp and elsewhere outside the site.
Ptilotula keartlandi	Grey-headed Honeyeater	-	C		x	x	x			x	Common, more so in rocky areas.
Ptilotula plumula	Grey-fronted Honeyeater	-	C	x	x	x	x	x		x	Common throughout.
Manorina flavigula	Yellow-throated Miner	-	C			x				x	Very uncommon.
Pardalotus striatus	Striated Pardalote	-	C					x		x	Heard twice.
Smicrornis brevirostris	Weebill	-	C					x		x	Seen once.
Pomatostomus temporalis	Grey-crowned Babbler	-	C	x				x		x	Heard occasionally.
Oriolus sagittatus	Olive-backed Oriole	-	C							x	Heard once.
Pachycephala rufiventris	Rufous Whistler	-	C							x	Heard occasionally.
Colluricincla harmonica	Grey Shrike-thrush	-	C	x	x	x	x			x	Occurred throughout the site in small numbers.
Coracina novaehollandiae	Black-faced Cuckoo-shrike	-	C							x	Seen once at the mine camp.
Lalage tricolor	White-winged Triller	-	C	x						x	Seen once on site, patchily common elsewhere.
Artamus cinereus	Black-faced Woodswallow	-	C	x						x	Seen on site daily in small numbers.
Artamus leucorynchus	White-breasted Woodswallow	-	C							x	Seen in small numbers at the mine camp.
Rhipidura leucophrys	Willie Wagtail	-	C							x	Uncommon.
Myiagra nana	Paperbark Flycatcher	-	C							x	Several seen, mostly near water.
Grallina cyanoleuca	Magpie-lark	-	C		x					x	Seen once on site.

Scientific Name	Common Name	EPBC Act	NC Act	Site 1	Site 2	Site 3	Site 4	Borrow Pit	Inc.	Surrounds	Comments
Corvus coronoides	Australian Raven	-	C	x						x	Seen and heard occasionally.
Microeca fascinans	Jacky Winter	-	C							x	Several seen, mostly near water.
Cincloramphus mathewsi	Rufous Songlark	-	C	x		x	x			x	Common on site.
Petrochelidon ariel	Fairy Martin	-	C							x	Flock seen near Gunpowder Creek. Numerous martins seen and not identified to species.
Petrochelidon nigricans	Tree Martin	-	C			x					Occasional birds seen on site.
Dicaeum hirundinaceum	Mistletoebird	-	C		x					x	Pair seen in riparian habitat on site, where mistletoe may have been overlooked.
Neochmia phaeton	Black-bellied Crimson Finch	-	C							x	Only seen at the mine camp.
Poephila acuticauda	Long-tailed Finch	-	C						x	x	Group of four seen on site. Reasonably common elsewhere, including in the mine camp.
Taeniopygia castanotis	Zebra Finch	-	C							x	Reasonably common, including in the mine camp.
Taeniopygia bichenovii	Double-barred Finch	-	C					x		x	Reasonably common, including in the mine camp.
Gehyra lauta	Gulf Tree Dtella	-	C						x		One, probably more, seen during spotlighting on site.
Lialis burtonis	Burton's Snake-lizard	-	C				x				One seen on site.
Carlia amax	Two-spined Rainbow Skink	-	C		x						One seen on site.
Cryptoblepharus pannosus	Ragged Snake-eyed Skink	-	C					x			One seen.
Cryptoblepharus zoticus	Agile Snake-eyed Skink	-	C		x						One caught by hand on site.
Ctenotus spaldingi	Spalding's Ctenotus	-	C		x	x				x	Reasonably common. One trapped on site.
Ctenotus striaticeps	Stripe-headed Ctenotus	-	C	x		x					One trapped and one seen on site.
Proablepharus tenuis	Slender Snake-eyed Skink	-	C			x					One trapped on site.
Ctenophorus slateri	Slater's Ring-tailed Dragon	-	C	x							Three seen on site.
Lophognathus horneri	Horner's Dragon	-	C		x					x	Only seen in the riparian habitat on site. Common elsewhere.

Scientific Name	Common Name	EPBC Act	NC Act	Site 1	Site 2	Site 3	Site 4	Borrow Pit	Inc.	Surrounds	Comments
Varanus acanthurus	Spiny-tailed Monitor	-	C	x						x	One found dead on site. One seen at the mine camp.
Varanus storri	Storr's Monitor	-	C							x	Seen twice, once at the mine camp and once nearby. Different individuals.
Aspidites melanocephalus	Black-headed Python	-	C						x		One seen on site during spotlighting.
Liasis olivaceus	Olive Python	-	C						x		One seen on site.
Demansia quaesitor	Sombre Whipsnake	-	C							x	One seen in the mine camp.
Cyclorana australis	Northern Giant Frog	-	C		x						One caught by hand in riparian vegetation.
Litoria caerulea	Green Tree Frog	-	C						x	x	Camera trap image from a target site. One seen in the mine camp.
Litoria coplandi	Common Rock Frog	-	C						x		Two seen during spotlighting on site.
Litoria pallida	Pallid Rocket Frog	-	C						x		One seen during spotlighting on site.
Litoria rothii	Northern Laughing Tree Frog	-	C						x		Heard on site.
Litoria rubella	Ruddy Tree Frog	-	C	x	x		x				Often heard on site.
Rhinella marina	Cane Toad	-	I			x	x			x	Common.

EPBC Act = *Environment Protection and Biodiversity Conservation Act* 1999; NC Act = Queensland's *Nature Conservation Act* 1992. Status: C = Common (Least Concern), E = Endangered, I = Introduced, V = Vulnerable.
Inc. = Incidental, recorded on site but not on sites 1-4.

* based on known distributions (ABS 2024).

A.5 TSF3 Air Quality Assessment, Trinity Consultants Australia

CAPRICORN COPPER MINE TAILINGS STORAGE FACILITY 3 (TSF3)

Air Quality Assessment

Capricorn Copper



Date
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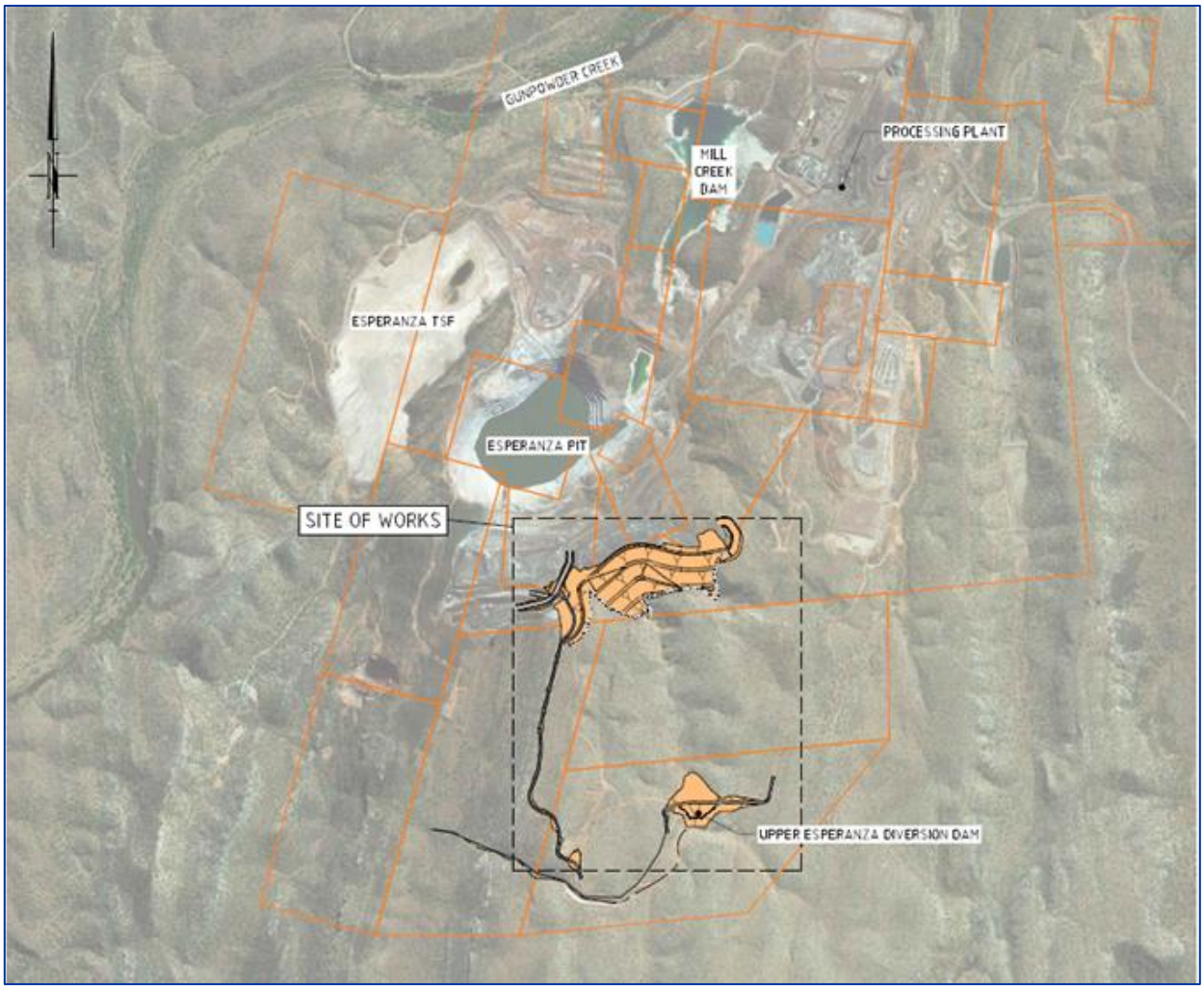
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1. INTRODUCTION

1.1 Overview

Trinity Consultants Australia has been commissioned by Epic Environmental on behalf of Capricorn Copper Mine (CCM) to provide air quality consultancy services for the CCM new greenfield tailings storage facility (TSF3) Project (the Project). The Project is located approximately 125 kilometres north-west of Mount Isa and 160 kilometres north-west of Cloncurry, North Queensland as shown in **Figure 1.1**.

Figure 1.1: Location of the Capricorn Copper Mine Project



1.2 Scope

This report presents an assessment of the potential air quality impacts associated with CCM TSF3 Project. It is to form an appendix to the Environmental Authority (EA) Amendment application for consideration by Queensland Department of Environment, Science and Innovation (DESI).

This report is based on the following tasks:

- Review the project and the associated potential air emissions.
- Review existing air quality monitoring data applicable to the project site.

- Develop emission inventories based on National Pollutant Inventory and USEPA AP-42 literature. Air pollutants to be included are particulates less than 2.5 microns ($PM_{2.5}$), particulates less than 10 microns (PM_{10}), total suspended particulates, dust deposition and hydrogen fluoride (HF).
- Model meteorological conditions using TAPM and CALMET.
- Model the dispersion of expected air pollutants based on proposed activities using Calpuff to estimate levels of the emissions reaching sensitive receptors and develop contours over the modelling domain.
- To enable cumulative impact assessment, model similar emissions from existing mining activities.
- Analyse the results of meteorological and pollutant dispersion modelling, including cumulative impacts and compare results with the relevant air quality criteria designed to protect human health and wellbeing, and dust deposition guidelines designed for amenity purposes.
- Provide recommendations on control measures and for monitoring and corrective actions.

To aid in the understanding of the terms in this report a glossary is included in **Appendix A**.

2. PROJECT DESCRIPTION

2.1 Overview

Capricorn Copper Pty Ltd (CCPL), a wholly owned subsidiary of 29Metals Limited, owns and operates the CCM located in Gunpowder within the Mount Isa Council, Northwest Queensland. The CCM is operated under the approval of EA EPML00911413 (dated 30 September 2022) and managed by DESI.

CCPL is currently seeking to construct a new greenfield tailings storage facility, TSF3, of approximately 54 hectares. The aim is to enable additional tailings storage as the current storage solutions are fast reaching capacity. It is understood that potential air quality issues arising from the project are likely to be dust from construction and from open surfaces including dry tailing surfaces. It is understood that cyanide is not used in the process or present in the tailings. Hydrogen fluoride (HF) is naturally occurring in the ground and so will be present in the particulate emissions.

The following sections provide details of the project and other existing CCM operations that are relevant to the air quality assessment.

2.2 Mining Process

Current mining process involves underground copper mining using traditional mining equipment. The underground mine ventilation system includes three exhaust vent shafts, as presented in **Figure 2.1**, which release particulates into the atmosphere.

Mined ore is transported to the co-located processing facility situated in the north-east corner of the CCM. The movement of transfer trucks on haul roads is a source of wind-blown dust emissions. **Table 2.1** presents the list of dust-generating equipment and the maximum number of units operational.

Table 2.1: Equipment Used for Underground Mining

Equipment Type	Model	Maximum number of operational units
Excavator	EX2500	2
Underground Loader (LHD)	Sandvik LH621i loader	5
Underground Truck	Sandvik TH663i truck	14
Production Drill	Sandvik DL422i production drill	3
Jumbo	Sandvik DD422i - DC jumbo	2
Integrated Tool Carrier	Volvo L120h wheel loader	6
Grader	Komatsu GD555-5 motor grader	2
Chargeup Unit	Normet MC605D charmec	2
ROM Loader	Komatsu WA600-6LC loader	1
Water Cart	Volvo A40G water truck	2
Agitator	Normet	3
Spray Rig	Normet	2
Light Trucks	Isuzu Service Truck	3
Light Buses	Isuzu NPS300	3
Light Vehicles	Toyota Landcruiser	22

Figure 2.1: Underground Mine Vent Locations



2.3 Processing Plant

The existing processing plant is designed for optimum recovery of copper at a commercially acceptable grade. The design has a maximum feed of 2,038,681 t/y of ore.

The processing of copper ores typically includes the following steps, as presented in the NPI Manual (1999) :

- crushing
- grinding
- flotation
- thickening/ concentrating
- smelting/electro-refining
- leaching/solvent extraction

Copper (Cu) is produced via two distinct processes, smelting/electro-refining and heap leach/solvent extraction/electrowinning. However, prior to the ore undergoing these processes, the copper must be liberated from the majority of waste rock. Depending on the mineralogy of the ore, this is typically achieved in three stages, crushing, grinding and flotation. The grade of the copper concentrate depends largely on the mineralogy of the ore and the degree of recovery, for example, a concentrate of pure chalcopyrite will contain nearly 35% Cu compared to a concentrate of pure bornite of 63% Cu, and chalcocite which would contain nearly 80% Cu (NPI Manual, 1999).

According to the provided information, smelting is undertaken in an offsite facility. Therefore, this assessment has not considered any air emissions associated with smelting/electro-refining and leaching/solvent extraction activities.

Particulate and fluoride are emitted from these processing operations, which are further discussed in **Section 6.3**.

2.4 Tailings Storage Facility (TSF)

2.4.1 Existing TSFs

Currently, CCM has two existing TSFs, namely E pit Tailings Storage Facility (EPit TSF) and Esperanza Tailings Storage Facility (ETSF), as shown in **Figure 1.1**. The tailings at EPit TSF are deposited as a wet slurry which does not produce dust, and the initial deposition will be via sub-aqueous means. The potential for tailings to dry and produce dust for the EPit TSF is limited, given the adoption of water cover to prevent oxidation of the potentially acid forming tailings. Under normal operating conditions, the ETSF is dry with minimal water held on the surface.

2.4.2 Proposed TSF3

Figure 2.2 illustrates the extent of tailings deposition in the proposed TSF3. The design requires civil works for the northern and southern embankments. To provide materials for TSF or embankment construction, potential borrow pits have been identified both close to the footprint of the project and offsite, as shown in **Figure 2.3**. A network of pipelines will be constructed to deliver the tailings from the processing operations to TSF3.

It is understood that potential air quality impacts arising from activities related to TSF3 are likely to be $PM_{2.5}$, PM_{10}, TSP, and fluoride during construction and operations.

Figure 2.2: TSF3 Concept Design

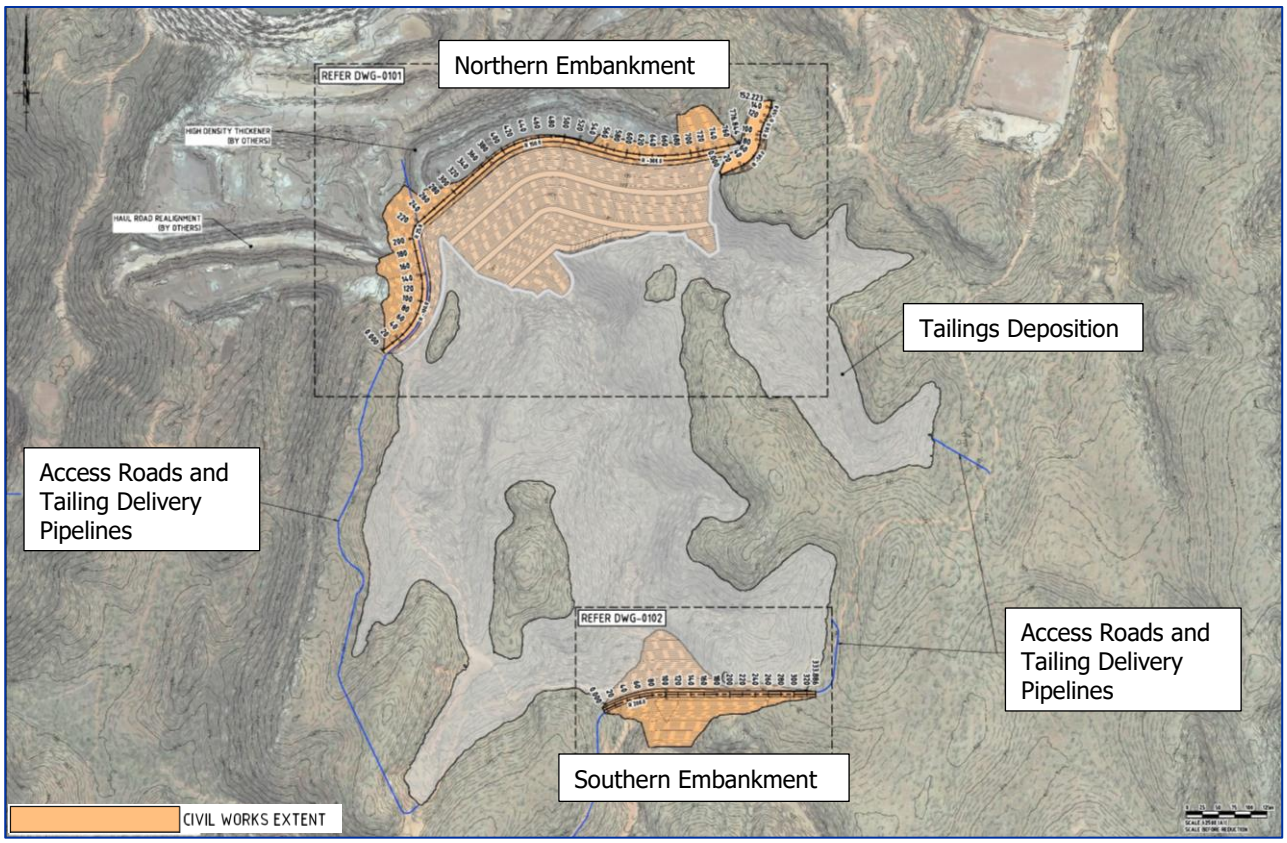
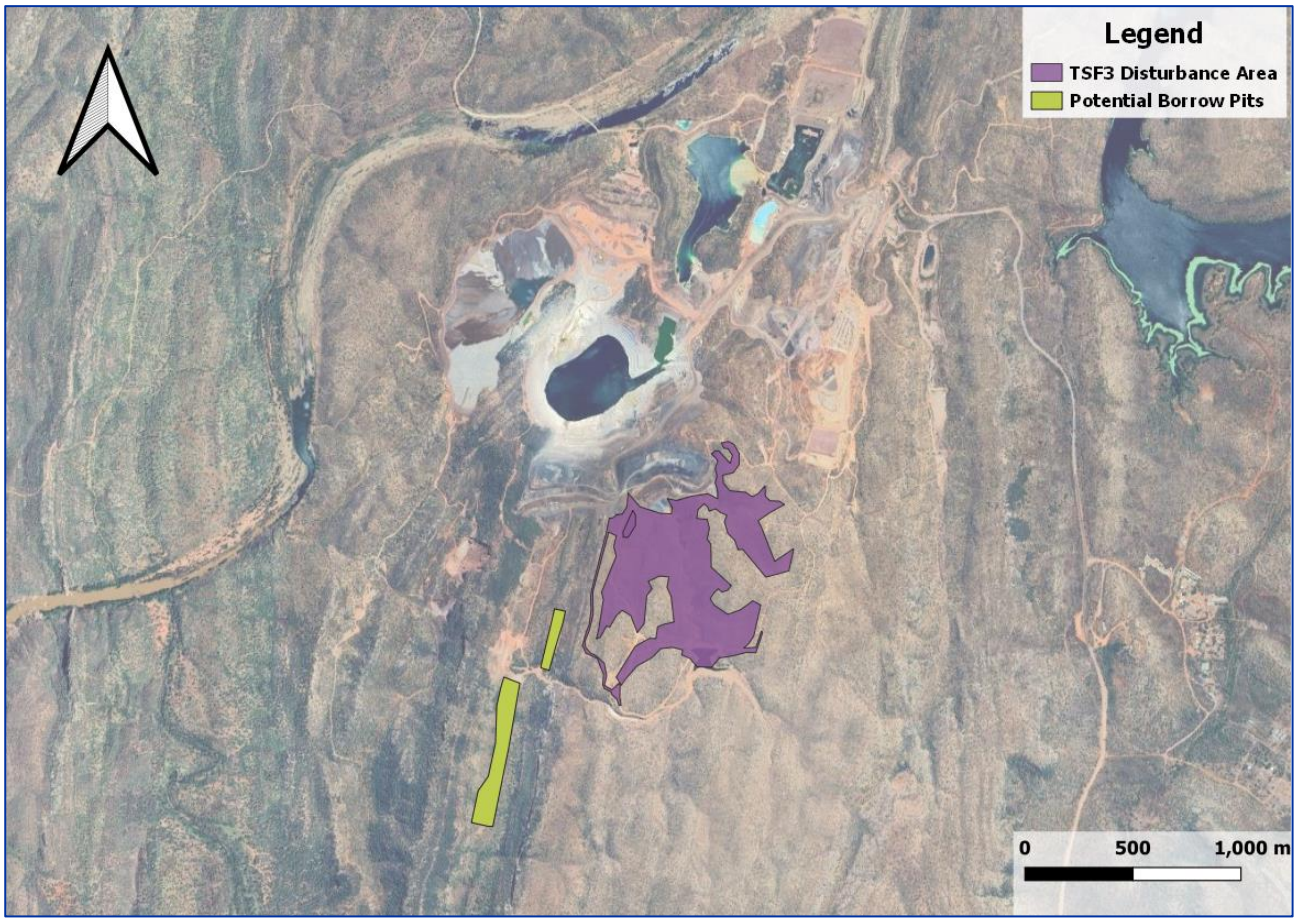


Figure 2.3: Provisional Clay Fill Borrow Pits



3. AIR QUALITY CRITERIA

3.1 Relevant Pollutants

The focus of the assessment is on the potential impacts due to emissions of particulate matter, through the resultant dust deposition and airborne concentrations.

Particulates include the following fractions:

- TSP is the total suspended particulate matter (TSP).
- PM_{10} is the fraction of particulate matter with equivalent aerodynamic diameters of 10 µm or less.
- $PM_{2.5}$ is the fraction of particulate matter with equivalent aerodynamic diameters of 2.5 µm and less.
- Fluoride in elemental form and as compounds.

Quantitative details of these emissions are provided in **Section 6**.

3.2 State Legislative Instruments

3.2.1 State Development Requirements

Table 22.1.2 of the State Development Assessment Provisions (2022) contains performance outcomes and acceptable outcomes for environmentally relevant activities. It requires development to be assessed against the following requirements:

- It must be suitably located and designed to avoid or mitigate environmental harm to the air environment.
- It must meet the air quality objectives of the Environmental Protection (Air) Policy 2019.

3.2.2 Queensland Environmental Protection Policy

The Environmental Protection (Air) Policy 2019 (EPP Air) provides objectives for air quality indicators (pollutants) that address the protection of health, the aesthetic environment, ecosystems and agriculture. The objectives relevant to this project have been summarised in **Table 3.1**.

Table 3.1: **EPP Air Quality Criteria**

Air Quality Indicator	Environmental value	Period	Criteria, µg/m^3
$PM_{2.5}$	Health and wellbeing	1 day	25
		1 year	8
PM_{10}		1 day	50
		1 year	25
TSP		1 year	90
fluoride	Health and biodiversity of ecosystems (other than protected areas)	24 hours	2.9
		30 days	0.84
		90 days	0.5
	Health and biodiversity of ecosystems (for protected areas)	90 days	0.1
	Protecting agriculture	24 hours	1.5
		30 days	0.4
		90 days	0.25

It is important to note that the EPP Air also contains a criterion for visibility reducing particles, but this is a measure of regional air quality and is not relevant to local sources. The impact of visible particles from local sources is addressed by the $PM_{2.5}$ criteria.

3.2.3 National Environmental Protection (Ambient Air Quality) Measure

The EPP Air incorporates most of the goals set out within the National Environmental Protection (Ambient Air Quality) Measure (NEPM). The current NEPM dated May 2021 includes $PM_{2.5}$ standards and goals, which are listed in **Table 3.2.** Exceedances of the particulate standards are no longer allowed apart from the exceptional events defined below.

Table 3.2: NEPM Ambient Air Quality Criteria

Air Quality Indicator	Period	Criteria, µg/m³
$PM_{2.5}$ goals for 2025	1 day	20
	1 year	7

Notes: For the purpose of reporting compliance against $PM_{2.5}$ 1-day average standards, jurisdictions shall exclude monitoring data that has been determined as being directly associated with an exceptional event (bushfire, jurisdiction authorised hazard reduction burning or continental scale windblown dust that causes exceedance of 1-day average standards).

At the time of this assessment, these $PM_{2.5}$ NEPM goals for 2025 had not been adopted in the EPP (Air). As such, the goals were not adopted for this Project. However, it is noted that the $PM_{2.5}$ emissions, most commonly associated with fuel combustion, are not likely to present a significant constraint to future mine operations.

3.2.4 DESI Guideline

3.2.4.1 Suspended Particulate Trigger Levels

The DESI Guideline for the *Application requirements for activities with impacts to air* (DESI, 2024) suggested that a short-term (24-hour average) TSP concentration at a sensitive receptor of greater than 90 µg/m³ may cause dust nuisance. Accordingly, it advises assessing the short-term (24-hour average) maximum TSP impacts against the trigger levels provided in the *Good practice guide for assessing and managing the environmental effects of dust emissions* (NZ Ministry for the Environment, 2016), as shown in **Table 3.3**.

The 24-hour average trigger level for a residential area is 60 µg/m³ which is more stringent than the EPP (Air) annual average TSP criterion of 90 µg/m³. The NZ Ministry for the Environment guide clearly states that these trigger levels are not meant for regulatory compliance purposes but are only applicable to monitoring data and for the purpose of alerting the operators into potentially taking additional dust control measures when triggered. This trigger level, which is well below the EPP (Air) threshold that protect human health, provide an indication of any need for dust impacts to be addressed in site management plans.

Table 3.3: Suggested 24-Hour Trigger Levels for TSP (NZ Ministry for the Environment, 2016)

Sensitivity of Receiving Environment	High	Moderate	Low
Trigger Level (µg/m³)	60	80	100

Notes: 1. In general, all residential areas will be high sensitivity
2. For managing chronic dust only

3.2.4.2 Dust Deposition

Whilst there are no quantitative limits specified in the legislation, there are guidelines designed to avoid nuisance caused by dust deposition fallout onto near horizontal surfaces.

The aforementioned DESI guideline suggests that a dust deposition limit of 120 mg/m²/day (3.6 g/m²/month), averaged over one month, is frequently used in Queensland. For extractive industries, it is the insoluble component of analysed dust that is used.

It should be noted that these values serve as indicators for the dust deposition levels that may cause nuisance at a sensitive place.

3.3 Summary of Relevant Pollutant Concentration Criteria

Table 3.4 presents a summary of the relevant air quality criteria adopted in this assessment.

Table 3.4: Summary of Relevant Air Quality Criteria

Air Quality Indicator	Environmental value	Period	Criteria, µg/m³
TSP	Health and wellbeing	24 hours	60
		1 year	90
PM_{10}		24 hours	50
		1 year	25
$PM_{2.5}$		24 hours	25
		1 year	8
dust deposition		1 month	120 mg/m²/day
fluoride	Health and biodiversity of ecosystems (other than protected areas)	24 hours	2.9
		30 days	0.84
		90 days	0.5

4. EXISTING ENVIRONMENT

4.1 Study Area Description

4.1.1 Overview

The Project is located in Gunpowder, approximately 125 kilometres (km) North-west of Mount Isa and 160 kilometres (km) north-west of Cloncurry, North Queensland.

4.2 Identification of Existing Sensitive Receptors

Key environmental priority areas to be considered in the assessment of environmental values to be enhanced or protected under the EPP (Air) is provided in the Air–EIS information guideline (DESI, 2022). These areas are referred to as sensitive receptors and include:

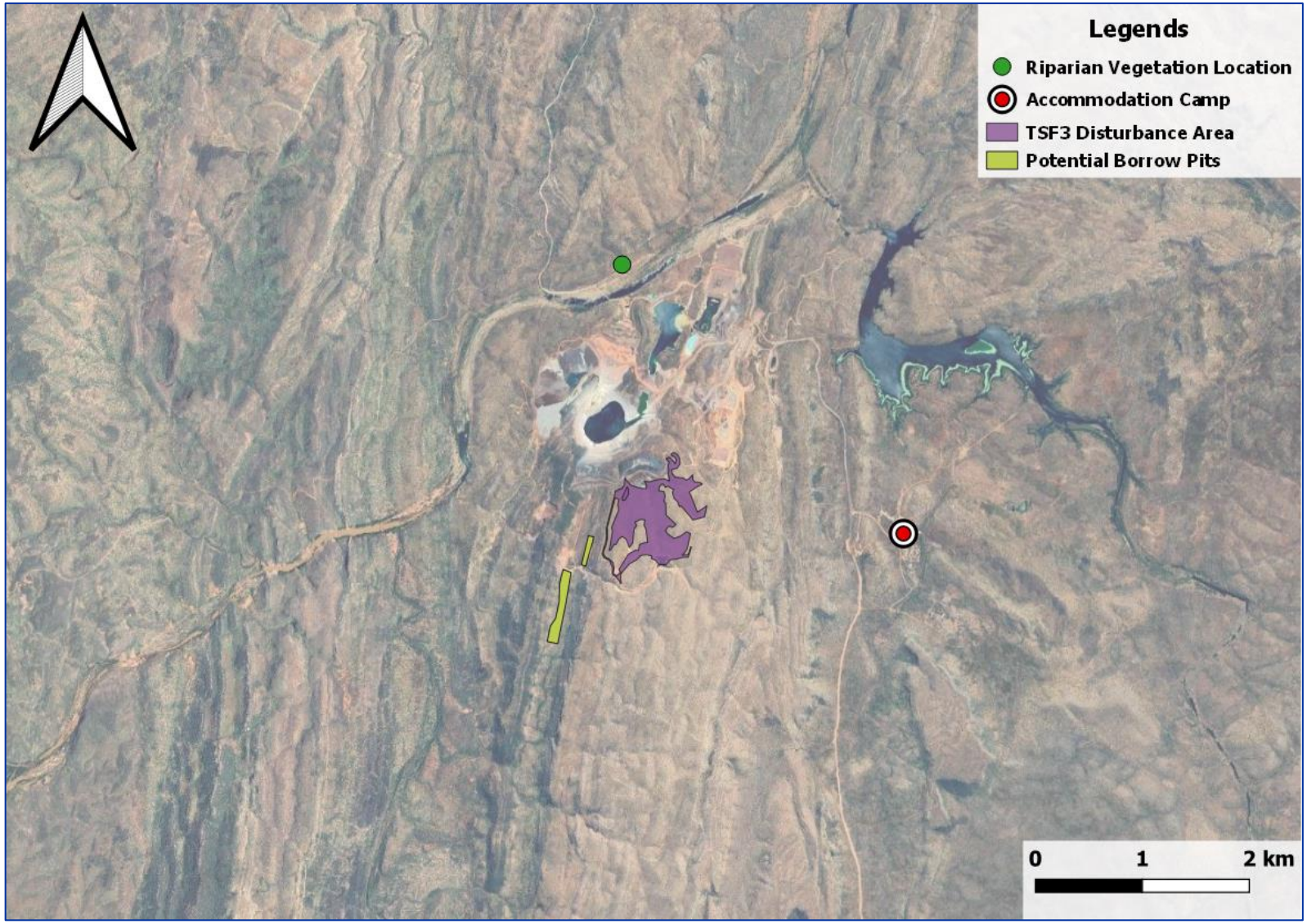
- remnant and regrowth ecosystems of all types
- a protected area under the Nature Conservation Act 1992 or the Marine Parks Act 2004 or a World Heritage Area
- all dwellings, residential allotments, mobile home or caravan parks, residential marinas or other residential premises
- a motel, hotel or hostel
- a kindergarten, school, university or other educational institution
- a medical centre or hospital
- a public park or garden
- a place used as a workplace including an office for business or commercial purposes

Potential sensitive receptors were identified in the Project area and their locations are shown in **Table 4.1** and **Figure 4.1**. The mine accommodation camp is part of the current Project operation and is considered as a sensitive receptor for due diligence purposes. The identified remnant vegetation is classified to be of Least Concern and is assessed using the relevant fluoride criteria for ecosystems other than protected areas.

Table 4.1: Potential Sensitive Receptors

Receptor	Receptor Description	Easting, m	Northing, m	Distance from Mining Area
Mine Accommodation Camp	Residential	330540	7819945	2.3 km SE
Bortala	Homesteads	340428	7820924	12.2 km E
Bar Creek	Homesteads	319081	7829175	11.7 km NW
New Chidna	Homesteads	329894	7842209	21 km NE
Riparian vegetation along Gunpowder Creek	Least Concern remnant vegetation	328384	7822658	0.4 km NW

Figure 4.1: Location of Potentially Sensitive Receptors



4.3 Existing Air Quality

4.3.1 Overview

Based on the rural nature of the regional area, it is expected that the air quality for the study area would be acceptable for the majority of the time with possible exceptions including dust and particulates. The existing air quality would be influenced by sporadic traffic on unsealed roads as well as bushfires, and controlled burning and dust from agriculture. Localised or short-term degradation of the air quality environment would most likely be due to smoke and dust from fires.

4.3.2 DESI The Gap (Mount Isa)

DESI's The Gap monitoring station, located approximately 120 kilometres south of the Project, provides the most representative air quality data for the Project area. The monitoring station was established in 2009 and is located close to an operating mine and a large metal smelter. The pollutant concentrations at this station are considered suitably conservative to represent background levels for this project. **Table 4.2** shows the PM_{10} concentrations over the period from 2010 to 2020.

Table 4.2: Concentrations Recorded by DESI The Gap Station

Year	70th percentile 24-hour average PM_{10} concentration, µg/m³	Annual average PM_{10} concentration, µg/m³
2010	10	9
2011	19	18
2012	22	19
2013	25	23
2014	22	20
2015	21	19
2016	19	17
2017	20	18
2018	25	24
2019	28	30
2020	21	20
Average	**21**	**20**

Based on a typical ambient $PM_{2.5}$ to PM_{10} ratio of 0.35, the background 24-hour average $PM_{2.5}$ concentration was estimated as 7.4 µg/m³ and the annual average $PM_{2.5}$ concentration as 7 µg/m³.

Based on a typical PM_{10} to TSP ratio of 0.39 (ACARP, 1999) at Australian mines, the annual average TSP background concentration for the assessment has been estimated as 51.3 µg/m³.

4.3.3 Dust Deposition

It is noted that dust deposition varies substantially depending on local sources within 1 kilometre of the site. Based on the experience of Trinity over a wide range of projects in rural agricultural or industrial areas across Queensland, dust deposition levels are typically 50 mg/m²/day. In urban areas, they are typically 40 mg/m²/day, and in forested areas, they are typically 30 mg/m²/day.

As the vicinity is rural with agricultural activities, a dust deposition level of 50 mg/m²/day has been adopted as the background for this study.

4.3.4 Summary of Estimated Background Levels

Based on the discussions in the preceding sections, the expected background air quality for key pollutants has been summarised with the estimated concentrations listed in **Table 4.3**. These are well within the criteria contained in **Table 3.4**. It is anticipated that the criteria are exceeded during regional events such as bushfires or dust storms.

Table 4.3: Adopted Background Air Quality

Air Quality Indicator	Period	Concentration, µg/m^3
$PM_{2.5}$	1 day	7.4
	1 year	7
PM_{10}	1 day	21
	1 year	20
TSP	1 year	51.3
dust deposition	1 month	50 mg/m^2/day

5. METEOROLOGY

5.1 Regional Climate

5.1.1 Overview

The climate class nominated by the Bureau of Meteorology (2023) for the area is grassland with hot humid summer and dry winter.

5.1.2 Weather Stations

The closest Australian Bureau of Meteorology (BOM) weather stations are located at Lake Julius (ID 029181) and the Mount Isa Aero (ID 0291274), approximately 60 kilometres south-east and 112 kilometres south of the Project area, respectively. **Table 5.1** shows information for the two nearby weather stations.

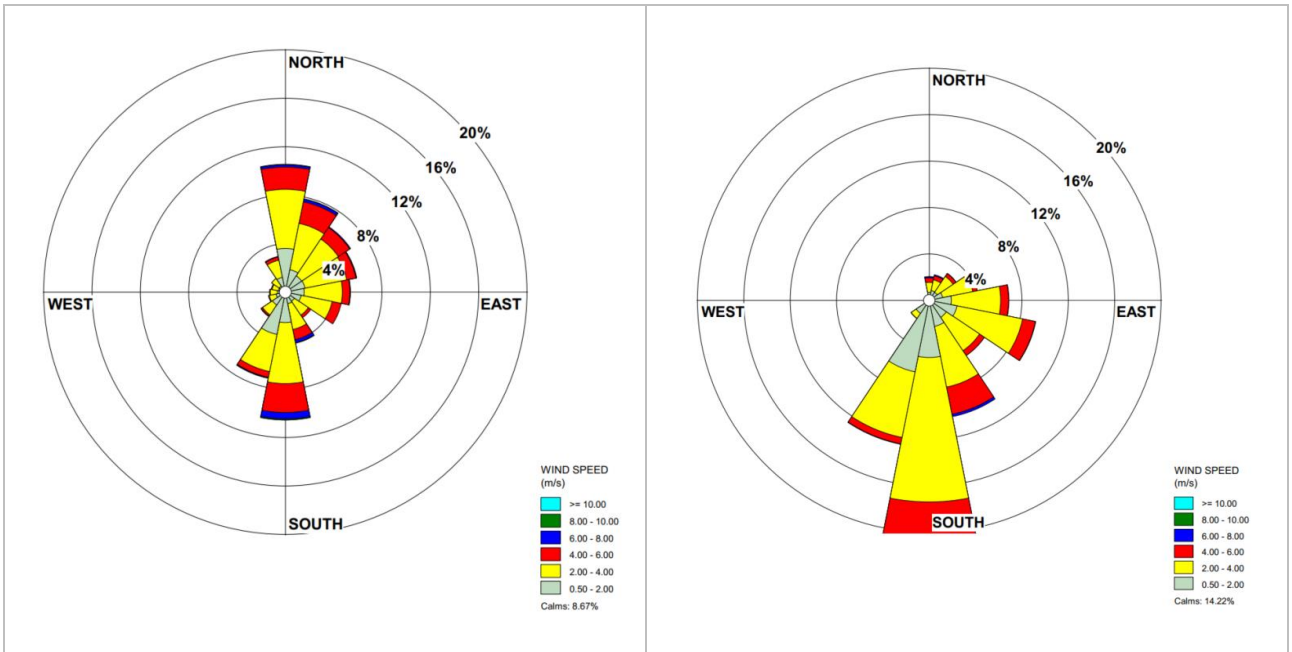
Table 5.1: Weather Stations

Station Name	Station Id	Coordinates	Distance from Site	Sensor Height	Operation Period	Used Parameters in this Assessment
Lake Julius	029181	366781, 7775095	60 km south-east	8 m	2013 - current	Wind Speed, Wind Direction,
Mount Isa Aero	029127	342459, 7712776	112 km south	8 m	1975 - current	Evaporation, Air Temperature, Rainfall

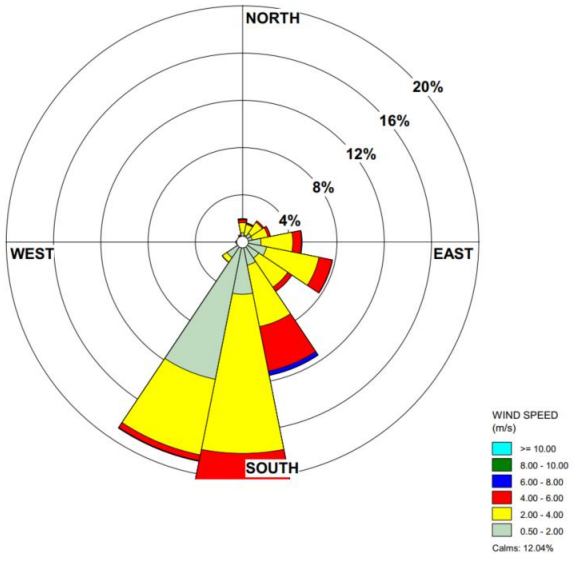
5.1.3 Historical Wind Records

Seasonal wind roses derived from BoM Lake Julius station data from January 2018 until December 2022 are provided in **Figure 5.1**.

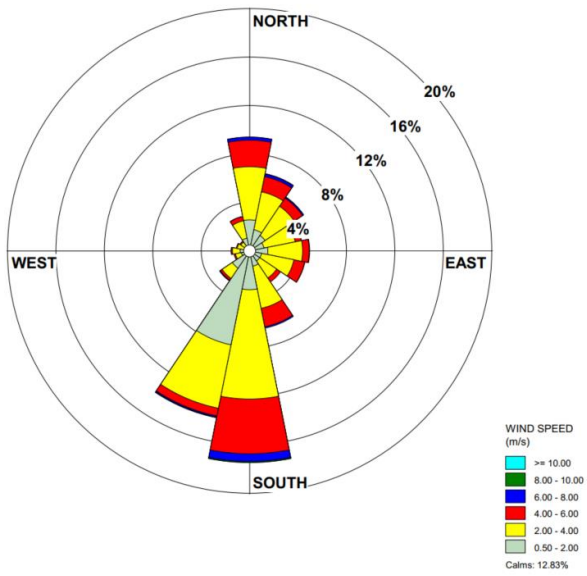
Figure 5.1: Seasonal Wind Roses (Year 2018 – 2022) – BoM Lake Julius Station



Summer (December – February)	Autumn (March – May)



Winter (June – August)



Spring (September – November)

5.1.4 Historical Temperature and Rainfall Data

Long-term temperature and rainfall data from the Mount Isa Aero weather station are summarised in **Table 5.2**.

Table 5.2: Climate Statistics for Mount Isa Aero (years 1991-2020)

Month	Mean Daily Maximum Temperature, °C	Mean Daily Minimum Temperature, °C	Mean Monthly Rainfall, mm	Highest Monthly Rainfall, mm	Lowest Monthly Rainfall, mm
Jan	36.5	23.6	133.2	535.2	7.6
Feb	35.7	23.1	114.6	278.2	12.8
Mar	34.7	21.6	65.6	276.6	0
Apr	32.5	18.4	10.9	167.8	0
May	28.3	13.5	8	56.2	0
Jun	25.3	9.9	9.2	111.8	0
Jul	25.5	8.7	2.9	26.4	0
Aug	27.8	9.8	2.3	18	0
Sep	32.3	14.1	8.6	117	0
Oct	35.3	18.4	16.8	88.2	0
Nov	37	21.4	47.8	205.6	0.6
Dec	37.4	23.2	82.2	275.2	0
Mean	**32.4**	**17.1**	**41.8**	**179.7**	**1.8**

5.2 Potential Future Changes to Climate

Future climate patterns may differ from the existing data due to global warming or other trends. The important parameters for dispersion are wind speed and direction, rain and humidity, and the frequency of temperature inversions. Predicted changes in climate in Queensland are provided on the Queensland Future Climate Dashboard (State of Queensland 2021).

5.2.1 Wind

Prevailing wind patterns are determined by regional topography and land-sea interface, so it is unlikely that in the foreseeable future, these patterns will change even with global warming. Average wind speeds for the project area are predicted to increase slightly (less than 0.05 m/s).

To allow for minor fluctuations in wind patterns, contours can be smoothed to remove inward curves when recommending buffer zones.

5.2.2 Rain & Humidity

Predicted changes in rainfall in North-West Queensland due to climate change are shown in **Table 5.3**. If rainfall is reduced, more water would be required for dust suppression or dust emissions would increase. Reduced rain and humidity would also cause a minor reduction in wet deposition of particles.

Note that the Queensland government's approach is to allow for a 25% increase in rainfall intensity when designing projects.

Table 5.3: Annual Rainfall Projections for North-West Queensland (Percentage Change)

Emissions Scenario	Projections for 2030 [Range – 5th to 95th percentile (median change) %]	Projections for 2050 [Range – 5th to 95th percentile (median change) %]	Projections for 2070 [Range – 5th to 95th percentile (median change) %]
Low Emissions (RCP 4.5)	-11 to +10 (-2)	-14 to +14 (-1)	-26 to +12 (-3)
High Emissions (RCP 8.5)	-19 to +13 (-3)	-24 to +18 (-0)	-24 to +19 (+1)

Notes:

1. *Source: Queensland Government (2022)*
2. *RCP is Representative Concentration Pathways. RCP 4.5 assumes a reduction in greenhouse gas emissions. RCP 8.5 assumes business as usual or no curbing of greenhouse gas emissions*

5.2.3 Temperature Inversions

When temperature inversion occurs at heights of 100 or 200 metres above the ground, a mixing layer is formed underneath trapping emissions within this layer. This condition tends to be strongest during early mornings with cold stable atmospheric conditions. There is very little change in winter solar radiation predicted for the project area.

5.3 TAPM Meteorological Modelling

The absence of a weather station in the immediate vicinity of the project area poses a challenge in assimilating surface data for the subject site. To improve accuracy, meteorological output from the regional model TAPM was used to initialise the local meteorological model CALMET to obtain the most representative meteorological input for air dispersion modelling.

5.3.1 TAPM Fundamentals

The meteorological component of The Air Pollution Model (TAPM) was evaluated to provide wind fields over the region.

The databases required to run TAPM are provided by CSIRO and include global and Australian terrain height data, vegetation and soil type datasets, sea surface temperature datasets and synoptic scale meteorological datasets.

The Australian terrain data are in the form of 9-second grid spacing (approximately 0.3 kilometres) and are based on data available from Geosciences Australia. Australian vegetation and soil type data are on a longitude/latitude grid at 3-minute grid spacing (approximately 5 kilometres) and is public domain data provided by CSIRO Wildlife and Ecology.

The synoptic scale meteorology dataset used is a six-hourly synoptic scale analysis on a longitude/latitude grid at 0.75 or 1.0-degree grid spacing (approximately 75 kilometres or 100 kilometres). The database is derived from US NCEP reanalysis synoptic products.

TAPM dynamically fits the gridded data for the selected region to finer grids including the influences of terrain, surface type and surface moisture conditions. It produces detailed fields of hourly estimated temperature, winds, pressure, turbulence, cloud cover and humidity at various levels in the atmosphere as well as surface solar radiation and rainfall.

5.3.2 TAPM Configuration

TAPM was set up using four nested 30 x 30 grids centred on latitude 19°41.5′ south, longitude 139°22.0′ east. The four nested grids were as follows:

- 750 km x 750 km with 25 km resolution
- 192 km x 192 km with 6.4 km resolution
- 48 km x 48 km with 1.6 km resolution
- 12 km x 12 km with 0.4 km resolution

Thirty (30) vertical levels were used with lower-level steps at 10, 25, 50, 75 and 100 metres up to 8 kilometres in altitude. This is a greater than normal number of vertical layers in order to provide better resolution of vertical layers. Boundary conditions on the outer grid were derived from the synoptic analysis. Non-hydrostatic pressures were ignored due to the gentle terrain and moderate resolution.

TAPM land use data was updated using the latest aerial photography available from Google Earth.

5.3.3 Observational Data Assimilation

The wind speed frequency distribution over five years from 2018 to 2022 at the BoM Lake Julius station is presented in **Table 5.4**. The year 2020 experienced typical average wind speed conditions. Calm conditions, which are worst case for ground-level emissions, occurred at higher-than-average frequency in 2020 so this year is reasonably conservative. Hence, 2020 wind data was used for dispersion modelling.

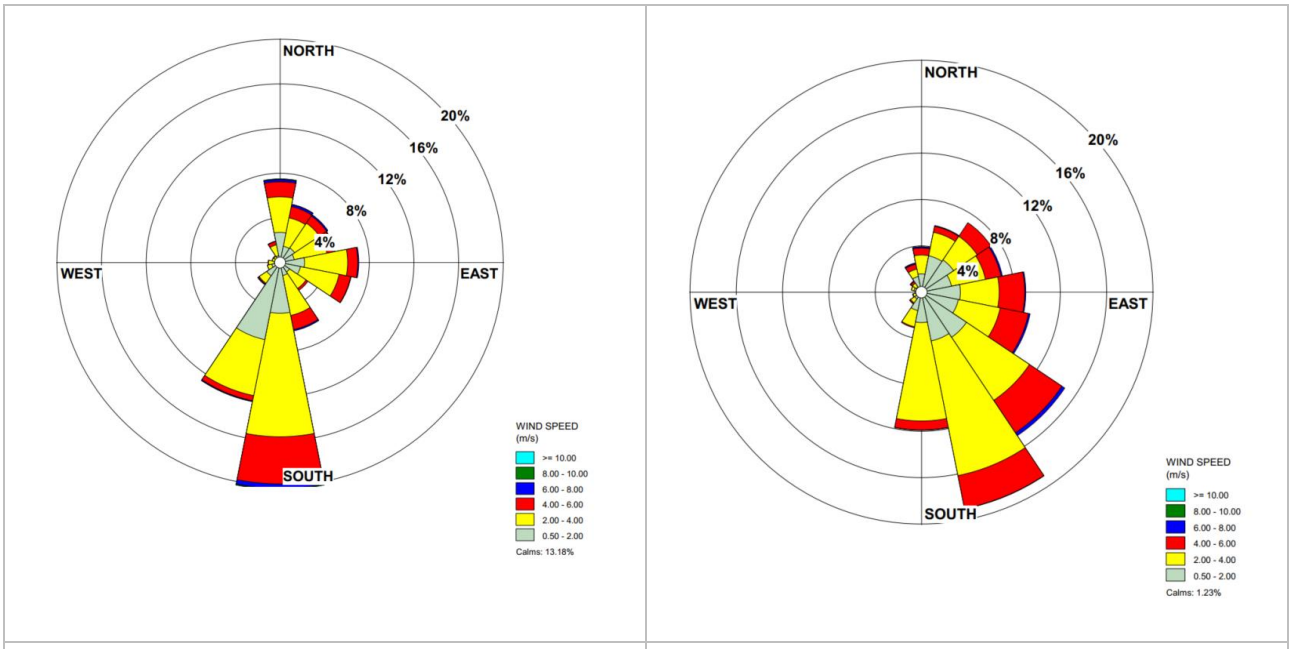
Table 5.4: Frequency Distribution of Wind Speeds

Year	Calm (0-0.5 m/s), %	0.5–2 m/s, %	Avg wind speed, m/s
2018	9.9	31.8	2.3
2019	8.1	28.8	2.5
2020	**13.2**	**28.9**	**2.2**
2021	15	25.1	2.2
2022	13.6	20.2	2.3
Average	**12**	**27**	**2.3**

Meteorological data from the BoM Lake Julius station for the period from 1 January to 31 December 2020 was available for analysis and assimilation into the model run. TAPM was run without assimilation of this data and the wind rose for the same period. A comparison of the wind rose derived form the Lake Julius station and that predicted by TAPM is shown in **Figure 5.2**.

The two wind roses show a comparatively similar wind direction pattern, with a higher proportion of winds with a southerly component in both datasets, although this is more dominant in the TAPM dataset. Calm conditions are less frequent with TAPM predictions, but frequency of low wind speeds (0.5–2 m/s) were higher at 34.7% compared to the observational data, which is at 28.9%. TAPM predicted a higher proportion of light winds from the south-east and north-east directions.

Figure 5.2: Wind Rose of BoM Lake Julius Weather Station Data and TAPM for Year 2020



BoM Lake Julius	TAPM

5.4 CALMET Modelling

5.4.1 CALMET Configuration

The CALMET configuration used is consistent with the NSW OEH guidance (TRC 2011).

The model was run over the full year of 2020 based on a 3-dimensional grid produced using the CALWRF utility program to convert WRF data to M3D format suitable for CALMET to read. The CALMET grid was set to a grid spacing of 100 metres and 100 by 100 grid points. Twelve vertical layers were modelled with cell face

heights between 0, 20, 40, 80, 160, 320, 640, 900, 1200, 1800, 2500, 3000 and 4000 metres. This is greater than the normal number of vertical layers to provide better resolution.

Mixing height calculation parameters were set to default values. Temperature prediction parameters were set to default. Divergence minimisation was used. The critical Froude number was set to 1. Slope flow effects were included. The radius of influence of terrain features for the CALMET setup was set to 2 km.

The output from CALMET was a three-dimensional grid of wind-field data and it was then used as input into CALPUFF.

5.4.2 Terrain and Land Use Data

Terrain height was based on data from the Shuttle Radar Imaging Mission (SRTM) and obtained from Geoscience Australia. This produced terrain height data on 1 arc-second longitude/latitude grid (approximately 0.03 kilometres) for a grid domain of 100 km x 100 km encompassing the site region. Land use data from Queensland Spatial Catalogue was incorporated into the CALMET model. **Figure 5.3** presents the modelled land use and **Figure 5.4** presents modelled terrain for the site.

Figure 5.3: Modelled Land Use

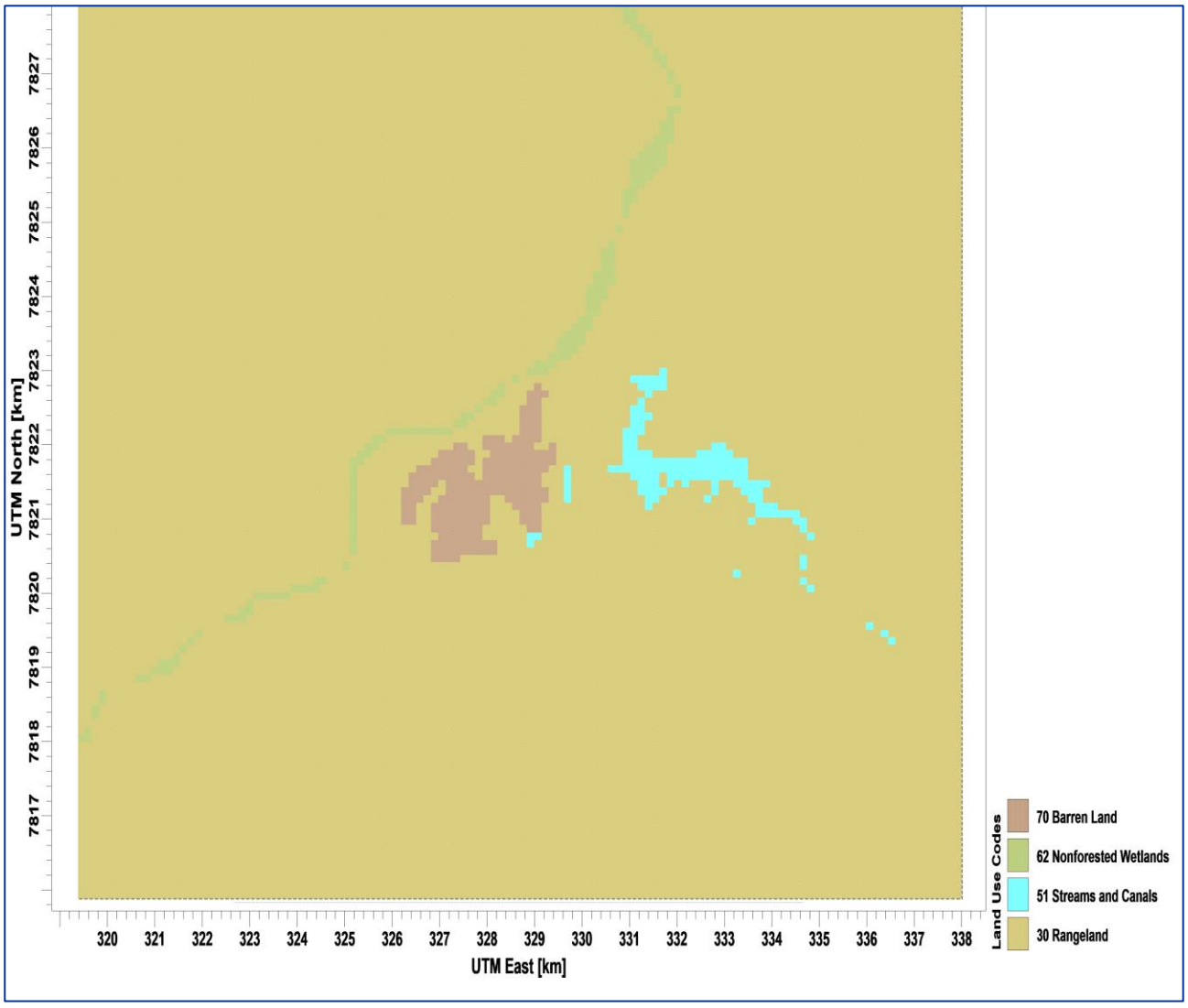
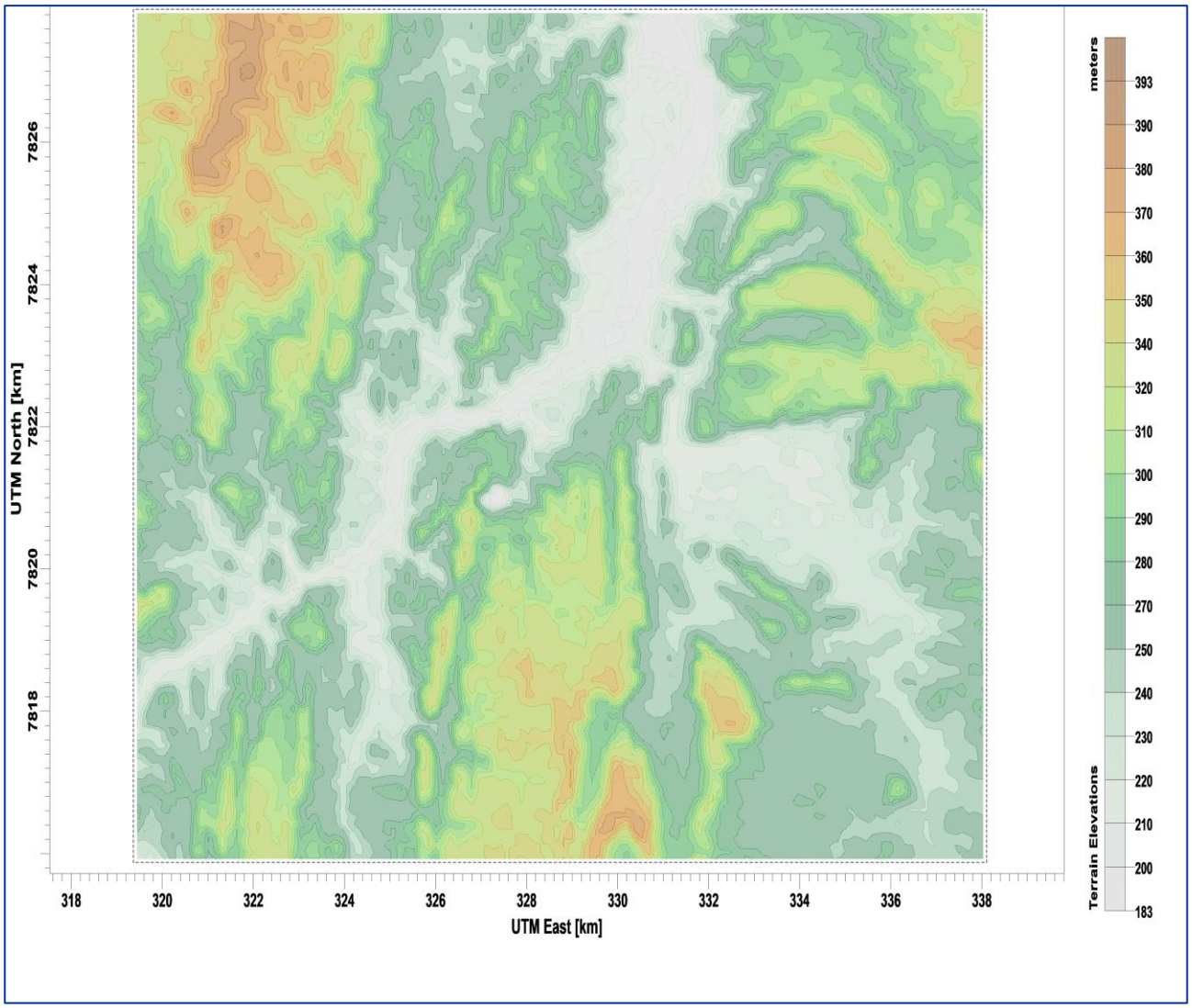


Figure 5.4: Modelled Terrain



5.5 Meteorological Predictions

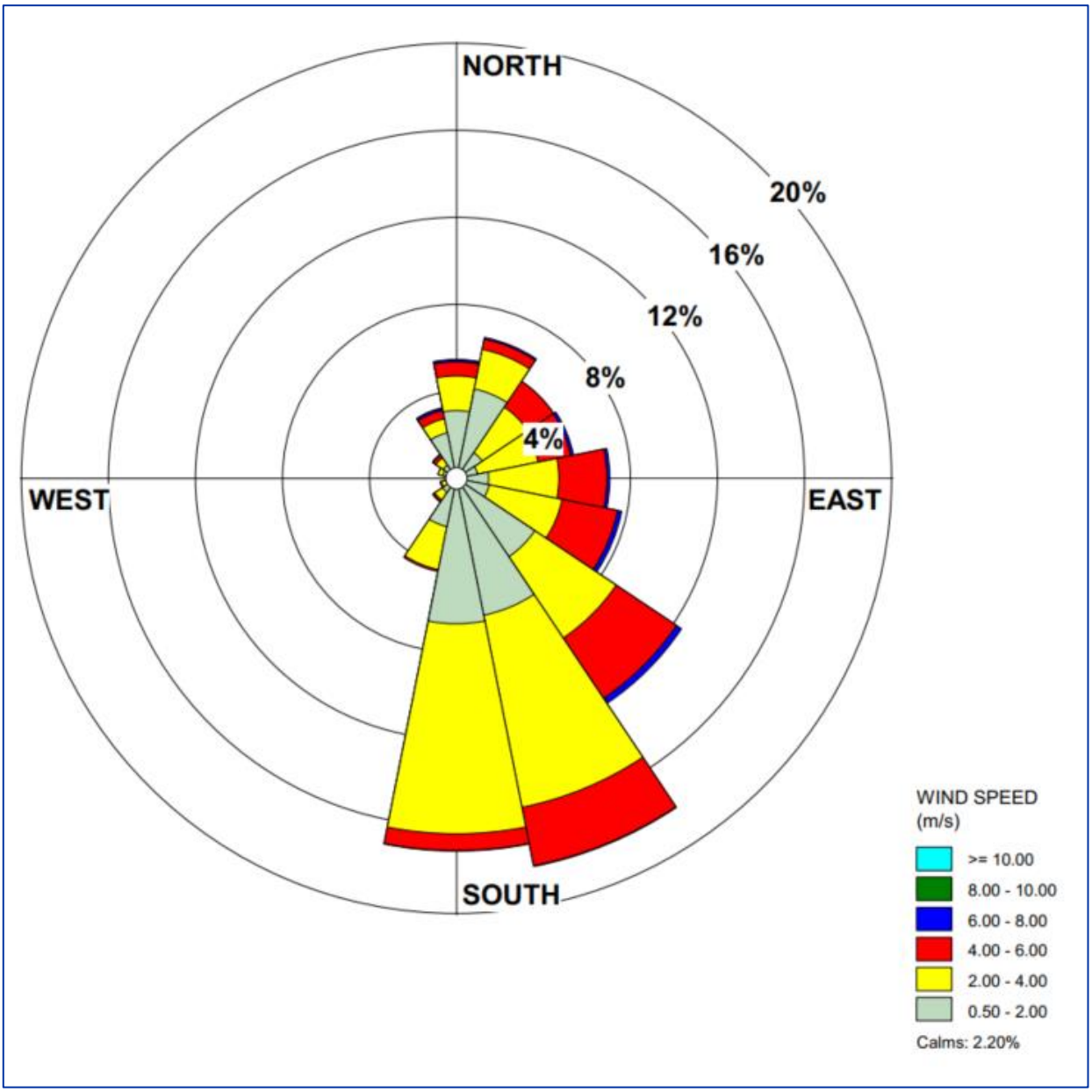
5.5.1 Wind Speed and Direction

The frequency distributions of occurrences of winds for each direction sector and each wind speed class as predicted by CALMET are shown in **Table 5.5** and illustrated as wind rose in **Figure 5.5**. The frequency of calm to light winds up to 2.0 m/s is 39.7%. The wind rose shows predominant winds originating from the south-southeast direction.

Table 5.5: Frequency Distribution of Wind Speed and Direction Predicted by CALMET for Project Site

Direction	Wind Speed (m/s)						Total %
	0.50-2.00	2.00-4.00	4.00-6.00	6.00-8.00	8.00-10.00	>= 10.00	
Calm	-	-	-	-	-	-	**2.2**
N	3.1	1.6	0.6	0.1	0.0	0.0	**5.5**
NNE	4.2	1.9	0.5	0.1	0.0	0.0	**6.6**
NE	1.4	2.5	1.4	0.0	0.0	0.0	**5.4**
ENE	1.0	2.8	1.5	0.1	0.0	0.0	**5.5**
E	1.5	3.2	2.2	0.1	0.0	0.0	**7.0**
ESE	1.5	3.4	2.6	0.2	0.0	0.0	**7.7**
SE	4.3	4.5	3.3	0.3	0.0	0.0	**12.4**
SSE	6.4	9.0	2.7	0.0	0.0	0.0	**18.1**
S	6.7	9.6	0.8	0.0	0.0	0.0	**17.1**
SSW	2.3	2.0	0.1	0.0	0.0	0.0	**4.4**
SW	0.8	0.4	0.1	0.0	0.0	0.0	**1.3**
WSW	0.5	0.2	0.1	0.0	0.0	0.0	**0.8**
W	0.4	0.2	0.0	0.0	0.0	0.0	**0.6**
WNW	0.6	0.2	0.0	0.0	0.0	0.0	**0.9**
NW	0.7	0.4	0.2	0.0	0.0	0.0	**1.3**
NNW	2.1	0.7	0.4	0.1	0.0	0.0	**3.3**
Total %	**37.5**	**42.7**	**16.5**	**1.1**	**0.0**	**0.0**	**97.8**

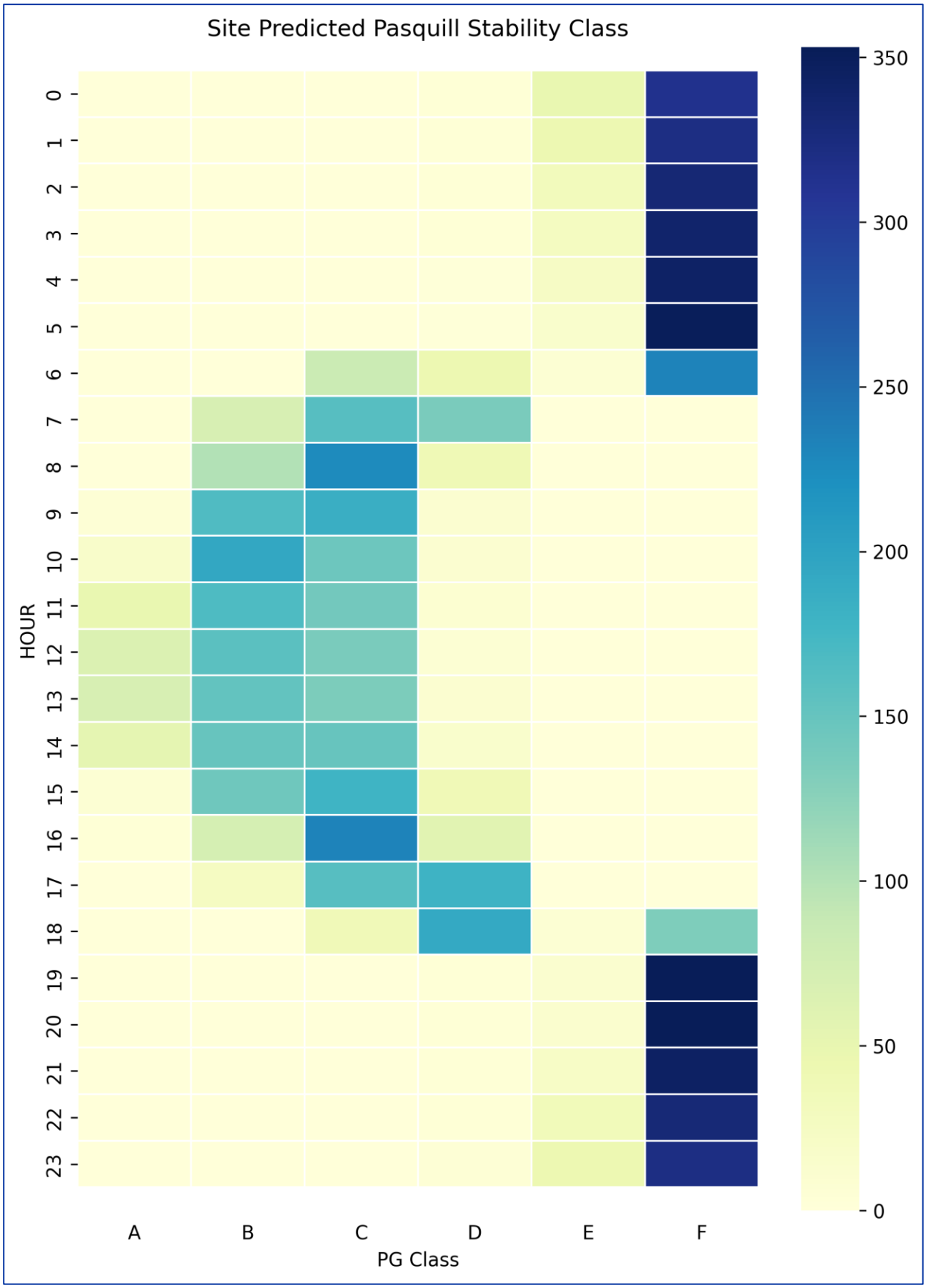
Figure 5.5: CALMET Predicted Windrose for Project Site



5.5.2 Stability Class

Figure 5.6 shows the frequency of stability classes throughout the day. Daytime conditions are either neutral or unstable, whilst nighttime conditions are stable or neutral.

Figure 5.6: Diurnal Frequency of Stability Classes

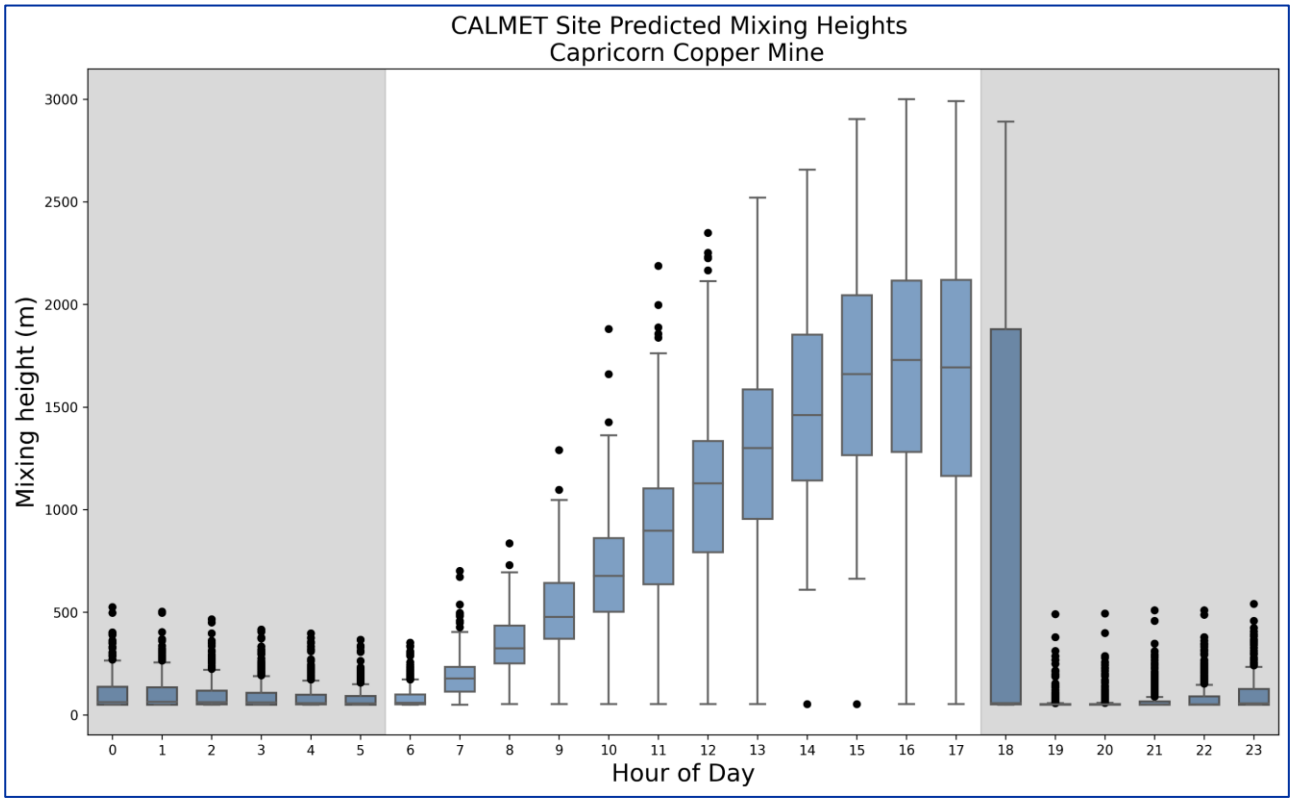


5.5.3 Mixing Height

Figure 5.7 shows the variation in mixing height throughout the day.

In the morning, the mixing height rises gradually, reaching an average of approximately 1.6 kilometres by the afternoon, and then rapidly reforming at ground level again at nightfall.

Figure 5.7: Prediction of Mixing Height from CALMET Model for Croydon Gold Mine Project



6. EMISSION INVENTORY

6.1 Fluoride to PM_{10} Ratio

NPI-reported emissions by CCM for the five most recently available years have been analysed to obtain the ratio of fluoride to PM_{10} emissions. The average ratio of PM_{10} to fluoride compounds was determined to be 0.00117, which was then used in this assessment to estimate fluoride emissions from different processes and sources.

6.2 Emission Inventory for the Mining Activities

6.2.1 Emission Inventory Calculations for Particulates

The emission rates entered into the dispersion modelling are based on the activity and source information provided as listed in **Section 2.2**. For the purpose of dispersion modelling, it has been conservatively assumed that product will be transported via a dedicated haul route which will have a comparatively higher potential to generate dust emissions. **Appendix B** provides the calculation methods for significant particulate sources.

Note that the NPI manual is designed for estimating total annual emissions. Some of the equations are based on annual averages of wind speed and rainfall. Using annual averages is not appropriate for dispersion modelling where maximum 24-hour concentrations may occur during dry, windy conditions.

Therefore, in this project, rain has been removed from the emission calculations and, emission rates are variable dependent on wind speed category.

Major emission sources associated with the mining activities include the following:

- Underground mining emissions released through the mine ventilation system;
- Haul route emissions;
- Loading ore and overburden (waste) to the raw stockpile;
- Loading ore to the processing facility;
- Wind erosion from stockpiles.

The three underground mine exhaust vents have diameters of 5 metres and flow rates of 230 m^3/s, 200 m^3/s and 56 m^3/s for Vent 1, Vent 2, and Vent 3, respectively. The concentration of particulate matter in the exhaust air is unknown and will depend on a number of factors, in particular the effectiveness of dust controls in the mine. The maximum flow rate in each vent was used for emission calculations and it was assumed conservatively that 100% of the emissions are TSP and at 10 mg/m^3 which corresponds to the exposure standards for inhalable dust in NSW mines (NSW Resources Regulator, 2018). Inhalable dust includes particles as large as 100 microns in diameter, which includes the size fractions represented by TSP. Therefore, TSP concentrations in the exhaust air are unlikely to exceed 10 mg/m^3.

PM_{10} and $PM_{2.5}$ were estimated based on a typical PM_{10} to TSP ratio of 0.39 around Australian mines (ACARP, 1999), and an assumed $PM_{2.5}$ to PM_{10} ratio of 0.35. **Table 6.1** presents the underground mining emission inventory.

Table 6.1: Underground Mining Emission Inventory for 1 Year Period

Pollutant	Unit	Vent 1	Vent 2	Vent 3	Total
TSP	kg/year	72,533	63,072	17,660	**153,265**
PM_{10}	kg/year	28,288	24,598	6,888	**59,774**
$PM_{2.5}$	kg/year	9,901	8,609	2,411	**20,921**
Fluoride	kg/year	33	29	8	**70**

A summary of emission inventory for all mining activities is provided in **Table 6.2**. Emissions are based on the projected maximum production rates of ore and overburden (waste) at 2,038,681 t/y and 471,676 t/y, respectively.

Table 6.2: Emission Inventory Associated with Mining Activities for 1 Year Period

Source	TSP, kg/year	PM_{10}, kg/year	$PM_{2.5}$, kg/year	Fluoride, kg/year
Truck Unloading Ore	5,763	2,726	0	3.2
Truck Unloading Overburden/Waste	1,078	510	77	0.6
Mine Trucks on Unpaved Roads (Overburden/Waste)	3,493	1,069	107	1.3
Mine Trucks on Unpaved Roads (Ore)	278,971	85,399	8,540	100
Wind Erosion	19,814	9,907	743	12
Underground Mine Exhaust Vents (total three)	153,265	59,774	20,921	70
Total	**462,384**	**159,385**	**30,388**	**187**

Insubstantial sources not included in the dispersion model were:

- dust from covered products in haul trucks on sealed public roads;
- particulates from engine exhausts;
- dust from light vehicles and water trucks.

6.2.2 Dust Control Measures

Emission controls recommended to be implemented to reduce particulate emissions that have been included in the dispersion modelling are presented in **Table 6.3.** The control efficiencies of these technologies are derived from Environment Australia (2012).

Table 6.3: Dust Emission Controls

Emission Source	Control(s) Utilised	Control Efficiency Applied	Water Application, $L/m^2/h$
Vehicles on unpaved roads	Chemical suppressants and/or watering	80%	0.006
Loading to stockpiles	Water sprays on stacker	80%	0.006

In addition to **Table 6.3**, pit retention factors of 50% for TSP and 5% for PM_{10} were utilised for activities located within the pit. These factors are specified by Environment Australia (2012).

6.2.3 Other Source Parameters

Other source parameters for mining used in modelling are provided in **Table 6.4** and **Table 6.5**. The modelled source locations are presented in **Figure 6.1** and **6.2**.

Table 6.4: Other Source Parameters for Underground Mining Equipment

Source	Easting, m (UTM)	Northing, m (UTM)	Effective height, m	SigmaY, m	SigmaZ, m
Truck Unloading Overburden/Waste	328857.1	7821082.5	6	7	7
Truck Unloading Ore	328695.6	7821814.1	6	4.7	7

Table 6.5: Other Source Parameters for Underground Mine Exhaust Vents

Items	Units	Vent 1	Vent 2	Vent 3
Vent Height	m	3	3	3
Vent Positioning	-	Vertical	Vertical	Vertical
Vent Diameter	m	5	5	5
Flow Rate	m^3/s	230	200	56
Exit Velocity	m/s	11.7	10.2	2.9
Exit Temperature	°C	25	25	25
Location	Easting (m), Northing (m)	327447.2, 7820030.9	328544.8, 7820660.8	329167.3, 7821526.6

Figure 6.1: Modelled Source Locations (Mining and Processing)

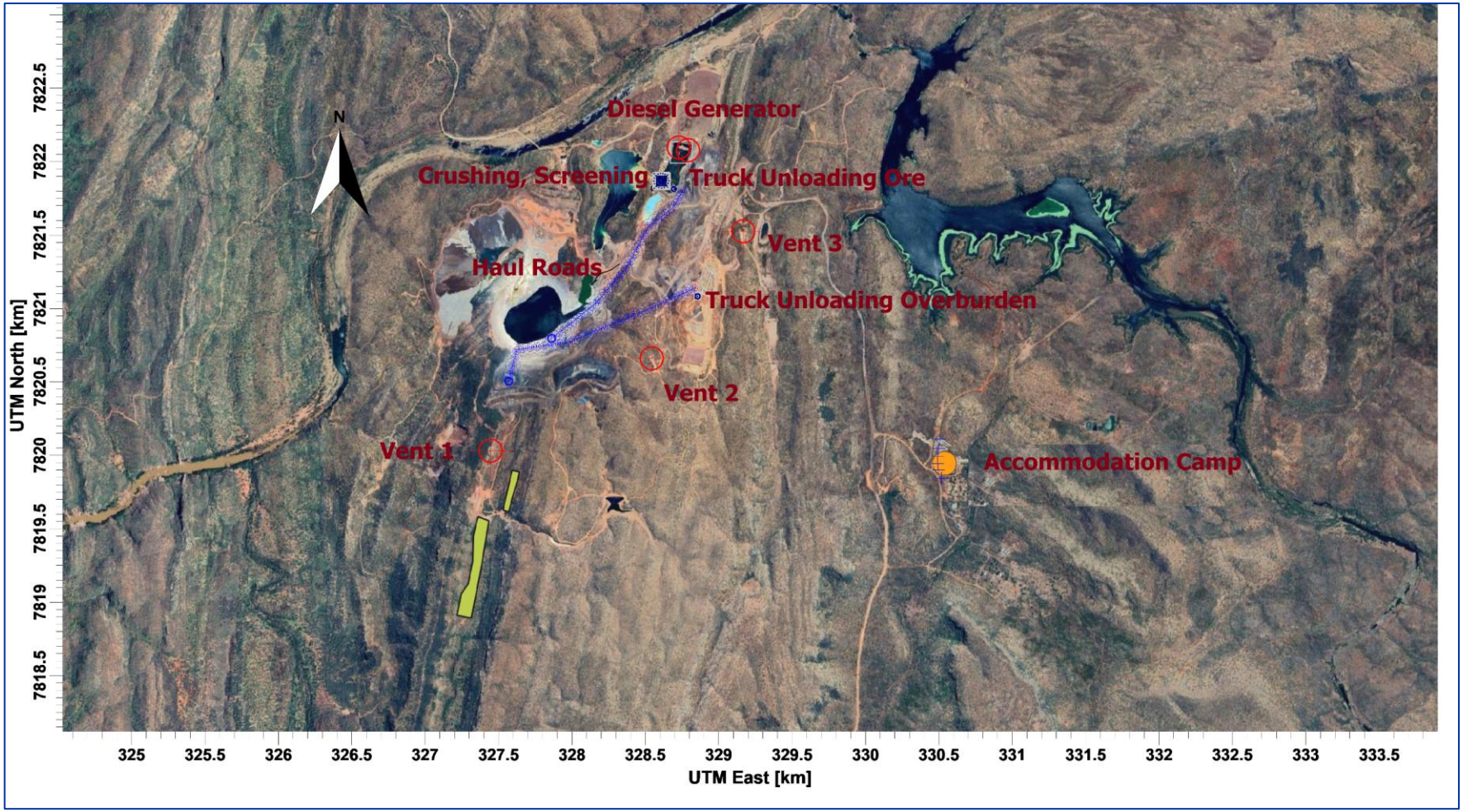
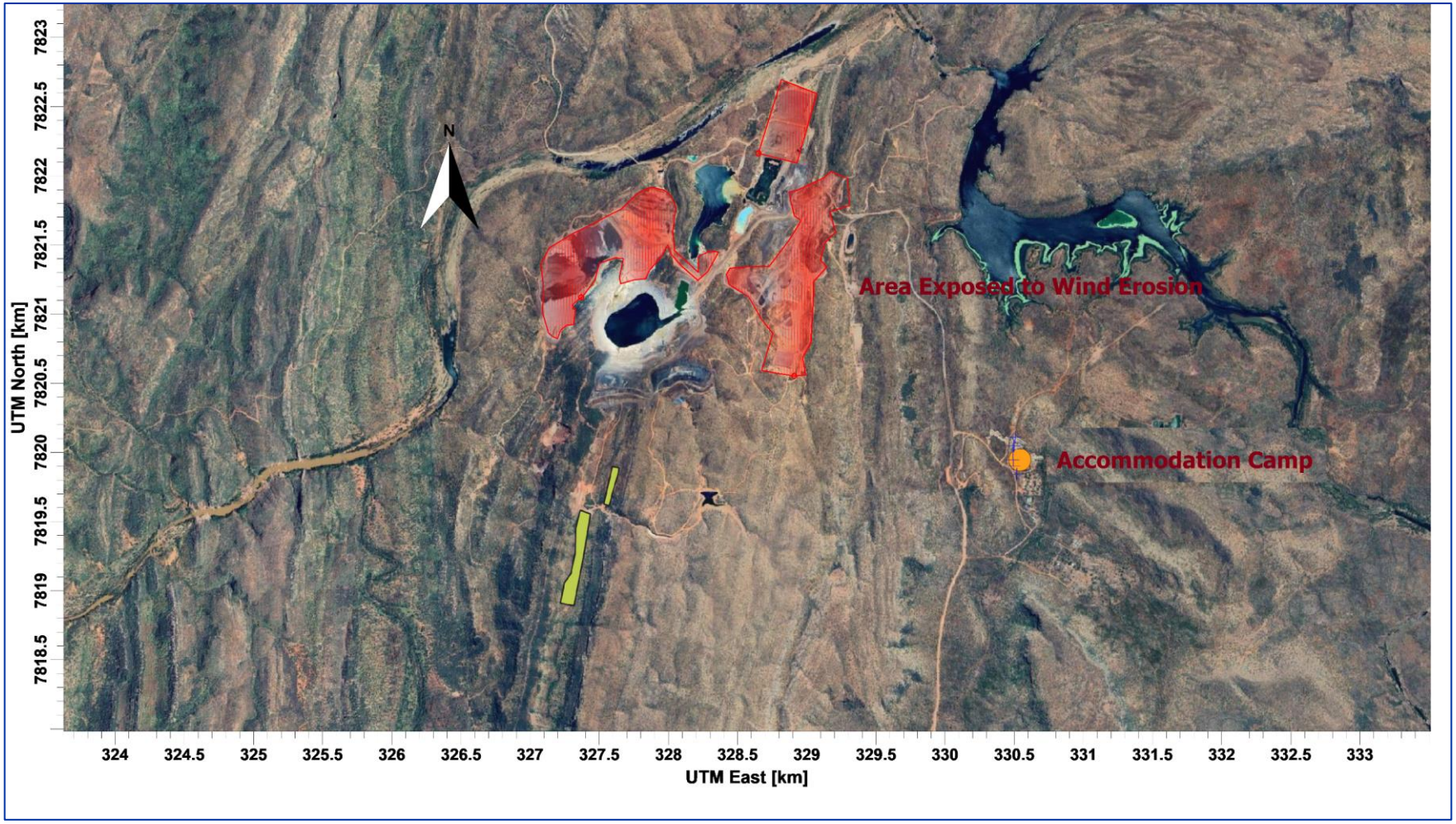


Figure 6.2: Modelled Area Source Locations (Mining and Processing)



6.3 Emission Inventory for Processing Plant

The emission rates entered into the dispersion modelling are based on the activity and source information presented in **Section 2.2**.

6.3.1 Crushing, Screening and Transfers to Stockpiles

Crushing, screening and transfers to stockpiles emissions have been calculated based on the maximum ore extraction rate of 2,038,681 t/y. The current crushing and screening equipment is equipped with a standard dust suppression control. Following the guidelines presented in Table 4 of the NPI Mining manual (NPI, 2012), a conservative 65% control efficiency (cyclone dust collectors) has been considered for these processes that employ dust control. **Figure 6.3** shows the flowchart of crushing, screening and transfers to stockpiles processes, which have been modelled as volume sources. The emission inventory of processing the projected maximum of 2,038,681 t/y of ore is presented in **Table 6.6**. The wet processes shown in **Figure 6.3** will have minimal potential to generate air emissions, and hence, are not included in the emissions calculation.

Figure 6.3: Crushing, Screening and Transfers to Stockpiles Flowchart

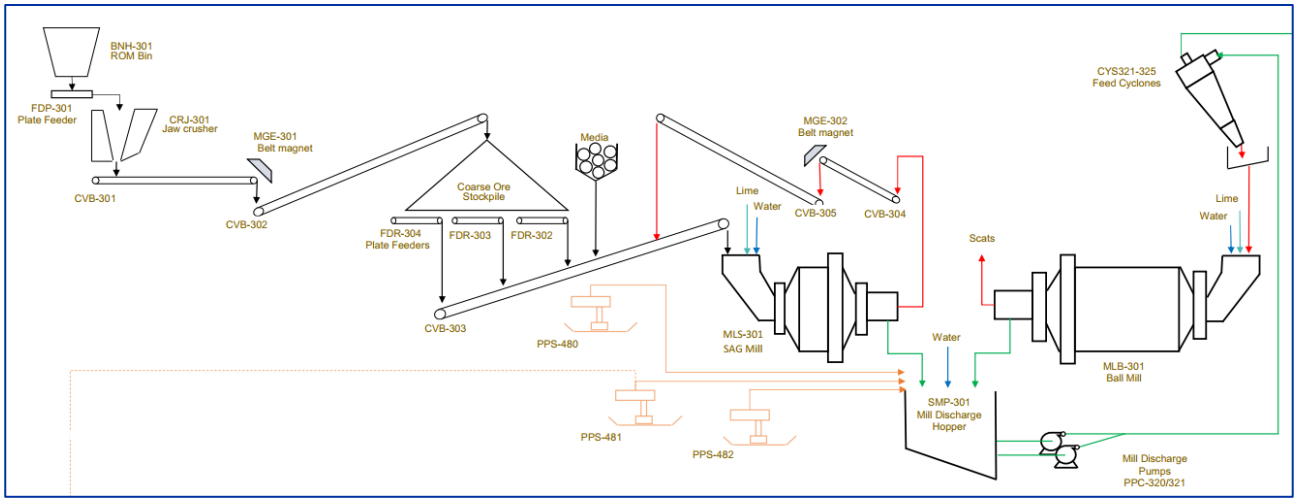


Table 6.6: Controlled Emission Rates Associated with Crushing, Screening and Transfers to Stockpiles

Source	TSP, kg/year	PM_{10} , kg/year	$PM_{2.5}$, kg/year	Fluoride, kg/year
Crushing, Screening and Transfers to Stockpiles	185,520	35,677	0	42

6.3.2 Process Combustion Emissions

Some processes require elevated temperatures, so gas burners are used, specifically for thickening/concentrating. These sources use comparatively cleaner fuel, resulting in insignificant particle emissions. Therefore, these sources are not modelled in this assessment.

6.3.3 Diesel Generators

Two 1 MW diesel generators were modelled for the processing plant. For conservatism, the two generators with shorter stacks were modelled in this assessment. Fuel consumption rate for each generator was 140 L/h. Based on this, an emission flow rate of 120 m^3/minute has been estimated by scaling the known emission flow rates of diesel generators and their corresponding fuel consumption rates. The emission concentrations for a single generator are shown in **Table 6.7**.

The particulate emissions were assumed to be $PM_{2.5}$.

Table 6.7: Emissions from Each Diesel Generator

Pollutant	Emission rate, kg/y
$PM_{2.5}$	1,892

6.3.4 Other Source Parameters

Other source parameters used in the modelling are provided in **Table 6.8.** The temperatures were based on the typical temperatures of the processes but conservatively underestimated to allow for cooling in the discharge stack. All the point sources were modelled with the rain cap option.

Table 6.8: Point and Volume Source Parameters

Source	Easting, m	Northing, m	Release height, m	Diameter, m	Velocity, m/s	Temperature, °C
Crushing, screening, transfers to stockpiles	328610.8	7821868.5	6	23.3	4.7	-
Diesel generator 1	328728	7822096	3	0.5	10	400
Diesel generator 2	328791	7822079	3	0.5	10	400

6.3.5 Summary of Emission Inventory from Processing Plant

A summary table of emission rates from the processing plant is presented in **Table 6.9**.

Table 6.9: Summary of Emission Rates

Source	TSP, kg/year	PM_{10}, kg/year	$PM_{2.5}$, kg/year	Fluoride, kg/year
Crushing, screening, transfers to stockpiles	185,520	35,677	0	42
Diesel generators	-	-	1,892	-
Total	**185,520**	**35,677**	**1,892**	**42**

6.4 Emission Inventory for TSF

6.4.1 TSF3 Construction

Construction activities for the proposed TSF3 are estimated to last for six months, however, they were modelled for one year period as a conservative approach. **Table 6.10** shows the list of equipment usually utilised for similar construction projects. The quantity of each equipment type was estimated based on a comparable construction project. The operation and movements of these vehicles on roads result in particulate emissions. Emissions from borrow pits and associated haul roads were also modelled.

Table 6.10: Equipment Used for TSF3 Construction

Equipment Type	Number
Excavator	1
Front-end loaders	1
Trucks	4
Track Dozer	1
Wheel Dozer	1

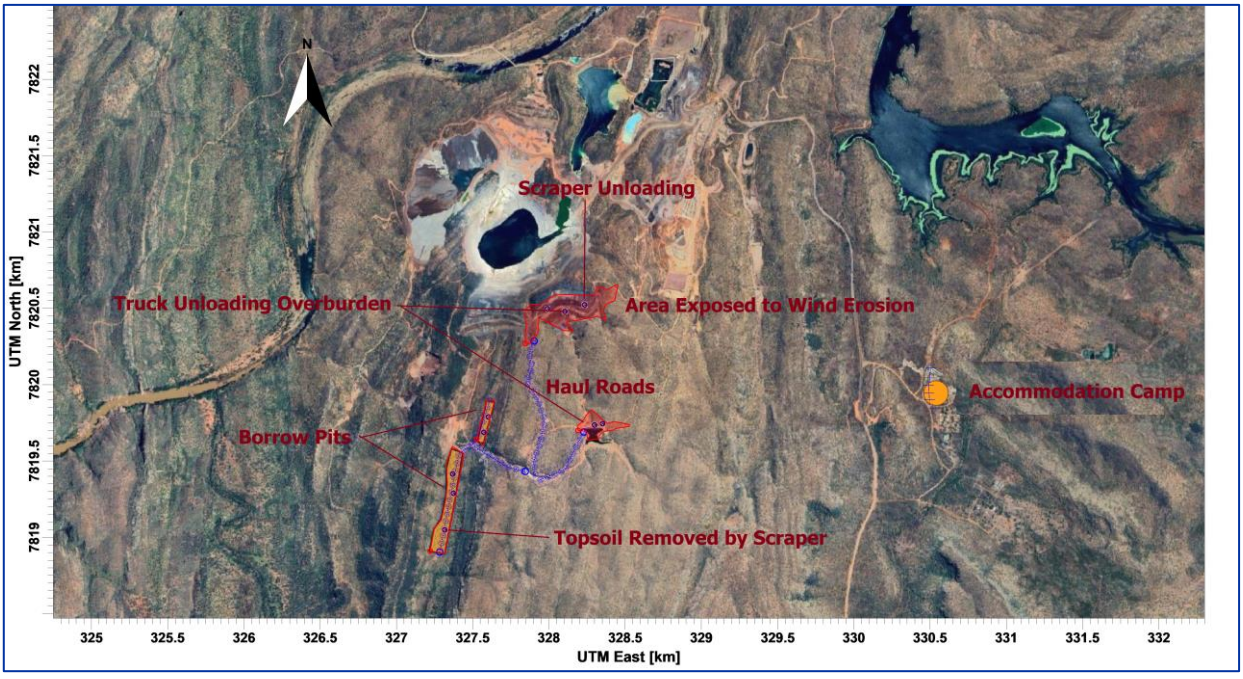
Equipment Type	Number
Grader	1
Scraper	1
Drill	1
Service Trucks	1
Light Vehicles	3

Table 6.11 presents the TSF3 construction emission inventory, and **Figure 6.4** shows the modelled TSF3 construction source locations.

Table 6.11: Total Controlled Emission Rates for Construction Activities for 6 Month Period

Source	TSP, kg/period	PM_{10}, kg/period	$PM_{2.5}$, kg/period	Fluoride, kg/period
Loading to Trucks with Overburden	4,825	4,336	691	5
Truck Unloading Overburden	9,650	4,564	691	5
Mine Trucks on Unpaved Roads in Pit (OB)	2,961	1,722	181	2
Mine Trucks on Unpaved Roads Out of Pit (OB)	26,052	7,975	798	9
Topsoil Removal by Scraper	2,084	521	65	1
Scraper Unloading	2,875	719	89	1
Wind Erosion	3,932	1,966	147	2
Total	**52,379**	**21,803**	**2,662**	**25**

Figure 6.4: Modelled Sources (TSF Construction)



6.4.2 TSF Operations

Emissions from existing TSF (EPit TSF and ETSF) operations and proposed TSF (TSF3) operations will be mainly wind-blown dust. The tailings at EPit TSF are deposited as a wet slurry which does not produce dust, and the initial deposition will be via sub-aqueous means. The potential for tailings to dry and produce dust for the EPit TSF is limited, given the adoption of water cover to prevent oxidation of the potentially acid-forming tailings. In the same way, a portion of the TSF 3 will be a decant pond, therefore dust emissions from the dry tailings surfaces have been conservatively estimated. Wind-blown dust from ETSF and TSF3 has been modelled based on wind speed classes using the emission rates presented in **Table 6.11**.

6.5 Summary of Emission Inventory

Table 6.12 presents a summary of emission inventory for all processes and activities.

Table 6.12: Summary of Emission Inventory

Source	TSP, kg/period	PM_{10} , kg/period	$PM_{2.5}$, kg/period	Fluoride, kg/period
Mining	462,384	159,385	30,388	187
Processing	185,520	35,677	1,892	42
TSF	52,379	21,803	2,662	25
Total	**700,283**	**216,865**	**34,942**	**254**

7. DISPERSION MODELLING METHOD

7.1 Overview

In order to predict to the fate of the pollutants after they are emitted into air, a mathematical model is used to simulate their dispersion and deposition. It is accepted by regulatory agencies that this type of modelling has associated uncertainties. These are normally addressed by using statistics over long simulation times and deriving emission rates based on published emission factors from data representing high emission conditions.

With sources close to ground level, the critical wind conditions tend to be near-calm i.e. low wind speeds. Gaussian plume models such as Ausplume and Aermod cannot model near-calm conditions and have low accuracy in light winds, especially in valleys where katabatic flows are present and where drainage flows turn to follow the valley. Calpuff, being a non-steady-state Lagrangian puff model, is able to simulate stagnation over time, which is critical in near-calm conditions. Its meteorological pre-processor Calmet performs diagnostic simulation of terrain effects on the wind field. It has a specific slope flow algorithm that predicts katabatic flows (Scire, J.S. & Robe, F.R., 1997).

In near-calm conditions, there is little turbulent mixing and less dilution by incoming wind. Large dust sources (such as mine dust) can travel long distances (slowly) with only slight reduction in concentration. Windy conditions cause more emissions of dust from some sources, but with much greater mixing and dispersion of the dust before it travels far.

Thus Calpuff (Version 7.2.1) was chosen as the most appropriate model. The predictions undertaken for this assessment are based on the following method:

- The scenarios selected for modelling were based on the highest potential to cause impact to nearby sensitive receivers.
- Dust emission estimates were based on accepted methods and data consolidated by the National Pollutant Inventory (NPI) and the United States Environmental Protection Agency (USEPA). The main emission calculation methods utilised are included in Section 7.2.
- Prediction of input meteorology was completed using TAPM as described in **Section5.1.3**.
- TAPM input meteorology was enhanced using Calmet, the meteorological pre-processor for Calpuff, as detailed in **Section 5.4**.
- Airborne dust concentrations and dust deposition rates were predicted using Calpuff.

7.2 CALPUFF Configuration

The three dimensional wind fields from Calmet for the full year 2020 were entered into Calpuff. For this project, Calpuff was run over a computational grid (12 kilometres x 12 kilometres) with a spacing of 100 metres, the same as the outer Calmet grid.

Dry deposition was modelled with vegetation state set to active and unstressed.

Wind speed profile was set to the Industrial Source Complex (ISC) Rural exponents. Calm conditions were not invoked until the wind speed dropped below 0.5 m/s.

The emissions were modelled as puffs (not slugs). Puff-splitting was turned off.

Dispersion coefficients were derived by the model using turbulence generated by micrometeorology. The Heffter curve was used to compute time-dependent dispersion beyond 550 metres. The partial plume height adjustment method was used to allow winds to approach hills as terrain increases.

The minimum turbulence velocity, sigma v, was set to 0.2 m/s.

For the purpose of calculating the influence of deposition, Calpuff only allows each particulate species to be characterised by a single mean diameter and standard deviation. Therefore, suspended TSP concentrations were modelled as three separate components: $PM_{2.5}$, coarse (between 2.5 and 10 microns) and "large"

(between 10 and 75 microns). Emission rates of the "large" fractions were calculated as the difference between TSP and PM_{10} emissions from the inventory. In the same manner, emission rates of the "coarse" fractions were calculated as the difference between PM_{10} and $PM_{2.5}$ emissions from the inventory. The predicted TSP results were then calculated as the sum of the model outputs for each of the three components. Similarly, dust deposition was predicted as the sum of the deposition of each of the three components.

8. DISPERSION MODELLING RESULTS

8.1 Limitations

The uncertainties associated with this type of assessment are normally only dealt with in a qualitative manner, but include:

- emission estimation techniques
- meteorological data variability
- inherent uncertainty in dispersion modelling.

In this case, the uncertainty is mostly due to assumptions regarding the applicability of emission factors. This has been addressed by conservative assumptions that will overpredict the ambient concentrations including the following:

- Emission rates are based on conservatively high quantities of materials to be handled.
- Activities are assumed to operate throughout the day and year.
- The mining activities with the closest disturbance footprint to the nearest sensitive receptors were used in this assessment.
- Within the footprint for the modelled scenarios, the sources were modelled relatively close to receptors.
- The adopted background deposition and suspended concentrations are conservatively high.

8.2 Model Results

The predicted highest suspended particulate concentrations and deposition rate, and fluoride concentrations at the sensitive receptors are shown in **Table 8.1** and **Table 8.2**, respectively, along with the background levels and relevant criteria presented in **Table 3.4**.

The tables show both the incremental impacts and the cumulative impacts. Incremental impacts are those due to the activities of the sources only, and cumulative impacts include the background concentrations. The list of potential sensitive receptors presented in **Table 4.1** shows that the mine accommodation camp is the closest receptor, located approximately 2.3 kilometres south-east of the site. Other receptors are located approximately 11 to 21 kilometres from the site. Therefore, only the mine accommodation camp has been modelled in the current assessment.

To illustrate the extent of the exceedances, the modelling results are illustrated in **Figure 8.1** to **Figure 8.3** by pollution contours overlayed onto an aerial photo. Concentrations provided in tabular form are a prediction at a point in space and are hence more accurate than the contours, which are graphical interpolations.

Table 8.1: Predicted Suspended Particulate Concentrations and Deposition Rate at Accommodation Camp

	Annual Average TSP ($\mu g/m^3$)	Maximum 24h Average PM_{10} ($\mu g/m^3$)	Annual Average PM_{10} ($\mu g/m^3$)	Maximum 24h Average $PM_{2.5}$ ($\mu g/m^3$)	Annual Average $PM_{2.5}$ ($\mu g/m^3$)	Dust Deposition ($mg/m^2/day$)
Criterion	**90**	**50**	**25**	**25**	**8**	**120**
Background	51.3	21	20	7.4	7	50
Source Only	0.2	20.2	0.5	1.4	0.04	19.6
Cumulative (Source + Background)	51.5	41.2	20.5	8.8	7.04	69.6

Table 8.2: Predicted Fluoride Concentrations at the Least Concern Riparian Vegetation

	Maximum 24-h average fluoride ($\mu g/m^3$)	30-day average fluoride ($\mu g/m^3$)	90-day average fluoride ($\mu g/m^3$)
Criterion	**2.9**	**0.84**	**0.1**
Background	-	-	-
Source Only	0.02	0.002	0.001

Figure 8.1: Predicted Maximum 24 Hour PM_{10} Concentrations (µg/m³) Including Background (Criterion: 50 µg/m³)

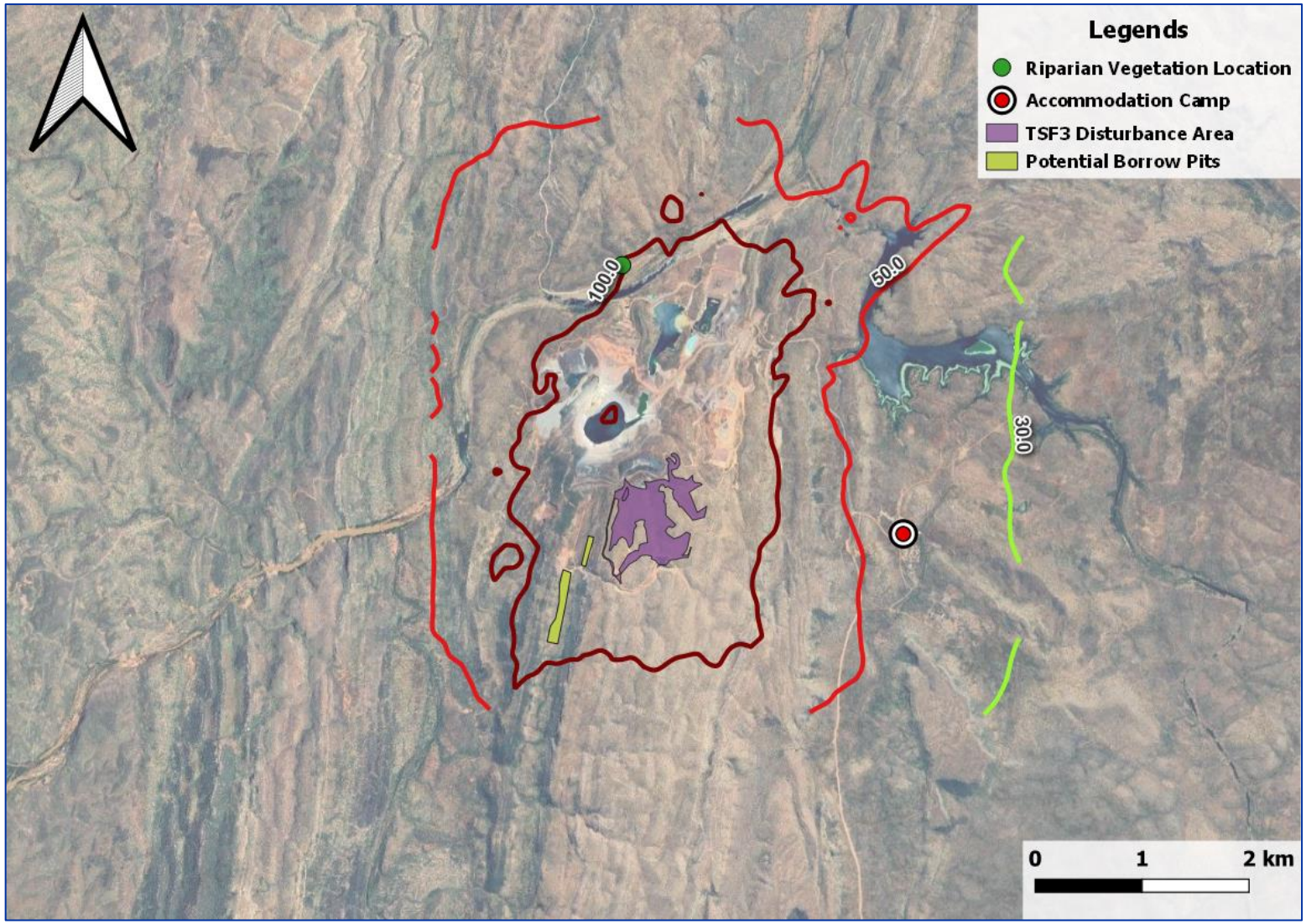


Figure 8.2: Predicted Maximum 30-Day Dust Deposition Levels (mg/m²/day) Including Background (Criterion: 120 mg/m²/day)

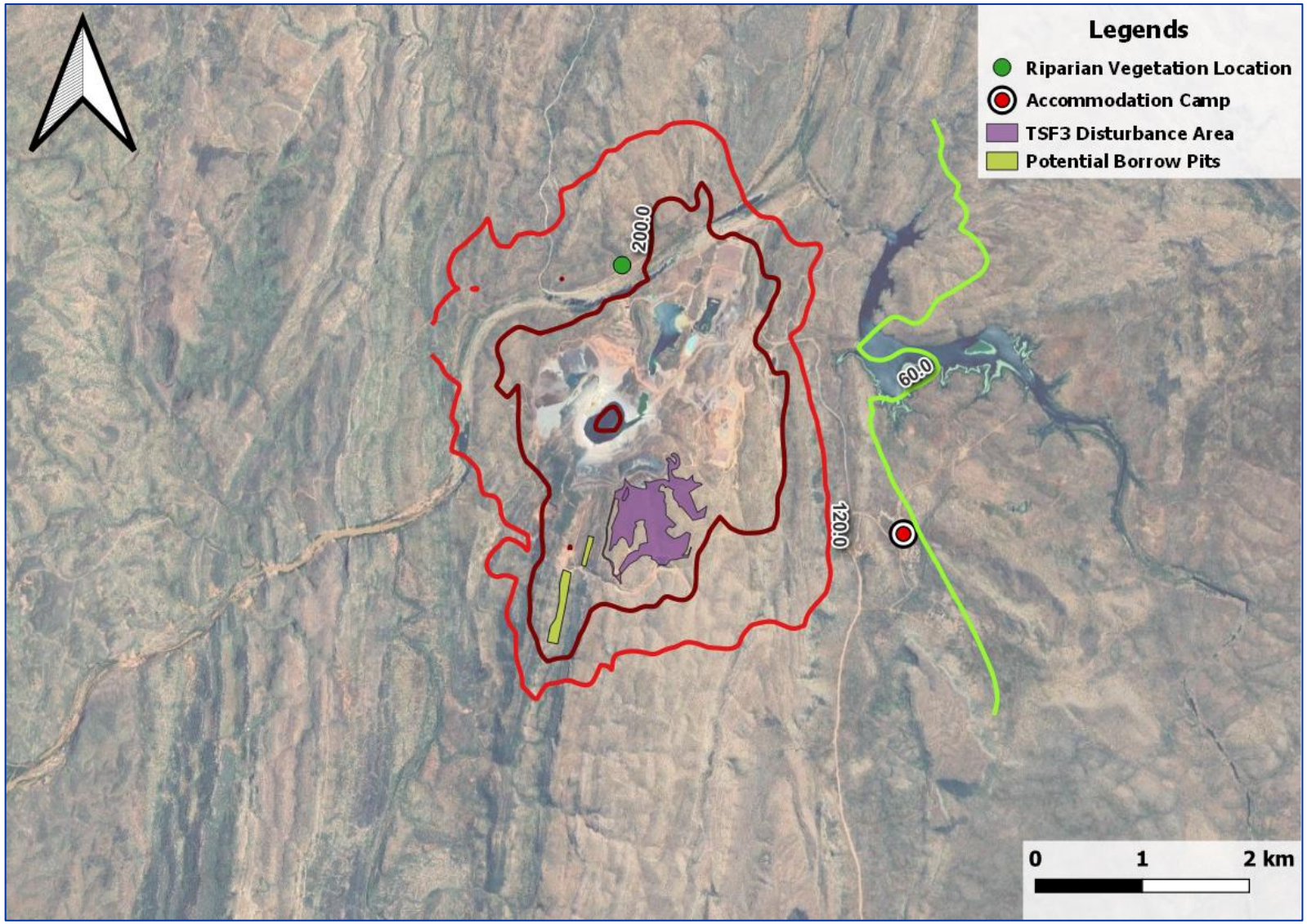
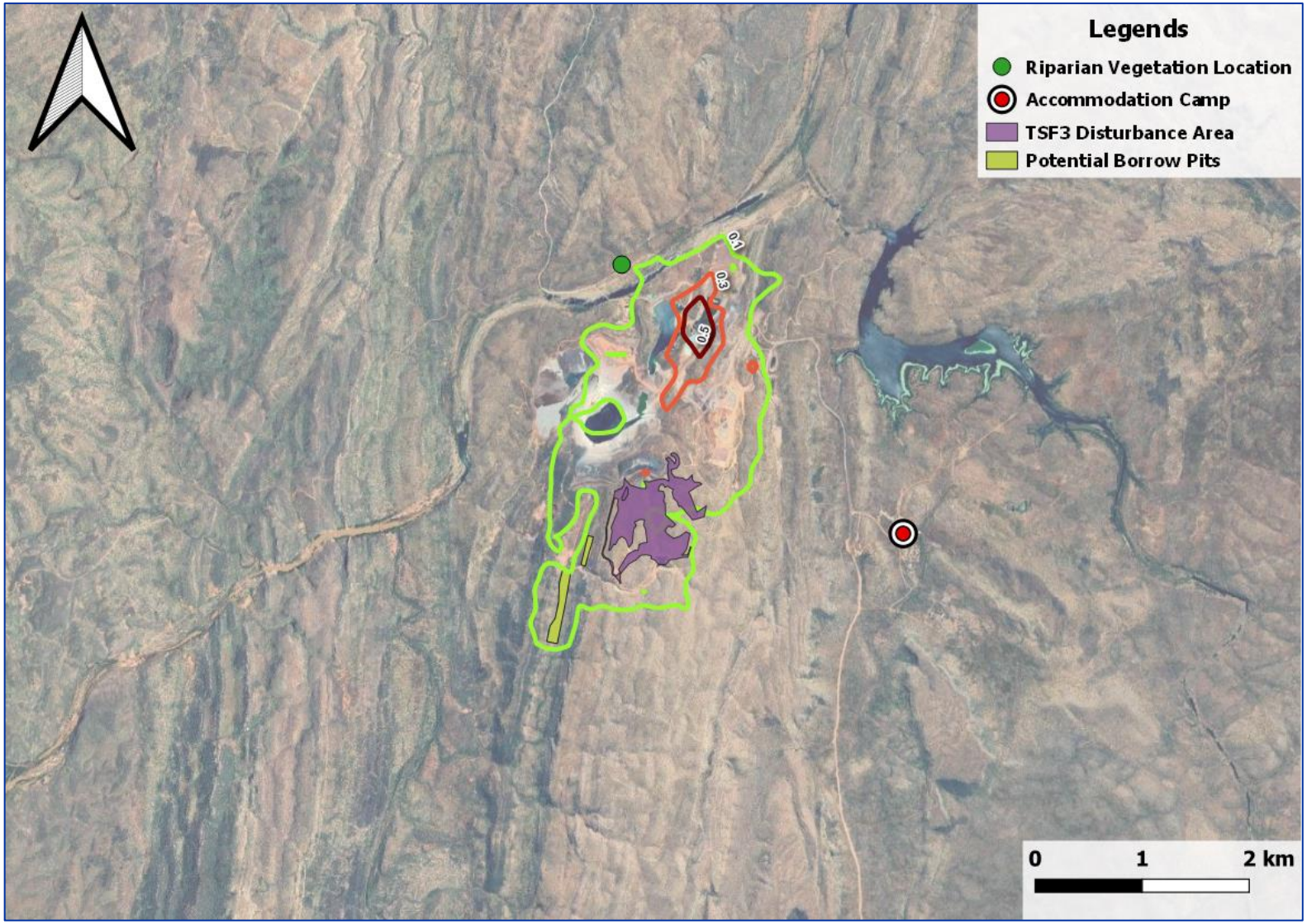


Figure 8.3: Predicted Maximum 24 Hour- Fluoride Levels, µg/m³ (Criterion: 2.9 µg/m³)



9. DISCUSSION

9.1 Summary of Results

The predicted concentrations and levels of all indicators are within the relevant criteria at the modelled receptors as summarised in **Table 8.1** and **Table 8.2**.

The product haul roads, crushing and screening operations at the site have been identified as the most critical sources, contributing to the majority of emissions.

All other sensitive receptors are located approximately 11 to 21 kilometres from the Project site and are not likely to be impacted. Fluoride emission criteria have been focused on protecting health and biodiversity of ecosystems. Presented results in **Table 8.2** show fluoride emissions comply with the relevant criteria at the riparian vegetation.

9.2 Recommended Dust Management Measures

The results have shown that predicted cumulative concentrations arising from mining operations are within the required criteria. The existing crushing and screening dust control and proposed water application rates for dust suppression can potentially achieve compliance with all relevant criteria at the mine accommodation camp.

10. CONCLUSION

An air quality assessment has been conducted for the proposed Project. The results of the assessment are summarised as follows:

- Air quality cumulative impacts of the Project from mining, processing plant operations, and TSF construction and operations are predicted to be within the relevant criteria.
- Fluoride concentrations predicted at sensitive ecosystems comply with the criteria.
- Identified sensitive receptors are unlikely to be impacted by emissions from the mine with the existing and recommended dust control measures.

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APPENDIX A GLOSSARY

Parameter or Term	Description
bcm	Bank Cubic Metres (volume of material in the ground prior to mining)
DESI	Department of Environment, Science and Innovation
Dust fallout deposition	Dust that has fallen out of the air onto a horizontal surface
EPP (Air)	Queensland Environmental Protection (Air) Policy 2019
$g/m^2/month$	Grams per square metre per month
kg	Kilogram
kt	Kilotonnes
kWh	Kilowatt hours
$mg/m^2/day$	Milligrams per square metre per day
MLA	Mining Lease Application
Mt	Million tonnes
NPI	National Pollutant Inventory
NEPM	National Environmental Protection (Ambient Air Quality) Measure
$PM_{2.5}$	Particulates suspended in air with aerodynamic diameter less than 2.5 microns
PM_{10}	Particulates suspended in air with aerodynamic diameter less than 10 microns
ROM	Run-of-mine ore from the pit
SRTM	Shuttle Radar Topography Mission
TAPM	The Air Pollution Model developed by CSIRO and used by Trinity for meteorological modelling
TSP	Total particulates suspended in air
$\mu g/m^3$	Micrograms per cubic metre
USEPA	United States Environmental Protection Agency

APPENDIX B EMISSION INVENTORY EQUATIONS FOR PARTICULATES

Loading Overburden to Trucks by Excavator

Equation 10 of Environment Australia (2012) has been used because it provides a method of varying emission rates with wind speed.

$$E = 0.0016\ k\ \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where

E = Emission Factor with units kg/t of overburden
U = mean wind speed (m/s)
M = soil moisture content (%)
k = 0.74 for TSP
k = 0.35 for PM_{10}

Loading to Trucks by Front End Loader

Equation 12 of Environment Australia (2012) has been used.

$$E_{TSP} = \frac{0.58}{(M)^{1.2}}$$
$$E_{PM_{10}} = \frac{0.0447}{(M)^{0.9}}$$

where

E = Emission factor with units kg/t of ore
M = Soil moisture content (%)

Bulldozing Overburden

Equations 16 and 17 of Environment Australia (2012) have been used.

$$E_{TSP} = 2.6 \times \frac{(s)^{1.2}}{(M)^{1.3}}$$
$$E_{PM_{10}} = 0.34 \times \frac{(s)^{1.5}}{(M)^{1.4}}$$

where

E = Emission factor with units kg/h/vehicle
s = Material silt content (%)
M = Soil moisture content (%)

Trucks Dumping Overburden

From equation 1 of USEPA (2006):

$$E = 0.0016\ k\ \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where

E = Emission Factor with units kg/t of overburden
U = mean wind speed (m/s)
M = soil moisture content (%)
k = 0.74 for TSP
k = 0.35 for PM_{10}

Trucks Dumping

From Section A1.1.7 of Environment Australia (2012):

$E_{TSP} = 0.010$ kg/t

$E_{PM10} = 0.0042$ kg/t

Drilling

From Section A1.1.8 of Environment Australia (2012):

$E_{TSP} = 0.59$ kg/hole

$E_{PM10} = 0.31$ kg/hole

Blasting

Equation 19 of Environment Australia (2012) was used in the modelling.

$$E = 0.00022\, k \times (A)^{1.5}$$

where

E = Emission factor in units kg/blast
k = 1 for TSP
k = 0.52 for PM_{10}
A = Area blasted (m^2)

High emission of NO_x from blasting can occur under the following conditions:

- Unstable, poorly mixed, or unsensitive explosive mixtures are used.
- Explosives are used that are not appropriate for the rock type.
- Explosives that are not water-resistant are used in wet holes.
- Explosives are left in the holes for too long.
- Poor design of blast timing causes damage to unexploded holes.
- Explosives leak into fissures.

Proper management of blasting should ensure that NO_x fumes are minimised and disperse before leaving the mine site.

Wheel Dust Generation from Mine Vehicles on Unpaved Roads

The PM_{10} emission factor used in this assessment is 260 g/km, which was recommended by Pacific Environment Limited (2015), based on measurements undertaken at Australian coal mines.

The TSP emission factor was calculated using the PM_{10} emission factor of 260 g/km and the ratio of the calculated TSP and PM_{10} emissions using the below formulae (Environment Australia (2012), resulting in a TSP emission factor of 1029 g/km.

TSP

$$E = 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W}{3}\right)^{0.45} \{lb/VMT\}$$

PM_{10}

$$E = 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45} \{lb/VMT\}$$

Where: E = Emission factor
s = Material silt content (%)
W = mean vehicle weight (tonnes)
Note – lb/VMT was converted to kg/VKT by multiplying lb/VMT by 0.2819
– vkt = vehicle kilometres travelled

Grader

From Section A1.1.14 of Environment Australia (2012):

$E = 0.0034 \times S^k$

where

E = Emission factor with units kg/vkt (vkt = vehicle kilometre travelled)

k = 2.5 for TSP

k = 2.0 for PM_{10}

S = Mean Vehicle Speed (km/h)

Loading to Stockpile

From Section A1.1.15 of Environment Australia (2012):

$E_{TSP} = 0.0040$ *kg/t*

$E_{PM10} = 0.0017$ *kg/t*

Wind Erosion from Un-vegetated and Unsealed Surfaces

Environment Australia (2012) provides an NPI method for estimating annual emissions of dust from wind erosion based on either a default value published in 1983 or an equation published in 1998, which has several variables including number of rain days and average wind speed. However dispersion modelling is normally based on hourly time-steps and using this equation, the model will predict a small quantity of wind-blown dust every hour of the year. In reality, peak emissions of wind-blown dust will occur only during high wind speeds conditions during dry periods. During low wind speed conditions when particulates from other sources can accumulate, wind-blown dust will be negligible. Thus using the NPI equations will lead to inaccurate and un-timely contribution of wind-blown dust to the peak 24 hour predictions.

ASK calculates variable wind-blown dust emissions from exposed surfaces based on equations 2 and 3 of USEPA (2006), which combine to become:

$E = k \times \left(58 \times (u^* - u_t^*)^2 + 25\,(u^* - u_t^*)\right)$

Where: E = Emission factor with units g/m^2/disturbance hour
k = Constant (1.0 for TSP, 0.5 for PM10 and 0.075 for PM2.5)
u^* = surface friction velocity (m/s)
u_t^* = threshold friction velocity (m/s)

The surface friction velocity can be calculated for different wind speed classes (at 10 metre anemometer height, based on Equations 13.2.5-6 and 13.2.5-7 of AP-42 (USEPA 2006) using the following three factors:

- Based on Table 13.2.5-3 the ratio of surface wind to 10 metre approach wind over a steep stockpile area ranges from 0.2 to 1.1. Parts of the stockpile where the ratio is 0.2 will likely never be eroded by wind. Parts of the stockpile where the ratio is 0.6 will not trigger. Overburden will only trigger when the ratio reaches 1.1, which is 4% of less of the stockpile.
- Using equation 13.2.5-7, the surface friction velocity is one tenth of the surface wind.
- However these calculations are based on "fastest-mile" wind speeds, which approximate the fastest 1-minute mean wind speed (Graybeal 2006). The wind speeds used in modelling are one hour means. Ratios ("G_{60}") of 1 minute means to one hour means are estimated by Ashcroft (1984) for different terrain types. For mostly open, fairly level terrain with a few buildings, G_{60} = 1.26.

Therefore for overburden, the surface friction velocity is calculated as 1.1 x 0.1 x 1.26 times the 10 metre approach wind.

For each wind speed category, the geometric mean surface friction velocities are shown in **Table 10.1** and **Table 10.2**.

Table 10.1: Wind Speeds and Corresponding Surface Friction Velocities for 4% of Exposed Earth and Overburden

Pasquill Wind Speed Class	Corresponding Surface Friction Velocities, m/s	Mean Surface Friction Velocity, m/s
0 – 1.54	0 – 0.21	0.11
1.54 – 3.09	0.21 – 0.43	0.30
3.09 – 5.14	0.43 – 0.71	0.55
5.14 – 8.23	0.71 – 1.14	0.90
8.23 – 10.80	1.14 – 1.50	1.31
> 10.80	> 1.50	1.52

Table 10.2: Wind Speeds and Corresponding Surface Friction Velocities for 15% of Exposed Ore

Pasquill Wind Speed Class	Corresponding Surface Friction Velocities, m/s	Mean Surface Friction Velocity, m/s
0 – 1.54	0 – 0.17	0.09
1.54 – 3.09	0.17 – 0.35	0.25
3.09 – 5.14	0.35 – 0.58	0.45
5.14 – 8.23	0.58 – 0.93	0.74
8.23 – 10.80	0.93 – 1.22	1.07
> 10.80	> 1.22	1.25

The threshold friction velocity (Table 13.2.5-2, USEPA 2006) for overburden is 1.02 m/s, and for fine dust on concrete stockpile pads is 0.54 m/s. The resultant emission rates for different Pasquill wind speed classes are given in **Table 10.3**.

Table 10.3: Wind Erosion Emission Rates for Exposed Surfaces

Source	Pasquill Wind Speed Class (m/s)	TSP (kg/ha/hour)	PM_{10} (kg/ha/hour)	$PM_{2.5}$ (kg/ha/hour)
Overburden dumps	5.15 – 8.23	0.7	0.3	0.03
Overburden dumps	8.24 – 10.80	5	2	0.2
Overburden dumps	> 10.80	10	5	0.4
ROM stockpile pads	3.09 – 5.14	0.8	0.4	0.03
ROM stockpile pads	5.15 – 8.23	11	5	0.4
ROM stockpile pads	8.24 – 10.80	44	22	2
ROM stockpile pads	> 10.80	70	35	3



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A.6 Cultural Heritage Clearance Report and Maps

DATE: 7 – 11 July 2025	PROJECT: TSF3 (UPPER ESPERANZA) and Borrow Investigation Areas (on-lease and off-lease), and Magazine Creek TSF

AREA TO BE INSPECTED:

1. Upper Esperanza – proposed Tailings Storage Facility (TSF3) - follow up from Inspections conducted in September 2023 and June 2016 – approximately 46ha not including stockpile areas
2. On-lease Borrow Investigation Areas – various sizes
3. Off-lease Borrow Investigation Areas – various sizes
4. Magazine Creek – proposed TSF for Life of Mine and borrow area for TSF3

Refer to Attached Maps

(Note: reference may be made to the relevant Notice of Proposed Activity that initiated the survey to describe the area).

Important: The company can rely on the survey undertaken for all activities it wants to do in the Work Area in the future, including mining.

INSPECTED BY:

NAME OF KALKADOON SURVEY TEAM MEMBERS (Surname, First)	SENIORITY (ie. Elder, Intermediate, or Junior)	CONTACT DETAILS: (Optional)
Craigie, Beverly	Senior/Elder	Kalkadoon PBC
Sam, Veronica	Intermediate	Kalkadoon PBC
Body, Sharlene	Intermediate	Kalkadoon PBC
Page, Graham	Intermediate	Kalkadoon PBC

COMPANY REPRESENTATIVE(S):

NAME (Surname, First)	POSITION:	CONTACT DETAILS:
Geraldine McGuire	Environment & Community Manager	geraldine.mcguire@29metals.com
Bailey Millett	Environment Field Tech	bailey.millett@29metals.com

Authorised Kalkadoon Elder/Senior Survey Team Member: Beverly Craigie	Capricorn Copper Inspection Representative Team Member: Geraldine McGuire
Signed:	Signed:
Date: 11/07/2025	Date: 11/07/2025

INSPECTION RESULTS - General Comments:

Mt Oxide Borrow Area – 6 stone artefacts found, photographed and relocated to adjacent high ground

TSF3 Footprint – potential fossil – noted and photographed, geologists who completed previous survey to be informed

TSF3 Topsoil stockpile areas – nothing found, very rocky area

Airport/Greenstone Creek Borrow Area – multiple artefacts adjacent to Greenstone Creek – proposed to isolate/protect area from disturbance

Magazine Creek – nothing found

Other smaller borrow Areas – on and off-lease areas – refer to maps – nothing found

(Note – Specific comments can be made in the section below instead of or in addition to commenting here)

RECOMMENDED PROTECTION MEASURES (I.E. ACTION TO BE TAKEN) - This can include suggested alternative areas that the Company may use in order to avoid Aboriginal Cultural Heritage and other recommendations for the avoidance of and the proper management, protection and conservation of any Aboriginal Cultural Heritage, including recommendations for Monitoring.

General Comments:

Artefacts relocated to higher ground away from potential disturbance if only a few artefacts were found e.g. Mt. Oxide Road Borrow Area.

If multiple artefacts were found in close proximity to each other, it was recommended that the area could be a quarry site and should be protected from any future disturbance. e.g. Airport/Greenstone Creek Area.

Only areas where no cultural heritage was found or artefacts were able to be relocated should be used.

(Note – Specific comments can be made in the section below instead of or in addition to commenting here)

Aboriginal Cultural Heritage – Kalkadoon Work Completion Form

Authorised Kalkadoon Elder/Senior Survey Team Members - Beverly Craigie	Capricorn Copper Inspection Representative Team Members – Geraldine McGuire
Signed:	Signed:
Date: 11/07/2025	Date: 11/07/2025

INSPECTION RESULTS (SPECIFIC COMMENTS AND RECOMMENDATIONS IN RELATION TO ABORIGINAL CULTURAL HERITAGE FOUND):

ITEM:	GPS COORDINATES:	-19.647857° -139.352100°	IMAGE NO:	A1
1.	DESCRIPTION:	Mount Oxide Road Borrow area – stone artefact 1		
	RECOMMENDED ACTION:	Relocated to high ground: -19.655133°, -139.354542° - Image AR		
ITEM:	GPS COORDINATES:	-19.647661°, -139.352150°	IMAGE NO:	A2
2.	DESCRIPTION:	Mount Oxide Road Borrow area – stone artefact 2		
	RECOMMENDED ACTION:	Relocated to high ground: -19.655133°, -139.354542° - Image AR		
ITEM:	GPS COORDINATES:	-19.644589°, -139.351714°	IMAGE NO:	A3
3.	DESCRIPTION:	Mount Oxide Road Borrow area – stone artefact 3		
	RECOMMENDED ACTION:	Relocated to high ground: -19.655133°, -139.354542° - Image AR		
ITEM:	GPS COORDINATES:	-19.645797°, -139.351028°	IMAGE NO:	A4
4.	DESCRIPTION:	Mount Oxide Road Borrow area – stone artefact 4		
	RECOMMENDED ACTION:	Relocated to high ground: -19.655133°, -139.354542° - Image AR		
ITEM:	GPS COORDINATES:	-19.645861°, -139.351036°	IMAGE NO:	A5
5.	DESCRIPTION:	Mount Oxide Road Borrow area – stone artefact 5		

	RECOMMENDED ACTION:	Relocated to high ground: -19.655133°, -139.354542° - Image AR		
ITEM:	GPS COORDINATES:	-19.646292°, -139.351064°	IMAGE NO:	A6
6.	DESCRIPTION:	Mount Oxide Road Borrow area – stone artefact 6		
	RECOMMENDED ACTION:	Relocated to high ground: -19.655133°, -139.354542° - Image AR		
ITEM:	GPS COORDINATES:	-19.707156°, -139.360764°	IMAGE NO:	B1
7.	DESCRIPTION:	TSF3 Catchment - possible fossilized bird footprint		
	RECOMMENDED ACTION:	No recommendations provided as not Aboriginal Cultural Heritage		
ITEM:	GPS COORDINATES:		IMAGE NO:	
8.	DESCRIPTION:			
	RECOMMENDED ACTION:			
ITEM:	GPS COORDINATES:		IMAGE NO:	
9.	DESCRIPTION:			
	RECOMMENDED ACTION:			
ITEM:	GPS COORDINATES:		IMAGE NO:	
10.	DESCRIPTION:			
	RECOMMENDED ACTION:			

Authorised Kalkadoon Elder/Senior Survey	Capricorn Copper Inspection Representative
Team Member: Beverly Craigie	**Team Member:** Geraldine McGuire
Signed:	**Signed:**
Date: 11/07/2025	**Date:** 11/07/2025

WORK COMPLETION FORM APPROVED

Authorised Kalkadoon Elder/Senior Survey	Capricorn Copper Inspection Representative
Name: Beverly Craigie	**Name:** Geraldine McGuire
Signature:	**Signature:**
Date: 11/07/2025	**Date:** 11/07/2025

IF AGREED THIS REPORT IS TO SERVE AS THE FINAL CULTURAL HERITAGE SURVEY REPORT, COMPLETE SECTION BELOW

Authorised Kalkadoon Person	Authorised MINING Person
Name: Beverly Craigie	**Name:** Geraldine McGuire
Signature:	**Signature:**
Date: 11/07/2025	**Date:** 11/07/2025

29 Metals Capricorn Copper

Aboriginal Cultural Heritage – Kalkadoon Work Completion Form

TIMESHEET: 7 July 2025

NAME: (Surname, First)	PICK UP TIME:	DROP OFF TIME:	TOTAL HOURS:	SIGNATURE:
Veronica Sam	9:00am	5:00pm	8	
Beverly Craigie	9:00am	5:00pm	8	
Sharlene Body	9:00am	5:00pm	8	
Graham Page	9:00am	5:00pm	8	

TOTAL FEE PAYABLE: (GST inclusive)

(Payment will be made within 10 business days after receipt of a tax invoice)

ANY ADDITIONAL COMMENTS:

Picked Up from Mount Isa
Driven to Site
Inductions and paperwork
Discussion on Cultural Heritage Clearance Work Program and Priorities
Recognisance of areas with Bailey Millett
CH Clearance of Mt. Oxide Off-Lease Borrow Investigation Area

29 Metals Capricorn Copper

Aboriginal Cultural Heritage – Kalkadoon Work Completion Form

TIMESHEET: 7 July 2025

NAME: (Surname, First)	PICK UP TIME:	DROP OFF TIME:	TOTAL HOURS:	SIGNATURE:
Veronica Sam	9:00am	5:00pm	8	
Beverly Craigie	9:00am	5:00pm	8	
Sharlene Body	9:00am	5:00pm	8	
Graham Page	9:00am	5:00pm	8	

TOTAL FEE PAYABLE: (GST inclusive)

(Payment will be made within 10 business days after receipt of a tax invoice)

ANY ADDITIONAL COMMENTS:

Picked Up from Mount Isa
Driven to Site
Inductions and paperwork
Discussion on Cultural Heritage Clearance Work Program and Priorities
Recognisance of areas with Bailey Millett
CH Clearance of Mt. Oxide Off-Lease Borrow Investigation Area

29 Metals Capricorn Copper

Aboriginal Cultural Heritage – Kalkadoon Work Completion Form

TIMESHEET: 8 July 2025

NAME: (Surname, First)	PICK UP TIME:	DROP OFF TIME:	TOTAL HOURS:	SIGNATURE:
Veronica Sam	9:00am	5:00pm	8	
Beverly Craigie	9:00am	5:00pm	8	
Sharlene Body	9:00am	5:00pm	8	
Graham Page	9:00am	5:00pm	8	

TOTAL FEE PAYABLE: (GST inclusive)

(Payment will be made within 10 business days after receipt of a tax invoice)

ANY ADDITIONAL COMMENTS:

Picked Up from Camp
Driven to Site
Breathalyser and paperwork follow-up (JHA)
Discussion on Cultural Heritage Clearance Work Program and Priorities
TSF3 Footprint and Topsoil stockpile areas

Aboriginal Cultural Heritage – Kalkadoon Work Completion Form

TIMESHEET: 9 July 2025

NAME: (Surname, First)	PICK UP TIME:	DROP OFF TIME:	TOTAL HOURS:	SIGNATURE:
Beverly Craigie	9:00am	5:00pm	8	
Sharlene Body	9:00am	5:00pm	8	
Graham Page	9:00am	5:00pm	8	

TOTAL FEE PAYABLE: (GST inclusive)

(Payment will be made within 10 business days after receipt of a tax invoice)

ANY ADDITIONAL COMMENTS:

Picked Up from Camp
Driven to Site
Breathalyser and sign-in
Veronica Sam not well, taken to clinic to see medic and returned to her room in camp
Discussion on Cultural Heritage Clearance Work Program and Priorities
Airport/Greenstone Creek Borrow Area

29 Capricorn Copper Metals

Aboriginal Cultural Heritage – Kalkadoon Work Completion Form

TIMESHEET: 10 July 2025

NAME: (Surname, First)	PICK UP TIME:	DROP OFF TIME:	TOTAL HOURS:	SIGNATURE:
Veronica Sam	9:00am	1:00pm	4	
Beverly Craigie	9:00am	5:00pm	8	
Sharlene Body	9:00am	5:00pm	8	
Graham Page	9:00am	5:00pm	8	

TOTAL FEE PAYABLE: (GST inclusive)

(Payment will be made within 10 business days after receipt of a tax invoice)

ANY ADDITIONAL COMMENTS:

Picked Up from Camp
Driven to Site
Breathalyser and sign-in
Discussion on Cultural Heritage Clearance Work Program and Priorities
Magazine Creek TSF Footprint and other borrow areas
Veronica Sam not well at lunch break, taken to clinic to see medic and returned to her room in camp and medic advised that she should return to Mount Isa

29 Capricorn Copper Metals

Aboriginal Cultural Heritage – Kalkadoon Work Completion Form

TIMESHEET: 11 July 2025

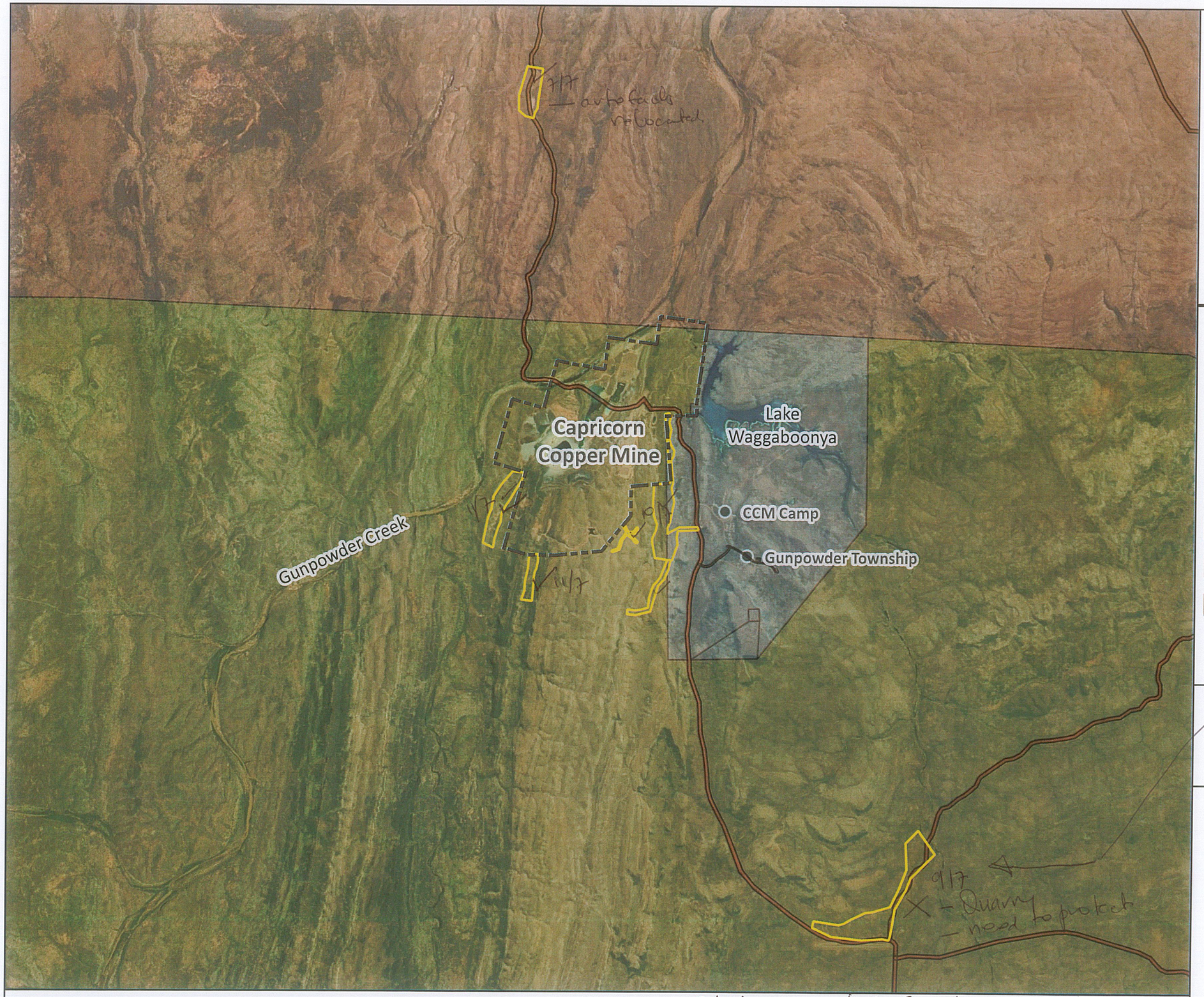
NAME: (Surname, First)	PICK UP TIME:	DROP OFF TIME:	TOTAL HOURS:	SIGNATURE:
Craigie, Beverly	9:00am	5:00pm	8	
Body, Sharlene	9:00am	5:00pm	8	
Page, Graham	9:00am	5:00pm	8	

TOTAL FEE PAYABLE: (GST inclusive)

(Payment will be made within 10 business days after receipt of a tax invoice)

ANY ADDITIONAL COMMENTS:

Picked Up from Camp
Driven to Site
Breathalyser and sign-in
Discussion on Cultural Heritage Clearance Work Program and Priorities
Remaining Borrow Areas – on and off-lease –Southern ETSF, Diversion Drain, rocky outcrops near MCD and Pond 3&4
Veronica Sam still unwell but did not want to return to Mount Isa yesterday
Drove back to Mount Isa to Kalkadoon PBC Office



29 Metals Capricorn Copper Mine

Investigation Areas for Borrow Pits

LEGEND

- ML permits granted - merged
- Borrow investigation extents

Land Parcels:

- Barr Creek Holding
- Calton Hills
- null
- Road parcel

Quarry Area to be protected.

0 1 2 3 4 km

KG ENVIRONMENTAL

KG Environmental
Creation Date: 06/04/2025

Figure 1. CCM Investigation Areas (for borrow pits) — off-lease

7/7/25, 9/7/25, 10/7/25, 11/7/25

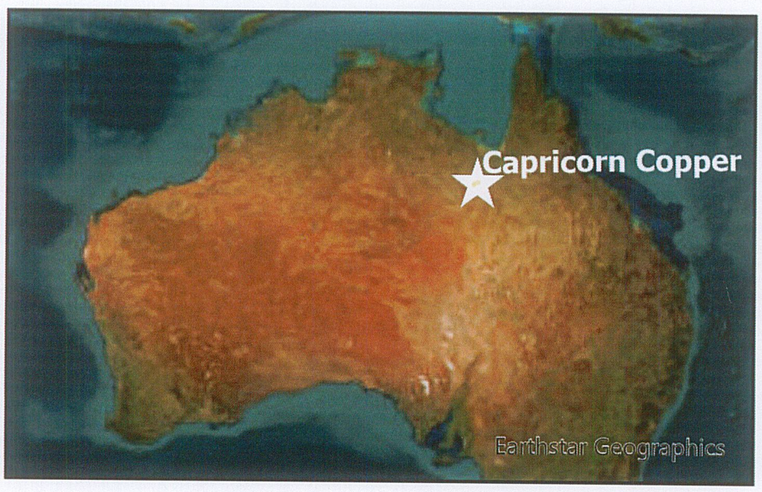
GP. gmg SB

29 Metals

Capricorn Copper Upper Esperanza Life of Mine Tailings Storage Facility

nothing found. GP 8/7/25 ✓ gmg





0 0.1 0.2 0.4 Kilometers

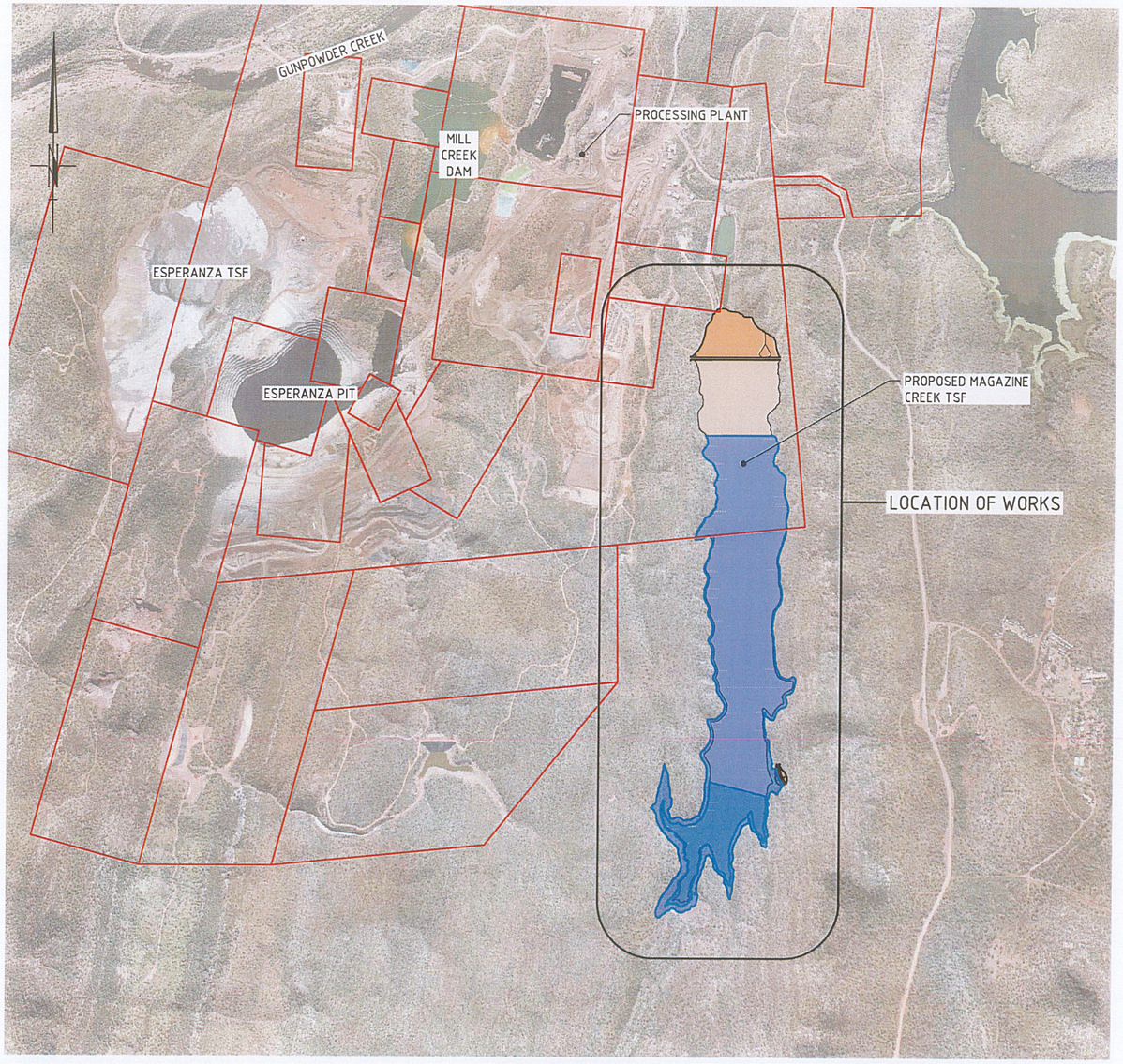
Legend

- Tailings storage
- Top Soil Stock piles
- Mine Lease

N W E S

SB

29METALS PTY LTD - CAPRICORN COPPER
MAGAZINE CREEK TSF - CONCEPT DESIGN



LOCALITY PLAN
SCALE 1:10000 m

DRAWING INDEX		
DRAWING No.	DRAWING TITLE	REVISION
BBNE00006-0027-DWG-0001	LOCALITY PLAN, DRAWING INDEX, GENERAL NOTES - AND LEGEND	A
BBNE00006-0027-DWG-0100	GENERAL ARRANGEMENT PLAN	A
BBNE00006-0027-DWG-0101	DETAIL PLAN - EMBANKMENTS	A
BBNE00006-0027-DWG-0110	DETAIL PLAN - DECANT ACCESS ROAD	A
BBNE00006-0027-DWG-0201	TYPICAL SECTIONS AND DETAILS	A
BBNE00006-0027-DWG-0301	LONGITUDINAL SECTION - NORTHERN EMBANKMENT	A
BBNE00006-0027-DWG-0302	LONGITUDINAL SECTION - EASTERN EMBANKMENT	A

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS NOTED OTHERWISE. ALL ELEVATIONS ARE IN METRES (m). ALL CO-ORDINATES ARE IN METRES (m).
2. VERTICAL DATUM IS AUSTRALIAN HEIGHT DATUM (A.H.D.)
3. HORIZONTAL DATUM IS IN ACCORDANCE WITH GDA2020 MGA ZONE 54.
4. SECTION NUMBERS REFER TO THE LAST FOUR NUMBERS OF THE DRAWING NUMBER. IE. REFER DRAWING 0201
5. DESIGN BASED ON LiDAR SURVEY DATED SEPTEMBER 2024 SUPPLIED BY THE PRINCIPAL. ENGENY TAKES NO RESPONSIBILITY FOR INACCURACIES ASSOCIATED WITH THE PRINCIPAL SUPPLIED LiDAR SURVEY AND DISCREPANCIES WITH EXISTING GROUND LEVELS.
6. EXISTING SERVICE LOCATIONS ARE INDICATIVE ONLY.

LEGEND - GENERAL

240 240 FINISHED CONTOUR MAJOR
FINISHED CONTOUR MINOR

LEGEND - EXISTING

MINE LEASE BOUNDARY
WATERWAY

LEGEND - PROPOSED

CIVIL WORKS EXTENT
GRAVEL CAPPING
FULL SUPPLY EXTENT
BATTER SLOPE INDICATOR
CONTROL LINE

No artefacts
✓ - nothing found 10/7/25.
GMG.
SP
SB

0 100 200 300 400 500m
SCALE 1:10,000 (A1)
SCALE BEFORE REDUCTION

CAD REF:D:\JOBS\DATA\EGBR\2021\BBNE#####_0027 - CCM MAGAZINE CREEK TSF.CD_1162245 DESIGN\AUTOCAD\DRAWINGS\BBNE#####-0027-DWG-0001.DWG
LAST MODIFIED:29/11/2024 5:15 PM

THIS DRAWING IS CONFIDENTIAL AND SHALL ONLY BE USED BY ENGENY'S CLIENT FOR WHICH IT WAS PREPARED.

REV	BY	DATE	REVISION DESCRIPTION	PM APPD.	REFERENCE DOCUMENTS	
A	MT	29.11.24.	ISSUED FOR REVIEW	BW	DOC. NUMBER	DOCUMENT TITLE

29 Metals

ENGENY
Ph. 07 3221 7174
Level 1
500 Queen St
Brisbane QLD
www.engeny.com.au

STATUS: NOT FOR CONSTRUCTION - CONCEPT DESIGN

DESIGNED	MT	CHECKED	BW	
DRAWN	MT	CHECKED	BW	
PM APPD.	BW	PD APPD.	TW	
RPEQ		RPEQ No.		

29METALS PTY LTD - CAPRICORN COPPER
MAGAZINE CREEK TSF - CONCEPT DESIGN
LOCALITY PLAN, DRAWING INDEX, GENERAL NOTES AND LEGEND

ORIGINAL SIZE: A1
DWG NO.: BBNE00006-0027-DWG-0001
REV.: A



29 Metals Capricorn Copper Mine

EPML00911413 EA Amendment Application

LEGEND

- Mining Lease
- Maximum investigation extents

0 0.5 1 km

KG ENVIRONMENTAL

KG Environmental
Creation Date: 03/04/2025

Figure 1. CCM Mining Leases and Proposed Investigation Areas — on lease

No artefacts found.

SB

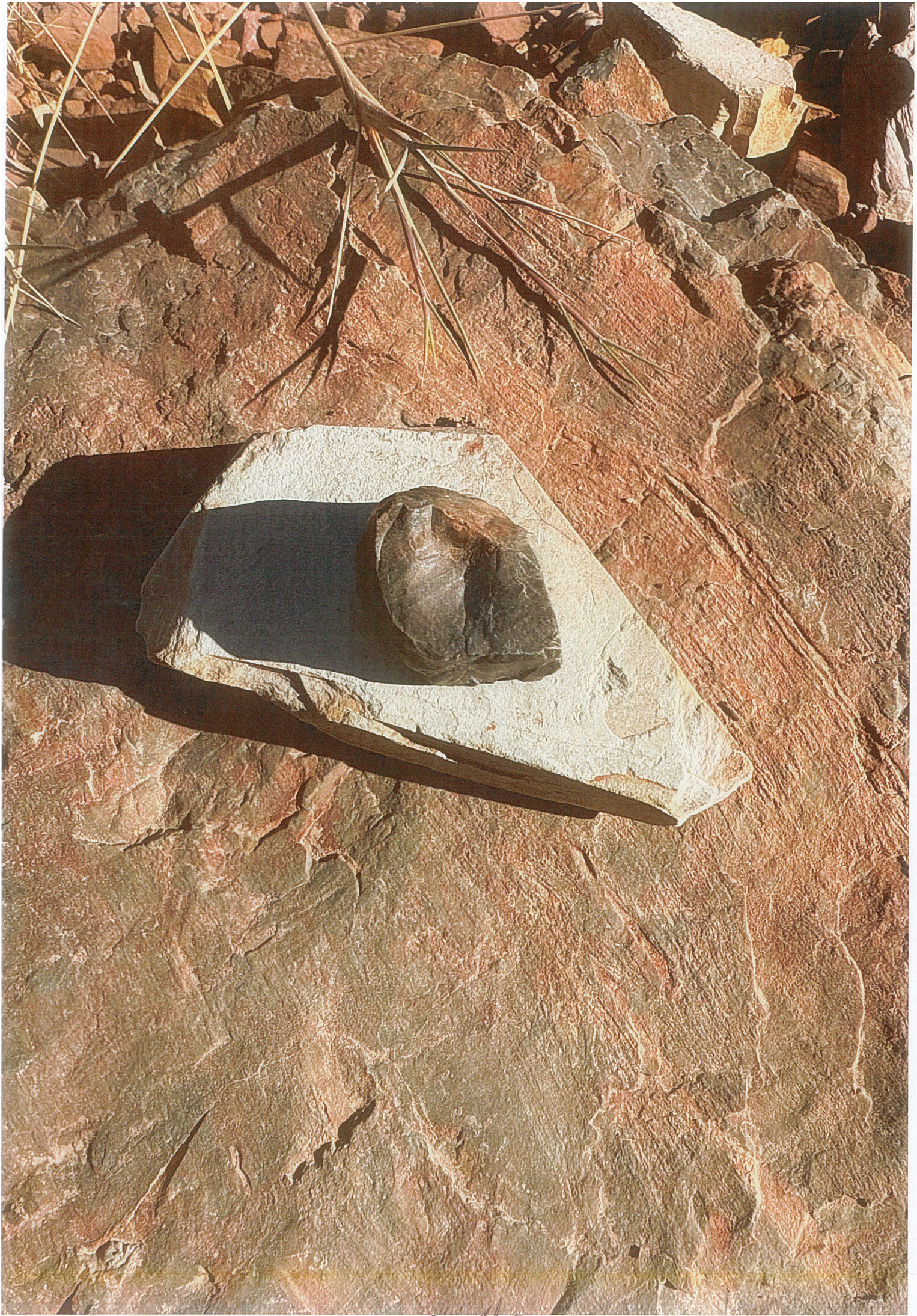
10/7/25
11/7/25



A1 SB



A2 GP SB



A3









A.7 TSF3 Risk Register

EA Amendment Risk Register - TSF3

Rev1

Project Name : CCM TSF3 Upper Esperanza

Items included:

Job No.: CCM-TSF3

Workshop Facilitator: GM **Date:** 10/07/2025

Participants: MH MG BS

Risk Matrix	Likliehood				
Consequence	**A. Rare**	**B. Unlikely**	**C. Possible**	**D. Likely**	**E. Almost Certain**
5. Catastrophic	15 - High	19 - High	22 - Extreme	24 - Extreme	25 - Extreme
4. Major	10 - Medium	14 - High	18 - High	21 - Extreme	23 - Extreme
3. Moderate	6 - Low	9 - Medium	13 - Medium	17 - High	20 - High
2. Minor	3 - Low	5 - Low	8 - Medium	12 - Medium	16 - High
1. Insignificant	1 - Low	2 - Low	4 - Low	7 - Medium	11 - Medium

EA Amendment Risk Register - TSF3

Project Name : CCM TSF3 Upper Esperanza

Job No.: CCM-TSF3
Risk Framework: 29 Metals - 20211216-HO-POL-APPROVED Risk Evaluation Matrix

Item No.	Type	Asset Location	Design Life Cycle Phase	Risk	Hazard	Likelihood	Consequences	Risk Rating and Score	Existing Controls/Management Strategies	Residual Likelihood	Residual Consequences	Residual Risk Rating and Score	Control Rating	Further Controls/Management Strategies	Follow Up Actions
1	Air	TSF3	Construction	Earth moving activities during construction disturb topsoil causing dust impacts on sensitive receptors	• Air pollution impacts on sensitive receptors	B. Unlikely	2. Minor	5 - Low	•Regular dust supression (road watering) during construction activities utilising treated water •The nearest sensitive receptor is the mine accommodation camp which is not located within proximity of the TSF3 (Upper Esperanza) to receive dust emissions	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Undertake air quality monitoring if complaints are received. • Reduce earth moving construction activities in high wind conditions if complaints are received	•Include dust supression (road watering) details in Construction Management Plan
2	Air	Borrow Areas	Construction	Earth moving activities during construction disturb topsoil causing dust impacts on sensitive receptors	• Air pollution impacts on sensitive receptors	B. Unlikely	2. Minor	5 - Low	•Regular dust supression (road watering) during construction activities utilising treated water •The nearest sensitive receptor is the mine accommodation camp which is not located within proximity of the proposed borrow areas to receive dust emissions	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Undertake air quality monitoring if complaints are received. • Reduce earth moving construction activities in high wind conditions if complaints are received	•Include dust supression (road watering) details in Construction Management Plan
2	Air	TSF3	Construction	Earth moving activities during construction generate additional green house gas (GHG) emissions	Increase in GHG emissions during construction	D. Likely	1. Insignificant	7 - Medium	•Regular maintenance of vehicles to ensure that emissions are minimised	D. Likely	1. Insignificant	7 - Medium	2. Partially Effective	• Consideration of low emisison vehicles for construction phase	•Include consideration for low emission vehicles in Construction Contract
3	Surface Water	TSF3	Construction	Earth moving activities during construction disturb toposil causing contamination of surface water	▪Contaminated surface waters runoff into the surrounding receiving environment	C. Possible	3. Moderate	13 - Medium	•Toposoil stockpiles located adjacent to construction areas •Runoff captured within footprint of TSF3 catchment •No direct surface water pathway to Gunpowder Creek	C. Possible	1. Insignificant	4 - Low	1. Effective	• Minimise earth moving construction activities during high rainfall events or periods • Update of existing site surface water monitoring programs to incorporate TSF3	•Include erosion and sediment control measure in Construction Management Plan and Detailed Design Report
3	Surface Water	Borrow Areas	Construction	Earth moving activities during construction disturb toposil causing contamination of surface water	▪Contaminated surface waters runoff into the surrounding receiving environment	D. Likely	3. Moderate	17 - High	•Potential borrow areas under investigation •Runoff to captured within footprint of borrow area •No direct surface water pathways to Gunpowder Creek to be allowed in borrow area selection and design	C. Possible	2. Minor	8 - Medium	1. Effective	• Minimise earth moving construction activities during high rainfall events or periods • Update of existing site surface water monitoring programs to incorporate TSF3 Borrow Areas Sediment control measures to be incorporated into borrow areas prior to operation	•Include erosion and sediment control measures for borrow areas in Construction Management Plan and Detailed Design Report
4	Groundwater	TSF3	Construction	Geotechnical and groundwater drilling during construction cause contamination of groundwater aquifers	▪Contaminated groundwaters seeping into the surrounding groundwater aquifers	B. Unlikely	2. Minor	5 - Low	•Geological setting indicates TSF3 sited in stable low permeability setting. •Groundwater modelling predicts seepage pathways to EPit and Esperanza Underground (ESS) •Pumping and treatment of water from EPit and ESS to release quality water standards	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Minimise geotechnical and groundwater drilling around seepage pathways • Update of existing site groundwater monitoring programs to incorporate TSF3	•Include groundwater protection measures in Construction Management Plan and Detailed Design Report
5	Noise	TSF3	Construction	Earth moving activities during construction result in noise impacts on sensitive receptors	• Noise impacts on sensitive receptors	B. Unlikely	2. Minor	5 - Low	•The nearest sensitive receptor is the mine accommodation camp which is not located within proximity to receive noise associated with construction activities in the Upper Esperanza catchment	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Undertake noise monitoring if complaints are received. • Minimise high noise activities during night hours if complaints are received.	•Include consideration for low noise vehicles in Construction Contract
5	Noise	Borrow Areas	Construction	Earth moving activities during construction result in noise impacts on sensitive receptors	• Noise impacts on sensitive receptors	B. Unlikely	2. Minor	5 - Low	•The nearest sensitive receptor is the mine accommodation camp which is not located within proximity to receive noise associated with proposed borrow areas	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Undertake noise monitoring if complaints are received. • Minimise high noise activities during night hours if complaints are received.	•Include consideration for low noise vehicles in Construction Contract
7	Ecology	TSF3	Construction	Land clearing activities during construction result in impacts on species/habitat of National or State environmental significance	• Loss of species/habitat of National or State environmental significance	B. Unlikely	2. Minor	5 - Low	•Ecological studies completed for wet and dry seasons and management strategies detailed in ecological reports •Pre-referral meeting with EPBC undertaken in June 2025 to dicuss strategy for Carpentarian Wren and Northern Blue Tongue Skink	B. Unlikely	1. Insignificant	2 - Low	1. Effective	•Referral of project to determine if a controlled action (significant loss of species/habitat) is deemed likely •Permit to Clear to be submitted for Ipomoea antonschimdii •Develop off-set program if required	•Include ecological protection measures in Construction Management Plan and Detailed Design Report
7	Ecology	Borrow Areas	Construction	Land clearing activities during construction result in impacts on species/habitat of National or State environmental significance	• Loss of species/habitat of National or State environmental significance	B. Unlikely	2. Minor	5 - Low	•Ecological studies completed for wet and dry seasons and management strategies detailed in ecological reports	B. Unlikely	1. Insignificant	2 - Low	1. Effective	•Referral of project to determine if a controlled action (significant loss of species/habitat) is deemed likely •Permit to Clear to be submitted for Ipomoea antonschimdii	•Include ecological protection measures in Construction Management Plan and Detailed Design Report
8	Cultural & Spirital	TSF3	Construction	Land clearing activities during construction result in impacts on Aboriginal Cultural Heritage in TSF3 footprint or topsoil stockpile areas	• Loss of artefacts or places of Aboriginal cultural heritage significance	B. Unlikely	3. Moderate	9 - Medium	•Cultural Heritage surveys and clearances undertaken in June 2016 and July 2025 •One artefact found and relocated in June 2016 •No Abriginal Cultural Heritage artefacts or places of signifiance identified in July 2025	A. Rare	2. Minor	3 - Low	1. Effective	•Development of a Cultural Heritage Management Plan for future disturbance in sensitive areas	•Include cultural heritage protection measures in Construction Management Plan and Detailed Design Report
9	Cultural & Spirital	Borrow Areas	Construction	Land clearing activities during construction result in impacts on Aboriginal Cultural Heritage in TSF3 borrow areas	• Loss of artefacts or places of Aboriginal cultural heritage significance	B. Unlikely	3. Moderate	9 - Medium	•Cultural Heritage surveys and clearances undertaken in July 2025 •Stone artefacts identified and moved to higher ground to avoid damage •Areas of significance notified, mapped and protected from disturbance e.g. Greenstone Creek Quarry	B. Unlikely	2. Minor	5 - Low	1. Effective	•Development of a Cultural Heritage Management Plan for future disturbance in sensitive areas	•Include cultural heritage protection measures in Construction Management Plan and Detailed Design Report
10	Land	TSF3	Construction	Clearance activities during construction disturb lands which are currently vegetated with local native plants and are not suitable for grazing	•Permanent loss of land capability for native vegetation	B. Unlikely	2. Minor	5 - Low	•Closure strategy included in preliminary design which assumes revegetation with native species	B. Unlikely	1. Insignificant	2 - Low	1. Effective	•Finalise Rehabilitation Plan for TSF3 Upper Esperanza catchment •Rehabilitate as soon as tailings deposition is completed or tailings deemed of no further use	•Include Rehabilitation Plan for TSF3 in Detailed Design Report

11	Land	Borrow Areas	Construction	Clearance activities during construction disturb lands which are currently vegetated with local native plants or used for low intensity grazing	•Permanent loss of land capability for native vegetation or low intensity grazing	B. Unlikely	2. Minor	5 - Low	•Rehabilitation strategy included in EA amendment which assumes revegetation with native species •Potential areas for borrow areas are insignificant when compared with overall size of the surrounding grazing property (1Mha)	B. Unlikely	1. Insignificant	2 - Low	1. Effective	•Finalise Rehabilitation Plan for Borrow Areas following investigation studies •Rehabilitate progressively as soon as borrow materials have been extracted	•Include Rehabilitation Plan for Borrow Areas in Detailed Design Report
12	Waste	TSF3	Construction	Construction activities generate significant additional general and regulated waste due to an increase in staff/contractors and vehicle movements	•Increase in general and regulated waste during construction compared to suspension phase	C. Possible	2. Minor	8 - Medium	•JJ Richards currently remove general waste on a monthly basis to be dispoed in Mount Isa Waste Facility and this would be increased if required •Regulated waste is removed on an as-needs basis and this would continue to be monitored and removed as required	C. Possible	1. Insignificant	4 - Low	1. Effective	•Update Waste Management Plan with additional waste predictions during the construction phase •Monitor waste production andIncrease frequency of waste removal as required	•Include Waste Management Plan in Detailed Design Report

EA Amendment Risk Register - TSF3

Project Name : CCM TSF3 Upper Esperanza

Job No.: CCM-TSF3
Risk Framework: 29 Metals - 20211216-HO-POL-APPROVED Risk Evaluation Matrix

Item No.	Type	Asset Location	Design Life Cycle Phase	Risk	Hazard	Likelihood	Consequences	Risk Rating and Score	Existing Controls/Management Strategies	Residual Likelihood	Residual Consequences	Residual Risk Rating and Score	Control Rating	Further Controls/Management Strategies	Follow Up Actions
1	Air	TSF3	Operation	Vehicle activities during operation disturb road surfaces causing dust impacts on sensitive receptors	• Air pollution from road dust impacts on sensitive receptors	B. Unlikely	2. Minor	5 - Low	•Regular dust supression (road watering) during operational activities utilising treated water •The nearest sensitive receptor is the mine accommodation camp which is not located within proximity of the TSF3 (Upper Esperanza) to receive dust emissions	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Undertake air quality monitoring if complaints are received • Reduce earth moving operation activities in high wind conditions if complaints are received	•Include dust supression (road watering) details in Operations, Maintenance and Surveliance (OMS) Manual
2	Air	TSF3	Operation	Tailings dust during operations impacts on sensitive receptors	• Air pollution from tailings dust impacts on sensitive receptors	C. Possible	2. Minor	8 - Medium	•Minimise tailings dust supression during operational activities by appropriate slurry deposition strategy •The nearest sensitive receptor is the mine accommodation camp which is not located within proximity of the TSF3 (Upper Esperanza) to receive dust emissions	B. Unlikely	2. Minor	5 - Low	1. Effective	• Undertake air quality monitoring if complaints are received • Deposition strategy to maintain appropriate levels of moisture in tailings slurry without causing seepage	•Include tailings deposition details in Operations, Maintenance and Surveliance (OMS) Manual
3	Air	TSF3	Operation	Activities during operation generate additional green house gas (GHG) emissions	Increase in GHG emissions during operation	B. Unlikely	1. Insignificant	2 - Low	•Regular maintenance of vehicles to ensure that emissions are minimised	B. Unlikely	1. Insignificant	2 - Low	2. Partially Effective	• Consideration of low emisison vehicles for operational phase	•Include consideration for low emission vehicles in operation Contract
4	Surface Water	TSF3	Operation	Tailings deposition activities during operation cause contamination of surface water	▪Contaminated surface waters runoff into the surrounding receiving environment	B. Unlikely	3. Moderate	9 - Medium	•Decant pond to be minimised through thickened tailings •Operational procedures to recycle water through new WTP and minimise water inventory held on site •Site Water Balance Model (DSA/ESS) - SWIA modelling did not show overflows from site under any scenario P99 • TSF3 Monitoring Instrumentation • Suitable Freeboard to be maintained (ESS ~180 ML at final tailings deposition surface) •No direct surface water pathway to Gunpowder Creek •Spillway overflow into EPit	A. Rare	2. Minor	3 - Low	1. Effective	• Minimise operational activities during high rainfall events or periods • Update existing site surface water monitoring programs to incorporate TSF3 • OMS Manual to be developed for TSF3 •Water treatment plant and management plan. •Diversions and emergency pumping to be investigated •Mechanical evaporators to be maintained •Water release criteria for EA to be finalised	•Include decant and deposition plan details in Operations, Maintenance and Surveliance (OMS) Manual •Update Water Management Plan and procedures
5	Groundwater	TSF3	Operation	Tailings deposition causes contamination of groundwater aquifers	▪Contaminated groundwaters seeping into the surrounding groundwater aquifers	B. Unlikely	2. Minor	5 - Low	•Geological setting indicates TSF3 sited in stable low permeability setting. •Groundwater modelling predicts seepage pathways to EPit and Esperanza Underground (ESS) •Pumping and treatment of water from EPit and ESS to release quality water standards •Northern Embankment design incorporating recontouring of Esperanza Waste Rock Dump, plastic lining and grout curtain to minimise seepage •Southern Embankment (UEDD) incorporating plastic lining and grout curtain to minimise seepage •Decant size to be minimised through appropriate operational procedures including thickened tailings and recycling of water through new WTP.	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Ongoing investigations into UEDD seepage and repairs of plastic lining Update of existing site groundwater monitoring programs to incorporate TSF3 •Additional active seepage management (i.e. pumped dewatering of seepage interception wells / sumps) if required •Investigate alternative decant location away from perimiter embankments •Finalise site wide numerical groundwater model during detailed design to quanitify change in groundwater flows / groundwater quality •Complete geotechnical investigation for TSF3 embankments during detailed design •Operational controls to minimise water available for seepage into groundwater aquifers	•Include groundwater protection and seepage management measures in Detailed Design Report and OMS Manual
6	Noise	TSF3	Operation	Operational activities result in noise impacts on sensitive receptors	• Noise impacts on sensitive receptors	B. Unlikely	2. Minor	5 - Low	•The nearest sensitive receptor is the mine accommodation camp which is not located within proximity to receive noise associated with operation activities	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Undertake noise monitoring if complaints are received. • Minimise high noise activities during night hours if complaints are received.	•Include consideration for low noise vehicles in Operational Phase
7	Ecology	TSF3	Operation	Operational activities result in impacts on species/habitat of National or State environmental significance	• Loss of species/habitat of National or State environmental significance	B. Unlikely	1. Insignificant	2 - Low	•Control vehicle interactions with wildlife through traffic management and signage •Monitor any fauna deaths associated with TSF3 operations •Permit to disturb land system managed by on-site Enviro team	B. Unlikely	1. Insignificant	2 - Low	1. Effective	•Monitor and record wildlife interactions and deaths •Regularly include fauna protection in safety breifings	•Include ecological protection measures in operation Management Plan and Detailed Design Report
8	Cultural & Spirital	TSF3	Operation	Operational activities result in impacts on Aboriginal Cultural Heritage in TSF3 footprint or topsoil stockpile areas	• Loss of artefacts or places of Aboriginal cultural heritage significance	B. Unlikely	2. Minor	5 - Low	•Cultural Heritage surveys and clearances undertaken in June 2016 and July 2025 prior to operation •All cultural heritage matters signed off prior to operation •Cultural Heritage included in all site inductions	B. Unlikely	2. Minor	5 - Low	1. Effective	•Development of a Cultural Heritage Management Plan for future disturbance of sensitive areas	•Include cultural heritage protection measures in Detailed Design Report
9	Land	TSF3	Operation	TSF3 footprint remains disturbed during the operational phase	•Permanent loss of land capability for native vegetation	B. Unlikely	2. Minor	5 - Low	•Closure strategy included in preliminary design which assumes revegetation with native species	B. Unlikely	1. Insignificant	2 - Low	1. Effective	•Finalise Rehabilitation Plan for TSF3 Upper Esperanza catchment •Rehabilitate as soon as tailings deposition is completed or tailings deemed of no further use	•Include Rehabilitation Plan for TSF3 in Detailed Design Report
10	Waste	TSF3	Operation	Operational activities generate significant additional general and regulated waste due to an increase in staff/contractors and vehicle movements compared to suspension phase	•Increase in general and regulated waste following restart of operations	C. Possible	2. Minor	8 - Medium	•JJ Richards currently remove general waste on a monthly basis to be dispoed in Mount Isa Waste Facility and this would be increased if required •Regulated waste is removed on an as-needs basis and this would continue to be monitored and removed as required	C. Possible	1. Insignificant	4 - Low	1. Effective	•Update Waste Management Plan with additional waste predictions during the operation phase •Monitor waste production and increase frequency of waste removal as required	•Include Waste Management Plan in Detailed Design Report

11	Multiple	TSF3	Operation	•Dam Break (potentially non-credible for failures reaching off site)	• Release of stored contents off-site • Release of stored contents on-site •Potential impacts to persons / enviornment / property / social licence.	A. Rare	5. Catastrophic	15 - High	• Design to industry recommended guidelines. • Site specific seizmic hazard assessment completed. •Preliminary CCAs completed (DESI/ANCOLD) •Large landform embankment (EWRD) •Annual Regulated Structure Inspection	A. Rare	4. Major	10 - Medium	2. Partially Effective	•Remove upstream raise methodology from UEDD embankment. • OMS Manual / TARPs to be developed / updated. • Routine Surveillance Inspections • TSF Monitoring Instrumentation. • Emergency Response Plan to be developed / updated. •Detailed CCAs including FIA (if required) (DESI/ANCOLD/GISTM =) to be undertaken during detailed design. •Geotechnical Investigation to be completed as part of detailed design.	•Include embankment dam break in Detailed Design Report

EA Amendment Risk Register - TSF3

Project Name : CCM TSF3 Upper Esperanza

Job No.: CCM-TSF3
Risk Framework: 29 Metals - 20211216-HO-POL-APPROVED Risk Evaluation Matrix

Item No.	Type	Asset Location	Design Life Cycle Phase	Risk	Hazard	Likelihood	Consequences	Risk Rating and Score	Existing Controls/Management Strategies	Residual Likelihood	Residual Consequences	Residual Risk Rating and Score	Control Rating	Further Controls/Management Strategies	Follow Up Actions
1	Air	TSF3	Closure	Vehicle activities during rehabilitation disturb road surfaces causing dust impacts on sensitive receptors	• Air pollution impacts on sensitive receptors	B. Unlikely	2. Minor	5 - Low	•Regular dust supression (road watering) during rehabilitation activities utilising treated water •The nearest sensitive receptor is the mine accommodation camp which is not located within proximity of the TSF3 (Upper Esperanza) to receive dust emissions	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Undertake air quality monitoring if complaints are received. • Reduce earth moving rehabilitation activities in high wind conditions if complaints are received	•Include dust supression (road watering) details in Closure and Rehabilitation Plan
2	Air	TSF3	Closure	Activities during rehabilitation generate additional green house gas (GHG) emissions	Increase in GHG emissions during rehabilitation	B. Unlikely	1. Insignificant	2 - Low	•Regular maintenance of vehicles to ensure that emissions are minimised	B. Unlikely	1. Insignificant	2 - Low	2. Partially Effective	• Consideration of low emisison vehicles for rehabilitational phase	•Include consideration for low emission vehicles in rehabilitation Contract
3	Surface Water	TSF3	Closure	Earthmoving activities during rehabilitation cause contamination of surface water	▪Contaminated surface waters runoff into the surrounding receiving environment	B. Unlikely	3. Moderate	9 - Medium	•Conceptual TSF3 Closure Landform Design •Progressive Rehabilitation and Closure Plan (PRPC) submitted in June 2024 and additional studies ongoing to address not-properly made aspects, due for resubmission in September 2025 • Suitable Freeboard to be maintained (ESS ~180 ML at final tailings deposition surface) •No direct surface water pathway to Gunpowder Creek •Spillway overflow into EPit	B. Unlikely	2. Minor	5 - Low	1. Effective	• TSF3 Rehabilitation Plan being drafted • Minimise rehabilitation activities during high rainfall events or periods • Continue to monitor surface water during closure and rehabilitation phases • PRCP to be updated for TSF3	•Develop TSF3 Rehabilitation Plan for submission during Information Request phase of application •Update PRCP with TSF3 following approval
4	Groundwater	TSF3	Closure	Earthmoving activities during rehabilitation contamination of groundwater aquifers	▪Contaminated groundwaters seeping into the surrounding groundwater aquifers	B. Unlikely	2. Minor	5 - Low	•Geological setting indicates TSF3 sited in stable low permeability setting. •Groundwater modelling predicts seepage pathways to EPit and Esperanza Underground (ESS) •Continued pumping and treatment of water from EPit and ESS to release quality water standards during closure and rehabilitation phases •Embankment design to incorporate controls to reduce seepage where appropriate •Progressive rehabilitaton where possible	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Ongoing monitoring of groundwater during closure and rehabilitation phases •Additional active seepage management (i.e. pumped dewatering of seepage interception wells / sumps) if required •PRCP to be updated for TSF3	•Develop TSF3 Rehabilitation Plan for submission during Information Request phase of application •Update PRCP with TSF3 following approval
5	Noise	TSF3	Closure	Rehabilitation activities result in noise impacts on sensitive receptors	• Noise impacts on sensitive receptors	B. Unlikely	2. Minor	5 - Low	•The nearest sensitive receptor is the mine accommodation camp which is not located within proximity to receive noise associated with rehabilitation activities	B. Unlikely	1. Insignificant	2 - Low	1. Effective	• Undertake noise monitoring if complaints are received. • Minimise high noise activities during night hours if complaints are received.	•Include consideration for low noise vehicles in Rehabilitation Phase
7	Ecology	TSF3	Closure	Rehabilitation activities result in impacts on species/habitat of National or State environmental significance	• Loss of species/habitat of National or State environmental significance	B. Unlikely	1. Insignificant	2 - Low	•Control vehicle interactions with wildlife through traffic management and signage •Monitor any fauna deaths associated with TSF3 rehabilitation	B. Unlikely	1. Insignificant	2 - Low	1. Effective	•Monitor and record wildlife interactions and deaths •Regularly include fauna protection in safety breifings	•Include ecological protection measures in Rehabilitation Plan
8	Cultural & Spirital	TSF3	Closure	Rehabilitation activities result in impacts on Aboriginal Cultural Heritage in TSF3 footprint or topsoil stockpile areas	• Loss of artefacts or places of Aboriginal cultural heritage significance	B. Unlikely	2. Minor	5 - Low	•Cultural Heritage surveys and clearances undertaken in June 2016 and July 2025 prior to construction •All cultural heritage matters signed off prior to construction •Cultural Heritage included in all site inductions	B. Unlikely	2. Minor	5 - Low	1. Effective	•Development of a Cultural Heritage Management Plan for future disturbance	•Include cultural heritage protection measures in Rehabilitation Plan
10	Land	TSF3	Closure	TSF3 footprint remains disturbed following the rehabilitation phase	•Permanent loss of land capability for native vegetation	C. Possible	3. Moderate	13 - Medium	•Closure strategy included in preliminary design which assumes revegetation with native species •Conceptual TSF3 Closure Landform Design in preliminary design •Progressive Rehabilitation and Closure Plan (PRPC) submitted in June 2024 and additional studies ongoing, due for resubmission in September 2025 •Borrow materials for rehabilitation being investigated both on-lease and off-lease •Annual Regulated Structures inspections. •Regular flyover surveys. •Development of rehabilitation monitoring methodolgy as a component of the PRCP	C. Possible	1. Insignificant	4 - Low	1. Effective	•Finalise Rehabilitation Plan for TSF3 Upper Esperanza catchment •Rehabilitate as soon as tailings deposition is completed or tailings deemed of no further use • Routine and intependent surveillance inspections. • Develop training program for rehabilitational personnel resoponsible for TSF3 rehabilitation / Management	•Include Rehabilitation Plan for TSF3 in Detailed Design Report
12	Waste	TSF3	Closure	Rehabilitation activities generate significant additional general and regulated waste due to an increase in staff/contractors and vehicle movements compared to operations phase	•Increase in general and regulated waste following restart of rehabilitations	B. Unlikely	2. Minor	5 - Low	•JJ Richards currently remove general waste on a monthly basis to be dispoed in Mount Isa Waste Facility and this would be increased if required •Regulated waste is removed on an as-needs basis and this would continue to be monitored and removed as required	B. Unlikely	1. Insignificant	2 - Low	1. Effective	•Update Waste Management Plan with additional waste predictions during the rehabilitation phase •Monitor waste production and increase frequency of waste removal as required	•Include Waste Management Plan in Detailed Design Report
13	Multiple	TSF3	Closure	•Dam Break (potentially non-credible for failures reaching off site)	• Release of stored contents off-site • Release of stored contents on-site •Potential impacts to persons / enviornment / property / social licence.	A. Rare	5. Catastrophic	15 - High	• Design to industry recommended guidelines. • Site specific seizmic hazard assessment completed. •Preliminary CCAs completed (DESI/ANCOLD) •Large landform embankment (EWRD). •Tailings dewatered, no decant • Annual Regulated Structure Inspections	A. Rare	4. Major	10 - Medium	2. Partially Effective	•Remove upstream raise methodology from UEDD embankment • OMS Manual / TARPs to be developed / updated for closure • Routine Surveillance Inspections during and post-closure • TSF Monitoring Instrumentation. • Emergency Response Plan to be developed for closure and post-closure	•Include embankment dam break for closure and post-closure scenarios in Detailed Design Report

A.8 GW Model Response to DETSI Comments

MEMORANDUM

Project:	QC1022_018-MEM-005-0 TSF 3 Design	Date:	24 July 2025
To:	29Metals	From:	Yohannes Yihdego
ATT:		CC:	Travis Warren
Subject:	Response to Preliminary DETSI Comments on Groundwater Modelling Presentation		

INTRODUCTION

Engeny Australia Pty Ltd (Engeny) have been engaged to develop a site wide transient groundwater flow model (the Model) for the Capricorn Copper Mine (CCM). We provide the following responses in consideration of the feedback received by Department of Environment, Tourism, Scient and Innovation (DETSI) following presentation of limited results of the Model during a pre-lodgement meeting in support of the proposed TSF3 Project by CCM.

The modelling to date has not incorporated the proposed TSF3 facility, but the area of the proposed TSF3 is included in the model boundary and initial model results to increase understanding of groundwater characteristics in the areas have bene undertaken.

Please find below our responses to each of the items raised (a–o). A detailed technical report and model files will be submitted as part of the TSF3 Groundwater Impact Assessment, following finalisation of the transient modelling.

a. **Class 2 model**: While this model is expected to support the impact assessment, it will require robust calibration and predictive confidence (i.e., alignment between observed and modelled data). A description of uncertainties and limitations must be detailed.

The model is being developed to meet the requirements of a Class 2 model (per the Australian Groundwater Modelling Guidelines) and is undergoing calibration against historical groundwater level trends for the transient calibration period (2016-2024). Calibration statistics will be included in the final submission. A dedicated section will document the model's assumptions, limitations, and uncertainty sources (e.g. fault hydraulic properties, recharge patterns, and material hydraulic conductivity/ anisotropy).

b. **Water quality and inflow patterns**: Confirmation on whether water quality data and inflow patterns have been incorporated into the model, particularly in relation to predicting groundwater behaviour over time.

At this stage, the model has been primarily developed and calibrated for groundwater flow simulation, with inflow patterns assessed based on observed water levels and dewatering volumes.

While water quality data has not yet been explicitly modelled, it has been used qualitatively to support interpretations of flow directions and connectivity (e.g. chloride and sulphate trends consistent with seepage influence).

Importantly, the model has also supported an assessment of the degree of connection between surface water and groundwater, as well as potential seepage pathways between mining facilities and groundwater systems, including interactions between WRDs, ETSF, Epit, and the underground mines.

This work has enhanced our conceptual understanding of groundwater behaviour and will inform both the ongoing monitoring strategy and any future contaminant transport assessments.

c. **Dewatering and WRD/s**: Has the interaction between dewatering activities and WRDS been considered, particularly regarding potential alterations to seepage gradients? What is the likelihood of contaminants being mobilised from WRDs?

Yes, the model incorporates dewatering from underground workings (ESS, MAM, GST) and seepage loads from WRDs. These are implemented as time-varying flux boundary conditions and distributed recharge. Gradient reversal and potential mobilisation pathways from WRDs particularly around the Mammoth WRD and Esperanza WRD are acknowledged as key risks and will be reported in the impact assessment.

d. **Seepage pathways and boundary conditions:** Are seepage pathways sensitive to boundary conditions? Additionally, are there any receptors that should be included in the model calibration?

Seepage pathways are sensitive to both fault connectivity and boundary assumptions. Known surface water/groundwater interaction zones and potential receptors (e.g., Gunpowder Creek) are included in the model calibration dataset where data exists. The updated dataset and observation comparisons will be presented in the report.

e. **Intermediate aquifer (Layer 3):** On page 3, Layer 3 is described as an intermediate aquifer. Clarify which aquifer this refers to?

Based on the model conceptualisation, each HSU (Hydrostratigraphy Unit) contains upper, middle and deep aquifers with different hydraulic conductivity. The one to two layer represents the mine facilities and shallow HSUs. Layers three encapsulate the intermediate HSUs, and the deeper, unfractured lithologies is included in layers four to ten. A summary of the layer configuration is presented in Table 1

Table 1: Model Layers

HSU	Mode Layer	Thickness (m)	Infrastructure
Metabasalts/Dolomitic Rocks/ Argillaceous Rocks/ Arenaceous Rocks - Upper	Layer 1 – Unconfined Aquifer	0.1 to 74	ETSF, WRD (North, Mammoth, Esperanza), Old TSF, Sumps (North and 6)
Metabasalts/Dolomitic Rocks/ Argillaceous Rocks/ Arenaceous Rocks - Upper	Layer 2 – Confined/Unconfined Aquifer	5 to 14	
Metabasalts/Dolomitic Rocks/ Argillaceous Rocks/ Arenaceous Rocks – Middle (Intermediate)	Layer 3 – Confined/Unconfined Aquifer	8 to 24	
Metabasalts/Dolomitic Rocks/ Argillaceous Rocks/ Arenaceous Rocks - Deep	Layer 4 to 10 – Confined/Unconfined Aquifer	25 to 350	Underground Mines (ESS, MAM, GST)

f. **Deep aquifers (Layers 4–10):** Layers 4 to 10 are described as a "deep aquifer." Should this instead refer to "aquifers," given that multiple aquifers or sub-formations are likely to exist within these layers?

Yes, we agree with this observation. Layers 4–10 represent multiple hydrostratigraphic units within the deeper fractured bedrock system and will be referred to as “deep aquifers” in plural to reflect their hydrogeological variability. This includes major fault compartments. Please refer to Table 1

g. **South fault:** The south fault is not included in the table on page 4, despite being within the model boundaries. This fault must be incorporated into the model.

The table on page 4 of the presentation shows the hydraulic conductivity (K) values estimated from field investigations, including slug/pumping tests.

We confirm that all major faults, including the South Fault, are incorporated into the numerical model. Each fault has been assigned a spatially distributed hydraulic conductivity based on geological interpretation and calibrated against observed groundwater trends and mine inflows.

h. **Hydraulic conductivity:** Confirmation on whether the hydraulic conductivity results presented are based on observed field data.

Yes, hydraulic conductivity values were derived from field data, including pumping tests, slug tests, and inferred from calibration to observed data (groundwater levels). The model integrates these as zoned and pilot point parameters, with vertical anisotropy informed by geology and structural context.

i. **Esperanza fault:** The Esperanza fault is identified as having low permeability, but the figure suggests the southern part of the fault may act as a conduit. Does this imply higher hydraulic conductivity (or leaky conductivity) in the southern section, with the northern section acting as a low-permeability barrier? If so, the model must account for this spatial variability.

Correct, the Esperanza Fault exhibits spatial variability. The northern portion appears to act as a low-permeability barrier, while the southern segment may function as a leaky conduit. This is reflected in the model via variable hydraulic conductivity pilot points (zonation) along the fault trace, supported by calibration to observed groundwater level responses patterns.

j. **Faults as barriers:** The presentation states that faults act as barriers in the shallow aquifer, despite high permeability in the upper aquifers. Clarification is required on this statement (i.e., barrier despite high permeability).

The statement refers to the contrast between the hydraulic conductivity of the shallow hydrostratigraphic units (HSUs) and the faults.

In the shallow aquifer, the HSUs generally exhibit relatively high hydraulic conductivity, while the faults often have lower permeability due to weathered fault gouge or infilling. As a result, faults may act as hydraulic barriers to horizontal flow in the shallow zone.

In contrast, at greater depths, the hydraulic conductivity of the surrounding rock typically decreases, and the faults may become relatively more permeable or comparable in conductivity to the host rock. In these cases, faults may act as conduits or leaky features, depending on local conditions.

The model reflects this depth-dependent behaviour by assigning variable hydraulic conductivity values to faults and adjacent units, calibrated against observed groundwater levels.

k. **Particle tracking:** It is noted that particle tracking assumes no dispersion, diffusion, or chemical reactions. Has the potential for plume spread or contaminant transport, particularly in fractured areas, been considered?

Yes, particle tracking simulations, used to assess capture zones and seepage destinations, are currently based on advection-only transport. These simulations do not account for dispersion, diffusion, or chemical reactions, in line with standard groundwater modelling practice for particle tracing.

However, preferential flow pathways, particularly through fractured zones and fault structures, are explicitly included in the model. These features are represented with enhanced hydraulic conductivity based on field and structural data, allowing particle tracking to reflect likely seepage directions through pathways.

The potential for plume migration or contaminant transport beyond advection may be evaluated in future solute transport modelling stages, particularly under closure and long-term scenarios.

l. **Future stages**: A note on page 4 states that the model "does not fully capture future stages." When will this be addressed? Consideration of potential changes in seepage direction during closure is also required.

The note refers to infrastructure that will be added in future (e.g., final landform of WRDs or additional TSFs (TSF3)). These will be incorporated in closure scenario modelling. Seepage direction changes under closure (e.g., from cessation of pumping or altered recharge) are a key focus of the closure modelling phase, and scenarios are being constructed accordingly.

m. **Seepage from TSF3:** Page 6 states that seepage from TSF3 would be minimal. Has the model included an estimate of the potential seepage rate?

No model scenario/ simulation has yet been performed using the final proposed TSF3 design, including the decant pond level at 300 m AHD-312 m AHD.

Instead, a baseline assessment was undertaken, focusing on forward particle tracking from the proposed TSF3 footprint. This scenario did not incorporate the TSF structure itself but assumed infiltration from the footprint area to provide a first-order estimate of seepage.

Based on assumed areal recharge through the TSF footprint, the model estimates a potential seepage rate of ~110 m^3/day, which is considered minimal under the assumed conditions. This value will be refined in subsequent modelling which Engeny is now undertaking which will assess the TSF3 at its full extent (dam and tailings) under operational and closure scenarios. Proposed TSF3 seepage will be incorporated as a flux boundary based on design permeability, base area, and pore pressure conditions. Preliminary seepage rates are low due to lining and distance to saturated zones. A conservative seepage flux is assumed for current modelling (baseline), and sensitivity runs are planned to evaluate seepage under liner failure or ageing scenarios.

n. **High-permeability faults near TSF3:** The presentation suggests that high-permeability faults near TSF3 could increase water levels to the east and west of TSF3. Should "east" instead refer to "north"?

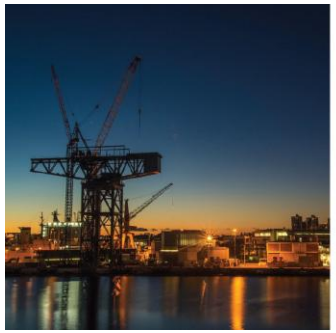
To clarify: under the proposed TSF3 full pond level scenario (300 m AHD-312 m AHD), preliminary analysis suggests divergent groundwater flow may develop toward both the east and west, but the eastern direction is of particular interest, as it represents a new potential seepage risk area.

The particle tracking analysis and seepage risk characterisation will be refined once TSF3 is incorporated in the model.

o. **Mammoth Fault:** The Mammoth fault in the north of MAM UG is described as creating a hydraulic connection between the mine and surrounding facilities (i.e., EPit, Esperanza and Mammoth WRD). However, the statement also suggests that the faults act as barriers for the shallow aquifer, despite high permeability in the upper HSUs. This requires clarification as high permeability in shallow aquifers would typically indicate that the fault acts as a conduit rather than a barrier.

While the Mammoth Fault connects the underground mine to adjacent WRDs and the EPit, it exhibits mixed hydraulic behaviour. In deeper zones, it acts as a conduit; in shallow zones, the fault infill may impede lateral flow. The model applies spatially variable permeability to reflect this dual behaviour, aligned with geological interpretations and water level gradients.

A.9 Greenhouse Gas Emissions Assessment






RPS & 29Metals Capricorn Copper – Greenhouse Gas Emissions Review for TSF3 EA Amendment

June 2025

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Executive Summary

Capricorn Copper Pty Ltd, a subsidiary of 29Metals are seeking to amend the Environmental Approval for the Tailings Storage Facility 3. Per the Environmental Protection Act Greenhouse Gas Emissions Guidelines, this amendment requires a Greenhouse Gas Emissions assessment is undertaken. This assessment must encompass Scope 1 and Scope 2 direct emissions from the operation as they relate to the amendment. Furthermore, if Scope 1 and Scope 2 emissions exceed 25,000tCO2e per annum, the project/facility will be classified as a medium-large emitter and will be required to disclose Scope 3 estimates and abatement plans. RPS are seeking to assist Capricorn Copper through this process.

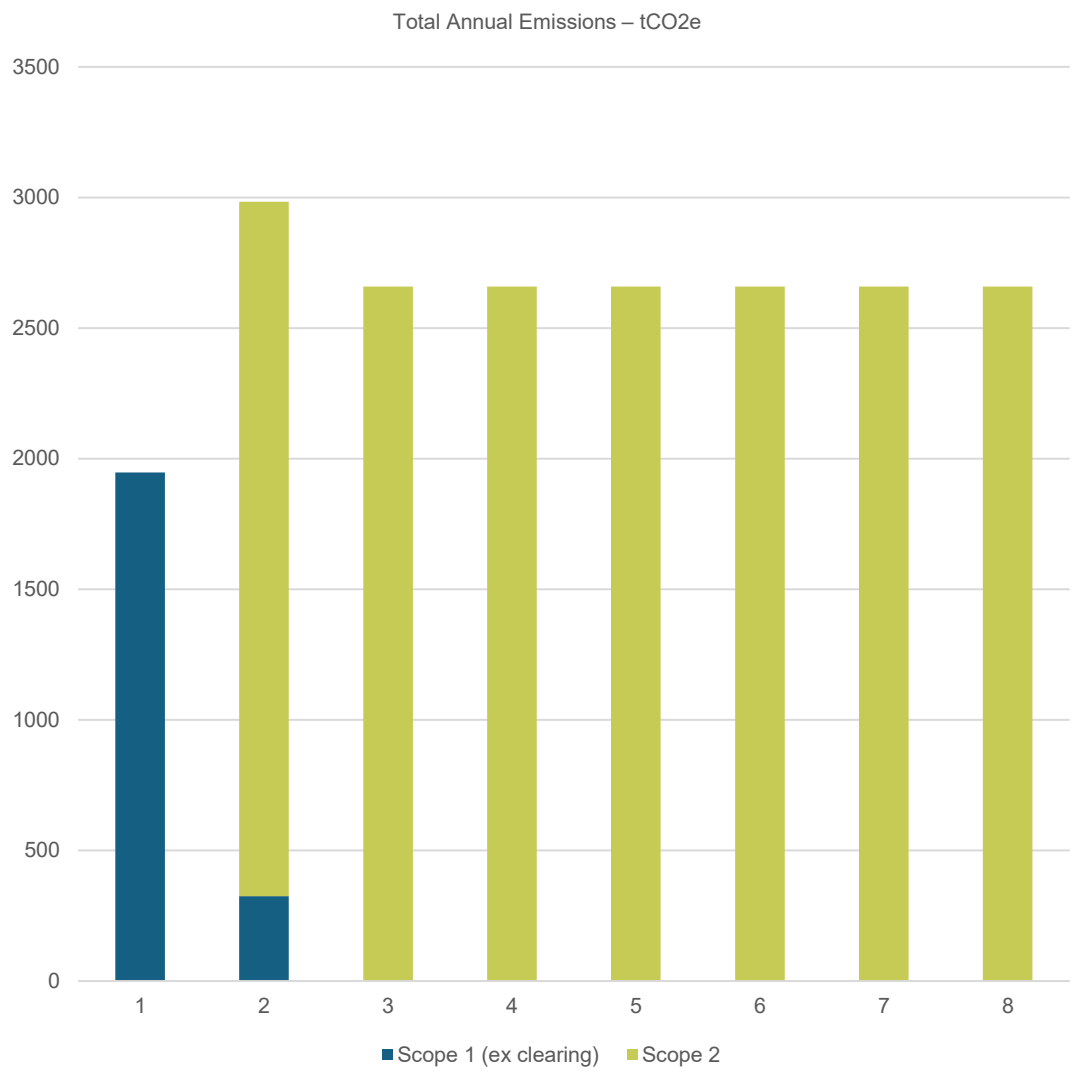
Total emissions from the project are expected to amount to 20,884 tCO2e (excluding clearing) over its entire construction and operational life. This includes Scope 1 (Construction Phase) and Scope 2 (limited to Operational Phase).

Scope 1/Construction emissions are predominantly limited to sources from the operation of vehicles and machinery requiring the combustion of diesel oil. This has been estimated at 2,272tCO2e over the 14-month construction phase of the project. Impacts to vegetation could amount to 4,072tCO2e however it has been indicated that this area will be rehabilitated after the project is complete, therefore offsetting these impacts and bringing their ultimate impact to 0tCO2e.

Scope 2/Operational emissions arise due to the use of electrically powered pumps and evaporation equipment to be installed at the TSF3 facility. This amounts to a constant 2,659tCO2e/annum throughout the operational life the project (7 years upon commissioning).

With total annual emissions being below 25,000tCO2e, Scope 3 emissions have been excluded form this analysis.

Average annual emissions from the project amount to 2,611tCO2e/annum.

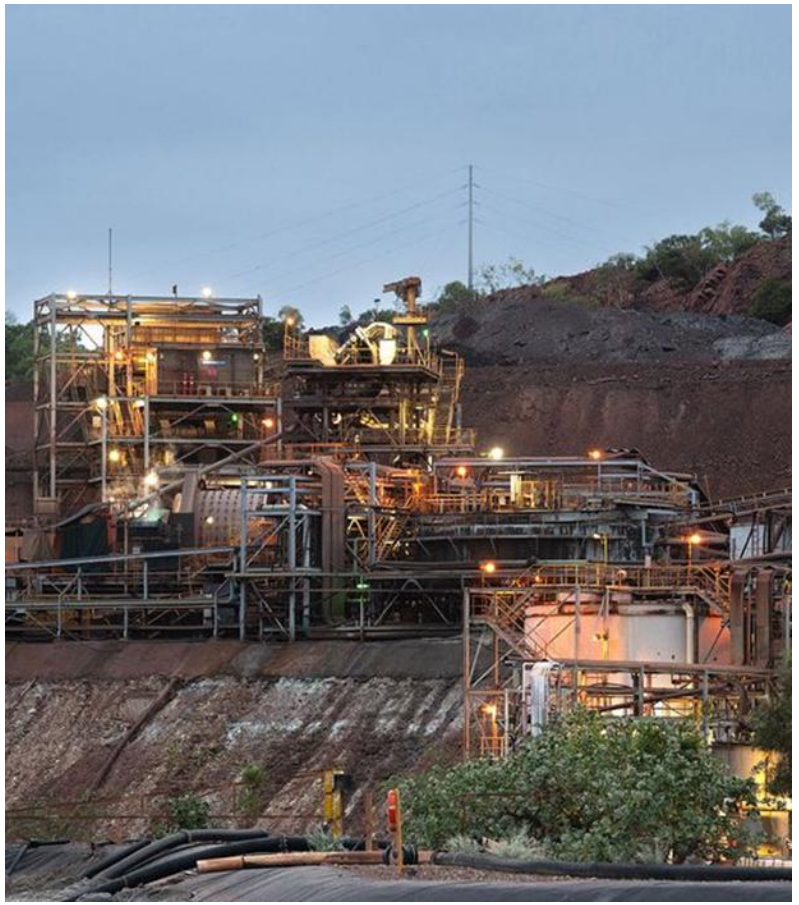


Project Information and Scope of Memo

Capricorn Copper Pty Ltd, a subsidiary of 29Metals are seeking to amend the Environmental Approval for the Tailings Storage Facility 3. Per the Environmental Protection Act Greenhouse Gas Emissions Guidelines, this amendment requires that a Greenhouse Gas Emissions assessment is undertaken. This assessment must encompass Scope 1 and Scope 2 direct emissions from the operation as they relate to the amendment. Furthermore, if Scope 1 and Scope 2 emissions exceed 25,000tCO2e per annum, the project/facility will be classified as a medium-large emitter and will be required to disclose Scope 3 estimates and abatement plans. RPS are seeking to assist Capricorn Copper through this process.

earthrade, through its partnership with ARTEH, offers greenhouse gas emission modelling services utilising a purpose developed SaaS based platform. This platform has been built to all requirements per state, national and international requirements and guidelines. The ARTEH platform can model emissions at a building, office, project, facility, and business unit scale across multiple years. It includes Scope 1, 2 and 3 breakdowns and contains a data dictionary for expedited data upload and input.

This report, and its associated analysis has been constructed based on data and advice provided by RPS and 29Metals in line with requirements of the Environmental Protection Act Greenhouse Gas Emissions Guidelines.



Scope 1 – Environmental Approval Requirements

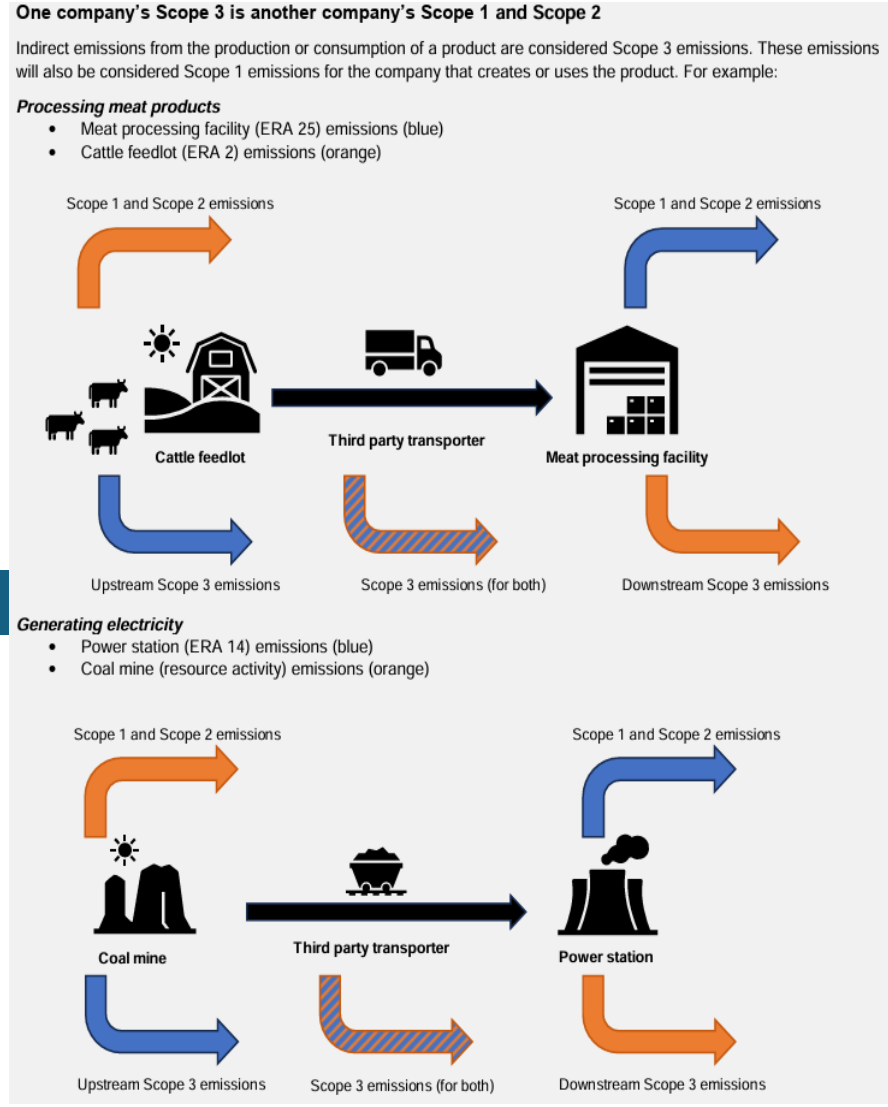
Scope 1 is related to Greenhouse Gas (**GHG**) emissions released to the atmosphere as a direct result of an activity, which includes direct emissions and fugitive emissions

Following activities are the main sources of the emissions:

- Generation of energy, heat, steam and electricity, such as fuel combustion in generators;
- Manufacturing processes which produce emissions such as cement, aluminium and ammonia production;
- Transportation of materials, products, waste and people; such as the use of vehicles owned and operated by the reporting organisation;
- Solid waste disposal and wastewater treatment including on-site waste management; and
- Intentional or unintentional GHG releases (fugitive emissions) such as methane emissions from coal mines, natural gas leaks from joints and seals.

Within the scope of the project, Scope 1 emissions directly relate to the development/construction phase of the facility. This includes diesel oil combustion and habitat clearing.

Source	Amount
Vehicles	49
Days/Shifts	1,550
Total Shifts	5,590
Total Diesel L	838,500
Vegetation Clearing	115 hectares



Scope 1 – Capricorn Copper Data EA Relevant Data Sources

Scope 1 emissions as it directly relates to the project are only present during the construction of the facility itself. Upon completion, TSF3 will be operated by electric pumps pushing emissions for operations into the Scope 2 category.

Scope 1 emissions therefore primarily consist of diesel used in the development of the site and infrastructure itself. As the final project development process is not yet finalised, this has been estimated based on the vehicles estimated to be required to achieve project milestones. Furthermore, due to the wide range of vehicles in and out of use as required during the project development phase, diesel use cannot be estimated per vehicle – instead, a conservative average of 150L per shift has been used. It has been assumed that any diesel required within explosives mixture is included within the Drill and Blast assumption.

This results in total emissions from diesel use estimated at 2,272 tCO2e based on a factor of 2.71kgCO2e/L diesel (Australian National Greenhouse Gas Factors).

The project will be developed over a 14-month period. Therefore, these emissions have been equally apportioned monthly. This results in annual Scope 1 emissions from diesel use of:

- Year 1 – 1,948 tCO2e
- Year 2 – 325 tCO2e

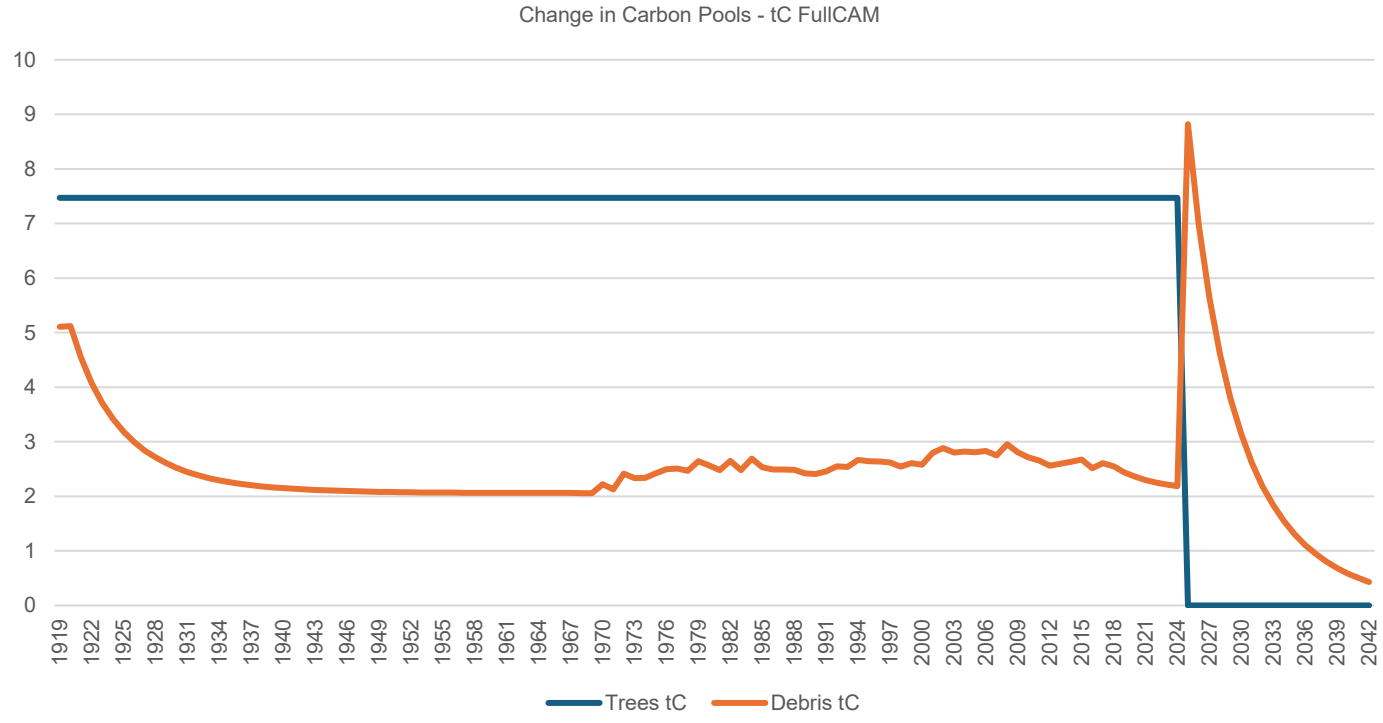
Source	Clearing	Drill and Blast	Excavation	Haulage/compaction	Haulage/compaction clay	Crushing	Screening	Piping	Concrete	Drilling Grouting	Powerline	Dust suppression	Other
No. Vehicles	4	3	4	6	8	3	4	2	3	4	3	2	3
Days Operating	30	100	150	150	60	100	60	50	100	300	50	300	100
Total Shifts	120	300	600	900	480	300	240	100	300	1,200	150	600	300
Estimated Diesel (150L per shift)	18,000	45,000	90,000	135,000	72,000	45,000	36,000	15,000	45,000	180,000	22,500	90000	45000
Scope 1 Emissions from Diesel Use	48.77	121.94	243.87	365.81	195.10	121.94	97.55	40.65	121.94	487.75	60.97	243.87	121.94
Total Scope 1 Emissions	2,272												
Project Year	1	2											
Emissions Allocation	1947.51	324.59											

Scope 1 emissions – Clearing of Vegetation

To establish a conservative estimate of vegetation impacts to Scope 1 emissions, vegetation has been assumed to be in a remnant state. Assessing the emissions from the decay of vegetation is completed using the FullCAM model. Assessing the Broad Vegetation Groups (BVGs) present around the facility indicates that any impacts are likely to be to BVG 19a – a low open Eucalypt Woodland (Queensland Herbarium and Biodiversity Science, 2023).

Using FullCAM, it was assumed that vegetation on site has been in permanent existence including a runup calculation since 1920 to account for potential regeneration characteristics. This results in potential carbon on site (trees and debris only) of 9.66tC/ha. It has been assumed that the entirety of this amount will be lost through construction. It should be noted that rehabilitation requirements have been identified as part of this assessment. If the area is to be rehabilitated back to its original state, the carbon emitted from the destruction of the environment will be reinstated resulting in a null effect overall. As such Scope 1 including and excluding habitat clearing have been included. An inclusion assumption results in an addition 4,072.8tCO2e being included within the Scope 1 emissions calculations.

29Metals have confirmed that the project will require vegetation rehabilitation therefore the net effect from vegetation will be 0tCO2e over the life of the project.



FullCAM Settings and Results	
Vegetation Type - BVG	BVG19a - Low open woodlands dominated by Eucalyptus leucophloia (snappy gum) with Triodia spp. dominated ground layer, mainly on hills and ranges
Vegetation Type - FullCAM	Low Open Eucalypt Woodland
Pre-project tC/ha (Trees + Debris)	9.66
Pre-project tCO2e/ha (Conversion Factor 44/12)	35.42
Post Project tCO2e/ha	0.0
Area (hectares)	115
Total tCO2e lost from vegetation impact (excl rehab)	4,072.8

Scope 1 – Summary of Results

All Scope 1 emissions for the project are emitted within the development/construction phase. Operationally, there will be no Scope 1 emissions from the project.

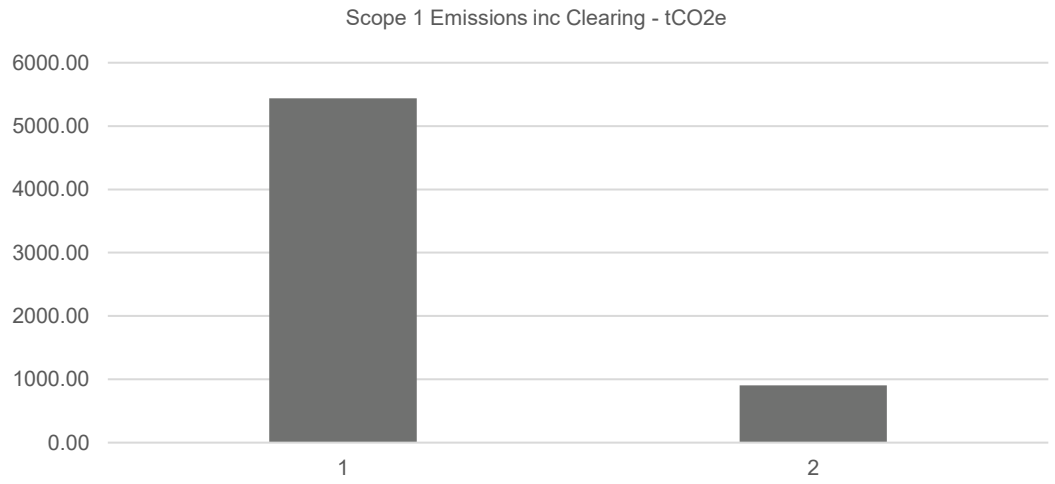
The construction phase emissions can be broken into two main sources – those created by the combustion of diesel oil through the operation of vehicles and machinery, and the emissions from the potential destruction of vegetation.

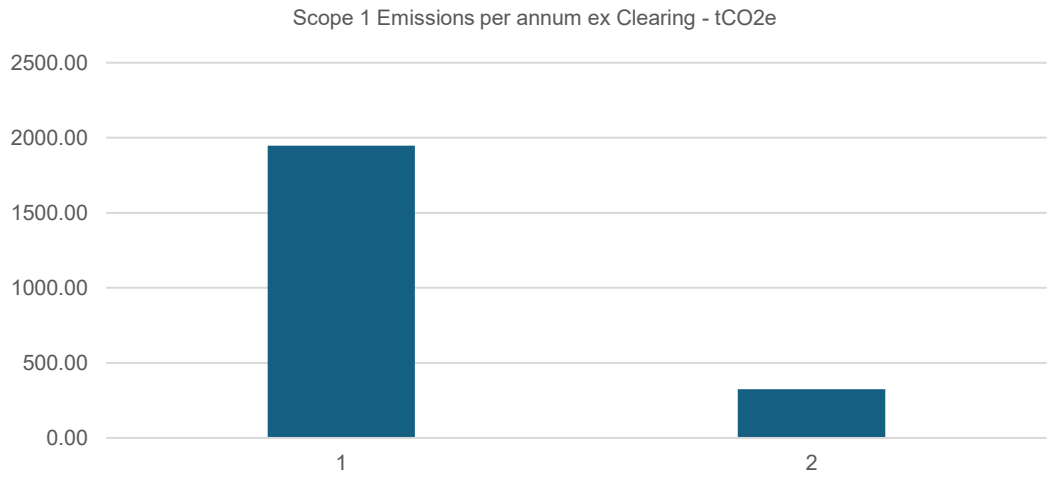
The operation of vehicles and machinery is expected to contribute 2,272tCO2e to the Scope 1 emissions profile based on 150L of diesel consumption per shift averaged across all vehicle types and shifts. It has also been assumed that this includes any diesel used in the creation of ANFO explosives during the drill and blast program.

Vegetation clearing will be dependent on the specific area being impacted by the project. As of this report, it has been conservatively assumed that the 115ha development area is comprised of remnant vegetation. As there is an obligation to rehabilitate the impacted area to its previous state, this vegetation, and therefore carbon, will be reinstated throughout the project and mine life.

Net Scope 1 emissions therefore are **2,272tCO2e with the exclusion of clearing.**

Source	tCO2e
Diesel	2,272
Vegetation Clearing	4,072.8
Total Scope 1 Inc Clearing	6,345
Total Scope 1 ex Clearing	2,272





Scope 2 – Environmental Approval Requirements

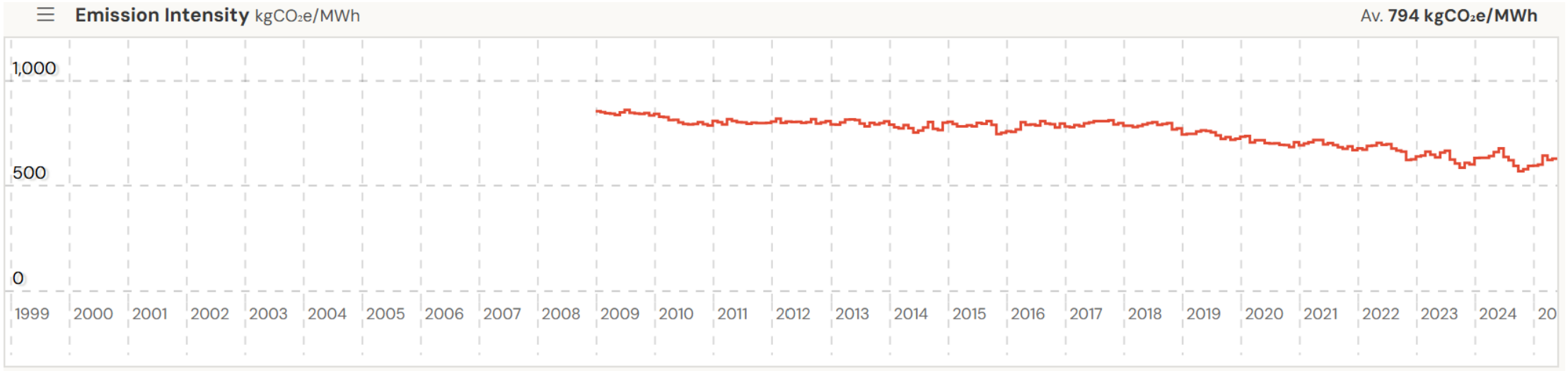
Scope 2 emissions relate to energy inputs (excluding those combusted/generated as part of the project) purchased from external suppliers to enable the project – within Queensland, and as it pertains to the project, this consists of purchased electricity form the National Electricity Market (NEM) within Queensland.

Under the Environmental Approval Guidelines, estimates throughout the lifecycle of the project/amendment must be made. This includes construction, operations and any rehabilitation of the project.

The Queensland NEM is under significant development with Scope 2 emissions from grid electricity use reducing year on year since 2018 reducing from 0.79tCO2e/MWH in January 2018 to 0.64tCO2e/MWH as of May 2025 (OpenNem, 2025). The 2024 edition of the National Greenhouse Accounts Factors (DCCEEW, 2024) detail an official factor of 0.71tCO2e/MWH for 2024. This figure shall be used in calculations for this project.

Operational Phase emissions are limited to only Scope 2 therefore this section will double as an exploration of operational emissions.

Sources	Amount (kwh) per annum	Factors
New tailings booster pumps using 300kW - operating 95% of the year.	2,496,600	
New decant pump using 110kw - operating 75% of the year	722,700	Current QLD Factor = 0.71 (National Greenhouse Accounts Factors, 2024)
Optional TSF evaporators using 200kW - operating 30% of the year (0% when total inventory is low)	525,600	



Scope 2 – Capricorn Copper Results

Scope 2 emissions arising to the project are limited to the Operational Phase only. This phase occurs over 7 years and will require the installation of several pieces of tailings infrastructure including pumps and evaporators.

All installed equipment is expected to be electrically operated and connected to grid electricity. All equipment is expected to be operated year-round with downtime captured in efficiency/uptime rates.

No additional Scope 1 emissions are expected to be required during the operational phase.

As all machines are expected to be operated year-round, this results in a static annual emissions estimation. Based on the power draw and uptime expectations provided by the client, the new facility will require 3,745MWH of grid electricity per annum. Using the 2024 Queensland Grid Intensity Factor from the National Greenhouse Accounts Factors, this results in annual emissions of 2,659tCO2e based on an intensity of 0.71tCO2e/MWH.

It should be noted that the grid emissions intensity of Queensland is expected to decrease further with the establishment of lower emissions power sources throughout the state. As of May 2025, the intensity factor was as low as 0.64tCO2e/MWH. Therefore, the calculations provided are expected to be conservative in nature and unabated.

Operational Year	1	2	3	4	5	6	7
New tailings booster pumps (kwh)	2,496,600	2,496,600	2,496,600	2,496,600	2,496,600	2,496,600	2,496,600
New decant Pump (kwh)	722,700	722,700	722,700	722,700	722,700	722,700	722,700
Operational TSF evaporators (kwh)	525,600	525,600	525,600	525,600	525,600	525,600	525,600
Total KWH	3,744,900	3,744,900	3,744,900	3,744,900	3,744,900	3,744,900	3,744,900
MWH	3,744.9	3,744.9	3,744.9	3,744.9	3,744.9	3,744.9	3,744.9
tCO2e (0.71/MWH)	2,658.879	2,658.879	2,658.879	2,658.879	2,658.879	2,658.879	2,658.879

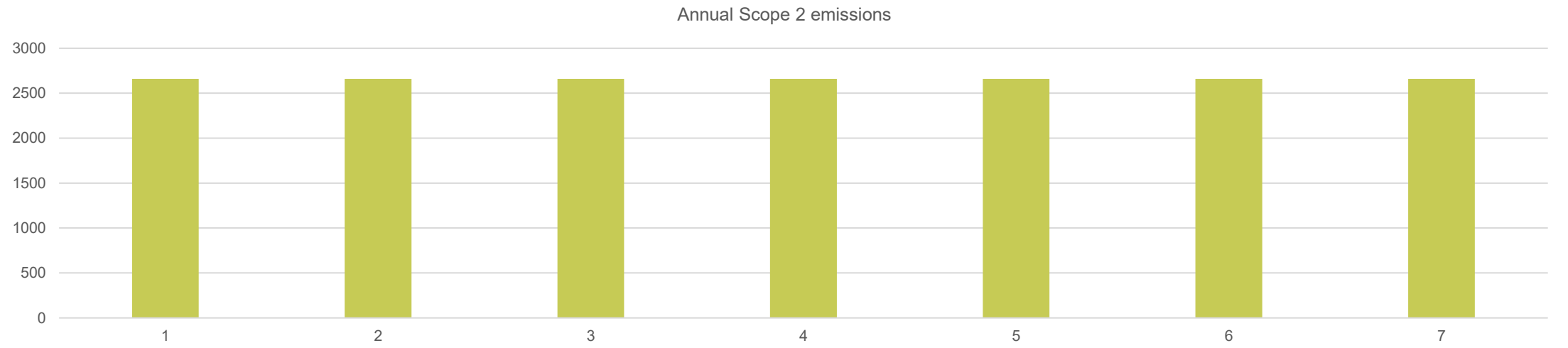
Scope 2 – Summary of Results

Operational Emissions from the project are limited to Scope 2 only. Based on a static equipment base and average uptime expectations, the emissions profile of the Operational life is static with annual emissions of 2,659 tCO2e/annum.

This is based on a grid emissions intensity factor in Queensland of 0.71tCO2e/MWH. The project is expected to require 3,745MWH of grid supplied electricity per annum, including allowance for downtime. No assumptions around the gradual decarbonisation of the Queensland NEM have been included.

Furthermore, it is assumed that all machines will be operating constantly (within their uptime allowance). It has been noted that the evaporators will not be operating when inventory at the site is low. Low inventory will result in these machines being turned off further reducing Scope 2 emissions.

Source	Annual tCO2e
New tailings booster pumps using 300kW - operating 95% of the year.	1772.586
New decant pump using 110kw - operating 75% of the year	513.117
Optional TSF evaporators using 200kW - operating 75% of the year (0% when total inventory is low)	373.176
Total Annual Emissions	2,659



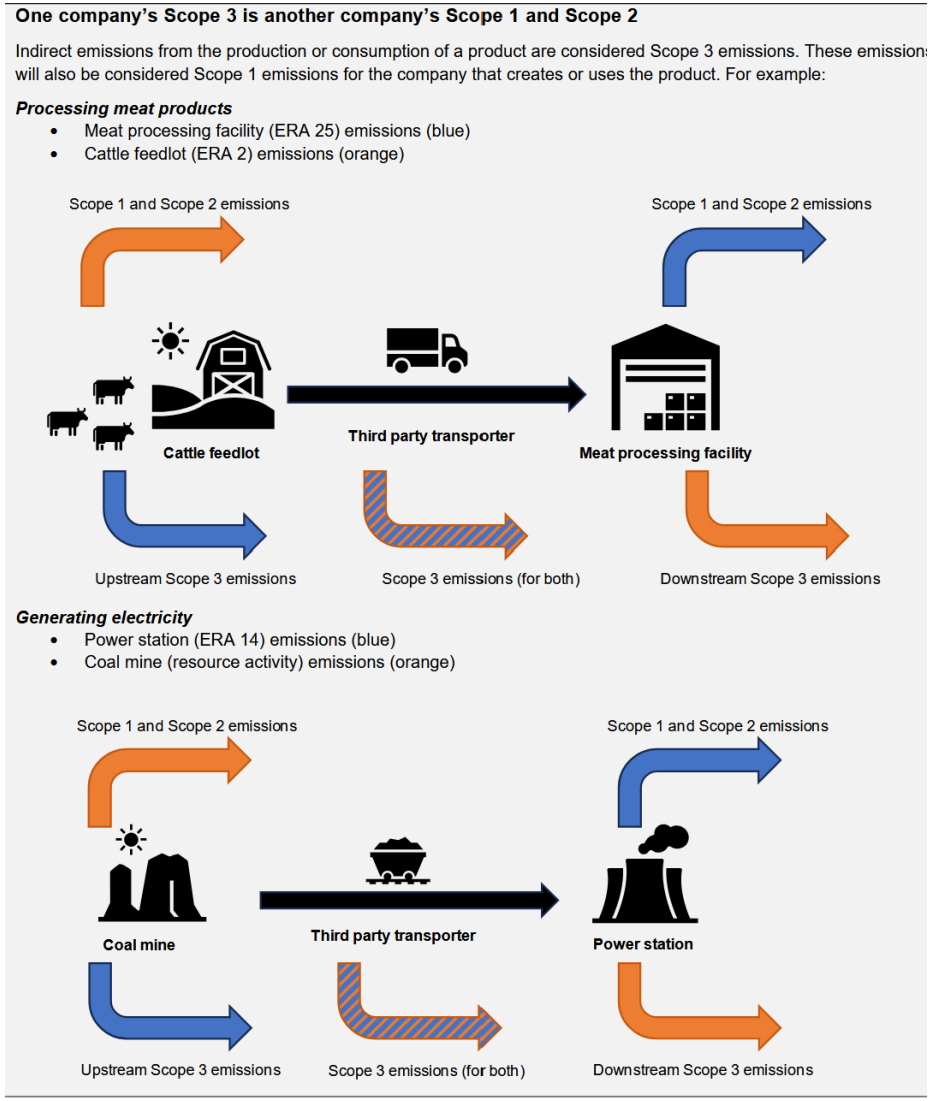
Scope 3 – Environmental Approval Requirements

Scope 3: indirect GHG emissions, other than Scope 2 emissions, that are generated in the wider economy, either in Australia or overseas. They occur as a consequence of a relevant activity, but from sources not owned or controlled by that activity. Scope 3 emissions include upstream emissions (from the goods and services required to produce the product) and downstream emissions (from the use or consumption of the product).

Application Requirements

- Provide an estimate of annual Scope 3 emissions and total Scope 3 emissions over the life of the project.
- Estimated Scope 3 emissions are not required to be included in applications where projected Scope 1 and Scope 2 emissions are expected to be less than 25,000 tonnes of CO_2-e per annum.
- Applicants can provide an estimation of the quantum of Scope 3 emissions expected expressed as a range (i.e., lower and upper amount) and an identification of the boundary of where Scope 3 emissions were considered.
- Only consider Scope 3 emissions that occur as a consequence of the activities authorised by the EA (or amendment). Scope 3 emissions that occur as a consequence of activities that are not regulated by the EA do not need to be considered.

As the project results in **LESS** than 25,000 tCO2e Annually, Scope 3 emissions have been excluded from this assessment.



Combined Emissions and Results

The Capircorn Copper TSF3 project requires an emissions profile, source and Sope analysis to be undertaken as part of its Environmental Approval Amendment process. Two distinct phases were identified for the project with corresponding emissions profiles and sources:

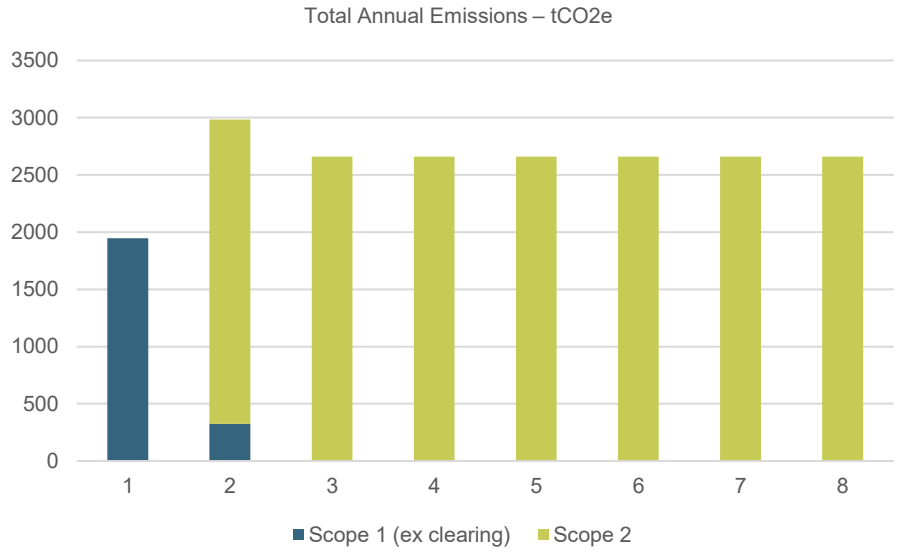
- Construction Phase – Scope 1 emissions
- Operational Phase – Scope 2 emissions

Scope 1 emissions total to 2,272 tCO2e with the exclusion of clearing. It is assumed that the net effect of vegetation will 0 tCO2e as there is a requirement to rehabilitate the area back to vegetation. Scope 1 emissions are only expected to be present through the construction phase of the project.

Similarly, the operational phase is limited to Scope 2 only. This is due to operations being limited to the use of electrical pumps and evaporators. This phase is expected to result in 2,659 tCO2e in Scope 2 emissions annually based on power use of 3,745MWH per annum. Scope 2 emissions have been based on the 2024 Queensland NEM emissions intensity factor of 0.71tCO2e/MWH. This rate is expected to reduce annually with the development of lower carbon power sources.

The project overall is expected to result in 20,884 tCO2e (ex clearing) over its entire construction and operational life. This results in net annual emissions of 2,611 tCO2e/annum (3,152 tCO2e/annum including clearing). This figure is well below the 25,000 tCO2e/annum requirement for assessing Scope 3 emissions. Therefore, they have been excluded from this report.

	Construction	Construction + Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
Scope 1 (ex clearing)	1948	325	0	0	0	0	0	0
Scope 1 (clearing)	3712	619	0	0	0	0	0	0
Scope 2	0	2659	2659	2659	2659	2659	2659	2659
Total ex Clearing								
Total inc Clearing	1948	2983	2659	2659	2659	2659	2659	2659
Average – inc clearing	2611							
Average – ex clearing	3152							



earthtrade and ARTEH – Proven Capability

earthtrade are the leading environmental market solution specialists in Australia, offering a full suite of pricing, assessment, negotiation, procurement, management, monitoring, and auditing services. At earthtrade, we also have an established relationship with environmental market regulators, enabling us to assist you with your regulatory negotiations and obligations.

earthtrade can offer you a complete solution, from sourcing through to commercial and regulatory finalisation. Environmental market products are complex both technically and commercially. However, earthtrade's pragmatic and strategic approach to environmental markets makes your business needs achievable in the short and long term.

With over 17 years of experience, earthtrade has negotiated, secured, managed, monitored and implemented over 50,000 hectares (100,000 acres) of biodiversity offsets, carbon offsets and sediment offsets in Queensland as well as provided advisory services to market providers and regulators internationally.

Within the region of interest in this project, earthtrade has a former experience assisting Westside procure, negotiate and secure legislated biodiversity offsets.

earthtrade has strong connections to developers, agents, valuers and advisors of both demand and supply into the market. This enables earthtrade to create and facilitate deals and transactions that are both ecologically and commercially sustainable.

ARTEH is Australia's premier carbon emissions accounting, modelling and forecasting solution – offering a simple, scientifically and policy succinct solution to an ever changing business and regulatory environment.

The award winning ARTEH platform offers a complete carbon accounting platform designed specifically for the Australian regulatory environment. Built from the principles underpinning the Taskforce for Climate Related Financial Disclosures (TCFD), the platform integrates Australian Government endorsed datasets, factors and regulations to reporting is compliant with Treasury's new Climate-Related Financial Disclosure regulations, the Safeguard Mechanism and National Greenhouse Emissions Reporting standards, and extra-governmental requirements such as the Science Based Targets Initiative (SBTi) and the United Nations TCFD.

The ARTEH platform is scalable to any business size with current clients including ASX Listed mining companies, large scale real estate and service-based charities, down to small consulting and advisory firms.

Personnel	Position
Thomas Key	CEO and Project Lead
Alan Key	Managing Director - earthtrade
Natalie Hurtado	Founder and Director - ARTEH
Saphira Rekker	Founder and Director - ARTEH
Hugo Silva	Founder, Director and CTO - ARTEH
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April Batzul	Project Operations
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