APPENDIX G: Dugald Rive Mine TSF Lift – Offset Assessment Report (WTS, 2025a)

DUGALD RIVER MINE - OFFSET ASSESSMENT REPORT

PREPARED BY: WULGURU TECHNICAL SERVICES
DOCUMENT ID: 2024.07003
VERSION: 1.2
DATE OF REPORT: 24 February 2026
ENVIRONMENTAL AUTHORITY: EPML00731213
EA HOLDER: MMG DUGALD RIVER PTY LTD

WULGURU TECHNICAL SERVICES

Contact Details	
Company	Wulguru Technical Services Pty Ltd
Project Manager	Madison Jackson
Email	madison@wulgurutechservices.com.au
Mail	PO Box 2553 IDALIA QLD 4810
ABN	79 644 301 655

Disclaimer

This report has been prepared by Wulguru Technical Services Pty Ltd for and on behalf of Wulguru Technical Services Pty Ltd's Client and is subject to and issued in connection with the agreement between Wulguru Technical Services Pty Ltd.

Wulguru Technical Services Pty Ltd cannot be held liable for third party reliance on this document. This report is based on information available to Wulguru Technical Services Pty Ltd and could be different if the information on which this report is based upon is inaccurate or incomplete.

Whilst all reasonable effort has been made to ensure that the contents of this publication are factually correct, Wulguru Technical Services Pty Ltd does not accept responsibility for the accuracy or completeness of the contents and shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this publication.

This report may utilise the results of work carried out by others. These results have been used in good faith by Wulguru Technical Services Pty Ltd and Wulguru Technical Services Pty Ltd cannot be held responsible for their accuracy.

Document Control and History

Version	Date	Description	Prepared By	Reviewed By
V1.0	17/04/2025	Final	Harry Bonnell	Haley Harding
V1.1		Amended final	Harry Bonnell	Madison Jackson
V1.2	24/02/2026	Amended final	Harry Bonnell	Madison Jackson

Citation

Wulguru Technical Services, 2025, *MMG – Dugald River Mine TSF Lift – Offset Assessment Report*, Prepared by Wulguru Technical Services Pty Ltd for MMG Dugald River Pty Ltd.

Contents

Figures 3

Tables 3

1. Introduction 4

1.1. Project Description 4

1.2. Scope 4

1.3. Site Description 4

1.4. Legislation 7

2. Methodology 9

2.1. Desktop Assessment 9

2.2. Review of Historic Ecological Surveys 9

2.3. Habitat Spatial Analysis 9

2.4. Impact Assessment 10

2.5. Offset Assessment 10

2.5.1. Financial Settlement Offset 11

3. Results 14

3.1. Flora and Vegetation Communities 14

3.1.1. Regional Ecosystems 14

3.2. Matters of State Environmental Significance 17

3.2.1. Regulated vegetation 17

3.2.2. PNRW Habitat 23

4. Impact Assessment 25

4.1. Regulated Vegetation – Intersecting a watercourse 25

4.2. Regulated Vegetation – Essential Habitat 26

4.3. Purple-necked Rock-wallaby (*Petrogale purpureicollis*) 29

5. Offset Assessment 32

1.1. Distinct Matter Areas 32

1.2. Financial settlement offset 33

6. Conclusion 34

7. References 35

APPENDIX A – Financial settlement offset calculation 37

APPENDIX B – Map of Environmentally Sensitive Areas 38

Figures

Figure 1. Proposed disturbance area 6

Figure 2. Ground-truthed regional ecosystems 15

Figure 3. Mapped regulated vegetation intersecting a watercourse 20

Figure 4. Mapped regulated vegetation – essential habitat 22

Figure 5. Modelled purple-necked rock-wallaby (*Petrogale purpureicollis*) habitat 24

Tables

Table 1. Regional Ecosystems within the proposed disturbance area 15

Table 2. Distance from the defining banks of watercourses based on bioregion and stream order 18

Table 3. Area of regional ecosystem within a defined distance from a watercourse within the Projects proposed disturbance area 18

Table 4. Significant residual impact criteria for impacts to regulated vegetation - intersecting a watercourse 25

Table 5. Significant residual impact criteria for impacts to regulated vegetation - essential habitat 26

Table 6: Significant residual impact criteria for impacts to the Purple-necked Rock-wallaby (*Petrogale purpureicollis*) 29

Table 7. DMAs of the proposed disturbance area and values relevant to the offset assessment 33

Table 8. Summary of financial offset calculation results 33

1. Introduction

1.1. Project Description

The Dugald River Mine (DRM) is predominantly a zinc mining operating authorised under Environmental Authority EPML00731213 (the EA) held by MMG Dugald River Pty Ltd (MMG). MMG are seeking approval to increase the scale of the existing Tailings Storage Facility (TSF) and Waste Pad.

The project disturbance area (Figure 1) demonstrates the difference between the current mine disturbance, and the proposed disturbance footprint, including the TSF max level as well as the associated features to support this increase including borrow pits, and several bunds situated around the TSF. This disturbance is permanent, and whilst the filled TSF will eventually be capped and rehabilitated, the final structure will be vastly different from that of the area currently, especially in regard to rocky habitat present along the slopes of the valley.

1.2. Scope

Wulguru Technical Services Pty Ltd (WTS) was engaged by MMG Dugald River Pty Ltd (MMG), to conduct an offset assessment in accordance with the Queensland Environmental Offsets Policy.

The specific objectives of this report are to:

- Assess desktop resources and data from previous ecological surveys (including the existing, Purple-necked Rock-wallaby (PNRW) Monitoring Program, as well as data from recent thermal mapping of the disturbance area undertaken by WTS);
- Assess impacts of the proposed disturbance on prescribed environmental matters (defined in Section 1.4) known to be present within the proposed disturbance area, or determined to have a likelihood of occurrence of likely or possible;
- Provide information to support a calculation for distinct matter areas; and
- Provide a calculated financial settlement requirement.

1.3. Site Description

DRM (the site) (Figure 1) is located approximately 70 km northwest of Cloncurry in western Queensland and situated adjacent to the Knapdale Range. Other infrastructure such as the accommodation village are located on the range itself along with the valley fill tailings dam which is situated in the northern one-third of the range. The site falls within the Cloncurry Shire Council region.

The Knapdale Range lies within the Mount Isa Inlier subregion of the Northwest Highlands bioregion which is characterised largely by the tilted metamorphic hills and ranges evident on the Knapdale Range. Weather in the region tends towards mild to cool winters and hot summers often with heavy tropical and intense rain events.

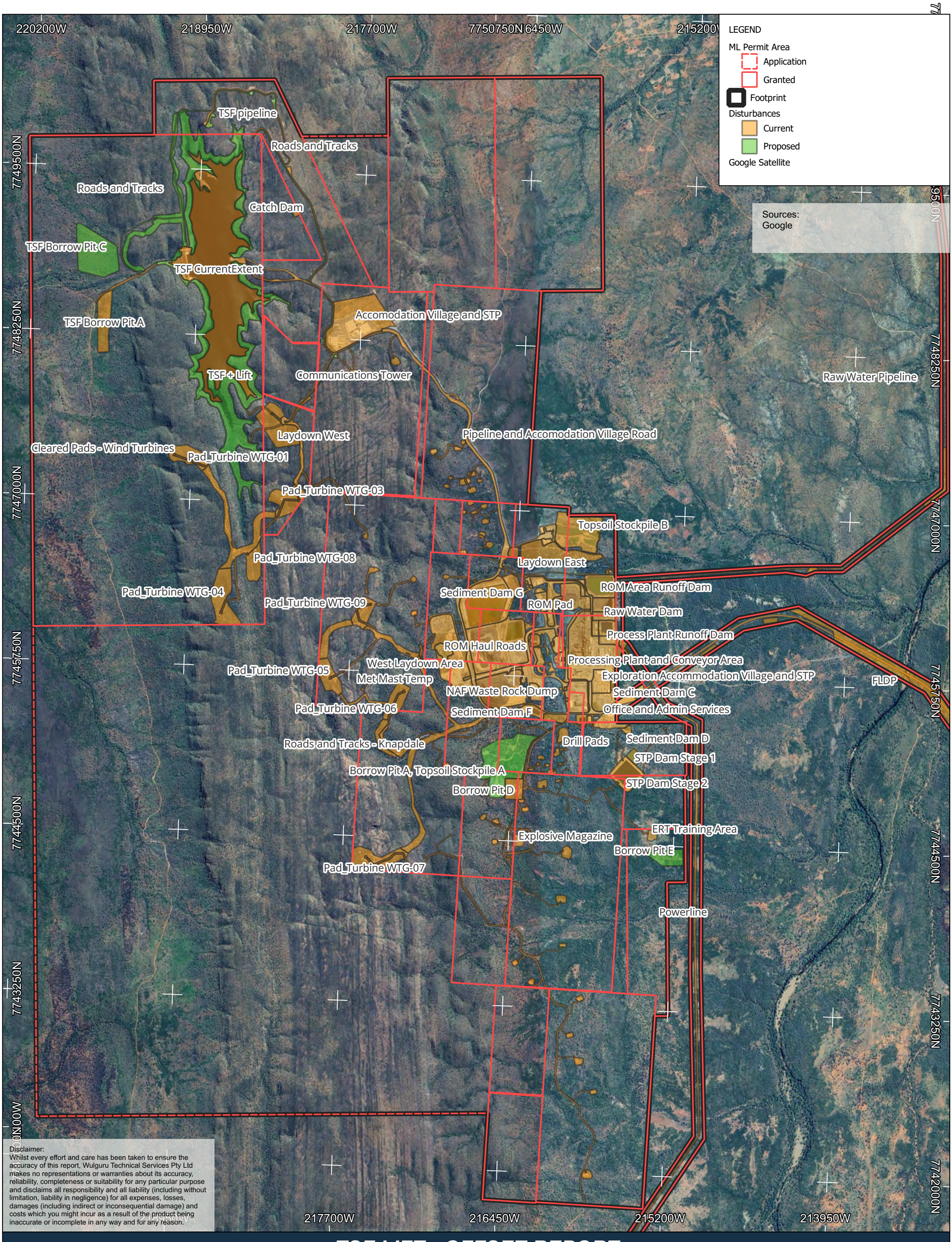
DRM sits at approximately 200m Australian Height Datum (AHD) on relatively flat, grassy plains. To the west the Knapdale Range reaches maximum elevation of approximately 300 m AHD.

DRM lies between the Leichhardt Basin and the Flinders Basin. Ephemeral drainage features in the site range between stream orders one and two. Two major rivers flow either side of the DRM, but do not enter the site: Cabbage Tree Creek in the northwest, a 5th order stream flowing north and draining into the Leichardt basin, and Dugald River in the southeast, another 5th order streaming flowing north and draining into the Flinders Basin.

Streams and drainage lines are ephemeral. Numerous rocky water holes are known to retain water for varying lengths of time into the dry season, and some may be deep and large enough to persist through the dry season in wetter years.

Vegetation of the site consists of low open woodland and open Spinifex dominant grasslands, with moderate to sparse Acacia dominant shrub layers throughout. Soil types range from rocky, skeletal soil types to shallow-moderate sandy loam towards the eastern base of the range.

The rocky habitat of Knapdale Range supports populations of Purple-necked Rock-wallaby (PNRW) (*Petrogale purpuriecolis*) which is considered a vulnerable species under the *Nature Conservation Act 1992* (NCA). Local populations are currently monitored under the MMG DRM Purple-necked Rock-wallaby Monitoring Program and reported annually to the Department of Environment, Tourism, Science and Innovation (DETSI) in accordance with the EA.



Disclaimer:
Whilst every effort and care has been taken to ensure the accuracy of this report, Wulguru Technical Services Pty Ltd 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 inconsequential damage) and costs which you might incur as a result of the product being inaccurate or incomplete in any way and for any reason.

TSF LIFT - OFFSET REPORT

FIGURE 1. PROPOSED DISTURBANCE AREA

250 0 250 500 m

CRS: GDA94 / MGA zone 55
Scale: 1:25,000 @A3

Date: 20 February 2026
Author: H. Bonnell
Version: 0.03

Project Number: 2024.07003
Client: MMG Dugald River Pty Ltd

WULGURU TECHNICAL SERVICES

Z:\2_Projects\2024\2024.07003_MMG_TSF Lift_EAA_PRCP\3_GGIS\2024.07003 Offset_report_figures TH COPY.qgz

1.4. Legislation

Environmental Offsets Act 2014

The *Environmental Offsets Act 2014*, and the Environmental Offsets Regulation 2014 provide a framework for environmental offsets with the purpose of counterbalancing significant residual impacts from proposed activities on prescribed environmental matters. Prescribed environmental matters include the following:

- A Matter of State Environmental Significance (MSES) listed in schedule 2 of the Environmental Offset Regulation 2014;
- An accredited Matter of National Environmental Significance (MNES), should Queensland receive accreditation in relation to offsets for the purpose of the *Environment Protection and Biodiversity Conservation Act 1999*; or
- A Matter of Local Environmental Significance (MLES), as described in section 10(1)(c) of the *Environmental Offsets Act 2014*.

The Queensland Environmental Offsets Policy provides a single, consistent, whole-of-government policy for the assessment of offset proposals to satisfy offset conditions. This policy clarifies how offsets for matters of environmental significance in Queensland should be designed and delivered.

Environmental Protection Act 1994 (Queensland)

The *Environmental Protection Act 1994* (EP Act) is Queensland's primary piece of environmental legislation. The objective of the EP Act is 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 the ecological processes on which life depends'. The EP Act ensures adherence to the protection and conservation of protected matters listed in Queensland's other key pieces of legislation such as the *Nature Conservation Act 1992*, the *Water Act 2000*, and the *Vegetation Management Act 1999.*

The undertaking of an environmentally relevant activity (ERA) in Queensland requires an Environmental Authority (EA) under the EP Act. An ERA is any industrial, resource or intensive agricultural activity with the potential to release contaminants into the environment and includes activities such as mining and resource activities.

- The holder of an EA can apply for an amendment to the EA should they wish to undertake activities outside of the scope of the existing EA. MMG are required to submit an application to amend the current EA to include activities associated with the proposed disturbance and to obtain approval from DETSI prior to commencement of works. The EA amendment will include a downstream raise of the existing TSF, plus ancillary disturbance for pipelines, tracks, and

borrow pits for construction materials. In accordance with sections 125 and section 226 of the EP Act, an application for an EA includes an assessment of the likely impact of each environmentally relevant activity on environmental values. Environmental values that should be considered and addressed in an EA application include:

- Category A and category B environmentally sensitive areas (ESAs) as defined under Schedule 19 of the Environmental Protection Regulation 2019 (EP Regulation);
- Category C ESAs where defined in a relevant model conditions document[1] or ERA standard[2]; and
- Matters of State environmental significance (MSES) as defined in Schedule 2 of the Environmental Offsets Regulation 2014 (EO Regulation),

Nature Conservation Act 1992

The *Nature Conservation Act 1992* (NCA), the Nature Conservation (Animals) Regulation 2020 and the Nature Conservation (Plants) Regulation 2020 provide a legislative framework for the protection and conservation of Queensland's native plants and animals.

Under the framework, species of conservation significance are assessed and categorised with respect to population, distribution and potential threats and impacts.

The objectives of the NCA are achieved through an integrated and comprehensive conservation strategy that protects, and conserves threatened and special interest species and their habitat, and protected areas.

Vegetation Management Act 1999

The *Vegetation Management Act 1999* (VM Act) exists to regulate the clearing of vegetation in a way that:

- conserves remnant vegetation;
- ensures clearing does not cause land degradation;
- prevents loss of biodiversity;
- maintains ecological processes;
- reduces greenhouse gas emissions; and
- allows for sustainable land use.

The objectives of the VM Act are achieved through providing for assessment benchmarks for vegetation clearing, the enforcement of vegetation clearing provisions, the regulated of certain regrowth vegetation, and the application of the precautionary principle.

2. Methodology

2.1. Desktop Assessment

A comprehensive desktop assessment was undertaken for this Project to determine matters of conservation significance within the proposed disturbance area.

2.2. Review of Historic Ecological Surveys

A significant cumulative sum of technical and ecological studies have been undertaken with regard to the MMG DRM project site and provide the information to which this report largely refers. Available information dates back to 2008 with the commencement of environmental assessments for the EIS which was submitted for approval in 2011. More recent assessments and monitoring surveys relating to the requirements of the EA and ongoing development of the mine bring to currency the information used to support the desktop component of this report.

WTS undertook supplementary assessments of vegetation and habitat assessments of the Project footprint area in October 2023 to ensure compliance with the requirements for currency of information and due diligence of process.

The methodologies for the above surveys are described in Section 2.2 of WTS's EAR for Stage 1 of the DRM Windfarm (Wulguru Technical Services, 2023). WTS undertook subsequent BBUS in 2024 following the same methodology used by EcoSmart and conducted additional vegetation surveys for the purpose of rehab in line with the Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland V7.0 (Neldner, et al., 2023).

A review of the extensive ecological survey history of the DRM was completed with particular reference to PNRW monitoring, Regional Ecosystem (RE) ground-truthing, and surveys for other matters of environmental significance. The combination of all survey effort on site provides a robust dataset with which to assess the ecological values present within the proposed disturbance area.

2.3. Habitat Spatial Analysis

Known occurrences of the PNRW within the Knapdale Range, along with the 18 confirmed PNRW active denning locations, were used to infer denning, foraging, and dispersal habitat across the extent of the range. Dens were found to be located in rocky gorges in the upper reaches of drainage lines of the Knapdale Range, and visual assessment of available high resolution satellite imagery, as well as recent thermal drone surveys (outlined in WTS's Thermal Habitat of PNRW Report (Wulguru Technical Services, 2024)), was used to determine additional denning areas. A 16 ha buffer was added around the known and proposed dens representing home range (foraging area), based on known home ranges from closely related and morphologically similar rock-wallaby species (Horsup, 1994). PNRW rarely

venture into flat plains due to a lack of shelter (Mittermeier & Wilson, 2015) and it is therefore assumed that any areas adjacent to habitat and of medium to high slope is possible dispersal habitat for the species.

2.4. Impact Assessment

The significance of impacts to MSES are assessed in accordance with the impact assessment section within *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (Department of Environment and Heritage Protection, 2014) (the guideline) relevant to the applicable MSES and their conservation status. Impact assessments, as per the guideline, consider the cumulative impact of the Dugald River Mine project.

The Significant Residual Impact (SRI) assessment also considers whether habitat critical to survival of the species occurs within the disturbance area, and whether impacts to this defined aspect are significant. Habitat critical to the survival of the species can be defined as, but not limited to, areas that are identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of critical Habitat maintained by the Minister under the EPBC Act; or habitat is necessary for the following:

- Activities such as foraging, breeding, roosting, or dispersal;
- The long-term maintenance of the species or ecological community (including the maintenance of;
- Species essential to the survival of the species or ecological community, such as pollinators);
- Maintaining genetic diversity and long-term evolutionary development; or
- The reintroduction of populations or recovery of the species or ecological community.

The impact assessment is presented in Section 4.

2.5. Offset Assessment

The Queensland Offset Policy defines a mitigation hierarchy of avoid, minimise and lastly offset.

Where the administering agency for the application for the prescribed activity identifies that an offset is a reasonable requirement, this will be reflected as a condition, or conditions, on the authority.

The Offsets Act provides flexibility in delivering a conservation outcome through the following offset delivery options:

- financial settlement offset;

- proponent-driven offset; or
- a combination of proponent-driven offset and financial settlement offset.

The administering agency must agree to the proposed offset delivery approach. There are two options for seeking the administering agency's agreement. The proponent provides a notice of election to the administering agency:

- prior to the issuing of the authority (i.e. before or during the assessment process for the authority); or
- after the authority has been issued.

The notification must be made on the approved form and is to identify that the offset will be delivered in one of the three ways listed above.

2.5.1. Financial Settlement Offset

Where a financial settlement offset is elected, the agreed delivery arrangement must specify the agreed financial settlement amount to be paid in full and an agreed timeframe in which the payment will be made.

The location of the impact area(s) and the ability of some prescribed environmental matters to be co-located can affect the overall cost of a financial settlement offset. To determine this cost an impact site area needs to:

- be divided into one or more sections; and
- consider the ability for prescribed environmental matters to be co-located by firstly defining one or more Distinct Matter Areas (DMA) (as described in Section 2.5.1.1).

The financial settlement calculation is based on the following formula:

Financial settlement = (offset area x on-ground cost per ha) + landholder incentive payment + administrative cost.

The offset area is calculated by multiplying each DMA with its associated matter multiplier, before summing the results together.

To account for economies of scale for large offsets, a sliding scale of per hectare costs is applied to the financial settlement amount for certain matters. The sliding scale calculation produces a sliding scale multiplier which is a percentage of costs ranging from 10% to 100%. The components of the financial

settlement calculation described below are multiplied by the sliding scale multiplier, which has the effect of reducing the financial settlement amount for those large offsets.

- The on-ground cost is calculated by multiplying the offset area with the on-ground cost per hectare for the subregion.
- The landholder incentive payment is not intended to cover the full lost economic opportunity costs of a proposed offset, but rather provide enough motivation for the individual landholder to be willing to participate in the market. The landholder incentive payment for each section is the offset area multiplied by the 20-year productivity loss per ha of the subregion in question
- The administrative cost is the estimated cost to the government to maintain and administer the land-based offset over its life. The administrative cost is 22.8% of the on-ground cost.

Each component of the formula is described in more detail in Appendix 4 of the Queensland Environmental Offsets Policy (DESI, 2024).

2.5.1.1. Distinct Matter Area

An impact area may have more than one prescribed environmental matter located on it. In these cases, the calculation needs to know whether to count each matter separately or combine the matters for the impact area. Where prescribed environmental matters cannot be co-located, they are counted separately in the calculation of the financial settlement offset. Where there is a requirement to account for each matter separately, the area that contains the matter is identified as a DMA to the calculation. Each area of impact for co-located matters is also termed a DMA. The calculation deals with the DMA as if it contains a single matter (the matter with the highest multiplier as per Section 4.3.6 of Appendix 4 of the Queensland Environmental Offsets Policy (DESI, 2024)).

The Financial Settlement Offset Calculation Methodology assumes that all prescribed environmental matters on the impact site can be co-located if treated as a single DMA, and only one offset site should be needed in most cases. It must be feasible, however, for the required conservation outcome to be achieved for all co-located prescribed environmental matters in the DMA. The following principles provide guidance on when separate DMAs must be used:

- there should be one only regional ecosystem per DMA
- wetlands must be in separate DMAs to non-wetland areas
- koala habitat in SEQ must be treated as a separate DMA to other matters impacted
- impacts to protected areas are treated as a separate DMA to the other matters impacted

- species that have very specific habitat requirements (such as rocks for rock wallabies and certain endangered plant species or caves for certain bat species) must be in separate DMAs
- species of fauna not covered above must be in separate DMAs where any of the following are true:
    - the species do not occupy the same regional ecosystem; or
    - the species do not respond to the same management actions.
- matters imposed by Queensland Government agencies must be in separate DMAs from matters imposed by local governments.

3. Results

3.1. Flora and Vegetation Communities

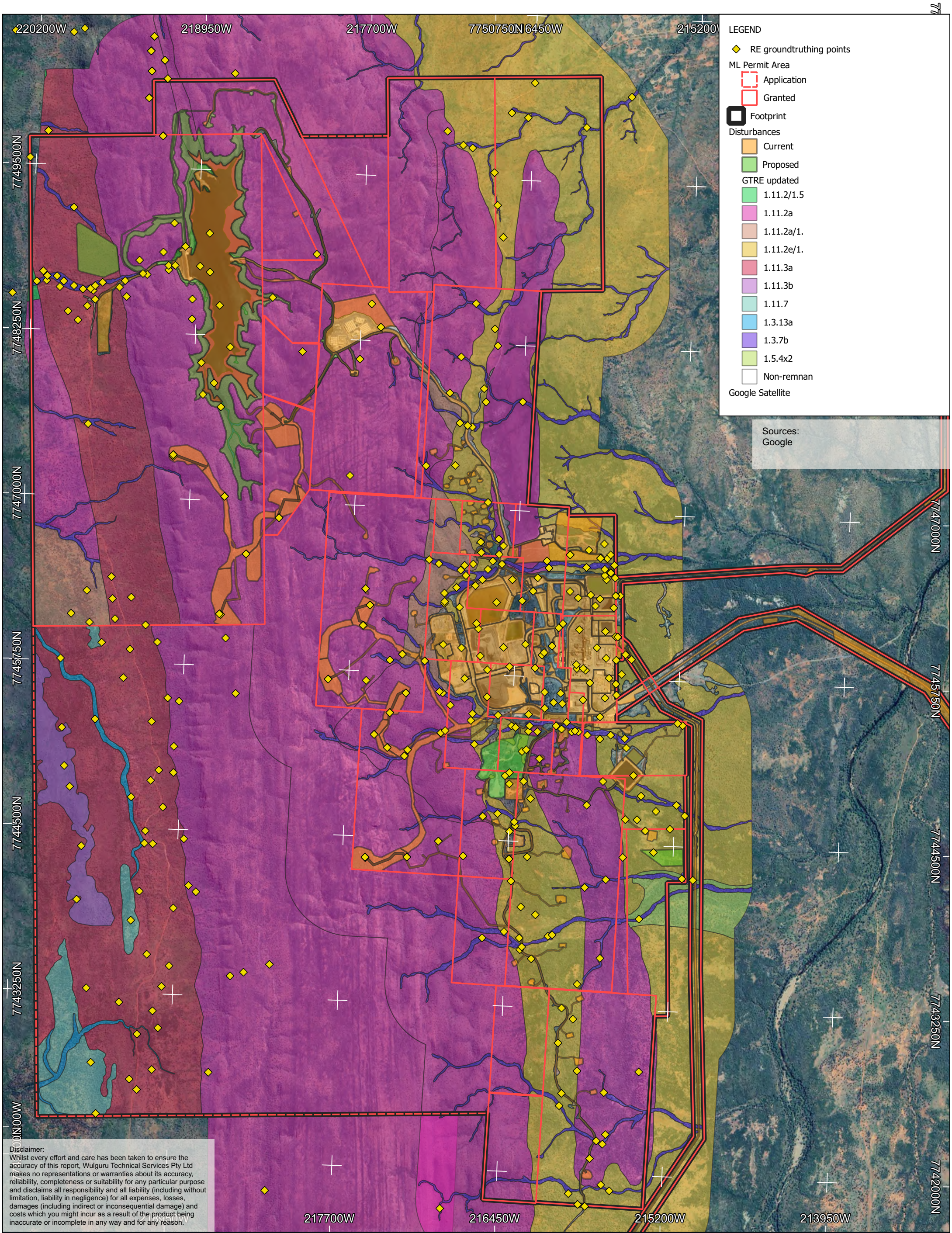
3.1.1. Regional Ecosystems

Regional Ecosystems (REs) mapped for the broader Dugald River Area are largely heterogeneous (mixed) polygons, with the vast majority of the Knapdale Range itself contained within a single mapped polygon of RE 1.11.2a/1.7.7a. Previous ground-truthing of REs delineated vegetation across the top of the Knapdale Range to be consistent with the description for RE 1.11.2a. Lower and flatter areas surrounding the range were consistent with the description for RE 1.11.3a. Additionally, RE 1.3.7b was identified along a drainage line on the southern end of the TSF. Whilst this RE is listed as least concern under the VM Act, it has a biodiversity status of Endangered. REs ground-truthed within the proposed disturbance area are described in Table 1, and mapped, along with ground-truthing sites, in Figure 2.

Table 1. Regional Ecosystems within the proposed disturbance area

Regional Ecosystems	Long Description	VM Status*	BD Status#	Special Values
1.11.2a	*Eucalyptus leucophloia* low open woodland often with *Corymbia terminalis, Corymbia capricornia, Terminalia aridicola* and *Eucalyptus leucophylla* with shrub layer of *Acacia spp.* and ground layer of *Triodia spp.* Occurs on steep hills and strike ridges. Not a wetland. (BVG1M: 19a).	LC	NC	1.11.2: Potential habitat for NCA listed species: *Eucalyptus nudicaulis*, *Ipomoea antonschmidii*, *Solanum carduiforme*, *Trachymene glandulosa*.
1.11.3a	Low open woodland of *Corymbia terminalis* and/or *Eucalyptus leucophylla* with *Acacia* spp. dominated shrub layer and ground layer of *Triodia* spp. and/or tussock grasses. Includes areas of *Acacia* spp. shrubland and *Triodia* spp. grassland. Occurs on metabasalts and dolerites; some felsic metavolcanics; skeletal soils, some shallow loams. Not a Wetland. (BVG1M: 19b).	LC	NC	1.11.3: Potential habitat for NCA listed species: *Eucalyptus nudicaulis*.
1.3.7b	*Eucalyptus camaldulensis* fringing woodland, usually with *Lophostemon grandiflorus* and *Melaleuca bracteata* and/or *M. dissitiflora*. Occurs on recent levees and channel deposits of medium and smaller tributaries which are dry for most of the year; alluvial soils. Riverine. (BVG1M: 16a).	LC	E	1.3.7: Important seasonal water bird habitat; regional corridor for fauna.

VM Status = status under the Vegetation Management Act: BD Status# = Biodiversity Status: L – Least Concern. NC – No concern at present, OC – Of concern, E – Endangered.*



TSF LIFT - OFFSET REPORT

FIGURE 2. GROUNDTRUTHED REGIONAL ECOSYSTEMS

250 0 250 500 m

CRS: GDA94 / MGA zone 55
Scale: 1:25,000 @A3

Date: 20 February 2026
Author: H. Bonnell
Version: 0.03

WULGURU TECHNICAL SERVICES

Project Number: 2024.07003

Client: MMG Dugald River Pty Ltd

Z:\2_Projects\2024\2024.07003_MMG_TSF Lift_EAA_PRCP\3_QGIS\2024.07003-Offset_report_figures TH COPY.qgz

3.2. Matters of State Environmental Significance

Matters of state environmental significance (MSES), as referred to in Schedule 2 of the Environmental Offsets Regulation 2014, include the following:

- Regulated vegetation;
- Connectivity areas;
- Wetlands and watercourses;
- Designated precinct in a strategic environmental area;
- Protected wildlife habitat;
- Protected areas;
- Protected marine areas and habitat; and
- Legally secured offset areas.

3.2.1. Regulated vegetation

3.2.1.1. Regulated Vegetation Mapping

Vegetation management regulated vegetation management map - version 7.00 maps the entire proposed disturbance area as category B remnant vegetation.

3.2.1.2. Regulated vegetation – endangered or of concern regional ecosystem

There are no endangered or of concern REs as defined under the VM Act mapped as present within the proposed disturbance area.

3.2.1.3. Regulated vegetation – Regional Ecosystem intersecting a wetland

There are no vegetation management wetlands mapped within the proposed disturbance area and therefore no REs intersecting a wetland.

3.2.1.4. Regulated vegetation – Intersecting a watercourse

Table 2 shows the distance from a defining bank that specifies the extent to which a prescribed RE is intersecting a regulated vegetation watercourse based on the bioregion and stream order (Department of Environment and Science, 2020).

It is important to note that the watercourses are mapped as linear features rather than representative width of the defined bank which is described in the clearing for infrastructure code as:

- the bank that confines the seasonal flows, but which may be inundated by flooding from time to time, and can be either:
    - the bank or terrace that confines the water before the point of flooding;
    - or where there is no bank, the seasonal high water line that represents the point of flooding (Department of Resources., 2023).

Approximately 6.74 ha of clearing is required within areas mapped as regulated vegetation, vegetation intersecting a watercourse, as calculated in Table 50. A 26 m buffer from mapped stream order 1 and 2 watercourses, 51 m from stream order 3 and 4 has been used to determine this area, to account for a watercourse width of 2 m. Stream order 5 and above watercourses are mapped to their actual extents on the watercourse identification map.

Table 2. Distance from the defining banks of watercourses based on bioregion and stream order

Watercourse steam order	Distance from the defining bank (m)
Coastal bioregions	
1 or 2	10
3 or 4	25
5 or greater	50
Non-coastal bioregions and sub-regions	
1 or 2	25
3 or 4	50
5 or greater	100

For some watercourses, only the buffer from the defining bank lies within the proposed disturbance footprint and not the watercourse itself. In these cases, only the area has been recorded and therefore the regulated vegetation area does not directly correlate with the watercourse length listed in Table 3.

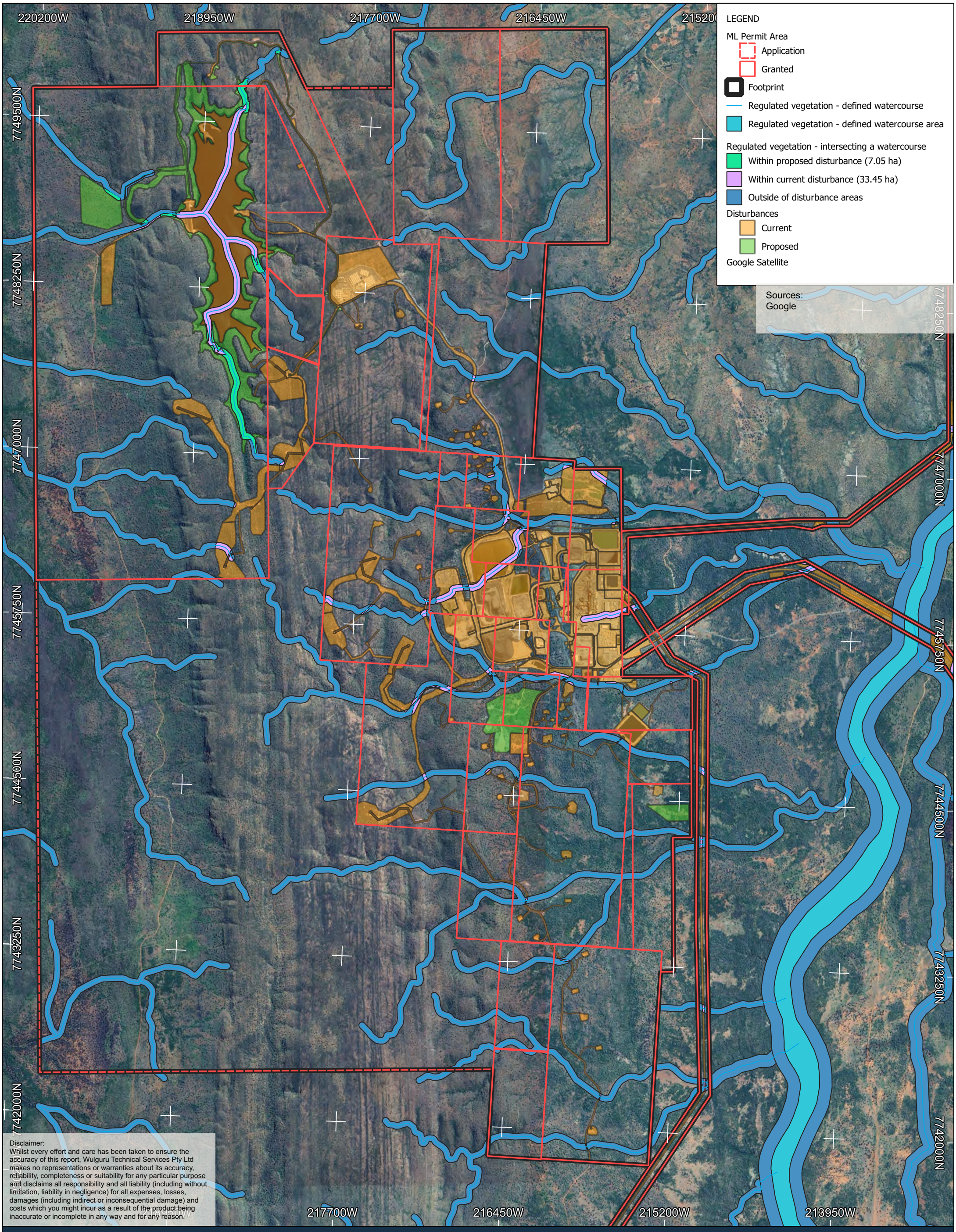
Table 3. Length of Watercourse and Area of regional ecosystem within a defined distance from a watercourse within the Projects proposed disturbance area

Watercourse Stream orders	Watercourse Length (m)	Regulated Vegetation Area (ha)*
1 and 2	997.19	34.25
3		0.07
5		5.87
Total		**40.19**

**Area calculated from buffer of watercourses in QGIS using an estimated average watercourse width of 2 m and the defined distance of 25 m. Length is a sum of clipped watercourses within the disturbance area.*

There is therefore 40.19 ha of regulated vegetation – intersecting a watercourse mapped within the total disturbance footprint, 7.05 ha of which is mapped across the proposed disturbance footprint (Figure 3).

A significant residual impact assessment for disturbance to this regulated vegetation is undertaken in section 4.1.



TSF LIFT - OFFSET REPORT

FIGURE 3. MAPPED REGULATED VEGETATION - INTERSECTING A WATERCOURSE

250 0 250 500 m

CRS: GDA94 / MGA zone 55
Scale: 1:25,000 @A3

Date: 24 February 2026
Author: H. Bonnell

WULGURU TECHNICAL SERVICES

Project Number: 2024.07003

Client: MMG Dugald River Pty Ltd

Version: 0.04

Z:\2_Projects\2024\2024.07003_MMG_TSF Lift_EAA_PRCP\3_QGIS\2024.07003-Offset_report_figures TH COPY.qgz

3.2.1.5. Regulated vegetation – Essential habitat

Essential habitat, for protected wildlife, is defined in section 20AC of the VM Act as:

- A category A area, a category B area or category C area shown on the regulated vegetation management map —

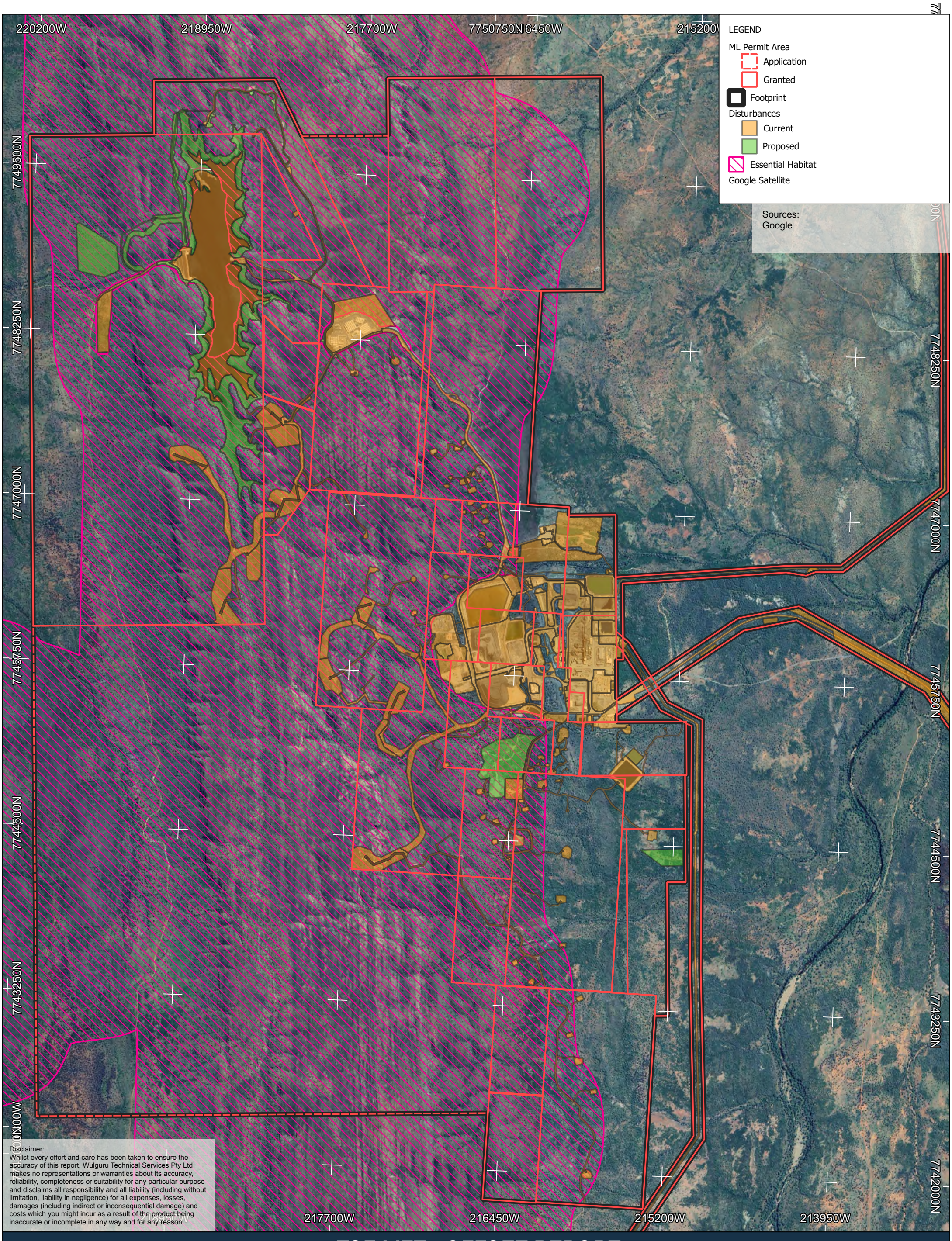
    a) that has at least 3 essential habitat factors for the protected wildlife that must include any essential habitat factors that are stated as mandatory for the protected wildlife in the essential habitat database; or

    b) in which the protected wildlife, at any stage of its life cycle, is located.

The entire Knapdale Range and other locally connected areas are mapped as essential wildlife habitat [endangered or vulnerable] on the *Vegetation management essential habitat map - version 12.00.* Version 12.00 of the essential habitat mapping was released 22 November 2023 and increases the area of mapped habitat significantly from that previously mapped. This essential habitat refers to the Purple-necked Rock-wallaby (PNRW) (*Petrogale purpureicollis*). There is 194.59 ha of essential habitat for the PNRW mapped within the total disturbance footprint, of which 73.18 ha is located within the proposed disturbance footprint (Figure 4).

Ground-truth surveys and records of the PNRW within the Knapdale Range confirm the presence of values meeting the criteria for essential habitat for the PNRW as per section 20AC (2b): a category A area, a category B area or category C area shown on the regulated vegetation management map— (b) in which the protected wildlife, at any stage of its life cycle, is located.

A significant residual impact assessment for disturbance to PNRW essential habitat is undertaken in section 4.2.



TSF LIFT - OFFSET REPORT

FIGURE 4. MAPPED REGULATED VEGETATION - ESSENTIAL HABITAT

250 0 250 500 m

CRS: GDA94 / MGA zone 55
Scale: 1:25,000 @A3

Date: 20 February 2026
Author: H. Bonnell
Version: 0.03

Project Number: 2024.07003
Client: MMG Dugald River Pty Ltd

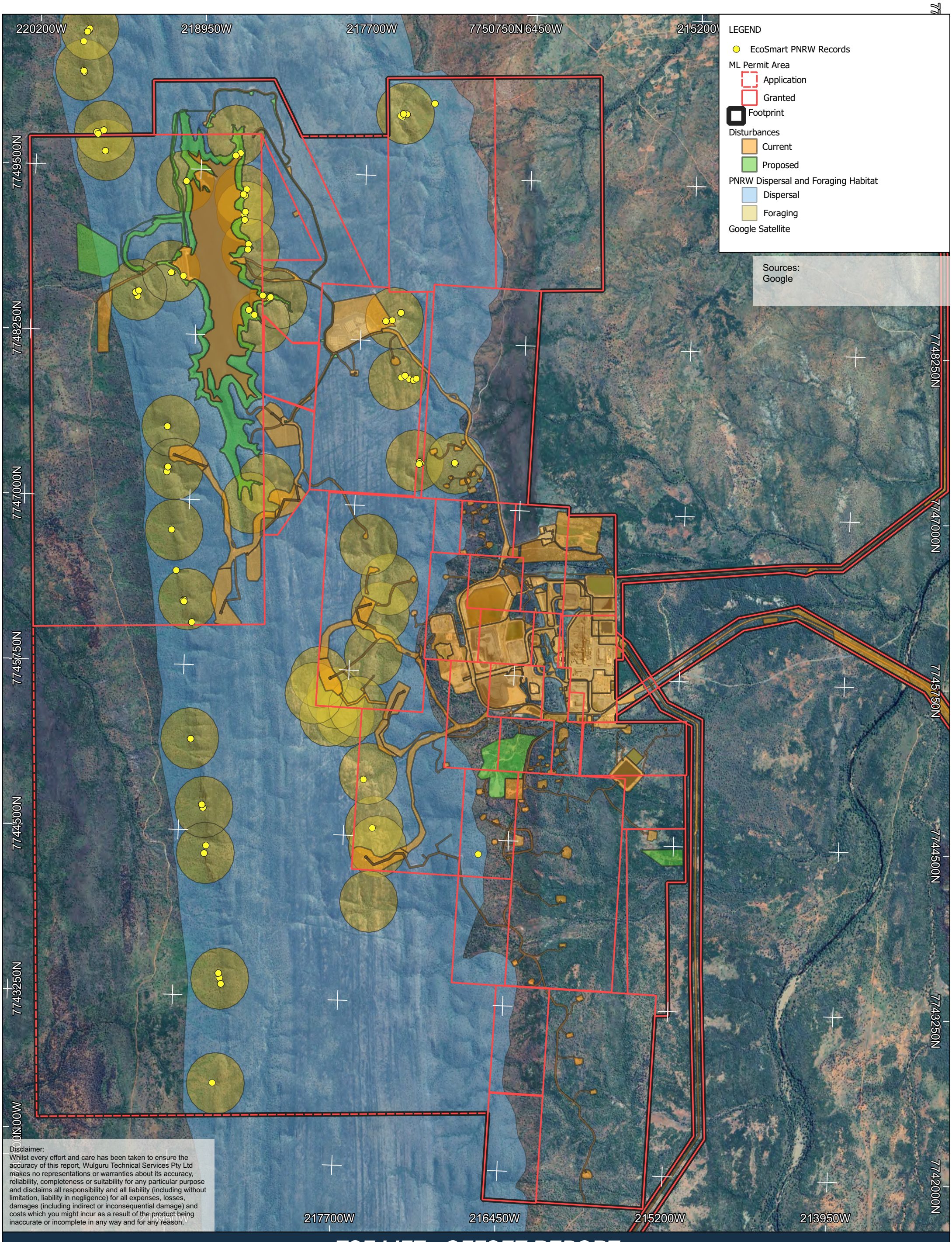
WULGURU TECHNICAL SERVICES

Z:\2_Projects\2024\2024.07003_MMG_TSF Lift_EAA_PROP\3_GGIS\2024.07003 Offset_report_figures TH COPY.qgz

3.2.2.PNRW Habitat

The Knapdale Range is confirmed suitable habitat for the vulnerably listed (NC Act) Purple-necked rock-wallaby (PNRW). Large bouldery rocky gorges form suitable habitat for denning and contain potentially perennial rocky waterholes. Surrounding areas are grassy woodland suitable for foraging. Spatial analysis of the ground-truthed habitat values and species records extrapolated denning, foraging and dispersal habitat for the area within the Knapdale Range (Figure 5). Potential habitat beyond the range was not considered in this assessment. EcoSmart Ecology estimate the current PNRW population within the Knapdale range could be as high as 270 (Ecosmart Ecology, 2023).

PNRW habitat impacted by the proposed disturbance includes both primary (denning and foraging) habitat and secondary (dispersal) habitat. A significant residual impact assessment for disturbance to the PNRW and its habitat is undertaken in section 4.3.



Disclaimer:
Whilst every effort and care has been taken to ensure the accuracy of this report, Wulguru Technical Services Pty Ltd 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 inconsequential damage) and costs which you might incur as a result of the product being inaccurate or incomplete in any way and for any reason.

TSF LIFT - OFFSET REPORT

FIGURE 5. MODELLED PURPLE-NECKED ROCK-WALLABY HABITAT

250 0 250 500 m

CRS: GDA94 / MGA zone 55
Scale: 1:25,000 @A3

Date: 20 February 2026
Author: H. Bonnell
Version: 0.03

Project Number: 2024.07003

Client: MMG Dugald River Pty Ltd

WULGURU TECHNICAL SERVICES

Z:\2_Projects\2024\2024.07003_MMG_TSF Lift_EAA_PRCP\3_GGIS\2024.07003 Offset_report_figures TH COPY.qgz

4. Impact Assessment

SRI assessments were undertaken for prescribed environmental matters known to be present within the proposed disturbance area, of which an impact was unavoidable. Impact assessments, as per the guideline, consider the cumulative impact of the Dugald River Mine project.

4.1. Regulated Vegetation – Intersecting a watercourse

The total approximate area of regulated vegetation intersecting a watercourse proposed to be impacted by the Project disturbance area is 7.05 ha (Figure 3). Impacts are unavoidable due to the use of the valley for tailings storage. Impacts to regulated vegetation intersecting a watercourse exceed criteria 1 and 3 of the significant residual impact test of table 1 of the guidelines, and therefore it is likely the proposed disturbance will result in a SRI to this matter (Department of the Environment, 2013). As such, an offset has been calculated in Sections 5 and 1.2.

Table 4. Significant residual impact criteria for impacts to regulated vegetation - intersecting a watercourse

		Clearing in a regional ecosystem that is within the defined distance of a watercourse
1	**For clearing for linear infrastructure:** - greater than 25m wide in a grassland (structural category) regional ecosystem; or - greater than 20m wide in a sparse (structural category) regional ecosystem; or - greater than 10m wide in a dense to mid-dense (structural category) regional ecosystem. **For clearing other than clearing for linear infrastructure:** - area greater than 5 ha where in a grassland (structural category) regional ecosystem; or - - area greater than 2 ha where in a sparse (structural category) regional ecosystem; or - - area greater than 0.5 ha where in a dense to mid-dense (structural category) regional ecosystem.	✓
2	Clearing within 50m of the defining bank	N/A
3	Clearing within 5m of the defining bank	✓

NOTES:

For a prescribed activity to have a significant residual impact on a regional ecosystem that is within the defined distance of watercourses, criteria 1 and 3 must be exceeded.

The values of the wetland and watercourses themselves are not covered in this section (only the vegetation associated with these natural features) —the values of the wetland and watercourses themselves are considered in section.

4.2. Regulated Vegetation – Essential Habitat

Impacts to regulated vegetation essential habitat relate to the habitat for the PNRW located on the Knapdale Range. There is 73.18 ha of essential habitat within the proposed disturbance area (Figure 4). Impacts are unavoidable due to the proposed continues use of the valley for tailings storage. A significant residual impact assessment for the PNRW has been provided in Section 4.3. The below assessment relates to impacts to essential habitat and how those impacts will affect the population present across the Knapdale Range. The assessment determines that significant residual impacts to the PNRW as a result of the project will be likely due to the reduction of the species' extent of occurrence. As such, an offset has been calculated in Sections 5 and 1.2.

Table 5. Significant residual impact criteria for impacts to regulated vegetation - essential habitat

Is there a chance or possibility that an action will?	Response
Lead to a long-term decrease in the size of a local population; or	**Unlikely:** Project works in the site are unlikely to lead to a long-term decrease in the size of a local population. There are 611 records of the PNRW on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. Between August 2014 and April 2020 the average number of PNRW observed across monitored colonies remained relatively steady, since September 2020 however there has been a notable increase in average rock wallaby numbers. Whilst two of the four monitoring sites located adjacent to the TSF have experienced a small decline in PNRW numbers, likely due to inundation of habitat by rising tailings levels, the majority of monitoring sites have experienced an increase. These sites, as well as two adjacent to the TSF, monitor other PNRW colonies located close to other mining activities including the village, access road, and exploration areas, indicating that there appears to be no obvious effect of mining activities at colonies located nearby to non-TSF mining activities. Mixing between colonies within the Knapdale range is likely to be frequent. Larger more secure colonies probably act as 'source' populations, allowing dispersal to nearby habitats and facilitating recolonisation following local extinction of more marginal areas. Due to this, the population across the Knapdale Range as a whole is able to modify its distribution in response to impacts and thus regulate the population level. The patch of essential habitat covering the Knapdale Range is 6761 ha, of which only 73.18 ha (~1%) is located in the proposed disturbance area, increasing the total area associated with DRM to 195.25 ha (~2.8%). Whilst an impact to colonies in the path of rising tailings is evident, the abundance of colonies within the area and the tendency of PNRWs to disperse among nearby colonies has, thus far, been offsetting any single colony population decline across the broader Knapdale Range population. As such, the proposed disturbance is unlikely to lead to a long-term decrease in the size of a local population, even when considering cumulative impact.

Is there a chance or possibility that an action will?	Response
Reduce the extent of occurrence of the species; or	**Likely:** Project works in the site are likely to reduce the area of occupancy of an important population. Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred, or projected sites of present occurrence of a species, excluding cases of vagrancy (IUCN, 2012). There are 611 records of the PNRW on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. The patch of essential habitat covering the Knapdale Range is 6761 ha, of which only 73.18 ha (~1%) is located in the proposed disturbance area, increasing the total area associated with DRM to 195.25 ha (~2.8%). The disturbance area is comparatively small; however disturbance is permanent due to the inundation of habitat with tailings, and therefore it is likely project works will reduce the extent of occurrence of the population.
Fragment an existing population; or	**Unlikely:** Project works in the site are unlikely to fragment an existing population. There are 611 records of the PNRW on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. The small subpopulations in the denning habitat areas confirmed along the Knapdale Range can be collectively considered as a single population. Whilst an impact to colonies in the path of rising tailings is evident, the abundance of colonies within the area and the tendency of PNRWs to disperse among nearby colonies has, thus far, been offsetting any single colony population decline across the broader Knapdale Range population. As such, the proposed disturbance is unlikely to fragment any existing populations.
Result in genetically distinct populations forming as a result of habitat isolation; or	**Unlikely:** Project works in the site are unlikely to result in genetically distinct populations forming as a result of habitat isolation. There are 611 records of this species on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. The small subpopulations in the denning habitat areas confirmed along the Knapdale Range can be collectively considered a single population. The patch of essential habitat covering the Knapdale Range is 6761 ha, of which only 73.18 ha (~1%) is located in the proposed disturbance area, increasing the total area associated with DRM to 195.25 ha (~2.8%). Due to small size of the proposed disturbance footprint, the connectivity of the surrounding habitat, and the small range of rock-wallabies, works within the site are unlikely to cause habitat isolation and result in genetically distinct populations forming.
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the	**Unlikely:** Project works in the site are unlikely to introduce and/or allow a harmful invasive species to become established in the habitat of the species. Feral cats and European Red Foxes are recognised threats to several similar species and have been detected on site.

Is there a chance or possibility that an action will?	Response
endangered or vulnerable species' habitat; or	Several species of invasive flora have been detected on site and have the potential to modify the species' habitat. The project will operate under the *Biosecurity Act 2014* and follow the General Biosecurity Obligation (GBO) to identify and manage any potential invasive species. Weed and Seed and pest management processes are well established for the mine. As this disturbance is related to an increase of an existing footprint and not new linear disturbance, it is less likely that construction equipment or vehicles will introduce new weeds to the site. There is not likely to be an introduction and establishment of a harmful invasive species in the habitat of the species.
Introduce disease that may cause the population to decline, or	**Unlikely:** Project works are unlikely to introduce diseases to the site that may cause the population to decline. Hydatid disease (*Echinococcus granulosus*) and Toxoplasmosis (*Toxoplasmosis gondii*) are both recognised diseases that have the potential to threaten rock-wallaby populations. The project will operate under the Biosecurity Act (2014) and follow the General Biosecurity Obligation (GBO) to identify and manage detrimental diseases or pathogens if present. There is not likely to be an introduction of diseases to the rock-wallaby population on site.
Interfere with the recovery of the species; or	**Unlikely:** Project works in the site are unlikely to interfere substantially with the recovery of the species. There are 611 records of this species on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range near the proposed disturbance area. Due to small size of the proposed disturbance footprint, the large area of local habitat available, and the connectivity of the surrounding habitat, works within the site are unlikely to interfere with the recovery of the species.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species; or	**Likely:** Project works in the site are likely to adversely affect habitat critical to the survival of the species. There are 611 records of this species on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. The purple-necked rock wallaby favours habitat which includes boulder piles, rocky slopes, cliffs and gorges in limestone areas, and sandstone and quartzite outcrops amongst dry Eucalyptus and Acacia woodlands. It also inhabits spinifex grasslands in association with the rocky areas (Rowland, 2012). The patch of essential habitat covering the Knapdale Range is 6761 ha, of which 73.18 ha (~1%) is located in the proposed disturbance area, increasing the total area associated with DRM to 195.25 ha (~2.8%). The disturbance area is comparatively small; however disturbance is permanent due to the inundation of habitat with tailings, and therefore it is likely the proposed disturbance will adversely affect habitat critical to the survival of the species.

4.3. Purple-necked Rock-wallaby (*Petrogale purpureicollis*)

EPBC Act – Not listed. NC Act – Vulnerable

The Purple-necked Rock-wallaby (*Petrogale purpureicollis*) (PNRW) is a comparatively small wallaby species. Their weight ranges from 4.7 to 7.0 kg, their head-body length ranges from 500 – 610 mm, and their tail length ranges from 450 – 600 mm (Menkhorst & Knight, 2011). Their body is light brown, with a paler underside and a characteristic purple-mauve colouration over the neck, face, head, and sometimes upper chest and shoulders. They have a dark brown stripe extending from the eyes to between the ears along the midline of the top of the head (Menkhorst & Knight, 2011). The PNRW favours habitat which includes boulder piles, rocky slopes, cliffs and gorges in limestone areas, and sandstone and quartzite outcrops amongst dry Eucalyptus and Acacia woodlands. It also inhabits spinifex grasslands in association with the rocky areas (Rowland, 2012). They are largely nocturnal in summer, crepuscular or partially diurnal in other months. The PNRW shelters during the day among rocks or within boulder piles. In cooler months, they tend to sit in regular sites on rocks to bask in the sun in early morning and sometimes in afternoon. They move off the rocks in late afternoon or evening to feed in surrounding woodland (Mittermeier & Wilson, 2015).

PNRW habitat (both primary and secondary) is modelled within the proposed disturbance area (Figure 5). The below assessment determines that significant residual impacts to the PNRW as a result of the project will be likely based on the disturbance of the PNRW and its habitat, therefore an offset has been calculated in Sections 5 and 1.2. This impact is permanent, and whilst the filled TSF will eventually be capped and rehabilitated, the final structure will be vastly different from that of the area currently, especially in regard to rocky habitat preferable to the PNRW present along the slopes of the valley.

Table 6: Significant residual impact criteria for impacts to the Purple-necked Rock-wallaby (*Petrogale purpureicollis*)

Is there a chance or possibility that an action will?	Response
Lead to a long-term decrease in the size of a local population; or	**Unlikely:** Project works in the site are unlikely to lead to a long-term decrease in the size of a local population. There are 611 records of the PNRW on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. The area of primary habitat mapped on the Knapdale Range is 3208.65 ha, of which < 2 % is proposed for development. The disturbance area is comparatively small, and it is likely the species population will relocate and continue at the same size.
Reduce the extent of occurrence of the species; or	**Likely:** Project works in the site are likely to reduce the extent of occurrence of the species. There are 611 records of the PNRW on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including

Is there a chance or possibility that an action will?	Response
	several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. The area of primary habitat mapped on the Knapdale Range is 3208.65 ha, of which < 2 % is proposed for development. The disturbance area is comparatively small; however disturbance is permanent due to the inundation of habitat with tailings, and therefore it is likely project works will reduce the extent of occurrence of the species.
Fragment an existing population; or	**Unlikely:** Project works in the site are unlikely to fragment an existing population. There are 611 records of the PNRW on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. The small subpopulations in the denning habitat areas confirmed along the Knapdale Range can be collectively considered as a single population. The area of primary habitat mapped on the Knapdale Range is 3208.65 ha, of which < 2 % is proposed for development. Due to small size of the proposed disturbance footprint, the connectivity of the surrounding habitat, and the small range of rock-wallabies, works within the site are unlikely to fragment any existing populations.
Result in genetically distinct populations forming as a result of habitat isolation; or	**Unlikely:** Project works in the site are unlikely to result in genetically distinct populations forming as a result of habitat isolation. There are 611 records of this species on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. The small subpopulations in the denning habitat areas confirmed along the Knapdale Range can be collectively considered a single population. The area of primary habitat mapped on the Knapdale Range is 3208.65 ha, of which < 2 % is proposed for development. Due to small size of the proposed disturbance footprint, the connectivity of the surrounding habitat, and the small range of rock-wallabies, works within the site are unlikely to cause habitat isolation and result in the forming of genetically distinct populations.
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat; or	**Unlikely:** Project works in the site are unlikely to introduce and/or allow a harmful invasive species to become established in the habitat of the species. Feral cats and European Red Foxes are recognised threats to several similar species and have been detected on site. Several species of invasive flora have been detected on site and have the potential to modify the species' habitat. The project will operate under the *Biosecurity Act 2014* and follow the General Biosecurity Obligation (GBO) to identify and manage any potential invasive species. Weed and Seed and pest management processes are well established for the mine. There is not likely to be an introduction and establishment of a harmful invasive species in the habitat of the species.
Introduce disease that may cause the population to decline, or	**Unlikely:** Project works are unlikely to introduce novel diseases to the site. Hydatid disease (*Echinococcus granulosus*) and Toxoplasmosis (*Toxoplasmosis gondii*) are both recognised diseases that have the potential to threaten rock-wallaby populations.

Is there a chance or possibility that an action will?	Response
	The project will operate under the Biosecurity Act (2014) and follow the General Biosecurity Obligation (GBO) to identify and manage detrimental diseases or pathogens if present. There is not likely to be an introduction of a novel diseases to the rock-wallaby population on site.
Interfere with the recovery of the species; or	**Unlikely:** Project works in the site are unlikely to interfere with the recovery of the species. There are 611 records of this species on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range near the proposed disturbance area. Due to small size of the proposed disturbance footprint, the large area of local habitat available, and the connectivity of the surrounding habitat, works within the site are unlikely to interfere with the recovery of the species.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species.	**Likely:** Project works in the site are likely to adversely affect habitat critical to the survival of the species. There are 611 records of this species on the site over 13 years. There are multiple confirmed and multiple speculated dens around the site, including several along the Knapdale Range within and immediately adjacent to the proposed disturbance area. The purple-necked rock wallaby favours habitat which includes boulder piles, rocky slopes, cliffs and gorges in limestone areas, and sandstone and quartzite outcrops amongst dry Eucalyptus and Acacia woodlands. It also inhabits spinifex grasslands in association with the rocky areas (Rowland, 2012). The area of primary habitat mapped on the Knapdale Range is 3208.65 ha, of which < 2 % is proposed for development. The disturbance area is comparatively small; however disturbance is permanent due to the inundation of habitat with tailings, and therefore it is likely the proposed disturbance will adversely affect habitat critical to the survival of the species.

5. Offset Assessment

The Queensland Environmental Offsets Policy defines a mitigation hierarchy of avoid, minimise and lastly offset. Avoidance and minimisation have been implemented with the design of the TSF and associated disturbance areas.

As such, DRM have elected to offset the residual impact through the delivery of a financial settlement offset. The agreed financial settlement will be paid in full prior to any part of the activity commencing.

MMG has a current land-based offset for the existing disturbance associated with the Dugald River Project. As such, this financial settlement offset will offset impact associated with the proposed disturbance footprint only.

1.1. Distinct Matter Areas

The prescribed environmental matters assessed in section 4 have been separated into four DMAs as per Section 4.3.4 of the Queensland Environmental Offsets Policy Version 1.15 (DESI, 2024). The values of these DMAs relevant to the offset assessment have been listed in Table 7.

DMA 1 consists of regulated vegetation – essential habitat for the PNRW. Additionally, PNRW habitat has been modelled on site, and determined to be at risk of a significant residual impact resulting from the proposed disturbance. However, essential habitat is mapped as covering a larger area within the disturbance footprint than the modelled habitat, and as these matters can be co-located, essential habitat can be assessed for the offset and cover the impact to both matters.

DMA 2, 3, and 4 consist of regulated vegetation – intersecting a watercourse, and is separated by each RE that intersects the watercourse.

Table 7. DMAs of the proposed disturbance area and values relevant to the offset assessment

Field	DMA 1	DMA 2	DMA 3	DMA 4
Local governmental area	Cloncurry Shire Council	Cloncurry Shire Council	Cloncurry Shire Council	Cloncurry Shire Council
Bioregion	Northwest Highlands	Northwest Highlands	Northwest Highlands	Northwest Highlands
Subregion	Mount Isa Inlier	Mount Isa Inlier	Mount Isa Inlier	Mount Isa Inlier
DMA area (ha)	73.18	5.72	0.27	0.75
Matter group	Regulated vegetation - VMA essential habitat	Regulated vegetation - VMA watercourse / drainage feature	Regulated vegetation - VMA watercourse / drainage feature	Regulated vegetation - VMA watercourse / drainage feature
Matter	*Petrogale purpureicollis* (purple-necked rock-wallaby)	1.11.2a – intersecting a watercourse	1.11.3a – intersecting a watercourse	1.3.7b – intersecting a watercourse
Matter multiplier*	4	4	4	4

*A matter multiplier is a number used to calculate the size of the offset requirement given the significant residual impact area, for a given prescribed environmental matter.

1.2. Financial settlement offset

The financial settlement offset amount has been calculated as per Section 4.3 of the Queensland Environmental Offsets Policy Version 1.15 (DESI, 2024). The calculations are performed in Appendix A and the results are shown in Table 8 below.

Table 8. Summary of financial offset calculation results

Component of calculation	Calculated value
Offset area	319.68 ha
Sliding scale multiplier	81.31 %
Components costs (with sliding scale multiplier applied)	
Total on-ground cost	$519,863.62
Total landholder incentive payment	$13,516.45
Total administrative cost	$118,528.90
Total financial settlement	
$651,908.97	

6. Conclusion

The following prescribed environmental matters are known to be present within the proposed disturbance area:

- Regulated vegetation – intersecting a watercourse
- Regulated vegetation – essential habitat
- Purple-necked Rock-wallaby (*Petrogale purpureicollis*) – Endangered (NC Act)

SRI assessments were undertaken for these matters and determined that an impact as a result of the proposed disturbance is likely to all three matters.

Avoidance and minimisation have been implemented with the design of the TSF and associated disturbance areas, however a residual impact is still anticipated. As such, DRM have elected to offset this impact through the delivery of a financial settlement offset.

The area of each matter to be impacted has been calculated, and a financial settlement offset amount calculated in accordance with the Queensland Environmental Offsets Policy Version 1.15 (DESI, 2024), totalling $651,908.97.

The agreed financial settlement will be paid in full prior to any part of the activity commencing.

7. References

BASE Consulting. (2022). *Mount James Wind Farm Bird and Bat Management Plan.* Porcupine: BASE Consulting.

Bennett, E. F. (2022). Curtailment as a successful method for reducing bat mortality at a southern Australian wind farm. *Austral Ecology*, 1329-1339.

Bibby, C., Burgess, N., & Hill, D. (1982). Bird Census Techniques. *Academic Press*.

Bibby, C., Jones, M., & Marsden, S. (2000). *Expedition Field Techniques - Bird Surveys.* Cambridge: BirdLife International.

Brett Lane & Associates Pty Ltd. (2005). *Wind Farms and Birds: Interim Standards For Risk Assessment.* Carlton North: Australian Wind Energy Association.

Debus, S. (1995). Surveys of large forest owls in northern New South Wales: methodology, calling behaviour and owl responses. *Corella, Vol. 19*, 38-50.

Department of Environment and Heritage Protection. (2014). *Significant Residual Impact Guideline.* Queensland Government.

Department of Environment and Science. (2020). *Method for mapping Matters of state environmental significance .For the State Planning Policy 2017. Version 6.0.* Brisbane: Queensland Government.

Department of Resources. (2023). *Accepted development vegetation clearing code: Clearing for infrastructure - Effective 22 November 2023.* Brisbane: State of Queensland.

Department of State Development, Infrastructure, Local Government and Planning. (2023). *Planning Guidance - State code 23: Wind farm development.*

Department of the Environment. (2013). *Matters of National Environmental Significance: Significant impact guidelines 1.1.* Canberra: Australian Government .

DESI. (2024). *Queensland Environmental Offsets Policy Version 1.15.* Brisbane: State of Queensland.

Drapeau, P., Leduc, A., & McNeil, R. (1999). Refining the use of point counts at the scale of individual points in studies of bird-habitat relationships. *Journal of Avian Biology, Vol. 30*, 367-382.

Ecosmart Ecology. (2023). *Dugald River Wind Farm Fauna Survey Results.*

Horsup, A. (1994). Home Range of the Allied Rock-wallaby, Petrogale assimilis. *Wildlife Research*, 65-84.

Kavanagh, R., & Peake, P. (1993). *Survey procedures for nocturnal forest birds: an evaluation of the variability in census results due to temporal factors, weather and technique.* Melbourne: Australasian Raptor Association.

Keast, A. (1984). *Assessment of community composition and species richness in contrasting habitats', in Methods of Censusing Birds in Australia.* Melbourne; Perth: Royal Australian Ornithologists Union; Department of Conservation and Environment.

Menkhorst, P., & Knight, F. (2011). *A Field Guide to the Mammals of Australia.* Melbourne: Oxford University Press.

Mittermeier, R. A., & Wilson, D. E. (2015). Macropodidae. In *Handbook of the Mammals of the World – Volume 5 Monotremes and Marsupials.*

Neldner, V., Wilson, B., Dilleward, H., Ryan, T., Butler, D., McDonald, W., . . . Appelman, C. (2023). *Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland.* Brisbane: Queensland Herbarium, Queensland Department of Environment, Science and Innovation.

Pizzey, G., & Knight, F. (2012). *The Field Guide to the Birds of Australia.* Sydney: Harper Collins.

Rowland, J. (2012). *Purple-necked rock-wallaby, Petrogale purpureicollis. Targeted species survey guidelines.* Department of Environment and Science. Brisbane: Queensland Herbarium.

Slater, P. (1994). Factors affecting the efficiency of the area search method of censusing birds in open forests and woodlands. *Emu, vol. 94*, 9-16.

Wulguru Technical Services. (2023). *MMG - Dugald River Windfarm Ecological Assessment Report.*

Wulguru Technical Services. (2024). *MMG - Dugald River Windfarm Bird and Bat Management Plan .*

Wulguru Technical Services. (2024). *Thermal Habitat of PNRW.* Townsville.

APPENDIX A – Financial settlement offset calculation

Offset area = (DMA 1 area * matter multiplier) + (DMA 2 area * matter multiplier) + (DMA 3 area * matter multiplier) + (DMA 4 area * matter multiplier)

Offset area = (73.18 * 4) + (5.72 * 4) + (0.27*4) + (0.75*4) = 319.68 ha

Sliding scale multiplier = ((the first 100 ha of the offset area * 100% of the per ha cost) + (the next 900 ha (1000 ha less the first 100 ha) * 72.8% of the per ha cost) (and so on if offset area >1000 ha)) / offset area

Sliding scale multiplier = ((100*100%) + (219.68*72.8%)) / 319.68 = 259.93/ 319.68 = 81.31%

On-ground cost = offset area * on-ground cost for the subregion

On-ground cost = 319.68 ha * $2000/ha = $639,360

Total on-ground cost = on-ground cost * sliding scale multiplier

Total on-ground cost = $639,360 * 81.31% = $519,863.62

Landholder incentive payment = offset area * LGA statutory land value per ha

Landholder incentive payment = 319.68 ha * $52/ha = $16,623.36

Total landholder incentive payment = landholder incentive payment * sliding scale multiplier

Total landholder incentive payment = $16,623.36 * 81.31% = $13,516.45

Administrative cost = on-ground cost * 22.8%

Administrative cost = $639,360 * 22.8% = $145,774.08

Total administrative cost = administrative cost * sliding scale multiplier

Total administrative cost = $145,774.08 * 81.31% = $118,528.90

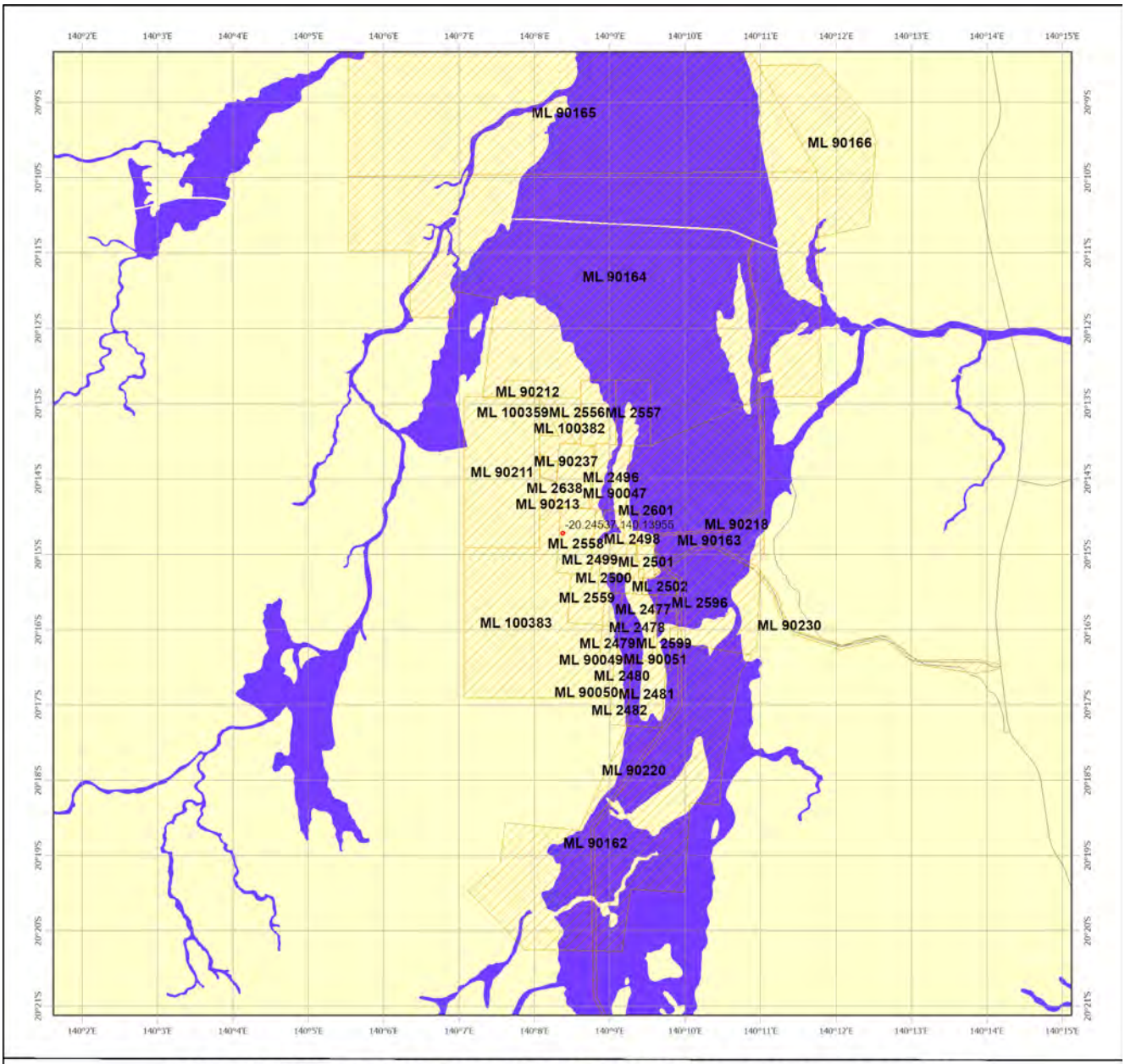
Financial settlement = total on-ground cost + total landholder incentive payment + total administrative cost

Financial settlement = $519,863.62 + 13,516.45 + 118,528.90 = $651,908.97

APPENDIX B – Map of Environmentally Sensitive Areas

Tenure type: Mining Lease
Centred on point position: Longitude: 140.13955 Latitude: -20.24537

Map produced: 20/01/2025 09:54:38



ENVIRONMENTALLY SENSITIVE AREAS - Mining Activities

CATEGORY A
- National Parks
- Conservation Parks
- Forest Reserves
- Special Wildlife Reserve
- Wet Tropics World Heritage Area
- Great Barrier Reef Region
- Marine Parks other than General Use Zones

CATEGORY B
- Queensland Heritage Register Places
- Ramsar Sites
- Cultural Heritage Registered Areas and DLA's other than Stanbroke
- Special Forestry Areas
- Seaward Side of Highest Astronomical Tide
- Fish Habitat Areas
- Coordinated Conservation Areas
- Endangered Regional Ecosystems - regrowth and remnant (Biodiversity Status)
- General Use Zones of Marine Parks
- Marine Plants
- Coordinates
- Mining Leases

CATEGORY C
- Nature Refuges
- Resources Reserve
- State Forests
- Timber Reserves
- River Improvement Areas
- Stanbroke DLA
- Coastal Management District
- Dams and Weirs

OTHERS
- Towns
- Roads
- Repealed Wild River Nominated Waterways
- Repealed Wild River Preservation Areas
- Repealed Wild River High Preservation Areas
- Mahogany Glider Habitat
- Directory of Important Wetlands
- Queensland

LOCALITY DIAGRAM



N

0 1,000 2,000 3,000 4,000 5,000 m

This product is displayed in GDA2020

Information presented on this product is distributed by the Queensland Government as an information source only. While every care is taken to ensure the accuracy of this data, The State of Queensland makes no statements, representations or warranties about the accuracy, reliability, completeness or suitability of any information contained in this product.

The State of Queensland disclaims all responsibility for information contained in this product and all liability (including without limitation, liability in negligence) for all expenses, losses, damages and costs you may incur as a result of the information being inaccurate or incomplete in any way for any reason.

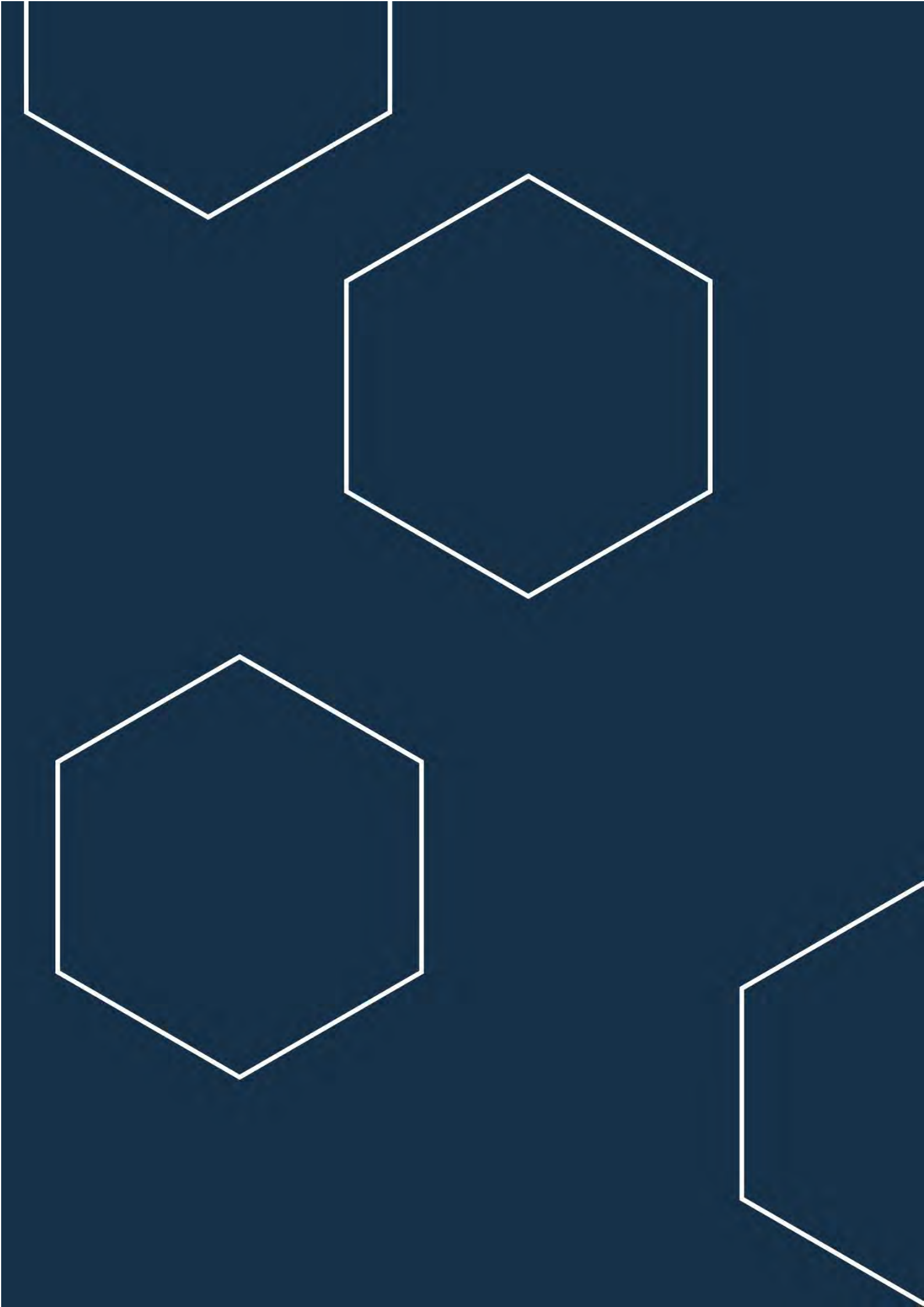
NOTE TO USER: Themes presented in this map are indicative only. Field survey may be required to verify the 'true' spatial extent and value. Not all environmentally sensitive areas are presented in this map. A user should refer to the particular circumstances relevant to their situation to assess the 'completeness' of themes provided.

The user should note that some boundaries and indicated values are ambient and may change over time (e.g. regional ecosystem boundaries and conservation status, watercourse mapping etc.).

The user should be aware that due to multiple overlapping themes/ layers present, some themes/layers may be obscured by others. Ordering in the Legend does not accurately reflect the order by which themes/layers are displayed.

© The State of Queensland, 2025

Queensland Government



APPENDIX H: Dugald River Mine Progressive Rehabilitation and Closure Plan (WTS, 2025b)

Contact Details	
Company	Wulguru Technical Services Pty Ltd
Project Manager	Madison Jackson, CEnvP
Email	madison@wulgurutechservices.com.au
Mail	PO Box 1681, Townsville, QLD 4810
ABN	79 644 301 655

Disclaimer

This report has been prepared by Wulguru Technical Services Pty Ltd for and on behalf of Wulguru Technical Services Pty Ltd's Client and is subject to and issued in connection with the agreement between Wulguru Technical Services Pty Ltd.

Wulguru Technical Services Pty Ltd cannot be held liable for third party reliance on this document. This report is based on information available to Wulguru Technical Services Pty Ltd and could be different if the information on which this report is based upon is inaccurate or incomplete.

Whilst all reasonable effort has been made to ensure that the contents of this publication are factually correct, Wulguru Technical Services Pty Ltd does not accept responsibility for the accuracy or completeness of the contents and shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this publication.

This report may utilise the results of work carried out by others. These results have been used in good faith by Wulguru Technical Services Pty Ltd and Wulguru Technical Services Pty Ltd cannot be held responsible for their accuracy.

Document Control and History

Version	Date	Description	Prepared By	Reviewed By
1.0	2/10/2022	Final	Madison Jackson	Scott Hayes-Stanley
2.0	23/10/2024	Final – Approval of October 2024 EAA	Madison Jackson	Madison Jackson
2.1	18/03/2025	Draft – April 2025 EAA	Taysha Hall	Madison Jackson
3.0	17/04/2025	Final – April 2025 EAA	Taysha Hall	Madison Jackson
3.1	30/05/2025	Response to NPM	Madison Jackson	Madison Jackson
4.0	5/03/2026	Response to Information Request	Taysha Hall	Madison Jackson

Citation

Wulguru Technical Services, 2026, *Progressive Rehabilitation and Closure Plan*, Prepared by Wulguru Technical Services Pty Ltd for MMG Dugald River Pty Ltd.

Contents

1. Introduction 1

2. Purpose of Plan 1

2.1. Requirements of the Plan 1

2.2. Amendments to the Current Schedule 3

2.2.1. Condition PRCP5 4

3. Rehabilitation Planning 5

3.1. Project Planning 5

3.1.1. Project Description 5

3.1.2. Mining Tenements 7

3.1.3. Underlying Landholders 8

3.1.4. Primary Mine Features and Infrastructure On-Site 9

3.1.5. Pre-mining Land Use 11

3.1.6. Communities 11

3.1.7. Native Title 12

3.1.8. Type of Operations 12

3.1.9. Duration Of Operation 12

3.1.10. Existing Environmental Context 13

3.1.10.1. Climate 13

3.1.10.1.1. Rainfall and Temperature 13

3.1.10.1.2. Long-term Climate Projections 14

3.1.10.2. Topography and Hydrology 14

3.1.10.2.1. Topography 14

3.1.10.2.2. Hydrology 15

3.1.10.3. Surface Water 17

3.1.10.3.1. Environmental Values 17

3.1.10.3.2. Water Quality Trigger Limits 18

3.1.10.3.3. Receiving Environment Monitoring Program 20

3.1.10.3.4. Surface Water Quality 20

3.1.10.4. Groundwaters 25

3.1.10.4.1. Groundwater Occurrence and Hydrostratigraphy 25

3.1.10.4.2. Groundwater Recharge and Discharge 25
3.1.10.4.3. Groundwater Flow 26
3.1.10.4.4. Groundwater Users 27
3.1.10.4.5. Groundwater – Surface Water Interaction 27
3.1.10.4.6. Groundwater Dependent Ecosystems 27
3.1.10.4.7. Environmental Values 27
3.1.10.4.8. Groundwater Monitoring Network 28
3.1.10.4.9. Groundwater Trigger Limits 28
3.1.10.4.10. Groundwater Quality 29
3.1.10.5. Soils 36
3.1.10.5.1. Soil Types 36
3.1.10.5.2. Soil Properties 37
3.1.10.5.3. Agricultural Land Classes 39
3.1.10.5.4. Land Suitability Assessment 40
3.1.10.5.5. Land Stability 41
3.1.10.5.5.1. Soil Erosion Susceptibility 41
3.1.10.5.5.2. Erosion Hazard (Average Rainfall) 42
3.1.10.6. Geology 42
3.1.10.7. Vegetation Communities and Ecological Data 44
3.1.10.7.1. Matters of National Environmental Significance (MNES) 44
3.1.10.7.1.1. EPBC Listed Threatened Flora Species 44
3.1.10.7.1.2. EPBC Listed Threatened Fauna and Migratory Species 45
3.1.10.7.2. Matters of State Environmental Significance 47
3.1.10.7.2.1. Environmentally Sensitive Areas 47
3.1.10.7.2.2. Regional Ecosystems 47
3.1.10.7.2.3. Regulated Vegetation 52
3.1.10.7.2.4. EVNT or Special Least Concern Species under the NC Act 52
3.2. Community 57
3.2.1. Community Profile 57
3.2.2. Community Consultation Plan 57
3.3. Post Mining Land Use 59

3.3.1. Rehabilitation Areas 59
3.3.2. Existing Rehabilitation 63
3.3.3. Assessment of PMLU Options 63
3.3.3.1. Community Consultation 65
3.3.3.2. Regional Planning Integration 66
3.3.3.2.1. Cloncurry Shire Planning Scheme 66
3.3.3.2.2. Regional Strategies 66
3.3.4. Proposed PMLU 68
3.3.4.1. RA1 – Ancillary Infrastructure and Services 68
3.3.4.1.1. Overview 68
3.3.4.1.2. Outcome 68
3.3.4.1.3. Environmental Benefit 68
3.3.4.1.4. Economic Benefit 68
3.3.4.1.5. Social Benefit 68
3.3.4.2. RA2 – Borrow Pits and Stockpiles 68
3.3.4.2.1. Overview 68
3.3.4.2.2. Outcome 68
3.3.4.2.3. Environmental Benefit 69
3.3.4.2.4. Economic Benefit 69
3.3.4.2.5. Social Benefit 69
3.3.4.3. RA3 – Dams and Diversion Structures 69
3.3.4.3.1. Outcome 69
3.3.4.3.2. Environmental Benefit 69
3.3.4.3.3. Economic Benefit 70
3.3.4.3.4. Social Benefit 70
3.3.4.4. RA4 – Mineralised Waste Dumps 70
3.3.4.4.1. Outcome 70
3.3.4.4.2. Environmental Benefit 70
3.3.4.4.3. Economic Benefit 70
3.3.4.4.4. Social Benefit 71
3.3.4.5. RA5 – Mining and Processing Areas 71

3.3.4.5.1. Outcome 71
3.3.4.5.2. Environmental Benefit 71
3.3.4.5.3. Economic Benefit 71
3.3.4.5.4. Social Benefit 72
3.3.4.6. RA6 – TSF 72
3.3.4.6.1. Outcome 72
3.3.4.6.2. Design 72
3.3.4.6.3. Environmental Benefits 72
3.3.4.6.4. Economic Benefit 72
3.3.4.6.5. Social Benefit 73
3.3.4.7. RA7 – Renewable Energy Infrastructure 73
3.3.4.7.1. Outcome 73
3.3.4.7.2. Economic Benefit 73
3.3.4.7.3. Social Benefit 73
3.4. Non-use management areas 74
3.5. Rehabilitation and Management Methodologies 74
3.5.1. Voids in Floodplains 81
3.5.2. Site Services 81
3.5.3. Built Infrastructure 81
3.5.4. Contaminated Land Assessment 83
3.5.5. Site Preparation 83
3.5.6. Material Assessment 83
3.5.6.1. Material Quantity and Quality 83
3.5.6.2. Topsoil Striping 86
3.5.6.3. Topsoil Stockpiling 86
3.5.6.4. Soil Monitoring Program 86
3.5.6.5. Topsoil Application 88
3.5.6.6. Soil Loss 88
3.5.6.7. Erosion and Sediment Control 89
3.5.7. Revegetation Plan 89
3.5.7.1. Low Intensity Grazing 89

3.5.7.1.1. Seed Mix 90
3.5.7.2. Native Ecosystem 90
3.5.7.2.1. Seed Mix 91
3.5.7.3. Revegetation Method 91
3.5.7.4. Application Rate 92
3.5.7.5. Weed Management 92
3.5.8. Water Management 95
3.5.8.1. Stormwater Management 95
3.5.8.2. Closure Water Balance 103
3.5.8.3. Flooding 103
3.5.9. Subsidence Management 104
3.5.10. Waste Structures 105
3.5.10.1. Waste Rock Dumps 105
3.5.10.1.1. Waste Rock Characterisation 105
3.5.10.1.1.1. Methodology 105
3.5.10.1.1.2. ARD Classification 106
3.5.10.1.1.3. Elemental Analysis 106
3.5.10.1.2. Identification of Waste Rock 106
3.5.10.1.3. Waste Rock Dump Design 106
3.5.10.1.4. Implications for Closure 107
3.5.10.2. Tailings Storage Facility 107
3.5.10.2.1. Tailings Characterisation 107
3.5.10.2.2. Tailings Physical Properties 108
3.5.10.2.3. TSF Construction 109
3.5.10.2.4. TSF Closure Objectives 112
3.5.10.2.5. Tailings Deposition Strategy and Landform Surface 112
3.5.10.2.6. Final Landform Design 115
3.5.10.2.7. TSF Cover System 116
3.5.10.2.8. Seepage Management 119
3.5.10.2.9. Revegetation Strategy 119
3.5.10.2.10. Long Term Stability 119

3.5.10.2.11. Limitations and Assumptions 120
3.5.10.2.12. QAQC 120
3.5.10.2.13. Rehabilitation Trials 120
3.5.11. Voids 122
3.5.12. Summary of Key Rehabilitation Milestones 122
3.5.13. Rehabilitation Milestones 123
3.6. Risk Assessment 145
3.6.1. Risk Identification 145
3.6.2. Risk Analysis and Evaluation 146
3.7. Monitoring and Maintenance 166
3.7.1. Rehabilitation Monitoring Phases 166
3.7.2. Establishment of Reference Sites 167
3.7.3. Monitoring Program 167
3.7.3.1.1. Initial Monitoring Program 168
3.7.3.1.1.1. Desktop Monitoring 168
3.7.3.1.1.2. Landform and Erosion 168
3.7.3.1.1.3. Soil 168
3.7.3.1.1.4. Vegetation 169
3.7.3.1.1.5. Fauna 169
3.7.3.1.1.6. Surface Waters 169
3.7.3.1.1.7. TSF Seepage 169
3.7.3.1.1.8. Groundwater 169
3.7.3.1.2. Minor Monitoring Methods 170
3.7.3.1.2.1. Desktop Monitoring 170
3.7.3.1.2.2. Landform and Erosion 170
3.7.3.1.2.3. Vegetation 170
3.7.3.1.2.4. Surface Water 171
3.7.3.1.2.5. TSF Seepage 171
3.7.3.1.2.6. Groundwater 171
3.7.3.1.3. Major Monitoring Methods 171
3.7.3.1.3.1. Desktop Monitoring 172

3.7.3.1.3.2. Landform and Erosion 172
3.7.3.1.3.3. Vegetation 172
3.7.3.1.3.4. Grazing Land Suitability Assessment 172
3.7.3.1.3.5. Surface Water 172
3.7.3.1.3.6. TSF Seepage 172
3.7.3.1.3.7. Groundwater 172
3.7.3.1.4. Opportunistic Monitoring 172
3.7.4. Maintenance 173
3.7.5. Analysis, Recording, and Reporting 173
3.7.6. Quality Assurance 173
3.7.7. Review 174
3.7.8. EA Relinquishment 174
4. References 175
Appendix A: PRCP Schedule 177
Appendix B: DRM Community and Social Performance Standard 178
Appendix C: DRM Community Engagement Plan 179
Appendix D: Dugald River TSF Stage 3 Detailed Design Report 180
Appendix E: TSF Conceptual Closure Design Report 181
Appendix F: TSF and Process Area Hydraulic Impact Assessment 182
Appendix G: Surface Subsidence Risk 183
Appendix H: Assessment of the Geochemical Characteristics and ARD Potential of Waste Rock for the Dugald River Zinc, Lead & Silver Deposit 184
Appendix I: Column Cover Trials 185
Appendix J: Conceptual Cover System Options 186
Appendix K: Concept Stormwater Closure Plan and Site-wide Closure Landform 187
Appendix L: Preliminary TSF Closure Landform Design (Surface) 188
Appendix M: Conceptual Cover System Modelling Results 189
Appendix N: Landform Conceptual Design – Erosion Modelling 190
Appendix O: Proposed Changes to PRCP Schedule 191

Tables

Table 1. Requirements of a PRCP 1
Table 2. Granted tenures for the Dugald River Mine 7
Table 3. Underlying landholder 8
Table 4. Mine features 9
Table 5. Mean monthly rainfall recorded at the Cloncurry Airport (BOM, 2024) 14
Table 6. Local catchments and mine features 15
Table 7 Receiving waters trigger levels and contaminant limits (Schedule C - Table 5 of the EA) 18
Table 8: Surface water chemistry 2020-2024 22
Table 9. Hydrostratigraphic units (CDM Smith, 2024) 25
Table 10. Groundwater bore details 28
Table 11. Groundwater trigger levels and contaminant limits (EPML00731213) 29
Table 12. Groundwater chemistry (2009-2024) 32
Table 13. DRM soil types (AARC 2010a) 36
Table 14. Rehabilitation related chemical properties 37
Table 15. Agricultural land classes 39
Table 16. Agricultural land class of the Project soils from AARC (2010) 39
Table 17. Land suitability classes 40
Table 18. Land suitability assessment for Project soils 41
Table 19. Soil erosion susceptibility 41
Table 20. Erosion hazard (IECA, 2008) 42
Table 21. Mapped geology for the Project area 42
Table 22. Listed threatened flora species 44
Table 23. EPBC listed migratory and marine species identified within 50km of DRM 45
Table 24. Mapped vegetation communities and their current conservation status (Qld 2021) 49
Table 25. EVNT or Special Least Concern Species under the NC Act 52
Table 26. Stakeholder consultation register 58
Table 27. Rehabilitation areas 59
Table 28. Mine domains and agreed PLMU 63
Table 29. Requirements of a PMLU 64
Table 30. Key rehabilitation activities 75
Table 31. Built infrastructure 81
Table 32 Preliminary materials balance 84
Table 33. Stockpiles topsoil volumes 86
Table 34. Analysis parameters for the soil monitoring program 87
Table 35. Grazing seed mix 90
Table 36. Native ecosystem seed mix 91
Table 37. Weed and pest species 93

Table 38. Weed control techniques 94
Table 39. Water management volumes 103
Table 40. ARD classification of DRM waste rock (EGi, 2010) 106
Table 41. Tailings design density parameters 108
Table 42. Stability assessment criteria 108
Table 43. Material properties 109
Table 44. Stability Assessment 109
Table 45. TSF cover system 116
Table 46. Annual cover water balance (ATC Williams, 2025) 119
Table 47. WEPP model results - TSF surface 120
Table 48 Key rehabilitation and management practices 122
Table 49. Rehabilitation milestones 126
Table 50. Risk matrix 147
Table 51. Risk scores 148
Table 52. Risk evaluation 149
Table 53 Preliminary completion criteria summary 171

List of Figures

Figure 1. Project location 6
Figure 2. Climate statistics recorded at the Cloncurry Airport (BOM, 2024) 13
Figure 3. Cloncurry Airport 9am and 3pm wind rose (BOM, 2024) 14
Figure 4. Topography and hydrology 16
Figure 5. Surface water monitoring 21
Figure 6. Conceptual hydrogeological model (CDM Smith, 2024) 26
Figure 7. Groundwater monitoring network 31
Figure 8. Soil mapping 38
Figure 9. Geology West-East Cross-section (CDM Smith, 2025) 44
Figure 10. Matters of State Environmental Significance 55
Figure 11. Regional ecosystems 56
Figure 12. Reference Map A 61
Figure 13. Reference Map B 62
Figure 14. Proposed post mine land uses 67
Figure 15. Available materials 85
Figure 16. Closure landform surface and stormwater accommodation area (ATCW, 2025c) 97
Figure 17. Closure landform surface and stormwater accommodation area cross section (ATCW, 2025c) 98
Figure 18. Closure landform surface and stormwater accommodation area (ATCW, 2025c) 99
Figure 19. Closure landform surface and stormwater accommodation area cross section (ATCW, 2025c) 100
Figure 20. Closure landform surface and stormwater processing area cross section (ATCW, 2025c) 101
Figure 21. Closure landform surface and stormwater waste storage area cross section (ATCW, 2025c) 102
Figure 22. TSF raise design 111
Figure 23. Conceptual closure final tailings surface (ATCW, 2025b) 113
Figure 24. Conceptual closure final tailings surface – Section N-S (ATCW, 2025b) 113
Figure 25. Conceptual closure final tailings surface – embankment (ATCW, 2025b) 114
Figure 26. Embankment at closure (ATCW, 2025b) 115
Figure 27. Embankment at closure – section (ATC Williams, 2025b) 116
Figure 28. TSF cover system configuration (ATCW, 2025d) 118
Figure 29. ISO 31000: 2018 Risk management process 145
Figure 30. Rehabilitation monitoring phases 166

1. Introduction

Dugald River Mine (the Project) is owned and operated by MMG Dugald River Pty Ltd. The Project operates under Environmental Authority EPML00731213 (the EA) and Progressive Rehabilitation and Closure Plan (PRCP) schedule PRCP-EPML00731213-V2. Wulguru Technical Services Pty Ltd (WTS) was engaged by MMG to revise the existing PRCP for activities proposed by an EA amendment application, submitted for assessment in April 2025.

This document summarises the technical components and supporting information relating to the rehabilitation and closure of the Project and has considered the following Department of Environment, Tourism, Science and Innovation (DETSI) guideline:

- Guideline ESR/2019/4964 – *Progressive rehabilitation and closure plans (PRC plans)*, Version 3.01 – 16 September 2024.

The PRCP outlines the Project planning and post-closure requirements, community consultation, post-mining land use, rehabilitation methods, risk assessment, monitoring and maintenance, and rehabilitation schedule. A summary of proposed changes is provided in Appendix O.

2. Purpose of Plan

The purpose of this document is to assess the existing environmental values and provide for rehabilitation and closure planning based on approved activities. This PRCP will:

- Outline how MMG will meet landholder expectations for final land use;
- Outline how MMG will achieve a decommissioned site that is safe, fit for purpose, and non-polluting;
- Outline how MMG will minimise residual impact or liability for community and future land holders following rehabilitation; and
- Outline how MMG will return the landform to an agreed or pre-mine condition.

2.1. Requirements of the Plan

The PRCP is required to provide the information stated in the Guideline ESR/2019/4964 – Progressive rehabilitation and closure plans as well as sections 126C and 126D of the Environmental Protection Act 1994 (EP Act). Table 1 details how each requirement has been met to achieve a ‘properly made’ PRCP application.

Table 1. Requirements of a PRCP

PRCP Requirement	PRCP Reference
Project description	
Describe each resource tenure, including the area of each tenure, to which the application relates.	Section 3.1.2

PRCP Requirement	PRCP Reference
Describe the relevant activities to which the application relates.	Section 3.1.4
Describe the likely duration of the relevant activities.	Section 3.1.9
Include a detailed description, including maps, of how and where relevant activities are carried out.	Section 3.1.1, Section 3.1.4
Consultation	
Include details of the consultation undertaken by the applicant in developing the proposed PRCP.	Section 3.2
Include details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan.	Section 3.2.2
Post-mining land use	
State the extent to which each proposed post – mining land use identified in the proposed PRCP schedule for the plan is consistent with the outcome of consultation with the community in developing the PRCP.	Section 3.3.3.1
State the extent to which each proposed post-mining land use identified in the proposed PRCP schedule for the plan is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.	Section 3.3.3.2
Non-use management area	
State the extent to which each proposed non-use management area identified in the PRCP schedule for the plan is consistent with the outcome of consultation with the community developing the PRCP.	N/A – No NUMAs proposed
State the extent to which each non-use management area identified in the PRCP schedule for the plan is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.	N/A – No NUMAs proposed
For each proposed non-use management area, state the reasons the applicant considers the area cannot be rehabilitated to a stable condition because of a matter mentioned in section 126D(2). Note for transitional PRCPs: The holder is not required to comply with the requirements under section 126C(1)(g) or 126D(2) or (3) for the propose PRCP schedule for the plan in relation to land if a land outcome document identified the outcomes for the land as the same, or substantially similar to, the outcome for the land if it were a non-use management area.	N/A – No NUMAs proposed
For each matter mentioned in the requirement above, include copies of reports or other evidence relied on by the proposed for each proposed non-use management area. Note for transitional PRCPs: The holder is not required to comply with the requirements under section 126C(1)(g) or 126D(2) or (3) for the propose PRCP schedule for the plan	N/A – No NUMAs proposed

PRCP Requirement	PRCP Reference
in relation to land if a land outcome document identified if the outcomes for the land are the same, or substantially similar to, the outcome for the land if it were a non-use management area.	
Rehabilitation and management methodology	
For each post-mining land use, state the applicants' 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.	Section 3.5
For each non-use management area, state 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.	N/A – No NUMAs proposed
Risk assessment	
Identify the risk of a stable condition for land described as a post-mining land use not being achieved, and how the applicant intends to manage or minimise the risks.	Section 3.6
PRCP Guideline	
Include any other information prescribed by the administering authority in the Guideline - Progressive rehabilitation and closure plans.	Appendix B – Appendix H
Include the spatial information referred to in the Guideline - Progressive rehabilitation and closure plans.	Spatial submission
Other information	
Include the other information the administering authority reasonably considers necessary to decide whether to approve the PRCP schedule.	Appendix B – Appendix H
PRCP Schedule	
Include a PRCP scheduled prepared using the PRCP schedule template (ESR/2019/5103)	Appendix A
Include all maps showing all of the land mentioned in the PRCP schedule, as it relates to being progressively rehabilitated.	Figure 12 and Figure 14

2.2. Amendments to the Current Schedule

Rehabilitation of currently approved activities are scheduled to be carried out in accordance with the PRC Plan and approved PRCP Schedule (P-PRCP-100846032). An EA amendment application has been prepared, seeking approval of the following:

- Downstream raise of the Tailings Storage Facility (TSF);
- Construction of a borrow pit to access suitable material for the construction of the TSF raise;
- An expansion to the Potentially Acid Forming (PAF) Waste Pad;
- Construction of a borrow pit to access suitable material for the expansion of the PAF Pad;

- Replacing the groundwater contaminant limit for Fluoride with a site-specific value;
- Addition of Mining Lease (ML) 100383, 100359, and 100382 to the Project area; and
- Alternative air quality monitoring locations.

This PRC Plan and Schedule have been submitted in consideration of the proposed EA amendments detailed above. This amended PRC Plan and Schedule is submitted in accordance with Section 226AA (2) of the EP Act. Specific amendments to the PRCP Schedule are detailed in Appendix O.

Overall, the revisions to the timing within the PRCP Schedule have been made to reflect the current technical information available and are not necessarily a result of a reduced LoM. Future mine planning is still in progress, with potential extensions being considered.

2.2.1. Condition PRCP5

This application proposes amendment of PRCP Schedule Condition PRCP5.

PRCP5 – *'Within 3 years of approval of the PRCP Schedule P-PRCP-100846032, the PRCP holder must commence field trials to demonstrate the construction and performance of the alternative cover system…'.*

In accordance with the current conditioning, within 3 years of approval of the PRCP Schedule would necessitate rehabilitation trials to commence in 2026. The current approvals timeframe and project scheduling estimates construction of the tailings storage facility (TSF) stage 3 embankment raise, subject of the EA amendment application, to be completed in 2029. As such, the TSF area will not become available to conduct rehabilitation trials by 2026. The conditioning of PRCP5 is proposed to be amended to allow the commencement of rehabilitation trials following the TSF stage 3 embankment raise, as proposed by the following conditioning:

PRCP5 – '*The PRCP holder must commence field trials within 12 months of the completion of the tailings storage facility (TSF) stage 3 embankment raise to demonstrate the construction and performance of the alternative cover system…'*.

3. Rehabilitation Planning

3.1. Project Planning

3.1.1. Project Description

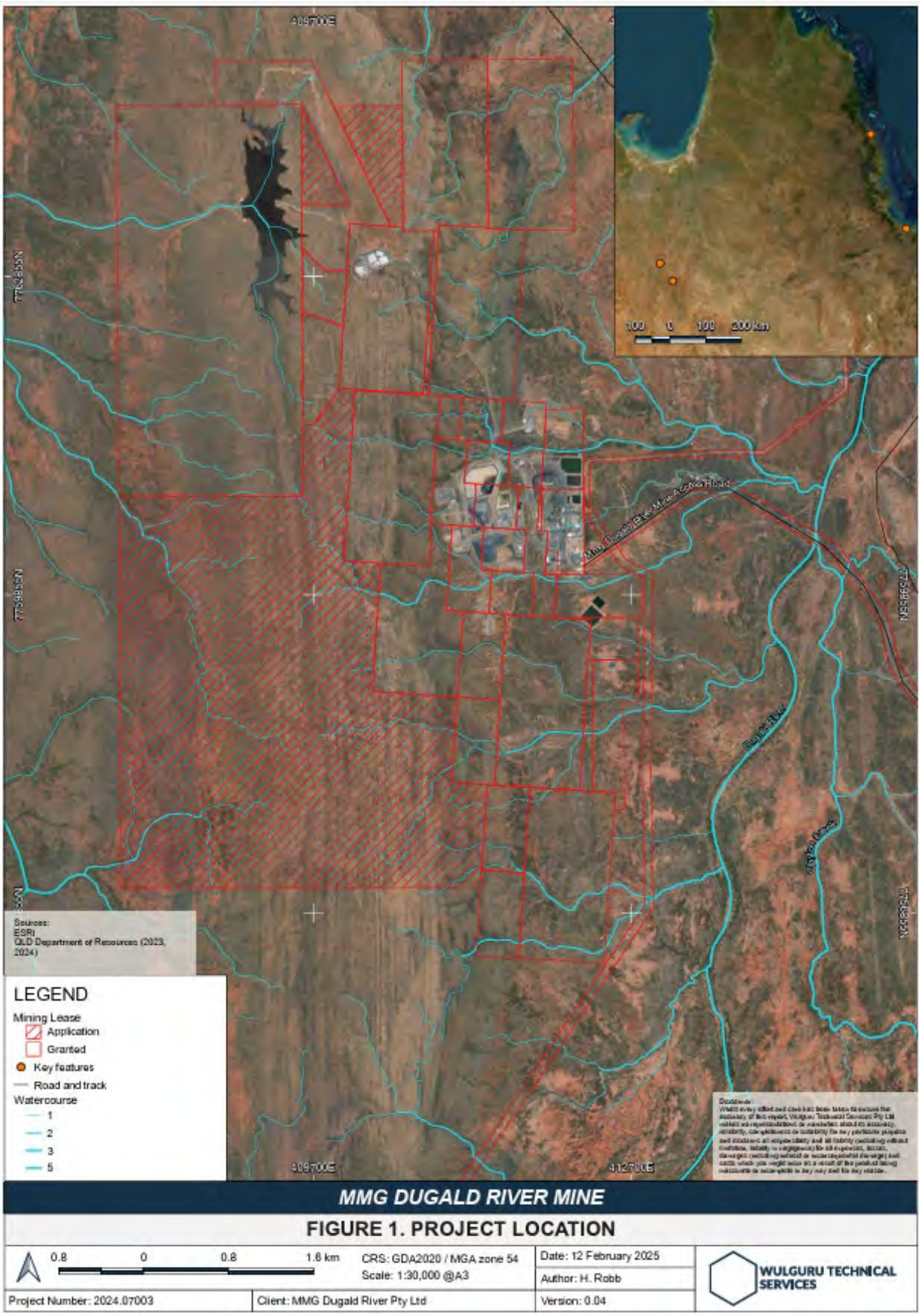
DRM is located approximately 63 km northwest of Cloncurry, in north-western Queensland (Figure 1).

The DRM ore body was discovered in the late 1900s following early small-scale mining and prospecting. The explorers identified gossanous zinc/ lead/ silver outcropping between two main drainage features on the plains below the Knapdale Range. Evidence of the outcropping is still visible within a demarcated area of the mines surface features. The surrounding area is littered with surficial copper oxide deposits as well as historic small scale mining features including waste dumps, collapsed shafts and rusted infrastructure (WTS, 2021).

Systematic exploration of the deposit began in the 1950s. Zinifex Australia Limited started the most recent phase of exploration in 2004 who subsequently began the process of gaining State and Federal approvals. During this period, the Project was purchased by Minerals and Metals Group (MMG) with approval being granted in 2012 and the first phase of construction (earth works, waste rock pads and dams and underground development) following in 2013. After a brief pause mid-construction to more thoroughly investigate the mining methodology, the Project was completed early 2017. MMG shipped the first parcel of zinc concentrate later that year (WTS, 2021).

Since 2017, the Project has continued to operate as an underground mine and processing facility. Approximately 13 million tonnes have been processed to date.

Figure 1. Project location



3.1.2. Mining Tenements

The project encompasses 40 mining leases and one mineral development lease, as detailed in Table 2. An additional three mining leases are proposed within the related EA amendment application, submitted April 2025.

Table 2. Granted tenures for the Dugald River Mine

Permit	Permit Name	Area (ha)	Land Tenure
MDL 79	NA	227.59	59TG40; 36AP23793; 92SP303378
ML 2467	DUGALD 1	16.21	27B15753; 36AP23793
ML 2468	DUGALD 2	16.21	27B15753; 35B15753; 36AP23793
ML 2469	DUGALD 3	16.2	35B15753; 36AP23793; 36B15753
ML 2470	DUGALD 4	16.19	36AP23793; 36B15753
ML 2471	DUGALD 5	16.19	36AP23793
ML 2477	DUGALD 6	32.51	36AP23793
ML 2478	DUGALD 7	129.49	36AP23793; 92SP303378
ML 2479	DUGALD 8	32.37	36AP23793; 92SP303378
ML 2480	DUGALD 9	32.37	36AP23793; 92SP303378
ML 2481	DUGALD 10	129.49	36AP23793; 92SP303378
ML 2482	DUGALD 11	32.37	36AP23793
ML 2496	DUGALD RIVER NO 6	129.49	36AP23793
ML 2497	DUGALD RIVER NO 7	8.09	36AP23793
ML 2498	DUGALD RIVER 8	29.06	36AP23793; 36B15753
ML 2499	DUGALD RIVER 9	28.08	36AP23793
ML 2500	DUGALD RIVER 10	28.35	36AP23793
ML 2501	DUGALD RIVER 11	30.4	36AP23793
ML 2502	DUGALD RIVER 12	31.63	36AP23793
ML 2556	CLANDESTINE 7	127.72	36AP23793; 92SP303378
ML 2557	CLANDESTINE 8	129.14	36AP23793
ML 2558	CLANDESTINE 13	128.5	36AP23793; 92SP303378
ML 2559	CLANDESTINE 14	98.7	36AP23793; 92SP303378
ML 2596	DUGALD RIVER 51	19	36AP23793
ML 2599	DUGALD RIVER 57	44.77	36AP23793; 92SP303378
ML 2601	DUGALD RIVER 61	28.5	36AP23793
ML 2638	KNAPDALE	122.51	36AP23793; 92SP303378
ML 2684	DUGALD NO 12	1.05	36AP23793
ML 2685	DUGALD NO 13	2.45	36AP23793
ML 7496	DUGULD	24.76	27B15753; 35B15753; 36AP23793
ML 90047	KNAPDALE NO 2	8.36	36AP23793
ML 90049	DUGALD SOUTH NO 7	0.31	36AP23793
ML 90050	DUGALD SOUTH NO 8	0.22	36AP23793
ML 90051	SCANLAN NO 6	9.59	36AP23793
ML 90211	DUGALD TSF	642.67	36AP23793; 92SP303378
ML 90212	DUGALD TXS1	100.48	36AP23793; 92SP303378
ML 90213	DUGALD TXS2	31.7	36AP23793; 92SP303378

Permit	Permit Name	Area (ha)	Land Tenure
ML 90218	DUGALD WPIPE	43.49	5AP23793; 36AP23793
ML 90220	DUGALD PLINE	507.93	2BD56; 3635SP274652; 36AP23793; 3AP23793; 4144SP256851; 521CP905413; 7CP905412; 91SP303378; 92SP303378
ML 90230	DACCESS	120.32	2577PH139; 36AP23793; 92SP303378; 211SP136468
ML 90237	DUGALD TXS3	20.5	36AP23793; 92SP303378
ML100383*	Dugald River Southwest	1075.4	36AP23793, 211SP136468, 2577PH139, 35B15753, 36AP23793, 92SP303378
ML 100359*	Dugald River Northwest	21.13	36AP23793, 211SP136468, 2577PH139, 35B15753, 36AP23793, 92SP303378
ML 100382*	Dugald River Northeast	43.53	36AP23793, 211SP136468, 2577PH139, 35B15753, 36AP23793, 92SP303378

**Subject to EA approval*

3.1.3. Underlying Landholders

The underlying landholders are shown in Table 3.

Table 3. Underlying landholder

Permit	Lot	Plan	Landholder
MDL 79, ML 2467, ML 2468, ML 2469, ML 2470, ML 2471, ML 2477, ML 2478, ML 2479, ML 2480, ML 2481, ML 2482, ML 2496, ML 2497, ML 2498, ML 2499, ML 2500, ML 2501, ML 2502, ML 2556, ML 2557, ML 2558, ML 2559, ML 2596, ML 2599, ML 2601, ML 2638, ML 2684, ML 2685, ML 7496, ML 90047, ML 90049, ML 90050, ML 90051, ML 90211, ML 90212, ML 90213, ML 90218, ML 90220, ML 90230, ML 90237	36	AP23793	Unallocated State Land
MDL 79, ML 2478, ML 2479, ML 2480, ML 2481, ML 2556, ML 2558, ML 2559, ML 2599, ML 2638, ML 90211, ML 90212, ML 90213, ML 90220, ML 90230, ML 90237, ML 100383, ML 100359, ML 100382	92	SP303378	Harold Henry McMillan
MDL 79, ML 90211	59	TG40	North Australian Pastoral Co Pty Ltd
ML 7496	27	B15753	MMG Australia Limited
ML 7496	35	B15753	MMG Australia Limited
ML 7496	36	B15753	MMG Australia Limited
ML 90230	211	SP136468	Queensland Rail

Permit	Lot	Plan	Landholder
ML 90220	521	CP05413	Jersey Plains Pastoral Company
ML 90220	3635	PH2175	Cameron Creek Pastoral Co Pty Ltd

3.1.4. Primary Mine Features and Infrastructure On-Site

The approved mine features, including proposed additional disturbances, are defined in Table 4.

Table 4. Mine features

Mine Domain	Mine Feature Name	Maximum Disturbance Area (hectares)
Ancillary Infrastructure and Services	Accommodation Village and sewage treatment plant	13.60
	Pipeline and Accommodation Village Road	6
	Communications tower	0.06
	Powerline	65.72
	Raw water pipeline	5.44
	Roads and Tracks	47.98
	Groundwater infrastructure	0.54
	Emergency response training area	0.5
	Tailing pipeline catch dam	0.16
Borrow Pits & Stockpiles	Topsoil Stockpile A	8.23
	Borrow Pit A	2.96
	Access Road Borrow Pit(s)	4.72
	TSF Borrow Pit A, TSF Borrow Pit B, TSF Stockpile	4.1
	TSF Borrow Pit C	9.23
	Topsoil Stockpile B	9.60
	Borrow Pit D	2.06
	Borrow Pit E	2.95
Dams and Diversion Structures	Diversion Drains	2.39
	Stage 2 PAF PAD Run Off Dam	11.60
	Underground Mine Water Collection Dam	0.65
	STP Dam Stage 1	0.9

Mine Domain	Mine Feature Name	Maximum Disturbance Area (hectares)
	STP Dam Stage 2	4
	ROM Area Run Off Dam	3.7
	Raw Water Dam	1.8
	Sediment Dam A	1.1
	Process Plant Run Off Dam	1.5
	Containment Dam	0.6
	Mine Workshop Run Off Dam	0.6
	Sediment Dam C	0.30
	Sediment Dam D	0.35
	Sediment Dam F	1.4
	Sediment Dam G	1.4
Exploration	Drill Pads*	10*
Mineralised Waste	NAF waste rock dump	8
	NAF waste rock dump bund	
	PAF waste rock dump (Stage 4)	14.56
Mining and Processing Area	West Laydown Area	10.3
	Waste Transfer Station	0.25
	Explosives magazine	0.6
	Fuel Storage	0.2
	Temporary Waste Laydown	1
	Construction Laydown, Warehouse, Mobile Equipment Laydown and Core Shed	6.8
	North decline	1
	South decline	1
	Ventilation shaft 1	0.05
	Ventilation shaft 2	0.05
	Ventilation shaft 3	0.05
	Ventilation shaft 4	0.05
	Ventilation shaft 5	0.05

Mine Domain	Mine Feature Name	Maximum Disturbance Area (hectares)
	Ventilation shaft 6	0.05
	Ventilation shaft 7	0.05
	Ventilation shaft 8	0.05
	Ventilation shaft 9	0.54
	Run of Mine (ROM) Pad	3.8
	ROM Haul Roads	3.53
	Processing Plant and Conveyor Area	13.53
	Switchyard 1	1.04
	Switchyard 2	0.99
	Exploration Camp and Camp Expansion Works	2.41
	Sewage Treatment Plants	0.16
	Workshop, Vehicle Washdown and Maintenance Area	3.8
	Office & Administration Buildings	2.72
	Laydown east	6.47
Tailings Storage Facility (TSF)	TSF and Seepage Collection Pond	103.51
	TSF Pipelines and Roads	6.37
Renewables	Wind Farm and Ancillary Infrastructure	27.86
	Laydown west	6.13
	Access Roads	33.08

*Exploration disturbance is conditioned by PRCP4 and not included in the total area defined in the PRCP Schedule

3.1.5. Pre-mining Land Use

The DRM is located on Roseby Station pastoral leases. Prior to the development of the operation, the area was used for cattle grazing. The site also contained several small, abandoned mine workings and previous exploration disturbance.

3.1.6. Communities

The nearest residential area is the McMillan family residence at Roseby Station, approximately 6 km from the operational area.

The DRM is located within the Mount Isa Mineral Province. This region is characterised by mineral exploration, mining and pastoral activities. Cloncurry is located 65 km southeast of the Project. Cloncurry's population is approximately 3,000 with the primary industries being cattle grazing and mining. The nearest regional centre is Mount Isa, located 80 km southwest of DRM. Mount Isa has a population of over 18,000 and is the administrative, commercial and industrial centre for north-western Queensland.

The Project ML area does not contain areas of regional interest (priority living areas, priority agricultural areas, strategic cropping land and strategic environmental areas) protected under the *Regional Planning Interests Act 2014* (DPI, 2024).

3.1.7. Native Title

The Kalkadoon Native Title Aboriginal Corporation (the Kalkadoon People) are the Registered Native Title Claimants of the land in and surrounding the Project.

Part of the southern section of the powerline to site is in the Mitakoodi and Mayi People's Native Title claim. The Mitakoodi and Mayi people have not achieved formal Native Title determination, however they are generally recognised to have ties to the areas directly surrounding the Cloncurry township.

A Cultural Heritage Management Agreement is in place for each group.

3.1.8. Type of Operations

The zinc/lead/silver ore is mined from underground by conventional mechanised methods (long hole open stoping and down hole benching methods). Ore and waste are drilled and blasted prior to excavation. The mine is accessed by twin declines that are also used to haul ore and waste from the mine.

The ore is processed onsite, then transported by rail to the Port of Townsville. Any tailings that are not transferred to the paste plant (to be used as paste fill underground) are disposed to the Tailings Storage Facility (TSF) via a 4 km pipeline.

Exploration drilling also occurs within the mining leases and on the mineral development lease. There is no other activity conducted on the mineral development lease.

3.1.9. Duration Of Operation

The Project began in 2018 and has a current Life of Mine (LoM) of 25 years (i.e. 2043). It is noted that this LoM has been revised from a previous date of 2047. The rehabilitation schedule has been amended to reflect the new LoM.

An approved rehabilitation schedule is provided in Appendix A, with works scheduled to commence in 2044. Where land becomes available for rehabilitation earlier than the nominated date, progressive rehabilitation will commence as soon as practical. A third-party review will be undertaken by an independent, appropriately qualified and experienced person annually, to review all authorised areas and assess availability for progressive rehabilitation. This review will be submitted to the administering authority within 10 business days of being requested. Within 90 days of the land becoming available for

rehabilitation, MMG will apply to the administering authority to amend the PRCP schedule in a way that maximises the progressive rehabilitation of the land to a stable condition, including bringing forward achievement of relevant milestones and criteria in the approved schedule.

Where progressive rehabilitation occurs, it is expected that at least one wet season will be needed to establish vegetation. As such each rehabilitation campaign is to be completed, at the latest, by October of each year to allow for vegetation establishment prior to the wet season and to minimise erosion potential.

3.1.10. Existing Environmental Context

3.1.10.1. Climate

3.1.10.1.1. Rainfall and Temperature

The Project is situated within the northwest highlands biogeographic region. The bioregion is characterised by distinctive wet and dry seasons with hot conditions and periods of rainfall between November to April, and relatively dry and mild conditions between May to October.

Statistics from the nearest Bureau of Meteorology weather station at the Cloncurry Airport (BOM Station ID 29141) generalise a 14°C spread of the mean monthly minimum and maximum daily temperatures during summer while increasing to 15°C in winter (Figure 2). The highest mean monthly temperatures are recorded in December and the lowest in July.

Most rainfall measured at the Cloncurry Airport is received between January and February with an annual average rainfall of 505 mm. With only 35 days where rainfall is ≥ 1mm, short and intense storm events are common (Table 5).

The predominant wind direction is south-southeast (Figure 3).

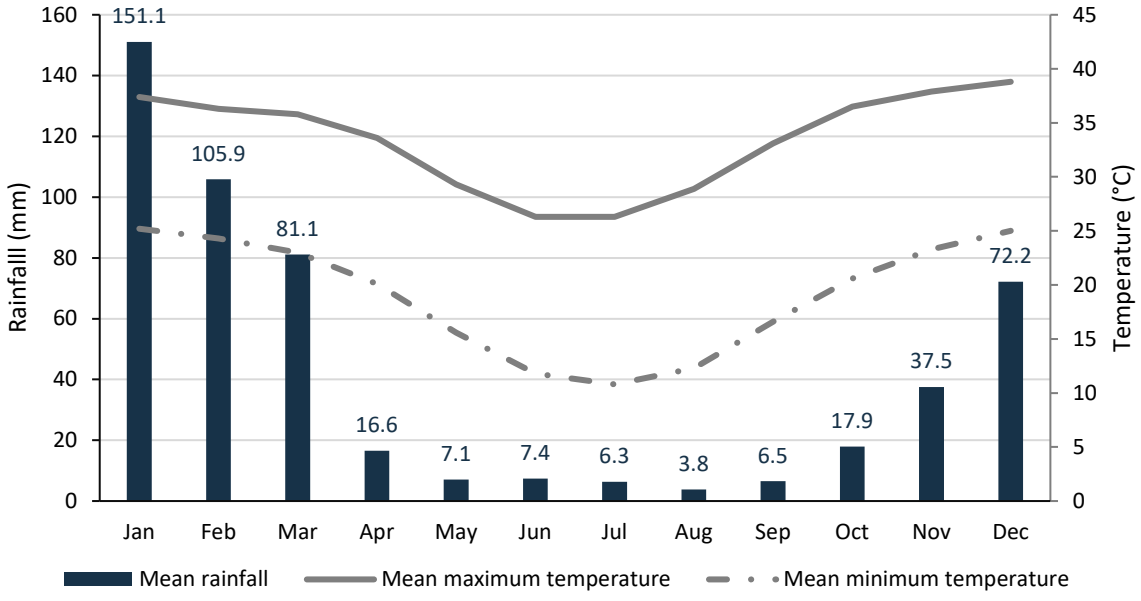


Figure 2. Climate statistics recorded at the Cloncurry Airport (BOM, 2024)

Table 5. Mean monthly rainfall recorded at the Cloncurry Airport (BOM, 2024)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean rainfall (mm)	151.1	105.9	74.1	15.1	7.1	7.4	6.3	3.8	6.5	17.9	37.5	72.2	502.3
Days ≥ 1mm	8.3	6.4	4.0	1.4	0.8	0.7	0.5	0.4	1.2	1.9	3.7	5.3	34.8

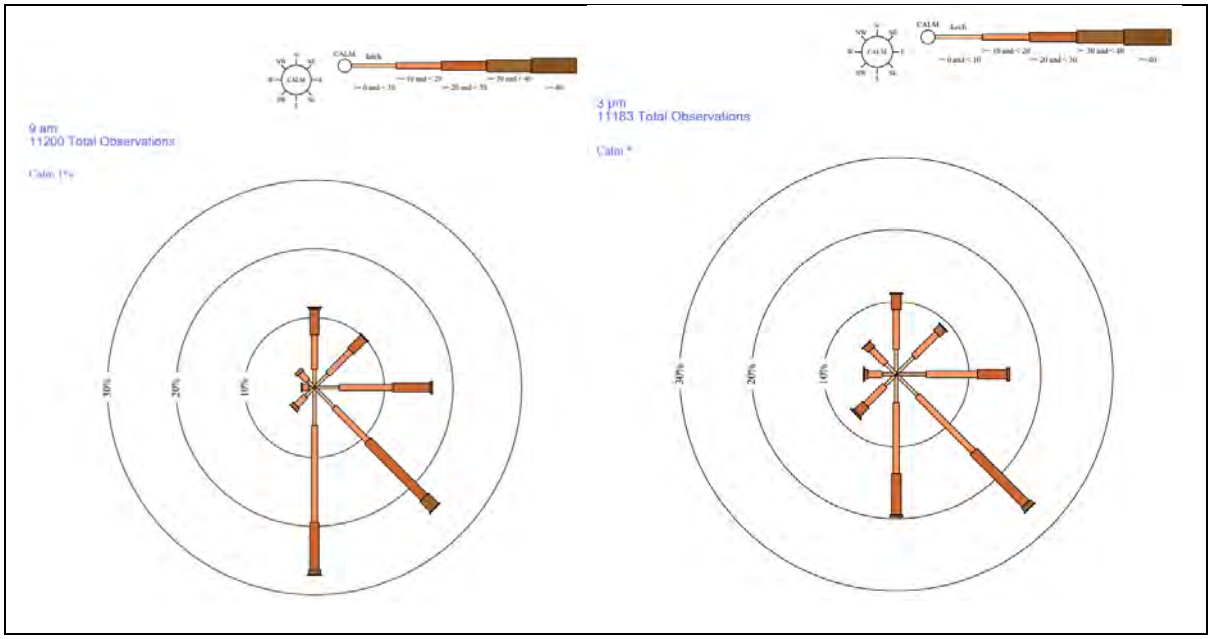


Figure 3. Cloncurry Airport 9am and 3pm wind rose (BOM, 2024)

3.1.10.1.2. Long-term Climate Projections

The 2024 State of the Climate Report (CSIRO & BOM, 2024) has predicted a continued increase in air temperatures, with more heat extremes and fewer cold extremes. There is a continued decrease, on average, in cool season rainfall across many regions of southern and eastern Australia, which will likely lead to more time in drought. Collectively, these contribute to an increase in the number of dangerous fire weather days and a longer fire season across eastern Australia. More intense short-duration heavy rainfall events even in regions where the average rainfall decreases or stays the same will contribute to increased flooding risk. Flooding risk may exacerbate erosion, impacting upon exposed or freshly rehabilitated surfaces.

3.1.10.2. Topography and Hydrology

3.1.10.2.1. Topography

The topography of the DRM is dominated by the Knapdale Range (Knapdales) as the topographical high (~310m Australian Height Datum (AHD)). The Knapdales is a north south orientated formation

~14km long and ~2.5km wide sharply transitioning to undulating country east to the Dugald River and west to Cabbage Tree Creek at ~200mAHD (Figure 4).

The mining and processing infrastructure is located on the eastern slope of the Knapdale Range with the Tailings Storage Facility (TSF) sited within the centre valley of the range, formerly draining to the west.

3.1.10.2.2. Hydrology

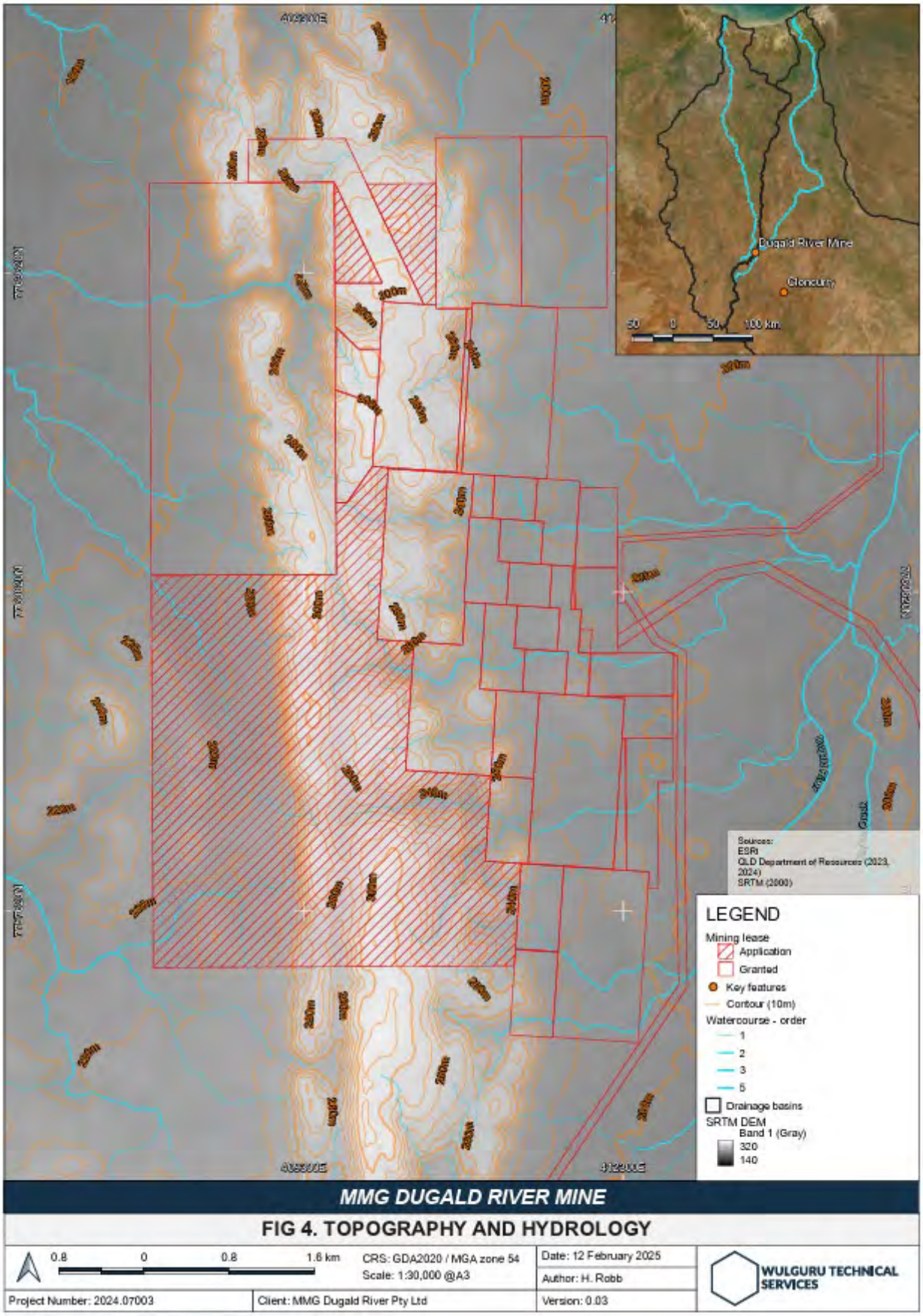
Regionally, DRM is situated in the Leichardt and Flinders drainage basins with the Knapdale Range providing the drainage divide between the two catchments (WRM, 2010). Both the Leichardt and Flinders Rivers drain north into the Gulf of Carpentaria ~400 km from the Project (Figure 4).

Locally, the Project area is dominated by stream order 1 and 2 ephemeral drainage features that only flow intermittently during wet season rains. To the north and west of the Knapdales, these features drain to Vieuex Rose Creek and Cabbage Tree Creek which flow into Pinnacle Creek, a tributary of the Leichardt River. Drainage to the east and south of the Knapdales enters the Flinders River via Dugald River, a tributary of the Cloncurry River (WTS, 2021). The catchments associated with the predominant mine features are listed in Table 6.

Table 6. Local catchments and mine features

Local catchment	Mine features
Silvermine Creek	Mining, processing, mineral waste storage, administration, mine access, village, and logistics
Vieuex Rose Creek	Village
Cabbage Tree Creek	Tailings storage facility

Figure 4. Topography and hydrology



3.1.10.3. Surface Water

3.1.10.3.1. Environmental Values

The Environmental Protection Policy (Water and Wetland Biodiversity) (EPP Water) details the scheduled water quality basins and their specific management intent. DRM is situated between the Leichardt and Flinders drainage basins with the Knapdale Range providing the drainage divide between the two catchments. No Environmental Values are listed in the EPP Water for either the Leichardt or Flinders drainage basins. In the absence of EVs for either catchment, the following EVs have been adopted from the EPP Water Part 3:

- For high ecological value waters—the biological integrity of an aquatic ecosystem that is effectively unmodified or highly valued; or
- For slightly disturbed waters—the biological integrity of an aquatic ecosystem that has effectively unmodified biological indicators, but slightly modified physical, chemical or other indicators; or
- For moderately disturbed waters—the biological integrity of an aquatic ecosystem that is adversely affected by human activity to a relatively small but measurable degree; or
- For highly disturbed waters—the biological integrity of an aquatic ecosystem that is measurably degraded and of lower ecological value than waters mentioned in paragraphs (a) to (c); or
- For waters from which aquatic foods intended for human consumption are taken—the suitability of the water for producing the foods for human consumption; or
- For waters that may be used for aquaculture—the suitability of the water for aquacultural use; or
- For waters that may be used for agricultural purposes—the suitability of the water for agricultural purposes; or
- For waters that may be used for recreation or aesthetic purposes—the suitability of the water for—
    - Primary recreational use; or
    - Secondary recreational use; or
    - Visual recreational use; or
- For waters that may be used for drinking water—the suitability of the water for supply as drinking water having regard to the level of treatment of the water; or
- For waters that may be used for industrial purposes—the suitability of the water for industrial use; or
- The cultural and spiritual values of the water (The State of Queensland, 2023).

3.1.10.3.2. Water Quality Trigger Limits

The EA provides receiving water reference sites and downstream monitoring locations (Schedule C – Table 4 of the EA) (Figure 5). Each site is monitored and sampled in accordance with Schedule C Table 5 of the EA, presented below in Table 7.

Table 7 Receiving waters trigger levels and contaminant limits (Schedule C - Table 5 of the EA)

Quality Characteristic[1]	Unit	Trigger Level [1, 10]	Contaminant Limit[1, 10, 12]	Monitoring Frequency
Hardness ($CaCO_3$)	mg/L	For interpretation purposes		Sites on tributaries of Dugald River: Sample daily for the first two days when releases or stream flows commence at interpretative sites. If releases or flows at interpretative sites persist, sample weekly until flow ceases. Dugald River Sites: Sample Dugald River sites daily while there is flows at DR-14, and daily for one week after cessation of flows at SC-38 and SN-23. Sample monthly if flows are present in Dugald River during the wet season. Cabbage Tree Creek sites: Sample CT3-08, CC-05 and CC-15 daily when flows are present at CT3-08 and sample CC-05 and CC-15 daily for two days after flows at CT3-08 cease.
pH	pH Units	6.0 (minimum) 8.6[13] (maximum)	5.5 (minimum) 9.0[13] (maximum)	
Electrical Conductivity	µS/cm	435 or 80th percentile of reference whichever is higher	1000	
Total Suspended Solids	mg/L	For interpretation purposes		
Sulfate	mg/L	77 [Duglad River] or 80th percentile of reference whichever is higher	400[4]	
Fluoride	mg/L	80th percentile of reference	2[3] or 95th percentile of reference[10] whichever is lower	
Aluminium (dissolved)	mg/L	0.055[2] or 80th percentile of reference whichever is higher	95th percentile of reference[10]	
Aluminium (total)	mg/L	For interpretation purposes		
Arsenic[8] (dissolved)	mg/L	0.013[2] or 80th percentile of reference whichever is higher	95th percentile of reference	
Arsenic (total)	mg/L	-	0.5[3]	

Quality Characteristic[1]	Unit	Trigger Level [1, 10]	Contaminant Limit[1, 10, 12]	Monitoring Frequency
Cadmium (dissolved)	mg/L	0.0002[2] or 80th percentile of reference whichever is higher	95th percentile of reference[10]	Sample CC-05 and CC-15 weekly if flows are present.
Cadmium (total)	mg/L	-	0.005[4]	
Copper (dissolved)	mg/L	0.0014[2] or 80th percentile of reference whichever is higher	95th percentile of reference[10]	
Copper (total)	mg/L	-	1[4]	
Lead (dissolved)	mg/L	0.0034[2] or 80th percentile of reference whichever is higher	95th percentile of reference[10]	
Lead (total)	mg/L	-	0.05[4]	
Manganese (dissolved)	mg/L	1.9[2] or 80th percentile of reference whichever is higher	95th percentile of reference[10]	
Manganese (total)	mg/L	For interpretation purposes		
Nickel (dissolved)	mg/L	0.011[2] or 80th percentile of reference whichever is higher	95th percentile of reference[10]	
Nickel (total)	mg/L	-	1[3]	
Zinc (dissolved)	mg/L	0.008[2] or 80th percentile of reference whichever is higher	95th percentile of reference[10]	
Zinc (total)	mg/L	-	20[3]	

[1] All metals and metalloids must be measured as both 'total' (from analysis of an unfiltered sample) and 'dissolved' (from analysis of a field filtered sample). All trigger levels are based on dissolved metal concentrations.

- Metals concentrations may be adjusted to the site-specific hardness in accordance with ANZECC 2000 (Section 3.4.3 and Table 3.4.3) as appropriate.

- If a filterable result exceeds the applicable trigger value, further analysis may be performed to quantify the dissolved component of the filtrate.

[2] Based on ANZG (2018).

[3] Based on ANZECC/ARMCANZ (2000) Table 4.3.2 for livestock drinking water.

[4] Based on ANZECC/ARMCANZ (2000) Table 5.2.3 for recreational purposes.

[8] Speciated arsenic concentrations for As (III) and As (V) only required if 13 mg/L is exceeded - note that the sample bottle requirements for As (total species) and As (speciated) may differ.

[9] 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.

[10] The contaminant limit '95th percentile of reference' is not applicable where the 95th percentile of reference site concentration is below the specified trigger level for the respective Quality Characteristic.

[11] Reference site concentration determined from reference sites specified in Schedule C – Table 6 (Receiving Water and Stream Sediment Reference Sites and Downstream Monitoring Points).

[12] Compliance at DR-18 and DR-22 is assessed when surface flows are present at either interpretive site SC-38 or SN-23

[13] Based on TropWATER Technical Memo – Recommended amendments to Dugald River Mine Environmental Authority EPML00731213 dated January 2020

3.1.10.3.3. Receiving Environment Monitoring Program

DRM implements a receiving environment monitoring program (REMP), that encompasses event-based surface water sampling, stream sediment sampling and macroinvertebrate and fish sampling.

REMP data collected to date indicates that the ephemeral sites on Silvermine Creek and Cabbage Tree Creek provide limited habitat opportunities for most aquatic organisms. Waterholes dry out too quickly to allow the establishment of sustained aquatic plant, macroinvertebrate or freshwater fish communities (TropWATER, 2020). The ephemeral waterholes are also too small and transient to have recreational value or provide watering points for terrestrial fauna.

The waterholes that form along the main channel of Dugald River are larger and semi-permanent. The waterholes periodically provide refugia for freshwater biological communities and provide a drinking water source for livestock and terrestrial fauna.

Overall, the waterholes assessed in the REMP are defined as being slightly to moderately disturbed, typical of waterways in free grazing areas (TropWATER, 2020).

3.1.10.3.4. Surface Water Quality

A summary of surface water chemistry is provided in Table 8.

Figure 5. Surface water monitoring

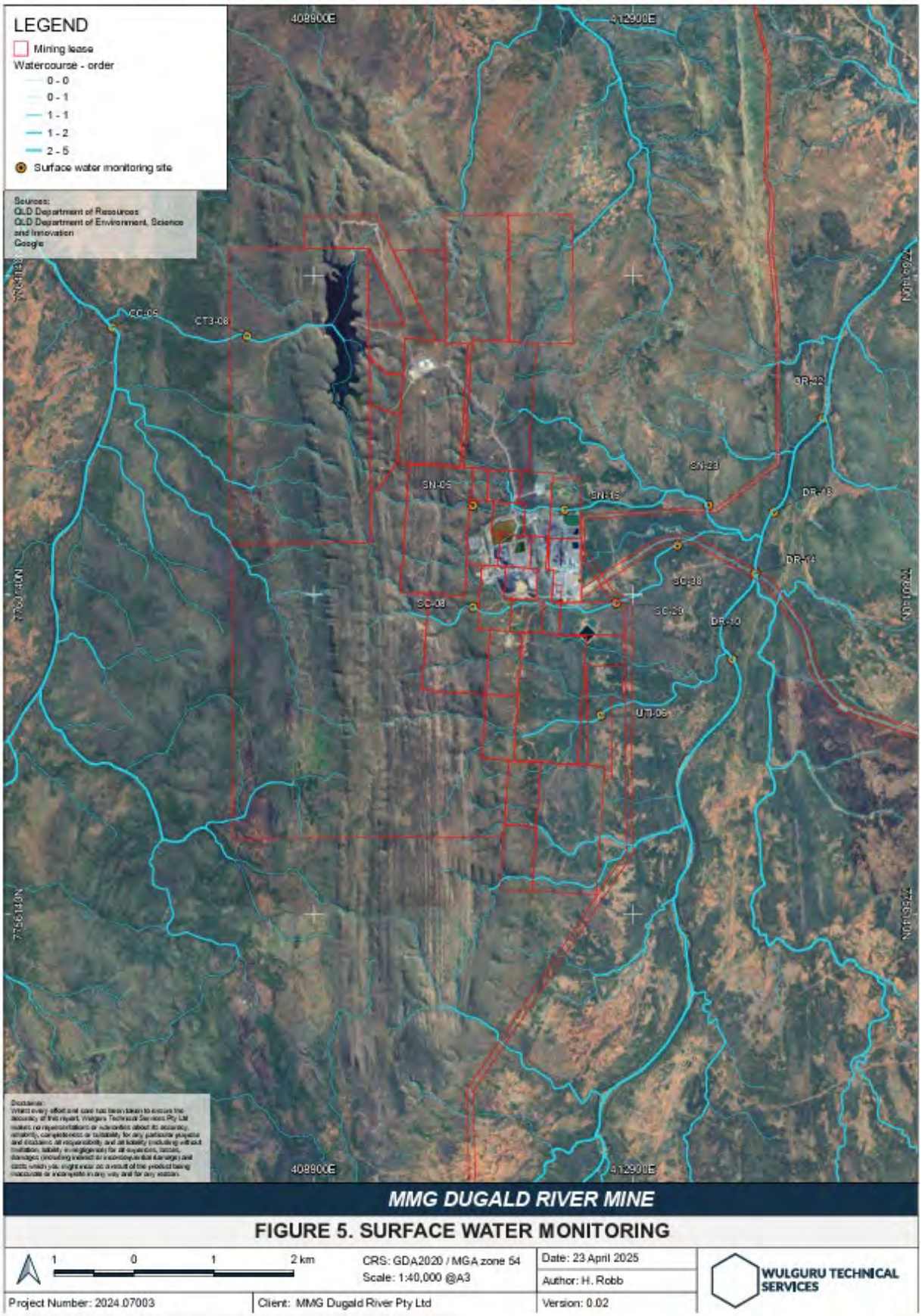


Table 8: Surface water chemistry 2020-2024

1		Hardness (mg/l)	pH	EC µS/cm	TSS (mg/l)	Sulphate (mg/l)	Fluoride (mg/l)	Total Metals (mg/l)								Filtered Metals (mg/l)							
								Al	As	Cd	Cu	Pb	Mn	Ni	Zn	Al	As	Cd	Cu	Pb	Mn	Ni	Zn
SC-08	Count	83	83	83	84	57	84	84	84	83	84	84	84	84	83	83	83	82	83	83	83	83	83
	Minimum	0.5	6.09	27	2.5	1	0.05	0.04	<0.001	<0.0001	0.001	0.001	0.00005	0.001	0.001	0.03	<0.001	<0.0001	0.001	0.001	0.001	0.001	0.003
	Maximum	48	8.6	365	78	26	0.5	4.17	<0.001	<0.0001	0.130	0.039	0.189	0.004	0.001	0.64	<0.001	<0.0001	0.003	0.016	0.067	0.001	0.019
	Mean	8.44	7.27	56.7	6.3	2.16	0.06	0.65	<0.001	<0.0001	0.004	0.002	0.02	0.001	0.001	0.15	<0.001	<0.0001	0.001	0.001	0.005	0.001	0.003
	Median	7.00	7.18	46.5	2.5	2.00	0.05	0.44	<0.001	<0.0001	0.002	0.001	0.01	0.001	0.001	0.11	<0.001	<0.0001	0.001	0.001	0.002	0.001	0.003
SN-05	Count	57	54	54	57	57	57	58	58	58	58	58	58	58	58	57	58	58	58	58	58	58	58
	Minimum	0.5	6.32	29.2	2.5	0.5	0.05	0.03	0.0005	0.00005	0.0005	0.0005	0.001	<0.001	0.0025	0.01	<0.001	0.00005	0.0005	0.0005	0.0005	0.0005	0.0025
	Maximum	47	8.38	172.6	20	17	0.5	1.24	0.002	0.0002	0.003	0.015	0.029	<0.001	0.082	0.89	<0.001	0.0002	0.002	0.006	0.026	0.003	0.048
	Mean	10.54	7.31	62	3.7	2.55	0.06	0.33	0.0005	0.0001	0.0008	0.001	0.006	<0.001	0.0087	0.13	<0.001	0.0001	0.0006	0.0007	0.004	0.0005	0.007
	Median	7	7.275	55.7	2.5	2	0.05	0.21	0.0005	0.00005	0.0005	0.0005	0.006	<0.001	0.0065	0.06	<0.001	0.00005	0.0005	0.0005	0.002	0.0005	0.0025
CT3-08	Count	47	44	44	48	48	48	49	49	49	49	49	49	49	49	48	48	48	48	48	48	49	48
	Minimum	9	6.28	49.7	2.5	0.5	0.05	0.005	0.0005	<0.0001	0.0005	0.0005	0.002	0.0005	0.0025	0.005	0.0005	<0.0001	0.0005	0.0005	0.0005	<0.001	0.0025
	Maximum	143	9.46	349.7	21	120	0.3	1.33	0.001	<0.0001	0.006	0.022	0.661	0.001	0.012	0.27	0.001	<0.0001	0.003	0.004	0.142	<0.001	0.009
	Mean	30	7.76	111.8	4.8	10.5	0.066	0.364	0.0006	<0.0001	0.0018	0.0015	0.056	0.0005	0.0036	0.0679	0.0005	<0.0001	0.0009	0.0007	0.0186	<0.001	0.0027
	Median	24	7.57	91.85	2.5	6	0.05	0.3	0.0005	<0.0001	0.002	0.0005	0.037	0.0005	0.0025	0.04	0.0005	<0.0001	0.001	0.0005	0.006	<0.001	0.0025
MS5	Count	15																					
	Minimum	7.00	6.56	39.00	2.50	1.00	<0.1	0.09	0.0005	0.0001	0.0010	0.0005	0.0080	0.0005	0.0025	0.0600	0.0005	0.0001	0.0005	0.0005	0.0005	0.0005	0.0025
	Maximum	45.00	7.66	126.00	107.00	20.00	<0.1	3.96	0.0040	0.0003	0.0360	0.0430	0.2030	0.0050	0.1590	0.6400	0.0020	0.0002	0.0110	0.0050	0.1490	0.0010	0.0350
	Mean	27.60	6.99	88.20	19.23	10.00	<0.1	0.94	0.0013	0.0001	0.0079	0.0084	0.0542	0.0014	0.0438	0.2636	0.0007	0.0001	0.0032	0.0017	0.0316	0.0005	0.0149
	Median	28.00	6.97	89.00	5.00	11.00	<0.1	0.49	0.0010	0.0001	0.0030	0.0040	0.0280	0.0005	0.0280	0.2100	0.0005	0.0001	0.0020	0.0010	0.0160	0.0005	0.0120
UT1-06	Count	12			13																		
	Minimum	9.00	6.43	39.00	2.50	0.50	0.05	0.06	<0.001	<0.0001	0.0005	<0.001	0.0020	0.0005	0.0025	0.0400	0.0005	<0.0001	0.0010	0.0005	0.0010	<0.001	<0.005
	Maximum	32.00	7.72	103.00	21.00	2.00	0.20	0.75	<0.001	<0.0001	0.0080	<0.001	0.0770	0.0010	0.0060	0.5000	0.0010	<0.0001	0.0060	0.0010	0.0700	<0.001	<0.005
	Mean	17.3	7.02	61.83	4.92	0.92	0.06	0.30	<0.001	<0.0001	0.0037	<0.001	0.0145	0.0005	0.0028	0.2200	0.0006	<0.0001	0.0028	0.0005	0.0111	<0.001	<0.005
	Median	17.00	7.04	56.50	2.50	1.00	0.05	0.19	<0.001	<0.0001	0.0030	<0.001	0.0070	0.0005	0.0025	0.2000	0.0005	<0.0001	0.0020	0.0005	0.0060	<0.001	<0.005
SN-15	Count	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
	Minimum	2	6.75	43.35	2.5	2	0.05	0.01	0.0005	0.00005	0.0005	0.0005	0.004	0.0005	0.0025	0.005	0.0005	0.00005	0.0005	0.0005	0.0005	<0.001	0.0025
	Maximum	119	9.01	319.1	136	68	0.5	6.03	0.007	0.0004	0.019	0.046	0.291	0.006	0.291	0.48	0.002	0.0002	0.008	0.02	0.064	<0.001	0.07
	Mean	43.8	7.67	130.1	12.21	15	0.085	0.755	0.001	0.0001	0.003	0.007	0.034	0.0009	0.044	0.09	0.0006	0.0001	0.001	0.0018	0.010	<0.001	0.017
	Median	36.5	7.58	121.25	2.5	10	0.05	0.28	0.0005	0.00005	0.002	0.004	0.012	0.0005	0.023	0.03	0.0005	0.00005	0.001	0.0005	0.006	<0.001	0.01
SN-23	Count	40	39	39	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
	Minimum	7	6.87	42.4	2.5	0.5	0.05	0.005	0.0005	0.00005	0.0005	0.0005	0.004	0.0005	0.0025	0.005	<0.001	0.00005	0.0005	0.0005	0.0005	<0.001	0.0025

1		Hardness (mg/l)	pH	EC µS/cm	TSS (mg/l)	Sulphate (mg/l)	Fluoride (mg/l)	Total Metals (mg/l)								Filtered Metals (mg/l)							
								Al	As	Cd	Cu	Pb	Mn	Ni	Zn	Al	As	Cd	Cu	Pb	Mn	Ni	Zn
	Maximum	73	9.73	224	30	32	0.1	1.28	0.001	0.0002	0.024	0.035	0.175	0.001	0.102	0.4	<0.001	0.0001	0.009	0.011	0.1	<0.001	0.033
	Mean	48.6	7.56	135.49	7.67	12.76	0.053	0.44	0.0005	0.00007	0.0053	0.0034	0.0345	0.0006	0.018	0.063	<0.001	0.0001	0.0024	0.001	0.0159	<0.001	0.0069
	Median	50	7.5	139.5	2.5	13	0.05	0.42	0.0005	0.00005	0.003	0.002	0.0195	0.0005	0.01	0.0075	<0.001	0.00005	0.002	0.0005	0.003	<0.001	0.0025
SC-38	Count	54	52	52	54	53	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
	Minimum	7.0	7.04	44	2.5	2	0.050	0.005	0.001	0.0001	0.001	0.001	0.005	0.001	0.003	0.005	0.001	0.0001	0.001	0.001	0.001	<0.001	0.003
	Maximum	156	8.20	404	88	109	0.100	3.49	0.008	0.0008	0.028	0.043	0.219	0.004	0.568	0.720	0.002	0.0006	0.010	0.005	0.157	<0.001	0.438
	Mean	43.6	7.43	132	8.65	20.6	0.056	0.756	0.001	0.0001	0.005	0.005	0.039	0.001	0.081	0.078	0.001	0.0001	0.002	0.001	0.011	<0.001	0.045
	Median	34	7.36	103	2.5	12	0.050	0.525	0.001	0.0001	0.003	0.003	0.028	0.001	0.036	0.020	0.001	0.0001	0.002	0.001	0.002	<0.001	0.013
DR-10	Count	215	195	194	215	216	216	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217
	Minimum	0.5	6.4	5.92	2.5	0.5	0.05	0.005	0.0005	0.00005	0.0005	0.0005	0.00005	0.0005	0.0025	0.005	0.0003	0.00005	0.0005	0.00005	0.0005	0.0005	0.0014
	Maximum	381	8.7	1000	702	104	0.9	38.4	0.005	0.0013	0.119	0.041	2.43	0.039	0.207	0.57	0.002	0.0003	0.006	0.005	0.122	0.019	0.102
	Mean	79.5	7.73	235	54	6.15	0.16	3.18	0.0008	0.0001	0.0094	0.0019	0.1706	0.0031	0.0084	0.0616	0.0005	0.0001	0.0018	0.0005	0.0109	0.0006	0.0032
	Median	61	7.72	170	11	3	0.2	1.14	0.0005	0.00005	0.004	0.0005	0.107	0.001	0.0025	0.005	0.0005	0.00005	0.002	0.0005	0.001	0.0005	0.0025
DR-14	Count	259	236	235	261	260	261	262	262	262	262	262	262	262	261	262	262	262	262	262	262	262	262
	Minimum	0.5	6.2	41.9	2.5	0.15	0.05	0.005	0.0005	0.00005	0.0005	0.0005	0.00005	0.0005	0.0025	0.0025	0.0005	0.00005	0.0005	0.00005	0.0005	0.0005	0.0025
	Maximum	297	8.93	1027	1030	46	0.5	41.9	0.004	0.0007	0.121	0.021	1.99	0.043	0.09	0.64	0.001	0.0001	0.01	0.005	0.69	0.019	0.1
	Mean	80.02	7.72	250.50	60.53	6.13	0.16	3.05	0.0007	0.0001	0.0092	0.0018	0.1758	0.0028	0.0068	0.0756	0.0005	0.0001	0.0020	0.0005	0.0227	0.0006	0.0034
	Median	60	7.7	171.4	14	3	0.2	1.195	0.0005	0.00005	0.00445	0.0005	0.1305	0.001	0.0025	0.005	0.0005	0.00005	0.002	0.0005	0.004	0.0005	0.0025
CC-05	Count	51	48	48	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
	Minimum	7	7.06	84.4	2.5	0.5	0.05	0.005	0.0005	0.00005	0.0005	0.0005	0.003	0.0005	0.0025	0.005	<0.001	<0.0001	0.0005	<0.001	0.0005	0.0005	0.0025
	Maximum	181	8.95	541	545	27	0.6	15.3	0.002	0.0001	0.03	0.012	0.99	0.018	0.038	1.02	<0.001	<0.0001	0.003	<0.001	0.11	0.001	0.008
	Mean	84.59	7.94	279.76	27.79	4.65	0.26	1.25	0.0005	0.0001	0.0035	0.0010	0.0852	0.0017	0.0057	0.0570	<0.001	<0.0001	0.0012	<0.001	0.0126	0.0005	0.0026
	Median	78	7.95	262.7	7	4	0.2	0.38	0.0005	0.00005	0.002	0.0005	0.05	0.0005	0.0025	0.005	<0.001	<0.0001	0.001	<0.001	0.003	0.0005	0.0025
DR-18	Count	244	221	220	245	244	245	245	245	245	245	245	245	245	245	245	245	245	245	245	245	245	245
	Minimum	14	7.09	52.9	2.5	0.15	0.05	0.005	0.0005	0.00005	0.0005	0.00034	0.00005	0.0005	0.0025	0.0025	0.0005	<0.0001	0.0005	0.00005	0.0005	0.0005	0.0025
	Maximum	332	8.85	1103	638	51	1.2	29.9	0.005	0.0012	0.089	0.026	1.12	0.024	0.212	0.7	0.002	<0.0001	0.006	0.002	0.47	0.002	0.08
	Mean	84.44	7.75	256.27	58.09	7.15	0.17	2.78	0.0008	0.0001	0.0084	0.0017	0.1773	0.0026	0.0073	0.0655	0.0005	<0.0001	0.0018	0.0005	0.0197	0.0005	0.0033
	Median	64.5	7.71	178.4	18	4	0.2	1.1	0.0005	0.00005	0.004	0.0005	0.136	0.001	0.0025	0.005	0.0005	<0.0001	0.002	0.0005	0.003	0.0005	0.0025
DR-22	Count	243	220	219	244	243	244	245	245	245	245	245	245	245	244	245	245	245	245	245	245	245	245
	Minimum	0.5	6.77	52.9	2.5	0.15	0.05	0.005	0.0005	0.00005	0.0005	0.0005	0.00005	0.0005	0.0025	0.0025	0.0005	0.00005	0.0005	0.00005	0.0005	0.0005	0.0005
	Maximum	318	8.91	1010	573	42	0.7	25.3	0.004	0.0003	0.4	0.02	1.53	0.022	0.065	0.61	0.002	0.0002	0.005	0.005	4	0.004	0.1

1		Hardness (mg/l)	pH	EC µS/cm	TSS (mg/l)	Sulphate (mg/l)	Fluoride (mg/l)	Total Metals (mg/l)								Filtered Metals (mg/l)							
								Al	As	Cd	Cu	Pb	Mn	Ni	Zn	Al	As	Cd	Cu	Pb	Mn	Ni	Zn
	Mean	76.63	7.72	229.26	51.06	5.75	0.156	2.768	0.00075	0.00005	0.01	0.0017	0.173	0.003	0.007	0.072	0.0005	0.0001	0.0018	0.0005	0.031	0.0005	0.003
	Median	56	7.69	161.5	15	3	0.1	1.06	0.0005	0.00005	0.004	0.0005	0.121	0.001	0.0025	0.01	0.0005	0.00005	0.002	0.0005	0.003	0.0005	0.0025
CC-15	Count	61	55	55	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61
	Minimum	24	7.12	54.1	2.5	0.5	0.05	0.005	0.0005	0.00005	0.0005	0.0005	0.02	0.0005	0.0025	0.005	0.0005	0.00005	0.0005	<0.001	0.0005	0.0005	0.0025
	Maximum	240	8.71	534	1520	13	0.6	45.7	0.002	0.0001	0.081	0.022	1.51	0.046	0.061	0.38	0.001	0.0001	0.005	<0.001	0.537	0.001	0.005
	Mean	93.62	7.94	258.75	52.33	4.37	0.23	2.06	0.0005	0.0001	0.0049	0.0013	0.1157	0.0025	0.0056	0.0317	0.0005	0.0001	0.0011	<0.001	0.0323	0.0005	0.0025
	Median	77	7.9	236.3	7	3	0.2	0.44	0.0005	0.00005	0.002	0.0005	0.049	0.0005	0.0025	0.005	0.0005	0.00005	0.001	<0.001	0.001	0.0005	0.0025

3.1.10.4. Groundwaters

3.1.10.4.1. Groundwater Occurrence and Hydrostratigraphy

Groundwater storage and flow at the DRM primarily occur within the fractured zone of unweathered metasedimentary rocks, predominantly through secondary porosity features such as fractures and joints. The Mount Roseby Schist is the prime aquifer, with fracturing extending to approximately 70 m deep and up to 200 m deep in some locations.

The hydrostratigraphic units of the Project are described in Table 9.

Table 9. Hydrostratigraphic units (CDM Smith, 2024)

Hydrostratigraphic Unit	Location	Hydrogeological Behaviour
Unconsolidated sediments	In patchy coverage, mostly found in the lower landscape such as along the courses of Dugald River and Cabbage Tree Creek.	May host aquifers where present and saturated; however with limited distribution and likely to be unsaturated
Mount Roseby Schist	To the east of the Knapdale Range, around the mine area.	Relative aquifer – fractured rock aquifer, with heterogenous behaviour. Fracturing typically down to 70 m below ground. Note that the calc-silicate facies is most likely to permit groundwater storage and flow
Coocerina Formation and Lady Clayre Formation	To the west of the Knapdale Range, at Cabbage Tree Creek.	Unknown behaviour, presume similar to the Mount Roseby Schist.
Knapdale Quartzite	In the Knapdale Range, including underlying the TSF.	Largely tight aquitard, with some fractured rock groundwater occurrences. Fracturing mostly within the upper 10 m.
Corella Formation	Deep underlying the constituent units of the Mount Albert Group.	Limited information, but presumed to be the hydrogeological basement as it occurs at great depth in the Project area.

3.1.10.4.2. Groundwater Recharge and Discharge

Evaporation at the Project exceeds rainfall, however recharge allows water levels to rise. Mount Roseby Schist groundwater monitoring bores experience seasonal variations in water levels which are consistent with rainfall patterns of the region. Recharge occurs primarily via diffuse recharge from rainfall, however during flow events of ephemeral creeks, enhanced recharge occurs along these watercourses with infiltration through creek beds. Recharge from rainfall predominantly occurs in the Knapdale Ranges and other elevated areas, and where rainfall exceeds evaporation. The preferential recharge zone of the Project is anticipated at the base of the ridge at the Knapdale Range and close to

the geologic contact with the Mount Roseby Schist. Recharge rates at the Project are estimated as low, comprising approximately 2% of rainfall received, or 10 mm/year (CDM Smith, 2024).

As groundwater is deeper than 4 m below ground level, baseflow is unlikely to occur and natural groundwater discharge does not occur in the vicinity of the DRM. Seasonal fluctuations in water levels may allow baseflow discharges to lower reaches of unnamed tributary creeks. During unusually wet years, groundwater levels may rise sufficiently to provide baseflow, such as through bank storage processes, to allow creeks to persist for several weeks. Outside of these rare occurrences, groundwater discharge is expected to only occur downstream after very long flow paths and residence times (given the low permeability) to Dugald River and Cabbage Tree Creek (CDM Smith, 2024).

3.1.10.4.3. Groundwater Flow

In the vicinity of the DRM, groundwater flows in the topographic direction from west to east towards and along tributaries of the Dugald River, namely North Creek and Silvermine Creek. To the west of the DRM, groundwater is also expected to flow in the topographic direction from east to west towards Cabbage Tree Creek. The elevated terrain in the Knapdale Ranges forms a groundwater divide, estimated to be along the topographic divide, with the TSF located west of the divide and only permitting seepage towards the west. It is likely that to the north of the TSF, groundwater flows in northernly/northeasterly directions towards other tributaries of Cabbage Tree Creek. The conceptual hydrogeological model at the DRM is presented in Figure 6 (CDM Smith, 2024).

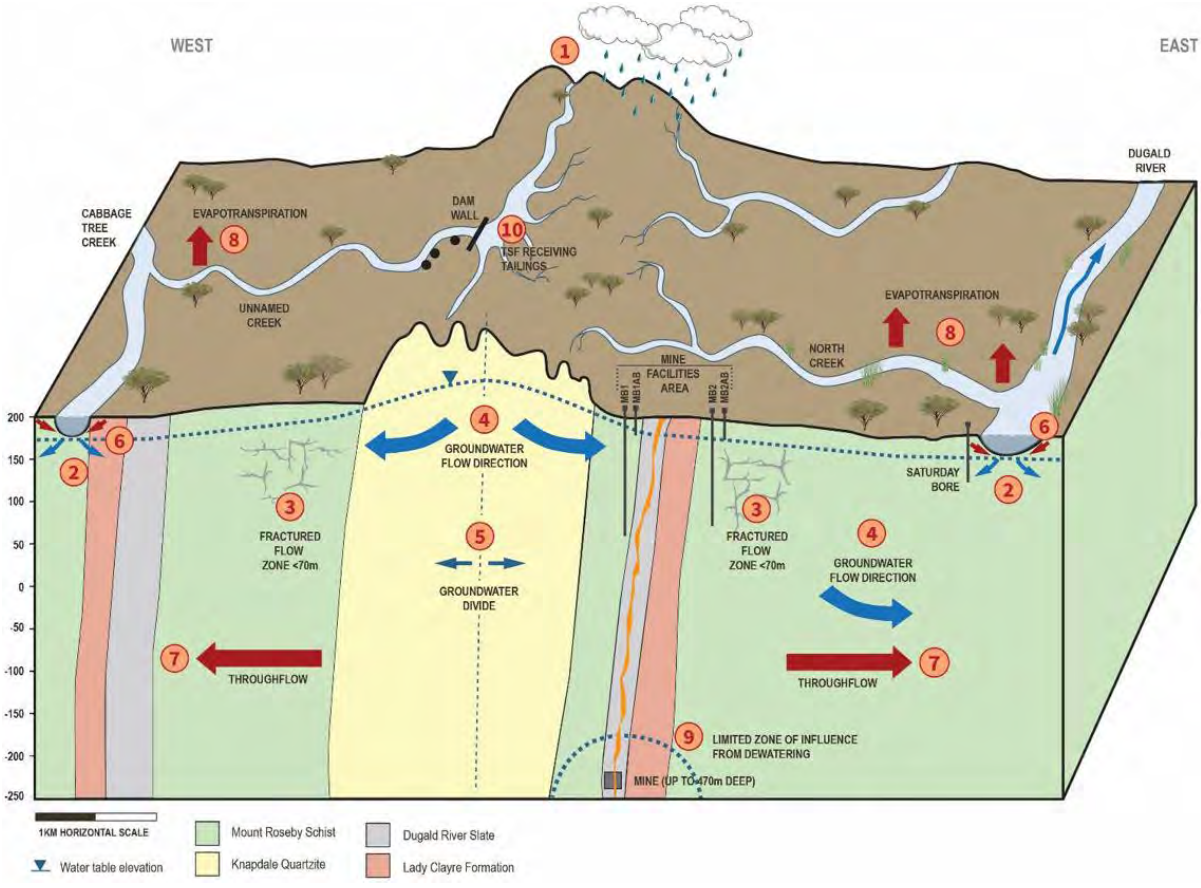


Figure 6. Conceptual hydrogeological model (CDM Smith, 2024)

3.1.10.4.4. Groundwater Users

There are no groundwater users within vicinity of the DRM TSF; registered bores within this area are monitoring bores associated with the DRM and its TSF. MMG do not extract groundwater for use on-site, rather raw water is sourced from Lake Julius.

Groundwater is not used for stock and domestic bores in the area of the DRM. Approximately 8 km to the north of the TSF, groundwater bores in alluvial deposits are used to supply water for cattle grazing. After excluding the bores associated with DRM, the nearest registered bores are over 3 km to the northeast and northwest, and well outside the DRM tenement areas. The registered bores beyond DRM operations may be associated with both industrial and agricultural activities (CDM Smith, 2024).

3.1.10.4.5. Groundwater – Surface Water Interaction

When ephemeral creeks are flowing, they become sites for enhanced recharge via infiltration through creek beds. Groundwater discharge in the form of temporary baseflow is possible in lower reaches of the watercourses when groundwater levels have sufficiently risen. Bank storage processes may operate, allowing ephemeral watercourses to temporarily persist following rain events. As such, there is only a short duration of groundwater-surface water interaction, consisting of a phase of recharge followed by a phase of discharge. During standard conditions, there is no groundwater-surface water interaction (CDM Smith, 2024).

3.1.10.4.6. Groundwater Dependent Ecosystems

The Bureau of Meteorology (BOM) Groundwater Dependent Ecosystem (GDE) Atlas indicates a low to moderate potential for terrestrial GDEs to be present across the Project area. This suggests that vegetation may access shallow groundwater. This may occur when the groundwater is close to the surface, such as in the Cabbage Tree Creek valley. In the Knapdale Range, water that infiltrates into fractures may be absorbed by vegetation; minimal volumes may be intercepted and therefore do not percolate deep enough to reach elevations beneath the topographic ridge (CDM Smith, 2024).

There is a low potential for aquatic GDEs within Cabbage Tree Creek and Dugald River; GDEs are not identified in tributaries. The highly ephemeral waterways do not support specialised riparian vegetation nor habitat for aquatic fauna, as the hydraulic habitats are too transient. Given that watercourses are non-perennial, and there is only a low potential for aquatic GDEs to be present, it is likely that any aquatic ecosystems would only be fed by groundwater when the water table is temporarily elevated to allow groundwater discharge. This suggests it is unlikely for aquatic ecosystems to be GDEs within vicinity of the Project (CDM Smith, 2024).

3.1.10.4.7. Environmental Values

The most relevant EVs were derived from the EPP (Water and Wetland Biodiversity) 2019 which include:

- For waters that may be used for agricultural purposes – the suitability of the water for agricultural purposes;
- For waters that may be used for recreation or aesthetic purposes – the suitability of water for:

- Primary recreational use; or
- Secondary recreational use; or
- Visual recreational use

- For water that may be used for drinking water – the suitability of the water for supply as drinking water having regard to the level of treatment of the water;
- For waters that may be used for industrial purposes – the suitability of the water for industrial use; or
- The cultural and spiritual values of the waters.

3.1.10.4.8. Groundwater Monitoring Network

The groundwater monitoring network is described in Table 10 and in Figure 7. The groundwater monitoring program focusses on risk associated with the mine infrastructure area. Several bores are located to the west of the Knapdale Range (MB5, MB6, MB9S and MB9D) to monitor for potential impacts from the TSF.

Table 10. Groundwater bore details

Bore	Formation	EA classification	Permeability
MB1	Mount Roseby Schist	Background	7.53×10^{-6}
MB3	Mount Roseby Schist	Background	2.60×10^{-1}
MB5	Mount Roseby Schist	Compliance	9.21×10^{-2}
MB6	Mount Roseby Schist	Compliance	2.23×10^{-3}
MB9S	Knapdale Quartzite	Compliance	No data
MB9D	Knapdale Quartzite	Compliance	No data
MB2	Mount Roseby Schist	Compliance	4.08×10^{-1}
MB4	Mount Roseby Schist	Compliance	7.52×10^{-2}
GWBFAB	Dugald River Slate	Interpretation	No data
MB1AB	Mount Roseby Schist	Interpretation	No data
MB2AB	Mount Roseby Schist	Interpretation	No data
MB3AB	Mount Roseby Schist	Interpretation	No data
MB4AB	Mount Roseby Schist	Interpretation	No data
SHALL6AB	Mount Roseby Schist	Interpretation	No data

3.1.10.4.9. Groundwater Trigger Limits

EA Schedule C – Table 8 specifies the groundwater quality trigger levels and contaminant limits for DRM. This is replicated in Table 11. Summary statistics of the groundwater monitoring bores at the Project from 2009 to 2024 are detailed in Table 12.

Table 11. Groundwater trigger levels and contaminant limits (EPML00731213)

Quality Characteristic[1]	Unit	Trigger Level[1]	Contaminant limit[2]
pH	pH unit	6.0 (minimum) 8.0 (maximum	6.0 (minimum) 9.0 (maximum)
Electrical Conductivity	µS/cm	1500[6]	2000[6]
Hardness (as $CaCO_3$)	mg/L	For interpretation purposes	
Total Dissolved Solids (TDS)	mg/L	For interpretation purposes	
Major ions	mg/L	For interpretation purposes	
Sulphate (mg/L)	mg/L	150[6]	1000[5]
Fluoride (mg/L)	mg/L	-	2[4]
Aluminium	mg/L	0.055[3, 11]	5[4]
Arsenic[7]	mg/L	0.013[3, 11]	0.5[4]
Cadmium (mg/L)	mg/L	0.0002[3, 11]	0.01[4]
Copper (mg/L)	mg/L	0.0014[3]	1[4]
Lead (mg/L)	mg/L	0.0034[3, 11]	0.1[4]
Manganese (mg/L)	mg/L	1.9[3, 11]	-
Nickel (mg/L)	mg/L	0.011[3, 11]	1[4]
Zinc (mg/L)	mg/L	0.008[3, 11]	20[4]

[1] All metals and metalloids must be measured as filtered with the exception of fluoride.

[2] All metals and metalloids must be measured as total (unfiltered).

[3] Based on ANZG (2018)..

[4] Based on ANZECC/ARMCANZ (2000) Table 4.3.2 for livestock drinking water.

[5] Based on ANZECC/ARMCANZ (2000) Section 4.3.3.4;

[6] MMG Dugald River - site specific value

[7] Speciated arsenic concentrations for As (III) and As (V) only required if 13 mg/L is exceeded - note that the sample bottle requirements for As (total species) and As (speciated) may differ.

[11] Where appropriate, the default trigger values may be hardness adjusted in accordance with ANZG (2018).

3.1.10.4.10. Groundwater Quality

A groundwater impact assessment (CDM Smith, 2025) was recently undertaken to review groundwater quality across the Project. Groundwater chemistry is summarised as follows:

- Most groundwater has a close to neutral pH ranging between 6.03 and 8.4.
- Salinity ranges from <100 mg/l to approximately 12,000 mg/l. The variable salinity occurs through change over time. The median salinity for each bore is generally between 400–1,900 mg/l.

- The ionic composition is bicarbonate dominant except for MB3 which is sulfate dominant. The water quality is described as suitable for stock watering and marginally potable at some locations.
- The average concentration of most metals are below trigger levels, with exception of copper and zinc. All average concentrations of metals are below the contaminant limits.

Figure 7. Groundwater monitoring network

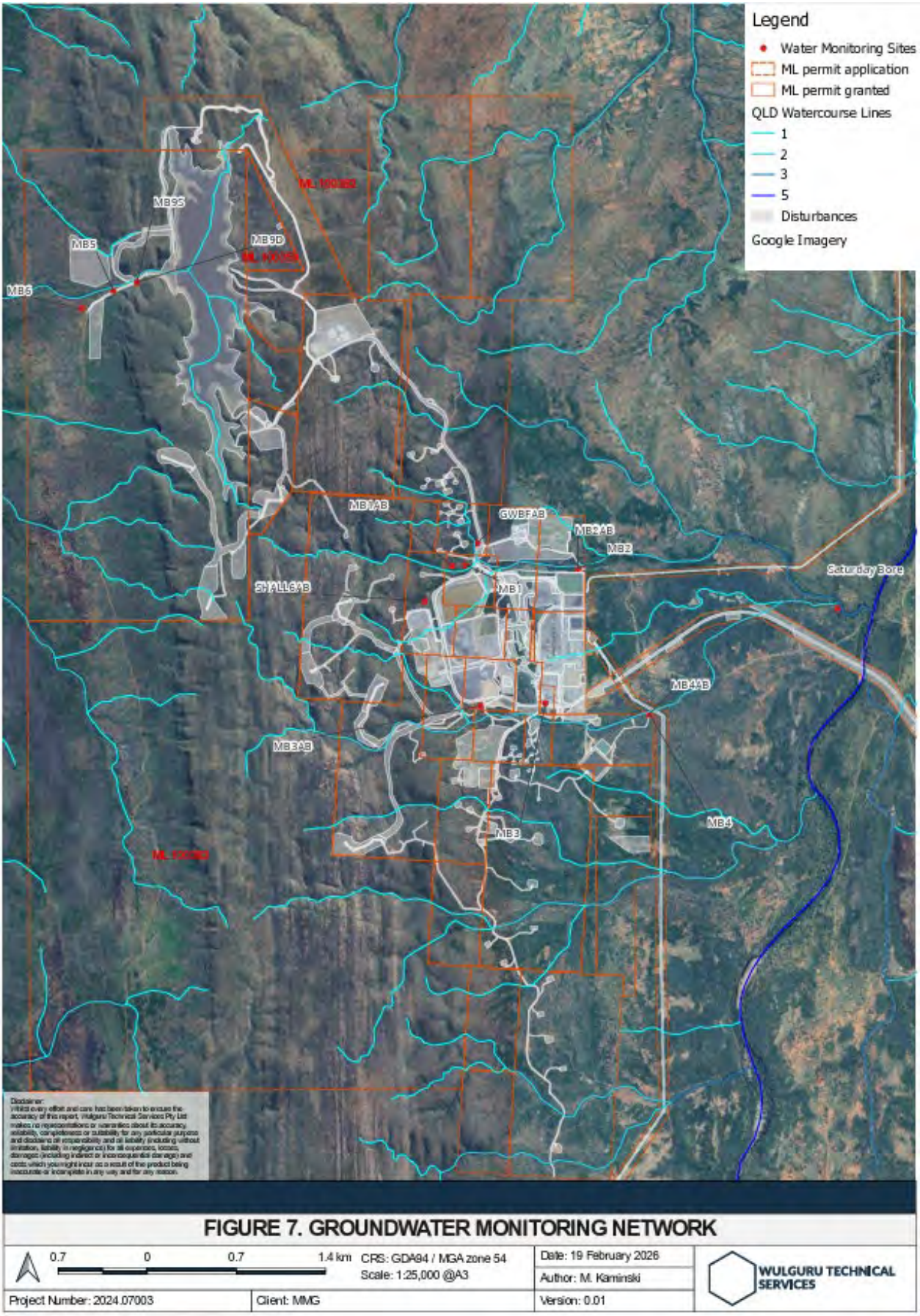


Table 12. Groundwater chemistry (2009-2024)

Analytes	pH	Electrical Conductivity	Sulphate as SO4	Fluoride	Aluminium		Arsenic		Cadmium		Copper		Lead		Manganese		Nickel		Zinc	
					Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Units	pH units	µS/cm	mg/L	mg/L	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
Limit of Reporting	0.01	1	1	0.1	0.01		0.001		0.0001		0.001		0.001		0.001		0.001		0.005	
Trigger Level	6.0 (Min.) 8.0 (Max.)	1500	150	-	0.055 (Dissolved)		0.013 (Dissolved)		0.0002 (Dissolved)		0.01 (Dissolved)		0.0014 (Dissolved)		1.9 (Dissolved)		0.011 (Dissolved)		0.008 (Dissolved)	
EA Contaminant Limit	6.0 (Min.) 9.0 (Max.)	2000	1000	2	5 (Total)		0.5 (Total)		0.01 (Total)		1 (Total)		0.1 (Total)		-		1 (Total)		20 (Total)	
Interpretation Bores - Depth																				
MB1AB																				
Number of samples	5	6	19	19	19	17	19	17	19	17	19	17	19	17	17	17	19	17	19	17
Minimum	7.52	966	10	1.6	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.00	0.0005	0.0025	0.0025
Maximum	7.88	1460	37	4.6	0.03	2.93	0.0005	0.002	0.0002	0.0007	0.007	0.019	0.006	0.042	0.071	0.175	0.00	0.004	0.223	0.556
Median	7.7	1190	12	3.5	0.005	0.06	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	0.002	0.006	0.00	0.0005	0.0025	0.0025
80th percentile	7.77	1300	13	3.74	0.005	0.342	0.0005	0.0005	0.00005	0.00005	0.0005	0.003	0.0005	0.005	0.01	0.0418	0.00	0.0005	0.0051	0.0248
95th percentile	7.85	1420	17.2	3.97	0.0075	2.13	0.0005	0.0012	0.000065	0.00038	0.0034	0.0142	0.0024	0.0252	0.035	0.171	0.00	0.0024	0.0556	0.1824
MB2AB																				
Number of samples	16	15	30	30	30	28	30	28	30	28	30	28	30	28	27	27	30	28	30	28
Minimum	7	913	20	0.4	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	0.001	0.002	0.00	0.0005	0.0025	0.0025
Maximum	8	1140	175	1.2	0.04	3.34	0.001	0.01	0.0005	0.0013	0.003	0.025	0.008	0.164	0.142	0.159	0.00	0.006	0.168	0.383
Median	7.46	1030	92	0.8	0.005	0.12	0.0005	0.0005	0.00005	0.00005	0.0005	0.001	0.0005	0.0005	0.007	0.013	0.00	0.0005	0.0025	0.0025
80th percentile	7.72	1062	143.2	1	0.005	0.23	0.0005	0.0016	0.00006	0.00026	0.0006	0.004	0.0006	0.0098	0.0118	0.0516	0.00	0.0008	0.0248	0.073
95th percentile	7.87	1133	149.55	1.055	0.01325	2.3595	0.0005	0.0033	0.0004	0.00076	0.00255	0.01615	0.00255	0.0487	0.0548	0.1349	0.00	0.0053	0.0697	0.25645
MB3AB																				
Number of samples	14	13	28	28	28	26	28	26	28	26	28	26	28	26	25	25	28	26	28	26
Minimum	7.73	1370	46	1.5	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.001	0.0005	0.0005	0.0005	0.004	0.00	0.0005	0.0025	0.0025
Maximum	8.11	2630	392	3.5	0.01	20.5	0.002	0.005	0.0001	0.0009	0.004	0.04	0.002	0.045	0.04	1.16	0.01	0.13	0.034	0.297
Median	7.92	2160	67	2.6	0.005	0.815	0.001	0.001	0.00005	0.00005	0.002	0.005	0.0005	0.0005	0.002	0.111	0.00	0.002	0.0025	0.00425
80th percentile	8.04	2356	226	2.86	0.005	2.32	0.001	0.002	0.00005	0.00005	0.0026	0.011	0.0005	0.002	0.007	0.2262	0.00	0.005	0.0025	0.016
95th percentile	8.10	2570	368.55	3.265	0.005	10.17	0.001	0.002	0.00005	0.00005	0.003	0.0315	0.000825	0.00575	0.0104	0.8158	0.00	0.031	0.02525	0.05575
MB4AB																				

Analytes	pH	Electrical Conductivity	Sulphate as SO4	Fluoride	Aluminium		Arsenic		Cadmium		Copper		Lead		Manganese		Nickel		Zinc	
					Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Number of samples	4	4	14	14	13	12	13	12	14	11	14	12	14	12	11	11	14	12	14	12
Minimum	7.14	2300	464	0.7	0.005	1.28	0.0005	0.0005	0.00005	0.00005	0.0005	0.002	0.0005	0.0005	0.023	0.187	0.0005	0.003	0.0025	0.01
Maximum	7.58	15000	4200	1.4	0.005	154	0.003	0.025	0.00005	0.0008	0.01	0.194	0.003	0.062	1.43	6.94	0.008	0.313	0.159	0.477
Median	7.46	2515	1855	1	0.005	5.93	0.0005	0.002	0.00005	0.00005	0.0005	0.0085	0.0005	0.004	0.242	1.2	0.0025	0.014	0.0115	0.0385
80th percentile	7.51	7596	3612	1.2	0.005	17.24	0.0014	0.004	0.00005	0.00005	0.0032	0.0254	0.0005	0.0058	1.3	1.76	0.0048	0.0324	0.052	0.0602
95th percentile	7.56	13149	4187	1.4	0.005	81.29	0.0024	0.01565	0.00005	0.0006	0.0087	0.1104	0.0017	0.0466	1.375	4.525	0.0067	0.16285	0.11675	0.3219
Compliance Bores – Depth and Quality																				
MB2																				
Number of samples	97	93	115	114	110	110	115	115	114	115	115	115	115	115	115	115	115	115	115	115
Minimum	7	753	4	0.6	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.00011	0.00012	0.0005	0.001	0.00	0.0005	0.0014	0.0025
Maximum	8.31	1580	530	6.5	0.02	0.23	0.002	0.002	0.0003	0.0004	0.094	0.102	0.011	0.006	0.404	0.422	0.03	0.029	0.078	0.085
Median	7.56	1120	144	1.7	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.006	0.014	0.0005	0.0005	0.037	0.039	0.00	0.0005	0.0025	0.0025
80th percentile	7.82	1426	404	2.5	0.005	0.02	0.0005	0.0005	0.00005	0.00005	0.0368	0.0444	0.0005	0.00144	0.0672	0.0704	0.00	0.0005	0.00818	0.00852
95th percentile	8.03	1490	483.9	2.8	0.005	0.05	0.0005	0.001	0.00005	0.00005	0.0545	0.065	0.00203	0.00321	0.0989	0.1133	0.00	0.00149	0.0238	0.0352
MB4																				
Number of samples	57	61	78	77	73	73	78	78	77	78	78	78	78	78	78	78	78	78	78	78
Minimum	7	0	16	0.4	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00	0.0005	0.0025	0.0025
Maximum	8.18	1390	146	2	0.03	0.91	0.002	0.002	0.0002	0.001	0.007	0.014	0.006	0.017	0.302	0.332	0.01	0.011	0.062	0.106
Median	7.72	763	71.5	1	0.005	0.01	0.0005	0.0005	0.00005	0.00005	0.0005	0.001	0.0005	0.0005	0.0085	0.0265	0.00	0.0005	0.0025	0.008
80th percentile	7.93	1298	93.6	1.4	0.005	0.06	0.0005	0.0005	0.00005	0.00005	0.002	0.003	0.0005	0.002	0.0614	0.1034	0.00	0.000788	0.012	0.0292
95th percentile	8.16	1362	106	1.7	0.005	0.1745	0.001	0.001	0.00005	0.000115	0.0052	0.012	0.004	0.0062	0.1597	0.2331	0.00	0.00215	0.0388	0.0524
MB5																				
Number of samples	51	53	67	66	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
Minimum	6.88	784	4	0.05	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00	0.0005	0.0025	0.0025
Maximum	8.01	1220	134	1.4	0.03	3.5	0.008	0.008	0.0002	0.0002	0.004	0.025	0.007	0.016	0.798	2.67	0.01	0.02	0.24	0.354
Median	7.48	1150	90	0.4	0.005	0.02	0.0005	0.0005	0.00005	0.00005	0.0005	0.002	0.0005	0.0005	0.529	0.616	0.00	0.0005	0.0025	0.007
80th percentile	7.79	1170	96	1	0.005	0.06	0.001	0.002	0.00005	0.00005	0.001	0.006	0.0005	0.004	0.6208	0.6598	0.00	0.00116	0.0088	0.019
95th percentile	7.93	1190	100	1.2	0.005	0.245	0.0057	0.0057	0.00005	0.0001	0.003	0.01075	0.003	0.0075	0.683	0.8139	0.00	0.0068	0.0412	0.06925
MB6																				
Number of samples	53	55	68	67	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68

Analytes	pH	Electrical Conductivity	Sulphate as SO4	Fluoride	Aluminium		Arsenic		Cadmium		Copper		Lead		Manganese		Nickel		Zinc	
					Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Minimum	7	365	1	0.05	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.00017	0.00018	0.0005	0.053	0.00	0.0005	0.0025	0.0025
Maximum	7.92	1610	191	1.4	0.03	0.41	0.005	0.006	0.0005	0.0009	0.017	0.052	0.008	0.021	0.916	0.973	0.00	0.008	0.485	0.581
Median	7.4	936	16	1.1	0.005	0.02	0.003	0.003	0.00005	0.00005	0.0005	0.003	0.0005	0.0005	0.3955	0.446	0.00	0.0005	0.0025	0.011
80th percentile	7.64	1250	104	1.2	0.005	0.078	0.004	0.004	0.00005	0.00005	0.00206	0.0066	0.0005	0.0026	0.5532	0.5972	0.00	0.001	0.0206	0.038
95th percentile	7.84	1480	135.6	1.3	0.005	0.224	0.00465	0.00565	0.00005	0.0001	0.00665	0.01765	0.003	0.01065	0.78555	0.8572	0.00	0.002195	0.0533	0.11425
MB9D																				
Number of samples	29	29	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
Minimum	6.99	1060	39	0.05	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	0.003	0.227	0.00	0.0005	0.0011	0.0025
Maximum	8.4	1630	111	0.7	0.01	10.2	0.0005	0.011	0.0002	0.0017	0.004	0.143	0.002	0.125	1.12	14.6	0.00	0.038	0.053	0.492
Median	7.49	1130	46	0.5	0.005	0.08	0.0005	0.0005	0.00005	0.00005	0.0005	0.002	0.0005	0.0005	0.494	0.552	0.00	0.0015	0.0025	0.0025
80th percentile	7.69	1174	48	0.5	0.005	0.418	0.0005	0.0009	0.00005	0.0002	0.0005	0.0088	0.0005	0.006	0.6164	1.0644	0.00	0.004	0.0186	0.0516
95th percentile	7.97	1318	67.6	0.6	0.005	2.914	0.0005	0.0049	0.0002	0.0008	0.00145	0.03485	0.0005	0.0559	0.9326	1.9	0.00	0.0182	0.0432	0.3272
MB9S																				
Number of samples	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Minimum	6.36	92	2	0.05	0.005	2.57	0.0005	0.001	0.00005	0.00005	0.0005	0.016	0.0005	0.001	0.003	0.022	0.00	0.004	0.0025	0.008
Maximum	7.01	118	4	0.1	0.21	10.7	0.0005	0.002	0.00005	0.00005	0.001	0.069	0.0005	0.005	0.028	0.31	0.00	0.014	0.015	0.044
Median	6.61	99	2.5	0.1	0.03	5.605	0.0005	0.0015	0.00005	0.00005	0.00075	0.0255	0.0005	0.0035	0.015	0.117	0.00	0.004	0.0025	0.022
80th percentile	6.85	110.4	3.4	0.1	0.108	8.966	0.0005	0.002	0.00005	0.00005	0.001	0.0444	0.0005	0.0044	0.0238	0.2056	0.00	0.008	0.0075	0.035
95th percentile	6.97	116.1	3.85	0.1	0.1845	10.2665	0.0005	0.002	0.00005	0.00005	0.001	0.06285	0.0005	0.00485	0.02695	0.2839	0.00	0.0125	0.013125	0.04175
Background Bores – Depth and Quality																				
MB1																				
Number of samples	59	56	75	73	71	71	75	75	74	75	75	75	75	75	75	75	75	75	75	75
Minimum	7	794	18	0.8	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.0005	0.00014	0.0005	0.0005	0.0535	0.0005	0.0025	0.0025
Maximum	8.29	1200	41	2.2	0.01	0.24	0.002	0.002	0.0002	0.0001	0.008	0.015	0.006	0.008	0.132	0.304	0.0005	0.028	0.038	0.061
Median	7.7	1095	24	1.6	0.005	0.015	0.0005	0.0005	0.00005	0.00005	0.0005	0.001	0.0005	0.0005	0.037	0.042	0.004	0.0005	0.0025	0.007
80th percentile	7.93	1140	29.2	1.8	0.005	0.05	0.0005	0.0005	0.00005	0.00005	0.001	0.0034	0.0005	0.002	0.0622	0.068	0.0005	0.0005	0.0074	0.015
95th percentile	8.08	1172.5	33.3	1.94	0.005	0.1	0.001	0.001	0.00005	0.00005	0.003	0.009	0.002	0.0053	0.1066	0.1184	0.0005	0.0023	0.0223	0.0441
MB3																				
Number of samples	56	60	76	75	71	71	76	76	75	76	76	76	76	76	75	76	76	76	76	76
Minimum	7	1120	43	1.2	0.005	0.005	0.0005	0.0005	0.00005	0.00005	0.0005	0.0005	0.00011	0.00015	0.0005	0.0005	0.00	0.0005	0.0025	0.001
Maximum	8.27	6140	1930	4.1	0.05	0.26	0.004	0.007	0.0011	0.0014	0.028	0.041	0.059	0.023	0.046	0.086	0.03	0.04	0.11	0.04

Analytes	pH	Electrical Conductivity	Sulphate as SO4	Fluoride	Aluminium		Arsenic		Cadmium		Copper		Lead		Manganese		Nickel		Zinc	
					Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Median	7.65	4660	155.5	2.5	0.005	0.015	0.001	0.001	0.00005	0.00005	0.0005	0.001	0.0005	0.0005	0.002	0.004	0.00	0.0005	0.0025	0.002
80th percentile	7.86	5260	952	2.9	0.005	0.044	0.001	0.001	0.00005	0.00005	0.003	0.004	0.002	0.004	0.004	0.014	0.00	0.002	0.012	0.0072
95th percentile	8.07	5645	1562.5	3.13	0.01325	0.1865	0.002	0.002	0.00005	0.00005	0.0076	0.0189	0.00875	0.01425	0.0216	0.075	0.00	0.01475	0.03525	0.0294

3.1.10.5. Soils

3.1.10.5.1. Soil Types

The soils of DRM area were described in AustralAsian Resource Consultants (AARC 2010a) and were dominated by Rudosols with minor areas of Calcarosols. The Australian Soil Classification (Isbell, 2016) define Rudosols as being soil with negligible pedology, minimal development of an A1 horizon or the presence of less than 10% of B horizon material (including pedogenic carbonate) in fissures in the parent rock or saprolite. The soils are apedal or only weakly structured in the A1 horizon and show no pedological colour changes apart from the darkening of an A1 horizon. There is little or no texture or colour change with depth unless stratified or buried soils are present.

Specifically, six soil types were described by AARC (2010a) in SGM Environmental Pty Limited (SGM (2021) (Table 13). All soil management units are dominated by features that severely limit their productive use in grazing or copping due to very low plant-available water, erosion potential and limited nutrient availability. Subsequent to the AARC (2010a) soil surveys, several pockets of dispersive red clays were identified during construction.

Table 13. DRM soil types (AARC 2010a)

Soil Type	Description
Red Plains	The Red Plains SMU consists of red sandy loams to sandy clay loams with a neutral to slightly acidic pH. These soils are Rudosols with weak pedality and a maximum depth of 0.5 m.
Knapdale	The Knapdale SMU consists of brown skeletal sandy clay loams with a neutral to slightly acidic pH. These soils are Rudosols and very shallow (less than (<)0.2 m thick). They are mostly found on the eastern and western slopes of the Knapdale Range.
Dale	The Dale SMU consists of brown to reddish sandy loams with a slightly acidic pH increasing down the profile. Pedality ranges from weak to moderate with a depth of between 0.5-0.7 m. These soils are Rudosols and are generally found in depressions such as valley floors or plateaus in the Knapdale Range.
Miners	The Miners SMU consists of dark yellowish-brown sandy clay loams to silty loams with a slightly alkaline pH. Pedality is weak with a maximum depth of 0.2 m. These soils are Rudosols and are found on and immediately supporting the outcropping of the Dugald River deposit lode on the eastern side of the Knapdale Range.
Prospectors	The Prospectors SMU consists of dark yellowish-brown clay loams with a slightly acidic pH. Pedality is weak with a maximum depth of 0.2 m. These soils are Rudosols and are found on the toe slope of the western side of the Knapdale Range.
Pocket	The Pocket SMU consists of brown-grey sandy clay loams with an alkaline pH due to elevated levels of calcium carbonate. Pedality is weak. These soils are Calcarosols and are found in small pockets on the eastern and northern side of the Knapdale Range.

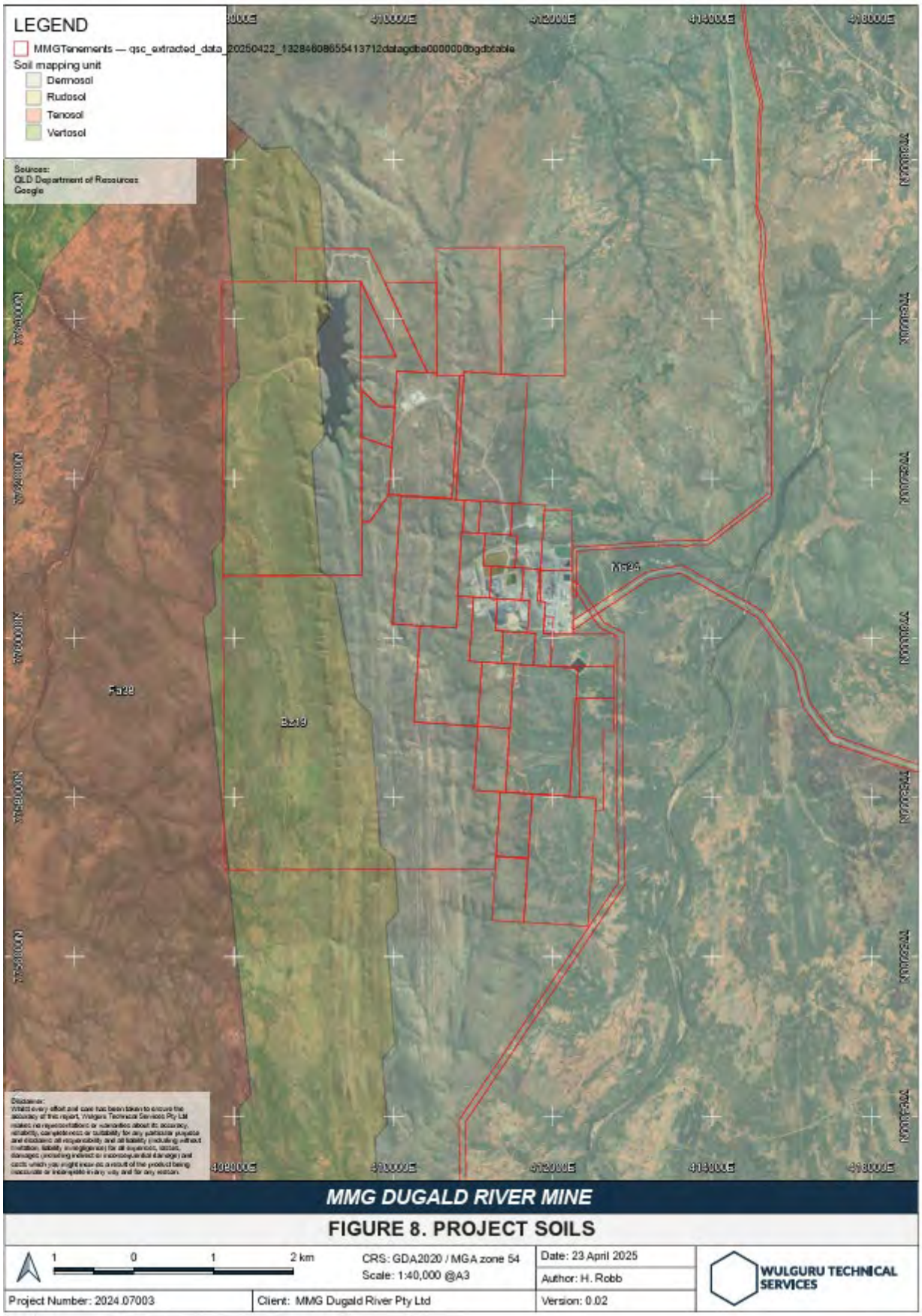
3.1.10.5.2. Soil Properties

Laboratory analysis of several soil parameters is summarised in Table 14. The soil types currently support native vegetation communities and there are no detrimental elements in the soil expected to limit that capacity in future (AARC, 2010).

Table 14. Rehabilitation related chemical properties

Soil Type	pH	EC (ds/cm)	Organic Carbon (%w/w)	CEC (meq/100mg)	ESP (%)
Red Plains	6.5	0.06	0.5	5.88	0.6
Knapdale	6.41	0.02	0.4	4.20	1.75
Dale	5.74	0.03	0.3	2.74	1.7
Miners	7.56	0.04	0.5	10.65	0.9
Prospectors	6.51	0.02	0.7	5.34	1.3
Pocket	8.8	0.08	0.5	22.89	0.5

Figure 8. Soil mapping



3.1.10.5.3. Agricultural Land Classes

The soil management units have been classified into land classes according to the *Planning Guideline -The Identification of Good Quality Agricultural Land* published by the Department of Infrastructure and Planning (DIP), 1993. Agricultural land classes are described in Table 15.

Table 15. Agricultural land classes

Class	Description	
A	Crop Land	Land that is suitable for current and potential crops with limitations to production which range from non to moderate levels.
B	Limited Crop Land	Land that is marginal for current and potential crops due to severe limitations: and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered for cropping.
C	Pasture Land	Land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate short period of ground disturbance for pasture establishment.
D	Non-Agricultural Land	Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrops and poor drainage.

Table 16 details the agricultural land class of each soil management unit based on the descriptions provided in Table 15. No soil management unit on the site was found to be good quality agricultural land due to limiting factors, such as water availability, low nutrient levels, shallow soils, steep slopes and rocky outcrops (AARC, 2010).

Table 16. Agricultural land class of the Project soils from AARC (2010)

Soil Management Unit	Limiting features	Agricultural Land Class
Red Plains	No available water, relatively shallow soil, low nutrient levels.	D
Knapdale	No available water, shallow rocky soil, low nutrient levels and steep slopes.	D
Dale	This soil type may be suitable as pasture land as it is found up to 50-70 cm however it still has low nutrient levels and it is very inaccessible as it is surrounded by steep slopes.	D
Miners	Shallow and rocky, high levels of lead, rocky outcrops, no available water and low nutrients.	D
Prospectors	No available water, shallow soil, low nutrient levels.	D
Pocket	No available water, relatively shallow soil, low nutrient levels, slightly alkaline.	D

3.1.10.5.4. Land Suitability Assessment

AARC (2010) conducted a land suitability assessment during the initial EIS for the project. Land suitability was assessed using the methods and criteria provided in the *Planning Guideline – The Identification of Good Quality Agricultural Land (*DIP, 1993) and the *Land Suitability Assessment Techniques Guideline* (DME, 1995).

The Land Suitability assessment uses a five-class system, where Class 1 indicates that the land is most suitable for the enterprise and Class 5 the least suitable. The overall land suitability ranking for each specific soil unit is determined by the most severe limitation, or a combination of the varying limitations. Land is considered less suitable as the severity of limitations for a land use increase. The increasing limitations may reflect any combination of:

- Reduced potential for production;
- Increased inputs to achieve an acceptable level of production; and/or
- Increased inputs required to prevent land degradation.

The Land Suitability Classes are described in Table 17.

Table 17. Land suitability classes

Class	Suitability	Limitations	Description
1	Suitable	Negligible	Highly productive land requiring only simple management practices to maintain economic production.
2	Suitable	Minor	Land with limitations that either constrain production, or require more than the simple management practices of class 1 land to maintain economic production.
3	Suitable	Moderate	Land with limitations that either further constrain production, or require more than those management practices of class 2 land to maintain economic production.
4	Unsuitable	Severe	Currently unsuitable land. The limitations are so severe that the sustainable use of the land in the proposed manner is precluded. In some circumstances, the limitations may be surmountable with changes to knowledge, economics or technology.
5	Unsuitable	Extreme	Land with extreme limitations that preclude any possibility of successful sustained use of the land in the proposed manner.

The pre-mining land use suitability for these six soil types are summarised in Table 18.

Table 18. Land suitability assessment for Project soils

Soil Type	Beef Cattle Grazing	Broadacre Cropping	Conservation	Limitations	Area (ha)
Red Plains	4	5	4	Severe to Extreme Limitations in plant available water capacity (PAWC). Extreme Limitation in Slope, Topography, Rockiness.	1327
Knapdale	5	5	4	Extreme Limitation in Slope, Rockiness, PAWC and Topography.	1623
Dale	4	5	4	Severe to Extreme Limitation in PAWC and access.	38
Miners	5	5	4	Extreme Limitation in Rockiness, and PAWC.	166
Prospectors	5	5	4	Extreme Limitation in Rockiness, and PAWC.	165
Pocket	4	5	4	Extreme Limitation in Rockiness, and PAWC.	48

3.1.10.5.5. Land Stability

3.1.10.5.5.1. Soil Erosion Susceptibility

An assessment of soil erosion susceptibility is given in Table 19, which lists influencing factors for each soil type.

Table 19. Soil erosion susceptibility

Soil Type	Sodicity	Texture	Landform	Vegetation cover	Erosion Susceptibility
Red Plains	Non- Sodic	Sandy loam to sandy clay loam	Flatter plain areas	Cloncurry Box and Snappy Gum Open Woodland	Nondispersive
Knapdale	Non- Sodic	Sandy clay loam	Slopes of The Knapdale Range (30-40°)	Snappy Gum Open Woodland and Spinifex grass	Nondispersive
Dale	Non- Sodic	Sandy loam	Valley floors or plateaus in the Knapdale Range	Snappy Gum Open Woodland	Nondispersive
Miners	Non-Sodic	Sandy clay loam	Outcropping of the deposit lode	Cloncurry Box Open Woodland	Nondispersive
Prospectors	Non- Sodic	Clay loam	Toe slope of The Knapdale Range	Snappy Gum Open Woodland	Nondispersive

Soil Type	Sodicity	Texture	Landform	Vegetation cover	Erosion Susceptibility
Pocket	Non- Sodic	Sandy clay loam	Areas of low relief pockets (<5°)	Snappy Gum and Cloncurry Box Open Woodland	Nondispersive

3.1.10.5.5.2. Erosion Hazard (Average Rainfall)

The International Erosion Control Association's (IECA) Best Practice Erosion and Sediment Control Guidelines (IECA 2008) sets erosion hazard based on average rainfalls for regions around Australia. IECA erosion hazard for the Mt Isa region is detailed in Table 20.

A detailed erosion assessment has been completed for the TSF, the only mine structure to be retained, post closure (Section 3.5.10.2.10).

Table 20. Erosion hazard (IECA, 2008)

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
High	High	Medium	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Medium

3.1.10.6. Geology

The DRM is located within a north to south trending feature named the Mt Roseby Corridor, within the Eastern Fold Belt of the Mount Isa Inlier. The Mount Roseby Corridor is bordered to the west by the Knapdale Quartzite and to the east by the Mt Rosebee Fault. The Knapdale Quartzite forms the Knapdale Range, a local topographic high. The Mount Roseby corridor is comprised of the Mount Roseby Schist Formation which includes the Dugald River Slate Sequence of hanging wall calc-silicates, Dugald River slate (host of the ore body) and the footwall limestone (SGM, 2021).

The geology of the rock units mined at the Project were described in EGi (2011). The units are calc-silicate, white mica schist, mafic feldspar porphyry, hanging wall slate, mineralized lode waste, footwall slate, and footwall limestone. Waste mined was found to be predominately non-acid forming (NAF) but areas of potentially acid forming (PAF) rock may be encountered proximal to the ore body and minor volumes within the hanging and foot wall slate. Table 21 describes the four dominant geological units at DRM. A cross section of the geology is provided in Figure 9.

Table 21. Mapped geology for the Project area

Geological Unit	Description	Age
Lady Clayre Dolomite	Dolomitic, locally pyrrhotitic siltstone, silty to sandy dolostone and fine-grained, variably dolomitic sandstone	Paleoproterozoic
Knapdale Quartzite	Pink, fine-grained, feldspathic to quartzose, locally micaceous sandstone	Paleoproterozoic
Dugald River Slate Sequence	Dark grey, carbonaceous shale and siltstone and grey mica schist;	Paleoproterozoic

Geological Unit	Description	Age
	Ore body; and Dark grey silty, dolomitic limestone and siltstone	
Mount Roseby Schist	Grey muscovite-biotite-quartz schist (psammopelite) and minor quartzite, calc-silicate granofels and limestone; commonly thin-bedded with abundant poikiloblastic scapolite porphyroblasts, particularly in the north.	Paleoproterozoic

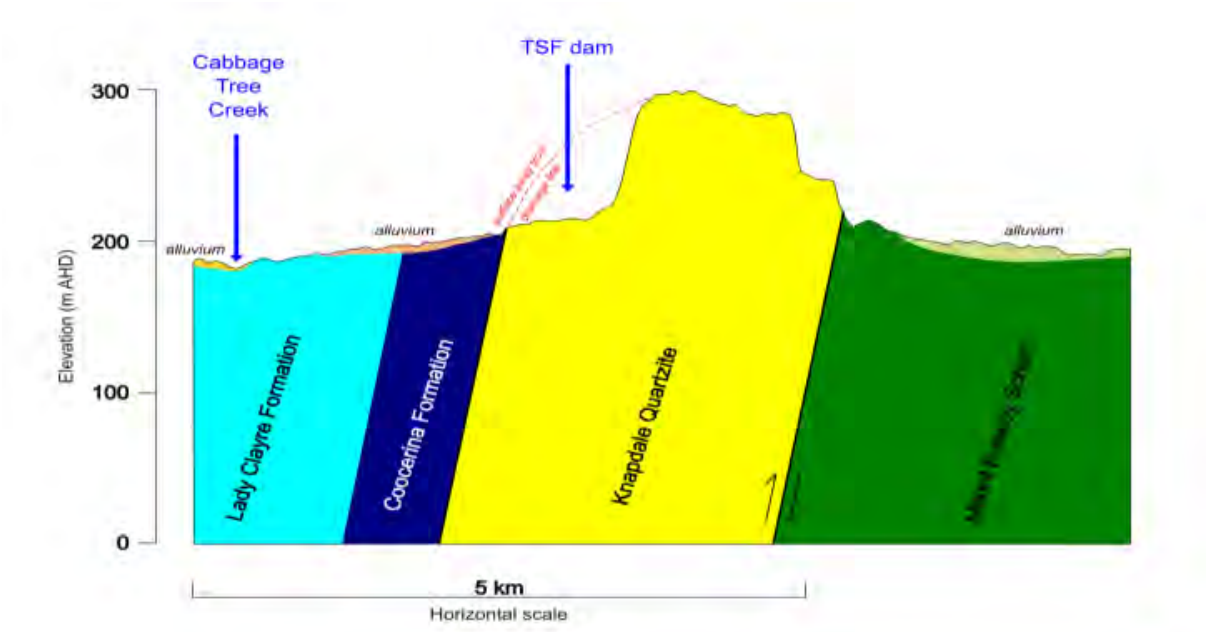


Figure 9. Geology West-East Cross-section (CDM Smith, 2025)

3.1.10.7. Vegetation Communities and Ecological Data

3.1.10.7.1. Matters of National Environmental Significance (MNES)

The Protected Matters Search Tool (PMST), accessed November 2024, was used to conduct a desktop analysis to determine the presence of any Matters of National Environmental Significance (MNES) listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC) (DCCEEW, 2024).

The following MNSES are not present within 50 km of the DRM:

- World Heritage Properties
- National Heritage Planes
- Wetlands of International Importance (Ramsar)
- Great Barrier Reef Marine Park
- Commonwealth Marine Area
- Listed Threatened Ecological Communities

3.1.10.7.1.1. EPBC Listed Threatened Flora Species

One (1) EPBC listed flora species was identified to occur within 50 km of the DRM. The species and likelihood of occurrence is described in Table 22.

Table 22. Listed threatened flora species

Taxa	Common Name (*Scientific name*)	EPBC Status	Likelihood of Occurrence
Flora	Mt Isa Mallee (*Eucalyptus nudicaulis*)	E	**Unlikely -** no records exist within a 50 km buffer of DRM. The 50 km buffer falls outside of the extent of occurrence identified

Taxa	Common Name (*Scientific name*)	EPBC Status	Likelihood of Occurrence
			within the conservation advice for the species.

Key: V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory, Ma = Marine, SL = Special Least Concern, LC = Least Concern, NL = Not Listed

3.1.10.7.1.2. EPBC Listed Threatened Fauna and Migratory Species

Table 23 describes the EPBC listed species identified to potentially occur within 50 km of DRM. Presence was assessed through the PMST mapping and review of survey data within the Project area. The likelihood of occurrence within the Project area was determined by the presence of local records and suitability of habitat.

Table 23. EPBC listed migratory and marine species identified within 50km of DRM

Taxa	Common Name (*Scientific name*)	EPBC Status	Likelihood of Occurrence
Birds ***(n = 24)***	Rainbow Bee-eater *(Merops ornatus)*	Ma	**Known**
	Common greenshank (*Tringa nebularia*)	E, M, Ma	**Possible** - four records exist within 50 km of DRM.
	Curlew sandpiper (*Calidris ferruginea*)	CE, M, Ma	**Possible** - Two records exist within 50 km of DRM.
	Latham's snipe (*Gallinago hardwickii*)	V, M, Ma	**Possible** - Two records are located approximately 40 km southwest of DRM. May fly through the area to access suitable habitat.
	Sharp-tailed sandpiper (*Calidris acuminata*)	V, M, Ma	**Possible –** three records exist within 50 km of DRM
	White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	Ma	**Possible** – multiple records within 50 km of DRM.
	Black-eared Cuckoo (*Chalcites osculans* as *Chrysococcyx osculans*)	Ma	**Possible** – three records exist within 50 km of DRM.
	Cattle Egret *(Bubulcus ibis* as *Ardea ibis)*	Ma	**Possible** – three records exist within 50 km of DRM.
	Australian Painted Snipe (*Rostratula australis* as *Rostratula benghalensis (sensu lato)*	E, Ma	**Possible** - one record approximately 40 km southwest of DRM.
	Carpentarian Grasswren (*Amytornis dorotheae*)	E	**Possible -** one record is located approximately 40 km northwest of DRM.

Taxa	Common Name (*Scientific name*)	EPBC Status	Likelihood of Occurrence
	Grey Falcon (*Falco hypoleucos*)	V	**Possible –** two records exist within 50 km of DRM.
	Painted Honeyeater (*Grantiella picta*)	V	**Possible** – two records exist within 50 km of DRM.
	Glossy ibis (Plegadis falcinellus)	M,Ma	**Possible** - 14 records exist within a 50 km radius of the Project area.
	Common sandpiper (*Actitis hypoleucos*)	M, Ma	**Unlikely** - no records or modelled flight paths exist within 50 km of the Project area.
	Fork-tailed swift (*Apus pacificus*)	M, Ma	**Unlikely -** no records or modelled flight paths exist within 50 km of DRM.
	Grey wagtail (*Motacilla cinerea*)	M, Ma	**Unlikely -** no records exist within 50 km of DRM.
	Barn Swallow (*Hirundo rustica*)	M, Ma	**Unlikely** - no records exist within 50 km of DRM.
	Oriental plover (*Charadrius veredus*)	M, Ma	**Unlikely -** no records exist within 50 km of DRM.
	Oriental pratincole (*Glareola maldivarum*)	M, Ma	**Unlikely -** no records exist within 50 km of DRM.
	Pectoral sandpiper (*Calidris melanotos*)	M, Ma	**Unlikely -** no records exist within 50 km of DRM.
	Yellow wagtail (*Motacilla flava*)	M, Ma	**Unlikely -** no records exist within 50 km of DRM.
	Gouldian Finch (*Chloebia gouldiae* listed as *Erythrura gouldiae*)	E	**Unlikely -** no records exist within 50 km of DRM.
	Red Goshawk (*Erythrotriorchis radiatus*)	E	**Unlikely -** no records exist within 50 km of DRM.
	Night Parrot (*Pezoporus occidentalis)*	E	**Unlikely -** no records exist within 50 km of DRM. The nearest record is over 250 km south.
Mammal (n = 3)	Ghost Bat (*Macroderma gigas*)	V	**Unlikely -** no records exist within 50 km of DRM.
	Greater Bilby (*Macrotis lagotis*)	V	**Unlikely -** no records exist within 50 km of DRM. The nearest record is approximately 250 km southwest of DRM.
	Julia Creek Dunnart (*Sminthopsis douglasi*)	V	**Unlikely -** no records exist within 50 km of DRM.

Taxa	Common Name (*Scientific name*)	EPBC Status	Likelihood of Occurrence
Fish ***(n = 1)***	Freshwater sawfish (*Pristis pristis*)	V, M	**Unlikely -** the nearest record on ALA is located over 250km North of DRM. There is no suitable habitat for this species on-site.
Reptile ***(n = 4)***	Mertens' Water Monitor (*Varanus mertensi*)	E	**Known**
	Freshwater crocodile (*Crocodylus johnstoni*)	Ma	**Possible –** two records exist within 50 km of DRM.
	Plains Death Adder (*Acanthophis hawkei*)	V	**Unlikely -** no records exist within 50 km of DRM.
	Gulf Snapping Turtle (*Elseya lavarackorum*)	E	**Unlikely -** No records exist within 50 km of DRM. The nearest population is over 225 km northwest.

Key: V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory, Ma = Marine, SL = Special Least Concern, LC = Least Concern, NL = Not Listed

3.1.10.7.2. Matters of State Environmental Significance

The following Matters of State Environmental Significance are mapped (Queensland Government, 2022) to occur within the Project area:

- Wildlife habitat (endangered or vulnerable/ special least concern);
- Regulated vegetation (essential habitat); and
- Regulated vegetation (intersecting a watercourse).

Wildlife habitat and essential habitat within the Project area are associated with the presence of the *Petrogale purpureicollis* (purple-necked rock-wallaby) (Figure 10).

3.1.10.7.2.1. Environmentally Sensitive Areas

No Category A Environmentally Sensitive Areas (ESAs) were identified to occur across the Project. The Protected Matters Search Tool (PMST) (DCCEEW, 2024) identified the following Category B Environmentally Sensitive Area within the Project:

- Endangered regional ecosystem 1.3.7 – Red Gum (*Eucalyptus camaldulensis*) woodland on channels and levees.

3.1.10.7.2.2. Regional Ecosystems

The Project area was largely classed as remnant under the *Vegetation Management Act 1999 (*VM Act) with the current footprint now classed as non-remnant. Mapped regional ecosystems (RE) were reviewed using the Queensland Globe interactive mapping tool (QLD, 2022). The Project MLs are

primarily comprised of heterogenous 1.112A/1.7.7A (70/30). Mapped regional ecosystems of the Project area are described in Table 24 and depicted in Figure 11.

An area of the Project is mapped as heterogenous 1.11.2a/1.5.13/1.3.7b (70/25/5). While RE 1.3.7b is considered least concern under the VM Act, it has a biodiversity status of endangered due to its importance as seasonal water bird habitat and a regional corridor for fauna. It is therefore classed as a Category B Environmentally Sensitive Area (ESA) under Schedule 19 of the *Environmental Protection Regulation 2019*.

Table 24. Mapped vegetation communities and their current conservation status (Qld 2021)

Regional Ecosystems	Percentages	Short Description	VM Status*	BD Status#
1.11.2a/1.5.13/1.3.7b	70/25/5	**1.11.2a:** *Eucalyptus leucophloia* low open woodland often with *Corymbia terminalis*, *Corymbia capricornia*, *Terminalia aridicola* and *Eucalyptus leucophylla* with shrub layer of Acacia spp. and ground layer of Triodia spp. Occurs on steep hills and strike ridges. **1.5.13:** *Eucalyptus pruinosa* low open woodland on older alluvial and residual soils. **1.3.7b:** *Eucalyptus camaldulensis* fringing woodland, usually with *Lophostemon grandiflorus* and *Melaleuca bracteata* and/or *M. dissitiflora*. Occurs on recent levees and channel deposits of medium and smaller tributaries which are dry for most of the year; alluvial soils. Riverine.	**1.11.2a**: LC **1.5.13:** LC **1.3.7b:** LC	**1.11.2a:** NC **1.5.13:** NC **1.3.7b:** E
1.11.2a/1.11.3a	90/10	**1.11.2a:** *Eucalyptus leucophloia* low open woodland often with *Corymbia terminalis*, *Corymbia capricornia*, *Terminalia aridicola* and *Eucalyptus leucophylla* with shrub layer of Acacia spp. and ground layer of Triodia spp. Occurs on steep hills and strike ridges. **1.11.3a:** *Eucalyptus leucophylla* low open woodland often with *Corymbia terminalis*, *C. aparrerinja*, *Eucalyptus leucophloia* and *Atalaya hemiglauca* with scattered shrubs of *Acacia chisholmii* and a sparse ground layer of *Triodia pungens* and tussock grasses. Occurs on broad low hills; metamorphosed igneous rocks.	**1.11.2a**: LC **1.11.3a:** LC	**1.11.2a:** NC **1.11.3a:** NC
1.11.2a/1.7.7a	70/30	**1.11.2a:** *Eucalyptus leucophloia* low open woodland often with *Corymbia terminalis*, *Corymbia capricornia*, *Terminalia aridicola* and *Eucalyptus leucophylla* with shrub layer of Acacia spp. and ground layer of Triodia spp. Occurs on steep hills and strike ridges. **1.7.7a:** Low open woodland of Corymbia capricornia, often with *Eucalyptus leucophloia*. Mixed shrub layer usually including *Grevillea wickhamii*. Ground layer of *Triodia pungens* and/or *Triodia bitextura*. Occurs on silcrete	**1.11.2a**: LC **1.7.7a:** LC	**1.11.2a:** NC **1.7.7a:** NC
1.11.3a	100	*Eucalyptus leucophylla* low open woodland often with *Corymbia terminalis*, *C. aparrerinja*, *Eucalyptus leucophloia* and *Atalaya hemiglauca* with scattered shrubs	LC	NC

Regional Ecosystems	Percentages	Short Description	VM Status*	BD Status#
		of *Acacia chisholmii* and a sparse ground layer of *Triodia pungens* and tussock grasses. Occurs on broad low hills; metamorphosed igneous rocks.		
1.11.3a/1.3.13a	90/10	**1.11.3a:** *Eucalyptus leucophylla* low open woodland often with *Corymbia terminalis*, *C. aparrerinja*, *Eucalyptus leucophloia* and *Atalaya hemiglauca* with scattered shrubs of *Acacia chisholmii* and a sparse ground layer of *Triodia pungens* and tussock grasses. Occurs on broad low hills; metamorphosed igneous rocks. **1.3.13a:** Woodland of *Eucalyptus leucophylla*, commonly with *Corymbia terminalis*, *Acacia cambagei*, *Atalaya hemiglauca* and *C. aparrerinja.* Occasional canopy species include *Corymbia confertiflora*, *Lysiphyllum cunninghamii* and *Eucalyptus pruinosa*. The ground layer is a mix of tussock grasses and Triodia spp. Occurs on recent levees of larger watercourses and in-channel deposits of ephemeral streams.	**1.11.3a:** LC **1.3.13a:** LC	**1.11.3a:** NC **1.3.13a:** NC
1.11.7	100	*Acacia cambagei* low woodland. Occurs on metamorphic hills and ranges. Not a Wetland.	OC	OC
1.11.2a	100	*Eucalyptus leucophloia* low open woodland often with *Corymbia terminalis*, *Corymbia capricornia*, *Terminalia aridicola* and *Eucalyptus leucophylla* with shrub layer of Acacia spp. and ground layer of Triodia spp. Occurs on steep hills and strike ridges.	LC	NC
1.11.3a/1.3.13a	90/10	**1.11.3a:** *Eucalyptus leucophylla* low open woodland often with *Corymbia terminalis*, *C. aparrerinja*, *Eucalyptus leucophloia* and *Atalaya hemiglauca* with scattered shrubs of *Acacia chisholmii* and a sparse ground layer of *Triodia pungens* and tussock grasses. Occurs on broad low hills; metamorphosed igneous rocks. **1.3.13a:** Woodland of *Eucalyptus leucophylla*, commonly with *Corymbia terminalis*, *Acacia cambagei*, *Atalaya hemiglauca* and *C. aparrerinja.* Occasional canopy species include *Corymbia confertiflora*, *Lysiphyllum cunninghamii* and *Eucalyptus pruinosa*. The ground layer is a mix of tussock grasses and Triodia spp. Occurs on recent levees of larger watercourses and in-channel deposits of ephemeral streams.	**1.11.3a:** LC **1.3.13a:** LC	**1.11.3a:** NC **1.3.13a:** NC

Regional Ecosystems	Percentages	Short Description	VM Status*	BD Status#
1.5.4a	100	*Corymbia terminalis* low open woodland, scattered shrub layer of *Carissa lanceolata* and tussock grass ground layer. *Eucalyptus pruinosa* is commonly present in the north. Occurs on older alluvial and residual soils with significant clay content.	LC	NC

Key: E = Endangered, OC = Of Concern, LC = Least Concern, NC = No Concern

3.1.10.7.2.3. Regulated Vegetation

Regulated vegetation is vegetation managed through the VM Act. Vegetation classifications described by the VM Act as being Category A, Category B, Category C, Category R or Category X are required to meet certain criteria prior to impact.

The entire DRM ML is mapped as Category B remnant vegetation. Category B vegetation is defined as vegetation, that is either an endangered, of concern or least concern regional ecosystem forming the predominant canopy of the vegetation:

- covering more than 50% of the undisturbed predominant canopy;
- averaging more than 70% of the vegetation's undisturbed height; and
- composed of species characteristics of the vegetation's undisturbed predominant canopy.

3.1.10.7.2.4. EVNT or Special Least Concern Species under the NC Act

Table 25 details EVNT or Special Least Concern Species listed under the NC Act, with potential to occur within 50 km of the Project.

Table 25. EVNT or Special Least Concern Species under the NC Act

Common Name (Scientific Name)	NC Act[1]	Source	Likelihood of Occurrence
Plants			
Ipomoea antonschmidii	NT	WO	**Possible** – There are several records within a 50 km buffer from a central point within the Project area. The initial population is ~40 km to the east of the Project area. A newer population has been found ~100 km northwest of the Project area.
Mt Isa Mallee (Eucalyptus nudicaulis)	E	PMST	**Unlikely** – No records exist within a 50 km buffer from a central point within the Project area. The 50 km buffer falls outside of the extent of occurrence identified within the conservation advice for the species.
Ptilotus maconochiei	NT	WO	**Unlikely** - One record exists approximately 40 km west of the Project area. The majority of records are centred around Mount Isa.
Birds			
Australian Painted Snipe (*Rostratula australis*)	E	PMST, ALA	**Possible** - one record exists approximately 40 km southwest of the Project area.
Carpentarian Grasswren (*Amytornis dorotheae*)	E	PMST, WO, ALA	**Possible -** One record is located approximately 40 km northwest of the Project area.

Common Name (Scientific Name)	NC Act[1]	Source	Likelihood of Occurrence
Purple-crowned Fairy-wren (*Malurus coronatus*)	V	WO	**Possible** - One record exists within a 50 km buffer of a central point within the Project area.
Gouldian Finch (*Erythrura gouldiae*)	E	PMST	**Unlikely** - no records exist within a 50 km buffer of a central point within the Project area.
Grey Falcon (*Falco hypoleucos*)	V	PMST, WO	**Unlikely –** There are two records within 50 km of a central point within the Project area. However, due to the low density of the species, it is considered unlikely to occur in the Project area.
Night Parrot (*Pezoporus occidentalis*)	E	PMST	**Unlikely -** no records exist within a 50 km buffer of a central point within the Project area. The nearest record is over 250 km south of the site.
Painted Honeyeater (*Grantiella picta*)	V	PMST	**Unlikely** – there are two records within a 50 km buffer of a central point within the Project area.
Red Goshawk (*Erythrotriorchis radiatus*)	E	PMST	**Unlikely** - No records exist within a 50 km buffer of a central point within the Project area.
Mammals			
Purple-necked rock-wallaby (*Petrogale purpureicollis*)	V	WO, ALA	**Likely** – 23 records exist within a 50 km buffer of a central point within the Project area.
Short-beaked echidna (*Tachyglossus aculeatus*)	SL	WO, ALA	**Likely** - Four records exist within a 50 km buffer of a central point within the Project area. This species is widely distributed and utilizes a variety of habitats across its range.
Ghost Bat (*Macroderma gigas*)	E	PMST	**Unlikely -** No records exist within a 50 km buffer of a central point within the Project area. The habitat on site may be suitable if roosting structures are available
Greater Bilby (Macrotis lagotis)	E	PMST	**Unlikely** - No records exist within a 50 km buffer of a central point within the Project area. The nearest record in the ALA database is approximately 250 km southwest of the site.
Julia Creek Dunnart (Sminthopsis douglasi)	E	PMST	**Unlikely -** No records exist within a 50 km buffer of a central point within the Project area. Most records for this species are centred around Julia Creek, with occasional outliers.
Reptiles			

Common Name (Scientific Name)	NC Act[1]	Source	Likelihood of Occurrence
Mertens' water monitor (*Varanus mertensi*)	E	WO	**Possible** – Six records exist within 50 km buffer of a central point within the Project area. Several records are located along the Dugald River.
Gulf Snapping Turtle (Elseya lavarackorum)	V	PMST	**Unlikely -** No records exist within a 50 km buffer of a central point within the Project area. The nearest population is over 225 km northwest of the site.
Plains Death Adder (*Acanthophis hawkei*)	V	PMST	**Unlikely** - No records exist within a 50 km buffer of a central point within the Project area. The site is likely unsuitable habitat as this species favours habitat that is flat, while the site is geographically complex.

Key: V = Vulnerable, E = Endangered, SL = Special Least Concern, NT = Near Threatened.

Figure 10. Matters of State Environmental Significance

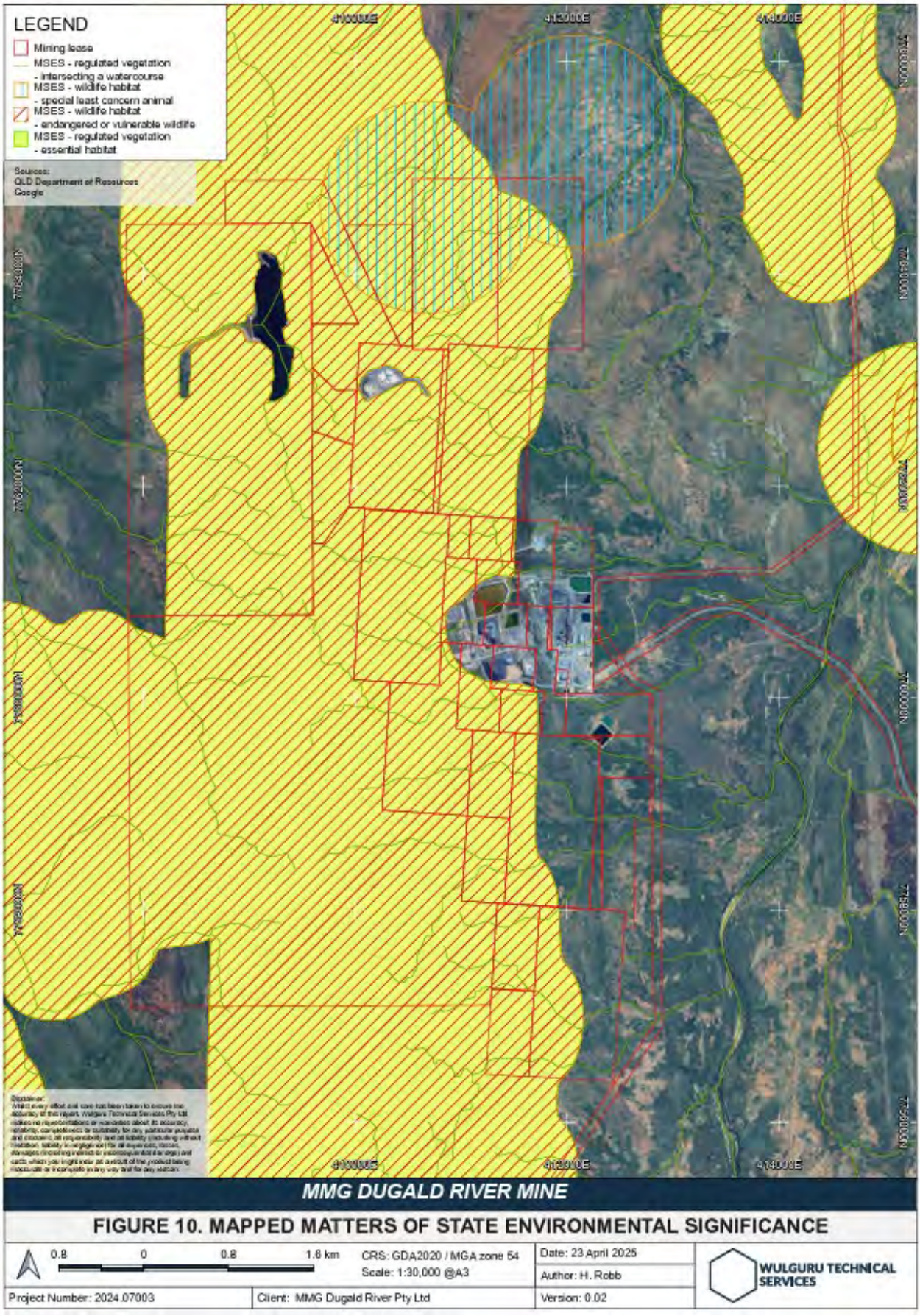
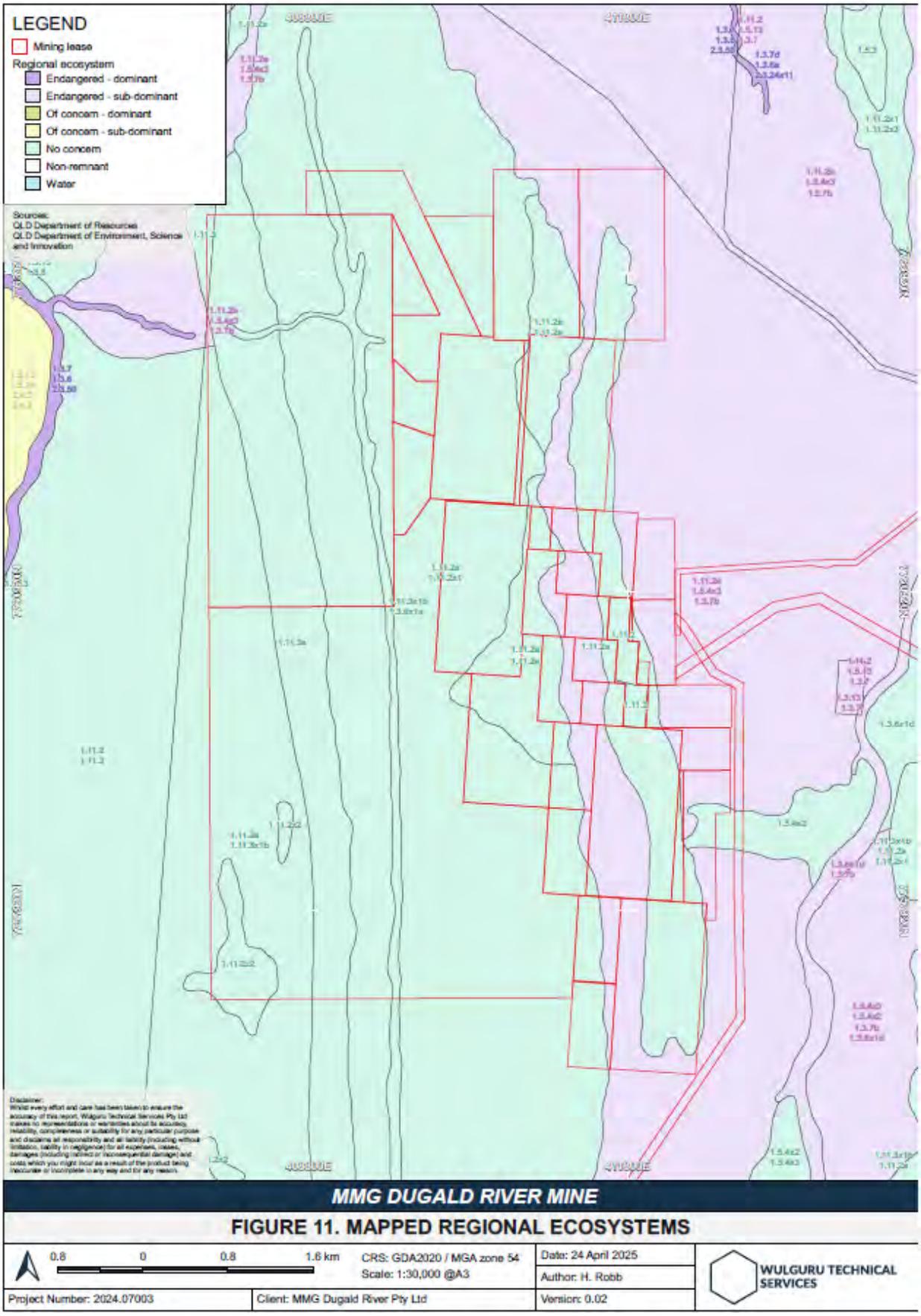


Figure 11. Regional ecosystems



3.2. Community

3.2.1. Community Profile

Cloncurry is the closest township to the Project, located approximately 65 km southeast of the Project. The 2021 Census recorded 3,644 people in the population, 56.6% male and 43.4 % female with a median age of 34. The labour force was recorded to be 1,904 people, with 64.9 % working full time. Technicians and Trades Workers was the largest employment industry (19.8%) followed by Machinery Operators and Drivers (17.9%) (ABS, 2021).

The nearest regional centre is Mount Isa, located 80 km southwest of DRM. Mount Isa has a population of over 18,000 and is the administrative, commercial, and industrial centre for north-western Queensland. As of the 2021 Census, the population was 18,727, with a median age of 31 with 51.6% male and 48.4 % female. The labour force was recorded to be 9,790 people, 70.4 % working full time. Technicians and Trades Workers was the largest employment industry at 20.8 % of the working population (ABS, 2021).

The Project employs approximately 700 employees and contractors with a mix of fly-in, fly-out workforce and local Cloncurry residents.

3.2.2. Community Consultation Plan

MMG has a Community and Social Performance Standard (Appendix B), which defines a range of programs that are implemented to meet community expectations. Within this, is a dedicated Community Engagement Plan (CEP) (Appendix C). This CEP documents the iterative consultation process to be followed to enable ongoing engagement with relevant stakeholders.

DRM has a dedicated Community and Stakeholder Advisor, to manage relationships with external stakeholders. In addition to the CEP, a Community Consultative Committee has been established and meets quarterly. The committee acts as a conduit between DRM and its key stakeholders, for sharing information and receiving feedback. The committee currently includes the following members:

- Commerce North West;
- Cloncurry Business Committee Representatives from the local Government;
- Representatives from the Kalkadoon, Mitakoodi and Mayi groups; and
- Pastoralists/landowners.

A community consultation register (Table 26) has been developed and will continue to be updated throughout the life of mine. In 2023, MMG completed targeted consultation with the landholders and Kalkadoon People regarding the PRCP, post mining land uses and the addition of the wind farm. Both parties were supportive of the proposed post mining land uses across the entire Project.

Table 26. Stakeholder consultation register

Activity date	Stakeholder	Communication type	Information provided	Discussion outcomes / issues raised	How issues have been considered	Decisions / outcomes of engagement	Commitment to stakeholder
4 July 2023	Kalkadoon People #4	In person meeting – Coffee Club Mount Isa	Mapping of proposed changes to PMLU	Proposed change to PMLU across the Project	Discussion during meeting.	Mr Kirkhoff, on behalf of the Kalkadoon People, support the change.	Submit application for revised PMLU – completed and approved November 2024.
23 October 2023	Landholder – McMillian family representatives.	In person meeting – Quamby Pub	Mapping of proposed changes to PMLU	Proposed change to PMLU across the Project	Discussion during meeting.	The McMillian family support the change.	Submit application for revised PMLU – completed and approved November 2024.

3.3. Post Mining Land Use

Land must be rehabilitated to a stable condition as defined in section 11A of the EP Act. Land is in a stable condition if:

- the land is safe and structurally stable, and
- there is no environmental harm being caused by anything on or in the land, and
- the land can sustain a Post Mining Land Use (PMLU).

A PMLU is defined under the EP Act as the purpose for which the land will be used after all relevant activities have ceased. The PMLU must be consistent with the outcome of consultation with the community and any strategies for the land of a local government, the State or Commonwealth (Department of Environment and Science, 2021).

3.3.1. Rehabilitation Areas

Project activities are grouped in this PRCP by Rehabilitation Areas (RAs), defined under the Progressive Rehabilitation and Closure Plans guideline as "*an area of land in the PMLU to which a rehabilitation milestone for the post-mining use relates".*

The RAs for the Dugald River Mine are detailed in Table 27 and mapped in Figure 12 and Figure 13.

Table 27. Rehabilitation areas

Rehabilitation Area	Area (ha)
RA1 – Ancillary infrastructure and services	**19.76**
Accommodation village	13.60
Pipeline and accommodation village road	6.00
Pipeline catch dam	0.16
RA2 – Borrow pits and stockpiles	**43.84**
Topsoil Stockpile A	8.23
Borrow Pit A	2.96
Access Road Borrow Pit(s)	4.72
TSF Borrow Pit A, TSF Borrow Pit B, TSF Stockpile	4.10
Topsoil Stockpile B	9.60
TSF Borrow Pit C	9.23
Borrow Pit D	2.06
Borrow Pit E	2.95
RA3 – Dams and diversion structures	**32.28**
Diversion Drains	2.39
Stage 2 PAF PAD Run Off Dam	11.60
Underground Mine Water Collection Dam	0.65
STP Dam Stage 1	0.9
STP Dam Stage 2	4
ROM Area Run Off Dam	3.7
Raw Water Dam	1.8

Rehabilitation Area	Area (ha)
Sediment Dam A	1.1
Process Plant Run Off Dam	1.5
Containment Dam	0.6
Mine Workshop Run Off Dam	0.6
Sediment Dam C	0.30
Sediment Dam D	0.35
Sediment Dam F	1.4
Sediment Dam G	1.4
RA4 - Mineralised waste	**22.56**
NAF WRD	8
PAF WRD	14.56
RA5 – Mining and processing area	**180.78**
ROM pad	3.8
ROM haul road	3.53
Processing plant and conveyor area	13.53
Underground portal and support infrastructure	2.94
Switchyard 1 and 2	2.03
Construction Laydown, Warehouse, Mobile Equipment Laydown and Core Shed	6.8
Office and administration services	2.72
Exploration camp	2.41
Sewage treatment plants	0.16
Workshop and vehicle maintenance	3.80
Raw water pipeline	5.44
Emergency response training	0.5
Explosives magazine	0.6
Communication tower	0.06
Powerlines	65.72
Roads and tracks	47.98
Groundwater infrastructure	0.54
Fuel storage	0.2
West laydown area	10.3
Waste transfer station	0.25
Temporary waste laydown	1
Laydown east	6.47
RA6 - TSF	**109.88**
TSF and seepage collection pond	103.51
TSF pipelines and roads	6.37
RA7 – Renewable Energy Infrastructure	**67.07**
Wind farm pads and ancillary infrastructure	27.86
Roads and tracks (Knapdale Range)	33.08
Laydown west	6.13

Figure 12. Reference Map A

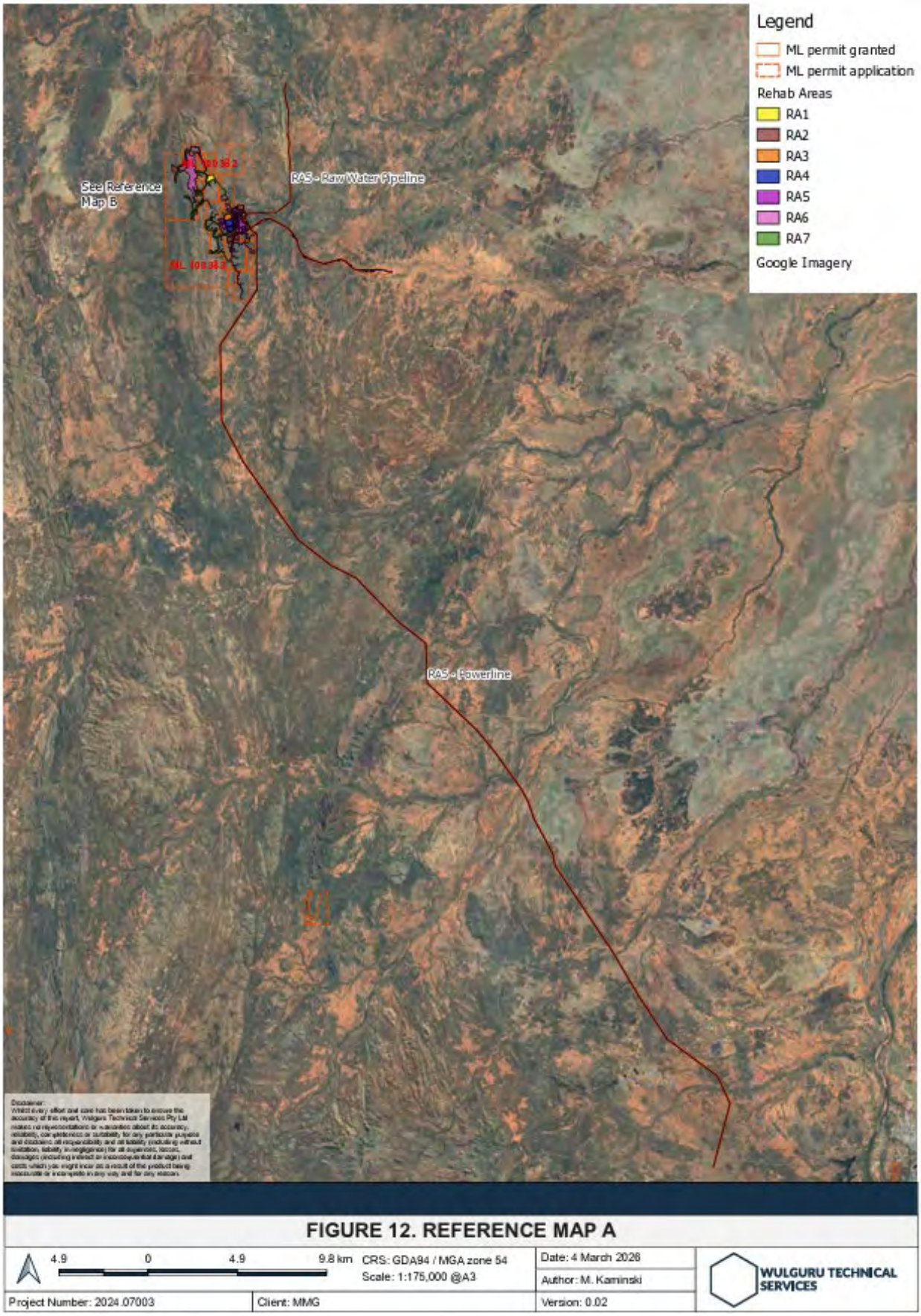
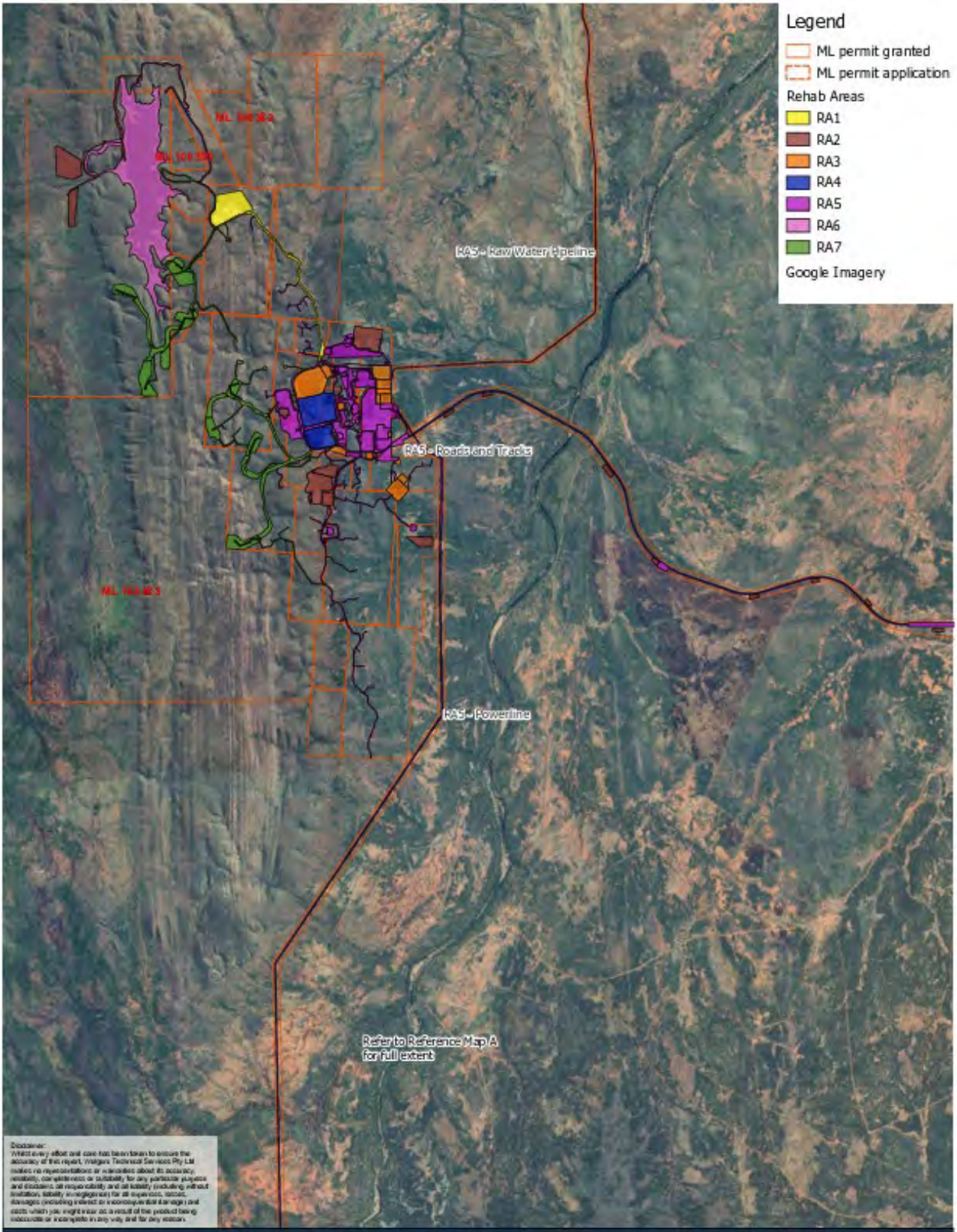


Figure 13. Reference Map B



3.3.2. Existing Rehabilitation

Exploration disturbance is rehabilitated, within 12 months of disturbance activities. Over the course of operations, the location of exploration disturbance will vary however the rehabilitation strategy will remain the same. All exploration disturbance will be completed in accordance with the EA and the *Code of Environmental Compliance for Exploration and Mineral Development*. Land will be rehabilitated to a stable condition that achieves the relevant post mine land use designated for location of disturbance.

3.3.3. Assessment of PMLU Options

As part of the assessment of PMLUs it is acknowledged that the EP Regulation requires that each PMLU:

a) Is viable having regard to the use of land in the surrounding region, and

b) Satisfies at least one of the following:

   a. the use is consistent with how the land was used before a mining activity was carried out on the land;

   b. the use is consistent with a development approval relating to the land;

   c. the use is consistent with a use of the land, other than a use that is mining, permitted under a State or Commonwealth Act, including, for example, a planning instrument under the Planning Act 2016; and

   d. the use will deliver, or is aimed at delivering, a beneficial environmental outcome.

Low intensity grazing was determined to be the most suitable PMLU for the majority of the Project. This was determined by considering the existing rehabilitation objectives specified in the EA and, community consultation, as well as its environmental, economic, and social benefits. Where the topography inhibits cattle grazing (slopes >10%), native ecosystem was proposed as the most suitable PMLU. Table 28 lists the previously approved PMLU for each mine domain. PMLUs are discussed further in Section 3.3.

This revision of the PRCP does not propose any change to previously accepted PMLUs.

Table 28. Mine domains and agreed PLMU

	Mine Domain	PMLU
RA1	Ancillary infrastructure and services	Native ecosystem
RA2	Borrow pits and stockpiles	Low intensity grazing
RA3	Dams and diversion structures	Low intensity grazing
RA4	Mineralised waste	Low intensity grazing
RA5	Mining and processing area	Low intensity grazing
RA6	TSF	Native ecosystem
RA7	Renewable energy infrastructure	Native ecosystem

Table 29 describes how these PMLU's meet the requirements of the EP Regulation.

Table 29. Requirements of a PMLU

Requirement of a PMLU	Justification
The land is safe and structurally stable, and	All infrastructure will be removed and landforms (e.g. Waste dumps) will be returned to a pre-mining profile. The only feature to remain is the TSF. The final landform of the TSF has been designed by suitably qualified persons. After initial rehabilitation, structures will continue to be monitored by suitably qualified persons to assess stability. Erosion monitoring will be conducted to assess stability. The flat areas (<10% slope) will be made safe to support cattle grazing. The natural steep slopes of the Knapdale range inhibit cattle from accessing RA1, RA6 and RA7. These domains have an assigned PMLU of native ecosystem. During rehabilitation, areas may be fenced to prevent cattle grazing until vegetation has established and the landform is unlikely to cause erosion and sedimentation. There will be no voids or water management structures retained after closure.
There is no environmental harm being caused by anything on or in the land, and	All contaminants will be removed from site. A contaminated land assessment will be conducted following rehabilitation activities to verify the removal of contaminants. All infrastructure and waste will be removed from site during the demolition phase of rehabilitation. All Potentially Acid Forming (PAF) material will be returned to the underground mine void. Water from storage dams will be removed through evaporation and any contaminated sediment will be removed from site. The site will be revegetated to reduce the possibility of erosion. Ongoing surface and groundwater monitoring will be conducted to assess the potential for environmental harm.
The land can sustain a Post Mining Land Use (PMLU).	The proposed PMLU of low intensity cattle grazing is consistent with surrounding land uses. It is also consistent with the Cloncurry Shire Planning Scheme, rural zone. The PMLU of native ecosystem for RA1, RA6 and RA7 is consistent with the pre-mining land use of these areas.

Requirement of a PMLU	Justification
The PMLU is viable having regard to the use of land in the surrounding region, and	The Cloncurry Shire is a significant beef producing region. The proposed PMLU of low intensity cattle grazing is consistent with previous and current land uses in the area. The PMLU of native ecosystem for RA1, RA6 and RA7 is consistent with the pre-mining land use of the area.
The PMLU satisfies at least one of the following: a. the use is consistent with how the land was used before a mining activity was carried out on the land; b. the use is consistent with a development approval relating to the land; c. the use is consistent with a use of the land, other than a use that is mining, permitted under a State or Commonwealth Act, including, for example, a planning instrument under the Planning Act 2016; and d. the use will deliver, or is aimed at delivering, a beneficial environmental outcome.	The proposed PMLUs of low intensity cattle grazing and native ecosystem are consistent with how the land was used before a mining activity was carried out on the land. The PMLUs presented within this PRCP have been previously approved. This revision does not propose any change to any PMLU.

3.3.3.1. Community Consultation

The proposed PMLUs of native ecosystem and grazing are consistent with the community consultation conducted to date, in that they are:

- Consistent with the land use prior to the commencement of mining activities;
- Consistent with the surrounding land use; and
- Compatible with, and beneficial to, the current underlying landholder activities.

In 2023, MMG consulted with the landholders and Kalkadoon People regarding the PRCP, post mining land uses and the addition of the wind farm. Both parties were supportive of the proposed post mining land uses across the entire Project.

There are currently no agreements with landholders for any infrastructure to be retained for future land use.

As this revised PRCP does not propose any change to PMLUs or rehabilitation methods/outcomes, no additional targeted community consultation has been completed for this revision.

3.3.3.2. Regional Planning Integration

3.3.3.2.1. Cloncurry Shire Planning Scheme

Under the Cloncurry Shire Planning Scheme 2016 (the Planning Scheme), the Project is within the Rural zone (Cloncurry Shire Council, 2017). The overall purpose of the Rural zone of the Cloncurry Shire is to:

- Provide for rural uses and activities;
- Provide for other uses and activities that are compatible with –
    - Existing and future rural uses and activities;
    - The character and environmental features of the zone;
- Maintain the capacity of land for rural uses and activities by protecting and managing significant natural resources and processes.

The proposed PMLUs of native ecosystem and grazing are compatible with the planning scheme.

3.3.3.2.2. Regional Strategies

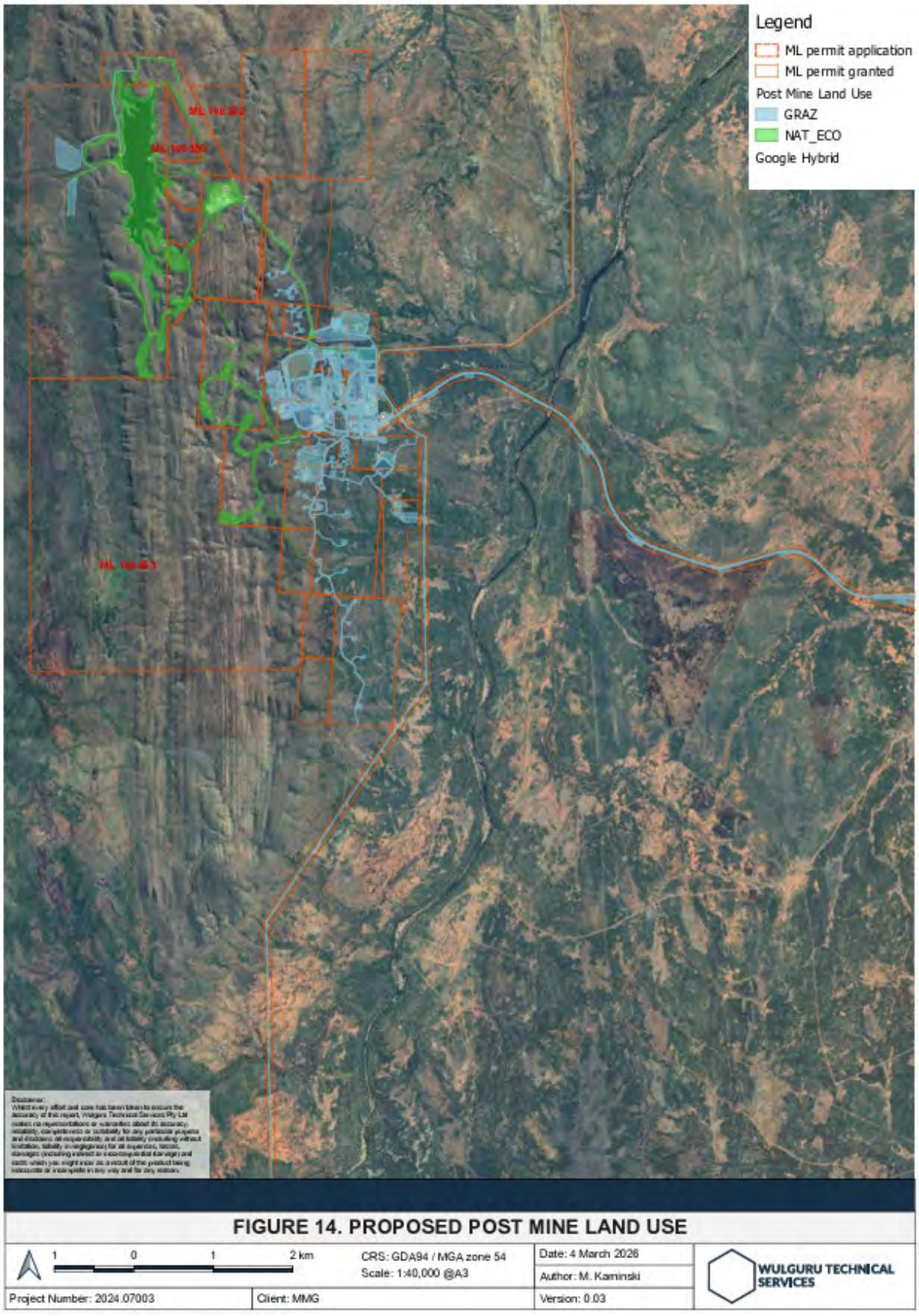
The North West Regional Plan (DIP, 2010) identifies both mining and beef production as significant primary industries with long histories in the region. The plan identifies the need to manage the cyclical nature of mining by ensuring that its development complements other industries. The plan also places importance on cultivating a natural environment that is resilient to the impacts of climate change and one that is well managed to maintain biodiversity, ecological processes, water resources and scenic amenity.

The proposed PMLUs of grazing and native ecosystem are compatible with the North West Regional Plan in that they provide an alternative land use (grazing), that is complementary to the mining industry and provides positive environmental outcomes.

Similar to the North West Regional Plan, the Cloncurry Shire Council Economic Development Strategy identifies mining and agriculture as key contributors to the regional economy, as the two highest employment industries. The strategy highlights future development of the beef industry with the potential for expanded saleyards, and beef processing and feed lotting facilities being investigated.

The proposed PMLU of grazing is consistent with the Cloncurry Shire Council Economic Development Strategy.

Figure 14. Proposed post mine land uses



3.3.4. Proposed PMLU

3.3.4.1. RA1 – Ancillary Infrastructure and Services

3.3.4.1.1. Overview

This RA includes the accommodation village, pipeline, catch dam and associated roads on the northern section of the ML. The RA is situated on the crest of the Knapdale Range. The area will be ripped however will not be topsoiled, consistent with the natural profile of the Knapdale Range. Revegetation will target species of regional ecosystem 1.11.2a/1.7.7a, consistent with the pre-clearance environment. Target species include *Eucalyptus leucophloia*, *Corymbia terminalis* and *Corymbia capricornia* with a groundcover of *Aristida latifolia*, *Eriachne obtusa*,*Sporobolus australasicus*,*Themeda triandra* and *Triodia pungens*. The target regional ecosystems will support native fauna populations, in keeping with the surrounding habitats. Features such as large woody debris or boulders will be selectively placed to provide suitable refuge for the purple neck rock wallaby.

3.3.4.1.2. Outcome

The PMLU for Ancillary Infrastructure and Services is native ecosystem.

3.3.4.1.3. Environmental Benefit

Revegetation will target species of regional ecosystem 1.11.2a/1.7.7a, consistent with the pre-clearance environment. This will establish connectivity with the surrounding environment. The revegetated area will provide additional habitat and foraging for the purple neck rock wallaby, which is known to inhabit the surrounding area.

3.3.4.1.4. Economic Benefit

The PMLU of native ecosystem does not have a direct economic benefit.

3.3.4.1.5. Social Benefit

The social benefit of re-establishing native ecosystem is the aesthetic appearance and cohesion with the surrounding environment.

3.3.4.2. RA2 – Borrow Pits and Stockpiles

3.3.4.2.1. Overview

RA2 of the Project includes borrow pits and topsoil stockpiles. Once borrow pits have been exhausted, the area will be reshaped, where required, to prevent water ponding and erosion. Topsoil stockpiles will be utilised in rehabilitation activities. The underlying footprint will be ripped and seeded.

3.3.4.2.2. Outcome

The proposed PMLU for the RA2 is low intensity grazing.

3.3.4.2.3. Environmental Benefit

The establishment of low intensity grazing will provide a coverage of vegetation, which will minimise the chance of erosion as a result of runoff. The establishment of pasture on the domains will also limit the amount of fuel load, reducing the impact of potential bushfires.

The pasture covered PMLU may provide a food source for native fauna. The pasture cover will produce seed and flowers throughout the seasons, which may be utilised by native fauna, therefore helping support local ecosystems.

Additionally, other than occasional watering during closure, no further activities would be required to form a stable landform consistent with grazing.

3.3.4.2.4. Economic Benefit

Establishing grazing pastures will result in a lower cost of direct seeding and a quicker establishment of adequate vegetation cover, potentially leading to an earlier relinquishment of the ML.

Additionally, the future landowners of the Project area will likely be pastoralists as per the surrounding land uses. Rehabilitating RA2 to low-intensity grazing will create additional grazing areas, leading to a direct increase in the economic benefit to the future landholder.

3.3.4.2.5. Social Benefit

Future landholders will likely be pastoral holdings. Returning the land to grazing pastures will result in a PMLU that is consistent with surrounding land uses.

3.3.4.3. RA3 – Dams and Diversion Structures

RA3 of the Project include diversion drains, sediment dams, PAF runoff dam, infrastructure runoff dams, STP dams, and raw water dams. At this stage there are no formal landholder agreements to retain any dams onsite. As such, water and sediment will be removed from dams and the dams will be filled with NAF or other suitable material. The landform will be shaped to be gently sloping, characteristic of the natural landform with drainage reinstated. The footprint will be ripped and seeded.

3.3.4.3.1. Outcome

The proposed PMLU for the RA3 is low intensity grazing.

3.3.4.3.2. Environmental Benefit

The establishment of low intensity grazing will provide a coverage of vegetation, which will minimise the chance of erosion as a result of runoff. The establishment of pasture on the domains will also limit the amount of fuel load, reducing the impact of potential bushfires.

The pasture covered PMLU may provide a food source for native fauna. The pasture cover will produce seed and flowers throughout the seasons, which may be utilised by native fauna, therefore helping support local ecosystems.

Additionally, other than occasional watering during closure, no further activities would be required to form a stable landform consistent with grazing.

3.3.4.3.3. Economic Benefit

Establishing grazing pastures will result in a lower cost of direct seeding and a quicker establishment of adequate vegetation cover, potentially leading to an earlier relinquishment of Mine Leases.

Future landowners of the Project area will likely be pastoralists as per the surrounding land uses. Rehabilitating to low-intensity grazing will provide an additional grazing area, leading to a direct increase in the economic benefit to the future landholder.

Additionally, other than occasional watering during closure, no further activities would be required to form a stable landform consistent with grazing.

3.3.4.3.4. Social Benefit

Future landholders will likely be pastoral holdings. Returning the land to grazing pastures will result in a PMLU that is consistent with surrounding land uses.

3.3.4.4. RA4 – Mineralised Waste Dumps

RA4 of the Project includes the PAF waste rock dump, NAF waste rock dump and the temporary ore stockpile. At the end of mine life, material from the PAF waste rock dump will be returned underground as part of the stope filling. Approximately 0.5 m of material will be excavated from the footprint of the PAF waste rock dump and disposed of in the TSF.

NAF waste rock will be removed and used as cover material for the TSF. NAF material may also be used to rehabilitate other areas onsite (eg. infill dams). A materials balance is provided in Table 32.

Once the material has been removed, the footprint of each of the WRDs will be graded to conform to the surrounding landscape. Topsoil will be applied at 0.1 - 0.2 m depth and the areas will be ripped and seeded with pasture species.

3.3.4.4.1. Outcome

The proposed PMLU for the RA4 is low intensity grazing.

3.3.4.4.2. Environmental Benefit

The establishment of low intensity grazing will provide a coverage of vegetation, which will minimise the chance of erosion as a result of runoff. The establishment of pasture on the domains will also limit the amount of fuel load, reducing the impact of potential bushfires.

The pasture covered PMLU may also provide a food source for native fauna. The pasture cover will produce seed and flowers throughout the seasons, which may be utilised by native fauna, therefore helping support local ecosystems.

Additionally, other than occasional watering during closure, no further activities would be required to form a stable landform consistent with grazing.

3.3.4.4.3. Economic Benefit

Establishing grazing pastures will result in a lower cost of direct seeding and a quicker establishment of adequate vegetation cover, potentially leading to an earlier relinquishment of Mine Leases.

Future landowners of the Project area will likely be pastoralists as per the surrounding land uses. Rehabilitating to low-intensity grazing will provide an additional grazing area, leading to a direct increase in the economic benefit to the future landholder.

Additionally, other than occasional watering during closure, no further activities would be required to form a stable landform consistent with grazing.

3.3.4.4.4. Social Benefit

Future landholders will likely be pastoral holdings. Returning the land to grazing pastures will result in a PMLU that is consistent with surrounding land uses.

3.3.4.5. RA5 – Mining and Processing Areas

RA5 of the Project includes ROM haul roads, processing plant, sewage treatment plant, battery farm, vehicle maintenance area and laydown yards. To achieve the nominated PMLU, domain infrastructure such as concrete hardstands, buildings, telecommunications, electrical supply etc., will be decommissioned and removed. With infrastructure removed, the landform will be shaped to be a stable, free draining landform. Topsoil will be applied at 0.1 - 0.2 m depth and the areas will be ripped and seeded with pasture species.

3.3.4.5.1. Outcome

The proposed PMLU for the RA5 is low intensity grazing.

3.3.4.5.2. Environmental Benefit

The establishment of low intensity grazing will provide a coverage of vegetation, which will minimise the chance of erosion as a result of runoff. The establishment of pasture on the domains will also limit the amount of fuel load, reducing the impact of potential bushfires.

The pasture covered PMLU may provide a food source for native fauna. The pasture cover will produce seed and flowers throughout the seasons, which may be utilised by native fauna, therefore helping support local ecosystems.

Additionally, other than occasional watering during closure, no further activities would be required to form a stable landform consistent with grazing.

3.3.4.5.3. Economic Benefit

Establishing grazing pastures will result in a lower cost of direct seeding and a quicker establishment of adequate vegetation cover, potentially leading to an earlier relinquishment of MLs.

Future landowners of the Project area will likely be pastoralists as per the surrounding land uses. Rehabilitating to low-intensity grazing will provide an additional grazing area, leading to a direct increase in the economic benefit to the future landholder.

Additionally, other than occasional watering during closure, no further activities would be required to form a stable landform consistent with grazing.

3.3.4.5.4. Social Benefit

Future landholders will likely be pastoral holdings. Returning the land to grazing pastures will result in a PMLU that is consistent with surrounding land uses.

3.3.4.6. RA6 – TSF

RA6 of the Project includes the Tailings Storage Facility and associated pipelines and seepage collection system.

3.3.4.6.1. Outcome

The proposed PMLU for RA6 is native ecosystem.

The TSF will be capped and revegetated with a mix of shallow rooting native species so as not to compromise the integrity of the sealing layer. The vegetation will act in removing moisture from the infiltration layer and prevent surface ponding and infiltration to subsequent layers of the TSF. Target species include *Aristida latifolia, Eriachne obtusa,Sporobolus australasicus,Themeda triandra* and *Triodia pungens.* The downstream embankment will be reshaped to create a safe, stable and non-polluting landform. Once monitoring indicates the absence of seepage, the seepage collection system will be rehabilitated, by removing contaminated sediment with the footprint graded, ripped and seeded.

3.3.4.6.2. Design

All infrastructure such as pumps and pipelines will be flushed and removed from site to be disposed of in a licenced waste facility. The final surface of the TSF will be shaped to be self-shedding. The tailings surface will be capped with a cover system that:

- Minimises infiltration to the maximum extent, such that seepage from the TSF is minimised.
- Minimises capillary rise from the tailings into the cover system, thereby contaminating the cover soils.
- Is physically stable
- Is chemically stable
- Is able to sustain a PMLU of native ecosystem.

The downstream embankment will be reshaped for stability. The spillway will be reinstated at RL 242.1 m acting as an outlet for the final TSF landform. Full details on the design of the TSF is provided in Appendix D.

3.3.4.6.3. Environmental Benefits

Revegetating with a mix of shallow rooting species will maintain the integrity of the capping layer and prevent potential contamination from tailings. Surface drainage will be directed over the cover system to the spillway outlets to allow continuous flow across the catchment.

3.3.4.6.4. Economic Benefit

The PMLU of native ecosystem does not have a direct economic benefit.

3.3.4.6.5. Social Benefit

The social benefit of re-establishing native ecosystem is the aesthetic appearance and cohesion with the surrounding environment.

3.3.4.7. RA7 – Renewable Energy Infrastructure

RA7 incorporates eight wind turbines, ancillary infrastructure such as cabling and meteorological masts, two laydowns and access roads.

3.3.4.7.1. Outcome

The proposed PMLU for RA7 is native ecosystem.

All infrastructure, including turbine components, hardstands, and underground and aboveground cabling, will be decommissioned and removed. All infrastructure will be decommissioned and disposed of in accordance with manufacturer's specifications and waste disposal regulations. No infrastructure will remain within the footprint of the wind farm.

During construction of the turbines, pads are required to be levelled for stability. Hardstands will be constructed for the assembly, construction and erection of the turbines. These hardstands will be retained throughout the life of operations for maintenance and decommissioning purposes. On closure, the hard stands will be removed. Each pad will be recontoured slightly to prevent water ponding. This will prevent water flows from accumulating and concentrating energy to create gullies. No other landform design or earthworks is required.

Revegetation will target species of regional ecosystem 1.11.2a/1.7.7a and RE1.11.3a/1.3.13a consistent with the pre-clearance environment. Target species include *Eucalyptus leucophloia*, *Corymbia terminalis* and *Corymbia capricornia* with a groundcover of *Aristida latifolia*, *Eriachne obtusa*,*Sporobolus australasicus*, *Themeda triandra* and *Triodia pungens*. The target regional ecosystems will support native fauna populations, in keeping with the surrounding habitats. Features such as large woody debris or boulders will be selectively placed to provide suitable refuge for the purple neck rock wallaby.

After infrastructure is removed, the natural landform will remain. Disturbances on the Knapdale Range will not be topsoiled, consistent with the natural profile of the range. The areas will be ripped and seeded with pasture species.

Access roads will be ripped and seeded as above.

3.3.4.7.2. Economic Benefit

The PMLU of native ecosystem does not have a direct economic benefit.

3.3.4.7.3. Social Benefit

The social benefit of re-establishing native ecosystem is the aesthetic appearance and cohesion with the surrounding environment.

3.4. Non-use management areas

There are no non-use management areas proposed for the Project.

3.5. Rehabilitation and Management Methodologies

The rehabilitation and management methodologies for each RA are described in Table 30. General rehabilitation principles are described further, throughout Section 3.5.

Table 30. Key rehabilitation activities

Rehabilitation Area	Relevant Activities	Rehabilitation Activities	Rehabilitation Timing	Rehabilitation Milestones
RA1 – Ancillary infrastructure and services	Accommodation village Remaining Ancillary Infrastructure and Services (e.g. warehousing, powerline, raw water pipeline etc)	• Decommission and remove infrastructure. • Remove all surfaces (concrete footings, culverts, road base etc.). • Conduct a contaminated land assessment. • Remove any contaminated material and dispose of at a licenced facility. • Complete validation sampling to determine success of contamination removal. • Shape landform to be free draining and of similar shape to the surrounding topography. • Rip landform parallel to landform contours. • Apply ~ 0.2m growth media. • Monitor to assess natural revegetation establishment. • Apply selected native vegetation seed mix • Monitor to assess rehabilitation success and whether the PMLU has been achieved.	• The accommodation village will become available for rehabilitation once mining activities have ceased and the mining and closure workforce is no longer required. • Available 2044	RM1 RM2 RM3 RM9 RM10 RM12 RM14
RA2 – Borrow pits and stockpiles	Borrow Pit Topsoil Stockpiles	• Borrow pits have previously been shaped to be stable and free draining post construction. Further shaping may be required if borrow pits are to be recommissioned or additional pits are utilised. • Remove topsoil and utilise in rehabilitation activities. • Rip landform parallel to landform contours. • Apply ~0.2m growth media. • Monitor to assess natural revegetation establishment. • Apply selected pasture seed mix. • Monitor to assess rehabilitation success and whether the PMLU has been achieved.	• Area will be available for rehabilitation once borrow pit and topsoil stockpiles have been exhausted. • Available 2050, after the TSF cover system has been applied.	RM4 RM9 RM11 RM13 RM15

Rehabilitation Area	Relevant Activities	Rehabilitation Activities	Rehabilitation Timing	Rehabilitation Milestones
RA3 – Dams and diversion structures	Dams and diversion structures	• Pump residual water to the TSF for evaporation. • Decommission any water management infrastructure (pumps, electricity supply etc.) and remove/dispose of. • Undertake assessment for contaminated sediment • Desilt dams and dispose of sediment to the TSF. • Remove liners if present. • Infill dams with inert material and shape landform to be free draining of similar shape to the surrounding topography. • Restore natural watercourses. • Rip landform parallel to landform contours. • Apply ~0.2m growth media. • Monitor to assess natural revegetation establishment • Apply selected pasture seed mix if natural revegetation has not been successful (<30% coverage of analogue site) • Monitor to assess rehabilitation success and whether the PMLU has been achieved.	• The runoff dam will be rehabilitated after associated areas (WRDs) have been revegetated. • Available 2051, after all mineral waste has been removed. • Sediment dams will be retained onsite until upstream landforms have been revegetated.	RM1 RM2 RM5 RM9 RM11 RM13 RM15
RA4 – Mineralised waste	Mineralised waste dumps	**Potentially Acid Forming Material** • Dispose of any PAF to underground • Excavate approximately 0.5m of material from underneath the PAF waste rock dumps and dispose within the TSF. • Undertake assessment for contaminated sediment. • Rip landform parallel to landform contours. • Apply ~0.2m growth media. • Monitor to assess natural revegetation establishment • Apply selected pasture seed mix.	• Any PAF remaining on the surface after closure will be returned underground before the portal is sealed. • The NAF waste rock dump will be rehabilitated concurrently with the TSF. • Available 2048 after the TSF has completed drying and is trafficable for placement.	RM2 RM6 RM9 RM11 RM13 RM15

Rehabilitation Area	Relevant Activities	Rehabilitation Activities	Rehabilitation Timing	Rehabilitation Milestones
		• Monitor to assess rehabilitation success and whether the PMLU has been achieved **Non-Acid Forming Material** • Remove NAF from dumps for use in rehabilitation of the TSF. • Undertake assessment for contaminated sediment. • Rip landform parallel to landform contours. • Apply ~0.2m growth media. • Monitor to assess natural revegetation establishment. • Apply selected pasture seed mix. • Monitor to assess rehabilitation success and whether the PMLU has been achieved		
RA5 – Mining and processing area	Mining and processing areas	• Remove surface infrastructure. • Undertake assessment for contaminated land and remediate if required. • Remove contaminated material and dispose in the TSF (if required). • Seal the portals and declines with a 5m long bulkhead. • Backfill the box cut void and portal with NAF waste rock. • Excavate approximately 0.5m of material from underneath the processing areas, and dispose of in the TSF • Rip landform parallel to landform contours. • Apply ~0.2m growth media. • Monitor to assess natural revegetation establishment.	• Ore may be processed after the cessation of mining activities. Processing areas will become available after all ore has been processed. • Available 2044 • The ROM, ROM haul roads, processing plant and conveyor area and powerlines will be retained until 2045 to allow processing of any residual ROM ore after closure.	RM1 RM2 RM6 RM9 RM11 RM13 RM15

Rehabilitation Area	Relevant Activities	Rehabilitation Activities	Rehabilitation Timing	Rehabilitation Milestones
		• Apply selected pasture seed mix. • Monitor to assess rehabilitation success and whether the PMLU has been achieved		
RA6 - TSF	Tailings Storage Facility and Seepage Detection System	**Seepage Detection System** • Water in seepage collection system is pumped back to the TSF (If any). • Complete ongoing monitoring of seepage rates and quality until seepage has ceased. • Decommission and remove infrastructure. • Undertake assessment for contaminated land and remediate if required. • Remove contaminated material and dispose in the TSF (if required). • Undertake assessment to determine if contaminated land had been successfully removed • Backfill the seepage detection pond, drain and sump with NAF waste rock. • Rip landform parallel to landform contours. • Apply ~0.2m growth media. • Monitor to assess natural revegetation establishment • Apply selected seed mix to support PMLU. • Monitor to assess rehabilitation success and whether the PMLU has been achieved **Tailings Storage Facility** • The tailings pipeline will be flushed, decommissioned and disposed of in a licenced facility.	• The TSF may remain active post mining cessation as processing of mined ore may continue until ore is depleted. TSF will be available for rehabilitation at the completion of processing. • Available 2044. Drying of tailings has been modelled to require four years.	RM1 RM7 RM9 RM10 RM12 RM14

Rehabilitation Area	Relevant Activities	Rehabilitation Activities	Rehabilitation Timing	Rehabilitation Milestones

		• Other TSF infrastructure (electrical equipment, water pump back pipelines etc.) to be decommissioned and removed.
		• Reshape TSF surface to achieve a grade of <1.5%.
		• Complete construction of cover system and spillway/erosion control features.
		• Reinstate spillway at RL 242.1m.
		• Conduct QA/QC testing at a rate of 1 sample per hectare to confirm depth of layers and permeability is as specified in the designs and no PAF material is present within the cover system.
		• Monitor to assess natural revegetation establishment
		• Apply selected native seed mix.
		• Install monitoring locations determined from rehabilitation trials, including:
		  • Meteorological station
		  • Piezometers within the tailings and capillary break layer
		  • Automated in situ water content and suction sensors in each layer of the cover system
		  • Temperature sensors
		  • A lysimeter.
		• Monitor to assess rehabilitation success and whether the PMLU has been achieved		

RA7 – Renewable energy infrastructure	Renewable Energy Infrastructure	• Decommission and remove infrastructure. • Remove all surfaces (concrete footings, culverts road base etc.). • Minor rounded at pad crests, where required.	• The renewable energy infrastructure will continue to be utilised to power the operation until all other infrastructure has been removed. • Available 2044	RM1 RM2 RM6 RM8 RM9

Rehabilitation Area	Relevant Activities	Rehabilitation Activities	Rehabilitation Timing	Rehabilitation Milestones
		• Locally stockpiled material from road and drainage development is replaced. • Monitor to assess natural revegetation establishment. • Apply selected native vegetation seed mix if natural revegetation has not been successful (<30% coverage of analogue site). • Monitor to assess rehabilitation success and whether the PMLU has been achieved.		RM10 RM12 RM14

3.5.1. Voids in Floodplains

There are no proposed voids associated with the Project.

3.5.2. Site Services

To ensure site safety, all services will be terminated, disconnected and isolated. Generators will be decommissioned and removed from site. Power substations will be removed, or sold or used as part of another project, and the switch room will be disconnected. Licenced contractors will remove sewerage to a licensed offsite facility. Telecommunication services will be disconnected and removed.

The infrastructure at the Project site will be decommissioned, removed, dismantled, or salvaged.

3.5.3. Built Infrastructure

After all services have been disconnected, built infrastructure will be demolished by a suitably qualified person and will be removed from site. All infrastructure will be transported and disposed to a facility authorised to receive the waste type. The infrastructure to be removed from site is detailed in Table 31.

Table 31. Built infrastructure

Rehabilitation/Improvement Area	Built Infrastructure	Decommissioning methodology
RA1 – Ancillary infrastructure and services	• Accommodation village and associated facilities • Pipeline and accommodation village road	• Electrical and mechanical disconnection from all building facilities. • Empty building contents, remove steel roofs, wall cladding, fencing and concrete slabs. • Dispose of building waste to offsite disposal facility authorised to receive waste. • Disposal of fuels and regulated waste to an offsite disposal facility authorised to receive waste. • Remaining infrastructure decommissioned, cut and removed from site to authorised disposal facility offsite. • Pipes flushed, cut, capped, and removed. • Road base removed.
RA2 – Borrow pits and stockpiles	• No built infrastructure present during LOM.	• Not applicable.

Rehabilitation/Improvement Area	Built Infrastructure	Decommissioning methodology
RA3 – Dams and diversion structures	• Pumps and pipelines • Liners	• Water removed from structures. • Pumps disconnected and removed from site. • Removal and disposal of synthetic liners to the TSF. • Pipes flushed, cut, capped, and removed.
RA4 – Mineralised waste	• No built infrastructure present during LOM.	• Not applicable.
RA5 – Mining and processing area	• ROM haul road • Processing plant and conveyor • Switchyards • Warehouse and core shed • Office and administration services • Exploration camp • Sewage treatment plants • Workshop and vehicle maintenance • Raw water pipeline • Explosives magazine • Communication tower • Powerlines • Fuel storage • Waste transfer station	• Disconnection and termination of all services at building boundaries e.g. Gas, electricity, and water. • Empty building contents, remove steel roofs, wall cladding, fencing and concrete slabs. • Dispose of building waste to offsite disposal facility authorised to receive waste. • Disposal of fuels and regulated waste to an offsite disposal facility authorised to receive waste. • Remaining infrastructure decommissioned, cut and removed from site to authorised disposal facility offsite. • Removal of any liquids and chemicals prior to demolition. • Decommission of the Processing Plant and related infrastructure (e.g. conveyor) • Pipes flushed, cut, capped, and removed. • Road base removed. • Demolition and removal of powerlines to Chumvale Power Station.
RA6 – TSF	• Pipelines • Pumps • Liners	• Pipes flushed, cut, capped, and removed. • Pumps disconnected and removed from site.

Rehabilitation/Improvement Area	Built Infrastructure	Decommissioning methodology
		• Removal and disposal of seepage detection pond liner to the TSF.
RA7 – Renewable Energy Infrastructure	• Wind turbine pads and ancillary infrastructure	• All infrastructure, including turbine components, hardstands, underground and aboveground cabling will be decommissioned and removed from site.

3.5.4. Contaminated Land Assessment

A contaminated land assessment is to be completed by a suitably qualified person, at all rehabilitation areas. Any contaminated material will be removed and disposed of at a licenced facility authorised to accept such waste, where required. Validation sampling will be completed to determine if the contaminant removal has been completed appropriately.

3.5.5. Site Preparation

Water storages and the TSF will be dewatered through enhanced evaporation.

Once all infrastructure and any contaminated material has been removed, the surface will be prepared to promote establishment of vegetation. Compacted surfaces will be deeply ripped to at least 300 mm into the soil profile. The application and incorporation of ameliorants such as gypsum, lime and other organic materials will be assessed based on the outcome of soil sampling at the time of use.

3.5.6. Material Assessment

3.5.6.1. Material Quantity and Quality

The materials required to successfully rehabilitate certain mine domains include topsoil and inert material (such as NAF waste rock). These materials shall provide armour between potential contaminants and supplement the growth of vegetation, reducing erosion and helping to sustain the PMLU. Material for rehabilitation will be sourced from site at locations shown in Figure 15.

A materials balance has been created, assuming that 0.1 to 0.2 m of topsoil will be required across all RAs. The materials balance and topsoil application rates will continue to be investigated over the LOM, utilising results from ongoing rehabilitation trials and monitoring. Further investigation will occur to determine alternative growth media options.

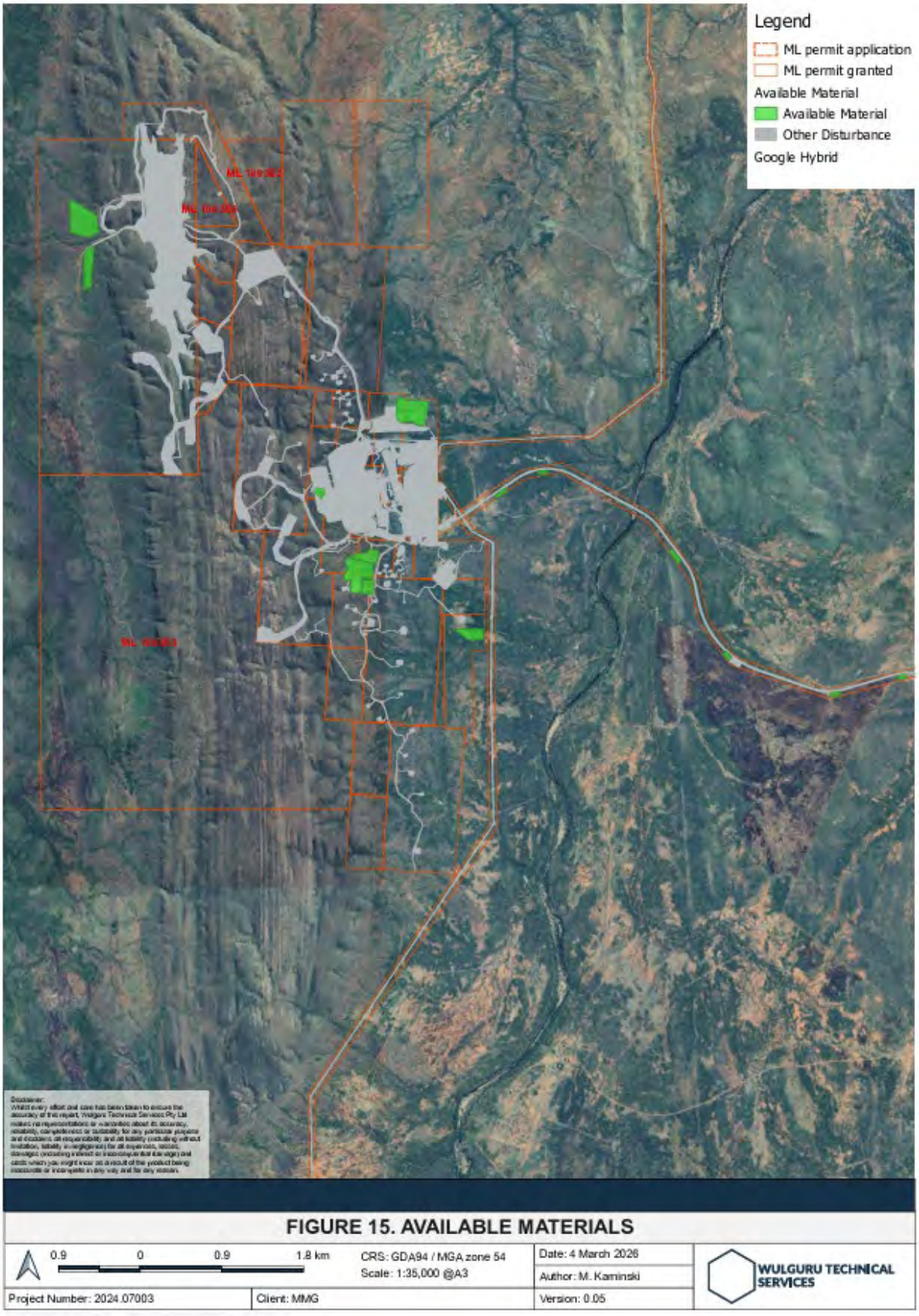
During operations, waste rock will continue to be managed in accordance with the *DRM Management of Mineral Waste Procedure*. Mineral waste generated from the mining operations is classified as either NAF or PAF and temporarily stored within designated WRDs. The NAF waste pad can accommodate 1,550,000 m^3 of material. There is sufficient NAF to be utilised in the closure of the TSF.

A preliminary materials balance is provided in Table 32. These volumes will continue to be finalised as the mine plan is updated and rehabilitation commences. Two cover systems are currently being considered for the TSF. The material balance below considers the largest material requirement; this demand will reduce if a geosynthetic clay liner (GCL) is utilised. If required, this will be sourced by a commercial provider.

Table 32 Preliminary materials balance

RA	Area (ha)	Topsoil application depth (m)	Volume of topsoil required (m^3) (assumed 50% coverage)	Volume of topsoil required (m^3) (assumed 100% coverage)	Volume of NAF required (m^3)
RA1	19.76	0	0	0	0
RA2	43.84	0	0	0	0
RA3	32.28	0.1	16,140	32,280	0
RA4	22.56	0.1	11,280	22,560	0
RA5	180.78	0.1	90,390	180,780	0
RA6	109.88	0.2	109,880	219,760	970,470
RA7	67.07	0	0	0	0
Total			**227,690**	**455,380**	**970,470**
Available			**144,002**	**144,002**	**1,550,000**

Figure 15. Available materials



3.5.6.2. Topsoil Striping

Where available, topsoil was stripped during the construction phase of the project. Topsoil is currently stockpiled at locations shown on Figure 15. Approximately 17,160 m^3 of topsoil is expected to be generated from the additional features proposed within the EA amendment application subject of this PRCP amendment. Prior to new ground disturbance, topsoil will stripped and added to one of the existing stockpiles. Stockpiles are surveyed annually, and the total volume is recorded in the Topsoil Stockpile Register.

Table 33. Stockpiles topsoil volumes

Stockpile category	Description	Volume (m^3)
TsH	High quality soil, almost entirely covered by regrowth, with high species diversity.	0
TsM	Medium quality soil with moderate regrowth visible and some species diversity.	5,003
TsL	Low quality soil, combined with subsoil, with some regrowth visible.	80,858
SkS	Skeletal soil (abundant rocks) with little to no regrowth.	35,329
Vg	Predominately vegetation stockpiles	5,652
Total stockpiled		**126,842**
Additional to be accessed during proposed construction of the TSF lift and PAF expansion borrow pit		17,160
Total		**144,002**

3.5.6.3. Topsoil Stockpiling

Once stripped, topsoil is stored at a maximum height of 2 m, and only in locations that have been previously designated by site plans. A register of topsoil stockpiles is kept and maintained on-site, recording stockpile number, placement date, source location, soil type, and any relevant comments. Stockpiles are designed and located to minimise topsoil loss through runoff and erosion and are marked and identifiable with signage. Active stockpiles are inspected as part of ongoing environmental inspections.

3.5.6.4. Soil Monitoring Program

Due to the long life of the operation, the condition of the topsoil is better assessed closer to its application. An assessment will be conducted to identify the need for any soil amelioration such as fertilizer, gypsum and/or organic matter. The results of the analysis will determine if any ameliorants are required and the application rate.

A soil monitoring program will be developed for the topsoil stockpiles, prior to use, and will aim to:

- Optimise rehabilitation processes;
- Accurately measure utilisation of stockpile storage and soil reuse; and

- Identify the need and rate of soil amelioration.

Samples will be acquired and analysed at an accredited laboratory. The analytes proposed to be tested are detailed in Table 34. This analysis program may be amended, as additional information is made available from the rehabilitation trials and ongoing monitoring.

Table 34. Analysis parameters for the soil monitoring program

Parameter	Purpose	Target values	Treatment
pH	Identify variations that may inhibit plant growth and sustainability.	5.5 – 8.0	Higher alkaline and acidic soils may have low nutrient levels. Lime or dolomite can be applied to treat the soil.
EC and Chloride	Identify areas that may inhibit germination and establishment.	<1 mS/cm	Plant adaptive species which can withstand conditions.
Exchangeable Sodium percentage (ESP)	The percentage of exchangeable cation capacity of the soil occupied by sodium	Loams <6% Clays <15%	ESP can be reduced by use of Gypsum.
Exchangeable cations	Links to soil stability, fertility, nutrient availability, and structure.	N/A	N/A
Organic carbon	Indicates soil nutrient stores and soil structure. Variations can indicate successfulness.	N/A	N/A
Major elements including N, P, K, S, Ca, and Mg.	Indicator of nutrients and potential for runoff or acid Metalliferous drainage.	N/A	N/A
Trace elements including Mn, Fe, Zn, and Cu	All are important to the vegetation success.	N/A	N/A
Metals	Metals that have been identified as occurring at elevated levels during material characterisation should be tested for during monitoring.	N/A	N/A
Physical parameters	Soil texture and other characteristics will affect water entry and storage as well as impact on erosion, dispersion, and success.	N/A	N/A

Parameter	Purpose	Target values	Treatment
Field analysis	Gain an understanding of soil profile characteristics for interpretation purposes.	N/A	N/A

3.5.6.5. Topsoil Application

The Project is partially located on the rocky scarps of the Knapdale Range. The Knapdale soil management unit and Miners soil management unit is described as being shallow rocky soils. Similarly, the Red Plains, Prospectors and Pocket soil management units are described as being shallow soils.

Disturbances located on the Knapdale Range will be ripped and seeded with no topsoil application. Where required, topsoil will be applied at high risk areas such as the TSF and processing areas. Topsoil will be placed in strips approximately 5 m in width, 0.1 – 0.2 m deep to maximise application.

If required, additional topsoil will be sourced from a commercial supplier.

3.5.6.6. Soil Loss

A tolerable soil loss rate is an acceptable soil loss that does not impede on long term soil productivity. Currently there are no acceptable erosion rates defined for rehabilitated lands. An erosion target of a mean average annual erosion rate of 5 t/ha/year and a mean maximum annual rate at any one point of 10 t/ha/year is commonly referred to as an acceptable rate to prevent rilling. It is noted that these rates are based on studies completed in the Pilbara, Western Australia (Loch, 2019) and may not be relevant to North Western Queensland.

Continent scale study results indicate that the current annual average erosion rates in the vicinity of the Project are greater than 10 t/ha/year and potentially in the range of 20 – 50 t/ha/year. This high erosion rate is due to the intense rainfall and semi-arid climate and soils of Northern Queensland.

Erosion modelling has been completed on the TSF, being the only mine structure to be retained. The modelling indicates that the TSF can achieve an erosion rate of between 1 t/ha/year and 13 t/ha/year, depending on the percentage of vegetation cover. A tolerable soil target for the Project has been defined as a mean average annual erosion rate of 5 t/ha/year and a maximum annual rate at any one point of 10 t/ha/year. This is suitable, given the following factors:

- Continental scale mapping for the region;
- Proposed PMLU of native vegetation and habitat on the TSF; and
- Removal and disposal of residual contaminants from other RAs.

Additionally, the risk of erosion will be minimised with a secondary rehabilitation milestone of “absence of erosion rills >30 cm”.

3.5.6.7. Erosion and Sediment Control

Erosion and sediment control measures will be implemented in accordance with the Best Practice Erosion and Sediment Control, published by the Australasian International Erosion Control Association (IECA). Revegetation will minimise erosion and act as a sediment control, and ensure landforms are both geochemically and physically stable.

Effective erosion and sediment control structures were installed during the operational phase of the project. An allowance has been made to retain four additional sediment controls post mine closure, with some minor earthworks required to ensure these controls are safe and effective. The site runoff dam is the primary sediment control on the Project. Site affected water will continue to be directed to this structure whilst closure activities are in progress. Once upstream features have successfully revegetated, the runoff dam will be rehabilitated.

Erosion and sediment control plans will be considered when conducting rehabilitation activities, and should include the following:

- Contours and drainage lines;
- Disturbance limits;
- Earthwork extents;
- Control measure locations;
- Order of work schedule;
- Construction details and notes; and
- Specific operating procedures.

3.5.7. Revegetation Plan

3.5.7.1. Low Intensity Grazing

The revegetation objectives for the following RAs are to achieve a PMLU of low intensity grazing that is safe, stable non-polluting and self sustaining:

- RA2 Borrow pits and stockpiles
- RA3 Dams and diversion structures
- RA4 Mineralised waste
- RA5 Mining and processing area

Once revegetation has occurred, rehabilitation areas will be secured to prevent cattle access whilst vegetation establishes. Cattle will only be permitted to graze once the achievement of surface requirements (RM13) have been achieved. Fire breaks will be maintained and weed management controls will be implemented as required, to ensure success of revegetation.

3.5.7.1.1. Seed Mix

The Project is located within the Southern Gulf Land Management Region, with the infrastructure areas within pastureland C2 land class. This class is defined as suitable for grazing native pastures, with or without the introduction of pasture species and within low fertility soils.

All soil units have very low plant-available water, erosion potential and limited nutrient availability. Grazing on unimproved pastures requires the establishment of an ecosystem to support sustainable productivity. Vegetation surveys confirm that disturbance areas are predominantly located within RE 1.11.3a and 1.11.2a. The native shrub and tree species have been selected from these REs to provide necessary stability during drought and fix nitrogen to allow productive pasture without external inputs such as fertiliser.

A species mix for revegetation (Table 35) has been developed based on these REs to maximise the success of the PMLU of grazing. Locally sourced seeds will be prioritized to optimise success. When possible, areas will be seeded directly with selected species. Where direct seeding is not possible, seeds will be manually broadcast.

Rehabilitation areas will be fenced to prevent access to cattle whilst vegetation establishes. Cattle will only be permitted to graze once the achievement of surface requirements (RM13) has been achieved. Fire breaks will be maintained and weed management controls will be implemented as required, to ensure success of revegetation.

Table 35. Grazing seed mix

Rehabilitation Area	Ground cover	Shrubs	Trees
RA2, RA3, RA4, RA5	*Triodia pungens* Appropriate 3P grass species to support the PMLU	*Acacia chisholmii* *Carissa lanceolata*	*Eucalyptus leucophloia* *Corymbia Capricornia* *Corymbia terminalis* *Eucalyptus pruinose* *Eremophila longifolia* *Atalaya hemiglauca* *Terminalia aridicola*

3.5.7.2. Native Ecosystem

Native ecosystem is the target PMLU for the following RAs:

- RA1 Ancillary infrastructure and services
- RA6 TSF
- RA7 Renewable energy infrastructure

Native ecosystem has been proposed for these RAs due to the steep terrain of the Knapdale Range. Revegetation will target the historic ecosystem, being REs 1.11.2 and 1.11.3.

3.5.7.2.1. Seed Mix

The TSF will be revegetated with native grasses and shallow-rooted shrubs that will stabilise the surface against erosion and reduce water stored within the cover. Native flora consistent with the descriptions for REs 1.11.2 and 1.11.3 is proposed for the vegetation of the TSF. Treeless areas of both 1.11.2 and 1.11.3 are common throughout the REs' ranges, and across the proposed TSF area. In addition to the species identified in Table 36, sterile cover crops may be utilised to provide rapid soil stabilisation and improve soil health.

Table 36. Native ecosystem seed mix

Rehabilitation Area	Ground cover	Shrubs	Trees
RA1	*Aristida latifolia* *Eriachne obtusa,* *Sporobolus australasicus,* *Themeda triandra* *Triodia pungens*	*Acacia chisholmii,* *Senna notabilis,* *A. chippendalei,* *A. holosericea,* *Gossypium australe*	*Eucalyptus leucophloia* *Corymbia terminalis* *Corymbia capricornia*
RA6	*Aristida latifolia* *Eriachne obtusa* *Sporobolus australasicus* *Themeda triandra* *Triodia pungens*	Nil	Nil
RA7	*Aristida latifolia* *Eriachne obtusa,* *Sporobolus australasicus,* *Themeda triandra* *Triodia pungens* Plus other suitable wetland groundcover species in riparian vegetation zones.	*Acacia chisholmii,* *Senna notabilis,* *A. chippendalei,* *A. holosericea,* *Gossypium australe*	*Eucalyptus leucophloia* *Corymbia terminalis* *Corymbia Capricornia* *Eucalyptus camaldulensis* *Melaleuca species* *Lophostemon species*

3.5.7.3. Revegetation Method

Surfaces will be prepared for vegetation, by ripping compacted surfaces and applying topsoil, where relevant. Ameliorants will be applied if determined to be required by the soil monitoring program (Section 3.5.6.4).

Revegetation methods used will be based on the RA position in the landscape and may include one or more of the following methods:

- Return from topsoil;
- Hand or broadcast seeding;
- Mechanical seeding;
- Drone or other aerial seeding techniques; or
- Manual tube stock planting.

A single application of fertiliser will be applied during seed application. Where possible, vegetation works will be completed prior to the onset of the wet season. The proposed seed mix has been selected as suitable for the regional climate. Permanent irrigation infrastructure is not proposed to be constructed. However, rainfall in revegetated areas will be monitored closely in the six to 12 months post seeding to determine if supplementary watering is required.

Other management actions to be considered based on the response of RA to the seeding activities include:

- The exclusion of cattle and other herbivores, via temporary measures;
- Pest and weed management; and
- Supplementary seeding and/ or fertilisation.

Supplementary planting will be conducted if monitoring indicates a risk of relevant rehabilitation milestones not being achieved.

3.5.7.4. Application Rate

Application/planting rates are generally based on a number of factors including:

- Structure of the target vegetation community, i.e. the presence of tree and shrub layers;
- Density of the target vegetation community, i.e. the typical basal area of the climax community - woodland or forest;
- Seed size; and
- Surface requirements, i.e. erosion control for sloped surfaces.

A seeding rate of 4 -10 kg/ha is provided as a guide; rates will be considered in conjunction with supplier recommendations at the time of rehabilitation and informed by ongoing monitoring during the LoM.

3.5.7.5. Weed Management

A desktop review of local biosecurity plans, and spatial analysis identified weed and pest species with the potential to occur within the Project area (Table 37).

Weed hygiene practices will continue to be implemented at all stages of operation and closure. All mobile plant, machinery, heavy vehicles and earthmoving equipment will be inspected upon entry to site. If weeds or seeds are identified, vehicles and equipment will be cleaned in the site washbay.

Weed density will be monitored as part of rehabilitation monitoring, and appropriate treatment controls will be implemented as required. Weed treatment will integrate manual, mechanical, fire, grazing, and herbicide control measures and will be conducted in accordance with the *Accepted Development Vegetation Clearing Code: Managing Weeds* (2023), developed by the Department of Resources. Control methods described in Table 37 may be applied individually or in combination, at the discretion of a suitable qualified person. It is anticipated that the focus of the weed control program would be the management of Cabbage Tree (*Calotropis procera*) due to its potential toxic effect on grazing cattle.

Table 37. Weed and pest species

Species	Legislative Status	Priority
Weeds		
Athel Pine (*Tamarix aphylla*)	WONS; Cat 3; Class 3: Locally Declared	1
Bellyache bush (*Jatropha gossypilifolia*)	WONS; Cat 3; Class 2	1
Hymenachne (*Hymenachne amplexicaulis* & hybrids)	WONS; Cat 3; Class 2: Locally Declared	1
Lantana (*Lantana camara*)	WONS; Cat 3; Class 2: Locally Declared	1
Mesquite (Prosopis sp)	WONS; Cat 3; Class 2: Locally Declared	1
Mother of Millions (*Bryophyllum delogoense*)	WONS; Cat 3; Class 2: Locally Declared	1
Parkinsonia (*Parkinsonia aculeata*)	WONS; Cat 3; Class 2: Locally Declared	1
Parthenium (*Parthenium hysterophorus*)	WONS; Cat 3; Class 2: Locally Declared	1
Prickly Acacia (*Acacia nilotica*)	WONS; Cat 3; Class 2: Locally Declared	1
Rubbervine (*Cryptostegia grandiflora*)	WONS; Cat 3; Class 2: Locally Declared	1
Salvinia (*Salvinia molesta*)	WONS; Cat 3; Class 1&2; Locally Declared	1
Siam Weed (*Chromolaena odorata*)	Cat 3; Class 1; Locally Declared	1
Agave (Agave spp)	Locally Declared; Unregulated	2
Awnless barnyard grass (*Echinochloa colona*)	Locally Declared; Unregulated	2
Bathurst Burr (*Xanthium spinosum*)	Locally Declared; Unregulated	2
Calotrope (*Calotrpis procera*)	Locally Declared; Unregulated	2
Castor Oil Plant (*Ricinus communis*)	Locally Declared; Unregulated	2
Chinee Apple (*Zizphus mauritiana*)	Cat 3; Class 2; Locally Declared	2
Colocynth (*Citrullus colocynthis*)	Locally Declared; Unregulated	2
Coral Cactus (*Culindropuntia fulfida* var. mamillata)	Cat 3; Class 2; Locally Declared	2
Gamba Grass (*Andropogon gayanus*)	Cat 5; Class 2; Locally Declared	

Species	Legislative Status	Priority
Giant Rat's Tail Grass (*Sporobolus pyramidalis*, S. natalensis)	Cat 3; Class 2; Locally Declared	2
Grader Grass (Themeda spp.)	Locally Declared; Unregulated	2
Harrisia Cactus (*Harrisia's martini, tortuosa* & *pomanensis*)	Cat 3; Class 1&2; Locally Declared	2
Leucaena (*Leucaena leucocephala*)	Locally Declared; Unregulated	2
Milk Weed (*Euphorbia heterophylla*)	Locally Declared; Unregulated	2
Mimosa Bush (*Vachellia farnesiana*)	Locally Declared; Unregulated	2
Neem Tree (*Azadirachta indica*)	Locally Declared; Unregulated	2
Noogoora burr (*Xanthium occidentale*)	Locally Declared; Unregulated	2
Porcipine Flower/ Barleria (*Barleria prionitis*)	Locally Declared; Unregulated	2
Sicklepods (Sicklepod *Senna obtusifolia*, foetid senna, *Senna tora* and hairy senna, *Senna hirsuta*)	Cat 3; Class 2; Locally Declared	2
Water Hyacinth (*Eichhornia crassipes*)	Cat 3; Class 2; Locally Declared	2
Yellow Oleander (*Cascabela thevetia*)	Cat 3; Class 3; Locally Declared	3
Pests	**Legislative Status**	**Priority**
Cane Toad (*Bufo marinus*)* *	Class 1; Locally Declared	1
Chital Deer (*Axis axis*)	Cat 3,4&6; Class 1&2; Locally Declared	1
Feral Cat (*Felis catus* & *Prionailurus bengalensis* x *Felis catus*)	Cat 3, 4 &6; Class 1&2; Locally Declared	1
Feral Goats (*Capra hircus*)	Cat 3, 4 &5; Class 1&2; Locally Declared	1
Feral Pig (*Sus scrofa*)	Cat 3,4 &6; Class 1&2; Locally Declared	1
Feral Rusa Deer (*Cervus timorensis*)	Cat 3,4&6; Class 1&2; Locally Declared	1
Wild dog (*Canis familiaris* & C. *familiaris dingo*)	Cat 3,4, 5*&6 ; Class 1&2 ; Locally Declared	1
Foxes (*Vulpes vulpes*)	Cat 3,4,5 & 6; Class 2; Locally Declared	2

Table 38. Weed control techniques

Management Technique	Description and Applicability
Mechanical control	Mechanical control involves the use of powered tools and machinery to manage weeds. Mechanical control can include slashing with tractors or mowers, felling, pulling, or dragging with bulldozers, or grading the top layer of soil. Mechanical control is ideal for larger infestations as it reduces manual effort.
Manual removal	Manual removal of weeds using handheld tools such as a mattock or hoe. Manual removal may also include pulling weeds by hand and is therefore more suitable for smaller areas. This method is best applied to areas where the species have only recently started to occur or at the end of an intensive treatment regime where there are only isolated plants occurring.

Management Technique	Description and Applicability
Foliar spraying	Foliar spraying is where a herbicide is diluted with water or diesel at a specific rate and sprayed over the foliage until every leaf is wetted, but not dripping. Suitable for shrubs, grasses and dense vines less than 6 m tall so that complete coverage is achieved. Advantages include speed of application and economy. Disadvantages include the potential for spray drift and off-target damage. Methods include blanket spraying using a boom spray mounted on a vehicle or spraying with a handgun connected by a hose to a herbicide tank and pump, carried by a tractor or vehicle. Smaller infestations can be sprayed using a backpack/knapsack spray unit. Foliar spraying should not be used during rainfall, or when rainfall is forecast in the proceeding 6 hours, to prevent run-off.
Cut stump	The cut stump method is where the plant is cut off completely at its base (typically no higher than 15 cm from the ground) using a chainsaw, axe, brush cutter or machete (depending on the thickness of the stem/trunk). Herbicide is then sprayed, squirted or painted on to the exposed surface of the cut stump emerging from the ground, killing the stump and the root system.
Basal bark spray	Basal bark spraying is where an oil-soluble herbicide is mixed with diesel and sprayed around the full circumference of the trunk or stem of the plant. This is suitable for plants with basal diameters up to 10 cm and heights of 30 to 100 cm with thin-barked woody weeds and undesirable trees. This is also effective to treat saplings, regrowth and multi-stemmed shrubs and weeds in inaccessible areas such as steep banks.
Fire control	Some weeds are fire-sensitive (fire will either destroy or suppress them). However, the susceptibility of plants to fire varies greatly. In some cases, fire is used to destroy the weed, in other cases it is used to get access to the weed. If required, controlled burns would be undertaken in accordance with the fire regimes specified for each respective regional ecosystem within the Queensland Herbarium Regional Ecosystem Fire Guidelines (2024).

3.5.8. Water Management

3.5.8.1. Stormwater Management

The operational water management strategy for the Project aims to separate clean stormwater from potentially affected site water. The water management objectives for closure are:

- Remove all unnecessary infrastructure and hard stand areas at closure. This will reduce overall runoff and peak flows, reducing downstream flood risk, as well as limiting erosion risk.
- Infill and regrade dams such that they do not hold water post closure.
- Remediate ground areas to naturalise flows and install flow reduction measures (such as swales) where required. Any installed infrastructure should be as simple as possible, requiring minimal ongoing monitoring and maintenance.
- Revegetate cleared or disturbed areas. This will help to slow runoff, promote infiltration, and reduce sediment runoff and erosion risk.

- Naturalise drainage channels and connect site drainage to downstream watercourses (ATC Williams, 2025).

The following closure strategy will be implemented:

- Infrastructure and hardstand areas will be removed.
- Any contaminated soil will be removed and placed within the TSF.
- Surfaces will be trimmed and graded.
- Surfaces will be revegetated.
- Site drainage will be reconnected to natural upstream and downstream watercourses.

A site wide final landform with surface water flows is provided in Figure 16 to Figure 21. Further detail is provided in Appendix K. Ongoing monitoring of TSF seepage rates and quality, along with regular surface and groundwater monitoring will guide further works, if required. Contaminated land validation sampling will verify that contaminated material has been removed or if additional work is required to prevent the release of contaminants to waters.

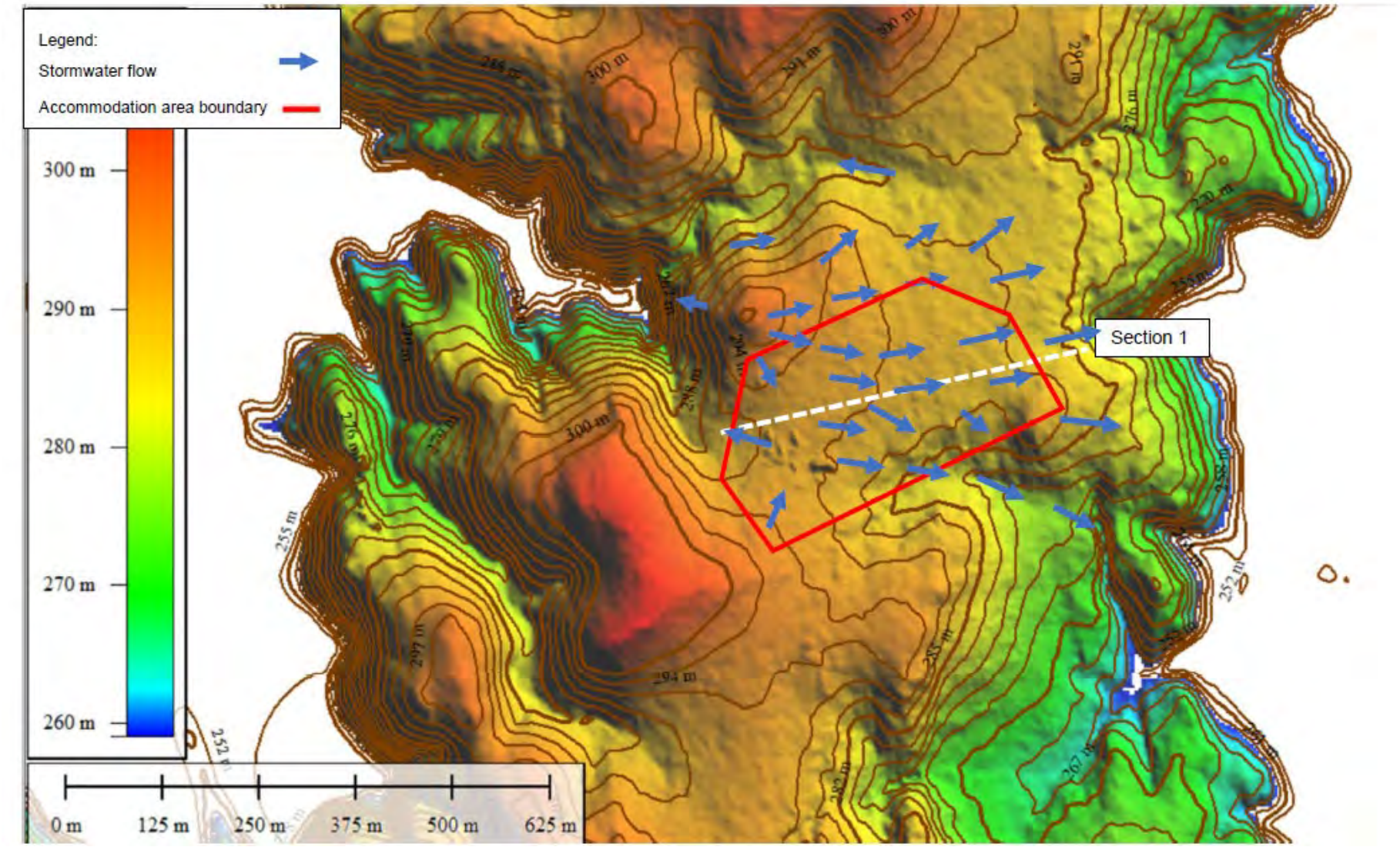


Figure 16. Closure landform surface and stormwater accommodation area (ATCW, 2025c)

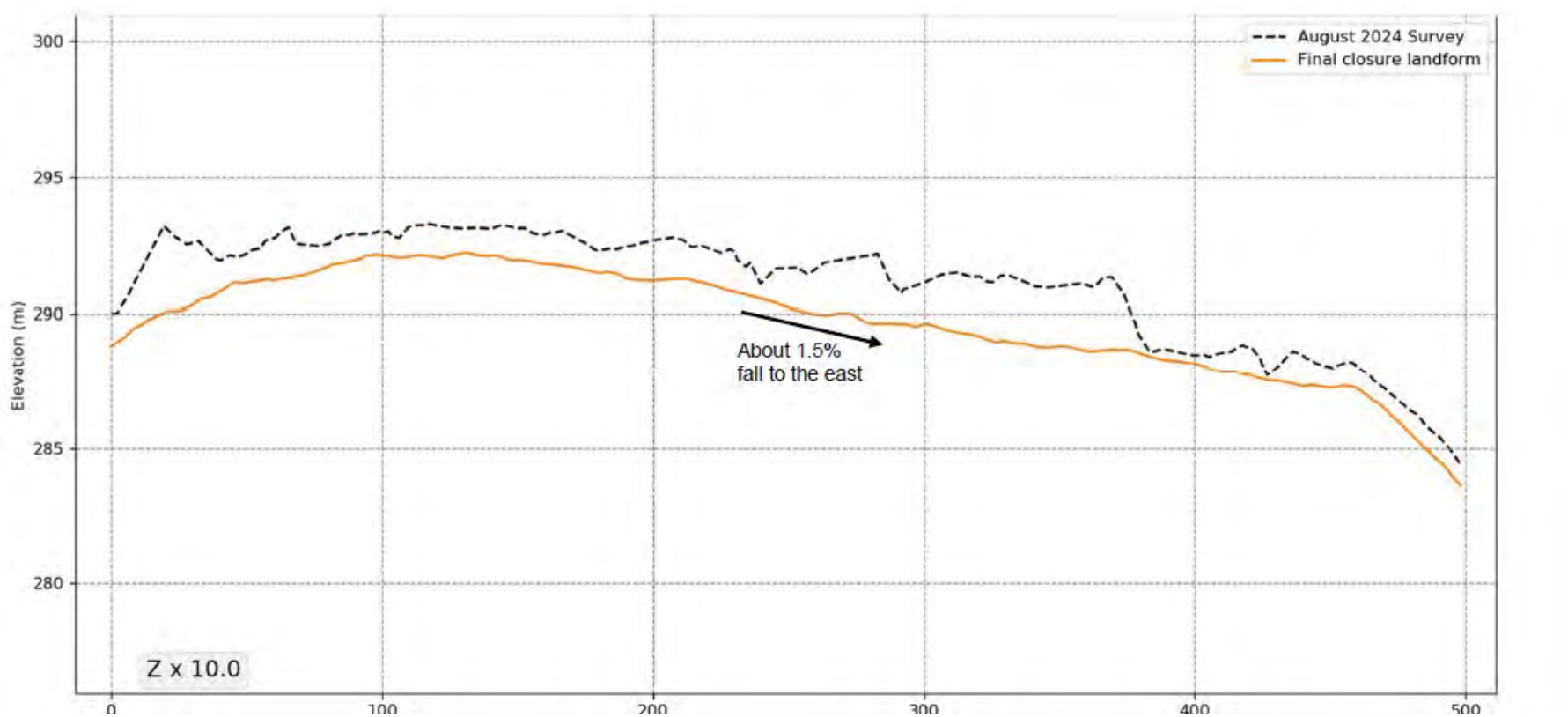


Figure 17. Closure landform surface and stormwater accommodation area cross section (ATCW, 2025c)

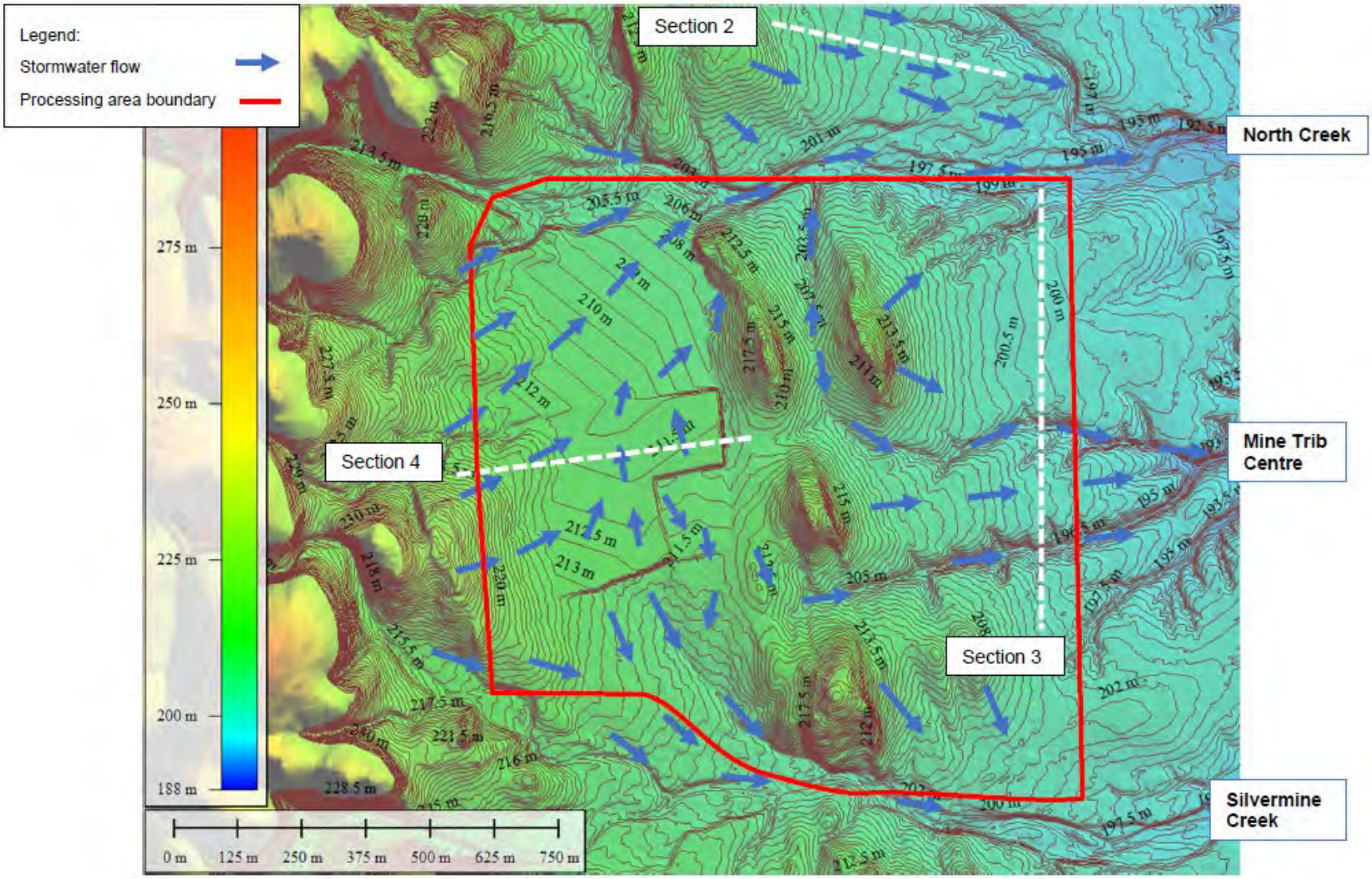


Figure 18. Closure landform surface and stormwater accommodation area (ATCW, 2025c)

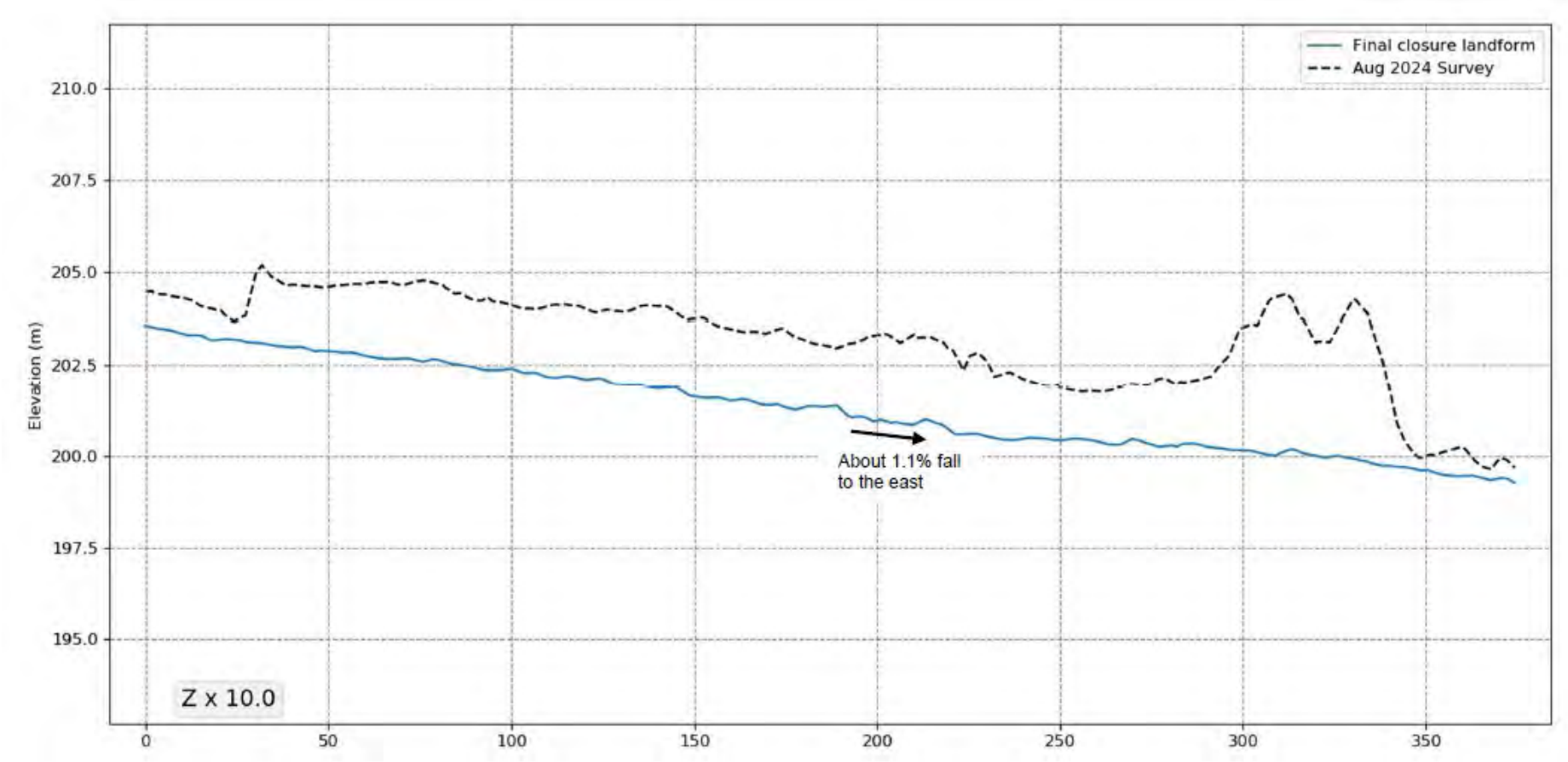


Figure 19. Closure landform surface and stormwater accommodation area cross section (ATCW, 2025c)

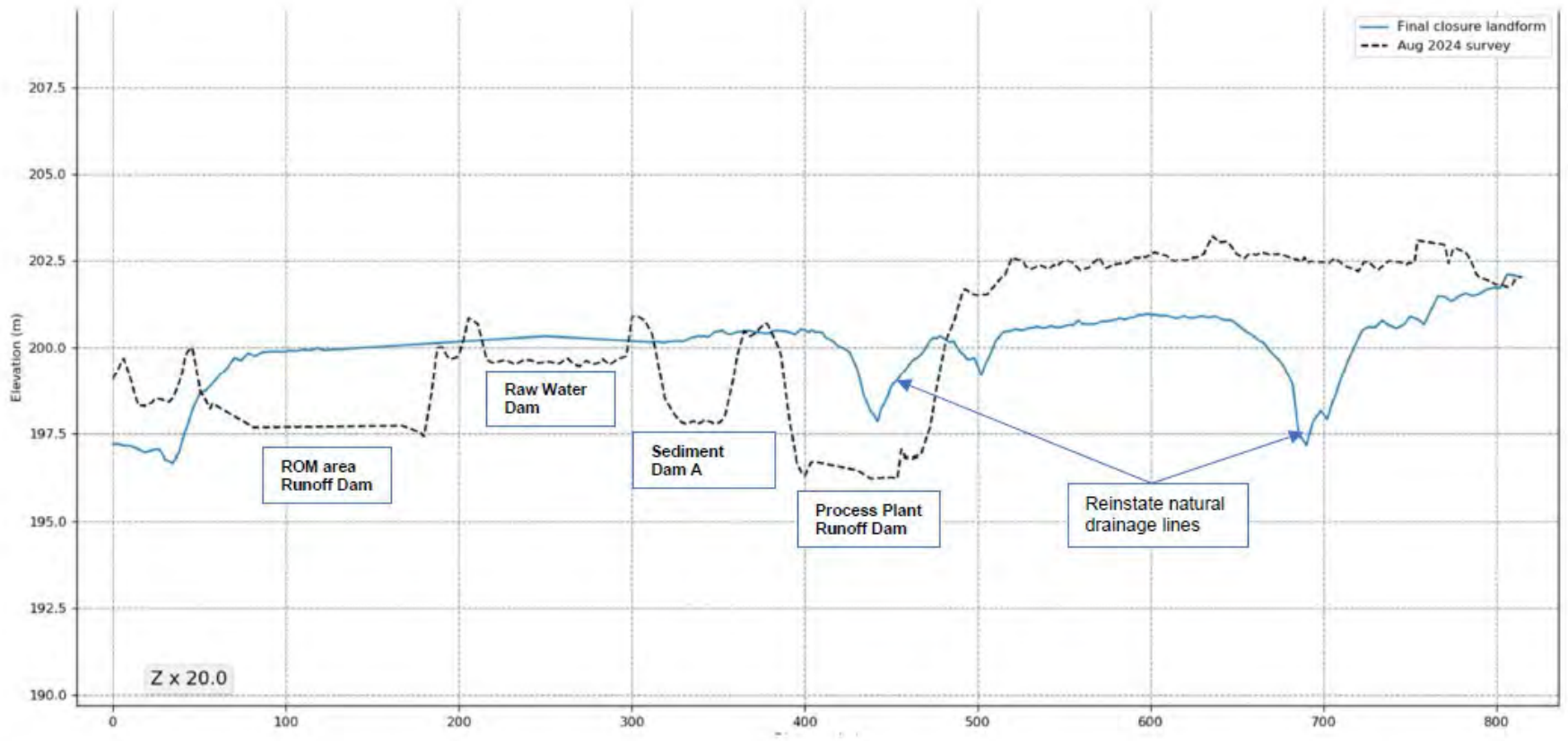


Figure 20. Closure landform surface and stormwater processing area cross section (ATCW, 2025c)

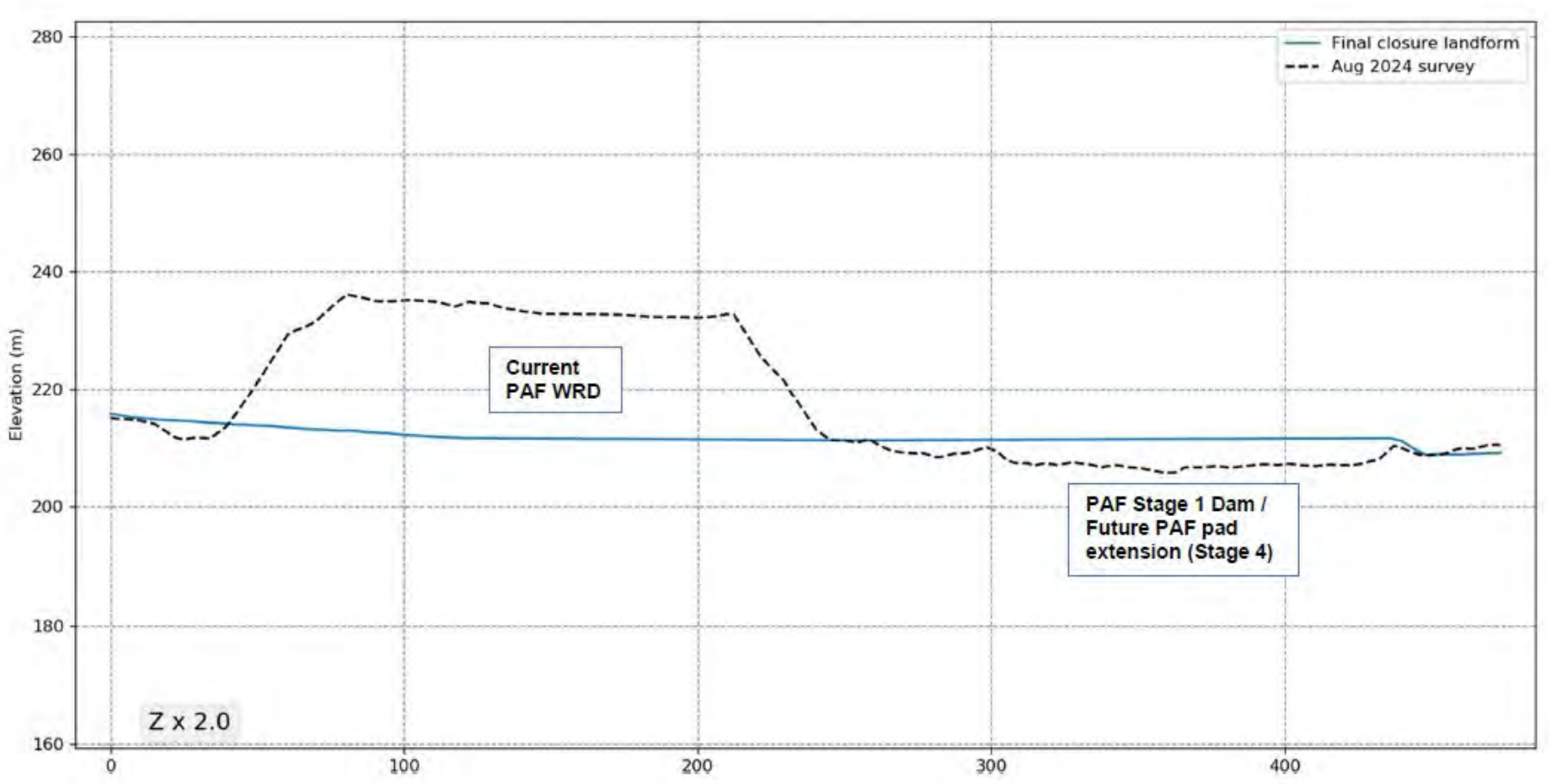


Figure 21. Closure landform surface and stormwater waste storage area cross section (ATCW, 2025c)

3.5.8.2. Closure Water Balance

Water balance modelling was conducted to determine the volume of water requiring management at closure. The model assumed that all water requiring containment would be pumped to the TSF for evaporation.

The results of the modelling are shown in Table 39. Due to the large volumes of water expected to require management on closure, intervention is likely (i.e. enhanced evaporation). Modelling identified that the use of mechanical evaporation would empty the TSF and contributing water storages 2.5 years after closure (2046). This dewatering timeline has been incorporated into the PRC schedule.

Table 39. Water management volumes

Purpose	Storage	Management Strategy	Volume at Closure (ML)	
			Median	10^{th} – 90^{th} percentile
Clean water dams	Raw water dam	Release	28.3	28.3 – 28.3
Sediment dams	Mine Workshop Runoff Dam	Release	0.0	0.0 – 1.4
	Sediment dam A		0.5	0.1 – 2.7
	Sediment dam C		0.0	0.0 – 1.0
	Sediment dam D		0.0	0.0 – 1.2
	Sediment dam F		0.1	0.0 – 3.0
	Sediment dam G		0.0	0.0 – 0.7
Total volume available to release			29	27 – 38
Mine water management	Process Plan Containment Dam	Contain/treat	0.2	0.0 – 1.4
	Process Plant Runoff Dam		0.7	0.1 – 6.2
	ROM Area Runoff Dam		3.2	1.9 – 9.3
	Underground Mine Water Containment Dam		3.3	3.2 – 3.3
Stockpile runoff	PAF pond stage 2	Contain/treat	54.9	39.8 – 74.6
STP containment	STP Dam 1	Contain/treat	0.3	0.1 – 1.0
	STP Dam 2		14.5	2.5 – 27.5
Tailings management	TSF Decant Pond	Contain/treat	2.751	1,829 – 3,882
	Seepage Collection Pond		0.2	0.1 – 0.2
Total volume required to contain or treat prior to release (ML)			2,828	1,877 – 4,006
Total combined volume (ML)			2,857	1,905 – 4,044

3.5.8.3. Flooding

Flood modelling completed for the project indicates that the mining operations and infrastructure are located above the Dugald River and Silver Creek 100-year ARI flood levels (WRM, 2010). Whilst the operations would not be impacted by flooding, the main access road from the Burke Developmental Road is susceptible to flooding at four locations. Due to the design of the crossings, the road would be overtopped whenever a significant runoff event occurs. The risk of flooding is not expected to impact upon the success of rehabilitation activities.

Flood mapping (ATC Williams, 2021) shows that the mine portals are not located below the 0.1% AEP flood level and are therefore not located within the floodplain. Further, both portals are at very low risk from flooding. The North Portal and the South Portal are not subject to inundation in any events up to and including the probable maximum flood (PMF). Additionally, the mine portals will be capped at closure, to prevent water entering the mine workings.

Post closure, the TSF will be the only remaining built landform, although this will be capped with surface drainage directed towards the spillway. The preliminary design has adopted a self-shedding cover system, with the main embankment flattened to a nominal 1V:6.5H to stabilise the embankment long-term and eliminate water ponding within the TSF. The Stage 2 spillway will be reinstated as the surface water outlet at closure. A spillway channel will be added, to achieve the following:

- Prevent water from ponding against the upstream face of the embankment;
- Prevent flow over the top of the embankment;
- Divert flows away from the toe of the embankment; and
- Reconnect catchment flows with the downstream watercourse.

The flood modelling demonstrates that the proposed spillway design is suitable to safely convey events up to and including the PMF. Additional engineering design activities will be undertaken to ensure the spillway channel accommodates the peak flood flow velocity (predicted to be 6.2 m/s) so as to achieve a stable spillway condition.

There are no voids or water containment structures proposed to be retained on closure, therefore there is no risk of flooding of such structures.

The flood modelling is presented in Appendix F.

3.5.9. Subsidence Management

The Project employs a sub level open stope mining method with both cemented and rock backfill. This method increases the long-term stability of the mine and ensures consolidation of voids.

DRM completed a geotechnical study (Appendix G) on surface subsidence risk and the implications for closure. The study found that the risk of surface subsidence is low. The Project has a shallow weathering profile and shallow ground water, therefore there is minimal influence of groundwater on the underground stability and crown pillar stability (MMG, 2020). All stopes extracted underground have limited stope strikes and are cable bolted to increase the short-term stability and are all backfilled with either waste rock or cemented backfill to ensure long term stability and confinement of voids to prevent long term subsidence (MMG, 2020). Surface subsidence will continue to be monitored throughout the life of the operations.

3.5.10. Waste Structures

3.5.10.1. Waste Rock Dumps

3.5.10.1.1. Waste Rock Characterisation

Geochemical characterisation has been undertaken on DRM waste rock and to determine the potential for generation of sulphate-rich neutral mine drainage. Studies were conducted on drill core samples by Minenco Pty Ltd in 1991, AARC in 2008, and EGi in 2010, with a cumulative 211 samples across the seven lithologies (Table 40).

3.5.10.1.1.1. Methodology

The initial study (Minenco, 1991) involved the assessment of the acid forming potential of 18 drill core samples and five samples within the Zn/Pb lode. A second investigation (AARC, 2008) included geochemical analysis of 121 drill core samples and the establishment of a series of kinetic leach column tests. The testing programs for both studies included measurements of:

- Existing pH and conductivity;
- Total sulphur content;
- Acid neutralising capacity (ANC); and
- Net acid producing potential (NAPP).

Multi element assays were also carried out on all samples in the 1991 study and half the samples in the 2008 study.

In the most recent geochemical study, 72 drill cores were sampled. Samples underwent static geochemical testing to evaluate the risk associated with the potential oxidation of sulphides, acid generation, and the presence of metals/metalloids and salts. Static analysis included the following analytes:

- Existing pH and conductivity;
- Total sulphur content;
- Maximum potential acidity (MPA);
- Acid neutralising capacity (ANC);
- Net acid producing potential (NAPP); and
- Net acid generation (NAG) capacity.

More detailed analyses were completed on selected samples to clarify acid rock drainage (ARD) classifications, assess sulphide or carbonate reactivity, and identify elemental enrichments and their potential leachability. A full description of the sampling methodology is presented in Appendix H.

3.5.10.1.1.2. ARD Classification

The ARD classifications of the 18 waste rock samples from the 1991 study were based solely on NAPP values. For all other samples, the ARD classifications were assigned on both NAPP values and net acid generation (NAG) capacity. ARD classifications are defined in Table 40. In summary, PAF waste rock from within the lode will have a high to very high capacity for acid generation. NAF waste rock is expected to be neutral to moderately alkaline.

Table 40. ARD classification of DRM waste rock (EGi, 2010)

Lithology	Number of samples	PAF	NAF
Calc-silicate	31	0 (0%)	31 (100%)
Mafic feldspar porphyry	7	0 (0%)	7 (100%)
White mica schist	17	2 (12%)	14 (88%)
Hanging wall slate	52	28 (54%)	24 (46%)
Lode waste	18	13 (72%)	5 (28%)
Footwall slate	44	9 (20%)	35 (80%)
Footwall limestone	42	1 (2%)	41 (98%)

3.5.10.1.1.3. Elemental Analysis

Elemental analyses of selected samples were carried out to identify any enrichments that might impact the quality of mine water and waste dump seepage. No significant metal or metalloid enrichments were identified in the calc-silicate, mafic feldspar porphyry and white mica schist but many of the hanging wall slate, footwall slate and lode waste samples were highly enriched with one or more of a range of environmentally important elements on comparison to concentrations typically occurring in background soils (EGi, 2010). The most prevalent enrichments were arsenic, cadmium and zinc. There was also less frequent enrichment with copper, lead, mercury, and selenium (EGi, 2010). Leach tests identified that releases of these elements were confined to PAF waste rock. NAF waste rock is not expected to release metals.

3.5.10.1.2. Identification of Waste Rock

Waste rock material is initially classified by the MMG Geologist using both the geological model and the limestone wireframe. Following firing and stockpiling of waste, the MMG Geologist inspects the material and confirms the initial classification as either NAF or PAF. Classified waste rock not required for use as backfill underground is transported to the surface for placement in the appropriate WRD. Once in the dump, the waste rock is again sampled to verify the classification. This ensures that the material has been placed in the correct location.

3.5.10.1.3. Waste Rock Dump Design

The PAF waste rock dump areas are used for the temporary storage of PAF and high sulphur NAF, until the material can be returned underground for stope fill. The PAF waste rock dumps were constructed with a 1 m layer of compacted low sulphur NAF waste rock at the base of the dump, to

prevent infiltration of contaminants to groundwater. The Stage 4 extension to the PAF Pad, which decommissioned PAF Dam 1, will be constructed with a 1.5 m thick layer of compacted NAF rockfill overlain by 0.5 m thick low permeability earthfill (ATCW, 2025c).

The waste rock dumps were designed with appropriate surface water drainage controls to ensure that leachate is minimised, and no discharges occur to surface or groundwater resources. Runoff from the PAF waste rock dump is directed to and collected in the Stage 2 PAF Pad Run Off Dam. Dams are regularly inspected, and water levels and quality are monitored as part of DRMs Water Management Strategy. Water captured in the runoff dams is either evaporated or sent to the TSF through the process plant water system. Any water retained within the runoff dam on closure will be pumped to the TSF for management.

3.5.10.1.4. Implications for Closure

EGi (2010) noted that it was essential that PAF waste rock was not unduly exposed to atmospheric conditions. The PAF waste rock is progressively returned to the underground for use as stope fill. NAF material is suitable to remain on the surface and will be used as a revegetation layer for other domains.

3.5.10.2. Tailings Storage Facility

3.5.10.2.1. Tailings Characterisation

Geochemical characterisation of Project tailings was undertaken by EGi and summarised by AARC for the DRM Environmental Impact Statement (EIS) (AARC, 2010), as detailed here-in.

Tailings liquor is classified as circum-neutral (pH 7.3) and moderately alkaline (53 mg CaCO3/L). The major ion chemistry is dominated by sulphate (1,310 mg/L), chloride (714 mg/L) and sodium (175 mg/L). There are also high concentrations of calcium, magnesium and potassium. Amongst the trace elements there were some soluble manganese, lead and zinc, but the concentrations of other environmentally important elements were relatively low. The low concentrations of dissolved metals are consistent with solubility constraints commonly observed under pH neutral conditions.

Assay results of tailings solids confirm the presence of high concentrations of sulphur (7.9%), lead (0.99%) and zinc (2.6%). In addition to the resource metals, the tailings were also enriched with non-resource elements including antimony, arsenic, bismuth, cadmium, mercury and molybdenum. All of these elements are part of the general elemental association reported for hydrothermal sulphide ores, and therefore it is expected that they are to occur in the tailings. The results demonstrate minor enrichment relative to background soil of chromium, copper, nickel, selenium and uranium.

Tailings solids have high pyritic-S content and a correspondingly high capacity for acid generation. Based on the net acid producing potential (NAPP) and net acid generation (NAG) testing, the Project tailings were classified as potentially acid forming (PAF). The results indicate that the acid neutralising capacity (ANC) of the DRM tailings is considered within the low to moderate range for process tailings. The tailings had a strongly positive NAPP result, indicating PAF material.

Column leach testing was undertaken over a 52-week period, which identified the main environmentally important metals that were released during testing were zinc, manganese, lead and cadmium. The concentrations of these metals were typically one or two orders of magnitude higher than the corresponding metal concentrations in tailings liquor, indicating mobilisation. These metals are captured in both the surface water and groundwater monitoring programs as potential contaminants of concern.

MMG implements a program of progressive tailings characterisation, including monthly analysis. A review of data collected from 2018 to 2020 was undertaken to confirm pre-development predictions. The review determined that the geochemical character of the as-deposited tailings has remained consistent throughout the operation to date and is broadly consistent with pre-development predictions.

3.5.10.2.2. Tailings Physical Properties

Tailings samples were prepared and shipped (Amdel Mineral Laboratories, 2008) to the National Association of Testing Authorities (NATA) accredited ATC laboratory for characterisation of their physical properties.

These samples were analysed by AARC for the EIS (2010), with the physical properties of the tailings summarised as follows:

- Specific Gravity (SG) – 2.96;
- Particle Size Distribution – P80 approximately 50 µm;
- Atterberg Limits:
    - Liquid Limit = 21; and
    - Plasticity Index = 6.
    - Unified Soil Classification – Low plasticity Silt; and
    - Segregation Threshold – 46% solids.

The tailings design density parameters that were adopted are presented in Table 41.

Table 41. Tailings design density parameters

Discharge Solids Content (%)	Sedimented Density		Shrinkage Limit Density (t/m^3)
	Solids Content (%)	Density (t/m^3)	
50	66	1.18	1.63

A stability assessment was conducted for the TSF Stage 3 embankment lift (ATCW, 2025f). The scenario and criteria modelled for the stability assessment are presented in Table 42, and the material properties are presented in Table 43.

Table 42. Stability assessment criteria

Scenario	Shear Strength Model	Minimum Factor of Safety (FoS)
Long-Term	Effective Strength	1.5
Dam Crest Flood	Effective Strength	1.3
End of Construction	Effective Strength	1.3

Table 43. Material properties

Material	Strength Envelope	Unit Weight (kN/m3)
Zone 2B	c' = 0 kPa, f' = 35°	20
Zone 2C	Leps' Lower-Average (Capped at 40°)	22.5
Zone 3A	Leps' Average (Capped at 40°)	22.5
Zone 3B		
Foundation – Quartzite Rock	Bedrock (Impenetrable)	22.5
Tailings	No strength	20

The results of the stability assessment are provided in Table 44. All analysed cases exceed the required FoS.

Table 44. Stability Assessment

Scenario	Description	Failure Direction	FoS Required	FoS Modelled
Long-Term	Tailings at RL 240 m Pond at RL 248 m	Downstream	1.5	1.66
		Upstream		2.34
Liner Leak	Tailings at RL 240 m Pond at RL 248 m	Downstream	1.5	1.66
Dam Crest Flood	Tailings at RL 240 m Pond at RL 253.5	Downstream	1.3	1.66
End of Construction	Tailings at RL 222 m Pond at RL 236 m	Upstream	1.3	1.62

3.5.10.2.3. TSF Construction

Civil construction of the existing TSF occurred from June 2016 to June 2018, with only non-civil works completed thereafter. The TSF was originally designed to be constructed in two stages, to facilitate disposal for the LoM. In August 2016, MMG decided to combine the Stage 1 and Stage 2 Works and construct the TSF embankment to its Stage 2 height.

Containment of the tailings is provided almost entirely by the natural topography of the valley, with the main built feature being the downstream embankment. The existing TSF consists of the following built infrastructure (ATCW, 2025f):

- The 37 m high TSF embankment, which is a water-retaining structure comprising of zoned rockfill and granular material with an impermeable bituminous geomembrane (BGM) liner;
- An emergency spillway excavated into the rock on the northern abutment of the TSF embankment, with a base width of 10 m;

- A seepage collection pond constructed downstream of the TSF embankment, to monitor and collect foundation seepage before it discharges off-site;
- The tailings delivery system, comprising the pumping station, steel pipelines, high-density polyethylene (HDPE) pipelines, spill containment ponds and end-point discharges; and
- Return water system, comprising a skid-mounted pump, floating offtake, and a discharge pipeline to pump water from the TSF decant water pond, which forms over the deposited tailings centrally within the TSF. The skid-mounted decant pump transfers water to a booster pump station on the east side of the TSF, from where it is pumped back to the Process Plant.

The Stage 3 TSF raise, submitted for assessment in April 2025 proposes the following works:

- Downstream raising of the existing TSF embankment by 9.25 m to a crest level of RL 253.5 m;
- Excavation of a new spillway approximately 250 m north of the TSF embankment;
- Construction of a new seepage collection system downstream of the TSF embankment;
- Construction of a discharge bund on the northern side of the impoundment (~9.5 m high);
- Construction of a haul road to the west of the TSF;
- Construction of access roads to the discharge points; and
- Relocation of the Return Water System and construction of a new access platform.

A general layout of the design is provided in Figure 22 (ATCW, 2025d).

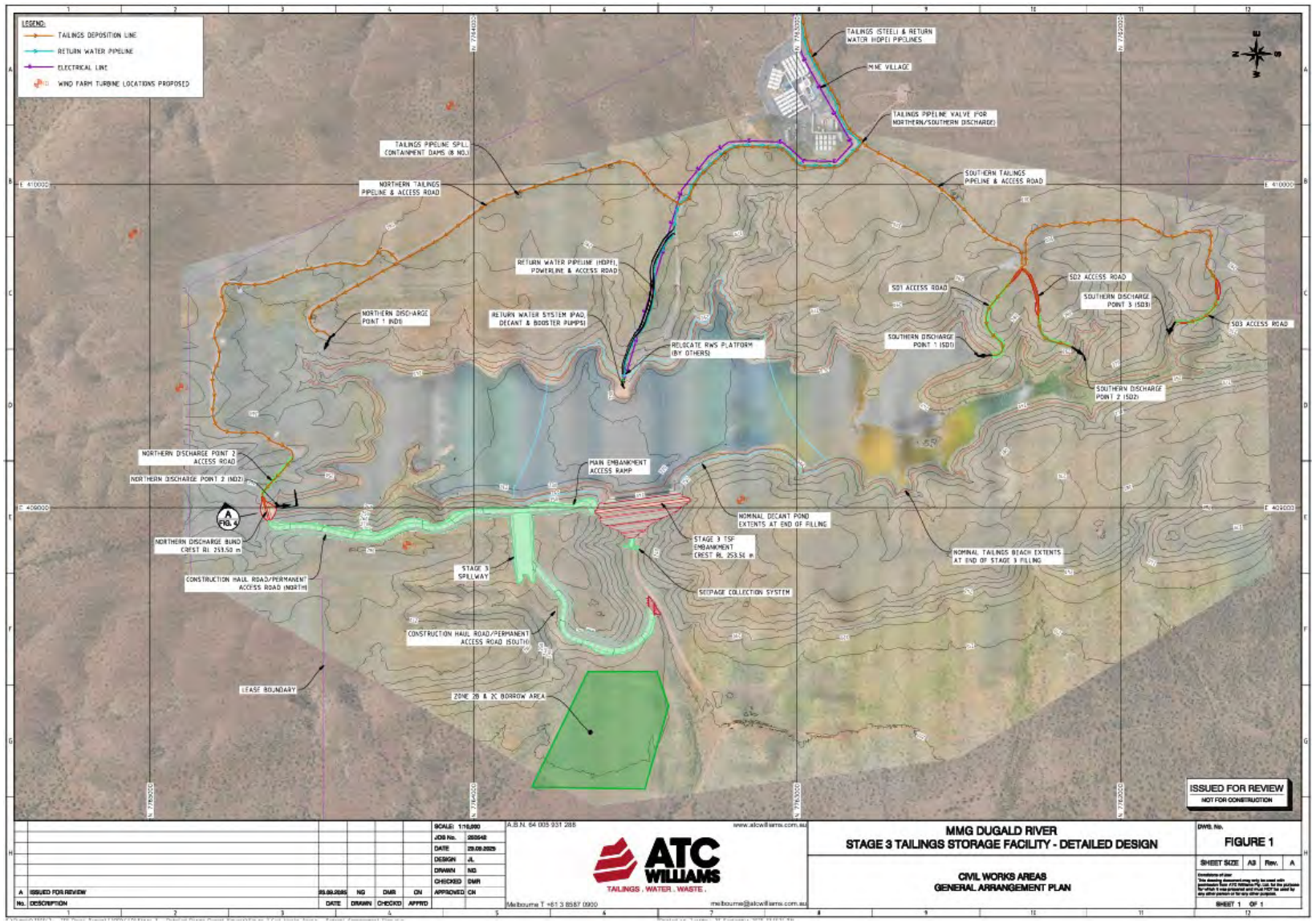


Figure 22. TSF raise design

3.5.10.2.4. TSF Closure Objectives

The PMLU for the TSF is native ecosystem. The closure landform has been developed to achieve a structure that is safe, stable and non-polluting through (ATCW, 2025b):

- Erosional stability;
- Geotechnical stability;
- Supporting and integrating the design cover system to promote geochemical stability;
- Supporting the PMLU of native ecosystem; and
- Forming a free-flowing landform that conveys surface waters from the upstream catchment through an outlet structure with no storage within the former TSF.

A detailed TSF Closure Plan is provided in Appendix E.

3.5.10.2.5. Tailings Deposition Strategy and Landform Surface

Tailings are deposited via sub-aerial deposition (i.e. on a drying beach). A bathymetric survey of the TSF was undertaken in January 2025, which showed sub-aerial (above water level) beach slopes ranging from 0.1 to 0.5%. Sub-aqueous (below water level) beach slopes ranged from 1.0 to 5.5%. On closure, the final surface will be modified to create a self-shedding and stable final landform.

The target beach slopes for the final TSF are <1.5%. Approximately 1.7 Mm^3 of cut and 1.9 Mm^3 of fill will be utilised to reshape the tailings surface. The additional material will be either won from the cut embankment or NAF waste rock (ATC Williams, 2025).

After final deposition, in 2043, a decant pond volume of 4,070 ML will progressively be removed through either natural or enhanced evaporation. Dewatering is expected to be achieved within 3 – 4 years.

Following surface reshaping, the spillway will be reinstated at RL 242.1 m acting as an outlet for the final TSF landform. Surface waters from upstream catchments will be conveyed through a series of surface channels to the outlet structures, located on either side of the embankment. Outlets have been sized to pass the peak flood resulting from the PMP.

A conceptual final tailings surface is provided in Figure 23 to Figure 25. Further detail is provided in Appendix L.

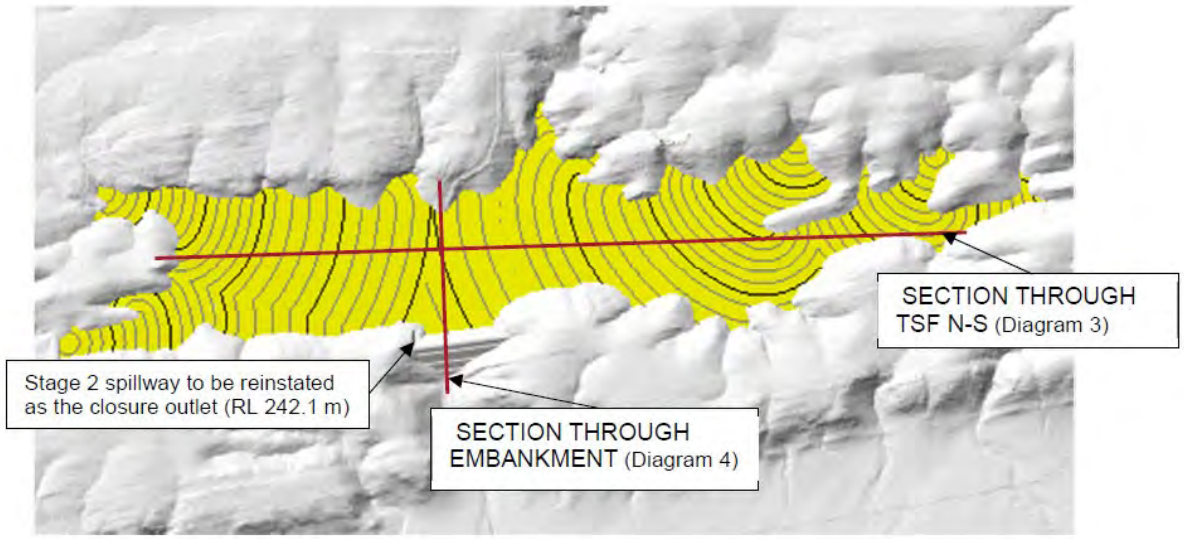


Figure 23. Conceptual closure final tailings surface (ATCW, 2025b)

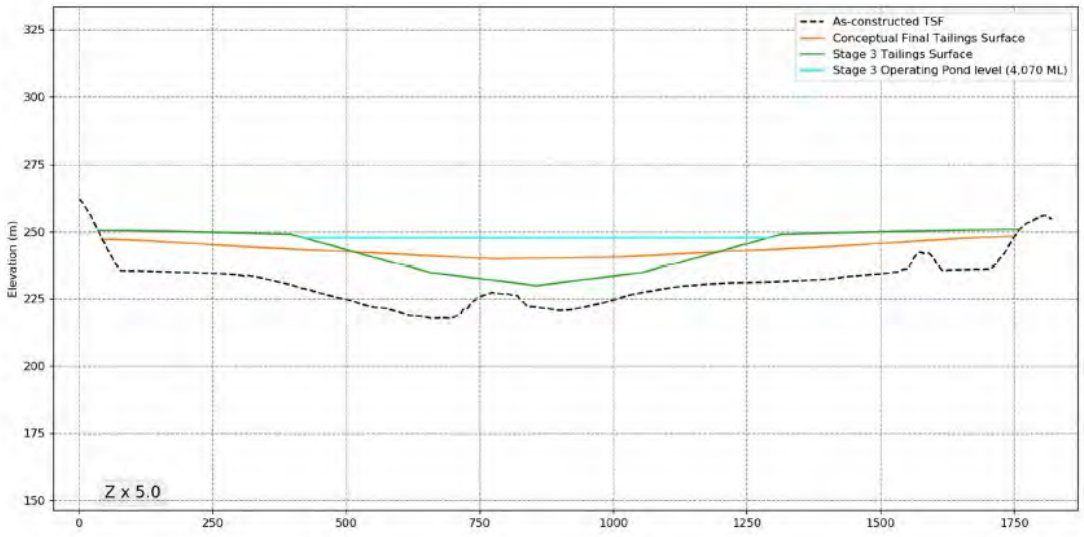


Figure 24. Conceptual closure final tailings surface – Section N-S (ATCW, 2025b)

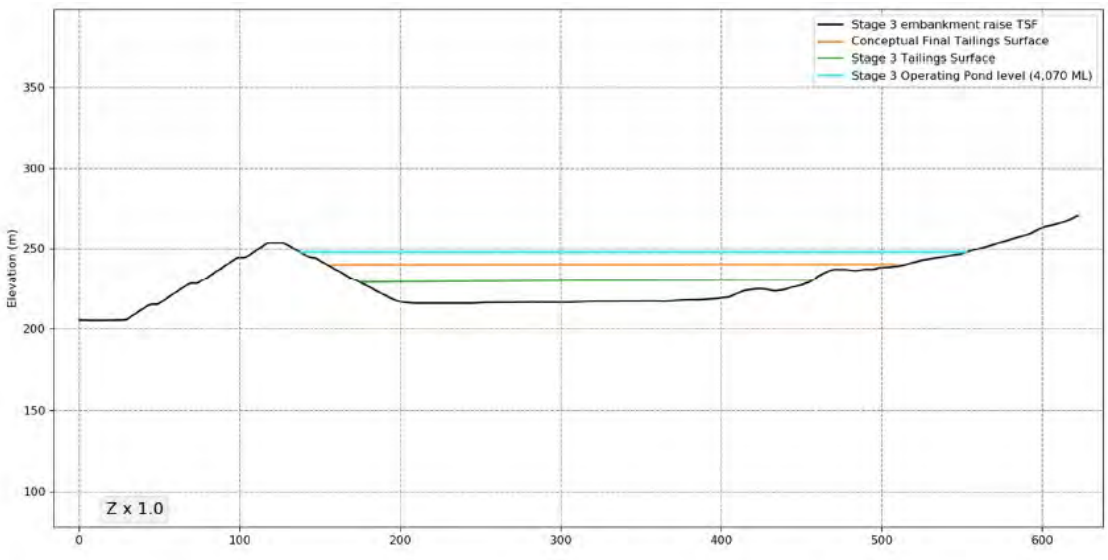


Figure 25. Conceptual closure final tailings surface – embankment (ATCW, 2025b)

3.5.10.2.6. Final Landform Design

As described above, the final tailings surface will be dewatered and reshaped to achieve a self-shedding landform.

The downstream face of the TSF main embankment will be flattened to a nominal 1V:6.5H to stabilise the embankment in the long term and eliminate water ponding and storage within the TSF. Reshaping will require approximately 170,000 m^3 of cut and 110,000 m^3 fill. The excess cut will be utilised for reshaping the tailings surface.

The Stage 3 embankment shell will be constructed from coarse rockfill and would therefore be resistant to erosion. The landform surface is designed to allow for stormwater to flow in a controlled manner towards the outlet structures and therefore, the TSF final landform will not hold water. The Stage 2 spillway at elevation of RL 242.1 m (covered by Stage 3 embankment raise) will be reinstated for closure following reshaping of the embankment, acting as an outlet for the final TSF landform (ATCW, 2054b). This outlet is sized to pass the peak flood resulting from the Probable Maximum Precipitation (PMP). To reduce the risk of erosion, a network of surface channels is proposed to convey flows from the upstream catchments to the discharge outlet structure (ATCW, 2025a). Erosion controls, such as erosional velocity dampeners will be designed by a suitably qualified person to ensure long term stability of the embankment and spillway.

To ensure long term stability of the TSF embankment, the crest will be cut down to the final tailings level and the downstream face will be flattened to direct storm water flows off the rehabilitated TSF embankment and out of the Knapdale Valley in a controlled manner. The embankment will be raised, and new spillway channels will be excavated at the northern and southern abutments to allow attenuation and controlled discharge. Additional engineering design activities will be undertaken to ensure the spillway channel accommodates the peak flood flow velocity (predicted to be 6.2 m/s) to achieve a stable spillway condition. Erosion controls, such as erosional velocity dampeners will be designed by a suitably qualified person to ensue long term stability of the embankment and spillway.

The concept plan of the flattened embankment is provided in Figure 26 to Figure 27.

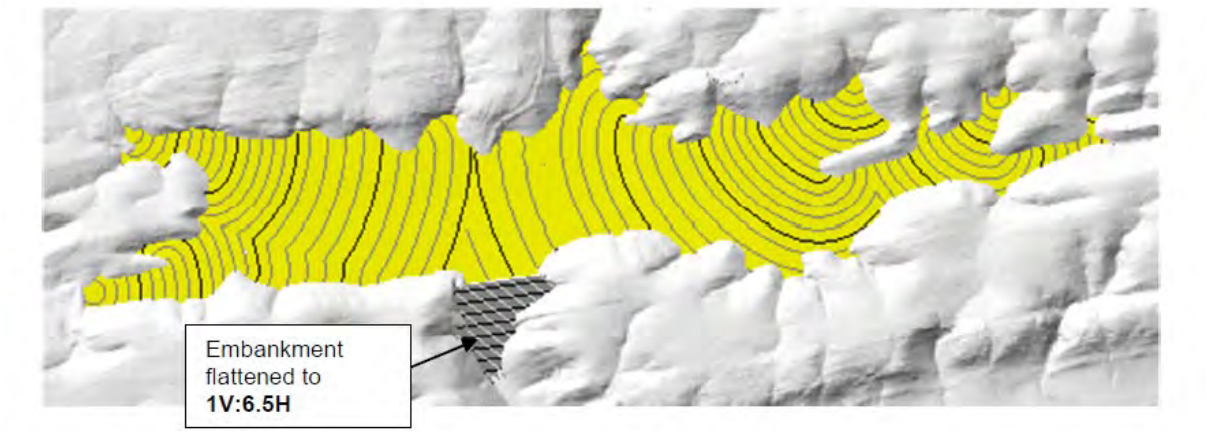


Figure 26. Embankment at closure (ATCW, 2025b)

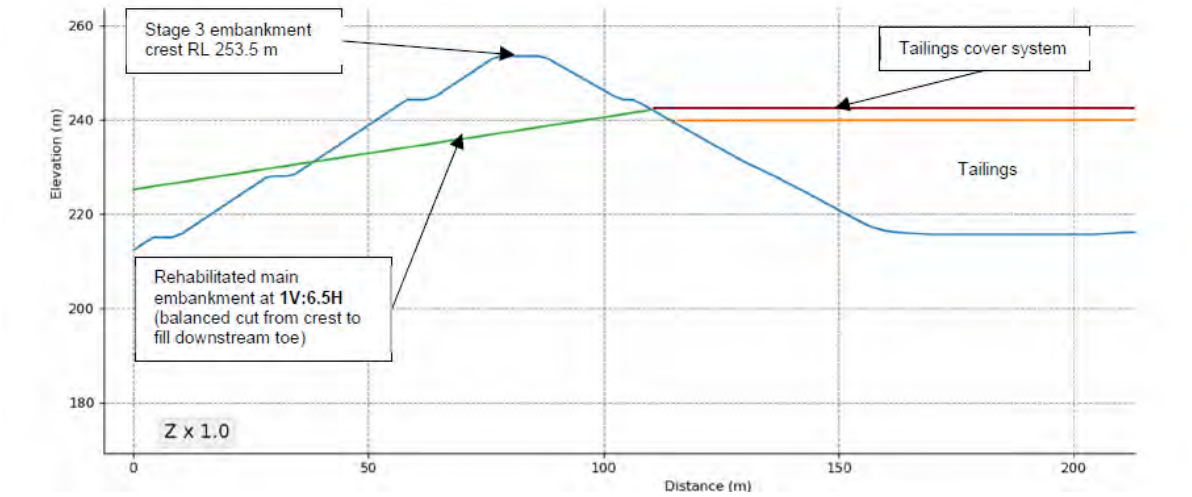


Figure 27. Embankment at closure – section (ATC Williams, 2025b)

3.5.10.2.7. TSF Cover System

A cover system will be constructed on the TSF surface to minimise infiltration and therefore seepage. Several potential cover systems were investigated before determining the most suitable outcome for the TSF. Additional details on the cover system options analysis is provided in Appendix J.

The selected cover system for the TSF final landform (Option 1 Store and Release) is described in Table 45 and Figure 28.

Table 45. TSF cover system

Layer	Depth (m)	Purpose	Source and description
Topsoil	0.2	Support vegetation	Site stockpiles or commercial provider.
Infiltration Storage Layer	1	Store moisture to support vegetation growth and limit downward flux into the tailings.	This material would be sourced from a borrow located near the TSF, and comprise the subsoil, being the material immediately beneath the topsoil and above the weathered rock.
Reduced permeability layer (RPL)	0.5	Limit flux through the cover system into the tailings.	A suitable source has not been identified on site. This would be sourced from a commercial provider.
Capillary Break Layer	0.3	Disrupt the upward and downward movement of water (and hence salt) through capillary action by providing a change in pore size distribution.	To comprise a clean gravel product. A manufactured material, sourced from a licenced quarry or crushed and screened NAF waste rock.
Geomembrane (GCL/HDPE)	N/A	Low permeability barrier, to be used in the absence of an RPL, if required. Geosynthetic clay liner (GCL) is a sodium-bentonite clay	To be purchased from specialised supply companies and installed by qualified installers.

Layer	Depth (m)	Purpose	Source and description
		sandwiched between non-woven geotextile and forms a very low permeability barrier to water but is susceptible to structural changes from high calcium content. High density polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE) are thermoplastic polymer sheets that form an impermeable barrier to water and many contaminants.	

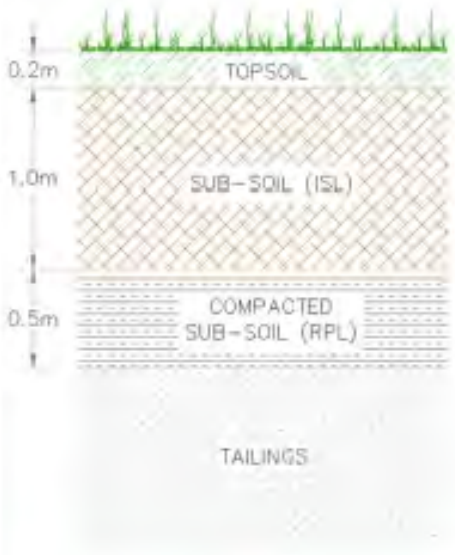
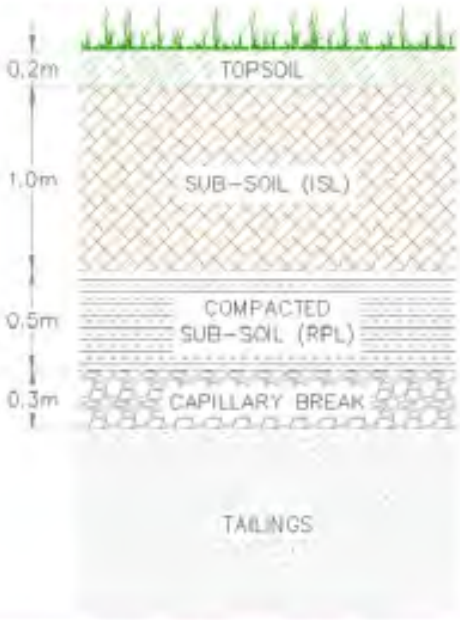
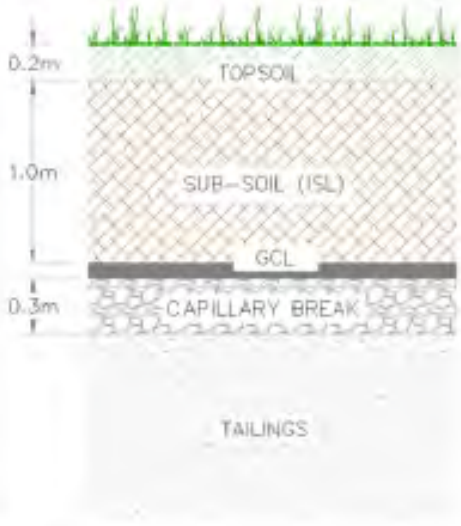
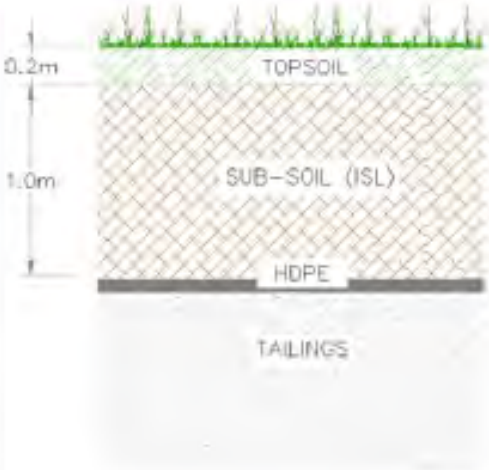
COVER 1: STORE AND RELEASE	COVER 2: CAPILLARY BREAK (PRCP)
• 0.2 m Topsoil • 1 m Infiltration Storage Layer (ISL) • 0.5 m Reduced Permeability Layer (RPL)	• 0.2 m Topsoil • 1 m Infiltration Storage Layer (ISL) • 0.5 m Reduced Permeability Layer (RPL) • 0.3 m Capillary Break
	
COVER 3: GCL	**COVER 4: HDPE**
• 0.2 m Topsoil • 1 m Infiltration Storage Layer (ISL) • GCL • 0.3 m Capillary Break	• 0.2 m Topsoil • 1 m Infiltration Storage Layer (ISL) • HDPE
	

Figure 28. TSF cover system configuration (ATCW, 2025d)

3.5.10.2.8. Seepage Management

During operations, TSF seepage will be managed through a seepage collection system, comprised of a rockfill seepage collection drain reporting to either a seepage monitoring sump or pond.

Numerical groundwater modelling from the Stage 2 TSF and the proposed Stage 3 TSF indicated that the raise will not result in increased groundwater levels, suggesting no significant impact on regional groundwater conditions (CDM Smith, 2025). Groundwater flux is the rate of groundwater movement through an aquifer and represents the rate of seepage predicted to occur from the TSF. The numerical model for the Stage 2 TSF returned a groundwater flux of 5.5 x 10-8 m3/sec/m2, compared to 6.2 x 10-8 m3/sec/m2 for the Stage 3 TSF. This is within the margin of error, and indicates that there will be no increase in seepage from the TSF as a result of the proposed Stage 3 raise.

No seepage is expected to occur from the TSF post-closure due to the reduction in rainfall infiltration as a result of capping the TSF (CDM Smith, 2025). It is expected that seepage collection and management would be required until the cover system has been applied across the entire TSF surface. During the rehabilitation period, seepage will continue to be contained and pumped to the TSF, if available, or removed from site as a regulated waste. Seepage rates will continue to be monitored until continuous recording demonstrates seepage volume is decreasing.

Following this, infrastructure and any potentially contaminated material will be removed. The drain, sump and/or pond will be backfilled with NAF material and revegetated.

3.5.10.2.9. Revegetation Strategy

Water balance modelling of the proposed cover system was completed to identify water availability to support vegetation (Table 46) (ATC Williams, 2025). The results indicate that with both proposed cover system options, there is a net deficit of rainfall that will require drought tolerant species to be utilised. Endemic native species have been utilised in the revegetation plan to increase the potential for survival and establishment. Refer to Appendix M for further detail.

The revegetation strategy is defined in Section 3.5.7.

Table 46. Annual cover water balance (ATC Williams, 2025)

Cover	Mean Annual Water Balance				
	Rainfall (mm/year)	Runoff (mm/year and % of rainfall)	Evaporation (mm/year and % of rainfall)	Transpiration (mm/year and % of rainfall)	Net Percolation (mm/year and % of rainfall)
Store and release cover	472.7	2.6 (0.5 %)	83.8 (17.7 %)	386.6 (81.7 %)	0.7 (0.2 %)
HDPE lined cover	472.7	3.5 (0.7 %)	85.9 (18.2 %)	382.4 (80.9 %)	0.0 (0.0 %)

3.5.10.2.10. Long Term Stability

The primary objectives for the closure landform with response to erosion are to:

- Avoid erosion which would impact the performance of the cover system;
- Prevent exposure of the underlying tailings; and

- Ensure long term stability of the landform. (ATC Williams, 2025)

Water Erosion Prediction Project (WEPP) modelling was undertaken on the TSF surface to predict long term erosion. Results of the modelling indicate that the TSF would achieve between 1.11/ha/year and 12.7 t/ha/year of soil loss, depending on the vegetation cover (Table 47).

A mean average annual erosion rate of 5 t/ha/y and a mean maximum annual rate at any one point of 10 t/ha/y is commonly referred to as acceptable rates to prevent rilling. This milestone has been applied to the Project.

Table 47. WEPP model results - TSF surface

70 % Vegetation Cover	30 % Vegetation Cover	0 % Vegetation Cover
1.11 t/ha/year	3.89 t/ha/year	12.70 t/ha/year

A hydraulic assessment indicates that flow velocity on the embankment would range from 1.5 m/s at the crest to 2.1 m/s and the toe of the embankment. Recommended D50 rock sizing for this range of flow velocities range from 150 mm to 300 mm (ATCW, 2025a). This material is available from the proposed borrow pit. Refer to Appendix N for further detail.

3.5.10.2.11. Limitations and Assumptions

The final closure landform is dependent on the mining schedule, which can change due to increased geological knowledge as mining progresses, exploration drilling, market factors and technology. This may result in a change to the predicted tailings volume within the TSF at the end of the LoM.

The assumption is that material properties will remain consistent with observed properties. Stability targets will be maintained in the final closure landform design.

The following timeline is assumed based on implementing enhanced evaporation at the TSF at closure:

- Years 1-4, Dewatering and consolidation of the tailings (4 years)
- Years 5-7, Placement of cover layers (3 years, dry season only)

Factors such as workforce availability and extreme weather may affect the assumed timeline.

3.5.10.2.12. QAQC

Construction of the landform will be deemed consistent with design by a suitably qualified professional (QA/QC), verified by a QA/QC document, confirming that the landform is stable and meets design specifications. This includes, but is not limited to, materials, workmanship, and components of the work. Control points are established in constructing the work and instrumentation shall be appropriately calibrated. Controls will be issued indicating procedures where corrections are necessary. Testing will be completed post-construction and QA/QC methodologies will be followed. This data will be aligned with the TSF OMS and used to inform TSF closure design inputs and rehabilitation.

3.5.10.2.13. Rehabilitation Trials

This PRCP application proposes to amend Condition PRCP5 to allow field trials to commence within 12 months of completion of the stage 3 TSF embankment raise to investigate the performance of the

cover system for the TSF. A suitable trial location has been identified in the north east corner of the TSF. Although this area is currently inaccessible, works can be undertaken during the proposed raise to establish a trial area. This will enable rehabilitation trials to be conducted directly on the TSF surface, rather than relying on laboratory or off-site manufactured trials. Establishing the trial in situ will provide site-specific data and ultimately produce more meaningful and representative results.

The field trials will be established and maintained for a minimum of five consecutive years. The trials will be carried out in accordance with the following requirements, prescribed in condition PRCP5 of the approved PRCP schedule:

a) The field trials may be located on another area of the tenure if the mine waste structures have not yet been constructed. The field trials must include multiple alternate cover systems, including the default high risk cover system specified in item #9.01 in Table of Values in the administering authority's ERC Calculator (ESR/2015/1824 Version 5) and the cover system proposed in the Rehabilitation Planning Part.
b) The following information must be documented prior to commencement of any trials:
    I. chemical and physical properties of material contained in the landform demonstrating it is representative of the mine waste.
    II. chemical and physical properties of all cover materials.
    III. surface and sub-surface preparation requirements including the base/lining layer under the landform (for example, ripping, compacting, establishing bunds).
    IV. amelioration requirements (for example, gypsum/lime etc, rate, spreading/layer application)
    V. details of installation methodology.
    VI. monitoring equipment installation.
    VII. QA and QC tests and processes implemented for the construction of each layer of the alternate cover system.
c) Prior to commencement of the trials, a planning report must be submitted to the administering authority that provides details as relevant for the matters above and also provides the following:
    I. specific objectives of the proposed design cover (i.e. reduction in surface water infiltration to a specified rate, prevention of salt rise that would impact on the establishment of vegetation).
    II. detailed design.
    III. justification for the quality control and assurance processes that will be implemented for the construction of each layer of the alternate cover system.
    IV. lab-based material characterisation results.
d) At a minimum, the following information must be collected during the course of the trial:
    I. Monitoring as per Section 8, INAP Global Cover System guideline (INAP 2017).
    II. Site specific climate data collected for the duration of the trial.
    III. Data relating to surface conditions (biological and erosion monitoring.
    IV. Data from in situ monitoring for:
        1) contaminant transport.
        2) drainage performance.

3) evapotranspiration.
4) soil performance
5) stability and biological factors..

e) Following completion of the trial a completion report incorporating supporting data must be provided demonstrating the performance of all trialled cover systems. This report must provide details of the matters described above, in addition to the following:
   I. Demonstration that the proposed cover system will achieve a stable condition (pursuant to section 111A of the EP Act) and comply with criteria specified in this PRCP schedule.
   II. Updated Landform Evolution Modelling and infiltration modelling based on the results of the trial.
   III. Calibration processes for all instrumentation.
   IV. SILO data for the duration of the trial period.
   V. As constructed plans and report by an appropriately qualified person certifying that each cover system was constructed according to the design in the trial planning report.
   VI. Destructive/non-destructive testing of each capping layer in the trial plot.
   VII. In situ QA and QC test report for each capping layer.
   VIII. QA and QC information for the overall landform construction.
   IX. Independent* certification from an appropriately qualified third party specifying the cover system for full scale application, based on the findings from the trial and including any necessary changes.
   X. Recommendations from an appropriately qualified person regarding the location of primary and secondary monitoring sites and the location of additional lysimeters referred to in RM7.

3.5.11. Voids

There are no proposed voids associated with the Project.

3.5.12. Summary of Key Rehabilitation Milestones

Table 48 summarises the Project rehabilitation milestones. The rehabilitation activities drive achievement of the Project rehabilitation milestones and inform the associated PRCP schedule. Where a milestone criterion requires any of the following, MMG will maintain appropriate records and will provide to DETSI on request:

- Certifications or assessments to be undertaken;
- Monitoring or maintenance to be carried out;
- Final design plans and/or specifications to be developed; and
- Reports, such as contaminated land investigations, rehabilitation reports (including monitoring records), validation reports and quality assurance/quality control reports.

Table 48 Key rehabilitation and management practices

Rehabilitation Milestone	
RM1	Infrastructure decommissioning and removal

Rehabilitation Milestone	
RM2	Remediation of contaminated land
RM3	Landform development and reshaping (RA1)
RM4	Landform development and reshaping (RA2)
RM5	Landform development and reshaping (RA3)
RM6	Landform development and reshaping (RA4/RA5)
RM7	Landform development and reshaping (RA6)
RM8	Landform development and reshaping (RA7)
RM9	Surface preparation
RM10	Revegetation (native ecosystem)
RM11	Revegetation (grazing)
RM12	Achievement of surface requirements (native ecosystem)
RM13	Achievement of surface requirements (grazing)
RM14	Achievement of post mining land use to a stable condition (native ecosystem)
RM15	Achievement of post mining land use to a stable condition (grazing)

3.5.13. Rehabilitation Milestones

A Rehabilitation Milestone (RM) is defined as *each significant event or step necessary to rehabilitate the land to a stable condition* (Department of Environment and Science, 2021). Rehabilitation milestones are used to determine if the rehabilitation area has been rehabilitated to a point that the PMLU has been achieved.

The rehabilitation milestones for each rehabilitation area are outlined below (Table 49). Where a milestone criteria requires any of the following, MMG will maintain appropriate records and will provide to DETSI on request:

- Certifications or assessments to be undertaken;
- Monitoring or maintenance to be carried out;
- Final design plans and/or specifications to be developed; and
- Reports, such as contaminated land investigations, rehabilitation reports (including monitoring records), validation reports and quality assurance/quality control reports.

In addition to the site wide rehabilitation milestones, the following reporting conditions are applied to the Renewable Energy Project:

- **PRCP6** Prior to the commissioning of the Renewable Energy Project* and within two (2) years of the PRCP effective date, the PRCP holder must develop an End of Operation Decommissioning Management Plan (EODMP). The EODMP must:

- Be prepared by a Registered Professional Engineer of Queensland who is experienced in the relevant decommissioning type; and
- Provide for the complete removal of all wind turbine infrastructure and ancillary infrastructure* from site; and
- Include a conceptual timeline for the decommissioning of wind turbine infrastructure and ancillary infrastructure in accordance with the associated milestone and criteria in this schedule; and
- Include a checklist of actions required to be completed for achievement of each applicable rehabilitation milestone and criteria; and
- Include an assessment of relevant rehabilitation intersects during decommissioning. This includes but is not limited to:
  - material balance and suitability assessments and management; and
  - flooding modelling assessments and management: and
  - water management; and
  - revegetation assessments and managements; and
- Include the plan required by condition **PRCP7;** and
- Be endorsed by an independent and suitably qualified and experienced third party; and
- Be submitted to the administering authority within 5 business days of request.

- **PRCP7** The EODMP required by condition **PRCP6** must include:
  - a Final Landform Design Plan which must:
    - Be prepared by a Registered Professional Engineer of Queensland with experience in the relevant decommissioning type; and
    - Be endorsed by an independent third party who is a suitably qualified and experienced person; and
    - Provide for reinstatement of all areas associated with the Renewable Energy Project including wind turbine infrastructure and ancillary infrastructure to approximate original contours; and
    - Demonstrate that all reinstated areas are geotechnically and erosionally stable and will achieve a stable condition (pursuant to section 111A of the EP Act); and
    - Demonstrate that all rehabilitated watercourse crossing designs have considered fluvial geomorphology, with certification by a suitably qualified and experienced person that the design achieves a safe, stable and non polluting outcome for rehabilitated watercourses.
- **PRCP8** The PRCP holder must revise the EODMP required by condition **PRCP6** within six months of becoming aware of a proposed change and/or update to the construction, operational and/or decommissioning phase of the Renewable Energy Project.

- **PRCP9** The PRCP holder must decommission the Renewable Energy Project in accordance with the EODMP under the supervision of an appropriately qualified person.

Table 49. Rehabilitation milestones

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
RM1	Infrastructure decommissioning and removal	For all areas: a) All buildings and associated infrastructure dismantled and removed offsite. b) All hardstand and concrete areas decommissioned removed. c) Fences are removed. d) All pipelines are removed. e) Powerlines and supporting electrical infrastructure (above and below ground) are removed. f) Roads removed (with the exception of those being retained for future site access). g) Waste is removed. h) Drillholes, sediment ponds and sumps decommissioned. i) Machinery/ equipment not required for rehabilitation removed from site. For RA7: j) All infrastructure is decommissioned and removed from site in accordance with EODMP under the supervision of an AQP	Infrastructure is required to be removed from site to enable surface treatment of areas	• Documented Inspections
RM2	Removal of contaminated land	a) Contaminated land assessment is completed by a suitably qualified person.	• Contaminated material is required to be removed to	• Preliminary Site Investigation Report • Detailed Site Investigation Report

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		b) Any identified contaminated material is removed from the mine domain and disposed of at a licenced facility. c) Validation sampling determines that contaminant removal has been successful. d) The validation sampling report is accepted by a suitably qualified Contaminated Land Auditor stating that contamination removal has been successful.	minimise potential for environmental harm • A validation report will provide verification that contaminants have been removed and landform shaping can commence	• Validation Investigation Report
RM3	Landform development and reshaping (RA1)	a) Landform is shaped to be gently sloping, characteristic of the natural landform with natural drainage lines reinstated. b) Landform is ripped parallel to contour. c) Features such as large woody debris or boulders are situated to provide suitable habitat for the Purple Neck Rock Wallaby. d) RA1 is determined to be geotechnically stable by a suitably qualified geotechnical engineer.	• The final landform must be consistent with the surrounding land and profiled to limit erosion • RA1 has been designated as a native ecosystem and therefore needs to support fauna populations	• Survey • Certification reporting from a suitably qualified person
RM4	Landform development and reshaping (RA2)	a) Landform is shaped to be gently sloping, characteristic of the natural landform with natural drainage lines reinstated. b) Landform is ripped parallel to contour.	The final landform must be consistent with the surrounding	• Survey • Certification reporting from a suitably qualified person

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		c) RA2 determined to be geotechnically stable by a suitably qualified geotechnical engineer.	land and profiled to limit erosion	
RM5	Landform development and reshaping (RA3)	a) General earthworks completed. b) HDPE Liner removed. c) Dams filled with NAF or other suitable material. Material placed in 500mm lifts, watered and compacted. d) Landform is shaped to be gently sloping, characteristic of the natural landform with natural drainage lines reinstated. e) RA3 determined to be geotechnically stable by a suitably qualified geotechnical engineer.	The final landform must be consistent with the surrounding land and profiled to limit erosion	• Survey • Certification reporting from a suitably qualified person
RM6	Landform development and reshaping / re-profiling (RA4 / RA5)	a) Removal of waste rock. PAF material is disposed of underground. NAF material is utilised in rehabilitation. b) Major earthworks are completed. c) Landform is shaped to be gently sloping, characteristic of the natural landform with natural drainage lines reinstated. d) Land reshaped to final landform design with suitable material as assessed by AQP and as per EODMP, where required. e) RA4/RA5 is determined to be geotechnically stable by a suitably qualified geotechnical engineer.	The final landform must be consistent with the surrounding land and profiled to limit erosion	• Survey • Certification reporting from a suitably qualified person

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
RM7	Landform development and reshaping (RA6)	a) The construction of the cover system has been certified by an appropriately qualified person as being consistent with the cover design. b) QAQC testing is completed post construction at a rate of at least 1 sample per ha and confirms depth of layers and permeability is to specified designs and no PAF material is present within the cover system. c) Primary monitoring locations have been established in representative locations recommended as an outcome of the trial mentioned in Condition PRCP5(e) and include: I. An automated meteorological station that records the following: rainfall (tipping bucket), i. evaporation, ii. relative humidity, iii. wind strength, iv. wind direction, and v. air temperature. II. piezometers within the tailings and capillary break layer, III. automated in situ water content and suction sensors in each layer of the cover system and in the tailings below the cover system that records data at 30 minute intervals (except in the capillary break),	• The final landform has been designed to shed water and provide stable slopes • RA6 has been designated as a native ecosystem and therefore needs to support fauna populations • Excessive rilling is unlikely to occur at erosion rates of <5t/ha/y • Erosion rilling <0.2m will prevent exposure of tailings	• Construction and maintenance design • Survey • Certification reporting from a suitably qualified person

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		IV. temperature sensor in each layer of the cover system and in the tailings below the cover system that records data at 30 minute intervals, V. a lysimeter. d) Secondary monitoring locations have been established in representative locations recommended as an outcome of the trial mentioned in Condition PRCP5(e) and include in each layer of the cover system and in the tailings below the cover system: I. piezometers within the tailings and capillary break layer, II. automated in situ water content sensors in each layer of the cover system and in the tailings below the cover system that records data at 30 minute intervals (except in the capillary break). e) Temperature sensor in each layer of the cover system and in the tailings below the cover system that records data at 30 minute intervals. All sensors are calibrated to each material type using the manufacturers specifications. f) Lysimeters and associated drainage collection and monitoring system are installed in at least 3 locations that are recommended as an outcome of the trial mentioned in Condition PRCP5(e).		

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		g) Sediment capture flumes have been installed and calibrated at the base of the TSF embankment. h) All monitoring equipment has been installed and calibrated by an appropriately qualified person. i) Slopes of TSF surface have a grade of <1.5% j) Certification by an AQP that landform has been constructed according to the design and has achieved an acceptable factor of safety. k) Spillway is reinstated at RL 242.1 m. Spillway has an approximate length of 330m and a longtitudinal grade of 2.0%. l) TSF is assessed as geotechnically stable by a suitably qualified geotechnical engineer. m) Features such as large woody debris or boulders are present to provide suitable habitat for the Purple Neck Rock Wallaby. n) TSF surface has been shaped to prevent ponding and concentration of surface water flow. o) Spillway is designed and constructed to support peak flood flow velocity. p) Average erosion rate of <5 t/ha/y with the maximum erosion rate at any point on the landform of <10 t/ha/y. q) Erosion rilling is <0.3m. r) No surface ponding.		

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		s) Installation of erosion and sediment control structures that comply with International Erosion Control Association (IECA).		
RM8	Landform development and reshaping (RA7)	a) Land reshaped to final landform design with suitable material as assessed by AQP and as per EODMP. b) Features such as large woody debris or boulders are situated to provide suitable habitat for the Purple Neck Rock Wallaby. c) RA7 is determined to be geotechnically stable by a suitably qualified geotechnical engineer.	• Minimise surface flows and gully erosion	• Documented Inspections • Survey
RM9	Surface preparation	a) Deep ripping of compacted surfaces, at least 300mm into soil profile, where required and avoiding habitat features associated with RM3 and RM8. b) An assessment of the need for soil amelioration undertaken and soil ameliorants such as fertiliser, gypsum and/or organic matter have been applied at rates determined by an appropriately qualified person. c) Topsoil placement of a minimum 0.1 - 0.2 m	• Ripping and application of growth media will encourage establishment of vegetation	• Survey • Certification reporting from a suitably qualified person
RM10	Revegetation (native ecosystem)	a) Seeding rate of 4 – 10 kg/ha is applied. b) Direct seeding species mix is endemic to Regional Ecosystem 1.11.2 and 1.7.7 on RA1 including *Eucalyptus leucophloia, Corymbia terminalis, Corymbia capricornia* with a groundcover of *Aristida latifolia, Eriachne obtusa,Sporobolus australasicus,Themeda triandra, Triodia pungens.*	• Monitoring will assess success of natural revegetation and determine if intervention measures are required eg.	• BioCondition Assessment Report • Annual REMP report • Laboratory Certificates of Analysis (COAs) • Annual Rehabilitation Monitoring Report

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		c) Direct seeding species mix is endemic to Regional Ecosystem 1.11.2 and 1.7.7 on RA6 including *Aristida latifolia, Eriachne obtusa,Sporobolus australasicus,Themeda triandra, Triodia pungens.* d) Direct seeding species mix is endemic to Regional Ecosystem 1.11.2a/1.7.7a and RE1.11.3a/1.3.13a on RA7, including the terrestrial species of *Eucalyptus leucophloia, Corymbia terminalis* and *Corymbia capricornia* with a groundcover of *Aristida latifolia, Eriachne obtusa,Sporobolus australasicus, Themeda triandra* and *Triodia pungens.* e) Direct seeding species mix on RA7 including riparian species of *Eucalyptus camaldulensis, Corymbia capricornia, Sporobolus australasicus*, Melaleuca species, Lophostemon species and other suitable wetland groundcover species in riparian vegetation zones. f) Deep rooting vegetation such as Eucalyptus Spp not present on RA6. g) Groundcover >50%.	further application of seed is required • Vegetation species have been selected based on pre mine Regional Ecosystems • Deep rooting species present a risk of exposing capped tailings on RA6	

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
RM11	Revegetation (grazing)	a) Direct seeding is applied at a rate of 4 – 10 kg/ha. b) Direct seeding of native species including *Eucalyptus leucophloia, Corymbia capricornia, Terminalia aridicola, Corymbia terminalis, Triodia pungens, Eucalyptus pruinose, Eremophila longifolia, Atalaya hemiglauca, Acacia chisholmi,i Atalaya hemiglauca, Carissa lanceolata* as well as appropriate 3P grass species to support the PMLU. c) Pasture vegetation seeding creates cover >30%.	• Monitoring will assess success of natural revegetation and determine if intervention measures are required eg. further application of seed is required • Vegetation species have been selected based on PMLU of grazing	• BioCondition Assessment Report • Annual REMP report • Laboratory Certificates of Analysis (COAs) • Annual Rehabilitation Monitoring Report
RM12	Achievement of surface requirements (native ecosystem)	For all areas: a) Weed species in densities less than 10% total coverage. b) Average erosion rate of <5 t/ha/y with the maximum erosion rate at any point on the landform of <10 t/ha/y. c) Vegetation cover 70%. d) Species used in revegetation in RM10 remain present and showing evidence of natural recruitment. e) Surface water quality measured at downstream monitoring sites (CT3-08 (MS2), CC-05, CC-15, MS8	• Excessive rilling is unlikely to occur at erosion rates of <5t/ha/y • Surface water values have been selected based on the Projects classification as slightly to	• BioCondition Assessment Report • Annual REMP report • Laboratory Certificates of Analysis (COAs) • Annual Rehabilitation Monitoring Report

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		(SN-15), SC-29 (MS5), SN-05 (MS8 REF), SN-08 (MS5 Ref) and DR-18) undertaken on an event basis1 complies with ANZECC/ARMCANZ (2000) Table 3.4.1 for 95% protection level and Table 3.3.4 values for aquatic ecosystems (slightly to moderately disturbed). f) Stream sediment quality at downstream monitoring sites (CT3-08 (MS2), CC-05, CC-15, MS8 (SN-15), SC-29 (MS5), SN-05 (MS8 REF), SN-08 (MS5 Ref) and DR-18) undertaken twice a year (at end of wet season and end of dry season) complies with ANZECC/ARMCANZ (2000) Interim Sediment Quality Guidelines – low. g) Quarterly groundwater monitoring at MB5, MB6, MB9S and MB9D demonstrate groundwater quality complies with groundwater trigger limits nominated in Schedule C – Table 8 of the EA. h) Soil testing indicates the following parameters are met: I. Rootzone EC <0.15mS/cm, II. Soil pH <9 and >6 as measured at any part of the root zone, III. Exchangeable Sodium Percentage (ESP%) <5% (at 0-10cm depth). For RA6:	moderately disturbed • Livestock drinking water values have been selected based on surrounding land use of grazing • Monitoring sites have been selected to capture all areas of disturbance, including downstream of the TSF • Soil parameters are consistent with pre-mine condition • TSF seepage is expected to decrease after rehabilitation	

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		i) There is no evidence of water ponding on the surface of the TSF. j) Continuous recording demonstrates seepage volume is decreasing. k) In-situ permeability and surface infiltration are not significantly decreasing compared with initial rates based on statistical analysis. l) In-situ permeability and surface infiltration are not significantly decreasing compared with initial rates based on statistical analysis. For RA7: m) Certification from AQP that all actions required in EODMP to achieve surface requirements have been completed. n) All temporary erosion and sediment control and stormwater management structures have been removed. o) No erosion classified as “moderate” or “severe”[3]. p) Riparian monitoring is undertaken every year[5], which shows a progressive improvement in the following attributes; tree species richness, bank stability, recruitment and projected foliage cover, or is similar to, representative reference ephemeral waterways in the region	• RA will be compared to reference sites to account for seasonal fluctuations	

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		q) Rehabilitated watercourses are stable and do not create any upstream or downstream impacts, as certified by an AQP.		
RM13	Achievement of surface requirements (grazing)	a) Weed species in densities less than 10% total coverage. b) Pasture covers has reached 70% of surface area. c) Average erosion rate of <5 t/ha/y with the maximum erosion rate at any point on the landform of <10 t/ha/y. d) Surface water quality measured at downstream monitoring sites (CT3-08 (MS2), CC-05, CC-15, MS8 (SN-15), SC-29 (MS5), SN-05 (MS8 REF), SN-08 (MS5 Ref) and DR-18) undertaken on an event basis1 complies with ANZECC/ARMCANZ (2000) Table 3.4.1 for 95% protection level and Table 3.3.4 values for aquatic ecosystems (slightly disturbed). e) Stream sediment quality at downstream monitoring sites (CT3-08 (MS2), CC-05, CC-15, MS8 (SN-15), SC-29 (MS5), SN-05 (MS8 REF), SN-08 (MS5 Ref) and DR-18) undertaken twice a year (at end of wet season and end of dry season) complies with ANZECC/ARMCANZ (2000) Interim Sediment Quality Guidelines – low. f) Quarterly groundwater monitoring at MB5, MB6, MB9S and MB9D demonstrate groundwater quality complies with groundwater trigger limits nominated in Schedule C – Table 8 of the EA.	• Site specific vegetation completion criteria will be determined based on reference site monitoring • Excessive rilling is unlikely to occur at erosion rates of <5t/ha/y • Surface water values have been selected based on the Projects classification as slightly to moderately disturbed • Livestock drinking water values have been	• BioCondition Assessment Report • Annual REMP report • Laboratory Certificates of Analysis (COAs) • Annual Rehabilitation Monitoring Report

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		g) Soil testing indicates the following parameters are met: I. Rootzone EC <0.15mS/cm, II. Soil pH <9 and >6 as measured at any part of the root zone, III. Exchangeable Sodium Percentage (ESP%) <5% (at 0-10cm depth). For RA5: h) Certification from AQP that all actions required in EODMP to achieve surface requirements have been completed.	selected based on surrounding land use of grazing • Monitoring sites have been selected to captured all areas of disturbance, including downstream of the TSF • Soil parameters are consistent with pre-mine condition • TSF seepage is expected to decrease after rehabilitation • RA will be compared to reference sites to account for	

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
			seasonal fluctuations	
RM14	Achievement of post-mining land use to a stable condition (native ecosystem)	For all areas: a) Vegetation cover exceeds 70% of the surface area. b) All species used in RM10 show natural recruitment. c) Weed species in densities less than 10% total coverage. d) Native fauna observed or indicators of these species have been recorded. e) There is no evidence of seepage occurring within the mining tenure. f) Certification from an REPQ that the domain has achieved stable condition.4 g) Certification from an AQP that the landform achieved a factor of safety 1.5. h) All results from surface water quality measured at downstream monitoring sites (CT3-08 (MS2), CC-05, CC-15, MS8 (SN-15), SC-29 (MS5), SN-05 (MS8 REF), SN-08 (MS5 Ref) and DR-18) undertaken on an event basis1 complies with ANZECC/ARMCANZ (2000) Table 3.4.1 for 95% protection level and Table 3.3.4 values for aquatic ecosystems (slightly disturbed) for a minimum of 5 consecutive years.1 i) All results from stream sediment quality at downstream monitoring sites (CT3-08 (MS2), CC-05, CC-15, MS8 (SN-15), SC-29 (MS5), SN-05 (MS8	• Site specific vegetation completion criteria will be determined based on reference site monitoring • Excessive rilling is unlikely to occur at erosion rates of <5t/ha/y • Surface water values have been selected based on the Projects classification as slightly to moderately disturbed • Livestock drinking water values have been selected based	• BioCondition Assessment Report • Annual REMP report • Laboratory Certificates of Analysis (COAs) • Annual Rehabilitation Monitoring Report

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		REF), SN-08 (MS5 Ref) and DR-18) undertaken twice a year (at end of wet season and end of dry season) complies with ANZECC/ARMCANZ (2000) Interim Sediment Quality Guidelines – low for a minimum of 5 consecutive years. j) All results from quarterly groundwater monitoring at MB5, MB6, MB9S and MB9D demonstrate groundwater quality complies with groundwater trigger limits nominated in Schedule C – Table 8 of the EA for a minimum of 5 consecutive years. k) Soil testing undertaken at yearly intervals indicates the following parameters are met: I. Rootzone EC <0.15mS/cm, II. Soil pH <9 and >6 as measured at any part of the root zone, III. Exchangeable Sodium Percentage (ESP%) <5% (at 0-10cm depth). For RA1: l) No evidence of erosion classified as 'Severe'[3]. m) No active erosion present as demonstrated by no increase in erosion ratings[3] over time. For RA6: n) There is no evidence of water ponding on the surface of the TSF.	on surrounding land use of grazing • Monitoring sites have been selected to captured all areas of disturbance, including downstream of the TSF • Soil parameters are consistent with pre-mine condition • TSF seepage is expected to decrease after rehabilitation • RA will be compared to reference sites to account for seasonal fluctuations	

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		o) Average erosion rate of <5 t/ha/y. p) No evidence of erosion classified as ‘moderate’ or 'severe'. q) No evidence of salt rise through the cover system of the TSF. r) In-situ permeability and surface infiltration are not significantly decreasing compared with initial rates based on statistical analysis. s) Results of monitoring gathered from primary and secondary monitoring stations established in RM7 demonstrate the following has been maintained for a minimum of 10 years: I. Hydraulic conductivity of the cover system is less than 1 x 10-8 m/s for at least 10 years, II. Net percolation through the cover into the tailings has been reduced to <5% of rainfall for at least 10 years as measured by primary and secondary monitoring locations and lysimeters, III. Water content of the reduced permeability layer is maintained above 85% over a 10 year period, IV. Temperature within the tailings has not increased over a 10 year period, V. Volumetric water content of tailings does not respond to rainfall events.		

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		For RA7: t) Certification by AQP that all actions as required in the EODMP to achieve a stable condition have been completed. u) No evidence of erosion classified as “moderate” or “severe”[3]. Riparian monitoring undertaken every year5 shows an achievement in the following attributes; tree species richness, bank stability, recruitment and projected foliage cover, which is similar to, representative reference ephemeral waterways in the region.		
RM15	Achievement of PMLU to a stable condition (grazing)	a) Weed species in densities less than 10% total coverage. b) Vegetation cover has reached 70%. c) All established species show natural recruitment. d) Land suitability assessment by an appropriately qualified person certifies land has achieved a post-mine land suitability[2] of 4[2] or better. e) Minimum of 4 palatable perennial pasture species and 2 shade tree species established. f) No evidence of erosion classified as ‘Severe’[3]. g) No active erosion present as demonstrated by no increase in erosion ratings[3] over time. h) There is no evidence of seepage occurring within the mining tenure.	• Site specific vegetation completion criteria will be determined based on reference site monitoring • Excessive rilling is unlikely to occur at erosion rates of <5t/ha/y. • Certification from a AQP is	• BioCondition Assessment Report • Annual REMP report • Laboratory Certificates of Analysis (COAs) • Annual Rehabilitation Monitoring Report

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		i) Certification from an REPQ that the domain has achieved stable condition. j) Certification from an AQP that the landform achieved a factor of safety 1.5. k) All results from surface water quality measured at downstream monitoring sites (CT3-08 (MS2), CC-05, CC-15, MS8 (SN-15), SC-29 (MS5), SN-05 (MS8 REF), SN-08 (MS5 Ref) and DR-18) complies with ANZECC/ARMCANZ (2000) Table 3.4.1 for 95% protection level and Table 3.3.4 values for aquatic ecosystems (slightly to moderately disturbed) for a minimum of 5 consecutive years.1 l) All results from stream sediment at downstream monitoring sites (CT3-08 (MS2), CC-05, CC-15, MS8 (SN-15), SC-29 (MS5), SN-05 (MS8 REF), SN-08 (MS5 Ref) and DR-18) undertaken twice a year (at end of wet season and end of dry season) complies with limits set for low risk and no adverse effects in ANZECC/ARMCANZ (2000) Interim Sediment Quality Guidelines – low for a minimum of 5 consecutive years. m) All results from quarterly groundwater monitoring at MB5, MB6, MB9S and MB9D demonstrate groundwater quality complies with groundwater trigger limits nominated in Schedule C – Table 8 of the EA for a minimum of 5 consecutive years.	required for relinquishment • Surface water values have been selected based on the Projects classification as slightly to moderately disturbed • Livestock drinking water values have been selected based on surrounding land use of grazing • Monitoring sites have been selected to captured all areas of disturbance, including downstream of the TSF	

Rehabilitation milestone		Milestone criteria	Justification of completion criteria	Verification
		n) Soil testing undertaken at yearly intervals indicates the following parameters are met: PAWC >50 at Red Plain and Pocket soil types, I. Rootzone EC <0.15mS/cm, II. Soil pH <9 and >6 as measured at any part of the root zone, III. Exchangeable Sodium Percentage (ESP%) <5% (at 0-10cm depth), IV. Carrying capacity is suitable to support a sustainable level of grazing. For RA5: o) Certification by AQP that all actions as required in the EODMP to achieve a stable condition have been completed.	• Soil parameters are consistent with pre-mine condition • TSF seepage is expected to decrease after rehabilitation • RA will be compared to reference sites to account for seasonal fluctuations	

[1] Sites on tributaries of Dugald River sample daily for the first two days when stream flows commence. If flows persist, sample weekly until flow ceases.

Dugald River Sites sample Dugald River sites daily while flows are present downstream of the mine and daily for one week after cessation of flows in the tributaries downstream of the mine. Sample monthly if flows are present in Dugald River during the wet season.

Cabbage Tree Creek sites Sample CT3 08, CC 05 and CC 06 daily when flows are present at CT3 08 and sample CC 05 and CC 06 daily for two days after flows at CT3 08 cease. Sample CC-05 and CC-06 weekly if flows are present.

[2] Department of Science, Information Technology and Innovation and Department of Natural Resources and Mines (2015) Guidelines for Agricultural Land Evaluation in Queensland (Second Edition), State of Queensland or later version. (https://www.publications.qld.gov.au/dataset/qld-agricultural_land-evaluation-guidelines/resource/d6591386-08e2-453f-a6fa-dff2a756215f)

[3]Erosion classification framework

Erosion classification	Minor	Moderate	Severe
Sheet erosion	Shallow soil deposits downslope	Partial exposure of roots; moderate soil deposits downslope, etc.	Loss of surface horizon; root exposure, etc
Rill/gully erosion	<15 rills and <0.3m deep	15-30 rills and <0.3m deep	>30 rills and/or any >0.3m deep.
Tunnel erosion	-	-	Present
Mass movement	-	-	Present

3.6. Risk Assessment

A closure and rehabilitation risk assessment has been prepared in accordance with Section 126C(1)(f) of the EP Act. The risk methodology utilised has been developed based on the *Australia and New Zealand Standard AS/NZS for Risk Management – Principles and Guidelines* (ISO 31000:2018).

The risk management process involves the systematic application of policies, procedures, and practices to the activities of communicating and consulting, establishing the context and assessing, treating, monitoring, reviewing, recording, and reporting risk (Figure 29).

Closure and rehabilitation risk assessments have the objective to identify and define specific risks from closure and rehabilitation and associated activities toward environmental, economic, and social values.



Figure 29. ISO 31000: 2018 Risk management process

3.6.1. Risk Identification

The purpose of risk identification is to find, recognise and describe risks that might help or prevent an organisation achieving its objectives. Relevant, appropriate, and up-to-date information is important in identifying risks (Standards Australia, 2018).

The following factors have been considered by this risk assessment:

- Tangible and intangible sources of risk;
- Causes and events;
- Threats and opportunities;
- Vulnerabilities and capabilities;

- Changes in the external and internal context;
- Indicators or emerging risks;
- The nature and value of assets and resources;
- Consequences and their impacts on objectives;
- Limitations of knowledge and reliability of information;
- Time-related factors; and
- Biases, assumptions, and beliefs of those involved.

3.6.2. Risk Analysis and Evaluation

The purpose of risk analysis is to comprehend the nature of risk and its characteristics, including, where appropriate, the level of risk. Risk analysis can be undertaken with varying degrees of detail and complexity, depending on the purpose of the analysis, the availability and reliability of information and the resources available. Risk analysis techniques can be qualitative, quantitative or a combination of these and should include:

- the likelihood of events and consequences;
- the nature and magnitude of consequences;
- complexity and connectivity;
- time-related factors and volatility;
- the effectiveness of existing controls; and
- sensitivity and confidence levels.

A likelihood of occurrence and severity of consequence rating has been assigned to each identified risk in accordance with the risk matrix detailed in Table 50. Control measures have been developed following the identification of risks to achieve a level of risk that is considered to be an acceptable level, as described in Table 51.

Table 50. Risk matrix

			Consequence			
	Environment	No impact to Environmental Value (EV).	Small-scale impact to EV. Localised impact confined to incident area.	Moderate-scale impact to EV. Localised impact confined to property boundary.	Large-scale impact to EV. Regional area of impact.	Extensive population or community scale impact to EV. Extensive area of impact.
	Community and Reputation	No actual or potential community criticism.	Minor level local community criticism (<week). No reputation impact.	Local community criticism (> week) or one-day community protest. Local company reputation impacted.	State-level community criticism or protest over multiple days/ occasion. State-based company reputation impacted.	National community criticism or large-scale protest. Company reputation and approvals impact. Shareholder intervention or short-term share price impact (< month).
	Financial (A$)	<30K	$30k to 300K	$300k to 3M	$3M to $30M	$30M to $300M
	Compliance EA, legislation, instruments (e.g. tenure licence) or contract.	Administrative non-conformance No regulatory or punitive action.	Non-conformance. Notification/report to; request for information by; and/or administrative/ warning notice from regulator.	Recurring non-conformance. Statutory notice from regulator.	Systemic administrative non-compliance (or one moderate non-conformance). Company charged with an offence or minor penalty/ fine.	Systemic moderate non-conformance (or single material non-conformance). Company charged with an offence with moderate penalty
		1	**2**	**3**	**4**	**5**
Likelihood	**Almost Certain (< 4 months)** Occurs in almost all circumstances OR could occur within days to week. **5**	**Medium (6)**	**High (7)**	**High (8)**	**Very High (9)**	**Very High (10)**

	Likely (4 months – 3 yearly) Occurs in most occurrence OR could occur within weeks to month.	**4**	**Medium (5)**	**Medium (6)**	**High (7)**	**High (8)**	**Very High (9)**
	Occasional (3 - 8 yearly) Has occurred before in OR could occur with months to years.	**3**	**Low (4)**	**Medium (5)**	**Medium (6)**	**High (7)**	**High (8)**
	Possible (8 - 15 yearly) Has occurred elsewhere OR could occur with decades	**2**	**Low (3)**	**Low (4)**	**Medium (5)**	**Medium (6)**	**High (7)**
	Unlikely (15 - 100 yearly) Has occurred elsewhere OR could occur within decades.	**1**	**Low (2)**	**Low (3)**	**Low (4)**	**Medium (5)**	**Medium (6)**

Table 51. Risk scores

Risk Score	Risk Rating	Actions Required
9 – 10	Extreme	Requires immediate action to reduce risk score.
7 – 8	High	Requires an action plan approved by senior management.
5 – 6	Moderate	Specific monitoring and procedures required.
2 – 4	Low	Management through routine procedures and protocols.

Table 52. Risk evaluation

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
RM1 Infrastructure decommissioning and removal	Infrastructure is not adequately identified during planning process	Failure to remove all infrastructure in accordance with schedule. Achievement of RM1 is delayed.	2	3	5	A register of infrastructure is to be developed to track which structures exist in each rehabilitation area. Demolition works to be scoped with area managers to identify all infrastructure.	The proposed actions will ensure the demolition works are correctly scoped and scheduled.	1	3	4	Contractors will return to site to remove all infrastructure.
RM2 Removal of contaminated land	Previously unidentified contamination source discovered.	Financial cost of remediation. Achievement of RM2 is delayed.	3	3	6	Records are to be kept of all spills and other incidents occurring at the Project that might result in contamination. Employees and contractors are to be made aware of their reporting obligations through a Site Induction. Initial consultation with an approved	Disturbance is restricted to approved areas as defined on the EA. Initial contaminated land assessments will identify areas for further investigation and remediation.	2	3	5	Ongoing rehabilitation monitoring will identify presence of previously unidentified contaminants. Any contamination will be investigated and further contaminated land

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
						contaminated land assessor to identify contamination targets for remediation or removal.					sampling/ removal will be conducted as required.
	Contaminated sediment is not removed to an appropriate depth.	Contamination of land and water resources Ongoing cost of remediation Financial cost of remobilising earthworks crew	3	3	6	Conduct validation sampling to determine that contaminant removal has been successful.	To be suitable for a PMLU of low-intensity grazing, contaminated land must be removed from the Contaminated Land Register or the Environmental Management Register. These works must be approved by a suitably qualified person and an approved auditor (under the	2	3	5	Ongoing rehabilitation monitoring will identify presence of previously unidentified contaminants. Any contamination will be investigated and further contaminated land sampling/ removal will be conducted as required

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
							Environmental Protection Act 1999 Act).				
RM3 Landform development and reshaping (RA1)	Final landform not adequately shaped per design.	Reduced safety or instability of landform. Erosion leading to contamination of water ways. Unsuccessfully revegetated.	4	3	7	Landform is assessed as geotechnically stable by a suitably qualified geotechnical engineer	Proposed landform is to be gently sloping, limiting potential for erosion. Little earthworks will be required to achieve profile.	2	3	5	Landform will be reshaped until stability is achieved.
RM4 Landform development and reshaping (RA2)	Final landform not adequately shaped per design.	Reduced safety or instability of landform. Erosion leading to contamination of water ways. Unsuccessfully revegetated.	4	3	7	Landform is assessed as geotechnically stable by a suitably qualified geotechnical engineer	Proposed landform is to be gently sloping, limiting potential for erosion. Little earthworks will be required to achieve profile.	2	3	5	Landform will be reshaped until stability is achieved.
RM5 Landform development and reshaping (RA3)	Final landform not adequately shaped per design.	Reduced safety or instability of landform. Erosion leading to contamination of water ways.	4	3	7	Landform is assessed as geotechnically stable by a suitably qualified	Proposed landform is to be gently sloping, limiting potential for erosion. Little	2	3	5	Landform will be reshaped until stability is achieved.

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
		Unsuccessfully revegetated.				geotechnical engineer	earthworks will be required to achieve profile.				
RM6 Landform development and reshaping (RA4/RA5)	Final landform not adequately shaped per design.	Reduced safety or instability of landform. Erosion leading to contamination of water ways. Unsuccessfully revegetated.	4	3	7	Landform is assessed as geotechnically stable by a suitably qualified geotechnical engineer	Proposed landform is to be gently sloping, limiting potential for erosion. Little earthworks will be required to achieve profile.	2	3	5	Landform will be reshaped until stability is achieved.
	Changes to mine plan resulting in additional PAF waste rock.	Unaccounted for material to be disposed of. Financial cost of waste disposal.	3	3	6	Ongoing mine planning throughout LOM. Materials balance regularly updated. Significant freeboard maintained to allow for TSF disposal.	Early detection of inconsistencies between mine plan and rehabilitation plan will allow adequate opportunity to adjust rehabilitation plan.	2	3	5	PAF will be disposed of in the TSF if additional volume cannot be placed underground.

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
	Incorrect waste type utilised in rehabilitation works (PAF v NAF)	Contamination of land and water resources	3	4	7	Material is tested multiple times before being added to the appropriate WRD. Material will be tested prior to use in rehabilitation activities. PAF will be removed completely prior to disturbance to the NAF WRD.	MMG employ a rigorous testing process to minimise risk of incorrect storage within WRD. Process will continue during rehabilitation works. Removing PAF first will reduce likelihood that incorrect material is selected and transported.	2	4	6	Ongoing rehabilitation monitoring will identify presence of previously unidentified contaminants. Any contamination will be investigated and further contaminated land sampling/ removal will be conducted as required.
RM7 Landform development and reshaping (RA6)	Landform instability	Stability of landform not being achieved, meaning the PMLU cannot be achieved.	3	4	7	The construction and maintenance design of the cover system / cap will be certified by an appropriately qualified person.	Performance measured through inspection by suitably qualified person	2	4	6	Landform will be reshaped until stability is achieved.

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
		Greater erosion risk and release of contaminants Wildlife exposure to contaminants Reduced ability to sustain vegetation Impacts to rehabilitation timing and achievement of rehabilitation milestones. Cover compromised by vegetation				AQP will certify that landform has achieved an acceptable factor of safety QAQC testing will be completed post construction Biannual vegetation monitoring will be completed.					
RM8 Landform development and reshaping (RA7)	Landform instability	Reduced safety or instability of landform. Erosion leading to contamination of water ways. Unsuccessfully revegetated.	4	3	7	Landform is assessed as geotechnically stable by a suitably qualified geotechnical engineer	Proposed landform is to be gently sloping, limiting potential for erosion. Little earthworks will be required to achieve profile.	2	3	5	Landform will be reshaped until stability is achieved.
RM9 Surface preparation	Insufficient topsoil	Erosion Unsuccessfully revegetated.	4	3	7	Topsoil will be selectively placed at in 5m wide sections.	The area naturally has low volumes of	3	3	6	Ongoing erosion and vegetation

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
		Cost of repeating landform reshaping and surface preparation.				Additional topsoil will be obtained from an external source if required.	topsoil. Vegetation has proven to establish successfully on rocky areas with limited topsoil.				monitoring will guide management interventions. Additional topsoil or ameliorants will be applied as required.
	Inappropriate topsoil management whilst stockpiled	Reduced viability of topsoil, limiting plant establishment at rehabilitated sites. Topsoil infested with weed propagules, which will invade rehabilitated sites.	3	2	5	Topsoil is managed as per existing site procedures. Topsoil is recorded in the Topsoil Register and is inspected regularly.	Site has established processes to minimise risk.	2	2	4	Topsoil will be inspected prior to application. Any contaminated topsoil will not be used for rehabilitation.
	Vehicles contaminated with weed seeds used for earthworks.	Weeds invading rehabilitated sites, inhibiting the establishment of desirable species and preventing	3	2	5	Vehicles will be inspected prior to entering site. Vehicles will be cleaned in the site washdown bay if	Site has established processes to minimise risk.	2	2	4	A weed treatment program will be implemented, if required.

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
		achievement of RM11 and RM12.				weeds or seeds are identified.					
	Heavy rainfall occurring prior to establishment of vegetative cover.	Loss of topsoil Siltation of downstream waterways. Failure of vegetation to establish on eroded surfaces. Cost of reapplying topsoil to eroded surfaces	3	2	5	Earthworks will be completed during the dry season. Earthworks will be scheduled progressively so that areas are exposed for the least amount of time possible.	The area has established wet/dry seasons and works can be scheduled.	2	2	4	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.
RM10 Revegetation (native ecosystem)	Natural revegetation unsuccessful	Inability to meet RM11 and RM13	3	2	5	Areas will be monitored annually, for 5 years, and seeded if natural vegetation is unsuccessful	Annual monitoring will allow early detection if seeding is required.	2	2	4	Apply seed as required.
	Heavy rain immediately after seeding.	Loss of topsoil. Siltation of downstream waterways. Failure of vegetation to establish on eroded surfaces.	3	2	5	Low slope gradient in landform design to limit capacity for sediment loss. Surface preparation and sowing is not to take place if heavy rain (>40 mm) is	The area has established wet/dry seasons and works can be scheduled taking this into account.	2	2	4	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
		Cost of reapplying topsoil and seed to eroded surfaces.				forecast over any one day within the next fortnight.					
	Drought over the first months after planting.	Poor seedling survival and establishment. Increased exposure of bare soil leading to erosion	3	2	5	Planting is to take place in the early wet season, when probability of further rain during seedling establishment is high.	The area has established wet/dry seasons and works can be scheduled taking this into account.	2	2	4	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.
	Vehicles and/or footwear contaminated with weed seeds	Weeds invading rehabilitated sites, inhibiting the establishment of desirable species and preventing achievement of RM11 and RM13.	3	2	5	Vehicles will be inspected prior to entering site. Vehicles will be cleaned in the site washdown bay if weeds or seeds are identified.	The site has established controls.	2	2	4	A weed treatment program will be implemented, if required.
	Intruding livestock.	Grazing could lead to poor seedling establishment.	2	2	4	RA1 and RA6 largely inaccessible to cattle due to steep slope. Areas will be fenced.	Fencing will limit cattle access.	1	2	3	Rehabilitation monitoring will guide corrective action (reseeding,

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
											etc) as required.
RM11 Revegetation (grazing)	Natural revegetation unsuccessful	Inability to meet RM12 and RM14	3	2	5	Areas will be monitored annually, for 5 years, and seeded if natural vegetation is unsuccessful	Annual monitoring will allow early detection if seeding is required.	2	2	4	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.
	Heavy rain immediately after seeding.	Loss of topsoil. Siltation of downstream waterways. Failure of vegetation to establish on eroded surfaces. Cost of reapplying topsoil and seed to eroded surfaces.	3	2	5	Low slope gradient in landform design to limit capacity for sediment loss. Surface preparation and sowing is not to take place if heavy rain (>40 mm) is forecast over any one day within the next fortnight.	The area has established wet/dry seasons and works can be scheduled taking this into account.	2	2	4	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.
	Drought over the first months after planting.	Poor seedling survival and establishment.	3	2	5	Planting is to take place in the early wet season, when probability of further	The area has established wet/dry seasons and works can	2	2	4	Rehabilitation monitoring will guide corrective

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
		Increased exposure of bare soil leading to erosion				rain during seedling establishment is high.	be scheduled taking this into account.				action (reseeding, etc) as required.
	Vehicles and/or footwear contaminated with weed seeds	Weeds invading rehabilitated sites, inhibiting the establishment of desirable species and preventing achievement of RM12 and RM14.	3	2	5	Vehicles will be inspected prior to entering site. Vehicles will be cleaned in the site washdown bay if weeds or seeds are identified.	The site has established controls.	2	2	4	A weed treatment program will be implemented, if required.
	Intruding livestock.	Grazing could lead to poor seedling establishment.	3	2	5	Areas will be fenced until RM12 is achieved.	Fencing will limit cattle access.	2	2	4	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.
RM12 Achievement of surface requirements (native ecosystem)	Weed species dominating native species	Weeds spreading to other rehabilitation areas. Outcompeting native species	3	2	5	Annual monitoring to identify high risk areas.	The site has established controls.	2	2	4	A weed treatment program will be

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
		Cost of treatment Delay in achieving RM				Weed treatment completed early to minimise outbreak					implemented, if required.
	Revegetation unsuccessful	Erosion Potential weed recruitment Delay in achieving RM Cost of additional seeding	3	3	6	Annual monitoring to high risk areas. Seeding to occur if revegetation is not successful	Annual monitoring will allow early detection if seeding is required.	2	3	5	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.
	Persistent seepage from TSF	Contamination of land and water resources Risk to native wildlife accessing as drinking water Cost of contaminated liquid disposal. Delay in achieving RM	2	3	5	Seepage collection pond to remain operational until seepage is not detected. Cover system will be applied to limit rainfall infiltration.	The seepage collection pond is a critical control for this risk. Modelling of both the cover system and groundwater has determined that persistent seepage is a low risk.	2	2	4	Seepage collection will remain. Ongoing monitoring of the cover system, vegetation and water quality will guide correction action as required.

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
	Significant erosion	Loss of topsoil. Siltation of downstream waterways. Failure of vegetation to establish on eroded surfaces. Cost of reapplying topsoil and seed to eroded surfaces.	3	2	5	Low slope gradient in landform design to limit capacity for sediment loss. Annual monitoring to identify high risk areas	Monitoring will allow early identification and intervention.	2	2	4	Rehabilitation monitoring will guide corrective action (topsoilling etc) as required.
RM13 Achievement of surface requirements (grazing)	Weed species dominating native species	Weeds spreading to other rehabilitation areas. Outcompeting native species Cost of treatment Delay in achieving RM	3	2	5	Annual monitoring to identify high risk areas. Weed treatment completed early to minimise outbreak	Monitoring will allow early identification and intervention	2	2	4	A weed treatment program will be implemented, if required.
	Revegetation unsuccessful	Erosion Potential weed recruitment Delay in achieving RM Cost of additional seeding	3	3	6	Annual monitoring to high risk areas. Seeding to occur if revegetation is not successful	Annual monitoring will allow early detection if seeding is required.	2	3	5	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
	Significant erosion	Loss of topsoil. Siltation of downstream waterways. Failure of vegetation to establish on eroded surfaces. Cost of reapplying topsoil and seed to eroded surfaces.	3	2	5	Low slope gradient in landform design to limit capacity for sediment loss. Annual monitoring to identify high risk areas	Monitoring will allow early identification and intervention.	2	2	4	Rehabilitation monitoring will guide corrective action (topsoilling etc) as required.
	Intruding livestock.	Grazing could lead to poor seedling establishment.	3	2	5	Areas will be fenced until RM12 is achieved.	Fencing will limit cattle access.	2	2	4	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.
RM14 Achievement of post mining land use to a stable condition (native ecosystem)	Weed species dominating native species	Weeds spreading to other rehabilitation areas. Outcompeting native species. Cost of treatment. Delay in achieving RM.	3	2	5	Annual monitoring to identify high risk areas. Weed treatment completed early to minimise outbreak	Monitoring will allow early identification and intervention	2	2	4	A weed treatment program will be implemented, if required.

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
	Revegetation unsuccessful	Erosion. Potential weed recruitment. Delay in achieving RM. Cost of additional seeding.	3	3	6	Annual monitoring of high risk areas. Seeding to occur if revegetation is not successful	Annual monitoring will allow early detection if seeding is required.	2	3	5	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.
	Persistent seepage from TSF	Contamination of land and water resources Risk to native wildlife accessing as drinking water Cost of contaminated liquid disposal. Delay in achieving RM	2	3	5	Seepage collection pond to remain operational until seepage is not detected. Cover system will be applied to limit rainfall infiltration.	The seepage collection pond is a critical control for this risk. Modelling of both the cover system and groundwater has determined that persistent seepage is a low risk.	2	2	4	Seepage collection will remain. Ongoing monitoring of the cover system, vegetation and water quality will guide correction action as required.
	Significant erosion	Loss of topsoil. Siltation of downstream waterways.	3	2	5	Low slope gradient in landform design to	Monitoring will allow early	2	2	4	Rehabilitation monitoring will guide

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
		Failure of vegetation to establish on eroded surfaces. Cost of reapplying topsoil and seed to eroded surfaces.				limit capacity for sediment loss. Annual monitoring to identify high risk areas	identification and intervention.				corrective action (topsoiling etc) as required.
RM15 Achievement of post mining land use to a stable condition (grazing)	Weed species dominating native species	Weeds spreading to other rehabilitation areas. Outcompeting native species Cost of treatment Delay in achieving RM	3	2	5	Annual monitoring to identify high risk areas. Weed treatment completed early to minimise outbreak	Monitoring will allow early identification and intervention	2	2	4	A weed treatment program will be implemented, if required.
	Revegetation unsuccessful	Erosion Potential weed recruitment Delay in achieving RM Cost of additional seeding	3	3	6	Annual monitoring to high risk areas. Seeding to occur if revegetation is not successful	Annual monitoring will allow early detection if seeding is required.	2	3	5	Rehabilitation monitoring will guide corrective action (reseeding, etc) as required.
	Significant erosion	Loss of topsoil. Siltation of downstream waterways.	3	2	5	Low slope gradient in landform design to limit capacity for sediment loss.	Monitoring will allow early identification and intervention.	2	2	4	Rehabilitation monitoring will guide corrective

Rehabilitation Milestone	Hazard	Potential Impact	Risk Rating			Risk Controls	Justification of controls	Residual Risk Rating			Remedial Measures
			L	C	R			L	C	R	
		Failure of vegetation to establish on eroded surfaces. Cost of reapplying topsoil and seed to eroded surfaces.				Annual monitoring to identify high risk areas					action (topsoilling etc) as required.
	Landform doesn't support grazing	Delay in achieving PMLU.	3	4	7	Annual monitoring to determine trajectory of vegetation establishment. Re-seeding as required.	PMLU is consistent with surrounding land use. Monitoring will allow early identification and intervention.	2	4	6	Rehabilitation monitoring will guide corrective action (seeding, etc) as required

3.7. Monitoring and Maintenance

3.7.1. Rehabilitation Monitoring Phases

The Rehabilitation Monitoring Program has been designed to demonstrate that RM14 and RM15 have been achieved. There are three main phases to the Project's rehabilitation monitoring program as displayed in Figure 30.



Figure 30. Rehabilitation monitoring phases

3.7.2. Establishment of Reference Sites

Analogue sites will be used to compare rehabilitation success with regard to groundcover, carrying capacity, weed proportion and species mix. Analogue sites will be established for each SMU to be rehabilitated. Analogue sites will be recorded using GIS and signposted to prevent disturbance during operational activities.

Monitoring of analogue sites will be completed using the same monitoring methods employed at rehabilitation areas, as described below. Monitoring will be completed biannually, in the wet and dry seasons, for the first five years of sites being established. Following this, this monitoring program will be spaced at 5-yearly intervals.

Early monitoring of reference sites will allow site specific milestone criteria to be developed for future rehabilitation works.

3.7.3. Monitoring Program

A Monitoring and Maintenance Program has been developed for the Project in accordance with Section 3.8 of the PRC Plan Guideline. The objective of the monitoring program is to evaluate the progress of rehabilitation towards fulfilling the rehabilitation criteria as well as to implement adaptive management techniques and interventions as required. The program will:

- Compare monitoring results against rehabilitation milestone criteria;
- Determine the trajectory of rehabilitation success;
- Identify areas for improvement;
- Compare rehabilitation areas to analogue sites;
- Assess effectiveness of environmental controls;
- Assess vegetation health;
- Identify areas where seeding or the application of fertilizers/ameliorants may be required;
- Assess existing and potential erosion; and
- Assess native fauna species diversity and the effectiveness of habitat creation for target fauna species.

Landscape function analysis will be used to assess the biophysical functioning of the rehabilitated ecosystems, in terms of soil habitat. These assessments will determine how resilient rehabilitated areas are when posed with possible disturbance, high rainfall events, and various climatic conditions. The process provides a snapshot of rehabilitation performance, and how sustainable vegetation will be long-term.

The success of rehabilitated areas will be determined by continued progression, stability, and self-sustainability, with analogue sites providing a comparative basis.

3.7.3.1.1. Initial Monitoring Program

Initial monitoring will occur approximately 12 months after rehabilitation has commenced to observe the success, identify risks, and develop baseline data. The elements of rehabilitation that will be assessed during this program are:

- Landform and erosion;
- Soils;
- Vegetation;
- Fauna;
- Surface water;
- TSF seepage; and
- Groundwater.

3.7.3.1.1.1. Desktop Monitoring

The initial monitoring program will involve desktop monitoring prior to on-site monitoring work. Using LiDAR and aerial imagery, an understanding of the following can be gained:

- Assessing landform design through a Digital Elevation Model;
- Potential erosion areas to investigate during field surveys; and
- Representative locations to establish permanent monitoring plots in respect to the rehabilitation slope, PMLUs, and accessibility.

3.7.3.1.1.2. Landform and Erosion

As discussed in Section 3.1.28, all soil types identified within the Project, express a low to medium erosion risk. Therefore, on ground monitoring will focus on any high risk areas identified during the desktop monitoring. Due to the potential risk of exposed contaminants, a focus area for erosion monitoring will be the capped surface of the TSF. In addition, the TSF will be monitored for surface ponding and infiltration to determine the effectiveness of the cover system. Monitoring locations will be determined based on the final surface of the TSF on closure.

3.7.3.1.1.3. Soil

A soil monitoring program will be developed for the topsoil stockpiles, prior to use, and will aim to:

- Optimise rehabilitation processes;
- Accurately measure utilisation of stockpile storage and soil reuse; and
- Identify the need and rate of soil amelioration.

Additional insitu sampling may be conducted during initial and major monitoring at areas identified as having low vegetation recruitment.

Samples will be acquired and analysed at an accredited laboratory. The analytes proposed to be tested are detailed in Table 34.

3.7.3.1.1.4. Vegetation

Initial vegetation monitoring will focus on germination success rate of target species, through natural revegetation. Vegetation monitoring will be conducted using the following methods:

- Queensland Herbarium Survey Technique (species richness and tree/shrub densities);
- Ground cover percentage method; and
- Photographic monitoring.

3.7.3.1.1.5. Fauna

MMG currently operates a purple necked rock wallaby monitoring program, with monitoring conducted biannually. This program will continue throughout the rehabilitation period until RM13 is achieved. Presence of the PNRW at RA1 and RA6 will provide evidence of successful rehabilitation.

3.7.3.1.1.6. Surface Waters

Event based monitoring will be conducted at surface water monitoring locations as defined in the EA. These monitoring locations will provide data across the whole site, including downstream of the TSF. Surface water quality results will be compared to ANZECC/ARMCANZ (2000) Table 3.3.4 values for slightly to moderately disturbed aquatic ecosystems to determine rehabilitation success. Compliance will be defined as all results complying with the vales for a minimum of five consecutive years.

The REMP monitoring will continue at locations specified in the REMP design document. Reports will be provided to the DETSI as requested. Downstream locations will be compared to reference sites to assess potential impact from rehabilitated areas.

3.7.3.1.1.7. TSF Seepage

Seepage from the TSF will continue to be collected in the seepage collection pond whilst rehabilitation activities are completed. Once the surface of the TSF is capped, seepage will be pumped to a storage tank before being disposed of at a licenced facility. Seepage rates and volumes will be continuously recorded. Regular water quality samples of seepage, surface waters and groundwaters will be obtained during the initial monitoring round. Visual observations will monitor for the presence of seepage at the toe of the embankments and will inform additional monitoring as needed. Additionally, infiltration will be monitored to assess the potential risks of seepage long term.

3.7.3.1.1.8. Groundwater

Groundwater will continue to be monitored quarterly at locations defined in the EA. These monitoring locations will provide data across the whole site, including downstream of the TSF. Water quality results will be compared to ANZECC/ARMCANZ Table 4.3.2 for livestock drinking water. Compliance will be defined as all results from MB5, MB6, MB9S and MB9D complying with the vales for a minimum of five consecutive years.

3.7.3.1.2. Minor Monitoring Methods

Minor monitoring will continue on a biannual basis (wet and dry) for the first five years following rehabilitation. The minor monitoring methods have been designed with two aims; to quickly identify and resolve issues as well as create a replicable record of the condition and success of rehabilitation. The permanent monitoring points from the initial monitoring program will continue along with any new erosion areas identified during monitoring. The aspects of focus are:

- Landform and erosion;
- Vegetation;
- Surface water;
- TSF seepage; and
- Groundwater.

3.7.3.1.2.1. Desktop Monitoring

The minor monitoring will involve desktop monitoring prior to on-site monitoring work. Through the use of LiDAR and aerial imagery, the following can be achieved:

- Update the Digital Elevation Model;
- Identify new areas of potential sedimentation and/or ponding; and
- Identify new areas of erosion for observation.

3.7.3.1.2.2. Landform and Erosion

Along with the permanent monitoring sites created during the initial program, other points identified during the desktop monitoring may be added. The data to be collected includes the coordinates, estimated topsoil coverage, and erosional process, size, state (active, partly stabilised, or stabilised), and severity.

3.7.3.1.2.3. Vegetation

Vegetation monitoring will continue biannually (wet and dry) as per the initial monitoring methods. At the fixed points determined in the initial program, the acceptance criteria will be utilised as required to determine the level of success and ensure the rehabilitation areas are on a trajectory to meet the milestone criteria.

Preliminary completion criteria are presented in Table 53. Completion criteria will be finalised based on results from monitoring at reference sites during the life of the operation.

Table 53 Preliminary completion criteria summary

Criterion	Completion Score
T1 Height	70% of reference site
Total Native Tree Species	70% of reference site
Shrub Species Richness	70% of reference site
Grass Species Richness	70% of reference site
Forbes and Other Species Richness	70% of reference site
Non-native Plant Cover (%)	<10%
Native Perennial Grass Cover (%)	70% of reference site
Native Forbes and Other Species Cover (%)	70% of reference site
Native Shrubs Cover (%)	25% of reference site
Non-native Grass Cover (%)	<10%
Non-native Forbes and Other Species Cover (%)	<10%
Stems/hectare (tree)	70% of reference site
Stems/hectare (shrub	50% of reference site
Stems/hectare (eucalypt)	25% of reference site

3.7.3.1.2.4. Surface Water

Monitoring of surface waters will continue as per the initial monitoring phase.

3.7.3.1.2.5. TSF Seepage

Monitoring of TSF seepage will continue as per the initial monitoring phase.

3.7.3.1.2.6. Groundwater

Monitoring of ground waters will continue as per the initial monitoring phase.

3.7.3.1.3. Major Monitoring Methods

Major monitoring will occur 5 years following rehabilitation, and every 5 years thereafter until a stable condition is achieved. The purpose for the major monitoring is to assess the performance of the rehabilitation. The points to be monitored will continue from the previous phases as well as any additional erosion areas identified during monitoring. The focus of the major monitoring includes:

- Landform and erosion;
- Soil and spoil;
- Vegetation;
- Surface Water;
- TSF Seepage;
- Groundwater; and
- Grazing Land Suitability Assessment.

3.7.3.1.3.1. Desktop Monitoring

The major monitoring will involve desktop monitoring prior to on-site monitoring work. Through the use of LiDAR and aerial imagery, the following can be gained:

- An understanding of historic conditions through a review of previous monitoring reports;
- Update the Digital Elevation Model and compare against previous models to detect changes; and
- Identify new areas of erosion for field validation.

3.7.3.1.3.2. Landform and Erosion

The focus will be towards assessing erosion at previous monitoring locations as well as any other areas identified during desktop monitoring.

3.7.3.1.3.3. Vegetation

Monitoring will continue as described in the initial monitoring methods.

3.7.3.1.3.4. Grazing Land Suitability Assessment

A land suitability assessment will demonstrate achieving the RM15 milestone criteria for a PMLU of cattle grazing at:

- Year five of the major monitoring to allow vegetation to establish; and
- Each scheduled major monitoring from Year 10+ until the rehabilitation meets the milestone criteria.

3.7.3.1.3.5. Surface Water

Monitoring of surface waters is to continue as per the initial monitoring phase. To achieve the PMLU, downstream water quality is required to meet the ANZECC/ARMCANZ (2000) Table 3.3.4 values for slightly to moderately disturbed aquatic ecosystems for five consecutive years.

3.7.3.1.3.6. TSF Seepage

Monitoring of TSF seepage will continue as per the initial monitoring phase.

3.7.3.1.3.7. Groundwater

Groundwater samples will be collected and analysed to achieve milestone criteria. To achieve the PMLU, groundwater quality is required to meet the ANZECC/ARMCANZ Table 4.3.2 for livestock drinking water for five consecutive years.

3.7.3.1.4. Opportunistic Monitoring

The creeks and drainage lines at the Project are ephemeral therefore inhibiting the ability to collect and assess surface water samples within fixed timings. Resultingly, surface water monitoring is required to be undertaken at nominated points when available and accessible. Monitoring will be conducted during releases as per the existing schedule in the EA.

3.7.4. Maintenance

Monitoring activities may identify rehabilitated areas that required additional maintenance. This could be a result of:

- Climate conditions;
- Invasive species;
- Drainage design;
- Insufficient vegetative cover;
- Surrounding land use influence; and
- Soil health.

Where required, maintenance activities will be planned and conducted to ensure the long term success of rehabilitation. Maintenance may include:

- Management of newly recruited vegetation (addition of fertiliser, re-planting of failed vegetation recruitment) prior to its establishment within the ecosystem;
- Repair eroded areas and damage drainage systems;
- Improved management of surface water runoff through modifying landforms or structures;
- Upkeep of water management structures;
- Removing drainage that is not needed for long-term stability; and
- Replacing and repairing fences and signage (where probable).

It is expected that maintenance will be more intensive in the first years following closure and will gradually decrease as PLMUs begin to establish.

3.7.5. Analysis, Recording, and Reporting

All monitoring will occur in accordance with relevant Queensland Guidelines including the Queensland Monitoring and Sampling Manual. This includes appropriately qualified personnel collecting and analysing the samples and data. The data will be analysed to identify trends, changes, anomalies, and to track progress. Throughout the process, the data and achievements will be assessed against the milestone criteria and remedial actions will occur where necessary.

The relevant data will be stored and processed within internal geospatial and document management systems.

3.7.6. Quality Assurance

All staff undertaking monitoring and reporting activities will be suitably qualified for that task. Quality assurance / quality control (QAQC) methodologies will be followed and acted upon should breaches in QAQC procedures occur.

Samples collected will be sent to a NATA accredited laboratory for analysis. For surface water and groundwater samples, at a minimum, for every 10 sites sampled, one field blank, travel blank, and duplicate sample will be taken.

Results from this monitoring program will provide information for future and post-mine closure monitoring requirements.

The monitoring and maintenance allows for a repetitive execution-verification-monitoring QAQC approach to ensure rehabilitation areas progress and achieve the milestone criteria.

3.7.7. Review

This Plan will be reviewed by a SQP should an amendment to the PRCP be made or under timed renewal of the PRCP. In the context of monitoring, a review of the plan must consider:

- Environmental performance;
- Rehabilitation objectives and indicators;
- Environmental inspection outcomes;
- Changes in relevant legislation, policy and guidelines;
- Changes in the mine plan; and
- Rehabilitation completion criteria.

3.7.8. EA Relinquishment

Prior to certification of progressive rehabilitation for part of the Project, or acceptance of EA surrender for part or the whole of the Project tenure, DETSI must be satisfied with the rehabilitation. The decision is based on either a final rehabilitation report (section 264 of the EP Act) for the whole Project tenure or a part being surrendered, or a progressive rehabilitation report for part of the Project (section 318Z of the EP Act).

The Proponent is required to prepare either of the above, including a compliance statement, and submit to DETSI for assessment. Relevant rehabilitation requirements (section 318Z or section 268 of the Ep Act) will be considered by DETSI when deciding whether to certify progressive rehabilitation or to approve surrender application. A post-relinquishment plan will also need to be developed by the proponent to assist with ongoing land management beyond the surrender of the Project tenure.

4. References

AARC. (2010a). *Dugald River Project Soil and Land Suitability Assessment .* AustralAsian Resource Consultants.

AARC. (2010b). *Dugald River Project Environmental Impact Statement.* AustralAsian Resource Consultants.

ABS. (2021). *2021 Census.* Australian Bureau of Statistics.

ANZG. (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. .* Australian and New Zealand Governments.

ATC Williams. (2025). *Closure Dewatering Strategy.*

ATC Williams. (2025). *DRM - Landform Conceptual Design - Conceptual Cover System Modelling Results.*

ATC Williams. (2025). *DRM - Landform Conceptual Design - Erosion Modelling.*

ATC Williams. (2025). *DRM - Preliminary TSF CLosure Landform Design (Surface).*

ATCW. (2015). *MMG Dugald River Tailings Storage Facility Revised Concept Design.* ATC Williams Pty Ltd.

ATCW. (2016). *Tailings Storage Facility Design Report.* ATC Williams Pty Ltd.

ATCW. (2021). *TSF and Process Area Hydraulic Impact Assessment.* ATC Williams Pty Ltd.

ATCW. (2024a). *DRM - Landform Conceptual Design - Erosion Modelling.* ATC Williams Pty Ltd.

ATCW. (2024b). *DRM - Preliminary TSF Closure Landform Design (Surface).* ATC Williams Pty Ltd.

ATCW. (2025c). *Concept stormwater closure plan and site-wide closure landform.* ATC Williams Pty Ltd.

ATCW. (2025d). *Dugald River Mine Tailings Storage Facility - Stage 3 Raise Detailed Design Report.* ATC Williams Pty Ltd.

AusRivAs. (2001). *Processing and Sampling Manual.* AusRivAs.

BOM. (2024). *Summary Statistics Cloncurry Airport.* Australian Government Bureau of Meteorology.

CDM Smith. (2021). *Dugald River Mine Biennial Review of Groundwater Monitoring Data: 2019-2020.* CDM Smith.

CDM Smith. (2024). *Groundwater Impact Assessment - Dugald River Mine TSF.* CDM Smith Australia.

CDM Smith. (2024). *Groundwater Impact Assessment - Dugald River Mine TSF.* CDM Smith.

CDM Smith. (2025). *Groundwater Impact Assessment - Dugald River Mine TSF.*

Cloncurry Shire Council. (2017). *Cloncurry Shire Planning Scheme 2016.* Cloncurry Shire Council.

CSIRO & BOM. (2024). *State of the Climate 2024.* Commonwealth Scientific and Industrial Research Organisation & Bureau of Meteorology.

DCCEEW. (2024). *Protected Matters Search Tool.* Department of Climate Change, Energy, the Environment and Water; Australian Government.

DESI. (2024). *Statutory Guideline - Progressive rehabilitation and closure plan (PRC plans)* (3.01 ed.). Department of Environment, Science and Innovation.

DIP. (1993). *Planning Guideline – The Identification of Good Quality Agricultural Land .* Department of Infrastructure and Planning.

DIP. (2010). *North West Regional Plan.* Department of Infrastructure and Planning.

DME. (1995). *Land Suitability Assessment Techniques Guideline .* Department of Minerals and Energy.

DPI. (2024). *Regional Planning Interests Act 2014.* Department of Primary Industries.

EGi. (2010). *Waste Rock Characterisation for the Dugald River Deposit.* Environmental Geochemistry International Pty Ltd.

IECA. (2008). *Best Practice Erosion and Sediment Control.* International Erosion Control Association.

Isbell. (2021). The Australian Soil Classification. *National Committee on Soil and Terrain*.

Queensland Government. (2024). *Queensland Globe*. Retrieved from https://qldglobe.information.qld.gov.au/

RL&A. (2024). *Dugald River Mining Project Biennial Review of Groundwater Monitoring Program - 2021 and 2022.* Rob Lait & Associates Pty Ltd.

SGM. (2021). *Progressive Rehabilitation and Closure Plan Dugald River Mine.* SGM Environmental Pty Ltd.

Standards Australia. (2018). *Risk Management - Guidelines (ISO31000:2018).* SAI Global.

The State of Queensland. (2023). *Environmental Protection (Water and Wetland Biodiversity) Policy 2019.* The State of Queensland (Office of the Queensland Parliamentary Counsel).

TropWATER. (2020). *Technical Memo – Recommended amendments to Dugald River Mine Environmental Authority EPML00731213 .* TropWATER.

WRM. (2010). *Dugald River Project, Surface Water Assessment.* WRM.

WTS. (2021). *Dugald River Mine - Environmental Authority Amendment - Supporting Information.* Wulguru Technical Services Pty Ltd.

Appendix A: PRCP Schedule

Appendix B: DRM Community and Social Performance Standard

Appendix C: DRM Community Engagement Plan

Appendix D: Dugald River TSF Stage 3 Detailed Design Report

Appendix E: TSF Conceptual Closure Design Report

Appendix F: TSF and Process Area Hydraulic Impact Assessment

Appendix G: Surface Subsidence Risk

Appendix H: Assessment of the Geochemical Characteristics and ARD Potential of Waste Rock for the Dugald River Zinc, Lead & Silver Deposit

Appendix I: Column Cover Trials

Appendix J: Conceptual Cover System Options

Appendix K: Concept Stormwater Closure Plan and Site-wide Closure Landform

Appendix L: Preliminary TSF Closure Landform Design (Surface)

Appendix M: Conceptual Cover System Modelling Results

Appendix N: Landform Conceptual Design – Erosion Modelling

Appendix O: Proposed Changes to PRCP Schedule

APPENDIX I: Dugald River Mine Environmental Impact Statement (AARC, 2010b)

TABLE OF CONTENTS

VOLUME 1

ABBREVIATIONS
GLOSSARY
EXECUTIVE SUMMARY

1.0 INTRODUCTION 1-1

1.1 PROJECT PROPONENT 1-1

1.2 PROJECT DESCRIPTION 1-1

1.2.1 Environmental Studies 1-8

1.3 PROJECT OBJECTIVES AND SCOPE 1-9

1.3.1 Background 1-9
1.3.2 Previous Studies and Development 1-10
1.3.3 Project Objectives and Establishment 1-10

1.4 THE ENVIRONMENTAL IMPACT STATEMENT (EIS) PROCESS 1-11

1.4.1 Methodology of the EIS 1-11
1.4.2 Objectives of the EIS 1-14
1.4.3 Submissions 1-15

1.5 PUBLIC CONSULTATION PROCESS 1-16

1.5.1 Relevant Legislation and Policy Requirements 1-20
1.5.1.1 Environmental Protection Act 1994 1-21
1.5.1.2 Environmental Protection Regulation 2008 1-22
1.5.1.3 Environmental Protection (Water) Policy 2009 1-23
1.5.1.4 Environmental Protection (Noise) Policy 2008 1-24
1.5.1.5 Environmental Protection (Air) Policy 2008 1-25
1.5.1.6 Environmental Protection (Waste Management) Policy 2000 1-25
1.5.1.7 Environmental Protection (Waste Management) Regulation 2000 1-26
1.5.1.8 Mineral Resources Act 1989 1-27
1.5.1.9 Sustainable Planning Act 2009 1-28
1.5.1.10 Water Act 2000 and Water Regulation 2002 1-28
1.5.1.11 Water Resource (Gulf) Plan 2007 1-29
1.5.1.12 Environment Protection and Biodiversity Conservation Act 1999 1-30
1.5.1.13 Nature Conservation Act 1992 and Nature Conservation (Wildlife) Regulation 2006 1-31
1.5.1.14 Vegetation Management Act 1999 1-31
1.5.1.15 Land Protection (Pest and Stock Route Management) Act 2002 1-32
1.5.1.16 Aboriginal Cultural Heritage Act 2003 1-32
1.5.1.17 Queensland Heritage Act 1992 1-33
1.5.1.18 Native Title Act 1993 1-33
1.5.1.19 Transport Infrastructure Act 1994 1-33
1.5.1.20 Fisheries Act 1994 1-34
1.5.1.21 National Greenhouse and Energy Reporting Act 2007 1-34
1.5.1.22 Energy Efficiency Opportunities Act 2006 1-35
1.5.2 Planning Processes and Standards 1-35

1.6 ACCREDITED PROCESSES AND STANDARDS 1-37

2.0 PROJECT NEED AND ALTERNATIVES 2-1

2.1 PROJECT JUSTIFICATION 2-1

2.2 ALTERNATIVES TO THE PROJECT 2-2

2.2.1 Consequences of Not Proceeding with the Project 2-2

2.2.2 Alternatives to the Location of the Project Itself 2-2
2.2.3 Alternatives Land Uses for the Project Site 2-3
2.2.3.1 Beef Cattle Grazing 2-3
2.2.3.2 Conservation 2-3
2.2.4 Alternatives within the Project 2-3
2.2.4.1 Power Supply 2-4
2.2.4.2 Power Transmission Line 2-5
2.2.4.3 Water Pipeline 2-7
2.2.4.4 Access Route 2-9
2.2.4.5 Accommodation Camp 2-11
2.2.4.6 Tailings Storage Facility Location 2-13
2.2.4.7 Tailings Storage Facility Embankment Design 2-17
2.2.4.8 Mining Methods 2-17
2.2.4.9 Processing Plant Location 2-17
2.2.4.10 Processing Methods 2-20
2.2.4.11 Final Project Layout and Infrastructure Corridor Alignments 2-20
2.2.5 Comparative Environmental Impacts and Ecologically Sustainable Development. 2-22

3.0 DESCRIPTION OF THE PROJECT 3-1

3.1 LOCATION 3-1

3.1.1 Regional Context 3-1
3.1.2 Local Context 3-2

3.2 CONSTRUCTION 3-11

3.2.1 Early Works 3-11
3.2.1.1 Fly Camp 3-12
3.2.1.2 Initial Water Supply 3-14
3.2.1.3 Access Roads 3-14
3.2.1.4 Borrow Pits 3-18
3.2.1.5 Upgrade to Communications 3-19
3.2.2 Accommodation Camp 3-20
3.2.2.1 Accommodation Camp Sewage Treatment 3-22
3.2.2.2 Construction Phase Rubbish Disposal Site 3-23
3.2.3 Water Supply Pipeline 3-23
3.2.4 Mine Establishment 3-23
3.2.4.1 Mining Area Stormwater Dams and Sediment Ponds 3-24
3.2.5 Processing Plant 3-24
3.2.5.1 Bulk Earthworks 3-24
3.2.5.2 Processing Plant Construction Methods 3-29
3.2.5.3 Process Area Stormwater Dams and Sediment Ponds 3-29
3.2.5.4 Other Associated Infrastructure 3-29
3.2.6 Power line Construction 3-29
3.2.7 Tailings Storage Facility 3-30
3.2.7.1 Construction of the Main Embankment 3-31
3.2.7.2 Construction of the TSF Perimeter 3-32
3.2.7.3 Construction of Seepage Collection Pond 3-32

3.3 OPERATIONS 3-39

3.3.1 Location and Tenure 3-39
3.3.2 Mine Life and Resource Base 3-45
3.3.3 Mining Methods and Equipment 3-46
3.3.3.1 Underground Mining Method 3-46
3.3.3.2 Mining and Processing Fleet 3-46
3.3.3.3 Fuel Storage and Hydrocarbon Storage 3-48
3.3.3.4 Explosives Magazine 3-48
3.3.4 Mine Sequencing 3-51
3.3.4.1 Workforce During Construction Stage (2012 -2013) 3-55
3.3.4.2 Workforce during Operations Stage 2014 - 2037 3-55
3.3.4.3 Workforce during Decommissioning Phase 2038 3-55
3.3.5 Processing and Products 3-56
3.3.5.1 Processing 3-56
3.3.5.2 ROM Stockpile and Crushing 3-58
3.3.5.3 Pre-Flotation 3-61
3.3.5.4 Froth Flotation 3-61

3.3.5.5 Tailings 3-61
3.3.5.6 Major Inputs 3-65
3.3.5.7 Miscellaneous Reagents 3-71
3.3.5.8 Grinding Media 3-71
3.3.5.9 Products 3-71
3.3.5.10 Other Major Wastes 3-71
3.3.6 Ongoing Evaluation and Exploration Activities 3-72
3.4 PRODUCT HANDLING 3-72
3.4.1 On Site Product Handling 3-72
3.4.2 Off Site Product Handling 3-76
3.5 INFRASTRUCTURE REQUIREMENTS 3-77
3.5.1 Transport—Road/Rail/Ship 3-77
3.5.1.1 Road Infrastructure 3-77
3.5.1.2 New Accesses onto State Controlled Roads 3-78
3.5.1.3 Traffic Generated 3-80
3.5.1.4 Police Escort 3-80
3.5.1.5 Current Road Usage 3-80
3.5.1.6 Proposed Increase in Road Use During Construction 3-81
3.5.1.7 Proposed Increase in Road Use During Operations 3-83
3.5.1.8 Rail Infrastructure and Proposed Increases During Operations 3-85
3.5.1.9 Shipping Infrastructure and Proposed Increase During Operations 3-85
3.5.1.10 Current Aviation Usage 3-86
3.5.1.11 Proposed Increase in Aviation Usage due to Operations 3-86
3.5.2 Energy 3-87
3.5.2.1 Power Transmission Line and Connection to the Grid 3-87
3.5.2.2 Energy Consumption During Construction and Operation 3-90
3.5.2.3 Greenhouse Gas Management and Energy Conservation 3-90
3.5.3 Water Supply and Storage 3-93
3.5.3.1 Water Supply and Water Balance 3-93
3.5.3.2 Water Use and Storage 3-95
3.5.3.3 Water Conservation and Recycling 3-96
3.5.4 Stormwater Drainage 3-97
3.5.4.1 Stormwater Dams and Sediment Ponds 3-97
3.5.4.2 Clean Water Diversions 3-104
3.5.4.3 Stormwater Run-off Modelling 3-106
3.5.4.4 Creek Crossings 3-111
3.5.5 Sewerage 3-115
3.5.6 Telecommunications 3-116
3.5.7 Accommodation and Other Infrastructure 3-117
3.5.7.1 Accommodation Camp 3-117
3.5.7.2 Work Shops and Laboratories 3-120
3.5.7.3 Other Infrastructure/Ancillary Buildings 3-121
3.6 WASTE MANAGEMENT 3-123
3.6.1 Character and Quantities of Waste Materials 3-123
3.6.1.1 Construction and Commissioning Phase 3-123
3.6.1.2 Operational Phase 3-124
3.6.1.3 Decommissioning Phase 3-127
3.6.2 Air Emissions 3-127
3.6.3 Excavated Waste 3-130
3.6.3.1 Waste Rock Dump Design 3-131
3.6.3.2 Waste Rock Disposal Schedule 3-135
3.6.3.3 Waste Rock Characterisation 3-139
3.6.4 Tailings Disposal 3-149
3.6.4.1 Paste Fill Plant 3-149
3.6.4.2 Tailings Storage Facility 3-152
3.6.4.3 Geochemical Characterisation of Tailings 3-161
3.6.4.4 TSF Monitoring and Management 3-165
3.6.5 Solid Waste Disposal 3-166
3.6.5.1 Rubbish Disposal Site 3-166
3.6.6 Liquid Waste 3-168
3.6.6.1 Truck Washdown 3-168
3.6.6.2 Sewage and Grey Water 3-168

3.6.6.3 Dewatering Water 3-168
3.6.6.4 Contaminated Stormwater, Process and Tailings Water 3-169
3.7 REHABILITATION AND DECOMMISSIONING 3-170
3.7.1 Pre and Post Mining Land Suitability 3-175
3.7.2 Tailings Storage Facility 3-178
3.7.3 NAF/PAF Waste Rock Dump 3-179
3.7.4 Underground Declines and Box Cut 3-180
3.7.5 Other Waste Rock Dump, ROM Pads and Mine Roads 3-180
3.7.6 Stormwater Dams and Sediment Ponds 3-180
3.7.7 Processing Plant , Accommodation Camp and Offices 3-181
3.7.8 Workshops and Chemical/Fuel Storages 3-181
3.7.9 Roads 3-181
3.7.10 Rubbish Disposal Site 3-181
3.7.11 Borrow Pits 3-181
3.7.12 Exploration Areas 3-182
3.7.13 Power Line and Water Pipeline 3-182
3.7.14 Revegetation Methods 3-182
3.7.15 Monitoring of Analogue and Rehabilitation Sites 3-183
3.7.15.1 Erosion Monitoring 3-184
3.7.16 Preliminary Rehabilitation Completion Criteria 3-185

4.0 ENVIRONMENTAL VALUES AND MANAGEMENT OF IMPACTS 4-1

4.1 REGIONAL CLIMATE 4-1
4.1.1 Flooding 4-4
4.1.2 Droughts 4-5
4.1.3 Bushfires 4-5
4.2 LAND 4-7
4.2.1 Description of Environmental Values 4-7
4.2.1.1 Topography/Geomorphology 4-7
4.2.1.2 Geology 4-9
4.2.1.3 Mineral Resources 4-15
4.2.1.4 Resource Utilisation 4-16
4.2.1.5 Soils 4-17
4.2.1.6 Land Use and Suitability 4-21
4.2.1.7 and Tenure and Native Title 4-27
4.2.1.8 Infrastructure 4-32
4.2.1.9 Sensitive Environmental Areas 4-34
4.2.1.10 Landscape Character 4-37
4.2.1.11 Visual Amenity 4-37
4.2.2 Potential Impacts and Mitigation Measures 4-42
4.2.2.1 Land Use Suitability 4-42
4.2.2.2 Land Disturbance 4-47
4.2.2.3 Land Contamination 4-49
4.2.2.4 Soil Erosion 4-52
4.2.2.5 Landscape Character 4-54
4.2.2.6 Visual Amenity 4-55
4.2.2.7 Lighting 4-56
4.2.2.8 Transport 4-57
4.3 WASTE 4-62
4.3.1 Description of Environmental Values 4-62
4.3.2 Potential Impacts and Mitigation Measures 4-63
4.3.2.1 Waste Management Strategy 4-64
4.3.2.2 Cleaner Production and Waste Minimisation 4-64
4.3.2.3 Mitigation Measures 4-65
4.4 WATER RESOURCES 4-69
4.4.1 Description of Environmental Values 4-69
4.4.1.1 Surface Waterways 4-69
4.4.1.2 Groundwater 4-103

4.4.2 Potential Impacts and Mitigation Measures 4-115
4.4.2.1 Surface Water and Watercourses....4-115
4.4.2.2 Surface Water and Stream Sediment Monitoring Program....4-119
4.4.2.3 Groundwater Impacts 4-131
4.4.2.4 Groundwater Mitigation Measures....4-132
4.4.2.5 Groundwater Monitoring Program 4-133
4.5 AIR 4-137
4.5.1 Description of Environmental Values 4-137
4.5.1.1 Greenhouse Gas Emissions....4-142
4.5.2 Potential Impacts and Mitigation Measures 4-144
4.5.2.1 Dust Emission Rates 4-144
4.5.2.2 Air Quality Modelling....4-149
4.5.2.3 Greenhouse Gas Abatement....4-166
4.5.2.4 Climate Change Adaptation....4-171
4.6 NOISE AND VIBRATION 4-173
4.6.1 Description of Environmental Values 4-173
4.6.1.1 Background Noise Conditions 4-173
4.6.1.2 Site Specific Noise Criteria 4-176
4.6.2 Potential Impacts and Mitigation Measures 4-177
4.6.2.1 Noise Modelling 4-177
4.6.2.2 Compliance with Noise Limits....4-183
4.7 NATURE CONSERVATION 4-188
4.7.1 Description of Environmental Values 4-188
4.7.1.1 Environmental Values....4-188
4.7.1.2 Listed Species and Species of Special and Ecological Note 4-188
4.7.1.3 Methodology....4-197
4.7.1.4 Terrestrial Flora – Project Site....4-199
4.7.1.5 Terrestrial Fauna – Project Site....4-214
4.7.1.6 Infrastructure Corridors....4-218
4.7.1.7 Aquatic Biology....4-238
4.7.2 Potential Impacts and Mitigation Measures 4-241
4.7.2.1 Potential Impacts....4-241
4.7.2.2 General Management Strategies....4-245
4.7.2.3 Power Line Construction Management Strategies....4-246
4.7.2.4 Pest Flora and Fauna Management Strategies 4-247
4.7.2.5 Aquatic Biology Management Strategies....4-248
4.7.2.6 Rehabilitation Acceptance Criteria....4-250
4.7.2.7 Fauna Monitoring Programme....4-250
4.8 CULTURAL HERITAGE....4-252
4.8.1 Description of Environmental Values 4-252
4.8.1.1 Non-Indigenous Cultural Heritage 4-252
4.8.1.2 Indigenous Cultural Heritage 4-262
4.8.2 Potential Impacts and Mitigation measures 4-262
4.8.2.1 Non-Indigenous Cultural Heritage 4-262
4.8.2.2 Indigenous Cultural Heritage 4-267
4.9 SOCIAL....4-268
4.9.1 Description of Environmental Values 4-268
4.9.1.1 Local Communities and Lifestyle....4-268
4.9.1.2 Recreation, Culture and Leisure....4-269
4.9.1.3 Community Services and Infrastructure....4-270
4.9.1.4 Whole Community Demographic Profile....4-270
4.9.1.5 Housing and Accommodation....4-281
4.9.1.6 Indigenous Community Demographic Profile....4-287
4.9.1.7 Land Prices and On-Farm Activities 4-294
4.9.1.8 Community Consultation Program....4-298
4.9.2 Potential Impacts and Mitigation Measures 4-299
4.9.2.1 Direct Impacts....4-299
4.9.2.2 Cumulative Impacts....4-304
4.9.2.3 Mitigation Strategies....4-305
4.10 HEALTH AND SAFETY....4-311
4.10.1 Description of Environmental Values 4-311

4.10.2 Potential Impacts and Mitigation Measures 4-312
4.10.2.1 Potential Impacts....4-312
4.10.2.2 On Site Mitigation....4-314
4.10.2.3 Off Site Mitigation....4-316
4.11 ECONOMY....4-317
4.11.1 Description of Economic Values....4-317
4.11.2 Potential Impacts and Mitigation Measures 4-318
4.12 HAZARD AND RISK....4-321
4.12.1 Description of Environmental Values 4-321
4.12.2 Potential Impacts and Mitigation Measures 4-322
4.12.2.1 Chemical Inventory 4-324
4.12.2.2 Spillage and Emergency Management 4-326
4.13 CROSS-REFERENCE WITH THE TERMS OF REFERENCE 4-329

REFERENCES

VOLUME 2

1.0 ENVIRONMENTAL MANAGEMENT PLAN 1
1.1 INTRODUCTION....1
2.0 DESCRIPTION OF THE MINING TENURE 4
2.1 PROJECT NAME AND LOCATION....4
2.2 MINING LEASES COVERED BY THE EM PLAN 6
2.3 RELEVANT STAKEHOLDERS....12
2.4 REAL PROPERTY DESCRIPTION AND CURRENT DISTURBANCE TYPES....16
2.5 ENVIRONMENTALLY SENSITIVE LOCATIONS....20
2.6 WILD RIVERS LEGISLATION 23
3.0 DESCRIPTION OF THE EXISTING ENVIRONMENT AND BASELINE STUDIES 24
3.1 REGIONAL CLIMATE 25
3.2 GEOLOGY 28
3.3 TOPOGRAPHY....28
3.4 SOIL ASSESSMENT....31
3.4.1 Erosion Potential 35
3.5 LAND USE AND SUITABILITY....35
3.6 BACKGROUND AIR QUALITY....41
3.6.1 Site Specific Wind Flows....41
3.6.2 Atmospheric Stability....42
3.6.3 Dust Deposition 43
3.6.4 TSP, PM_{10} and $PM_{2.5}$ 45
3.6.5 Metal Concentrations 45
3.7 BACKGROUND NOISE....45
3.7.1 Noise Monitoring....47
3.7.2 Results....47
3.8 SURFACE WATER AND DRAINAGE 50

3.8.1 Stream Flow 52
3.8.2 Flooding 55
3.8.3 Surface Water Quality 56
3.8.3.1 Monitoring 56
3.8.3.2 Results 59
3.8.3.3 Proposed Surface Water Triggers and Limits 67
3.8.3.4 Methodology for Development of Surface Water Triggers and Limits for Physiochemical Parameters 72
3.8.3.5 Methodology for Development of Surface Water Triggers and Limits for Toxicants (Metals) . 73
3.8.4 Stream Morphology 74
3.8.5 Stream Sediments 80
3.8.5.1 Particle Size Analysis 80
3.8.5.2 Sediment Metal Analysis 82
3.8.5.3 Proposed Stream Sediment Triggers and Limits 85
3.9 GROUNDWATER 86
3.9.1 Regional Groundwater Bores 86
3.9.2 Regional Groundwater Census 86
3.9.3 Project Site - Groundwater Quality 89
3.9.4 Hydrological Regime 91
3.9.5 Recharge and Flow 92
3.9.6 Aquifer Permeability 95
3.10 FLORA AND FAUNA ASSESSMENT – PROJECT SITE 96
3.10.1 Methodology 97
3.10.2 Flora Results – Project Site 98
3.10.3 Fauna Results – Project Site 101
3.11 FLORA AND FAUNA ASSESSMENT – CORRIDORS 101
3.11.1 Powerline Corridor 101
3.11.1.1 Methodology 101
3.11.1.2 Vegetation Communities 101
3.11.1.3 Features of Conservation Significance 106
3.11.1.4 Introduced Species 107
3.11.2 Water Pipeline Corridor 111
3.11.2.1 Methodology 111
3.11.2.2 Vegetation Communities 111
3.11.2.3 Rocky Outcrops 112
3.11.3 Access Route Corridor 115
3.11.3.1 Methodology 115
3.11.3.2 Vegetation Communities 115
3.11.3.3 Creek Crossings 116
3.12 AQUATICS 118
3.12.1 Methodology 119
3.12.2 Results 119
3.12.2.1 Aquatic Vertebrates 119
3.12.2.2 Macro-invertebrates 119
3.13 WASTE ROCK CHARACTERISATION 122
3.14 TAILINGS CHARACTERISATION 126
3.15 HISTORIC CULTURAL HERITAGE 127
3.15.1 Methodology 127
3.15.2 Cultural Heritage Sites – Project Site 127
3.15.3 Cultural Heritage Sites – Infrastructure Corridors 130
3.15.4 Significance Assessment for the Study Area 134
3.15.5 Sites for Nomination onto the Queensland Heritage Register 134
3.16 INDIGENOUS CULTURAL HERITAGE 135
3.17 SOCIAL AND ECONOMIC 135
3.17.1 Methodology 135
3.17.2 Whole Community Profile 136
3.17.3 Indigenous Community Profile 136
3.17.4 Local Community and Services 137

3.17.5 Near Project Land Use 138
3.17.6 Community Consultation 138
3.17.7 Project Employment and Training 139
3.17.8 Economic Benefits of Project 140

4.0 DESCRIPTION OF MINING ACTIVITIES 142

4.1 GENERAL OVERVIEW 142

4.2 ENVIRONMENTALLY RELEVANT ACTIVITIES 146

4.3 EXPLORATION 147

4.4 VEGETATION REMOVAL AND TOPSOIL STRIPPING AND STOCKPILING 147

4.5 CONSTRUCTION 151

4.6 RESOURCE 151

4.6.1 Mine Life and Resource Base 151

4.7 UNDERGROUND MINING 153

4.7.1 Mine Dewatering 153
4.7.2 Explosives Plant and Magazine 153

4.8 WASTE ROCK DUMPS 154

4.9 PROCESSING ACTIVITIES 157

4.9.1 ROM Stockpile and Crushing 158
4.9.2 Pre-Flotation 162
4.9.2.1 Zinc/Lead/Silver Process 162
4.9.2.2 Copper Process 162
4.9.3 Froth Flotation 162
4.9.4 On Site Product Handling 165
4.9.5 Off Site Product Handling 169
4.9.6 Tailings Disposal 169
4.9.6.1 Paste Fill Plant 169
4.9.6.2 Tailings Storage Facility 174

4.10 STORMWATER DAMS AND SEDIMENT PONDS 183

4.10.1 Dirty (Non-toxic) Catchment Areas – Sediment Ponds 184
4.10.2 Dirty (Low Toxicity) Catchment Areas – Low Hazard Dams 184
4.10.3 Contaminated (Sub-lethal) Catchment Areas – Significant Hazard Dams 184
4.10.4 Contaminated (Toxic) Catchment Areas – High Hazard Dams 186

4.11 WATER REQUIREMENTS 190

4.11.1 Raw Water Tank 190
4.11.2 Water Pipeline 190

4.12 POWER SUPPLY 193

4.12.1 Power Transmission Line 193

4.13 CONCRETE BATCHING 193

4.14 ABRASIVE BLASTING OF STRUCTURES 193

4.15 FUEL AND HYDROCARBON STORAGE 194

4.16 CHEMICAL STORAGE 194

4.17 ACCOMMODATION CAMP 199

4.18 WORK SHOPS AND LABORATORIES 202

4.19 SEWAGE TREATMENT 202

4.20 RUBBISH DISPOSAL SITE 203

4.21 SITE ACCESS ROAD 204

4.22 CREEK CROSSINGS 205

4.23 CLEAN WATER DIVERSIONS 209

5.0 REHABILITATION 211

5.1 PRE AND POST MINING LAND SUITABILITY 215

5.2 REHABILITATION METHODS 217

5.2.1 Tailings Storage Facility 217
5.2.2 NAF / PAF Waste Rock Dump 219
5.2.3 Underground Declines and Box Cut 220
5.2.4 Other Waste Rock Dump, ROM Pads and Mine Roads 221
5.2.5 Stormwater Dams and Sediment Ponds 221
5.2.6 Processing Plant , Accommodation Camp and Offices 221
5.2.7 Workshops and Chemical/Fuel Storages 222
5.2.8 Roads 222
5.2.9 Rubbish Disposal Site 222
5.2.10 Borrow Pits 222
5.2.11 Exploration Areas 222
5.2.12 Power Line and Water Pipeline 223
5.2.13 Revegetation Methods 223
5.2.14 Monitoring of Analogue and Rehabilitation Sites 224
5.2.14.1 Erosion Monitoring 225
5.2.15 Preliminary Rehabilitation Completion Criteria 225

6.0 ENVIRONMENTAL VALUES, IMPACTS, CONTROL STRATEGIES AND PROPOSED EA CONDITIONS 227

6.1 GENERAL EA CONDITIONS 228

6.2 AIR 234

6.2.1 Environmental Value 234
6.2.2 Description of Environmental Value 234
6.2.3 Assessment of Impacts on the Environmental Values 234
6.2.3.1 Dust Emission Rates 236
6.2.3.2 Air Quality Modelling 238
6.2.3.3 Greenhouse Gas Emissions 241
6.2.4 Proposed Environmental Protection Objective 242
6.2.5 Control Strategies 243
6.2.5.1 Greenhouse Gas Management Plan 243
6.2.6 Proposed EA Conditions using Measurable Indicators and Standards 245

6.3 WATER MANAGEMENT 246

6.3.1 Environmental Value 246
6.3.2 Description of Environmental Value 247
6.3.3 Assessment of Impacts on the Environmental Values 247
6.3.3.1 Surface Water and Watercourses 247
6.3.3.2 Groundwater 248
6.3.4 Proposed Environmental Protection Objective 250
6.3.5 Control Strategies 250
6.3.5.1 Surface Water 250
6.3.5.2 Groundwater 251
6.3.6 Proposed EA Conditions using Measurable Indicators and Standards 252

6.4 NOISE AND VIBRATION 268

6.4.1 Environmental Value 268
6.4.2 Description of Environmental Values 268
6.4.3 Assessment of Impacts on the Environmental Values 268
6.4.4 Proposed Environmental Protection Objective 271
6.4.5 Control Strategies 272
6.4.6 Proposed EA Conditions using Measurable Indicators and Standards 272

6.5 WASTE MANAGEMENT 274

6.5.1 Environmental Value 274
6.5.2 Description of Environmental Value 274

6.5.3 Assessment of Impacts on the Environmental Values 274
6.5.4 Proposed Environmental Protection Objective 275
6.5.5 Control Strategies 275
6.5.5.1 General Strategies 275
6.5.5.2 Waste Rock Management Strategies 276
6.5.6 Proposed EA Conditions using Measurable Indicators and Standards 279
6.6 LAND MANAGEMENT 279
6.6.1 Environmental Value 279
6.6.2 Description of Environmental Value 279
6.6.3 Assessment of Impacts on the Environmental Values 280
6.6.4 Proposed Environmental Protection Objectives 281
6.6.5 Control Strategies 281
6.6.6 Proposed EA Conditions using Measurable Indicators and Standards 283
6.7 COMMUNITY 290
6.7.1 Environmental Value 290
6.7.2 Description of Environmental Values 290
6.7.3 Assessment of Impacts on the Environmental Values 291
6.7.4 Proposed Environmental Protection Objective 292
6.7.5 Control Strategies 292
6.7.6 Proposed EA Conditions using Measurable Indicators and Standards 295
6.8 CULTURAL HERITAGE 295
6.8.1 Environmental Value 295
6.8.2 Description of Environmental Values 295
6.8.3 Assessment of Impacts on the Environmental Values 295
6.8.3.1 Non-Indigenous Cultural Heritage 295
6.8.3.2 Indigenous Cultural Heritage 298
6.8.4 Proposed Environmental Protection Objective 298
6.8.5 Control Strategies 298
6.8.5.1 Non-Indigenous Cultural Heritage 298
6.8.5.2 Indigenous Cultural Heritage 299
6.9 NATURE CONSERVATION 300
6.9.1 Identified Environmental Value 300
6.9.2 Description of Environmental Value 300
6.9.3 Assessment of Impacts on the Environmental Values 300
6.9.4 Proposed Environmental Protection Objective 302
6.9.5 Control Strategies 303
6.10 CONTINUOUS IMPROVEMENT 307
6.11 STAFF TRAINING 307
6.12 ENVIRONMENTAL AUDITING 308
6.13 ENVIRONMENTAL MANAGEMENT PLAN MILESTONES 309
7.0 REFERENCES 310

LIST OF FIGURES

VOLUME 1

Figure 1.1 Regional Location of Project 1-4
Figure 1.2 Project Tenements 1-5
Figure 1.3 Major Corridor Infrastructure Layout 1-6
Figure 1.4 Project Layout 1-7
Figure 1.5 EIS Process 1-13
Figure 2.1 Potential Powerline Route Options 2-6

Figure 2.2 Potential Water Pipeline Routes 2-8
Figure 2.3 Access Route Alternatives 2-10
Figure 2.4 Possible Accommodation Camp Locations 2-12
Figure 2.5 Potential TSF Sites 2-14
Figure 2.6 Proposed Processing Plant Location 2-19
Figure 2.7 Final Project Layout and Infrastructure Corridor Alignments 2-21
Figure 3.1 Project Regional Location 3-1
Figure 3.2 Local Context Map 3-2
Figure 3.3 Cadastral Map with Project Site 3-3
Figure 3.4 Cadastral Map with Powerline Corridor 3-4
Figure 3.5 Watercourses on the Project Site 3-6
Figure 3.6 Project Infrastructure Layout 3-7
Figure 3.7 Project Infrastructure Layout over Aerial Photograph 3-8
Figure 3.8 Proposed Power Line Location 3-9
Figure 3.9 Adjacent Mining Tenements 3-10
Figure 3.10 Location of Current Exploration Camp 3-13
Figure 3.11 Location of Waterway Crossings on Access and Accommodation Camp Roads and the Water Pipeline 3-17
Figure 3.12 Mine, Processing Plant and Borrow Pits Layout 3-19
Figure 3.13 Accommodation Camp Layout 3-21
Figure 3.14 Typical Chatoyer Wastewater Treatment Plant Layout 3-22
Figure 3.15 Processing Plant and Mine Location 3-26
Figure 3.16 Plant Site Design Earthwork Levels 3-27
Figure 3.17 Plant Site Cut and Fill Contours 3-28
Figure 3.18 Main Embankment General Layout 3-34
Figure 3.19 Anchorage and Main Embankment Face Details 3-35
Figure 3.20 Stage I Civil Works 3-36
Figure 3.21 Stage II Civil Works 3-37
Figure 3.22 Stage III Civil Works 3-38
Figure 3.23 Current Project Tenement Locations 3-40
Figure 3.24 Project Layout and Tenements over Aerial Photograph 3-44
Figure 3.25 Annual Ore to be Mined 3-46
Figure 3.26 Predicted Fuel Consumption Zinc/Lead and Copper Mining Equipment 3-49
Figure 3.27 Total Blasts Per Annum 3-50
Figure 3.28 Longitudinal View of Underground Mine showing Mining Sections 3-52
Figure 3.29 Process Plant Layout 3-57
Figure 3.30 Primary Crushing Circuit 3-59
Figure 3.31 Course Ore Stockpile and Reclaim System 3-60
Figure 3.32 Conceptual Lead/Zinc/Silver Process Flowchart 3-63
Figure 3.33 Conceptual Copper Process Flowchart 3-64
Figure 3.34 General Arrangement of the On-site Concentrate-Storage Building 3-74
Figure 3.35 Truck Wash Location 3-75
Figure 3.36 National Highways and Roads of Cloncurry 3-77
Figure 3.37 Location of the Project Access Road 3-79
Figure 3.38 Concentrate Transport Trucks 3-80
Figure 3.39 Proposed Power Transmission Line 3-89
Figure 3.40 Energy Consumption per Year (GWh) 3-92
Figure 3.41 Proposed Water Supply Route 3-93
Figure 3.42 Conceptual Schematic Diagram of Average Project Water Balance 3-94
Figure 3.43 Proposed Dirty and Contaminated Stormwater Storages 3-103
Figure 3.44 Conceptual Design of Clean Water Diversion Drains 3-104
Figure 3.45 Proposed Clean Surface Water Management Controls 3-105
Figure 3.46 Location of Creek Crossings 3-114
Figure 3.47 Accommodation Camp Layout 3-119
Figure 3.49 Waste Streams in the Operational Phase of the Project 3-126
Figure 3.50 Waste Rock and Stockpile Location and Design 3-133
Figure 3.51 Conceptual NAF/PAF Waste Rock Dump Design 3-134
Figure 3.52 Waste Rock Schedule and Disposal Methods 3-137
Figure 3.53 ARD Classification Plot for Dugald River Waste Rock 3-145

Figure 3.54 Paste Plant Location 3-150
Figure 3.55 Paste Plant Layout 3-152
Figure 3.56 Overall Site Plan of Tailings Storage Facility 3-154
Figure 3.57 Normally Consolidated Tailings Density Profile 3-157
Figure 3.58 TSF Decant Pond Storage at End of Each Stage 3-159
Figure 3.59 Location of Rubbish Landfill 3-166
Figure 3.60 Overview of Rehabilitated Landforms 3-172
Figure 3.61 Mining and Processing Area – Rehabilitated Landforms 3-173
Figure 3.62 TSF – Rehabilitated Landform 3-174
Figure 4.1 Mean Daily Maximum and Minimum Temperatures by Month and Mean Monthly Rainfall 4-1
Figure 4.2 Mean Monthly Potential Evaporation 4-2
Figure 4.3 Average Wind Roses for Cloncurry AERO and Cloncurry Airport Weather Stations 4-3
Figure 4.4 Tropical Cyclones Crossing Within 200 km of Mount Isa 4-4
Figure 4.5 Typical Fire Seasons in Australia (BOM, 2008) 4-6
Figure 4.6 Project Site Topography 4-8
Figure 4.7 Local Outcrop Geology and MMG Lease Boundaries (Whitcher 1982) 4-10
Figure 4.8 Local Outcrop Geology and Project Infrastructure Layout (Whitcher 1982) 4-11
Figure 4.9 Dugald River Host Rock Represented in Stratigraphic Order 4-12
Figure 4.10 Cross Section through the Dugald River Sequence at 14200mN 4-13
Figure 4.11 Plan of Surface and Underground Facilities and Surface Outcrop of Ore Body 4-16
Figure 4.12 Locations of Soil Types Across Project Site 4-20
Figure 4.13 Land Suitability Class Map for Beef Cattle Grazing 4-24
Figure 4.14 Land Suitability Class Map for Rainfed Broadacre Cropping 4-25
Figure 4.15 Land Suitability Class Map for Conservation 4-26
Figure 4.16 Cadastral Map with Project Boundary 4-29
Figure 4.17 Cadastral Map Showing Proposed Power Transmission Line 4-30
Figure 4.18 Native Title Claim Areas 4-31
Figure 4.19 Location of Current Infrastructure 4-33
Figure 4.20 Environmentally Sensitive Areas Map Overlaid with Project Boundary 4-35
Figure 4.21 Environmentally Sensitive Areas Map – Powerline Area 4-36
Figure 4.22 Pre-Mining Land Suitability Class Map (Beef Cattle Grazing) with Proposed Project Infrastructure 4-44
Figure 4.23 Hensley Drive turnoff and river crossing 4-59
Figure 4.24 Regional Drainage Network in the Vicinity of the Project Site 4-71
Figure 4.25 Local Catchments & Drainage Networks Affected by the Mine Operation 4-73
Figure 4.26 Silvermine Creek Recorded Rainfall and Water Levels (1998/1999) 4-74
Figure 4.27 Silvermine Creek Recorded Rainfall and Water Levels (1999/2000) 4-75
Figure 4.28 Silvermine Creek Recorded Rainfalls and Water Levels (2008/2009) 4-76
Figure 4.29 Average Annual Flows at the Railway Crossing on the Dugald River 4-77
Figure 4.30 Worst Case Scenario Flooding 4-79
Figure 4.31 Surface Water Sampling Locations within the Dugald River Project Site 4-81
Figure 4.32 Surface Water Sampling Locations within the Roseby Copper Project Site 4-82
Figure 4.33 Method of Determining Stream Order 4-91
Figure 4.34 Stream Morphology and Stream Sediment Sampling Sites (Project Site) 4-93
Figure 4.35 Stream Morphology and Stream Sediment Sampling Sites (Access Road) 4-94
Figure 4.36 Graphical Representation of Zinc Outlier Results at DRSS7 4-102
Figure 4.37 Locations and Registered Number of Bores Visited in 2008 Census 4-104
Figure 4.38 Groundwater Monitoring Bore Locations 4-107
Figure 4.39 Potentiometric Surface Contour Map March 2008 4-111
Figure 4.40 Proposed 'Clean' Surface Water Management Controls 4-117
Figure 4.41 Proposed Dugald River Surface Water and Stream Sediment Monitoring Sites 4-122
Figure 4.42 Extract from "Limits of Reporting" letter from ALS 4-129
Figure 4.43 Groundwater Monitoring Bore Locations 4-135
Figure 4.44 Annual Windrose 4-138
Figure 4.45 Atmospheric Mixing Heights 4-139
Figure 4.46 Monthly Dust Deposition Rates Measured at the Proposed Dugald River Project 4-141
Figure 4.47 Predicted Annual Average Ground-level Concentration of Lead for the Proposed Dugald River Project 4-148

Figure 4.48 Predicted 1-hour Average Ground-level Concentrations of Nitrogen Dioxide for the Proposed Dugald River Project Gensets Only (background levels not included)....4-151
Figure 4.49 Predicted 6th Highest 24-hour Average Ground-level Concentration of PM10 for the Proposed Dugald River Project....4-154
Figure 4.50 Predicted 6th Highest 24-hour Average Ground-level Concentration of PM_{10} for the Proposed Dugald River Project, Roseby Copper Project and Background. 4-155
Figure 4.51 Predicted Maximum Ground-level Concentration of 24-hour average $PM_{2.5}$ for the Proposed Dugald River Project....4-156
Figure 4.52 Predicted Maximum Ground-level Concentration of 24-hour average $PM_{2.5}$ for the Proposed Dugald River Project, Roseby Copper Project and Background. 4-157
Figure 4.53 Predicted Annual Average Ground-level Concentrations of $PM_{2.5}$ for the Proposed Dugald River Project 4-158
Figure 4.54 Predicted Annual Average Ground-level Concentrations of $PM_{2.5}$ for the Proposed Dugald River Project, the Roseby Copper Project and Background. 4-159
Figure 4.55 Predicted annual average ground-level concentrations of TSP for the Proposed Dugald River Project....4-160
Figure 4.56 Predicted Annual Average Ground-level Concentrations of TSP for the Proposed Dugald River Project, the Roseby Copper Project and Background. 4-161
Figure 4.57 Predicted Annual Average Dust Deposition Rate for the Proposed Dugald River Project 4-162
Figure 4.58 Predicted Annual Average Dust Deposition Rate for the Proposed Dugald River Project, the Roseby Copper Project and Background. 4-163
Figure 4.59 Noise Sensitive Places....4-174
Figure 4.60 Plot of Noise Monitoring Results 4-175
Figure 4.61 Plot of Background Noise Monitoring Results....4-175
Figure 4.62 Noise Contours for Scenario 1 4-181
Figure 4.63 Noise Contours for Scenario 2 4-182
Figure 4.64 Vegetation Communities on the Project site 4-201
Figure 4.65 Vegetation Communities within the Northern Section of the Power Line Corridor ..4-221
Figure 4.66 Vegetation Communities within the Central Section of the Power Line Corridor....4-222
Figure 4.67 Vegetation Communities within the Southern Section of the Power Line Corridor..4-223
Figure 4.68 Northern Section of Power Line Corridor Transect Locations 4-226
Figure 4.69 Central Section of Power Line Corridor Transect Locations 4-227
Figure 4.70 Southern Section of Power Line Corridor Transect Locations 4-228
Figure 4.71 Access Route Corridor Vegetation Communities and Creek Crossing Locations ...4-231
Figure 4.72 Northern Section Water Pipeline Corridor Vegetation Communities and Rocky Outcrop 4-236
Figure 4.73 Southern Section of Water Pipeline Corridor Vegetation Communities....4-237
Figure 4.74 Aquatic Study Locations Downstream of the Project Site....4-238
Figure 4.75 Location of Identified Historical Cultural Heritage Sites 4-257
Figure 4.76 Historical Cultural Heritage Site – Infrastructure Corridor (Northern Section) 4-260
Figure 4.77 Historical Cultural Heritage Sites - Infrastructure Corridor (Southern Section)....4-261
Figure 4.78 Non-Indigenous Cultural Heritage Sites and Proposed Infrastructure....4-264
Figure 4.79 Population Projection Scenarios for Cloncurry 4-271
Figure 4.80 Place of Usual Residence 5 Years Ago 4-273
Figure 4.81 Employment by Industry in Cloncurry – 2006 4-275
Figure 4.82 Employment by Occupation in Cloncurry – 2006....4-276
Figure 4.83 Low Income Households in Cloncurry 4-278
Figure 4.84 Number of People Usually Resident for Cloncurry vs. Queensland 4-282
Figure 4.85 Median Annual House Price Growth for Cloncurry (%)....4-284
Figure 4.86 Median Annual Growth of Unit Prices for Cloncurry (%)....4-285
Figure 4.87 Nature of Occupancy for Cloncurry and Queensland 4-285
Figure 4.88 Type of Internet Connection in Households....4-287
Figure 4.89 Residences in Relation to the Project Site....4-297
Figure 4.90 Enquiries/Complaints Management Process 4-310
Figure 4.91 Location of Sensitive Receivers....4-312

VOLUME 2

Figure 1 Project Location 4
Figure 2 Local Context Map 5
Figure 3 Current Project Tenement Locations 7
Figure 4 Location of Transport and Infrastructure Tenements 11
Figure 5 Cadastral Map with Project Site 18
Figure 6 Cadastral Map with Powerline Corridor 19
Figure 7 Environmentally Sensitive Areas Map – Project Site 21
Figure 8 Environmentally Sensitive Areas Map – Powerline Corridor 22
Figure 9 Mean Daily Maximum and Minimum Temperatures by Month 25
Figure 10 Mean Monthly Evaporation Cloncurry 26
Figure 11 Wind Roses for Cloncurry AERO and Airport Weather Stations 27
Figure 12 Project Site Topography 30
Figure 13 Locations of Soil Types Across Project Site 34
Figure 14 Land Suitability Class Map for Beef Cattle Grazing 38
Figure 15 Land Suitability Class Map for Rainfed Broadacre Cropping 39
Figure 16 Land Suitability Class Map for Conservation 40
Figure 17 Annual Windrose 41
Figure 18 Atmospheric Mixing Heights 43
Figure 19 Monthly Dust Deposition Rates Measured at the Proposed Dugald River Project 44
Figure 20 Noise Sensitive Places 46
Figure 21 Plot of Noise Monitoring Results 47
Figure 22 Plot of Background Noise Monitoring Results 48
Figure 23 Regional Drainage Network in the Vicinity of the Project Site 51
Figure 24 Silvermine Creek Recorded Rainfall and Water Levels (1998/1999) 52
Figure 25 Silvermine Creek Recorded Rainfall and Water Levels (1999/2000) 53
Figure 26 Silvermine Creek Recorded Rainfalls and Water Levels (2008/2009) 53
Figure 27 Average Annual Flows at the Railway Crossing on the Dugald River 55
Figure 28 Surface Water Sampling Locations within the Dugald River Project Site 57
Figure 29 Surface Water Sampling Locations within the Roseby Copper Project Site 58
Figure 30 Extract from “Limits of Reporting” letter from ALS 73
Figure 31 Method of Determining Stream Order 74
Figure 32 Stream Morphology and Stream Sediment Sampling Sites (Project Site) 75
Figure 33 Stream Morphology and Stream Sediment Sampling Sites (Access Road) 76
Figure 34 Graphical Representation of Zinc Outlier Results at DRSS7 83
Figure 35 Locations of Registered Bores Visited in 2008 Census 87
Figure 36 Potentiometric Surface Contour Map March 2008 94
Figure 37 Vegetation Communities on the Project Site 100
Figure 38 Vegetation Communities within the Northern Section of the Power Line Corridor 103
Figure 39 Vegetation Communities within the Central Section of the Power Line Corridor 104
Figure 40 Vegetation Communities within the Southern Section of the Power Line Corridor 105
Figure 41 Northern Section of Powerline Corridor – Significant Features 108
Figure 42 Central Section of Powerline Corridor – Significant Features 109
Figure 43 Southern Section of Powerline Corridor – Significant Features 110
Figure 44 Northern Section of Water Pipeline Corridor Vegetation Communities and Rocky Outcrops 113
Figure 45 Southern Section of Water Pipeline Corridor Vegetation Communities and Rocky Outcrops 114
Figure 46 Access Route Corridor Vegetation Communities and Creek Crossing Locations 117
Figure 47 Aquatic Study Locations Downstream of the Project site 118
Figure 48 ARD Classification Plot for Waste Rock 123
Figure 49 Location of Identifies Historical Cultural Heritage Sites 129
Figure 50 Historical Cultural Heritage Site – Infrastructure Corridor (Northern Section) 132
Figure 51 Historical Cultural Heritage Sites - Infrastructure Corridor (Southern Section) 133
Figure 52 Project Infrastructure Layout 144
Figure 53 Location of Proposed Power line, Water Pipeline and Access Road 145
Figure 54 Proposed Mining and Processing Plant Layout 150
Figure 55 Annual Ore to be Mined 152

Figure 56 Conceptual NAF/PAF Waste Rock Dump Design 156
Figure 57 Primary Crushing Circuit 160
Figure 58 Crushed Ore Stockpile and Reclaim System 161
Figure 59 Lead/Zinc/Silver Process Flowchart 163
Figure 60 Copper Process Flowchart 164
Figure 61 General Arrangement of the On-site Concentrate-Storage Building 166
Figure 62 Truck Wash Location 168
Figure 63 Paste Plant Location 170
Figure 64 Disc Filter Bank 171
Figure 65 Paste Mixer 172
Figure 66 Paste Plant Layout 173
Figure 67 Main Embankment General Layout 176
Figure 68 Stage I Civil Works 177
Figure 69 Stage II Civil Works 178
Figure 70 Stage III Civil Works 179
Figure 71 Stormwater Catchment Areas and Ponds 189
Figure 72 Conceptual Schematic Diagram of Average Project Water Balance 192
Figure 73 Accommodation Camp Layout 201
Figure 74 Location of the New Access Road 205
Figure 75 Location of Creek Crossings 208
Figure 76 Conceptual Design of Clean Water Diversion Drains 209
Figure 77 Proposed Clean Surface Water Management Controls 210
Figure 78 Overview of Rehabilitated Landforms 212
Figure 79 Mining and Processing Area – Final Rehabilitated Landforms 213
Figure 80 TSF – Final Rehabilitated Landform 214
Figure 81 Waste Rock Dump Final PAF Encapsulation Design 220
Figure 80 Schedule I – Map 1 - Surface Water and Stream Sediment Monitoring Locations 254
Figure 81 Schedule C – Map 2 - Location of Groundwater Monitoring Bores 267
Figure 82 Location of Non-Indigenous Cultural Heritage Sites on the Project Site and Infrastructure 297

LIST OF TABLES

VOLUME 1

Table 1.1 Significant Base Metal Resources of the Mt Isa Inlier (Australian Journal of Earth Sciences, 2002) 1-9
Table 1.2 Project Approval Timetable 1-11
Table 1.3 Interested Persons 1-17
Table 1.4 Affected Persons 1-18
Table 1.5 ERAs Associated with the Project 1-23
Table 1.6 Mining Projects and their Aggregate Environmental Score 1-23
Table 2.1 Comparison of TSF Options Against Criteria 2-16
Table 3.1 Dugald River Roads Geometric Design Criteria 3-15
Table 3.2 Summary of TSF Perimeter Works Quantities 3-32
Table 3.3 Current Project Tenements Details 3-41
Table 3.4 Infrastructure Corridor Tenement Details 3-43
Table 3.5 June 2009 - JORC Compliant Resource at a 6% Zinc Cut Off 3-45
Table 3.6 June 2010 - JORC Compliant Resource at a 1% Copper Cut Off 3-45
Table 3.7 Underground Mining Fleet 3-47
Table 3.8 Processing Plant Mobile Equipment List 3-47
Table 3.9 Underground Blasting Details 3-50
Table 3.10 Disturbance Footprint of the Project 3-54
Table 3.11 Reagents and Media Consumption Summary 3-65
Table 3.12 Reagents Storage and Use 3-66
Table 3.13 Townsville Transport Envelope Maximum Dimensions 3-81

Table 3.14 Vehicles Loads during Construction....3-82
Table 3.15 Expected Increase in Vehicle Movements during Construction Flinders Highway....3-82
Table 3.16 Expected Increase in Vehicle Movements during Construction Burke Developmental Road....3-83
Table 3.17 Expected Heavy Vehicle Increases For Burke Developmental Road....3-84
Table 3.18 Expected Heavy Vehicle Increases For Flinders Highway (Cloncurry to Yurbi)....3-84
Table 3.19 Expected Vehicle Increases due to Staff Movement....3-85
Table 3.20 Flights Servicing Cloncurry Airport....3-86
Table 3.21 Projected Number of Personnel Requiring Air flights Per Week for the Duration of the Project....3-87
Table 3.22 Proposed Charter Flight Schedule....3-87
Table 3.23 Energy Consumption per Year (GWh)....3-92
Table 3.24 Proposed Mining and Processing Area Stormwater Storages....3-101
Table 3.25 Surface Water Balance Model Configuration....3-107
Table 3.26 Configuration of Creek Crossings (Access Accommodation Camp Roads)....3-111
Table 3.27 Estimated 100 Year Flood Levels at Pipeline Crossings....3-112
Table 3.28 Waste Produced in Construction Phase....3-123
Table 3.29 Waste Sources During Operation....3-124
Table 3.30 Emission Rates of $PM_{2.5}$, PM_{10} and TSP for the Dugald River Project....3-128
Table 3.31 Emission Control Factors for Dust Control Measures....3-128
Table 3.32 Greenhouse Gas Emissions....3-129
Table 3.33 Estimate of PAF/NAF Materials....3-131
Table 3.34 Waste Stockpiled on Surface (tonnes) Each Year....3-138
Table 3.35 Volumes of Waste Rock to Remain on Surface at End of Mine Life....3-139
Table 3.36 Distribution of Waste Rock Samples Across Lithologies....3-140
Table 3.37 Sulphur Content....3-142
Table 3.38 Acid Neutralising Capacity....3-142
Table 3.39 Net Acid Producing Potential....3-143
Table 3.40 ARD Classification of Lithologies....3-146
Table 3.41 Adopted Tailings Density Parameters....3-156
Table 3.42 Comparison Of 1 In 10,000 Year And DSA Flood Data....3-159
Table 3.43 Acid Forming Characteristics of Tailings....3-163
Table 3.44 Pre and Post Mining Land Use Suitability....3-176
Table 3.45 Estimated Quantities of Materials Required to Rehabilitate TSF....3-179
Table 3.46 Native Species to be used in Rehabilitation....3-183
Table 4.9 Project Waste Streams....4-62
Table 4.10 Waste Management Schedule....4-67
Table 4.11 Average Monthly Flow - Dugald River (1969-2006)....4-76
Table 4.12 Surface Water Quality Analysis – Dugald River....4-85
Table 4.13 Surface Water Quality Analysis – Cabbage Tree Creek....4-88
Table 4.14 Particle Size Analysis....4-98
Table 4.15 Stream Sediment Quality Results....4-101
Table 4.16 Field Groundwater Quality Measurements – April 2008....4-105
Table 4.17 Annual Recharge Estimates....4-109
Table 4.18 Groundwater Analyses From Sampling Event Of 16th March 2010....4-112
Table 4.19 Calculate Aquifer Transmissivity and Permeability Values....4-114
Table 4.20 Calculated Permeability Values From Preliminary Geotechnical Investigation....4-115
Table 4.21 Surface Water and Stream Sediment Monitoring Program....4-120
Table 4.22 Surface Water and Stream Sediment Monitoring Sites....4-120
Table 4.23 Water Quality Percentile Calculations for Dugald River....4-125
Table 4.24 Water Quality Percentile Calculations for Cabbage Tree Creek....4-126
Table 4.25 Proposed Dugald River Triggers and Limits....4-127
Table 4.26 Proposed Cabbage Tree Creek Triggers and Limits....4-128
Table 4.27 Proposed Stream Sediment Triggers and Limits....4-130
Table 4.28 Locations and Purposes of Proposed Groundwater Monitoring Bores....4-134
Table 4.29 Dugald River Groundwater Monitoring Strategy....4-136
Table 4.30 Frequency of Occurrence (%) of Surface Atmospheric Stability Conditions....4-139
Table 4.31 Greenhouse Gas Emission Factors for Diesel Consumption and Landfill....4-143
Table 4.32 Greenhouse Gas Emissions for Project Operations (by year)....4-143

Table 4.33 Potential Emission Control Factors for Dust Control Measures....4-145
Table 4.34 Dust Emission Rates of TSP, PM_{10} and $PM_{2.5}$ for the Dugald River Project 4-145
Table 4.35 Dust Emission Rates of Metals for the Dugald River Project....4-146
Table 4.36 Predicted Ground-level Concentrations at the Homestead and the Roseby Copper Accommodation Camp due to the Dugald River Project....4-147
Table 4.37 Existing Ambient Air Quality Goals and Guidelines Applicable to the Project 4-149
Table 4.38 Summary of Stack and Emission Characteristics for the Proposes Gensets 4-150
Table 4.39 Predicted Ground-Level Concentrations of $PM_{2.5}$, PM_{10}, Carbon Monoxide and Nitrogen Dioxide at the Homestead due to the Gensets (First Two Years)....4-150
Table 4.40 Predicted Ground-level Concentrations at Roseby Homestead 4-152
Table 4.41 Predicted Ground-level Concentrations at the Roseby Copper Accommodation Camp 4-152
Table 4.42 Action Plan for Reducing Greenhouse Gas Emissions - Construction Phase....4-168
Table 4.43 Action Plan for Reducing Greenhouse Gas Emissions – Operations Phase 4-169
Table 4.44 Nearest Sensitive Receivers....4-173
Table 4.45 Summary of Measured Noise Levels 4-176
Table 4.46 DERM Proposed Draft Noise Limits for Roseby Homestead from Roseby Copper Project 4-177
Table 4.47 Mining Equipment....4-178
Table 4.48 Predicted Noise Levels for Mining Scenarios 4-179
Table 4.49 Predicted Noise Levels for Scenario 1 with Adverse Meteorological Conditions 4-180
Table 4.50 Predicted Noise Levels for Scenario 2 with Adverse Meteorological Conditions 4-180
Table 4.51 Predicted Low Frequency Noise Levels with Adverse Meteorological Conditions ..4-185
Table 4.52 Separation Distance to Achieve Nominated Ground Vibration Levels....4-186
Table 4.53 Threatened Fauna from the Region Not Observed on the Project Site 4-192
Table 4.54 Threatened Flora Species from the Region Not Observed on the Project Site 4-196
Table 4.53 Corresponding REs for the Snappy Gum Open Woodland 4-203
Table 4.54 Corresponding REs for the Cloncurry Box Open Woodland....4-205
Table 4.55 Corresponding RE for Mixed Bloodwood Riparian Woodland 4-207
Table 4.56 Corresponding REs for the River Red Gum Riparian Woodland....4-208
Table 4.57 Corresponding REs for Gidgee Open Woodland....4-210
Table 4.58 Corresponding RE for Silver Box / Cloncurry Box Open Woodland 4-212
Table 4.59 Summary of the Conservation Significance of Regional Ecosystems 4-213
Table 4.60 Vegetation Communities and Conservation Significance on the Powerline Corridor 4-219
Table 4.61 Summary of Rocky Outcrops Found Within the Power Line Route 4-225
Table 4.62 Vegetation Communities on the Access Route Corridor....4-229
Table 4.63 Vegetation Communities on the Water Pipeline Corridor 4-234
Table 4.64 Average Sensitivity Scores for Each Sample Location in 2004 4-240
Table 4.65 Average Sensitivity Scores for Each Sample Location in 2005 4-240
Table 4.66 Historical Cultural Heritage Sites Located on the Project site 4-255
Table 4.67 Historic Cultural Heritage Sites Located Within the Infrastructure Corridors 4-258
Table 4.68 Summary of Cultural Heritage Significance for Project Site and Corridors....4-265
Table 4.69 Population by Gender in Cloncurry Versus Queensland 4-271
Table 4.70 Population by Age Cloncurry Versus Queensland....4-272
Table 4.71 Marital Status by Place of Usual Residence 4-273
Table 4.72 Labour Force Characteristics in Cloncurry and Queensland 4-274
Table 4.73 Weekly Income Totals....4-277
Table 4.74 Level of Education Attained Cloncurry and Queensland - 2006 4-278
Table 4.75 Age left School Cloncurry and Queensland – 2006 4-279
Table 4.76 Country of Origin 4-279
Table 4.77 Primary Language Spoken at Home 4-280
Table 4.78 Religious Affiliation by Gender 4-280
Table 4.79 Family Structure of Cloncurry and Queensland (By Usual Residence) 4-281
Table 4.80 Dwelling Type by Tenure in Cloncurry 4-282
Table 4.81 Rental range for Cloncurry housing for 2006 4-283
Table 4.82 Property Prices for Houses and Units in Cloncurry....4-284
Table 4.83 Housing Stress and Affordability in Cloncurry versus Queensland. 4-286
Table 4.84 Indigenous Population in Cloncurry 4-287

Table 4.85 Indigenous Population by Age in Cloncurry 4-288
Table 4.86 Indigenous Family Structure in Cloncurry 4-288
Table 4.87 Dwelling Type by Tenure in Cloncurry 4-289
Table 4.88 Indigenous Labour Force Characteristics – Cloncurry 2006 4-290
Table 4.89 Indigenous Employment by Industry in Cloncurry 4-290
Table 4.90 Indigenous Occupation by Sex in Cloncurry - 2006 4-291
Table 4.91 Indigenous Weekly Income Totals 4-292
Table 4.92 Level of Education Attained Cloncurry - 2006 4-292
Table 4.93 Age left School Cloncurry and Queensland – 2006 4-293
Table 4.94 Indigenous Language Spoken 4-293
Table 4.95 Details of Properties Under and Surrounding the Project 4-294
Table 4.96 Aspects of FIFO Lifestyle (Graham, 2000) 4-301
Table 4.97 Mining Industry in Brisbane and Townsville Source Communities (ABS, 2006) 4-302
Table 4.98 Mining Industry in Mount Isa Source Community (ABS, 2006) 4-303
Table 4.99 SIMP Implementation Summary 4-305
Table 4.100 Sample Monitoring Framework 4-309
Table 4.101 Qualitative Risk Analysis Matrix – Level of Risk 4-322
Table 4.102 Dangerous Goods Inventory 4-325
Table 4.103 Procedure for Spill of Hazardous Substance 4-328
Table 4.104 Cross Reference with Terms of Reference 4-329

VOLUME 2

Table 1 Supporting Studies 3
Table 2 Current Project Tenements Details 8
Table 3 Tenement Applications for Water Pipeline, Power line, TSF and Tailings Pipelines 10
Table 4 Interested Persons 13
Table 5 Affected Persons 14
Table 6 Lot on Plan Details for the Project Area 17
Table 7 Soil Types 31
Table 8 Pre-Mining Land Use Suitability 37
Table 9 Frequency of Occurrence (%) of Surface Atmospheric Stability Conditions 42
Table 10 Nearest Sensitive Receivers 46
Table 11 Summary of Measured Noise Levels 49
Table 12 Average Monthly Flow - Dugald River (1969-2006) 54
Table 13 Surface Water Quality Analysis – Dugald River 61
Table 14 Surface Water Quality Analysis – Cabbage Tree Creek 64
Table 15 Water Quality Percentile Calculations for Dugald River 69
Table 16 Water Quality Percentile Calculations for Cabbage Tree Creek 70
Table 17 Proposed Dugald River Triggers and Limits 71
Table 18 Proposed Cabbage Tree Creek Triggers and Limits 72
Table 19 Particle Size Analysis 81
Table 20 Stream Sediment Quality Results 84
Table 21 Proposed Stream Sediment Triggers and Limits 85
Table 22 Field Groundwater Quality Measurements – April 2008 88
Table 23 Groundwater Analyses From Sampling Event Of 16th March 2010 89
Table 24 Annual Recharge Estimates 93
Table 25 Calculate Aquifer Transmissivity and Permeability Values 95
Table 26 Calculated Permeability Values From Preliminary Geotechnical Investigation 96
Table 27 Summary of the Conservation Significance of Vegetation Communities – Project Site 98
Table 28 Vegetation Communities and Corresponding Conservation Status - Powerline Corridor 102
Table 29 Introduced Flora Species within the Power Line Corridor 107
Table 30 Vegetation Communities on the Water Pipeline Corridor 111
Table 31 Vegetation Communities on the Access Route Corridor 115
Table 32 Average Sensitivity Scores for Each Sample Location in 2004 120
Table 33 Average Sensitivity Scores for Each Sample Location in 2005 121
Table 34 ARD Classification of Lithologies 124

Table 35 Historical Cultural Heritage Sites Located on the Project site 128
Table 36 Historical Cultural Heritage Sites Located on the Infrastructure Corridors 130
Table 37 Summary of Cultural Heritage Significance for Project Site and Corridors 134
Table 38 ERAs Associated with the Project 146
Table 39 Mining Projects and their Aggregate Environmental Score 147
Table 40 Proposed Disturbance Footprint of the Project 149
Table 41 June 2009 - JORC Compliant Resource at a 6% Zinc Cut Off 152
Table 42 June 2010 – JORC Compliant Resource at 1% Copper Cut Off 152
Table 43 Estimate of PAF/NAF Materials 154
Table 44 Comparison Of 1 In 10,000 Year And DSA Flood Data 180
Table 45 Proposed Stormwater Dams and Sediment Ponds 187
Table 46 Regents Storage and Use 196
Table 47 Estimated 100 Year Flood Levels at Pipeline Crossings 206
Table 48 Pre and Post Mining Land Use Suitability 215
Table 49 Estimated Quantities of Materials Required to Rehabilitate TSF 219
Table 50 Native Species to be used in Rehabilitation 223
Table 51 Existing Ambient Air Quality Goals and Guidelines Applicable to the Project 235
Table 52 Emission Control Factors for Dust Control Measures 236
Table 53 Dust Emission Rates of TSP, PM_{10} and $PM_{2.5}$ for the Dugald River Project 237
Table 54 Dust Emission Rates of Metals for the Dugald River Project 237
Table 55 Predicted Ground-Level Concentrations of $PM_{2.5}$, PM_{10}, Carbon Monoxide and Nitrogen Dioxide at the Homestead due to the Gensets (First Two Years) 238
Table 56 Predicted Ground-level Concentrations at Roseby Homestead 239
Table 57 Predicted Ground-level Concentrations at the Roseby Copper Accommodation Camp 239
Table 58 Greenhouse Gas Emission Factors for Diesel Consumption and Landfill 241
Table 59 Greenhouse Gas Emissions for Project Operations (by year) 242
Table 60 Schedule C –Table 1 - Receiving Water Monitoring Locations and Frequency 252
Table 61 Schedule C – Table 2 - Receiving Water Contaminant Trigger Levels Dugald River Catchment 255
Table 62 Schedule C – Table 3 - Receiving Water Contaminant Trigger Levels Cabbage Tree Creek Catchment 256
Table 63 Schedule C – Table 4 - Receiving Water Contaminant Limits Dugald River Catchment 257
Table 64 Schedule C – Table 5 - Receiving Water Contaminant Limits Cabbage Tree Creek Catchment 258
Table 65 Schedule C – Table 6 - End of Pipe Monitoring Locations and Frequency 259
Table 66 Schedule C – Table 5 - End of Pipe Contaminant Release Limits 259
Table 67 Schedule C – Table 6 - Water Storage Monitoring Locations of Hazardous Dams 260
Table 68 Schedule C – Table 7 - Water Quality in Dams Containing Hazardous Waste 261
Table 69 Schedule C – Table 8 - Storage Design for Dams Containing Hazardous Waste 261
Table 70 Schedule C – Table 9 - Receiving Stream Sediment Monitoring Locations and Frequency 263
Table 71 Schedule C – Table 10 - Receiving Stream Sediment Contaminant Trigger Levels 264
Table 72 Schedule C – Table 11 - Receiving Stream Sediment Contaminant Limits 264
Table 73 Schedule C – Table 12 - Sewage Effluent Quality Targets for Sub-surface Irrigation of Gardens 265
Table 74 Schedule C – Table 13 - Groundwater Monitoring Locations and Frequency 266
Table 75 Predicted Noise Levels for Mining Scenarios 269
Table 76 Predicted Noise Levels for Scenario 1 with Adverse Meteorological Conditions 269
Table 77 Predicted Noise Levels for Scenario 2 with Adverse Meteorological Conditions 270
Table 78 Predicted Low Frequency Noise Levels with Adverse Meteorological Conditions 271
Table 79 Schedule D – Table 1 - Vibration Limits 273
Table 80 Schedule D – Table 2 - Vibration Limits 273
Table 81 Waste Management Schedule 277
Table 82 Schedule F – Table 1- Final Land Use and Rehabilitation Approval Schedule 284
Table 83 Schedule F – Table 2 - Landform Design 288
Table 84 Schedule F — Table 3 - Size and Purpose of Dams Containing Hazardous Waste 288
Table 85 Schedule F - Table 4 - Location of Dams Containing Hazardous Waste 289
Table 86 SIMP Implementation Summary 292
Table 87 Summary of Milestones 309

LIST OF PHOTO PLATES

VOLUME 1

Photo Plate 3.1 Ground Conditions at the Accommodation Camp Site 3-120
Photo Plate 3.2 Column Leach Test Setup.....3-164

VOLUME 2

Photo Plate 1 First Order Stream at Site DRSS15 78
Photo Plate 2 First Order Stream at Site DRSS9 78
Photo Plate 3 Fourth Order Stream – Dugald River near Powerline Corridor 79
Photo Plate 4 Fourth Order Stream at Site DRSS19.....79

LIST OF APPENDICES

Appendix A	Final Terms of Reference	A
Appendix B	List of Development Approvals	B
Appendix C	Study Team	C
Appendix D	Standard Criteria	D
Appendix E	Community Consultation Summary Report	E
Appendix F	Transportation Assessment	F
Appendix G	Surface Water Assessment	G
Appendix H	Assessment of the Geochemical Characteristics and ARD Potential of Waste Rock	H
Appendix I	Geochemistry and Column Leach Testing of Tailings	I
Appendix J	Tailings Storage Facility Preliminary Geotechnical Investigation	J
Appendix K	Tailings Storage Facility Final Report	K
Appendix L	Final Land Use and Rehabilitation Plan	L
Appendix M	Soil and Land Suitability Assessment	M
Appendix N	Air Quality Assessment	N
Appendix O	Greenhouse Gas Management Plan	O
Appendix P	Noise and Vibration Impact Assessment	P
Appendix Q	Surface Water Quality, Stream Morphology and Stream Sediments Report	Q
Appendix R	Groundwater Aspects	R
Appendix S	Terrestrial and Aquatic Flora and Fauna Assessment	S
Appendix T	Historic Cultural Heritage Assessment and Management Plan – Project Site	T
Appendix U	Historic Cultural Heritage Assessment and Management Plan – Infrastructure Corridors	U
Appendix V	Social and Economic Impact Assessment	V
Appendix W	Social Impact Management Plan	W
Appendix X	Environmental and Social Risk Assessment	X

LIST OF ABBREVIATIONS

%	-	Percent
µg/m^3	-	micrograms per cubic metre
µm	-	micron
µS/cm	-	MircoSiemens per centimetre
AADT	-	Annual Average Daily Traffic
AARC	-	AustralAsian Resource Consultants Pty Ltd
ABS	-	Australian Bureau of Statistics
ACHA	-	*Aboriginal Cultural Heritage Act 2003*
AEP	-	Annual Exceedance Probability
AGD	-	Australian Geodetic Datum
AGE	-	Australasian Groundwater and Environmental Consultants Pty Ltd
AHD	-	Australian Height Datum
ALS	-	Australian Laboratory Services Group
AMD	-	Acid Mine Drainage
AMF	-	AMF Project Service Pty Ltd
ANC	-	Acid Neutralising Capacity
ANCOLD	-	Australian National Committee on Large Dams
ANRA	-	Australian Natural Resources Atlas
ANZECC	-	Australia and New Zealand Environment and Conservation Council
ARD	-	Acid Rock Drainage
ARI	-	Annual Recurrence Interval
AS	-	Australian Standard
ATC	-	Australian Tailings Consultants
BOM	-	Bureau of Meteorology
CCG	-	Community Consultative Group

CCP	-	Community Consultation Program
CD	-	Compact Disk
CHMP	-	Cultural Heritage Management Plan
CLO	-	Community Liaison Officer
CLR	-	Contaminated Land Register
cm	-	centimetre(s)
CNV	-	Carbonate neutralising value
CO_2-e	-	CO_2 equivalents
COS	-	crushed-ore stockpiles
Cth	-	Commonwealth
dB	-	unweighted decibel
dB(A)	-	A-weighted decibels
dB(Lin)	-	Linear decibels
DEEDI	-	Department of Employment, Economic Development and Innovation
DERM	-	Department of Environment and Resource Management
DEWHA	-	Department of Environment, Water, Heritage and the Arts
DIP	-	Department of Infrastructure and Planning
DME	-	Department of Mines and Energy
DRS	-	Dugald River Slate
DSA	-	Design Storage Allowance
DTMR	-	Department of Transport and Main Roads
EA	-	Environmental Authority
EAP	-	Employee Assistance Programme
EC	-	Electrical Conductivity
EEO Act	-	*Energy Efficiency Opportunities Act 2006*
EGi	-	Environmental Geochemistry International Pty Ltd
EIS	-	Environmental Impact Statement

EM Plan	-	Environmental Management Plan
EMOS	-	Environmental Management Overview Strategy
EMR	-	Environmental Management Register
EP Act	-	*Environmental Protection Act 1994*
EP Regulation	-	*Environmental Protection Regulation 2008*
EPBC Act	-	*Environment Protection and Biodiversity Conservation Act 1999*
EPM	-	Exploration Permit – Minerals
EPP	-	Environmental Protection Policy
EPP(Air)	-	*Environmental Protection (Air) Policy 2008*
EPP(Noise)	-	*Environmental Protection (Noise) Policy 2008*
EPP(Waste Management)	-	*Environmental Protection (Waste Management) Policy 2000*
EPP(Water)	-	*Environmental Protection (Water) Policy 2009*
ERA	-	Environmentally Relevant Activity
ERE	-	Endangered Regional Ecosystem
ESA	-	Environmentally Sensitive Area
FAQs	-	frequently asked questions
FEL	-	front end loader
FIFO	-	Fly In / Fly Out
FRP	-	fibre reinforced polymer
FSL	-	Full Supply Level
g/s	-	grams per second
g/t	-	grams per tonne
GAI	-	Geochemical Abundance Indices
Gg	-	greenhouse gas
GGMP	-	Greenhouse Gas Management Plan
GPS	-	Global Positioning System
GSS	-	geomembrane sealing system

GWh	-	Gigawatts hours
ha	-	hectare(s)
HDPE	-	High Density Polyethylene
IEC	-	International Electrotechnical Commission
ILUA	-	Indigenous Land Use Agreement
JORC	-	Joint Ore Reserves Committee
kg	-	kilogram(s)
kg/ha	-	kilograms per hectare
kg/hr	-	kilograms per hour
km	-	kilometre(s)
km/h	-	kilometres per hour
km^2	-	square kilometre(s)
kV	-	kilovolt(s)
L	-	Litre(s)
L/s	-	Litres per second
LAN	-	Local Area Network
LCG	-	Landholder Consultative Group
LGA	-	Local Government Area
LOR	-	Limit of Reporting
LP Act	-	*Land Protection (Pest and Stock Route Management) Act 2002*
m	-	metre(s)
m/s	-	metres per second
m^2	-	square metre(s)
m^3	-	cubic metre(s)
m^3/h	-	cubic metres per hour
m^3/s	-	cubic metres per second
MDE	-	Maximum Design Earthquake

MDL	-	Mineral Development Licence
mg/kg	-	milligrams per kilogram
mg/L	-	milligrams per Litre
Ml	-	megalitre(s)
ML	-	Mining Lease
Ml/y	-	megalitre(s) per year
MLA	-	Mining Lease Application
mm	-	millimetre(s)
mm	-	millimetre(s)
MMG	-	Minerals and Metals Group Pty Ltd
Moz	-	Million ounce(s)
MPA	-	Maximum Potential Acidity
MPa	-	Megapascals
MR Act	-	*Mineral Resources Act 1989*
MRL	-	Mandatory Reporting Level
MSDS	-	Material Safety Data Sheets
Mt	-	million tonnes
Mtpa	-	Million tonnes per annum
MVA	-	Megavolt Amperes
MW	-	megawatt(s)
NAF	-	Non Acid Forming
NAG	-	Net Acid Generation
NAPP	-	Net Acid Producing Potential
NATA	-	National Association of Testing Authorities
NC Act	-	*Nature Conservation Act 1992*
NCWR	-	*Nature Conservation (Wildlife) Regulation 2006*
ng/m^3	-	nanogram per cubic metre

NGER Act	-	*National Greenhouse and Energy Reporting Act 2007*
NHMRC	-	National Health and Medical Research Council
NPI	-	National Pollutant Inventory
OBE	-	Operating Basis Earthquake
ºC	-	degrees Celsius
OD	-	Outside Diameter
OSCAR	-	Online System for Comprehensive Activity Reporting
oz	-	ounce(s)
PAF	-	Potentially Acid Forming
PAWC	-	Plant Available Water Capacity
pH	-	Power of Hydrogen
PL	-	Poverty Line
PM_{10}	-	Particulate Matter less than 10 microns
$PM_{2.5}$	-	Particulate Matter less than 2.5 microns
PMP	-	Probable Maximum Precipitation
PPE	-	Personal protective equipment
ppm	-	parts per million
QEPA	-	Queensland Environmental Protection Agency
QHA	-	*Queensland Heritage Act 1992*
Qld.	-	Queensland
QR	-	Queensland Rail
RE	-	Regional Ecosystem
RL	-	Reduced Level
ROM	-	Run of Mine
RSS	-	Rising stage Sampler
SAG	-	semi-autogenous grinding
SEIA	-	Social and Economic Impact Assessment

SG	-	Specific Gravity
SIMP	-	Social Impact Management Plan
SKM	-	Sinclair Knight Merz
SRC	-	Seismology Research Centre
SWL	-	safe-working-load
t	-	tonne(s)
t/m^3	-	tonnes per cubic metre(s)
TAFE	-	Technical and Further Education
TAPM	-	The Air Pollution Model
TBR™	-	Turbo Bioreactor
TDS	-	Total Dissolved Solids
TOR	-	Terms of Reference
tpa	-	tonnes per annum
tph	-	tonnes per hour
TSF	-	Tailing Storage Facility
TSP	-	Total Suspended Particle
UC	-	Uncertain classification
UG	-	Under Ground
VM Act	-	*Vegetation Management Act 1999*
VMR	-	*Vegetation Management Regulation 2000*
WMP	-	Waste Management Plan
WRM	-	WRM Water & Environment Pty Ltd

GLOSSARY OF TECHNICAL TERMS

Abrasive Blasting - Abrasive blasting is the operation of forcibly propelling a stream of abrasive material against a surface under high pressure to smooth a rough surface, roughen a smooth surface, shape a surface, or remove surface contaminants.

Acid-Base Accounting (ABA) - The balance between the acid-production and acid-consumption properties of a mine-waste material. Minerals in waste material (mostly sulfides and pyrite) react with water and oxygen to produce sulfuric acid. ABA consists of measuring the acid generating and acid neutralizing potentials of a rock sample.

Acid-Base Account Plot – The graphical representation of Total Sulfur content (%) versus ANC (kgH_2SO_4/t). This graphical representation shows the NAPP negative and NAPP positive zones.

Acid Metalliferous Drainage - The acid generated is completely neutralised by the dissolution of common carbonate minerals. Since the solubility of many toxic metals is pH-dependent, the neutralisation process can lead to precipitation of metals such as aluminium, copper and lead, and thus their removal from the drainage. However, at near-neutral pH, concentrations of toxic components such as zinc, arsenic, nickel, and cadmium can remain elevated. As with acid drainage, metalliferous drainage will also generally contain high (sulfate) salinity.

Non-acid metalliferous drainage is less common than acid drainage, due to the requirement for specific sulfide minerals and a local excess of carbonate neutralisation.

Acid Mine Drainage (AMD) – Also called acid rock water or acid rock drainage, refers to the outflow of acidic water from (usually) abandoned metal mines or coal mines. Acid mine drainage occurs naturally within most environments as part of the rock weathering process. However, this is exacerbated by large-scale earth disturbances characteristic of mining and other large construction activities, usually within rocks containing an abundance of sulfide minerals.

Acid Neutralising Capacity (ANC) – A measure of the buffering capacity or inherent neutralising ability of the material (often due to the presence of carbonate minerals). This is determined by the addition of a known amount of standardised acid (H_2SO_4 or HCl) to an accurately weighed sample, allowing the sample time to react (with heating), then back-titrating the mixture with standardised NaOH to determine the amount of acid consumed by reaction with the sample. Units are in kg H_2SO_4 per tonne of ore.

Acid Rock Drainage - Low pH drainage derived from materials with an insufficient capacity to neutralize the acidic products to sulfide and elemental sulphur oxidation and the dissolution products of acidic minerals and amorphous minerals. ARD is also produced when neutralization potential is no longer capable of maintaining neutral pH conditions in a measurable volume of drainage. In the context of mining, may also be referred to as acid mine drainage (AMD).

Alkalinity - A pressure and temperature independent property of water that determines in part the carbon content. Formally defined as the equivalent sum of the bases that are titratable with strong acid.

Alluvial – Of or pertaining to alluvium; sand, silt, clay, gravel, or other matter deposited by flowing water, as in a riverbed, floodplain, delta, or alluvial fan. Alluvium is generally considered a young deposit in terms of geologic time.

Ambient Noise – The sum of (background) noise at a particular location.

ANABAT – Specialised electronic bat call recorder that allows for bats to be unobtrusively surveyed and identify.

Angle of Repose - The maximum angle that a soil, sediment or other loose material can be placed or accumulate and be stable. The angle of repose varies for different types of materials and different moisture conditions.

Annual Exceedance Probability (AEP) – The probability (or likelihood) that a given total rainfall accumulated over a given duration will be exceeded in any one year rainfall event.

Annual Recurrence Interval (ARI) – The expected period between exceedances of a given rainfall total, accumulated over a given duration. For example, if there is a 1 in 50 chance that 170 millimetres of rain will fall in a catchment in a 24-hour period during any given year, a rainfall total of 170 millimetres in a consecutive 24-hour period is said to have a 50-year ARI.

Anthropogenic – Produced by humans or human-related activity.

ANZECC 2000 Guidelines – Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000). These guidelines provide a summary of the water quality guidelines proposed to protect and manage the environmental values supported by the water resources. The guideline also provides advice on designing and implementing water quality monitoring and assessment programs.

Annual Return – The sending or receiving of yearly documents in compliance with the *EP Act*.

Aquifer – A geological formation bearing groundwater that is permeable (unconfined) or impermeable (confined) to the transmission of groundwater.

Aquifer (confined) - An aquifer that is bounded above and below by impermeable rock or sediment layers. There may or may not be enough pressure in the aquifer to make it an "artesian aquifer".

Authority – Environmental Authority (mining activities) under the *Environmental Protection Act 1994*.

A-weighted – The filtering of sound to correlate to the frequency response of a human ear.

Backfill - Filled up with soil.

Bank Cubic Meter – A traditional unit of volume in coal mining that represents the contents of a cubic meter of rock in place, before it is drilled and blasted.

Batter – An upwardly receding slope of the face of a waste rock dump.

Bedrock – The native consolidated rock underlying the Earth's surface. Above the bedrock is usually an area of broken and weathered unconsolidated rock in the basal subsoil.

Bench – A narrow ledge or shelf, along the top or bottom of a slope. A bench is essentially the same thing as a berm. They are narrow flattened areas that interrupt the declivity of the regraded slopes of the waste rock dump.

Benthic – Associated with the bottom of a watercourse.

Berm – See bench description.

Borrow Pit – An area that is excavated to provide earth / material for use in construction.

Bund – Also called a bund wall and bunding, is an embankment that is constructed around an area and / or structure that is designed to prevent inflow or outflow of various liquid types.

Capillary Break – A space, or layer, between two surfaces which is purposely made wide enough to prevent the movement of moisture through the space by capillary action.

Capping - Covering the rock with material like clay to keep the water and air out.

Capping material - Clay or something similar which is put on the waste rock dump to block out water and air from reaching the contaminated rock.

Catchment – A structure or land feature which collects water.

Concrete Batching - The production of concrete or concrete products by mixing cement with sand, rock, aggregate or other similar materials.

Conductivity - The ease with which a material transmits an electric current.

Datum - A reference location or elevation which is used as a starting point for subsequent measurements. Sea level is a datum for elevation measurements.

Decant Pond - An open pond where waste or process water is allowed to stand while suspended materials settle out.

Decibel (Weighted) dB(A) – The measurement of sound pressure level in which the amplitude of the sound signal is negatively weighted in frequencies below 1000 Hz in accordance with a weighing scale known as the 'A' weighing scale. This scale was established to closely simulate human perception of the relative level of pure tone sounds.

Decline - A sloping tunnel big enough for vehicles, loaders and trucks to drive up and down to get to the ore and take the ore out.

Decommissioning - Close down a mine after mining has finished. This involves taking away buildings and equipment and rehabilitating the mine site area.

Deposition - The settling from suspension of transported sediments.

Design Storage Allowance (DSA) – Excess water storage required at November 1 each year that will be filled by the process inputs and runoff from a critical wet period, should it occur.

Drawdown – A lowering of the water level of a confined or unconfined aquifer resulting from the pumping of groundwater.

Earthworks - Digging up and removing (taking away) and stockpiling the soil and rocks using bulldozers and excavators.

EcoAccess Guidelines – The DERM guidelines for environmental licensing and permits.

Effluent - Water discharged into the environment from a man-made structure.

El Nino / Southern Oscillation - El Niño-Southern Oscillation (ENSO) is a global coupled ocean-atmosphere phenomenon. The Pacific Ocean signatures, El Niño and La Niña are major temperature fluctuations in surface waters of the tropical Eastern Pacific Ocean.

Elliot Trapping – Small metal folding traps baited with oats and honey etc to catch small mammals and reptiles.

Embankment - A ridge constructed of earth, fill, rocks, or gravel and used most commonly to retain water. The length of an embankment exceeds both its width and its height.

Environmental Authority – Licence or Approval issued under the *EP Act* to conduct specified 'Environmentally Relevant Activities'.

Environmentally Relevant Activities – Activities that have the potential to release contaminants to the environment.

Ephemeral – Watercourse flows that are short-lived, often reliant upon direct precipitation input.

Equivalent Persons – Unit of measurement used to determine the demand for sewerage reticulation services.

Evaporation - The process of liquid water becoming water vapour. Includes vaporization from water surfaces and land surfaces.

Exploration - The work of identifying areas that may contain viable mineral resources. This work can include surface mapping, remote sensing, exploratory drilling, geophysical testing, geochemical testing and other activities.

Exploratory Drilling - Drilling done to locate mineral deposits in an area where little subsurface data about those minerals is available.

Evapotranspiration - All methods of water moving from a liquid to water vapour in nature. Includes both evaporation and transpiration.

Floatation - The process of separating different materials, especially minerals, by agitating a pulverized mixture of the materials with water, oil, and chemicals. Differential wetting of the suspended particles causes unwetted particles to be carried by air bubbles to the surface for collection.

Flood - An overflow of water onto lands that are normally above local water levels. Can be caused by stream discharge exceeding the capacity of the stream channel, storm winds and reduced pressure drawing water from a lake or ocean onto the coastline, dam failure, lake level increase, local drainage problems or other reasons.

Freeboard – The distance between the level of the water and the upper surface of a dam or storage facility, such as the tailings storage facility.

Froth Flotation - Froth flotation is one of the most widely accepted industrial practices for separation of valuable components from associated gangue materials in mineral ores.

Gauging Station - A facility on a stream, lake, canal, reservoir or other water body where instruments are installed to automatically monitor the water. Measurements such as stage, discharge, water temperature and pH are automatically taken and transmitted to hydrologists via satellite, radio or telephone.

Geochemistry - Chemical composition and changes of the earth.

Geomorphology - The science of Earth's landforms, their description, classification, distribution, origin and significance.

Greenhouse Gases – Gases such as carbon dioxide and methane which, when dispersed in the atmosphere, tend to trap heat.

Grey Water - Non-drinkable water that can be reused for irrigation, flushing toilets, and other purposes.

Grizzly - A grating, usually constructed of steel rails, placed over the top of a chute or ore pass for the purpose of stopping large pieces of rock or ore that may hang up in the pass.

Ground Water - Water that exists below the water table in the zone of saturation. Ground water moves slowly in the same direction that the water table slopes.

Ground Water Recharge Area - A location where surface water or precipitation can infiltrate into the ground and replenish the water supply of an aquifer.

Hazard – The capacity of a substance, an activity or an event to produce an adverse health, safety or environmental effect.

Hazardous Waste - Any substance, whether liquid, solid or gaseous, derived by or resulting from, the process of minerals that tends to destroy life or impair or endanger health.

Hopper - A bin or funnel that is loaded from the top and which discharges through a door or chute at the bottom.

Hydraulic Conductivity - The ability of a porous material to transmit a fluid.

Hydrology - The science of Earth's water, its movement, abundance, chemistry and distribution on, above and below Earth's surface.

Impermeable Layer - A layer of rock, sediment or soil that does not allow water to pass through.

Infiltration - The movement of surface water into porous soil.

Kinetic NAG Testing - 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 ABA predictions. This method involves the addition of hydrogen peroxide to a prepared sample of mine waste to oxidise contained reactive sulfides. This is followed by measurement of the pH of the reaction solution and titration of any net acidity produced by the acid generation and neutralisation reactions occurring in the sample. Units are in kg H_2SO_4 per tonne of ore.

L_{10} – The L_{10} is the A-weighted noise level which is exceeded 10% of the time.

L_{90} – The L_{90} is commonly referred to as the background noise level. The A-weighted sound pressure level that is equalled or exceeded for 90% of that part of the interval in which the investigated noise is absent.

Land Suitability - As defined in the DME 1995 *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland*.

Leaching - Chemical reactions that occur during the percolation of liquid through tailings or other materials. It may occur unintentionally, as when rainwater passes through waste heaps, or it may be used deliberately, such as to recover metals from a low-grade ore.

L_{eq} - The L_{eq} is the energy average noise level containing the same acoustic energy as the actual fluctuating noise level.

Macroinvertebrate – An invertebrate large enough to be seen without magnification.

Macropod - (large-foot) – a member of the family macropodidae, i.e. wallabies and kangaroos.

Material Safety Data Sheets - Contain information on the hazards associated with a chemical, along with guidance on its safe use.

Mine Life / Project Life – The life of the Project refers to the length of time the Project will be in operation.

Net Acid Generation (NAG) – The NAG value measures the acidity after oxidation and is expressed as kilograms of sulphuric acid per tonne of rock.

Net Acid Producing Potential (NAPP) – This is also a theoretical calculation value commonly used to indicate if a material has potential to generate ARD. It represents the balance between the capacity of a sample to generate acid (TAPP) and its capacity to neutralise acid (ANC). The NAPP is also expressed in units of kg H_2SO_4 per tonne ore and is calculated as follows:

NAPP = TAPP – ANC

Not Acid Forming (NAF) – A sample of waste rock is usually defined as NAF when it has a negative NAPP and the NAG pH ≥ 4.5. Material classified as NAF is considered unlikely to be a source of acidic drainage. Where there is significant total S (>1%), more detailed investigation may be required to confirm that the ANC measured is available at the same rates as acid production through sulfide oxidation.

Ore Deposit - A natural accumulation of a metal, gemstone or other valuable mineral substance, which is rich enough in concentration that it can be mined and processed at a profit.

Ore Mineral - A mineral that contains a high enough concentration of a useful element or compound that the element or compound can be extracted at a profit.

Outcrop - An exposure of bedrock.

Oxidation - A chemical reaction in which substances combine with oxygen.

Peak Flow - The maximum instantaneous discharge of a stream at a specific location.

Peak Particle Velocity – A measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres / second.

Permeability - A measure of how well a material can transmit water. Materials such as gravel, that transmit water quickly, have high values of permeability. Permeability is primarily determined by the size of the pore spaces and their degree of interconnection.

pH - A relative measure of the acidity or alkalinity of a water based upon a scale that ranges between 0 and 14 with 7 being neutral. Values of pH below 7 indicate acid solutions and values of pH above 7 indicate basic solutions.

Pit dewatering – The act of removing groundwater around the edges of the area to become an underground pit progressively as the pit is dug. This process keeps groundwater out of the pit so as mining can occur; often well below the water table.

Pitfall Trapping – Pitfall traps target small ground-dwelling fauna (reptilian, mammalian and amphibian). Each Pitfall trap line consists of a 20 cm tall wire-mesh drift fence running along the ground and crossing the middle of five 20 litre buckets buried flush with the soil surface. The bottoms of the drift fences were buried slightly to guide target species towards a bucket. A small amount of soil and a damp sponge are usually placed in the bottom of each bucket to provide shelter and moisture for captured wildlife.

PM_{10} – Fine airborne particles with an aerodynamic diameter of less than 10 µm (PM_{10}) are small enough to be breathed into the lungs. Fine particles are most commonly implicated as causing health effects. Health and amenity impacts of dust are regulated by setting limits on ambient levels of Total Suspended Particulates (TSP), PM_{10} and dust deposition.

$PM_{2.5}$ – Particles with an aerodynamic diameter of less than 2.5 µm ($PM_{2.5}$) or fine particles are generally produced by combustion processes and can penetrate deep into the lung where their removal rate is slow.

Potentially Acid Forming (PAF) – A sample is usually defined as PAF when it has a positive NAPP and the NAG pH < 4.5. A sample classified as PAF always has a significant sulphur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material.

Process Water - Water out of the treatment plant which has chemicals in it.

Raw water - Fresh water that has not been used in the process and does not contain process reagents salts or fine particulates.

Recharge - Water added to an aquifer or other water body. An aquifer is recharged by precipitation in an area where the aquifer has a porous connection to the surface.

Recharge Area - The geographic area where water infiltrates into the ground and enters an aquifer.

Reduced Level (RL) – Elevation relative to a specific datum point.

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

Regional Ecosystem – Regional ecosystems were defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.

Relief - Variations in the height and slope of Earth's surface. Also used in reference to the vertical difference between the highest and lowest elevations of an area.

Remnant Vegetation – Remnant vegetation is defined in the Vegetation Management Act 1999 as vegetation shown on a regional ecosystem or remnant map. Woody vegetation is mapped as remnant where the dominant canopy has greater than 70% of the height and greater than 50% of the cover

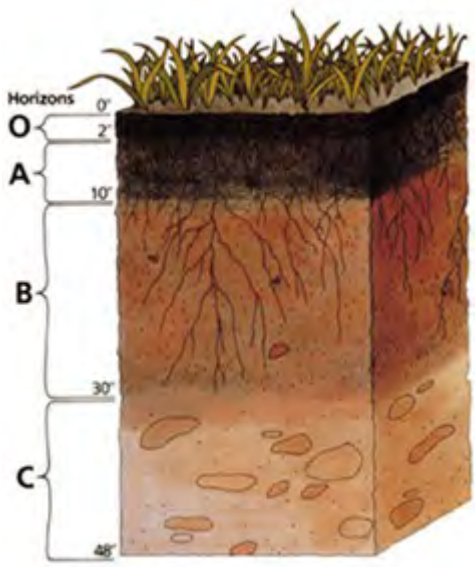
relative to the undisturbed height, and cover, of that stratum and dominated by species characteristic of the vegetation's undisturbed canopy. An undisturbed stratum (or layer) is defined as one that shows no evidence of extensive mechanical or chemical disturbance (logging, clearing, poisoning, etc.) evident in field inspections or on the available historical aerial photographic record.

Run of Mine - The unscreened output of a mine

Screening - Way of sizing crushed rock into different sizes by shaking them through different screens which have different sized holes or gaps. The crushed rock that passes through the screens is called the undersize.

Seed Bank – A store of viable seed buried and dormant in the soil or underwater sediments.

Soil Profile - Soil generally consists of visually and texturally distinct layers, which can be summarized as follows, from top to bottom:



O) Organic matter: Litter layer of plant residues in relatively undecomposed form.

A) Surface soil: Layer of mineral soil with most organic matter accumulation and soil life. This layer eluviates (is depleted of) iron, clay, aluminium, organic compounds and other soluble constituents. When eluviation is pronounced, a lighter coloured "E" subsurface soil horizon is apparent at the base of the "A" horizon.

B) Subsoil: Layer of alteration below an "E" or "A" horizon. This layer accumulates iron, clay, aluminium and organic compounds, a process referred to as illuviation.

C) Substratum: Layer of unconsolidated soil parent material. This layer may accumulate the more soluble compounds that bypass the "B" horizon.

Spillway – A weir, channel, conduit, tunnel, gate or other structure, designed to permit discharges from the reservoir when pondage levels rise above freeboard storage level; can include secondary, auxiliary, emergency spillways or fuse plugs.

Sterilisation Drilling – Drilling holes to test areas for prospective ore. If the results reveal low prospective zones, the area will be declared sterile and infrastructure, such as waste dumps and buildings, may be located in these sterile zones.

Stockpiles - Piles where ore that has been taken out of the pit and has been dumped. These are usually near the processing plant and away from the pit.

Stockpiling - Putting the ore and crushed ore into piles ready to be used.

Tailings – The solid residual material after the processing of ore.

Tailings Slurry - Tailings which is a mixture of fine mineral particles and water.

Tailings Storage Facility - An area used to confine tailings.

Topography - The shape of Earth's surface or the geometry of landforms in a geographic area.

Total Suspended Particulate (TSP) – Tiny airborne particles or aerosols that are less than 100 micrometers are collectively referred to as total suspended particulate matter

Total Suspended Solids (TSS) - refers to the identical measurement: the dry-weight of particles trapped by a filter, typically of a specified pore size.

Transformer - is an electrical device that transfers energy from one circuit to another by magnetic coupling with no moving parts. A transformer comprises two or more coupled windings, or a single tapped winding and, in most cases, a magnetic core to concentrate magnetic flux. A changing current in one winding creates a time-varying magnetic flux in the core, which induces a voltage in the other windings.

Uncertain Classification (UC) – UC is used when there is an apparent conflict between the NAPP and NAG results (i.e. when the NAPP is positive and NAG pH > 4.5; or when the NAPP is negative and NAG pH < 4.5). Uncertain samples require more detailed investigation, such as kinetic NAG or column leaching, to determine the acid potential.

Underground mining - Mining ore that is below the surface and deep in the ground. To reach this ore the miners use tunnels and shafts.

Waste Rock - the non-mineralised rock and/or rock that generally cannot be mined economically that is hoisted to the surface for disposal on the surface normally close to the shaft on an allocated dump.

Water Quality - An assessment of the physical, chemical and biological characteristics of water, especially how they relate to the suitability of that water for a particular use.

Water Table - A level beneath the Earth's surface, below which all pore spaces are filled with water and above which the pore spaces are filled with air. The top of the zone of saturation in a subsurface rock, soil or sediment unit

Windrowed – In the context of this EIS, windrowed refers to topsoil or earth graded into a line, or the collecting and piling of cleared vegetation to be left to dry before burning or for reuse.

Yield - The quantity of water or resource that can be produced from a deposit.

EXECUTIVE SUMMARY

PROJECT OVERVIEW

The Dugald River Project is located in north-west Queensland, approximately 65 kilometres north-west of Cloncurry and 85 kilometres north-east of Mount Isa. It is located adjacent and west of the proposed Roseby Copper Project. The Project will use conventional mechanised underground technology to mine zinc, lead, silver and copper. The mine production will be approximately two million tonnes per annum of ore for the zinc/lead/silver resource and one million tonnes per annum for the copper resource. Once full scale mining operations begin, the mine will run 24 hours a day, seven days a week.

The Project site boundary for the Environmental Impact Statement is approximately 3,426 hectares. Key infrastructure components include a processing plant, water storage dams, waste rock dumps, a tailings storage facility, access and haul roads and an accommodation camp.

PROJECT OBJECTIVES

The proponent for the Dugald River Project is Minerals and Metals Group Pty Ltd, which currently operates the Century, Golden Grove and Rosebery mining operations in Australia and the Sepon gold and copper operation in Laos in South East Asia. The company also has a large portfolio of advanced and early stage exploration projects through Australia, Asia and North America. Minerals and Metals Group Pty Ltd aims to develop the Dugald River Project into a world class zinc/lead/silver and copper underground mine with potential for future expansion to open cut copper mining.

Construction and commissioning of the Project is proposed to commence in early 2012 and be complete in approximately two years. The mine life of the Project is estimated to be in excess of 23 years.

It is estimated that the Project establishment costs will be in excess of $700 million.

PROJECT HISTORY

The Dugald River deposit was discovered in 1881 and has a long history of exploration and small scale prospecting and mining. The Project site currently consists of 33 existing Mining Leases, one Mineral Development Licences and one Mineral Development Licence Application.

Zinifex Australia Limited took control of the Mining Leases in 2004 and in addition to further exploration works, commenced environmental studies on the Project. An Application to Prepare a Voluntary EIS was granted by the Queensland Environmental Protections Agency (now known as the Department of Environment and Resource Management), and a draft Terms of Reference was advertised in April 2008. Following a period of public consultation, the Final Terms of Reference was handed down in August 2008. Zinifex Australia Limited subsequently underwent a merger with Oxiana Limited and became OZ Minerals Australia Limited.

Minerals and Metals Group Pty Ltd purchased the Project in June 2009 and is now the proponent for the Dugald River Project.

GEOLOGY AND RESOURCE

The Dugald River deposit is an example of a stra-bound base-metal deposit in a black shale environment. It forms part of a sedimentary basin within the Carpentarian Corella Formation (calc-silicate rocks). The geology of the Dugald River area is complex due to multiple deformation events and extensive faulting which has resulted in considerable truncation of the rock units. The rock consists of dolomite, quartzite, granofels, amphibolite, siltstone and shale. Tertiary and Quaternary sediments of the Dugald River are described as sand, gravel, silt and clay.

The Dugald River deposit is located within a three to four kilometre wide north-south trending high strain domain named the Mount Roseby Corridor. The Mount Roseby Corridor is bordered to the west by the Knapdale Quartzite and the east by the Mount Rose Bee Fault. The Knapdale Quartzite forms a prominent range of hills within the local area.

The zinc/lead/silver resource estimate defined for the Project totals 53 million tonnes (as of June 2009) at a cut off grade of 6% zinc. The average zinc grade of the ore is 12.5%, lead is 1.9% and silver is 36 parts per million. The Inferred copper resource defined for the Project totals 4.4 million tonnes (as of June 2010) at a cut off grade of 1% copper. The average copper grade is 1.8%, gold is 0.2 parts per million, cobalt is 147 parts per million and molybdenum is 50 parts per million.

MINING METHODS

The deep zinc/lead/silver and copper ore will be mined from underground by conventional mechanised methods (longhole open stoping). The mine will be approximately 1.6 kilometres along strike and 1,000 metres deep. It will be accessed by twin declines that will also be used to haul ore and waste from the mine in diesel powered trucks. All ore and waste will be drilled and blasted. The mine will be ventilated via five vertical shafts.

The twin declines will separate the mine into two distinct operating areas, the South Mine and the North Mine. Each area will have independent networks for ventilation, power, water and drainage and they will be joined by a single link drive approximately 300 metres below surface.

The South Mine is located in the thicker part of the orebody and will produce at a rate of 1,300 kilotonnes per annum and the North Mine, where the orebody is narrower will produce 700 kilotonnes per annum or ore.

Mined out voids will be backfilled with either rock fill, using waste rock, or paste fill, using process plant tailings.

PROCESSING

There will be a separate processing plant circuit for the zinc/lead/silver ore and the copper ore. The processing plant designs for each type of ore have a single processing line that includes a jaw crusher, stockpile conveyor, coarse ore stockpile, semi-autogenous grinding and ball mill grinding circuit, flotation circuits that include regrinding mills, concentrate dewatering, concentrate loading and tailings thickening facilities.

Processing of the zinc/lead/silver ore will be through a conventional flotation and concentrating plant producing 408,000 tonnes per annum of zinc/silver concentrate and 40,000 tonnes per annum of lead/silver concentrate. Processing of the copper resource will be through separate conventional copper concentrator circuit, producing 75,000 tonnes per annum of copper concentrate. Total concentrate production for the Project at full production is approximately 523,000 tonnes per annum.

The concentrates produced will be transported to smelting facilities in Australia and overseas.

WATER AND POWER SUPPLY

The raw water supply for the Project will be supplied from the Lake Julius / Ernest Henry pipeline. The pipeline passes to the north of the Project's Mining Leases. A take off point was included during construction of the line to allow water to be taken for future mining operations in the area around the Dugald River. Water on the Project will be conserved as much as possible by recycling stormwater run-off and decant water from the tailings storage facility to the process water tank. A series of dams and water storages are proposed as part of the Project's surface water management strategy.

Sediment ponds (for dirty/low toxicity water) collect runoff from the mine and contractor's workshops, the go-line, store and reagents shed, and the natural catchments between and around the portals. Dirty (low-toxicity) catchment areas have the potential to produce stormwater run-off that contains levels of suspended sediment and possibly hydrocarbons, and therefore these areas will be drained via sediment ponds which will discharge via a spillway. Discharge water monitoring will be conducted to measure compliance to any discharge criteria.

Significant hazard dams will collect runoff from the processing plant, concentrate storage area, the zinc and copper crushed ore stockpile, the copper run-of-mine pad and the south rockfill area. Significant hazard dams will be provided with high density polyethylene liners. These will be licensed as hazardous dams in the Project's Environmental Authority and therefore a suitable mitigation and control system will be put in place for their management.

High hazard dams collect runoff from the PAF/NAF waste rock dump, the off run-of-mine stockpile and the lead/zinc run-of-mine pad. High hazard dams will also be high density polyethylene lined, and will be licensed as hazardous dams in the Project's Environmental Authority and therefore a suitable mitigation and control system will be put in place for their management. These dams will have overflow spillways which will only be breached in emergency situations and after notification to the Department of Environment and Resource Management.

The main energy supply for the Project during the operational phase will be via the Mount Isa electricity grid system which is provided by gas fired power stations. Diesel generators will power the Project during the construction phase. Natural gas will also be used on the Project site in change rooms for water heating. Natural gas will be supplied to site by a local LPG supplier.

EXCAVATED WASTE

The main form of excavated waste created by the Project is waste rock from the underground workings. Waste rock is either categorised as non acid forming or potentially acid forming. Over the mine life approximately 77% of the waste rock produced by the underground mine will be non acid forming with 23% being potentially acid forming. Of the total waste rock mined, approximately 63% of all waste will be disposed of underground, leaving 37% to be stockpiled at surface.

During the construction phase of the Project, non acid forming waste rock material will be mainly used for constructing the run of mine pads and mine roads. Some non acid forming waste rock will also be used for encapsulating potentially acid forming material in a specifically designed waste rock dump. Potentially acid forming waste rock during the construction phase of the Project will be prioritised for disposal underground where possible, but as stoping will not have commenced underground, most of this material will be required to be disposed of to the surface. Potentially acid forming waste rock on the surface will either be encapsulated in a specifically designed waste rock dump or temporally stockpiled awaiting disposal underground.

The other excavated waste during the construction phase will be in the form of civil cut materials which will be removed from the stormwater dam and sediment pond areas at the mine and processing area during construction. This civil cut material will be non acid forming material and used for constructing the run-of-mine pads and mine roads during the construction phase.

During the operating phase of the Project, the majority of potentially acid forming waste rock will be prioritised for disposal underground as rock fill or co-disposed with paste fill. The remaining potentially acid forming waste rock will be encapsulated in a specifically designed waste rock dump on the surface, or temporarily stockpiled awaiting disposal underground. Non acid forming waste rock will be disposed of in surface waste rock dumps and used for encapsulating potentially acid forming waste rock or disposed of underground as rock fill or with paste fill. On mine closure the majority of non acid forming material remaining on the surface will be used in the rehabilitation of the tailings storage facility.

The PAF/NAF waste rock dump is the only place potentially acid forming waste rock will remain on the surface on mine closure. Stringent engineering and surface water drainage control will be employed in the construction of this dump to ensure that the generation of contaminated leachate is avoided or minimised and that no discharges occur to surface water or groundwater resources.

Stormwater drainage off the rehabilitated waste rock dump is expected to be non-contaminated due to the encapsulation strategy, although may contain levels of suspended sediment. Therefore the stormwater dam downstream of the waste rock dump will remain on rehabilitation to remove entrained sediment prior to stormwater discharge (which will only occur in extreme rainfall events).

TAILINGS

Tailings resulting from the processing plant will be disposed of to a purpose built tailings storage facility, to be located in a long, narrow bifurcated valley running north-south on the western side of the Knapdale Ranges. The valley is approximately 4 km north-west of the processing plant. Tailings containment is almost entirely provided by the valley topography. The Tailings Storage Facility will consist of a single large embankment on the western side, a down-valley discharge of tailings, and all decant and runoff water being stored centrally within the tailings impoundment (i.e. no secondary water storage pond). Tailings will be pumped up into the Knapdale Ranges from the process plant, running alongside the access road to the accommodation camp. A self-shedding profile will be developed for rehabilitation and closure.

Tailings characterisation testwork indicated that the tailing solids have a high pyritic sulfur content and a correspondingly high capacity for acid generation, and are therefore classified as potentially acid forming.

WORKFORCE AND ACCOMMODATION

During the initial construction phase of the Project the onsite workforce will be approximately 290 persons on site at any one. At peak production the Project will employ an on and off site workforce of approximately 795 workers across the mining, processing and administration fields. Of this workforce there will be approximately 264 – 396 persons accommodated on the Project site at any one time during the operational phase of the Project. Most employees will be on a fly-in-fly-out roster.

The accommodation camp will be located on a plateau on the Knapdale Range, and will have up to 766 rooms. The accommodation units will be clustered in groups of six. Six small laundries will be spread throughout the accommodation area, while the non-residential buildings and recreational facilities will be located on the eastern side of the village.

TRANSPORTATION

During the construction phase of the Project, the majority of equipment will be transported from Townsville via the Flinders Highway, Railway Street, Hensley Drive and then the Burke Developmental Road to the Project site or from Mount Isa, via the Barkly Highway and the Burke Developmental Road. Transport of equipment and materials will be via semi-trailer, low loaders, haul tankers and on occasion, escorted oversize trips on semi-trailers. Some equipment, such as tip trucks and fuel trucks will not require transport assistance and will make the journey as individual heavy vehicles.

Transport vehicles to be utilised in the operation of the Project will range from a fleet of four-wheel drive vehicles through to Quad trailer Road trains. Land Cruisers will service the majority of personnel movements required within the Project site. Coaster buses and coaches will move personnel between the Project site and Cloncurry airport. Triple Road trains, B-double Road trains, Single Trailer Trucks, and Single Trucks will be used to traffic supplies from Cloncurry, Townsville Port and Yurbi Rail Loading Facility. Haulage of concentrate between the on-site concentrating plants and the Yurbi Rail Loading Facility will be handled by 105 tonne capacity Quad Road Trains, which will be covered to prevent loss of concentrate and dust emissions.

REHABILITATION

On closure and decommissioning of the Project, it is proposed to return the majority of disturbed land to a condition similar to the pre-existing condition of low intensity grazing, native habitat or an agreed beneficial use.

The three main areas that will be disturbed on the main Project mining leases are the processing plant/mining area, the accommodation camp area and the tailings storage facility. Due to the potentially acid forming nature of the tailings, rehabilitation of the tailings storage facility will include a capillary break, a low permeability sealing layer and a water-shedding layer of waste rock as capping material. This will be covered with topsoil and revegetated with shallow-rooting native species.

The PAF/NAF waste rock dump will remain on mine closure, and will be rehabilitated using a compacted low permeability layer of waste rock, followed by a thicker layer of non acid forming, water-shedding waste rock. The top of the dump will be gently sloped to prevent water pooling on the surface.

Most of the stormwater dams, sediments ponds and roads on site will be returned to their pre-mining land use and suitability. The stormwater dam downstream of the rehabilitated waste rock dump will be retained to remove sediment from rainfall runoff from this permanent land form. The water pipeline and power transmission line will be retained on mine closure as this infrastructure may be of beneficial use to the region or future mining operations. The access road may also be retained through written agreement with the landholder.

EXISTING INFRASTRUCTURE

A water pipeline from Lake Julius to the Ernest Henry Mine passes above the northern portion of the Project Site in an east-west direction. This infrastructure is owned by the North West Queensland Water Pipeline Pty Ltd. The pipe runs underground, with some valve pits and outlet points along the cleared track that marks the course of the pipeline.

The Burke Developmental Road from Cloncurry to Normanton passes approximately eight kilometres to the east of the Project site, and is administered by the Department of Transport and Main Roads.

This road will be accessed to transport concentrate to Yurbi from the Project and supply goods and equipment to the Project.

The current site access route takes the road through several creek crossings, and the road condition is typical of natural formation roads in the area. The road crosses the Dugald River by ford and also crosses Silvermine Creek upstream of its confluence with the Dugald River.

The Project is situated near a corridor through which the now disused (and removed) Kajabbi Branch rail line passed. Initial contact with Queensland Rail indicated that the corridor (which is now classed as a 'Non rail Corridor') will be retained by the State as a future transport corridor and is not available for sale.

There is a drill cores shed, and a small exploration camp housing 25 people currently located on the Project site. Semi-permanent environmental monitoring devices are located throughout the Project site, including Rising Stage Samplers and Falling Stage Samplers (for collecting water samples) and dust deposition gauges.

LANDSCAPE CHARACTER AND VISUAL AMENITY

The Project site has undergone moderate changes since European settlement. On the eastern side of the Knapdale Ranges the pastoral lease holder has used the land for cattle grazing and much of the flatter grassland areas have been disturbed. The western side of the Knapdale Ranges appears to have had less grazing pressure (it is further from the pastoral station and associated cattle infrastructure). The Knapdale Range itself has had very little grazing pressure, most probably due to the slope and inaccessibility to cattle, hence the ranges being relatively undisturbed.

Overall the landscape character can be described as flat semi-grassed areas, undulating open woodlands with many rocky outcrops. The slopes of the Knapdale Ranges are dominant in the landscape and include a combination of rocky scree slopes and sheer rock walls. The Knapdales are sparsely vegetated mostly with Spinifex and Snappy Gum open woodland.

Due to the remote location of the Project, the lack of public viewing points and the distance of Project from public transport routes, the visual impact of the Project is unlikely to be of major concern to the general public. The only major public access road past the Project, the Burke Developmental Road, is approximately 10 kilometres to the east of the Project. The majority of the Project's infrastructure will not be visible from this road due to Mount Rose Bee forming a visual barrier along the eastern border of the Project site. The Knapdale Range borders the Project to the west and therefore provides a visual boundary on this side of the Project. There are no residences or public access roads in the region to the east of the Project.

The major features of the Project that will visible from a distance, mainly from the northern aspect of the Project and to some degree the south will be the processing facilities and the waste rock dumps. Processing facilities will be removed on decommissioning of the operations and therefore will only be a temporary addition to the landscape. Only one waste rock dump will remain at mine closure. Other inert waste rock material will be used to backfill the underground mine and also used in rehabilitation of the TSF.

The closest residence to the project site is the Mount Roseby Station (a pastoral homestead), which is located six kilometres southeast of the processing area. The Dugald River and its associated tall vegetation and a catchment divide should assist in shielding the majority of the Project from view from the homestead.

TOPOGRAPHY AND SOIL

The topography of the site is undulating with a dominant ridgeline, the Knapdale Range, running through the central portion of the Project site in a north-south direction. Immediately to the east of the Knapdale Range the topography forms gently sloping terrain which grades into the floodplain of the Dugald River. The Knapdale Range, which rises in steep, deeply dissected escarpments, forms the drainage divide between the Dugald River and Cabbage Tree Creek within the Project site. Mount Rose Bee is the other major topographic feature in the vicinity of the Project site, approximately two kilometres to the north-east of the Project boundary which rises to 285 metres above sea level.

Based on field and laboratory assessment, six soil types were observed to occur.

The following conclusions were made based on the results of the land suitability assessment:

- Three soil units Red Plain, Dale and Pocket, were found to have severe limitations for use as beef cattle grazing areas. The main limitations were the Plant Available Water Capacity and low nutrient levels. These soil types would require significant inputs to be productive and support pasture growth for cattle grazing. The input required would probably outweigh the benefit. It is noted that some of the Red Plain Soil Management Unit is currently used for very low intensity grazing, however the stocking rate of cattle decreases the closer the proximity to the Knapdale Ranges;

- The remaining three soil units, Knapdale, Miners and Prospectors, were found to have extreme limitations which preclude cattle grazing as a suitable land use on these soil management units. Again the main limitation of the soil is the Plant Available Water Capacity, however more practically, these areas could not be used for cattle grazing as they are extremely rocky and steep and do not support suitable pastures due to a lack of nutrients;

- All soil management units have been found to have extreme limitations precluding rainfed broadacre cropping as a suitable land use for the Project site. The obvious limitations are slopes, rockiness, topography and the limited Plant Available Water Capacity; and

- The lands contain some conservations values pre-mining, however nothing of significance that is not common in the wider area. Some areas on the Project site are disturbed from cattle grazing and exploration works that have already taken place, significant restoration of these areas would be required which is not feasible. The site is neither rare nor unique and would not warrant conservation as a primary land use.

All six soil management units identified on the Project site are non-sodic and thereby non-dispersive in nature, meaning they are not chemically predisposed to erosion. Most of the erosion potential on these soils originates from the short duration, high intensity rainfall events that can occur during the summer period.

In the areas of higher relief, the dominant soil types are Rudosols containing significant rock mulch cover, together with abundant rock outcrop. Although surface runoff from these areas may be rapid during high intensity rainfall events, the gravelly nature of the soils and the erosion resistant rock types limit the potentially high impact of surface sheet erosion and gullying.

The soil constituting the Red Plains Soil Management Unit is also characterised by a very low exchangeable sodium percentage, meaning that it is not chemically predisposed to erosion. These soils are also found on areas of lower relief on the Project site meaning that any surface flows are at a reduced rate as compared to the more sloped regions.

LAND CONTAMINATION

The Environmental Management Register and the Contaminated Land Register were searched for the properties underlying the Project site. These registers are maintained to enable identification of properties at risk of becoming contaminated due to Notifiable Activities being undertaken on them, or properties that are proven to be contaminated through scientific investigation. No land underlying the Project site was found to be listed on the Environmental Management Register or the Contaminated Land Register.

The Project will trigger three Notifiable Activities as described by Schedule 3 of the *Environmental Protection Act 1994*, which have the potential to cause land contamination. These relevant Notifiable Activities are:

- Mineral processing – chemically or physically extracting or processing metalliferous ores;
- Mine wastes – storage of hazardous mine or exploration wastes, including for example, tailings dams, overburden or waste rock dumps containing hazardous contaminants; or exploring for, or mining or processing minerals in a way that exposes faces, or releases groundwater, containing hazardous contaminants; and
- Explosive production or storage - operating a factory under the *Explosives Act 1999*. (An explosives factory means a place described in an explosives manufacturer licence where explosives are manufactured under the license).

ROADS AND TRAFFIC

The region is served by the National Highway 78 (Flinders Highway), which provides an east-west arterial traffic route connecting Cloncurry to the eastern Queensland coast at Townsville, passing through Hughenden and Charters Towers. The National Highway 66 (Barkly Highway) runs west from Cloncurry to Mount Isa, whilst the National Highway 83 (Burke Developmental Road) runs in a north-south direction connecting Cloncurry to Normanton in the north. The Railway Street/Hensley Drive bypass is a local government road developed to traffic heavy vehicles from the Flinders Highway to the Burke Developmental Road without travelling through the Cloncurry town centre.

The Project is expected to cause increases to traffic volumes on all roads, particularly the Burke Developmental Road. Ongoing consultation will be undertaken with the Department of Transport and Main Roads in the development of a Road Impact Assessment Report, to determine if specific mitigation measures are required.

Under the *Mineral Resources Act 1989*, the haulage plan proposed by the Project constitutes a *notifiable road use* as it exceeds an annual haulage rate of 50,000 tonnes. Under this arrangement, the mining tenement holder is liable to compensate the road authority for any cost, damage or loss it incurs, or will incur, which is caused by the notifiable activity. Arrangements between the Proponent and the respective road authorities, Department of Transport and Main Roads and Cloncurry Shire Council, need to be undertaken to satisfy this requirement.

WASTE

The main waste streams associated with the Project include waste rock, tailings, domestic waste, stormwater/process water, sewerage, scrap steel, batteries, oils and solvents and tyres.

The objective of the Project waste management strategy is to ensure the integrity of ecological processes and environmental values such as water and air quality, which may be impacted by the generation of waste materials from Project operations.

A Waste Management Plan will be developed prior to commencement of the Project which will detail and summarise exactly how each waste will be reused, recycled, disposed of or treated. This will be developed with respect to the *Environmental Protection (Waste) Policy 2000*, and will follow a four tiered waste management strategy according to practicalities and available markets, in preferential order:

- Waste minimisation;
- Waste reuse and/or recycling;
- Waste treatment; and
- Waste disposal.

WATER RESOURCES

Three major ephemeral drainage systems drain through the Project site and access areas:

- The southern and eastern sections of the Project site are located in the Dugald River catchment and within a number of its tributary catchments, including Silvermine Creek;
- The western and northern sections of the Project site are located in the Cabbage Tree Creek catchment and within a number of its tributary catchments, including Blackard Creek and Vieuex Rose Creek; and
- A significant portion of the mine access road from Burke Developmental Road is located within the Cattle Creek catchment.

Downstream uses of the regional surface water is limited to stock watering and aquatic habitat.

The groundwater in the vicinity of the Project site is alkaline and slightly brackish as a result of the influence of calc-silicate rocks and the arid environment in which the groundwater occurs. Groundwater in the vicinity of the Project is used for cattle watering.

The general principles for management of surface water are as follows.

- The fullest separation possible of ‘clean’, ‘dirty’ and ‘contaminated’ water runoff;
- Minimise the area of disturbance, thus minimising the volume of dirty or contaminated runoff;
- Contain all ‘dirty’ water on site (via sediment ponds) whenever possible. If not, release it in a controlled manner in compliance with adopted water quality criteria.; and
- Segregate, collect and contain all potentially contaminated water on site. If necessary pump this water to the tailings storage facility via the process plant without releasing it to the natural watercourses. This water will only be released downstream during an extreme rainfall event and after notification to the Department of Environment and Resource Management.

The following principles are recommended to minimise the impacts to groundwater resources:

- Chemical storage and handling areas will be bunded to contain accidental spills;
- Bulk petroleum products will be loaded and unloaded a designated area, which will include appropriate spillage management features in its design;
- A formal network of groundwater monitoring bores have been installed and these will be monitored on a regular basis;
- Minimal use of groundwater where practicable;
- No infrastructure that can cause groundwater contamination, will be constructed, or limited to only that which is absolutely necessary, in a corridor that extends 50 metres either side of Silvermine Creek and Tributary 'A";
- If there is any possibility of leachate runoff to these creeks, bund walls will be installed to divert flow to holding storage ponds for pumping back as processing water; and
- Surface runoff management ponds that contain waters classified as 'potentially contaminated' (either 'Toxic', or 'Sub-lethal') will be lined with a high density polyethylene liner.

Background sampling of both surface water and groundwater in the vicinity of the Project has been undertaken to establish a baseline for the area. Monitoring points have been established so that future monitoring can be compared with this baseline to determine if any impact or contamination may be occurring.

AIR

The area surrounding the Project is mostly uninhabited land with sparse vegetation and limited ground cover. The nearest residential dwelling is located approximately two and a half kilometres to the south-southeast of the Project boundary.

The major air quality issues and impacts that are commonly associated with underground mining activities and that are important for the Dugald River Project include:

- Emissions of oxides of nitrogen, carbon monoxide and fine particulates from the operation of diesel generators;
- Dust emissions associated with extracting and transporting large quantities of waste rock and ore and wind erosion of cleared areas and stockpiles. Dust emissions can result in elevated ground-level concentrations of dust, metals and dust deposition downwind;
- Dust emissions associated with the transport of ore via conveyor and stockpiling;
- Dust emissions associated with the crushing and milling processes at the ore processing plant producing the lead/zinc and copper concentrate; and
- Greenhouse gas emissions from fuel, electricity usage and waste disposed of in landfills.

Vehicle movements on-site will produce oxides of nitrogen, carbon monoxide, sulphur dioxide and fine particles. The emission rates of these air pollutants are unlikely to be large enough to cause adverse

air quality impacts at the nearest residence or to result in regional air quality problems such as acid rain or photochemical smog. No further assessment of these pollutants is necessary.

There are trace amounts of lead, manganese, nickel, arsenic and cadmium in the ore and waste rock. Whilst the emissions of the metals due to the Project are expected to be small, emissions of metals have been included in the air assessment for completeness.

Dispersion modelling was conducted assuming constant emission rates from all sources as detailed above and accounting for the range of atmospheric characteristics that are likely to occur over a twelve month period including worst-case meteorological conditions. Due to the proximity of the Project to the adjacent proposed Roseby Copper Project, the dispersion modelling accounted for the presence of this mining operation. The predicted cumulative dust and metal levels were compared against air quality goals/guidelines in order to assess the likely impact of the Project on air quality values. Key findings of the assessment include:

- The main sources of dust emissions from the mine will be from the stockpiles and the transport of ore and waste rock on haul roads;

- The contribution from the Dugald River Project to air pollutant concentrations at the location of sensitive receptors is predicted to be minor compared with background levels and the contribution from the Roseby Copper Project;

- There is compliance with the *Environmental Protection (Air) Policy 2008* objectives for predicted 24-hour and annual average ground-level concentrations of particulate matter (two and half microns), annual average ground-level concentrations of total suspended particulates and annual average dust deposition rates at the nearest homestead residence and the Roseby Accommodation Camp due to operations at the Dugald River Project, Roseby Copper Project and ambient background levels;

- The *Environmental Protection (Air) Policy 2008* objective for 24-hour average ground-level concentrations of particulate matter (ten microns) is predicted to be exceeded at the nearest homestead residence in the later years of the Roseby Copper Project when the Roseby Copper Project operations are closer to the location of the homestead. However, levels at the Roseby Accommodation Camp are predicted to comply with the *Environmental Protection (Air) Policy 2008* objective; and

- Predicted annual average ground-level concentrations of lead, arsenic, cadmium, manganese and nickel due to the Dugald River Project as an increment are well below the *Environmental Protection (Air) Policy 2008* objectives at the nearest homestead residence and the Roseby Accommodation Camp. Concentrations at these sites are unlikely to exceed the *Environmental Protection (Air) Policy 2008* objectives even with inclusion of a background level.

NOISE AND VIBRATION

The noise environment in which the Project is located is typical of rural regions of Australia, exhibiting relatively low minimum background noise levels during daytime, evening and night periods.

The nearest sensitive receiver to the Project is the Roseby homestead, located approximately six kilometres in a south-easterly direction. Due to separation distances, this is the only neighbouring residence that may potentially be impacted by noise from the Project.

Potential sources of noise from the Project, which may impact on the Roseby Homestead could include noise from:

- Light and heavy vehicles on the Project site and accessing the Project site;
- Hauling and dumping operations;
- Crushing; and
- Ore processing.

Noise modelling was undertaken to assess the likely noise impacts from the Project. Due to the proximity of the Project to the proposed Roseby Copper Project, the noise model included the effects of the adjacent operation. Two mining scenarios were assessed representing two stages of the Project life, accounting for different mining rates, as follows:

- Scenario 1: years 2014 to 2016 approximately two million tonnes of lead and zinc ore per year; and
- Scenario 2: years 2017 to 2031 an additional one million tonnes of copper ore per year.

In terms of the combined impact from this Project and the adjoining proposed Roseby Copper Project if both were operating simultaneously, the combined noise level is not predicted to exceed the proposed Project-specific noise limits proposed by the Department of Environment and Resource Management. Other non-project specific criteria may be exceeded under certain circumstances during evening and night times. Noise level predictions show that the World Health Organisation short-term event sleep disturbance goals and the night-time sleep annoyance goal are predicted to be met for all meteorological conditions at all receptors.

Strategies to minimise the impacts of noise on nearby sensitive receivers include:

Compliance with noise and vibration requirements will be managed by:

- Ensuring that mufflers fitted to mobile equipment are properly maintained;
- Undertaking continuous noise monitoring at the Mount Roseby homestead during construction and operations to determine compliance with the Project noise criteria; and
- Maintaining a complaints register during all phases of the Project and investigating all noise related complaints.

NATURE CONSERVATION

A total of seven vegetation communities inhabit the Project site with a total of 125 flora species identified. No flora species on conservation significance were identified, however six species are introduced.

One vegetation community on the Project site, known as River Red Gum Riparian Woodland, is listed as ‘Endangered’. Based on proposed disturbance plans for the Project and current infrastructure, minor additional clearing of this community will be required. Three communities, being the Gidgee Open Woodland, Silver Box/Cloncurry Box Open Woodland and the Mixed Bloodwood Riparian Woodland, are listed as ‘Of Concern’.

A combined total of 65 vertebrate fauna species were identified on the Project. Five species are listed as Migratory and/or Marine under the *Environment Protection and Biodiversity Conservation Act 1999*, however it is considered unlikely that the Project will have a significant impact on the regional populations of these species.

Mitigation strategies to manage the Project's potential impact on flora and fauna values include minimising vegetation clearance, developing a specific management strategy for the River Redgum Riparian Woodland Community and ensuring that appropriate erosion and sediment control strategies are in place to maintain the integrity of the existing habitat.

NON-INDIGENOUS CULTURAL HERITAGE

An independent Historic Cultural Heritage Assessment was undertaken to evaluate the non-Indigenous cultural heritage within the proposed mining development and associated infrastructure corridors. Studies determined that historically the area had been the focus of exploration, mining and pastoralism since the 1880s. With these developments came transport and trade demands which were met by an influx of Chinese and Afghan migrants. Gold prospecting also led to increase in Chinese immigration to the area. In 1908, Cloncurry was linked to Townsville by railway link. These historical activities are evident within the Dugald River Project site at a number of sites. No historical sites of cultural heritage significance sufficient to be of local significance or higher were noted within the area, however a number of sites indicating various phases of mining activity were located. These were mostly of low or no significance.

From a heritage perspective, the Project site contains, at best, low levels of local cultural heritage significance. However, management strategies will be implemented to avoid impacting on sites and places of significant where possible. This is particularly important during any clearing or Project development phases involving previously undisturbed areas.

INDIGENOUS CULTURAL HERITAGE

Two Native Title claimants groups have been recognised as owners of indigenous cultural heritage over the Project site and proposed power line corridor:

- The Kalkadoon People; and
- The Mitakoodi and Mayi People.

Several cultural clearance surveys were undertaken in the Project site by Pasminco and the Kalkadoon people in the past. More recently, the Kalkadoon people conducted surveys in the Project site to provide cultural clearance for exploration activities and the construction of the exploration camp. The potential impacts on indigenous cultural heritage sites on the Project are yet to be identified in detail. Minerals and Metals Group intends to engage the Kalkadoon people to conduct cultural heritage surveys to clear all areas required for the mining activities of the Dugald River Project. The surveys will be conducted in accordance with the Cultural Heritage Management Plan ahead of any disturbance in the Project site.

SOCIAL

The Project lies within the Cloncurry Local Government Area, which covers an area of approximately 48,000 square kilometres and encompasses the regional centre of Cloncurry as well as the smaller rural communities of Dajarra, Duchess, Kajabbi and Quamby. At the last census (2006) the Cloncurry Local Government Area had a population of 4,015. The most common family type was couples with no

children, and the percentage of Cloncurry residents in the labour force was higher than the state average. The main employment in the region is associated with mining, and mining-related industries.

The Dugald River Project site is surrounded by pastoral properties. The closest homestead is the Roseby Homestead, which lies two and a half kilometres to the south-east of the Project boundary. Other pastoral properties exist in the vicinity of the Project, with some owned/partially owned/operated by the owners of Roseby.

Minerals and Metals Group understands that its Dugald River Project has the potential to impact both positively and negatively on the local region. The company is, therefore, committed to working closely with all stakeholders to take advantage of or mitigate these impacts, so as to ensure sustainable development of the Project and the region. A community consultation process was initiated to allow the local community the opportunity to become informed and contribute to the development of the Project. A Social Impact Management Plan has also been proposed for the Project.

HEALTH AND SAFETY

The development of a mine involves a range of risks to the health and safety of employees and, in some instances, to those in the surrounding communities. The existing community values for public health and safety include that the Project be managed in a manner to prevent impacts on public health and prevent accidents both on the Project site and in the surrounding community. The Roseby Homestead is the closest of the sensitive receivers in the vicinity of the Project. The health and safety impacts associated with the development of the Dugald River Project on these receivers have been assessed and are considered negligible. Noise impacts are below the prescribed legislative limits under the *Environmental Protection (Noise) Policy 2008*. However, evening and night time noise levels under particular meteorological conditions do exceed the Department of Environment and Resource Management *EcoAccess Guideline - Planning for Noise Control*. Air impacts are below prescribed limits under the *Environmental Protection (Air) Policy 2008*, with one exception being a possible exceedance of one criteria in the later stages of the Roseby Copper Project when their operations are expected to be closest to the nearest sensitive receiver. The impacts of this exceedance on health and safety are considered minimal. The prescribed increase in vehicular traffic along major transport corridors may also pose a health and safety risk (or perceived risk) in Cloncurry.

A series of on-site and off-site mitigation strategies will be developed and employed to assist with the minimisation of health and safety risks associated with the proposed Dugald River Project. On-site these programs encompass, but are not limited to, comprehensive personnel training; the provision of support systems and infrastructure (through both health and support services); the provision of personal protection (through both procedures, maintenance and protective equipment requirements); and, monitoring and accountability. To ensure the health and safety of the surrounding community off-site strategies include, but are not limited to, road safety initiatives; noise and air quality monitoring as required; and, appropriate monitoring and management of site discharge points.

ECONOMIC

The regional economic climate is strongly focused on mining and agriculture. Within the Cloncurry Shire, approximately one third of the population is employed in the agriculture, forestry and fishing industries and the mining industry. Although pastoral activities have historically made a significant contribution to the local economy, the regional drought which has persisted over the last ten years has caused a significant decline in this industry. The local and regional decline in pastoral activities has been off-set by the productivity of the local mining industry, which is less susceptible to unpredictable rainfall events. Into the future, it is expected that the beef industry, mineral deposit exploration and alternate energy sources will be areas of economic opportunity.

The Project's construction will result in a positive input into the local, Queensland and Australian economy through the purchase of equipment, goods and services. During the 23 year long operating phase of the Project, industries associated with mining will be positively impacted through the provision of services, equipment and supply of consumables to the Project. The annual economic contribution is estimated to be $160 million in operating expenditure, $35 million in taxes and $14 million per year in royalties, subject to metal prices and production at the time.

HAZARD AND RISK

An assessment into the hazards and risks associated with the Dugald River Project was undertaken to identify the potential of specific impacts to occur before and after the implementation of mitigation strategies. This risk assessment compared the likelihood and consequence of a range of environmental and social risks associated with the development of the Project. The assessment identified several high and one extreme risk prior to the implementation of mitigation strategies. All risks, except for one, were re-ranked as either medium or low following the implementation of mitigation strategies. The highest risk following mitigation was associated with wall failure of the tailings storage facility. A situation which has major consequences but low likelihood and which mitigation strategies can not improve the outcome. Mitigation strategies improved the ranking of the six remaining medium risks which related to seepage or overflow from the tailing storage facility and associated contamination; off-site concentrate spillage; extreme rainfall events causing flooding; and processing plant machinery causing noise nuisance at the nearest sensitive receiver. Risks should be reassessed prior to construction and following any changes to the operation of the Project.

Dangerous goods information and a chemical inventory was compiled during impact statement process. A Spillage and Emergency Management Plan will be included in site induction and training programs for staff and contractors. The Spillage and Emergency Management Plan will include the use of best practice techniques to control, clean up and remediate any spills that may occur on the Project site.

1.0 INTRODUCTION

1.1 PROJECT PROPONENT

The Dugald River Project (the Project) is owned by Minerals and Metals Group (MMG). The contact details for the head office of the Proponent are as follows:

Proponent: Minerals and Metals Group Pty Ltd

Contact Person: Greg Martin – Principal Project Engineer

Proponent Address: Level 23, 28 Freshwater Place
Southbank Victoria 3006

Postal Address: PO Box 19421
Southbank Victoria 3006

1.2 PROJECT DESCRIPTION

The Dugald River Project is located approximately 65 kilometres (km) north-west of Cloncurry and 85 km north-east of Mount Isa (Figure 1.1). The Project is located adjacent and west of the proposed Roseby Copper Project.

The Project area currently consists of 33 existing Mining Leases (ML), one Mineral Development Licences (MDL) MDL79 and one MDL Application MDL393 (Figure 1.2). An Exploration Permit Minerals (EPM) EPM12163 underlies parts of the MDLs and MLs. A ML will be applied for in the near future over the area on which the Tailings Storage Facility (TSF) will be located, on MDL393. In addition, MLs for Transport will be applied for over the corridor areas where the proposed water pipeline, tailings pipelines and power transmission line will be located (Figure 1.3).

The Project site boundary for the Environmental Impact Statement (EIS) is approximately 3,426 hectares (ha) which includes the current MLs, MDL and MDL Application (Figure 1.4). The proposed water pipeline, tailings pipelines, power transmission line and access road corridors are additional to this area.

The zinc/lead/silver resource estimate defined for the Project totals 53.0 million tonnes (Mt) (as of July 2009) at a cut off grade of 6 percent (%) zinc. The average zinc grade of the ore is 12.5%, lead is 1.9 % and silver is 36 parts per million (ppm). The copper resource defined for the Project totals 3.4 million tonnes (as of June 2010) at a cut off grade of 1 % copper. The average copper grade is 1.8%, gold is 0.3 ppm, cobalt is 105 ppm and molybdenum is 60 ppm. Installation of the copper processing circuit will be subject to the successful proving up of sufficient resources from currently identified areas of copper mineralisation. Additional feed may also be sourced by toll treatment of third party ores.

The zinc/lead/silver and copper underground resources will be mined using conventional underground mining technologies. Two portals will be used to bring the ore to a run-of-mine (ROM) pad near the

processing plant. The mine production will be approximately 2 million tonnes per annum (Mtpa) of ore for the zinc/lead/silver resource and 1 Mtpa for the copper resource. Once full scale mining operations begin, the mine will run 24 hours a day, 7 days a week.

Processing of the zinc/lead/silver ore will be through a conventional flotation and concentrating plant producing 408,000 tonnes per annum (tpa) of zinc/silver concentrate and 40,000 tpa of lead/silver concentrate. Processing of the copper resource will be through separate conventional copper concentrator circuit, producing 75,000 tpa of copper concentrate. Total concentrate production for the Project at full production is approximately 523,000 tpa. The final concentrate products will be stored in a fully enclosed shed, prior to being transported off site.

The concentrates will be transported off site by covered quad road trains. Concentrate will be trucked from the Project site to BHP Billiton's Yurbi Rail Loading Facilities, east of Cloncurry. From here the concentrate will be transported 800 km by rail along the Mount Isa System to the Port of Townsville where it will be unloaded. MMG intend to negotiate a commercial agreement with BHP Billiton Cannington to expand capacity at their existing rail and port facilities to allow the storage and handling of the additional Dugald River concentrates. Therefore these facilities have been excluded from approvals under this EIS. Additional approvals will be sort for these facilities by BHP Billiton where required.

Waste rock from the underground operations will be disposed of either to surface waste rock dumps or backfilled underground. Some of the tailings from the processing plants will be treated via a paste fill plant and disposed of back underground. The remainder of the tailings will be piped for disposal to the on site TSF (Figure 1.4).

Dewatering of the mine will be required with a water inflow rate estimated at 6 litres/second (L/s). The mine dewatering system will be designed for 30 L/s, to allow for increased pumping during periods of high groundwater inflow, following high rainfall events. Water from the mine will be either passed through a clarifier/settling pond with a portion returned to a mine water intake tank or sent to the tailings thickener where it will be pumped to the TSF and returned to the process water stream via the decant return system.

The current Project site access road is the described ML access route for the Project, as required by the *Mineral Resources Act 1989*. The preferred access road for the Project is a proposal to modify the existing access road slightly to provide more direct access to the Burke Developmental Road at the eastern end, and the Project site at the western end. A deviation to the current access road, to the north around the Roseby Copper Project's Longumundi pit (Longumundi Deviation) may also occur in future if this pit is developed. An alternative to the preferred access road is located to the north of the existing access road and may be developed instead if required. Figure 1.4 shows the preferred access road, the Longumundi Deviation and the alternative access road.

Water for the Project will be sourced from the Lake Julius / Ernest Henry Pipeline, accessed via the existing take-off at the Green Hills valve station, which was designed for this purpose. Additional water will be reclaimed from the TSF and recycled from the processing plant. The average annual raw water requirement from Lake Julius for the Project will be 692 megalitres per year (Ml/y) which is an average rate of 86 cubic metres per hour (m^3/hr). The remaining plant water requirement will be met by recycling all water from the thickeners and filters and by reclaiming the maximum possible amount of water from the TSF. The amount of water available for reclaim from decant in the TSF will be dependent on rainfall, with an average annual supply of 549 Ml/y (average rate of 51 m^3/hr), although in years of low rainfall, there will be no water available for recycling from the TSF. In these low rainfall years, all raw water requirements for the Project will need to be supplied from Lake Julius, which will total 1,094 Ml/y (average rate of 136 m^3/hr).

The mine will be connected to the Mount Isa gas fired electricity grid via a 220 kilovolt (kV) line running south-east from the Project site and meeting the Chumvale Substation west of Cloncurry. The power requirements for the Project will be 33 megawatts (MW) of installed electrical power. During construction and commissioning of the Project power will be provided by on site diesel generators.

The construction of the Project and mine development is likely to begin in early 2012 and will take approximately 2 years, with production commencing in mid 2014. The Project's main construction phase will have seven discreet components. These components will be staged to a certain extent but will also be undertaken concurrently when appropriate. The major elements of the construction phase will be:

- Early works;
- Construction of the accommodation camp;
- Construction of the water supply pipeline;
- Mine Establishment;
- Lead/zinc/silver process plant construction;
- Power line construction; and
- Construction of the TSF.

As detailed above, the lead/zinc/silver processing plant will be constructed during the main Project construction phase. The copper processing plant will be constructed at a later date, which is expected to be during 2015

During the initial construction phase of the Project the on site workforce will be approximately 290 persons on site at any one time (590 in total including those rostered on and off). At peak production (lead/zinc/silver and copper) the Project will employ an on and off site workforce of approximately 795 workers across the mining, processing and administration fields. Of this workforce there will be approximately 264 – 396 persons accommodated on the Project site at any one time during the operational phase of the Project. Most employees will be on an 8 day on 6 day off Fly-In-Fly-Out (FIFO) roster. Employees will be mainly sourced from Brisbane, Townsville and Mount Isa. They will be flown to Cloncurry and bussed to site. Up to 20 employees will be sourced locally from Cloncurry, but this will vary depending on capacity of the local labour market.

Other major infrastructure required to be developed for the Project includes:

- An accommodation camp with approximately 502 - 622 rooms, with further capacity to expand to 766 rooms if required;
- Workshops and offices;
- Haul roads;
- Telecommunications infrastructure; and
- Process water, stormwater dams and sediment ponds.

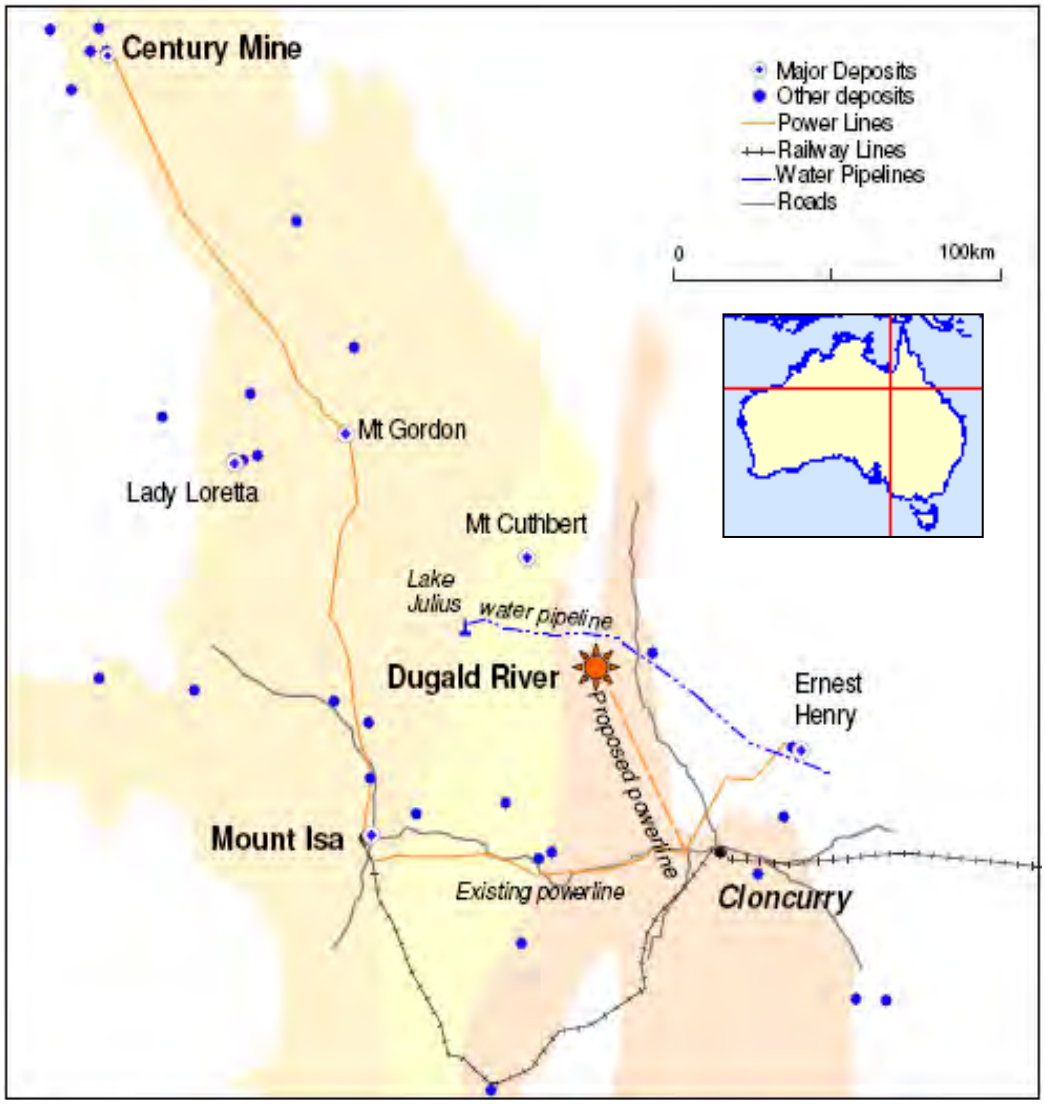
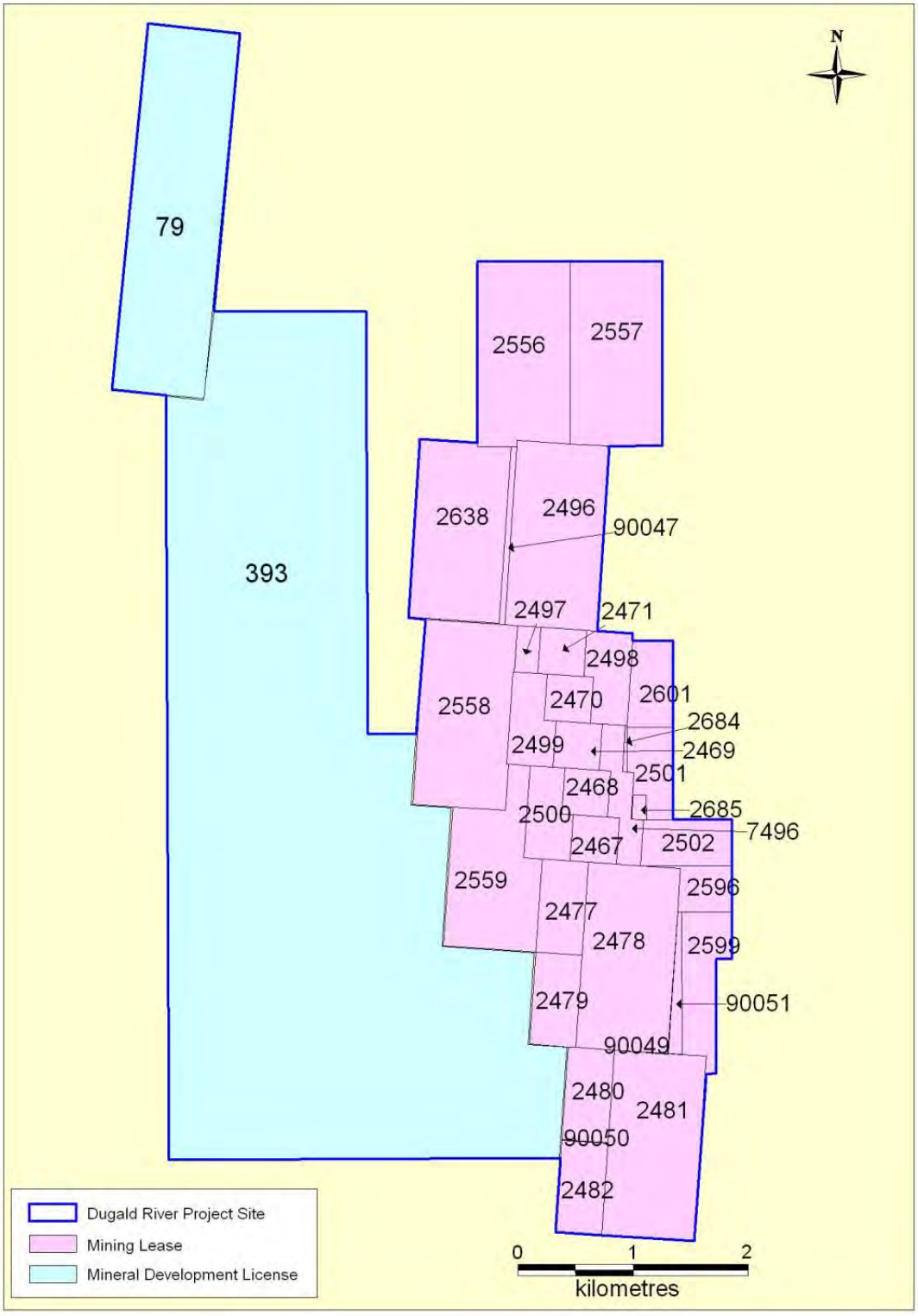


Figure 1.1 Regional Location of Project



Note: MDL393 is in the application stage only and not currently granted. EPM12163 underlies this tenure.

Figure 1.2 Project Tenements

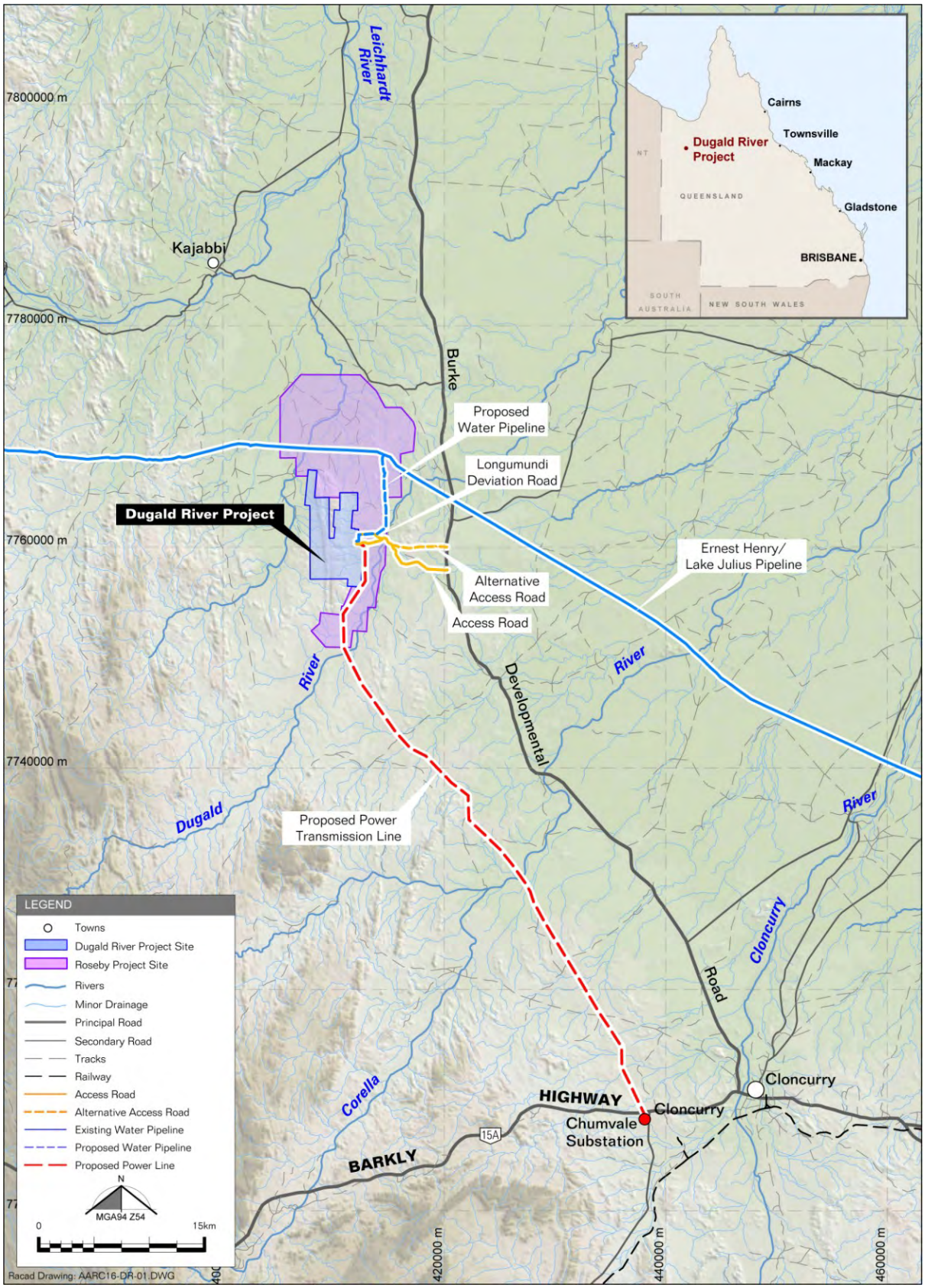


Figure 1.3 Major Corridor Infrastructure Layout

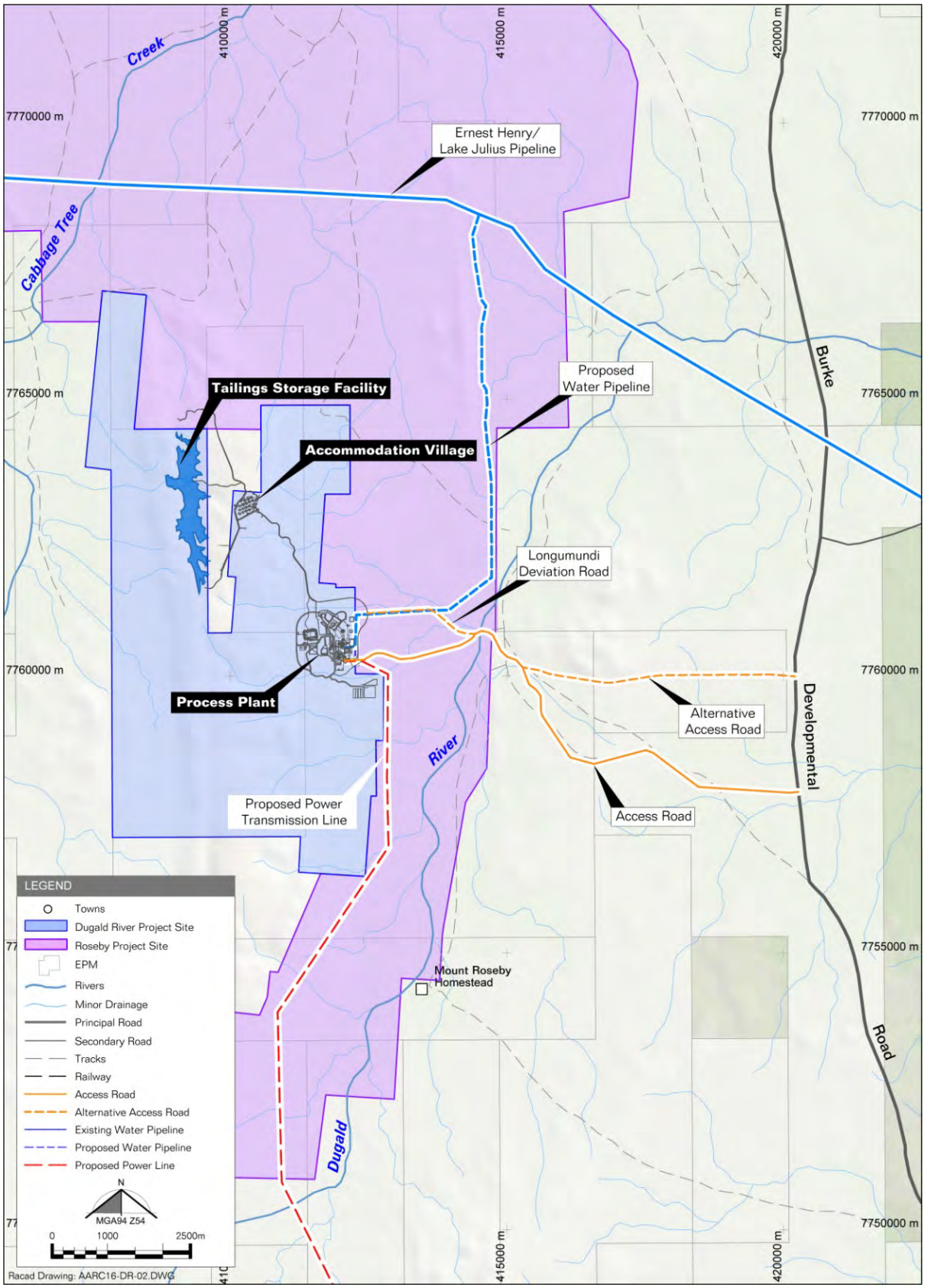


Figure 1.4 Project Layout

1.2.1 Environmental Studies

Environmental studies and assessments undertaken in developing the Project and included in this EIS are as follows:

- Terrestrial and Aquatic Flora and Fauna Impact Assessment (AustralAsian Resource Consultants Pty Ltd (AARC));
- Soil and Land Suitability Assessment (AARC);
- Surface Water Quality, Stream Morphology and Stream Sediment Report (AARC);
- Surface Water Assessment (WRM Water and Environment Pty Ltd);
- Groundwater Aspects (Rob Lait and Associates Pty Ltd);
- Air Quality Assessment (Katestone Environmental Pty Ltd);
- Greenhouse Gas Management Plan (AARC);
- Noise and Vibration Impact Assessment (ASK Consulting Engineers);
- Transportation Assessment (AARC);
- Historical Cultural Heritage Assessment and Management Plan (Converge Heritage and Community);
- Historical Cultural Heritage Assessment and Management Plan – Service Corridors (Converge Heritage and Community);
- Social and Economic Impact Assessment (AARC);
- Social Impact Management Plan (AARC);
- Assessment of the Geochemical Characteristics and ARD Potential of Waste Rock for the Dugald River Zinc, Lead and Silver Deposit (Environmental Geochemistry International Pty Ltd);
- Geochemistry and Column Leach Testing of Tailings (Environmental Geochemistry International Pty Ltd);
- Tailings Storage Facility Final Report – 2010 EIS Revision (ATCW Williams Pty Ltd);
- Final Landform and Rehabilitation Report (AARC);
- Environmental and Social Risk Assessment (AARC); and
- Development of Indigenous Cultural Heritage Agreements (MMG and Relevant Traditional Owner Groups).

The Project site has been subject to previous exploration and environmental studies prior to ownership by MMG. Environmental pre-feasibility studies were undertaken by Woodward-Clyde on behalf of CRA Exploration in 1991. Environmental data collected during these times, and more recently, has been added to the baseline dataset for the current EIS including dust deposition rates, water quality results, flora and fauna results, and soil types. Previous owners and their contribution to the existing dataset are described in Section 1.3.2.

1.3 PROJECT OBJECTIVES AND SCOPE

1.3.1 Background

The Dugald River Project falls within the Proterozoic Mt Isa Inlier, in the North West Mineral Province in Queensland, Australia. The Mt Isa Inlier is exceedingly rich in base and precious metals. The province contains one of the highest densities of base metal mineralisation in the world. It is host to several large developed and undeveloped mineral deposits, comparable to the best deposits within Australia and worldwide. The mineralisation in this area comprises a wide range of commodities, including particularly good deposits of copper, lead, zinc, silver, gold and uranium.

A selection of the more significant base and precious metal deposits within the Mt Isa Inlier is presented in Table 1.1.

Table 1.1 Significant Base Metal Resources of the Mt Isa Inlier (Australian Journal of Earth Sciences, 2002)

Deposit	Cu (Mt)	Au (Moz)	Zn (Mt)	Pb (Mt)
Cu-Au				
Mount Isa	8.41	-	-	-
Ernest Henry	1.85	2.9	-	-
Osborne	0.40	0.5	-	-
Zn-Pb-Ag				
Mount Isa	-	-	8.8	7.5
George Fisher	-	-	15.4	8.3
Cannington	-	-	1.9	5.1
Century	-	-	11.4	1.7

Note: Figures based on contained metal

The Project is located adjacent and to the west of the proposed Roseby Copper Project. The Roseby Copper Project has an approved EIS for the development of an open cut copper mine (3 – 4.5 Mtpa) producing 85,000 tpa of copper concentrate. The Project is currently awaiting final approval of its Environmental Authority (EA) and granting of MLs.

The Dugald River Project deposit is located on rural, regional, pastoral land which is also currently used for mineral exploration. The area has also been mined through small scale workings during the previous century. The Roseby Homestead is located approximately 2.5 km from the southern boundary of the Project. There is a small exploration camp located on the Project site itself which is utilised by MMG. Areas that are not suitable for cattle grazing or mineral exploration (such as the Knapdale Range) are relatively undisturbed and provide native habitat.

Grazing of cattle and mineral exploration/mining are currently the main feasible land uses for the Project site, especially given the high quality of the mineralisation and the history and culture of mining in the region. The consequences of not proceeding with the Project would be that a significant base metal resource would remain unutilised and royalties would not be realised for the State of Queensland.

1.3.2 Previous Studies and Development

The Dugald River deposit was discovered in 1881 and has a long history of exploration and small scale prospecting and mining. More recently, the Dugald River deposit has undergone several ownership transferrals. As such, several environmental studies have been undertaken over the last two decades. Environmental pre-feasibility studies were undertaken by Woodward-Clyde on behalf of CRA Exploration in 1991. Following this period, the Project was taken over by Pasminco Limited. Sinclair Knight Merz (SKM) produced an Environmental Management Overview Strategy in 1998 in preparation for the commencement of construction and mining activities on the Project site. Environmental monitoring reports were also prepared by SKM for the years 1998/1999, 1999/2000 and 2000/2001.

Zinifex Australia Limited took control of the MLs in 2004 and commenced further exploration on the Project site in 2008. Zinifex Australia Limited also commenced environmental studies and the current EIS process in early 2008. In August 2008, Zinifex Australia Limited underwent a merger with Oxiana Limited and became OZ Minerals Australia Limited. OZ Minerals completed a feasibility study of the Project and a preliminary draft EIS in early 2009. MMG purchased the Project from OZ Minerals Australia Limited in June 2009 and is now the proponent for the Dugald River Project. A review of the preliminary draft EIS and all baseline studies was commenced in April 2010 to ensure the Project description was current and that the EIS addressed current legislation and guidelines.

1.3.3 Project Objectives and Establishment

MMG operates the Century, Golden Grove and Rosebery mining operations in Australia and the Sepon gold and copper operation in Laos in South East Asia. MMG also has a large portfolio of advanced and early stage exploration projects through Australia, Asia and North America. MMG aims to develop the Dugald River Project into a world class zinc/lead/silver and copper underground mine with potential for future expansion to underground copper mining.

The approximate approval timeframe for the Project is described in Table 1.2. This timeline is based on statutory timeframes where they apply or estimated timeframes where no timeframe is applicable. As it can be seen from Table 1.2, final approval for the Project is predicted for November 2011.

Construction and commissioning of the Project is likely to commence in early 2012 and be complete in approximately 2 years. The zinc/lead/silver concentrator and circuit will be constructed first with the copper concentrator built several years later. The mine life of the Project is estimated at approximately 23 years plus.

It is estimated that the Project establishment costs will be more than $700 million.

Table 1.2 Project Approval Timetable

Project Approval Milestone	Status / Duration (months)	Date
Submission of Draft Terms of Reference (TOR)	*complete*	March 2008
Public Comment on Draft TOR	*complete*	April-May 2008
TOR Finalised and Published	*complete*	August 2008
Finalise Baseline Studies	*complete*	September 2010
Submit Draft EIS to DERM	*completed*	October 2010
DERM decide if Draft EIS meets TOR	2	December 2010
Public comment period on EIS	2	January – March 2011
Proponent response to public submission	1	April 2011
DERM decide whether or not EIS can proceed	1.5	May 2011
DERM Assessment Report on EIS	1.5	July 2011
Draft Environmental Authority (EA) issued	1	August 2011
EA and Mining Lease (ML) objection period	1	September 2011
DERM issues final EA (if no objections)	1	October 2011
Plan of Operations accepted and Financial Assurance paid	1	November 2011

1.4 THE ENVIRONMENTAL IMPACT STATEMENT (EIS) PROCESS

The *Environmental Protection Act 1994* (EP Act) provides the framework for the EIS approval process for mining activities.

The EIS process applies in the following circumstances (s37 EP Act):

1. An EIS requirement has been determined as part of the assessment level decision in relation to an application for an EA (Mining Activities); or

2. The voluntary preparation of an EIS for the Project has been approved by the Department of Environment and Resource Management (DERM).

An application for the voluntary preparation of an EIS for the Project has been approved by the DERM.

1.4.1 Methodology of the EIS

The EIS process that applies to the Project is described in DERM Guideline "*The EIS Process for Non-Standard Mining Projects*" (2003). A flowchart of the EIS process that has been undertaken so far and the process following submission of this Draft EIS is shown in Figure 1.5.

The EIS process commences when the proponent submits a Draft Terms of Reference (TOR) to DERM. The Draft TOR is advertised and made available to the public for review and comment. Submissions received during the comment period are considered by the proponent and relevant amendments made to the Draft TOR. A Final TOR is then issued by DERM, which forms the scope of the EIS. The EIS must be submitted to DERM within two years of receiving the Final TOR, unless a longer timeframe is agreed upon between DERM and the proponent.

Baseline studies and investigations are undertaken in preparing the EIS document and associated reports.

An Environmental Management Plan (EM Plan) is also submitted as part of the EIS document. The purpose of this document is to identify the environmental values of the Project site, propose control strategies to mitigate impacts on the identified values, and propose appropriate EA conditions for the Project.

Following submission of the Draft EIS, the DERM determines whether or not the EIS is acceptable and can proceed. This decision is based upon whether the EIS addresses the Final TOR and is in the appropriate form. Once allowed to proceed, the EIS is advertised and made available to the public for a period of time for review and comment. Submissions received during this period are provided to the proponent, who responds to each submission and amends the EIS where relevant or submits a supplementary EIS. DERM then prepares and provides to the proponent an assessment report on the submitted EIS.

Following the provision of the EIS assessment report, a draft Environmental Authority (EA) is issued by DERM for the Project. The draft EA is advertised and made available to the public for a period of time, during which anyone can lodge an objection to the draft EA. If there are no objections to the draft EA, it is made final.

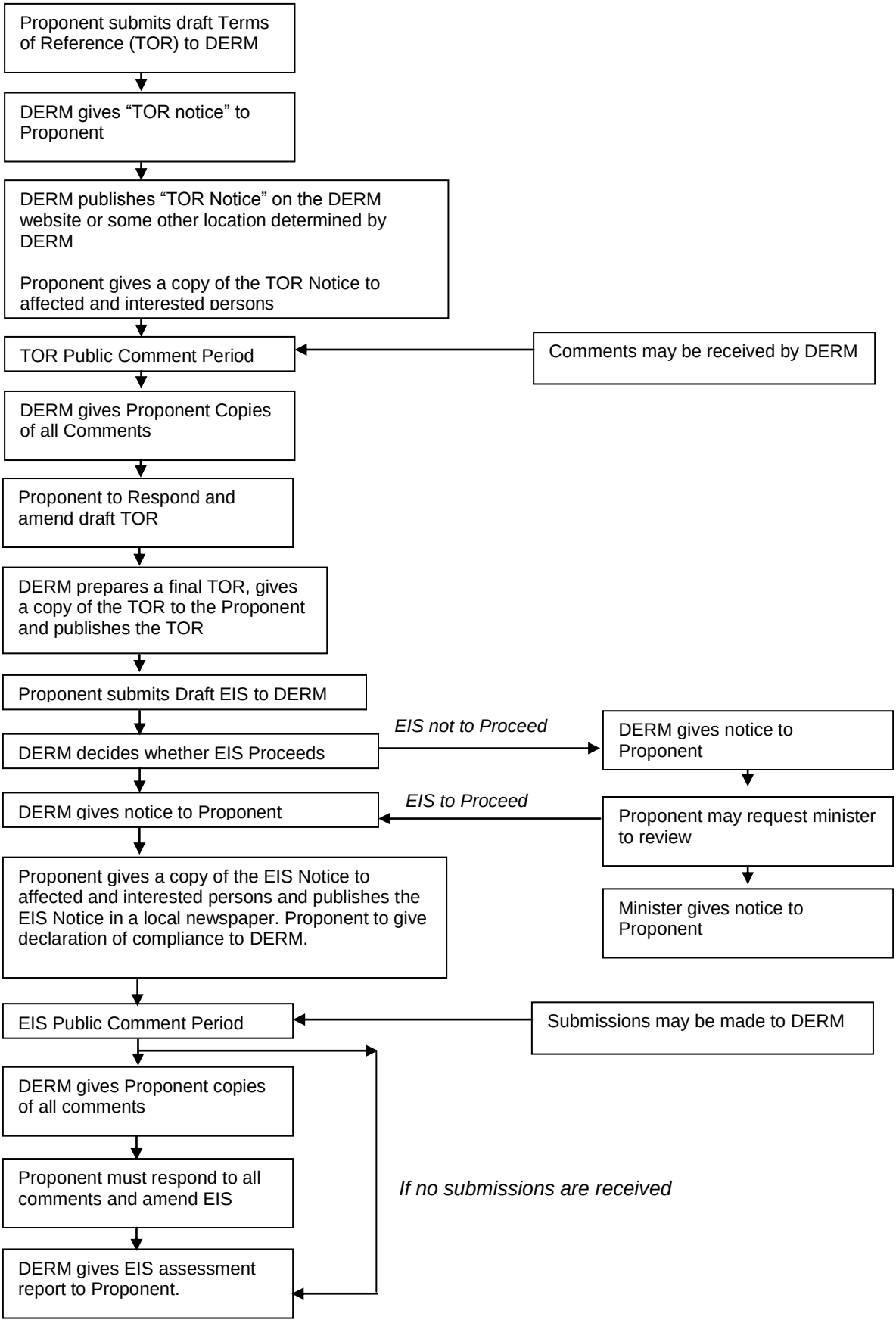


Figure 1.5 EIS Process

1.4.2 Objectives of the EIS

The primary objective of an EIS is to assess and address the identified adverse and beneficial impacts of a proposed Project on its natural, social and economic environment. In addition to this primary objective, it is the aim of the EIS to satisfy the information requirements of the general public, Affected and Interested parties and Advisory Bodies.

Broader objectives of the EIS also include:

- The EIS aims to be the key environmental document providing advice to decision makers considering approvals for the Project;
- This EIS process is designed to be flexible to allow for unseen or newly relevant information that warrants inclusion in the EIS document;
- The main text of the EIS will address all relevant matters concerning environmental values, impacts on those values and proposed mitigation measures. No relevant information will be raised for the first time in appendices or the draft EM Plan;
- Discussion of options and alternatives and their likely relative environmental management outcomes is a key aspect of the EIS;
- The EIS process will provide management measures that can be carried over into conditions in the draft EM Plan. These conditions will attach to any approval(s), environmental authorities and permits for the Project;
- The cumulative impacts of the proposal must be considered over time or in combination with other (all) impacts in the dimensions of scale, intensity, duration or frequency of the impacts. Cumulative impacts on the environmental values of land, air and water and cumulative impacts on public health and the health of terrestrial, aquatic and marine ecosystems will be discussed in the relevant sections;
- The EIS assessment may include air and water sheds affected by the proposal and other proposals competing for use of the local air and water sheds; and
- The EIS document will be written in plain English and will avoid jargon as much as possible.

The structure of the EIS document consists of the following sections:

1. Project Introduction – this section is a brief outline of the EIS process, the Project, the relevant legislation and guidelines.
2. Project Need and Alternatives – this section outlines alternatives to the Project itself and alternatives within the Project. The alternatives are discussed in relation to the framework of decision making including various factors in decision making like financial viability, practicality, materials, Ecologically Sustainable Development and Environmental Best Practice.
3. Project Description – this section outlines all facets of Project construction, operation and decommissioning. This is a detailed discussion.

4. Environmental Values and Management of Issues – this section provides all the environmental, social and economic baseline data along with mitigation and control strategies for any identified impacts.

5. Environmental Management Plan – this section is part of the EIS document but is also a stand alone management tool. This section provides all the proposed Environmental Authority conditions for management and monitoring of the environment in and around the Project site.

Within the EIS document, each impact identified is discussed and assessed in the following manner:

- The impact is discussed in terms of its nature and significance. Where appropriate, relevance to statutory requirements is also discussed;
- Appropriate targets or criteria are proposed as benchmarks for each impact;
- Proposed control methods or strategies for maintaining impacts within the proposed benchmarks;
- Where applicable, the control methods or strategies are related to statutory requirements; and
- Methods for validating performance for control methods or strategies are proposed, typically in the form of a monitoring program and auditing regime.

1.4.3 Submissions

After being notified by the DERM that the EIS can proceed, MMG must publish the EIS Notice and give a copy of the EIS Notice to each Affected and Interested party. The EIS Notice will state, among other things, where the Draft EIS may be inspected, how copies of the Draft EIS may be obtained, how to make a submission and the length of the submission period. The DERM sets the length of the submission period, which must be at least 20 business days. The approximate timing for when public submissions can be made on the Draft EIS is given in Table 1.2.

Anyone may make a submission to the DERM on the Draft EIS within the submission period. The submission does not need to be prepared by an expert and may relate to one or more aspects of the EIS. The only requirements of a submission to be accepted by the DERM and to gain standing for any appeals process, are that it must be received within the submission period and must be a “properly made submission”. A submission is considered to be properly made if it complies with the following criteria:

- It is written;
- It is signed by each person who made the submission;
- It states the name and address of each signatory;
- It is made to the chief executive of the DERM; and
- It is received on or before the last day of the submission period.

Submissions should be addressed to:

The Chief Executive

Attention: The EIS Coordinator –Dugald River Project

Department of Environment and Resource Management

PO Box 15155

City East QLD 4002

For further information regarding the EIS process for this proposal, contact Phil Rowland, EIS Coordinator by phone on (07) 3330 5602.

1.5 PUBLIC CONSULTATION PROCESS

During preparation of this EIS a community consultation process was undertaken to allow the community the opportunity to:

- Become fully informed of the Project status and the likely impacts of any development prior to approval;
- Express any concerns regarding current or planned Project activities and their environmental impacts; and
- Discuss, review and contribute to the formulation of the strategies proposed for the Project for mitigation of any potential adverse impacts that may arise.

A key component of the EIS preparation process has been the involvement of various Advisory Bodies and other stakeholders. Advisory Body and stakeholder consultation included meeting key stakeholders and Affected Persons one-on-one and addressing meetings of interested groups. This has included Traditional Owners, the owners of the Roseby Homestead, Department of Communities and the DERM.

Consultation with Traditional Owners over the Project site has occurred in order to put in place Cultural Heritage Management Plans (CHMP) with both the Kalkadoon and Mitakoodi. Consultation is ongoing with both of these parties in order to conduct indigenous cultural heritage assessments of the Project area and infrastructure areas.

The methodology used for consultation throughout the preparation of this EIS and contact details for all advisory bodies and stakeholders consulted is presented in Table 1.3 and Table 1.4 below and Appendix F, *Dugald River Project – Community Consultation Report*. Appendix F also includes a consultation database, which presents a comprehensive list of groups or individuals consulted, method of consultation, the issues raised, MMG's response to the issues and follow-up action to address the issues.

Table 1.3 Interested Persons

Name of Interested Person or Organisation	Relationship to Project	Contact Details
Southern Gulf Catchments Group	Member of the National Heritage Trust	Regional Coordinator PO Box 2211 Mount Isa Qld 4825 Phone: (07) 4743 1888
DERM – Cloncurry Regional Office	Administers leases, state land and natural resource planning	72 Uhr Street Cloncurry QLD 4824 Phone: (07) 4742 8222
Department of Transport and Main Roads North West District	Department responsible for roads, future roads and upgrades in the North West Region.	PO Box 338 Cloncurry QLD 4824
Cloncurry Justice Association	Administers community strategies in Cloncurry	Office 3/ 12 Ramsay St Cloncurry 4824 Phone: (07) 4742 0846
Department of Communities: Aboriginal and Torres Strait Islander Partnerships (Mt Isa)	Administers agreements and partnerships	52 Miles Street Mount Isa 4825 Phone: (07) 47447333
Department of Communities: Community Capacity and Service Quality	Liaison with local Indigenous groups	Suite 5b, Isa House Crn Camoweal and Mary Street, Mount Isa 4825 PO Box 1549 Mt Isa 4825 Phone: (07) 4743 3611
Sunwater	Possible supplier of water for the Project	6 Costin Street PO Box 1152 Mareeba, Qld, 4880 (07) 4048 4848
Ergon Energy	Potential construction of power transmission line that may be used as a source for the Project	PO BOX 308 Rockhampton Qld 4700
Copper String	Potential construction of power transmission line that may be used as a source for the Project	PO Box 7954 Garbutt, Townsville, QLD 4814 1 800 660 493
CS Energy	Potential supplier of electricity to the Project	Level 21 Central Plaza Two 66 Eagle Street BRISBANE QLD 4000 GPO Box 769 BRISBANE QLD 4001 Phone: (0) 3222 9333
Cloncurry Shire Council	Local Government in jurisdiction over the Project area.	Chambers 19, Scarr Street Cloncurry Qld 4824 Phone: (07) 4742 4100

Table 1.4 Affected Persons

Name of Affected Person or Organisation	Relationship to Project	Contact Details
North West Queensland Water Pipeline Pty Ltd	Holder of land on which a water pipeline is located just to the north of the Project. Also may be a supplier of water to the Project.	Lake Julius Cloncurry 4824 Phone: (07) 4742 5196
Harold Henry McMillan	Holder of land directly under the Project tenements and under the grid connection corridor. Leasehold: L2-4 BD56 : PH 13/3712 Urquhart Holding: Par Henry L6 GR33: (Non-specific) reserve 1: TL208859: Par Merkara L2577 PH139 : PH 13/2577 Yambani Holding: Par Knapdale L3692 PH2168: PH 13/3692 Carsland Holding: Par Henry, Knapdale, others	Mt Roseby Station Cloncurry Qld 4824 Phone: (07) 4742 5944
North Australian Pastoral Co Pty Ltd	Holder of land directly under the Project tenements. L59 TG40: PH 13/64 Coolullah Holding: Par Bivrambla	Level 11, 133 Mary St. Brisbane Qld 4000
Altona Mining Limited	These tenements are immediately adjacent to the main Project area: EPM10266, EPM8506, ML2654, ML90162, ML90163, ML90048, ML7497, ML90164. These tenements underlie the access road, the powerline and the water pipeline for the Project: EPM 8059, EPM8506, EPM13249, EPM10266, EPM 11611, EPM12493, EPM12121, EPM10833 ML2600, ML90163, ML 10964, ML90048, ML7497.	PO Box 1466 West Perth WA 6872 (08) 9486 8400
Kalkadoon #4 People	Native Title Claim over Project area.	C/- Michael Owens and Associates PO Box 1013, Townsville QLD 4810
Carpentaria Land Council Aboriginal Corporation	Aboriginal Representative group over the Project area.	31-33 Commercial Road Mount Isa, Qld 4825 Phone: (07) 4743 1322
Mitakoodi and Mayi People QC96/101	Native Title Claim over the Grid Connection Line area.	C/- Carpentaria Land Council 31-33 Commercial Rd Mount Isa Qld 4825 Phone: (07) 4743 1322

Name of Affected Person or Organisation	Relationship to Project	Contact Details
Cloncurry Shire Council	Local Government in jurisdiction over the Project area.	Chambers 19, Scarr Street Cloncurry Qld 4824 Phone: (07) 4742 4100
Queensland Rail	State Land lot 211 on SP136468	C/- Facilities Asset Manager PO Box 242 Hughenden Qld 4821
Jersey Plains Pastoral Company	Holder of land underlying grid connection corridor. Owner of Lot 521 on CP905413 (Chumvale Station) Holder of Lot 4144 on PH2265	PO Box 39 Cloncurry QLD 4824
Cameron Creek Pastoral Co PTY LTD (Hillside Station)	Holder of land underlying grid connection corridor. L3635 PH2175: PH 13/3635 Cameron Creek Holding: PAR Henry Alan Abdy – Station Owner Hillside Station	PO Box 18 Cloncurry QLD 4824
Anita Maree and Grant James Telford AS TTE	Holder of land underlying grid connection corridor. Dipvale Property LA AP6651:PO 216513: PAR Cirella & L4025 PH173:PH 13/4025 Dipvale Holding: PAR Corella	PO Box 424 Cloncurry QLD 4824
China Yunnan Copper Australia Limited	Holder of EPM15084 and EPM12205. These tenements underlie the proposed grid connection corridor and Project access road.	C/- Hetherington Exploration and Mining Title Services PO Box 13071 George Street Post Shop Brisbane QLD 4003 (07) 3303 0653
Exco Resources	The Holder of EPM 15740. This tenement underlies the proposed grid connection corridor.	PO Box 1726 West Perth WA 6872 (08) 9211 2000
Cudeco Limited	Owner of EPM 13049 and ML 90177. These tenements underlie or are adjacent to the proposed grid connection corridor.	Unit 34 Brickworks Annex 19 Brolga Avenue Southport QLD 4251
Elementos Limited	Applicant to EPM 18402. This tenement underlies the proposed grid connection corridor.	Level 1, 349 Coronation Drive Brisbane, QLD 4064 PO Box 1946 Milton, QLD 4064
Mount Isa Mines	The Holder of EPM12597, EPM8586, EPM14303. These tenements underlie the proposed grid connection corridor	C/- Exploration Manager Mount Isa Mines Locked Mail Bag 100 Mount Isa QLD 4825

Name of Affected Person or Organisation	Relationship to Project	Contact Details
Jamie Hacon – Manager Cubbaroo Station	Station within surrounding area of Project or power corridor	Hacon and Sons Pty Ltd Cubbaroo Station Cloncurry, QLD, 4824
Tom McMillan – Station Owner Jessievale Station	Station within surrounding area of Project or power corridor	TB & PL McMillan Jessievale Station Cloncurry QLD 4824 Phone: (07) 4742 5976
Mark McMillan – Station Owner Carsland Station	Station within surrounding area of Project or power corridor	AC & JA McMillan Carsland Cloncurry QLD 4824 Phone: (07) 4742 5912
Anthony McMillan – Station Owner Corella Park Station	Station within surrounding area of Project or power corridor	Anthony McMillan C/O Corella Station Cloncurry 4824 Ph 07 4742 0824
Dan Lynch – Property Owner Tara Station	Station within surrounding area of Project or power corridor	Dan Lynch Tara Station Cloncurry QLD 4824 Phone: 07 4742 5986

1.5.1 Relevant Legislation and Policy Requirements

Environmental legislation relevant to the Project includes:

- *Environmental Protection Act 1994;*
- *Environmental Protection Regulation 2008;*
- *Environmental Protection (Water) Policy 2009;*
- *Environmental Protection (Noise) Policy 2008;*
- *Environmental Protection (Air) Policy 2008;*
- *Environmental Protection (Waste Management) Policy 2000;*
- *Environmental Protection (Waste Management) Regulation 2000;*
- *Mineral Resources Act 1989;*
- *Sustainable Planning Act 2009;*
- *Water Act 2000;*
- *Water Regulation 2002;*
- *Water Resource (Gulf) Plan 2007;*

- *Environment Protection and Biodiversity Conservation Act 1999;*
- *Nature Conservation Act 1992;*
- *Nature Conservation (Wildlife) Regulation 2006;*
- *Vegetation Management Act 1999;*
- *Land Protection (Pest and Stock Route Management) Act 2002;*
- *Aboriginal Cultural Heritage Act 2003;*
- *Queensland Heritage Act 1992;*
- *Native Title Act 1993;*
- *Transport Infrastructure Act 1994;*
- *Fisheries Act 1994;*
- *National Greenhouse and Energy Reporting Act 2007; and*
- *Energy Efficiency Opportunities Act 2006.*

1.5.1.1 Environmental Protection Act 1994

The *Environmental Protection Act 1994 (*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 the ecological processes on which life depends.

The EP Act utilises a number of mechanisms to achieve its objectives in regard to mining activities. These include:

- Licensing or approving all Environmentally Relevant Activities (ERAs);
- Issuing Environmental Protection Policies (EPPs);
- Allowing for improvement through Transitional Environmental Programs; and
- Creating a general Environment Duty.

Under the EP Act, the DERM has assumed responsibility for environmental impact assessment, administration of environmental authorities, as well as compliance, auditing and monitoring of environmental management of mining.

Under the EP Act a proponent is required to prepare an EIS if the DERM or the Minister decides an EIS is appropriate for the mining project. The EP Act also provides for the proponent to prepare a voluntary EIS if it is considered the project may require an EIS. The proponent must apply to the DERM for approval to do so. MMG has applied to the DERM and been granted an approval to prepare a voluntary EIS.

The objective of the legislation is to give responsibility to the DERM for the assessment and decision-making on applications for EA mining activities and enforcement of the conditions of the authority. The holder of a mining tenement cannot carry out any mining activities on site unless those activities are authorised by an EA for the related tenement. Therefore, the applicant for the mining tenement must also apply for an EA. The Project currently holds a level 2 EA for mining leases that cover part of the Project area. MMG will as part of the EIS process apply for additional new mining leases and a new Level 1 EA for the Project.

If the EIS for the Project is approved, the EA will be issued with specific conditions relating to matters such as emissions control, maximum emissions levels (air, noise, vibration, water), waste management, monitoring and reporting. EA applications are assessed against the 'Standard Criteria' listed in the EP Act.

Section 319 of the EP Act established a duty for a person to take all reasonable and practicable measures for protecting the environment from harm when carrying out an activity that causes, or is likely to cause, environmental harm. The general environmental duty places a clear onus on operators of industrial sites to develop and implement measures for preventing environmental harm. The environmental mitigation strategies proposed within this EIS and the draft EM Plan are designed to prevent unauthorised environmental harm occurring on the Project site.

Section 147 of the EP Act defines a Mining Activity as an activity under the *Mineral Resources Act 1989* that is authorised to take place on land to which a mining tenement relates or land authorised under the *Mineral Resources Act 1989* for access to that land. This provision allows the access road for the Project to be approved in the same manner as activities on the Project site itself.

1.5.1.2 Environmental Protection Regulation 2008

The objective of the *Environmental Protection Regulation 2008* (EP Regulation) is to provide the basis for effective and efficient administration and enforcement of the object and provisions of the EP Act.

The EP Regulation sets out the criteria that define what constitutes a level 1 or 2 mining activity. Level 2 mining activities are lower risk activities which have comparatively less potential to cause environmental harm. Level 1 mining activities have a potentially greater risk of causing environmental harm. Schedule 6 of the EP Regulation advises how to calculate an aggregate environmental score for Level 1 mining activities. This score is emissions based and is used to calculate the annual fee for mining. In addition the EP Regulation defines ERAs which are specific activities that have the potential to cause an environmental impact.

Table 1.5 describes the activities proposed to be conducted on the Project, which would otherwise be ERAs as per Schedule 2 of the EP Regulation. Mining projects are covered separately under Schedule 6 of the EP Regulation and the Aggregate Environmental Score for the Project is shown in Table 1.6.

The ERAs and Aggregate Environmental Score for the Project are also described in the Draft EM Plan for the Project which is contained in Section 5.0 of this EIS.

Table 1.5 ERAs Associated with the Project

Environmentally Relevant Activity	Threshold	Aggregate Environmental Score
8. (3b) Chemical Storage	Storing more than 500 m^3 of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3	85
8. (4) Chemical Storage	Storing 200t or more of chemicals that are solids or gases, other than chemicals mentioned in items 1 to 3, under subsection (1)(d)	31
63.2(b) Sewage Treatment	Sewage treatment: >100 -1,500 equivalent persons	53
15. Fuel Burning	Fuel burning operation using equipment capable of burning at least 500kg/hr of fuel	35
17. Abrasive Blasting	Abrasive blasting – permanent location or mobile and temporary	16
31.2(b) Mineral Processing	Mineral processing: >100,00t/yr	280
43. Concrete Batching	Concrete batching: 200t/yr or more	30
60.1(d) Waste Disposal	Waste disposal facility (any combination of regulated waste, general waste and limited regulated waste – and <5t untreated clinical waste if in a scheduled area): >200,00t/yr	110
56.2 Regulated Waste Storage	Receiving and storing regulated waste (other than tyres)	21

Table 1.6 Mining Projects and their Aggregate Environmental Score

Item (Mining Activity)	Activity	Aggregate Environmental Score
Level 1 Mining Project	10. Mining lead, silver or zinc separately or in any combination	185
Level 1 Mining Project	9. Mining copper ore	217

1.5.1.3 Environmental Protection (Water) Policy 2009

The EP Act is the legislative document controlling the management of water in Queensland. As is the case with all EPPs, this legislation applies to government, industry and individuals. This legislation refers to the *Environmental Protection (Water) Policy 2009* (EPP (Water)).

Section 5 of the EPP (Water) states that the document's purpose is to provide a framework for:

> *(a) Identifying environmental values and management goals for Queensland waters;*
>
> *(b) Stating water quality guidelines and water quality objectives to enhance or protect the environmental values;*
>
> *(c) Providing a framework for making consistent, equitable and informed decisions about Queensland waters; and*
>
> *(d) Monitoring and reporting on the condition of Queensland waters.*

Section 6 and Scheduled 1 of the EPP (Water), detail the environmental values that may be enhanced or protected under the Policy, while Section 7 describes applicable water quality guidelines and indicators for Queensland.

As no environmental values for the protection of waters on or surrounding the Project site have been identified by Schedule 1 of the EPP (Water), this EIS has identified potential environmental values and appropriate water quality guidelines, objectives and indicators for the site. The water quality indicators may ultimately be used by DERM to set EA conditions for the Project in reference to receiving waters and any planned water discharges.

Section 4.4.1 of this EIS identifies applicable surface water and groundwater environmental values for the Project site, while Section 4.4.2 describes the proposed water quality monitoring programs and triggers and limits for the Project that may be used by DERM to set water quality indicators.

1.5.1.4 Environmental Protection (Noise) Policy 2008

The EP Act is the principal legislation in Queensland relating to environmental noise. This legislation refers to the Environmental Protection (Noise) Policy 2008 (EPP (Noise)).

Section 6 of the EPP (Noise) states the policy's purpose as:

> *(a) Identifying environmental values to be enhanced or protected; and*
>
> *(b) Stating acoustic quality objectives for enhancing or protecting the environmental values; and*
>
> *(c) Providing a framework for making consistent, equitable and informed decisions about the acoustic environment.*

Schedule 1 of the EPP (Noise) describes Acoustic Quality Objectives that may be applicable to the Project. As Site Specific Noise Criteria have been proposed by the DERM for the adjacent Roseby Copper Project for the nearest noise sensitive receiver, these criteria have been used when assessing the Project's noise impacts.

Section 4.6.1 of this EIS identifies the environmental values that are applicable to the Project under the EPP (Noise). Proposed Site Specific Noise Criteria and how the Project will meet these criteria are discussed in Section 4.6.2 of this EIS. The DERM may use these proposed Site Specific Noise Criteria to set EA conditions for the Project in reference to the nearest noise sensitive receiver.

1.5.1.5 Environmental Protection (Air) Policy 2008

The EP Act provides for the management of the air environment in Queensland. The legislation applies to government, industry and individuals and provides a mechanism for the delegation of responsibility to other government departments and local government and provides all government departments with a mechanism to incorporate environmental factors into decision-making.

The EP Act gives the Minister of the DERM the power to create EPPs that identify and aim to protect environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity. The EP Act refers to the Environmental Protection (Air) Policy (EPP (Air)) which was re-issued in 2008.

Section 6 of the EPP (Air) states that the policy achieves it purpose by:

> *(a) Identifying environmental values to be enhanced or protected; and*
>
> *(b) Stating indicators and air quality objectives for enhancing or protecting the environmental values; and*
>
> *(c) Providing a framework for making consistent, equitable and informed decisions about the air environment.*

The administering authority must consider the requirements of the EPP (Air) when it decides an application for an EA or amendment, or approval of a draft EM Plan. Schedule 1 of the EPP (Air) specifies air quality indicators and objectives for Queensland.

Section 4.5.1 of the EIS details the air quality environmental values that are applicable to the Project from the EPP (Air). Indicators and objectives from the EPP (Air) that are relevant to the Project and how they will be met is presented in Section 4.5.2.2 of this EIS. The DERM may use the air quality indicators and objectives to set EA conditions for the Project in reference to the nearest sensitive receiver.

1.5.1.6 Environmental Protection (Waste Management) Policy 2000

Section 3 of the EP Act lists the aims of the act as 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 the ecological processes on which life depends (ecologically sustainable development).'* The *Environmental Protection (Waste Management) Policy 2000* (EPP (Waste Management)) is designed to help achieve the purpose of the EP Act.

The EPP (Waste Management) aims to enhance and/or protect environmental values. This is to be done through the preparation of waste management programs, guidance for the preparation of industry waste reduction programs, and aiding government planning for waste management.

Section 7 of the EPP (Waste Management) states:

The environmental values to be enhanced or protected under this policy are:

> *(a) The life, health and wellbeing of people;*
>
> *(b) The diversity of ecological processes and associated ecosystems; and*
>
> *(c) Land use capability, having regard to economic considerations.*

Integral to the EPP (Waste Management) is the waste management hierarchy which is described in Section 10 of the EPP as:

- Waste avoidance;
- Waste re-use;
- Waste recycling;
- Energy recovery from waste; and
- Waste disposal.

Under Section 19 of the EPP (Waste Management) the DERM may impose a condition on the EA for the Project that a Waste Management Program needs to be developed for the Project within a specified timeframe.

Section 4.3.1 of this EIS describes the environmental waste management values that are applicable to the Project from the EPP (Waste Management) and the main waste types to be produced by the Project. Section 4.3.2.1 of this EIS describes the waste management strategy for the Project and how the Project will implement a waste management plan which will be developed in accordance with the waste management hierarchy as stated in Section 10 of the EPP (Waste Management). How the Project addresses the principals of *Cleaner Production* as described under the EPP (Waste Management) is described in Section 4.3.2.2 of this EIS.

1.5.1.7 Environmental Protection (Waste Management) Regulation 2000

The *Environmental Protection (Waste Management) Regulation* 2000 (EP (Waste Management) Regulation) aims to protect the environment by:

> *(a) Minimizing the impact of waste on the environment including, in particular, the impact of waste so far as it directly affects human health; and*
>
> *(b) Establishing an integrated framework for minimizing and managing waste under the principles of ecologically sustainable development.*

The EP (Waste Management) Regulation allows for the DERM to authorise waste disposal of certain wastes at a facility as part of conditions of an EA. Part 4 of the Regulation deals with Waste Tracking provisions for wastes deemed as Trackable Waste (under Schedule 1 of the Regulation). Wastes produced by the Project that need to be removed from the Project site, that are listed as Trackable Waste under the Regulation, will need to meet the Waste Tracking provisions detailed by the Regulation.

Section 4.3.2.3 of this EIS includes a commitment to manage Trackable Wastes removed from the Project as per the provisions of the EP (Waste Management) Regulation.

1.5.1.8 Mineral Resources Act 1989

The *Mineral Resources Act 1989* (MR Act) provides for the authorisation of mining tenures in the form of Prospecting Permits, Mining Claims, Exploration Permits, Mineral Development Licenses and Mining Leases.

The Project already holds numerous Mining Leases, and a Mineral Development Licence and Mineral Development Licence Application over the Project area. As part of this EIS process MMG will be applying for new Mining Leases where required to cover on site activities and infrastructure corridors (refer to Section 3.3.1 of this EIS).

The principal objectives of the MR Act are to:

> *(a) Encourage and facilitate prospecting and exploring for and mining of minerals;*
>
> *(b) Enhance knowledge of the mineral resources of the State;*
>
> *(c) Minimise land use conflict with respect to prospecting, exploring and mining;*
>
> *(d) Encourage environmental responsibility in prospecting, exploring and mining;*
>
> *(e) Ensure an appropriate financial return to the State from mining;*
>
> *(f) Provide an administrative framework to expedite and regulate prospecting and exploring for and mining of minerals;*
>
> *(g) Encourage responsible land care management in prospecting, exploring and mining.*

Section 319 of the MR Act states that the Sustainable Planning Act does not apply to any development authorised under the MR Act. Therefore Development Approvals under the *Sustainable Planning Act 2009* will not be required on the Project for activities that are authorised on a mining tenure. The exception to this is any approvals required for a Registered Place under the *Heritage Act 1992* or approvals required under the *Building Act 1975*.

Part 7A of the MR Act deals with Notifiable Road Use which relates to the transport of minerals from a mining tenement on State Controlled roads (or other roads) for quantities greater than that stated in this Section 318EO of the Act. The proponent must notify the road authority if they will be carrying out a Notifiable Road Use and compensation may be payable to the road authority for any cost, loss or damage to the roads. The Project will trigger the Notifiable Road Use provision under the MR Act and this is discussed in Section 4.2.2.8 of this EIS.

Part 9 of the MR Act details the payment of Royalties to the Crown from mining of minerals on a mining tenement. MMG will be required to pay Royalties for the mining of the minerals on the Project and this is discussed in Section 2.1 of this EIS.

Part 17 of the MR Act describes the Native Title provisions that are required on Mining Leases. The Project will be required to address these provisions with Native Title Claim proponents and the relevant claim details are described in Section 4.2.1.7 of this EIS.

1.5.1.9 Sustainable Planning Act 2009

The purpose of the *Sustainable Planning Act 2009* is to seek to achieve ecological sustainability by:

(a) Managing the process by which development takes place, including ensuring the process is accountable, effective and efficient and delivers sustainable outcomes;

(b) Managing the effects of development on the environment, including managing the use of premises; and

(c) Continuing the coordination and integration of planning at the local, regional and State levels.

Section 232(2) of the *Sustainable Planning Act 2009* legislates that the *Sustainable Planning Regulation 2009* may define development that is not covered by the Act. Schedule 4 Table 5 Items 1 and 2 of the *Sustainable Planning Regulation 2009* defines that activities authorised under the MR Act or mining activities subject to an EA under the EP Act are not declared to be a development under the *Sustainable Planning Act 2009*. Should any development be proposed on areas off the Mining leases, the above exemptions would not apply and a development application would be required.

Mining Leases are proposed to cover all mining related activities on the Project site and Mining Leases for Transport will be applied for over the proposed Power Transmission Line corridor, water pipeline and tailings pipelines and therefore these activities do not require a development application. The designated Project access road is deemed to be part of the Mining Activity authorised under the MR Act and EP Act for the Project and therefore would also be exempt from the *Sustainable Planning Act 2009.*

1.5.1.10 Water Act 2000 and Water Regulation 2002

The purpose of the *Water Act 2000* is to provide for the sustainable management of water and other resources and the establishment and operation of water authorities, and for other purposes.

Section 5 of the *Water Act 2000* defines a watercourse as:

> *(1) a river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow event;*
>
> *(a) in a natural channel, whether artificially modified or not; or*
>
> *(b) in an artificial channel that has changed the course of the stream.*
>
> *(2) A watercourse includes any of the following located in it:*
>
> *(a) in-stream islands;*
>
> *(b) benches;*
>
> *(c) bars.*
>
> *(3) However, a watercourse does not include a drainage feature.*

Under Part 6 of the *Water Act 2000* the holder of a Mineral Development License or Mining Lease may apply for a water license for the taking or interfering with the flow of water from a watercourse, lake, spring, aquifer, or water flowing across land. The main water supply for the Project will be sourced from the Lake Julius / Ernest Henry Pipeline and therefore groundwater production bores on the Project will not be required. The volume of water produced from mine dewatering of the underground workings is predicted to be not significant at this stage (see Sections 3.5.3.2 and 4.4.1.2 of this EIS). Should further investigations determine that mine dewatering bores are required, then applications for Water Licences under the *Water Act 2000* will be required.

A Water Licence for the taking or interfering with water in a watercourse is not thought to be required for the Tailings Storage Facility as this facility will be built at the head of a catchment within a valley which is drained by an unnamed drainage feature. This facility and the other stormwater dams on the Project will be licensed as hazardous dams (regulated dams) as part of the EA for the Project.

Part 8 of the *Water Act 2000* deals with the granting of permits for destroying vegetation, excavating or placing fill in a watercourse, lake or spring. Under Section 266 (4) (iii) of the *Water Act 2000*, the holder of a mining tenure under the MR Act may destroy native vegetation, excavate or place fill in a watercourse, lake or spring if the activities are necessary for, and associated with, mining operations within the area of the tenure. Section 49 of the *Water Regulation 2002* states that destroying vegetation in a watercourse, lake or spring is permitted if the destruction is carried out under a EA (Mining Activities) under the EP Act. Therefore works associated with constructing creek crossing on the Project tenements will not require Riverine Protection Permits. The service corridors for the Project will also be covered by Mining Leases for Transport (Power Transmission Line, Water Pipeline and Tailings Pipelines) and therefore will also be exempt from Riverine Protection Permits. Likewise the access road to the Project is deemed part of the Mining Activities for the Project (see Section 1.5.1.1 of this EIS) and would therefore also be exempt.

1.5.1.11 Water Resource (Gulf) Plan 2007

The purposes of the *Water Resources (Gulf) Plan 2007* (WR (Gulf) Plan) are:

> *(a) To define the availability of water in the plan area;*
>
> *(b) To provide a framework for sustainably managing water and the taking of water;*
>
> *(c) To identify priorities and mechanisms for dealing with future water requirements;*
>
> *(d) To provide a framework for establishing water allocations to take supplemented surface water;*
>
> *(e) To provide a framework for reversing, where practicable, degradation that has occurred in natural ecosystems;*
>
> *(f) To regulate the taking of overland flow water;*
>
> *(g) To regulate the taking of groundwater.*

The volume of water produced from mine dewatering of the underground workings on the Project is predicted to be not significant at this stage (see Sections 3.5.3.2 and 4.4.1.2 of this EIS). Should further investigations determine that mine dewatering bores are required, then applications for Water Licences under the *Water Act 2000* will be required. The allocation of the Water Licences would need to be consistent with relevant allocations as detailed by the WR (Gulf) Plan. Measuring devices would

need to be installed on all mine dewatering bores to measure the annual volume of water taken as required by the WR (Gulf) Plan.

A Water Licence for the taking or interfering with water in a watercourse is not thought to be required for the Tailings Storage Facility as this facility will be built at the head of a catchment within a valley which is drained by an unnamed drainage feature. This facility and the other stormwater dams on the Project will be licensed as hazardous dams (regulated dams) as part of the EA for the Project.

1.5.1.12 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) identifies and provides protection for Matters of National Environmental Significance. It streamlines national environmental assessment and approval processes, protects Australian biodiversity and integrates management of important natural and cultural places.

Under the EPBC Act 1999 an action will require approval from the Federal Environment Minister if the action has, will have, or is likely to have a significant impact on a Matter of National Environmental Significance, where a Matter of National Environmental Significance is:

- World Heritage properties;
- National Heritage Places;
- RAMSAR wetlands of international importance;
- Listed Threatened species and communities;
- Migratory species protected under international agreements;
- Nuclear Actions; and
- The Commonwealth marine environment.

Permits are required under the EPBC Act 1999 for:

- Certain activities in Commonwealth reserves;
- Activities that affect listed or threatened species and communities;
- The import and export of wildlife; and
- Activities involving protected species in the Territories of Christmas Island, Cocos (Keeling) Islands and Coral Sea Islands.

The Project is unlikely to impact on Matters of National Environmental Significance and has not been referred to the Department of Environment, Water, Heritage and the Arts. An assessment of the possible occurrence of Listed Threatened species and communities, and Migratory species on the Project is detailed in Section 4.7 of this EIS.

Consequently, the Queensland EIS process will not be accredited for the assessment of the Project under Part 8 of the *Environmental Protection and Biodiversity Conservation Act 1999.* In the unlikely event that at a later date it is found necessary to refer the Project to the Commonwealth and it is

declared a controlled action, impacts on the Matters of National Environmental Significance will be assessed under a separate process.

1.5.1.13 Nature Conservation Act 1992 and Nature Conservation (Wildlife) Regulation 2006

The most relevant portions of the *Nature Conservation Act 1992* (NC Act 1992) to the Project are the sections which pertains to Wildlife and Habitat Conservation. The classes of wildlife[1] to which the NC Act 1992 applies includes protected wildlife, which is defined as:

- Presumed extinct wildlife;
- Endangered wildlife;
- Vulnerable wildlife;
- Near Threatened wildlife; and
- Least Concern wildlife.

Species listed under the above classes are published in the associated *Nature Conservation Wildlife Regulation 2006* (NCWR 2006).

The NC Act 1992 defines 'threatening processes' as:

a) Threatening the survival of any protected area, area of major interest, protected wildlife, community of native wildlife or native wildlife habitat; or

b) Affecting the capacity of any protected area, area of major interest, protected wildlife, community of native wildlife or native wildlife habitat to sustain natural processes.

The NC Act 1992 is relevant to the Project should any flora or fauna species of conservation significance, as detailed in the NCWR 2006, be found on the Project. No flora or fauna species of conservation significance have been found on the Project site itself and this is discussed further in Section 4.7 of this EIS. One species of conservation significance, the Purple-necked Rock-wallaby was found to occur in close proximity to the proposed power transmission line alignment. This species occurrence and proposed mitigation strategies are described in Section 4.7 of this EIS.

1.5.1.14 Vegetation Management Act 1999

The *Vegetation Management Act 1999* (VM Act) was proclaimed as part of a planning framework for the management of native vegetation across Queensland. The *Vegetation Management Regulation 2000* (VMR) prescribes the status of each of the Regional Ecosystems identified to occur within Queensland.

Although the VM Act does not apply to the clearing of vegetation on the Project, the scientific basis for biodiversity conservation is still valid and can be used to assess the conservation significance of the vegetation communities on the Project. This includes the conservation status categories of each Regional Ecosystem (RE) under the VM Act, which are listed below as is the definition of Remnant Vegetation:

[1] Under the Nature Conservation Act 1992, Wildlife is defined to be any taxon of an animal, plant, protista, procaryote or virus.

Endangered Regional Ecosystems:

- <10% of pre-clearing extent remaining; and
- 10-30% of pre-clearing extent remaining and remnant <10,000 ha.

Of Concern Regional Ecosystems:

- 10-30% of its pre-clearing distribution remains; and
- 30% of the pre-clearing extent remains and the remnant vegetation remaining is <10,000 ha.

Not Of Concern Regional Ecosystems:

- >30% of the pre-clearing distribution remains and remnant vegetation remaining is >10,000 ha.

Remnant Vegetation:

'Remnant Vegetation' for an area of Queensland for which there is no RE map or remnant vegetation map, means any vegetation where the predominant canopy:

- Covers more than 50% of the undisturbed predominant canopy;
- Averages more than 70% of the vegetation's undisturbed height; and
- Is composed of species characteristic of the vegetation's undisturbed predominant canopy.

Although approvals for vegetation clearing on the Project site are not required under this VM Act, Section 4.7 of this EIS describes the conservation status categories of each Regional Ecosystem that occurs on the Project under the VM Act. Mitigation strategies have been developed where required for any impacts on Regional Ecosystems of conservation status.

1.5.1.15 Land Protection (Pest and Stock Route Management) Act 2002

The objectives of the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) are to consolidate, amend and provide laws for the management, control, prohibition, and regulation of the introduction, spread and keeping of certain plants and animals declared under the Act. The LP Act is relevant to the Project with regard to the control and management of declared pest plant (weed) and animal species.

Section 4.7 of the EIS describes the occurrence and proposed management of any declared weed and animal species.

1.5.1.16 Aboriginal Cultural Heritage Act 2003

The main purpose of the *Aboriginal and Cultural Heritage Act 2003* is to provide effective recognition, protection and conservation of Aboriginal Cultural Heritage.

Permits are no longer required for Cultural Heritage, but have been replaced by Duty of Care provisions. This duty of care provides that

> *"A person who carries out an activity must take all reasonable and practicable measures to ensure that the activity does not harm Aboriginal cultural heritage".*

The *Aboriginal and Cultural Heritage Act 2003* requires a Cultural Heritage Management Plan or another approved agreement be prepared and agreed to by registered aboriginal representative parties. Cultural Heritage Management Plans have been developed and approved for the Project with the relevant indigenous groups and these are detailed in Section 4.8.1.2.

1.5.1.17 Queensland Heritage Act 1992

The *Queensland Heritage Act 1992* exists for the protection of Queensland's historical Cultural Heritage since the time of non-indigenous settlement. It provides for the maintenance of a Queensland Heritage Register that records places of significance. Criteria for such places of significance are listed in the Act. The main objectives of the act are:

- Provide for the establishment of Queensland heritage council;
- Provide maintenance of a register of places of significance;
- Regulate development of registered places;
- Provide heritage agreements to encourage conservation of regulated places;
- Regulate excavation of sites that contain or may contain objects of significance to Queensland's Cultural Heritage; and
- Provide appropriate powers of protection enforcement.

Surveys of the Project site and infrastructure corridors have been conducted and determined that no places of non-indigenous cultural heritage significance occur on the Project site. The results of these surveys and any proposed mitigation strategies for sites of low significance are discussed in Section 4.8.1 of this EIS.

1.5.1.18 Native Title Act 1993

The *Native Title Act 1993* provides for the recognition and protection of native title. It is intended to set standards for the determination of claims to native title, and establish ways to deal with compensations relating to such claims. It also enables an Indigenous Land Use Agreements (ILUA) to be made between native title parties and other interest holders and to provide for the establishment of National Aboriginal and Torres Straight Islanders Land Funds.

The Project will be required to address the provisions of the *Native Title Act 1993* with Native Title Claim proponents and the relevant claim details described in Section 4.2.1.7 of this EIS.

1.5.1.19 Transport Infrastructure Act 1994

The *Transport Infrastructure Act 1994* provides for and encourages effective integrated planning and efficient management of a system of transport infrastructure. The main objectives of this act are as follows:

- Allow the government to have a strategic overview of the transport system;
- Allow for effective planning and management of a system of State and National roads;
- Allows influence over the total road network to contribute to efficient transport;

- Account is taken to provide adequate safety and community access to transport networks; and

- Takes in account all transport including roads, general rail, ports, air, public marine transport, bus ways and light rail.

The Project will impact to a certain degree on National and State controlled roads in the region, the Mount Isa System Rail Line, Townsville Port and Cloncurry Airport. The expected usage of these infrastructure facilities is detailed in Section 3.5.1 of this EIS while proposed mitigation strategies for impacts are detailed in Section 4.2.2.8 of this EIS.

1.5.1.20 Fisheries Act 1994

The main purpose of the *Fisheries Act 1994* is to provide for the use, conservation and enhancement of the community fisheries resources and fish habitats as a way to apply and promote the principles of ecologically sustainable development. This means using, conserving and enhancing the communities' fisheries so that ecological processes on which life depends are maintained and the total quality of life, both now and in the future can be enhanced.

Subdivision 3 of the *Fisheries Act 1994* deals with assessment of Development Applications for construction or raising of waterway barrier works. There are several creek crossings planned for the Project for roads and the water pipeline that would involve to some degree construction of waterway barrier works. As discussed under Section 1.5.1.9 of this EIS, Development Applications under the *Sustainable Planning Act 2009* are not required for activities authorised on the mining tenures under the MR Act, or as Mining Activities under the EP Act. Therefore the Project will not be required to apply for approval of waterway barrier works under the *Fisheries Act 1994*.

Not withstanding this, the Project will construct all creek crossings in a manner to avoid and limit any interference with waterway flows or impacts on aquatic fauna. The design of these creek crossings is discussed in Section 3.5.4.4 of this EIS while management strategies for aquatic fauna are discussed in Section 4.7.2.5 of this EIS.

1.5.1.21 National Greenhouse and Energy Reporting Act 2007

It may be a legislative requirement for the Project to report under the *National Greenhouse and Energy Reporting Act 2007* (NGER Act). The NGER Act establishes a national framework for Australian corporations to report greenhouse gas emissions, reductions, removals and offsets and energy consumption and production as of 1 July 2008.

Under the NGER Act, corporations are required to register and report if they emit greenhouse gases, produce energy or consume energy at or above the specified thresholds as follows:

- They control facilities that emit 25 kilotonnes or more of greenhouse gas, or produce/consume 100 terajoules or more of energy; or

- Their corporate group emits 50 kilotonnes or more of greenhouse gas, or produce/consume 200 terajoules or more of energy by 2010/2011.

This Act dictates the manner in which reporting needs to be undertaken.

The Project will trigger the above thresholds and therefore will be required to register and report under the provisions of the NGER Act. The greenhouse gas emissions for the Project, a Greenhouse Gas

Management Plan and reporting requirements are discussed in Sections 4.5.1.1 and 4.5.2.3 of this EIS.

1.5.1.22 Energy Efficiency Opportunities Act 2006

It may be a legislative requirement for the Project to report under the *Energy Efficiency Opportunities Act 2006* (EEO Act). The EEO Act took effect on 1 July 2006 (with an amendment in March 2007). It aims to improve the identification and evaluation of energy efficiency opportunities by large energy using businesses and, as a result, to encourage implementation of cost effective energy efficiency opportunities.

In order to achieve its aim, the Act requires large energy using businesses to:

- Undertake an assessment of their energy efficiency opportunities to a minimum standard in order to improve the way in which opportunities are identified and evaluated; and

- Report publicly on the outcomes of that assessment in order to demonstrate to the community that those businesses are effectively managing their energy.

The Act outlines the broad requirements for large energy using businesses, and allows for Regulations to provide detailed requirements for assessment, reporting, verification and other elements of the program.

MMG will be required to assess their energy use and report publicly on the results of the assessment under the EEO Act. This process is discussed further in Section 4.5.2.3 of this EIS.

1.5.2 Planning Processes and Standards

The Project is located within the North West Queensland Mineral Province which is a region of high quality copper, lead and zinc deposits. This Province has sustained successful mining operations for over 100 years.

The Project is consistent with regional and state planning objectives as the Queensland Government is currently promoting mineral exploration, investment and growth in four major mineral regions (Including the Mt Isa Region) by spending $20 million on the Smart Exploration initiative.

The Smart Exploration initiative follows on from previous initiatives such as The Exploration Attraction Initiative (2003-06), The Prospectivity Plus Initiative (1998-2001) and various geophysical data capture initiatives from 1994 onward. The Smart Exploration initiative aims to make Queensland more attractive for investment in mining and development by providing geological and geophysical data. The Mt Isa region is recognised as a significant region by the Smart Exploration initiative and accordingly will become one of the four focus areas for mineral development. The Dugald River Project complies with this initiative by developing a mine that will be operational for a minimum of 20 years in the Mt Isa Region.

Through this EIS the Project will comply with the below listed Codes, Standards and Guidelines which will be further discussed and referenced in the sections pertaining to the areas covered by each individual Code, Standard or Guideline.

- DERM EcoAccess Guideline: The EIS Process for Non-Standard Mining Projects (2003);

- DERM EcoAccess Guideline: Preparation of an Environmental Management Overview Strategy (EMOS) for Non-Standard Mining Projects (2003);
- DERM EcoAccess Guideline 7: Issue Identification and Community Consultation (2009);
- DERM EcoAccess Guideline 18: Rehabilitation Requirements for Mining Projects (2008);
- DERM EcoAccess Guideline: Landfill Siting, Design, Operation and Rehabilitation (2008);
- DERM EcoAccess Information Sheet: Determining Dams Containing Hazardous Waste (2003);
- DERM EcoAccess Information Sheet: Managing Dams Containing Hazardous Waste (2003);
- DERM EcoAccess Guideline: Planning For Noise Control (2008);
- World Health Organisation: Guidelines for Community Noise (April 1999);
- Department of Infrastructure and Planning: Draft Guidelines for Social Impact Plans (June 2009);
- Department of Climate Change: National Greenhouse Accounts Factors (2009);
- National Environment Protection Council: National Environment Protection Ambient Air Quality Measure (2003);
- DERM Monitoring and Sampling Manual 2009;
- The Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Department of Mines and Energy 1995;
- Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (Department of Environment 1998);
- Australia Standard (AS) 1940 – Storage and Handling of Flammable and Combustible Liquids;
- AS 3780 – Storage and Handling of Corrosive Substances;
- AS3580.10.1 – Methods for Sampling and Analysis of Ambient Air – Determination of Particulates – Deposited Matter – Gravimetric Method 1991;
- AS5667.1 – Guidance on Sampling of Bottom Sediments;
- AS/NZS ISO 31000:2009 Risk Management - Principles and Guidelines;
- HB203:2006 Environmental Risk Management Principals;
- Queensland Government Environmental Offsets Policy (QEPA 2008);
- Commonwealth of Australia: Leading Practice Sustainable Development Program for the Mining Industry - Mine Closure and Completion (2006);

- Commonwealth of Australia: Leading Practice Sustainable Development Program for the Mining Industry – Mine Rehabilitation (2006); and

- Commonwealth of Australia: Leading Practice Sustainable Development Program for the Mining Industry – Tailings Management (2007).

It is anticipated that the Project may require other approvals outside of the EIS process. These may include:

- Riverine Protection Permits for any major creek or river crossings or excavation works.

- Approvals for the additional Yurbi Rail Loading Facilities. The current Yurbi Rail Loading facilities are owned and operated by BHP Billiton and occur on a Mining Lease with an EA. MMG would need BHP Billiton to initiate any necessary EA amendments to allow for the proposed expansion of the loading facility; and

- Approvals for the expansion of BHP Billiton's Townsville port facilities, to allow for the storage of the Dugald River Project concentrate. The current BHP Billiton ship loading facilities are adequate to handle the additional Dugald River concentrate quantities.

1.6 ACCREDITED PROCESSES AND STANDARDS

The Dugald River Project is unlikely to impact on Matters of National Environmental Significance and has not been referred to the Department of Environment, Water, Heritage and the Arts.

Consequently, the Queensland EIS process will not be accredited for the assessment of the Project under Part 8 of the *Environmental Protection and Biodiversity Conservation Act 1999.* In the unlikely event that at a later date it is found necessary to refer the Project to the Commonwealth and it is declared a controlled action, impacts on the Matters of National Environmental Significance will be assessed under a separate process.

2.0 PROJECT NEED AND ALTERNATIVES

2.1 PROJECT JUSTIFICATION

The Dugald River Project contains a significant zinc/lead/silver and copper resource. With the on-going demand for metal products world wide, mining of this resource can provide economic benefits, employment and export trade for Queensland.

The Project will bring positive flow-on effects to the local and regional economy and community. The Project will employ up to 795 persons including both on and off site employees, during peak production (lead/zinc/silver and copper). Most of the onsite employees will be on a FIFO roster of 8 days on, 6 days off. Employees will be housed in an onsite accommodation camp during their time onsite. Of the 795 employment positions approximately 20 jobs will be offered to local residents of Cloncurry, but this will vary depending on capacity of the local labour market. The rest of the workforce will be sourced from Brisbane, Townsville and Mount Isa, with expert technical positions sourced from further afield if required.

MMG will support graduate employment and training, vacation work for students and will supply financial support to employees wishing to undertake further postgraduate studies, if they satisfy the criteria for this support.

An indigenous and local employment training policy will be developed and implemented to include indigenous and local people in the Project.

These initiatives are undertaken in order to secure ongoing development and retention of a skilled and diverse workforce.

The Project's construction will result in a positive input into the local, Queensland and Australian economy of more than $700 million through the purchase of equipment, goods and services. During the operational phase of the Project, which is estimated to be approximately 23 years, industries associated with mining will be positively impacted through the provision of services and equipment, and the supply of consumables to the Project. The annual economic contribution of the Project is estimated to be $160 million in operating expenditure, $14 million in royalties and $35 million in taxes, subject to metal prices and production at the time.

The local economy of Cloncurry and Mount Isa is expected to benefit from the economic flow on effects of the Project through the provision of the following goods and services including:

- Vehicle hire;
- Aviation services;
- Bus services;
- Concentrate transport;
- Light engineering;
- Road transport services;
- Fuel supply and transport;

- Training and personnel management services;
- Plant maintenance and fabrication services;
- Electricity supply from Mount Isa; and
- Water supply from Lake Julius.

The Project is also likely to have a positive impact on the establishment of additional new small businesses in Cloncurry and Mount Isa over time, to service the Project's needs.

The Dugald River Project will produce zinc/lead/silver and copper concentrate suitable for export to overseas markets. In accordance with Queensland legislation the Proponent will pay mineral royalties to the Queensland Government for the right to mine the State's resources. These royalties are paid on an *ad valorum* (or value) basis, they are calculated as a percentage of the value of the mineral or petroleum as determined by the Minister. The proponent is expected to pay an average of $14 million in royalties, depending on metal process and production at the time.

The main direct environmental impact of the Project will be land clearing which will be minimised where possible during construction and operations by ensuring only the minimum amount of land required is cleared. This has been a major design consideration in the location and layout of the processing and mining area, which has an approximate footprint of only 250 ha. The majority of vegetation that will be cleared due to the Project is common and widespread in the region, with no significant flora or fauna species to be adversely impacted. Where small areas of significant vegetation communities are required to be cleared, MMG proposes to offset these biodiversity impacts. In addition, the impact of land clearing on the Project site will be rectified in the long term by mine rehabilitation and closure, which will aim to return the land to a similar or better condition than pre-disturbance.

As the workforce will be located on the Project site in a purpose built accommodation camp, the Project's adverse social impacts on Cloncurry will be minimised.

2.2 ALTERNATIVES TO THE PROJECT

2.2.1 Consequences of Not Proceeding with the Project

Mining is a profitable activity for the Australian economy and if the Project were not to proceed, a significant mineral resource would remain unutilised. Local, Queensland and National economies would not benefit from the mineral royalties, employment, trade and export of goods associated with the Project.

2.2.2 Alternatives to the Location of the Project Itself

The nature of mining dictates that operations must be undertaken at fixed locations, where suitable ore bodies are found. There is very limited scope for changing the location of a mining operation because the further from the resource the infrastructure is located, the less likely it is that the operation will be financially viable. This relationship is the foundation of the interdependency of the components of the Project. The ore resources, the processing plant, key infrastructure and personnel need to be located within a certain distance of each other in order for the Project to be profitable and sustainable. Every additional kilometre of ore haulage and personnel travel, decreases efficiency, thus increasing energy consumption, emissions and ultimately decreasing project value.

Alternatives within the Project site itself, such as the location of components of infrastructure and the choice of technologies and methodologies to be utilised become very important for maintaining the profitability of the Project and reducing the waste streams. These alternatives will be discussed in Section 2.2.4.

2.2.3 Alternatives Land Uses for the Project Site

Should the Project Site not be utilised for mining, the main viable alternative land uses for the Project Site itself are as follows:

1. Beef cattle grazing; or

2. Conservation of the site for its ecological significance.

These two options were assessed using the methodology outlined in the *Land Suitability Assessment Techniques Guideline* (Department of Mines and Energy 1995). A full land suitability assessment is contained in Appendix M of this EIS.

The site is traversed north-south by the Knapdale Range, which rises approximately 280 metres (m) above sea level. The Knapdale Range, in combination with thin skeletal soils with low nutrients and low Plant Available Water Capacity (PAWC), provide a significant obstacle to agricultural or grazing land uses.

2.2.3.1 Beef Cattle Grazing

The majority of the site was found to have severe limitations for use as beef cattle grazing. The main limitations are the PAWC and low nutrient level in the soil. In addition, the majority of the site is of unsuitable topography and slope for cattle grazing due to the Knapdale Range. However, on the flatter areas, low intensity cattle grazing is possible.

Areas that can be used for low intensity cattle grazing are defined as Land Suitability Class 4 which is marginal land. This type of land has severe limitations which make it doubtful whether the inputs required to achieve and maintain production outweigh the benefits in the long term.

2.2.3.2 Conservation

The Project site contains some conservation values, however nothing of significance that is not common in the wider area. Some areas on the Project site are disturbed from cattle grazing, historic mining and exploration works that have already taken place. The site is neither rare nor unique and would not warrant conservation as a primary land use.

2.2.4 Alternatives within the Project

Many alternative options were assessed for the location of infrastructure, production and mining methods for the Project. The following alternatives within the Project will be discussed:

- Power supply;

- Power transmission line corridor;

- Water pipeline location;

- Site access routes;
- Accommodation camp location;
- TSF location;
- TSF embankment design;
- Mining methods;
- Processing plant location; and
- Processing methods.

2.2.4.1 Power Supply

MMG conducted a study into the most suitable power supply options for the Project which included alternatives such as renewable energy sources, onsite power generation through diesel, gas or heavy fuel oil, and establishing a new or utilising an existing gas fired power plant in Mount Isa.

Power from the National Electricity Grid is currently not available in the region. Private organisations are proposing to develop a power line from Townsville to Chumvale substation to provide major energy users in the region with access to the National Electricity Grid. This project is at an early development phase and would provide an alternative power source if developed.

Generation based on renewable energy sources is not an economically viable option for the Dugald River Project. The four main technologies that were considered included solar, wind, hydro and geothermal. The wind and hydro resources in the region are not considered adequate for providing power to the Project. Geothermal technology was discounted as it is still experimental. Solar generation does not supply a consistent reliable energy source, and has to be complemented with conventional generation or energy storage systems, in which case the upfront capital cost if installing dual power supplies becomes prohibitive. There is potential for attracting government funding for renewable energy projects but it is still not likely to provide an economically viable solution to providing power for the Project.

On-site generation options using gas, diesel and heavy fuel oil were considered. Gas is the preferred fuel for onsite power generation as it is cheaper than other fuel options, but it would require a lateral gas pipeline to be constructed from Mount Isa to the Project site for a distance of 90 km. This option would then require large deviations of the pipeline to avoid terrain, increasing the distance by approximately 30% to 120 km. Despite the benefits associated with decreased energy losses along a pipeline versus a powerline, the cost of installing a pipeline is far greater than installing a powerline, making the gas pipeline option less cost effective, both upfront and in the longer term. Diesel and heavy fuel oil, although considered, was not pursued for several reasons including the large costs on capital expenditure, operation and maintenance.

To establish an additional gas fired power station in Mount Isa or utilise energy from an existing gas fired power station is the most cost effective and preferred energy option for the Project. Utilising power from gas fired power generation also significantly decreases the Project's greenhouse gas emissions when compared to electricity sourced from diesel or coal fired power stations. MMG will negotiate with a third party to supply electricity via existing gas fired supplies in Mount Isa or a new gas fired power station depending on price. Transmission of the energy from Mount Isa to the Project

site would be via the existing transmission line to the Chumvale substation, and then via a new transmission line to the Project site as discussed in Section 2.2.4.2.

2.2.4.2 Power Transmission Line

The power transmission line from the Chumvale substation would involve constructing a 220 kV line from the substation to the Project site. Three options where originally investigated for the route of this transmission line (Figure 2.1):

Option 1: An overland route heading south-west from the Project site then following a southeast route; or

Option 2: An overland route travelling directly south from the processing plant (not initially going southwest as in Option 1), and then following the southeast route of Option 1; or

Option 3: A line running parallel to the Burke Developmental Road using the existing disused railway corridor and then following the same corridor as the Chumvale/Ernest Henry Powerline to the Chumvale substation.

Option 1 is the most direct route, and will minimise costs associated with construction and land clearing. However, Option 1 passes directly over rocky outcrops that could provide potential habitat for significant fauna.

Option 3 was discounted based on tenure issues associated with the State owned Queensland Rail tenements, on which the powerline was proposed to be constructed. Queensland Rail has plans to potentially use the rail tenements in future for a new railway line.

Option 2 was selected as the preferred option because it:

- Avoids close proximity to homesteads and infrastructure associated with grazing properties;
- Avoids infrastructure and potential mineralisation on the adjacent proposed Roseby Copper Project;
- Suits the topography;
- Minimises disturbance when crossing major watercourses; and
- Avoids rocky outcrops which are associated with significant fauna.

A European cultural heritage assessment, vegetation mapping and identification of areas of fauna significance along the preferred powerline route have been undertaken and the possible disturbance to sites of significance has been assessed as part of the final preferred route location. In addition, Indigenous Cultural Heritage Management Plans have been entered into with both Traditional Owner groups for the powerline route. Further discussion on heritage significance and vegetation communities along the corridor is provided in Section 4.7 and 4.8 of this EIS.

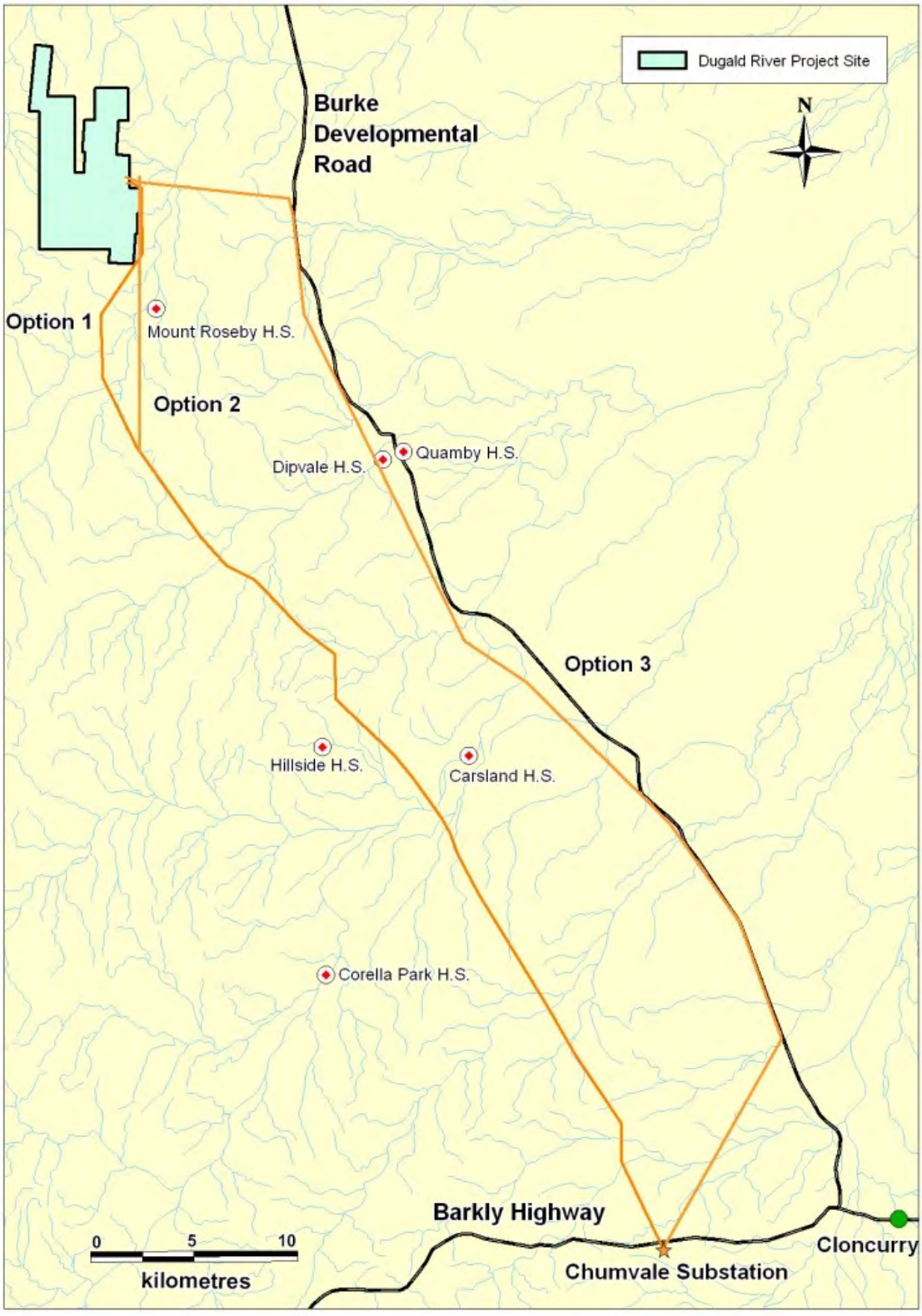


Figure 2.1 Potential Powerline Route Options

2.2.4.3 Water Pipeline

Water will be supplied from the Lake Julius/Ernest Henry pipeline. The pipeline passes to the north of the mining leases. A take-off point was constructed in the line at the Green Hills valve station when the pipeline was constructed. Five possible routes for a water pipeline off the Lake Julius/Ernest Henry pipeline to the Project site were assessed (Figure 2.2), as follows:

Option 1a, 1b and 1c, which all run down the eastern side of the Mount Rose Bee range of hills:

a. A more direct route that travels south and then southwest to enter the Project Site at the processing plant; or

b. A less direct route taking topography into account and avoiding potential significant fauna habitat at Mount Rose Bee; or

c. Following Option 1a and then travelling west to connect with onsite water pipeline midway between the accommodation camp and the processing plant.

Option 2: Along existing tracks, or proposed hauls roads, that would take it close to the proposed Roseby Copper Project's processing operations.

Option 3: Similar to options 1a, 1b and 1c over the northern section, though travels further south and then directly west over southern portion to enter the Project site at processing plant location.

Figure 2.2 shows the location of the Lake Julius/Ernest Henry pipeline and potential pipeline routes to the Project site.

All five routes had the same relative risk of surface disturbance to the environment; however three key factors were taken into consideration in the final choice of Option 3, as follows:

- Implementing a 150 – 200 m clearance distance from potential significant fauna habitat;
- Application of an appropriate separation distance from the planned infrastructure of the proposed Roseby Copper Project; and
- Reducing the clearing required by running the pipeline along the proposed access road (Longamundi Deviation).

The implementation of a buffer around potential significant fauna habitat is in accordance with conserving biodiversity and significant species (one of the five main tenets of Ecologically Sustainable Development).

The appropriate separation distances from the Roseby Copper Project infrastructure have been determined through agreement with the owners of the proposed Roseby Copper Project.

The pipeline will sit along the boundary between the operating area of the Roseby Copper Project and the exclusion zone around the significant fauna habitat, thus not affecting the operating room available for the Roseby Copper Project.

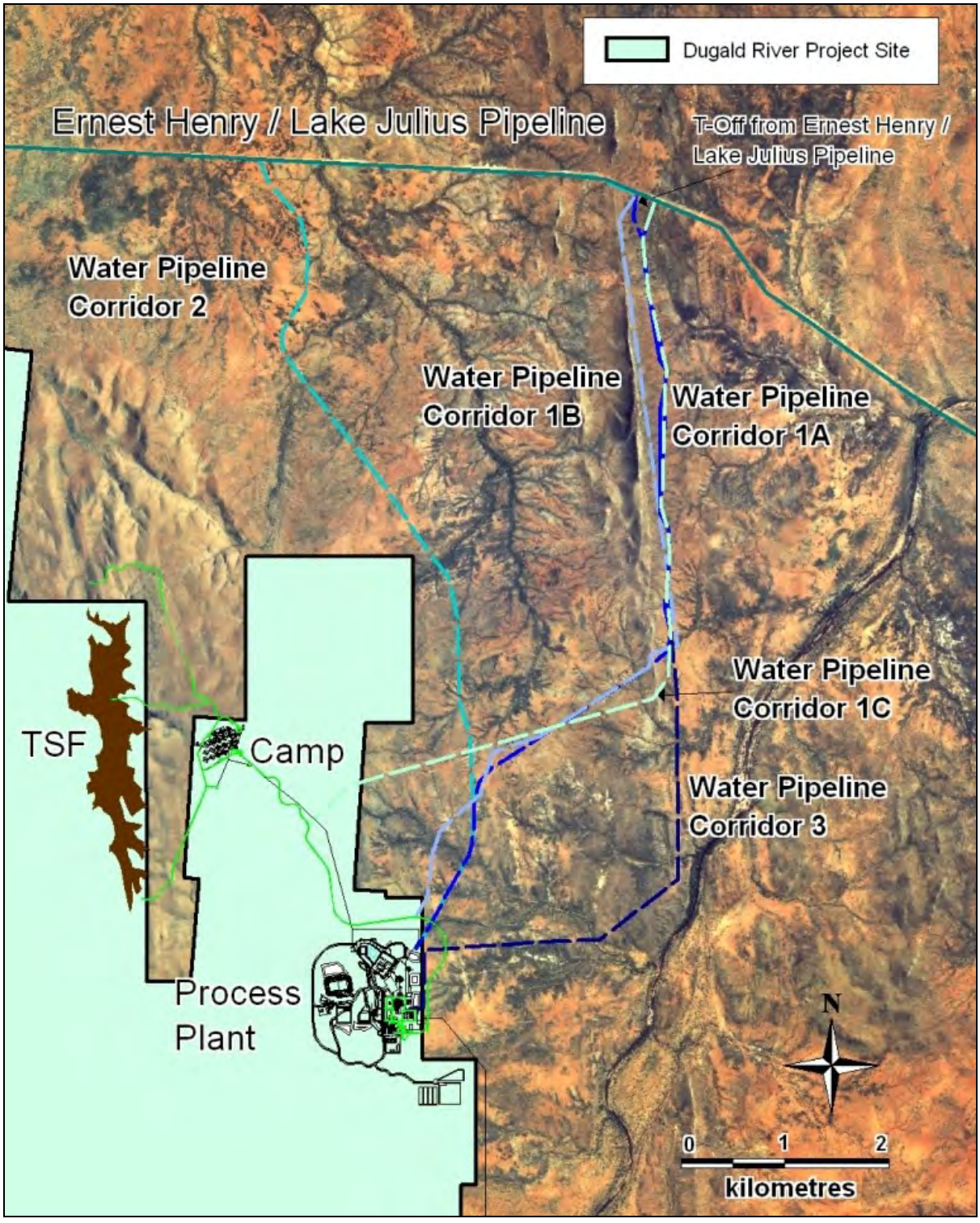


Figure 2.2 Potential Water Pipeline Routes

2.2.4.4 Access Route

The Project is currently accessed via a gazetted public road that was the old route to Kajabbi. The turn-off to this road is shared by the road to the Mount Roseby homestead. This route is also the described ML access route for the Project, as required by the *Mineral Resource Act 1989*. The current road travels parallel with the Burke Developmental Road for a short distance, before heading generally west towards the Project site.

There were two options assessed for future access to the mine site as shown in Figure 2.3.

The preferred access route was selected because it follows an existing track and upgrading this track would require less clearing and disturbance. This route also has less creek crossings and improved visibility (i.e. safety) at the intersection with the Burke Developmental Road, as it is located on a straight length of the road, not on a bend. The preferred route is also already in use for exploration works and the landholder is familiar with mine traffic along this access path.

The alternative access route offers more direct access to the Project Site, however it would require more clearing and it crosses a number of minor creeks.

Both access route options have been assessed throughout the EIS.

In the process of further evaluating both routes, it has been recognised that the access road intersects the proposed Longamundi mining pit and waste rock dump for the proposed Roseby Copper Project. Construction and mining of this pit is not planned until approximately 2020. Due to the lengthy interim period it is proposed to upgrade the existing track as planned, and re-direct the access road around the north of the Longamundi Pit when necessary.

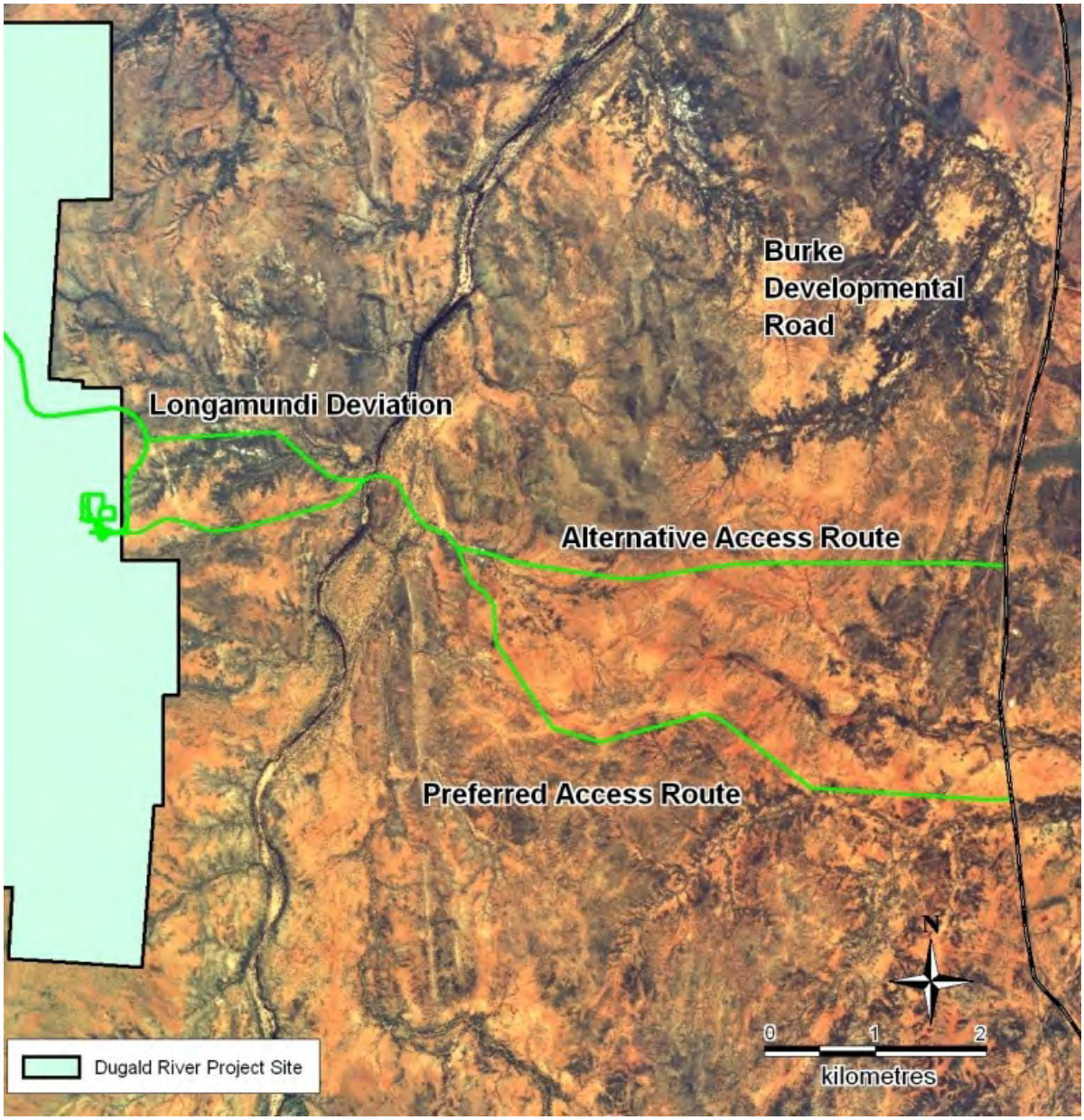


Figure 2.3 Access Route Alternatives

2.2.4.5 Accommodation Camp

Initially, the alternatives of accommodating the workforce on the Project site or in Cloncurry were considered.

The main disadvantage of having the workforce accommodated in Cloncurry is the distance that the workforce would need to travel each day to the Project site. The route is 72 km each way and takes approximately one hour to complete. This would means that employees would need to travel 2 hours each day, back and forth from the Project Site.

Even if buses were used to transfer employees this would still amount to considerable consumption of fuel, generation of greenhouse gases and additional safety risks relating to fatigue. In addition, the Cloncurry Township has suffered long term from water shortages that would be exacerbated by the addition of the proposed Project workforce of approximately 264 - 396 persons (maximum) at anyone time in Cloncurry. Therefore the preferred option is to base the accommodation camp on the Project site, close to the Project operations to reduce travel times and distances and where a suitable water supply is available.

Three options for the location of the accommodation camp on the Project site were assessed as shown in Figure 2.4. The locations were as follows:

Option A: On the western side of the Knapdale Range in the southern section of the tenements; or

Option B: On a flat plateau on top of the Knapdale Range in the northern sections of the tenements; or

Option C: On the eastern slopes of the Knapdale Range in the central section of the tenements.

The locations were assessed based on accessibility, distance from the operations, sterilisation of potential resources for mining, noise nuisance from the plant and mine operations, and scenic amenity.

Option B in the northern section of the leases on a plateau of the Knapdale Range was chosen as the most suitable location. This location is at approximately 275 m above sea level on the top of the Knapdale Range, which provides attenuation from the noise of the plant and mine areas. This location also minimises travel distances to and from the operations, provides scenic views of the surrounding landscape and will not sterilise any future ore resources.

Option A was considered to be too far from the mine operations, as access would be around the southern extent of the Knapdale Range and close to the Roseby Homestead. Option C was discounted as it would not provide sufficient area to fit the required number of rooms for the initial camp, or the expanded camp (camp size requirements are discussed in Sections 3.2.2 and 3.5.7 of this EIS).

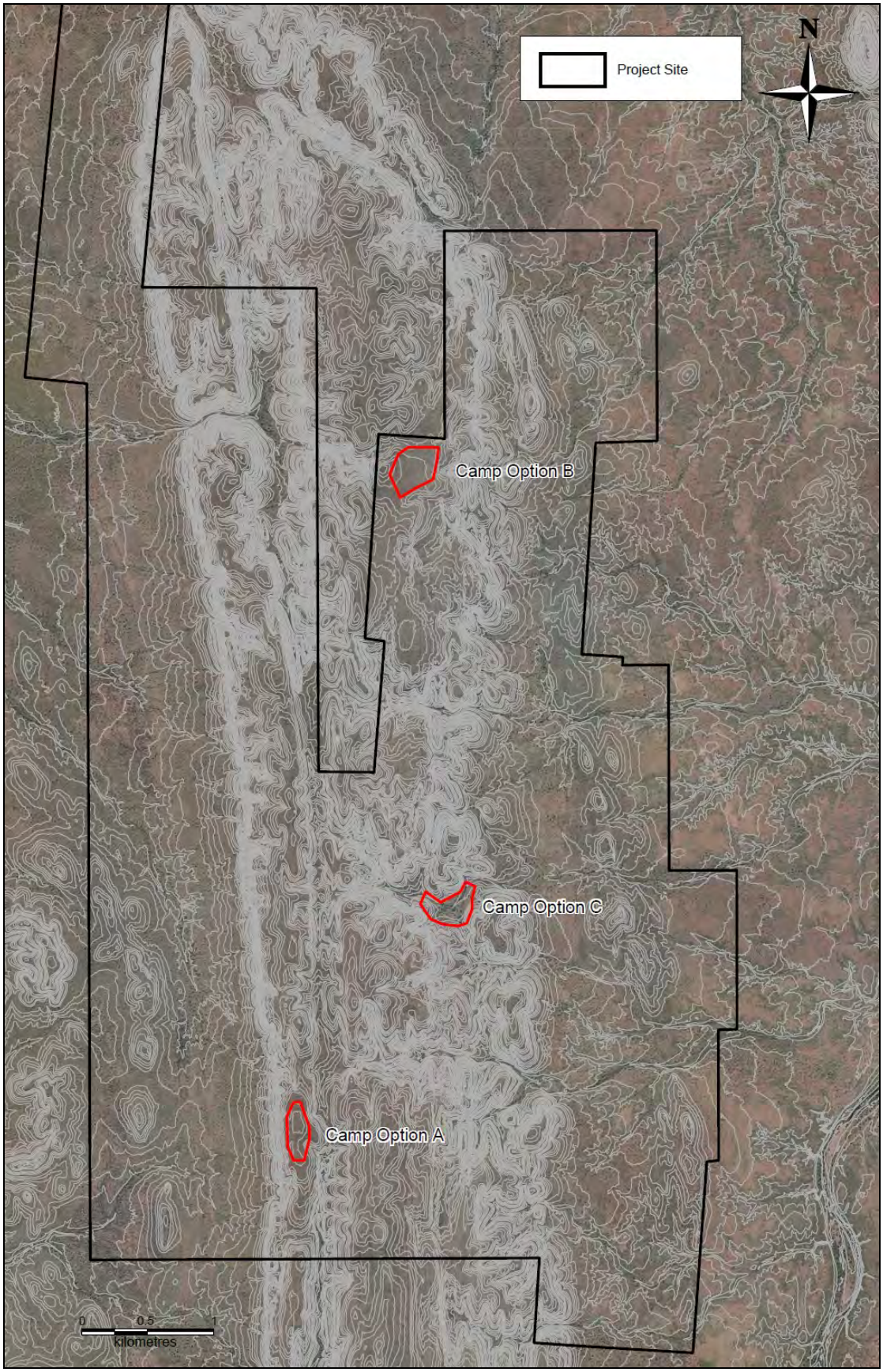


Figure 2.4 Possible Accommodation Camp Locations

2.2.4.6 Tailings Storage Facility Location

A TSF Site Options Assessment was completed by Australian Tailings Consultants (ATC) in March 2008. Six TSF sites were initially considered, two TSF sites were further developed to the conceptual design stage prior to selection of the preferred option. These options were as follows:

1. **Site A2 Valley Fill:**

   Site A2 is a bifurcated valley on the western side of the Knapdale Range and approximately 4 km north-west of the processing plant.

   The TSF would consist of a single large embankment, a down-valley discharge of tailings, and all decant and runoff water being stored within the tailings compound (i.e. no secondary water storage pond).

2. **Site H2 Upstream Raise Cell:**

   Site H2 is located on the relatively flat area 0.5 km south-west of the process plant site, south of Silvermine Creek and east of the hill known locally as “Copper Hill”.

   The proposed TSF is a perimeter discharge scheme with a series of upstream raises and a central decant structure.

Figure 2.5 shows a layout of the two preferred TSF options in relation to other key infrastructure.

A number of criteria were reviewed to determine the preferred option. These included costs, water management, environmental risk, rehabilitation, disturbance footprint, sterilisation and expandability.

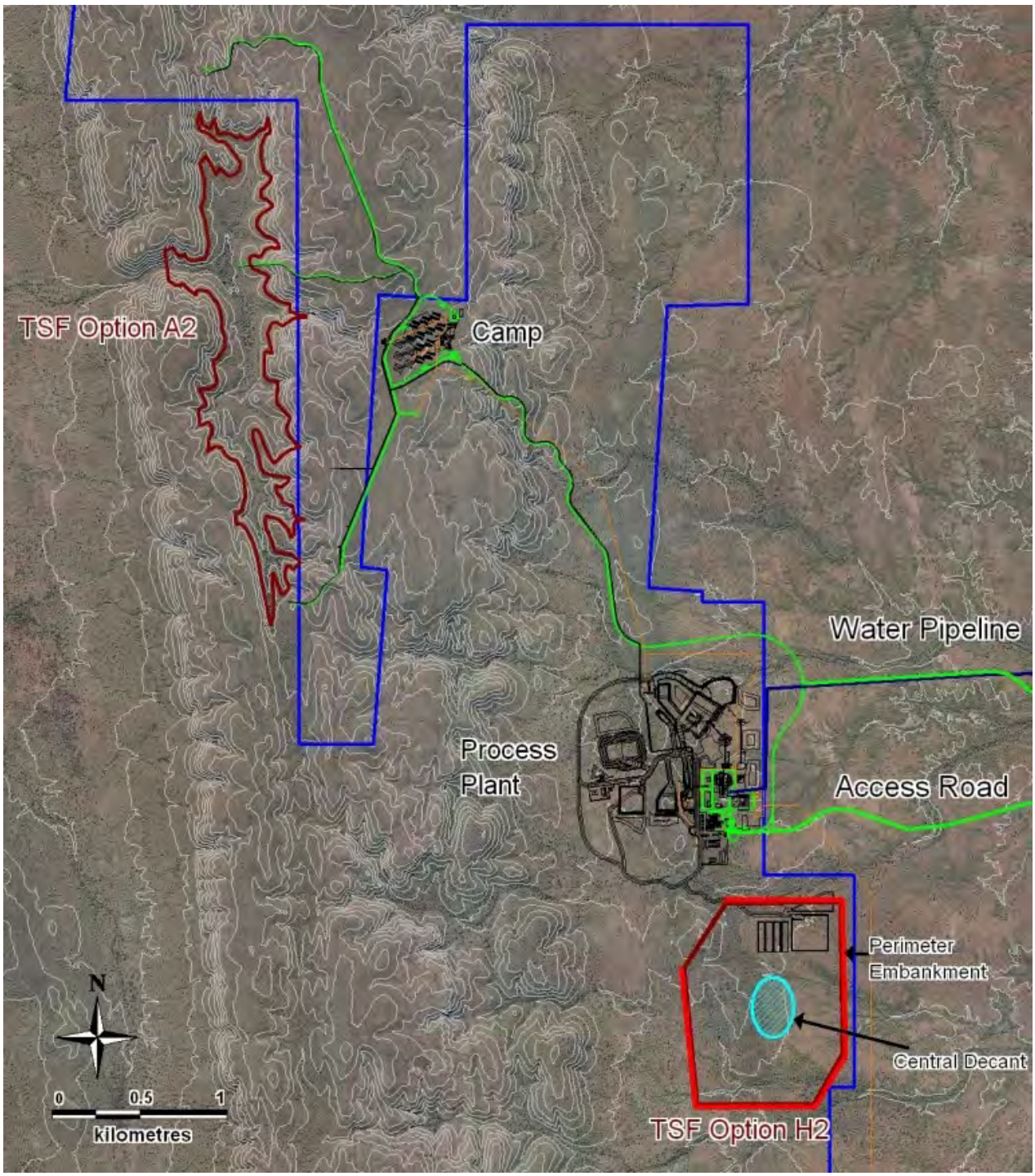


Figure 2.5 Potential TSF Sites

Costs

Option A2 Valley Fill scheme costs marginally more (<5%) to establish than the Option H2 Upstream Raise scheme but once the facility is established, Option A2 is able to support the entire life of mine tailings without any further expansion, whereas Option H2 requires ongoing investment in additional lifts as mine life progresses and would also cost more to rehabilitate at closure. Later enhancement of the final plan for Option A2 has also included staging to reduce upfront capital and improve the total economics of the option.

Both schemes have similar operating costs with increased labour requirements for operation of the Option H2 perimeter discharge cell, being offset by increased maintenance and power usage for Option A2. The result is Option A2 has a 10% higher operating cost than Option H2.

Water Management

Water balances for the various rainfall data indicate that in all cases, there are periods of high rainfall where the water ponds on the TSF. In these cases, the designs are sufficient to prevent overflow and there is potential to increase decant return pump rates. There are periods after and during high rainfall, where there is water ponded on the TSF for a period ranging from 12 months up to 4 years (greater volumes are always stored for Option A2 than for Option H2). Option A2 (valley fill) provides more decant return water to the plant that Option H2 (perimeter discharge) over the life of mine.

Environmental Risk, Disturbance and Rehabilitation

For both options, the consequences of a TSF breach would be 'Major' or potentially 'Catastrophic'. However, the overall risk associated with Option A2 is less than that for Option H2.

The total disturbance areas of both schemes are similar, although Option A2 is located in the Cabbage Tree Creek catchment rather than the Dugald River catchment where the rest of the mine and processing facilities and the Option H2 TSF are located. Meaning Option A2 will result in disturbance of a second catchment area.

The disturbance of this additional catchment area is not considered significant for two reasons:

- The immediate downstream area of the Dugald River is more environmentally significant than that of the Cabbage Tree Creek, as it contains several locally significant waterholes. Also, the geometry of creeks falling from the Option A2 facility toward Cabbage Tree Creek is amenable to installing effective seepage catchments if required.

- The potential of breaching associated with a downstream raised facility (such as Option A2) is far less than that associated with an upstream raised facility such as Option H2. This is because the stability of an upstream raised TSF is more dependent on the settling rates and good management, whereas a downstream raised facility is more robust to changes in design assumptions and requires less daily management.

To permit effective rehabilitation, tailings discharge into the valley fill system used in Option A2, will be managed so that the final tailings surface drains freely towards the main embankment and, after capping of the tailings solids, the main embankment will be cut down to permit surface water to drain away. Water will not be permitted to pond on the surface of the tailings, to prevent the ponded water from leaching salts out of the tailings below.

Management of the tailings discharge from the north and south discharge points in Option A2, will mean that major re-shaping earthworks are not required to create this self-shedding landform. Some minor re-shaping may be required to remove isolated ponding at the ends of some valleys. This will

reduce rehabilitation costs with the final works required consisting only of providing a cover over the tailings solids (capping) and revegetation.

As the Option H2 TSF cell is a perimeter discharge cell, the tailings solids will form a slope from the outside of the cell, towards the centre. As such, re-shaping earthworks will be required to create a slope that sheds water to the outside of the cell. This is a disadvantage compared to the Option A2. Also, with four walls that will require rehabilitation, the embankments of this facility would require increased expenditure, compared to the single wall in Option A2.

Sterilisation and Expandability

The Option A2 valley site is geologically less prospective than the area around and under the Option H2 cell. The Knapdale Ranges are quartzite and hold very low potential for discovery of minerals. The area covered by and neighbouring the Option H2 cell site holds potential for discovery of significant copper and other minerals.

Expansion of the Option A2 valley fill would be simple and relatively low cost compared to the Option H2 Cell. The only additional costs would be a downstream raise on the embankment. The pumps, pipes, roads and other infrastructure could continue to be used. This low cost expansion could be applied to increase capacity to approximately double the current size.

The Option A2 has greater expandability than the Option H2. Option A2 could be readily expanded by increasing the embankment height and installation of some small saddle dams around the periphery of the facility. Option H2 would require duplication of the entire cell, although during this options assessment, no suitable locations were identified. In reality, if Option H2 were selected initially, in order to expand, the next best option would be to construct Option A2, which would result in two separate facilities on the site.

If Option A2 is selected initially, that site can be expanded without requiring additional disturbance or installation of a second tailings facility

Preferred TSF Location

When reviewed against the decision criteria, Option A2 (valley fill scheme), is superior to Option H2 (upstream raised perimeter discharge cell). A force-ranked summary is shown in Table 2.1 where 1 corresponds to least preferred option and 5, the most preferred option.

Table 2.1 Comparison of TSF Options Against Criteria

Review Criteria	Rating / 5	
	Option A2	Option H2
Capital Costs – Upfront	4	5
Total Cost - Depreciated	5	3
Water Management	5	4
Risk of Breach	5	4
Rehabilitation	5	4
Disturbance Footprint	4	5
Potential Sterilisation	5	2
Expandability	5	1
Total /40	**38**	**28**

Apart from slightly increased upfront capital cost and disturbance to the Cabbage Tree Creek catchment, Option A2 is preferred across all areas and vastly superior in the key criteria of Total Cost, Potential Sterilisation and Expandability for future ore resources.

2.2.4.7 Tailings Storage Facility Embankment Design

The main construction decision to be made within the A2 Valley Fill scheme was the material constituents of the main embankment over the natural entrance to the valley.

For the reasons of construction costs and availability of materials, two main embankment configuration options have been considered for the TSF main embankment. These are as follows:

i. Clay Core Option – conventional zoned earth and rockfill embankment.

ii. Geomembrane Option – rockfill embankment fitted with a waterproofing geomembrane sealing system (GSS) on the upstream face.

Designs were completed and analysis performed for each option. Detailed cost estimates were then developed based on an assessment of materials requirements and sources, quantities, and budget rates submitted by specialist construction contractors. On the basis of capital costs, construction efficiency, materials availability and future expandability, the GSS option is the preferred configuration for the main embankment.

2.2.4.8 Mining Methods

Underground mining is preferred to open pit mining given the depth of the Dugald River resource which starts at 25 m below surface and extends to around 1000 m deep. It is more economic to extract a resource such as this using underground methods, due to the amount of waste rock that would need to be removed if open cut methods were employed.

Underground mining techniques remove much smaller quantities of waste rock than open cut mining methods, provide underground voids, which can be backfilled with waste rock and tailings, and also produce much smaller land disturbance footprints. For these reasons underground mining methods have less impact than surface mining methods from an environmental perspective.

2.2.4.9 Processing Plant Location

The processing plant is proposed to be located immediately to the east of the Dugald River deposit, near the eastern boundary of the Project as shown Figure 2.6. An alternative site to the immediate south-east was also considered.

The preferred site was selected so that the ROM Pads would be close to the mine portals to minimise the distance that haul trucks have to travel, and to keep the ROM Pad activities downwind of the terminal switchyard and administration area. The preferred processing plant site also minimises the amount of land disturbance required as all infrastructure is in close proximity and avoids any major disturbance to tributaries of the Dugald River.

Key factors for consideration in locating the processing plant were:

- Constrain the area disturbed by the processing plant within the boundaries defined by Silvermine Creek and its tributary to the north (Tributary 'A') to simplify surface water management and reduce the risk of contaminating discharge events;

- The location of the ROM Pads near the mine portals;
- Taking advantage of naturally high ground on which to build the ROM Pads;
- A desire to have the change house near the gatehouse to limit the distance employees have to walk from the bus drop-off point;
- Having the light- and heavy-vehicle go lines close to the change house;
- Having the mining, administration and processing staff offices close together to facilitate communication;
- Separating heavy mine vehicle traffic from non-mining light-vehicle traffic;
- Allowing plenty of room for the 49.1 m long quad concentrate trucks to turn on the arrival and departure routes to the concentrate storage shed;
- Limiting the mixing of the concentrate truck traffic with other traffic; and
- Allowing power line corridors access from the switchyard to the various substations around the plant.

MMG has undertaken a sterilisation drilling program for the proposed process plant area. There has been some copper mineralisation detected, but not of sufficient quantity or quality to justify changing the location of the process plant.

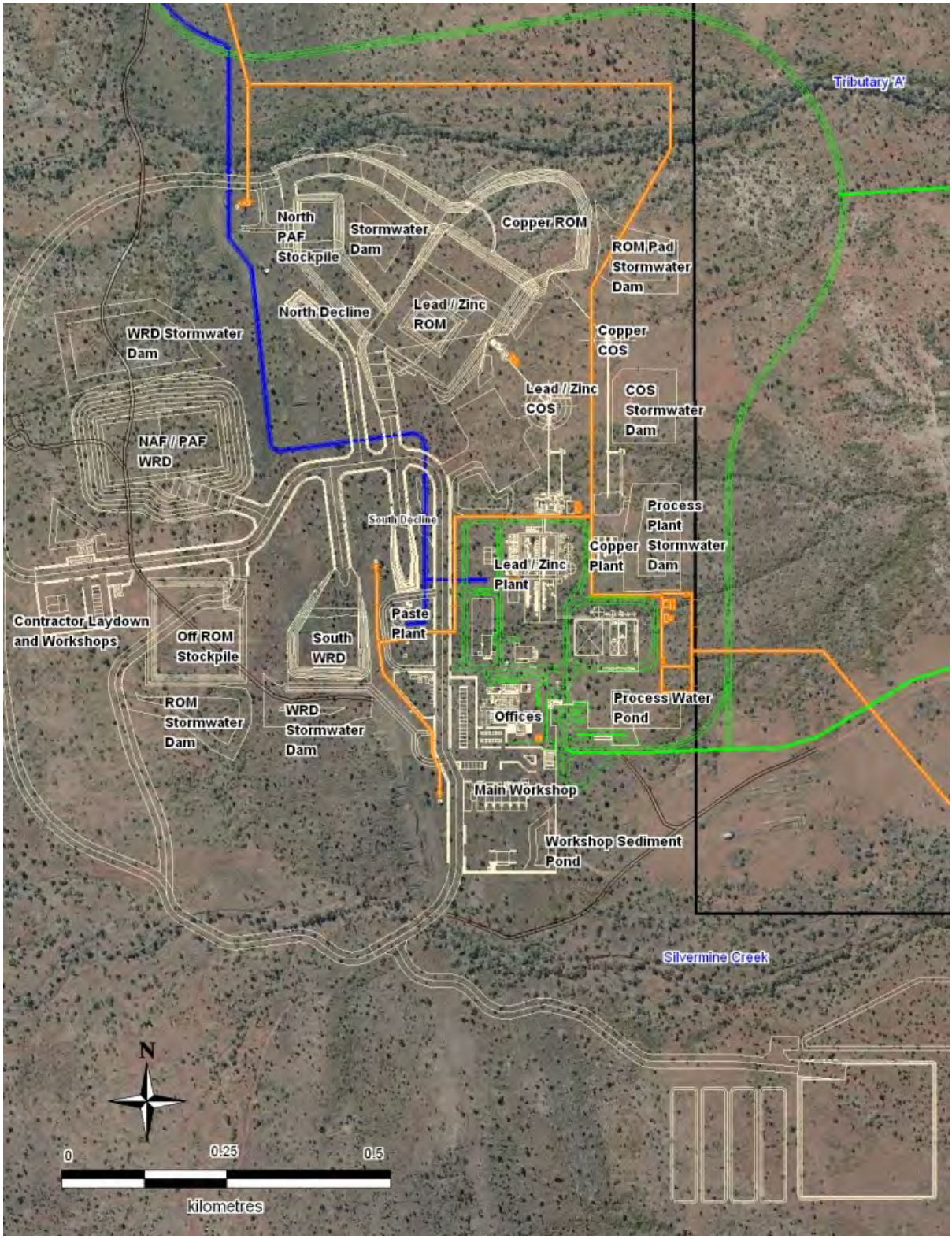


Figure 2.6 Proposed Processing Plant Location

2.2.4.10 Processing Methods

The production of metal concentrates suits small to medium sized ore bodies such as at the Dugald River Project. In order to justify building a smelter to produce metal rather than concentrate, a vast ore resource would need to be identified to justify the large capital expenditure requirement, but also, for a zinc smelter, large quantities of cheap electricity are required and this is not the case in northwest Queensland.

Given the proximity of the Project to rail transport infrastructure which provides access to both export markets (via the Port of Townsville) and the Sun Metals refinery at Stuart, the production and sale of mineral concentrates, rather than on-site smelting of metal, is the preferred processing option for the Project.

2.2.4.11 Final Project Layout and Infrastructure Corridor Alignments

Figure 2.7 shows the layout and alignments for the following Project components that have previously been discussed in this Section:

- Powerline route (see Section 2.2.4.2);
- Water pipeline route (see Section 2.2.4.3);
- Access route (see Section 2.2.4.4);
- Accommodation camp (see Section 2.2.4.5);
- Tailings Storage Facility (see Section 2.2.4.6); and
- Processing plant (see Section 2.2.4.9).

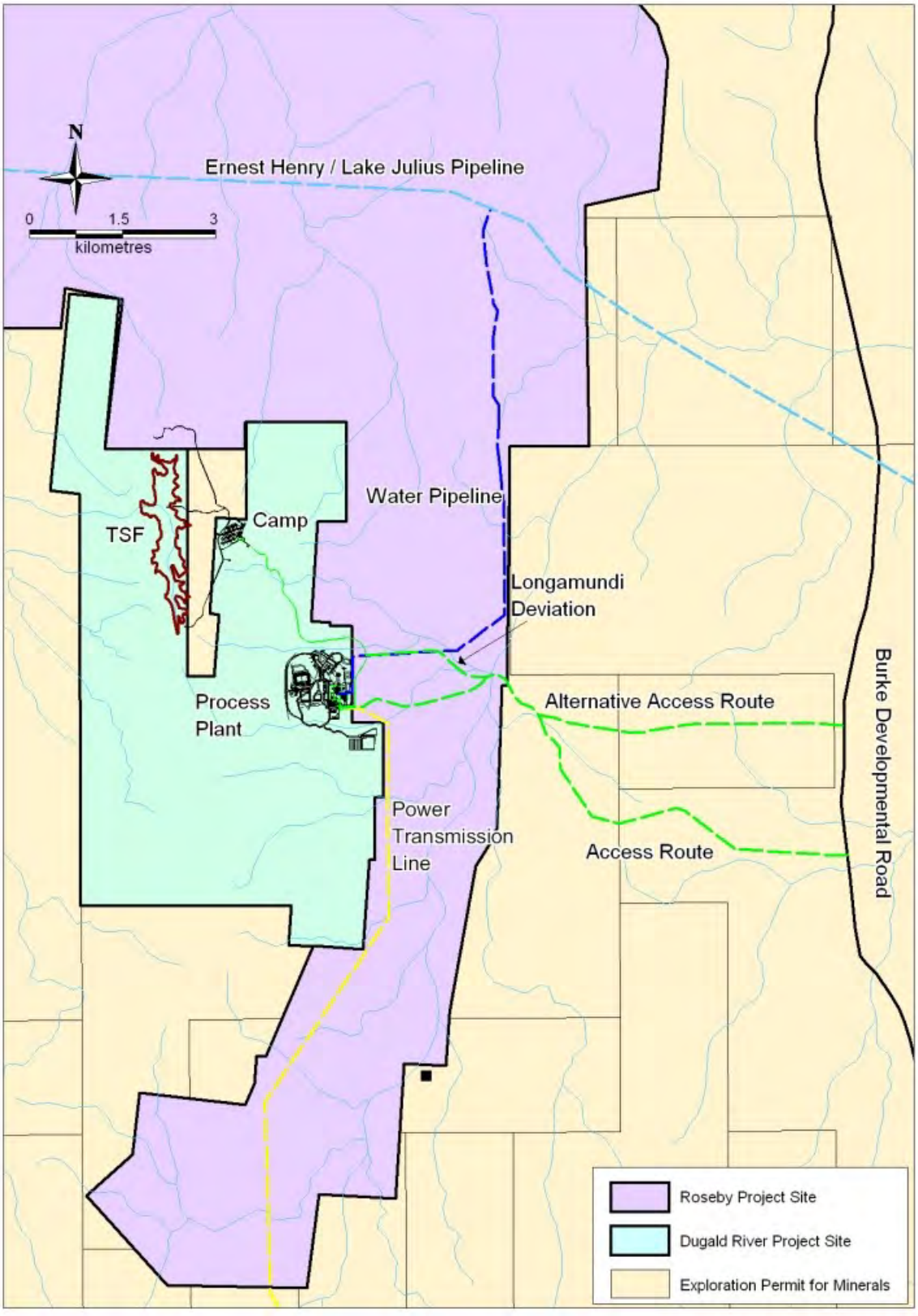


Figure 2.7 Final Project Layout and Infrastructure Corridor Alignments

2.2.5 Comparative Environmental Impacts and Ecologically Sustainable Development.

Mining has a potential risk of environmental harm, through land disturbance, processing activities and associated infrastructure. However, given the regulated nature of mining activities and the monitoring, mitigation and rehabilitation strategies that will be incorporated into the Environmental Authority for the Project, it is anticipated that any adverse impacts will be avoided where possible, or rehabilitated after operations cease. This will be ensured regardless of the profitability of the Project, as an amount of Financial Assurance (bank guarantee or cash) will be lodged with the Department of Employment, Economic Development and Innovation, to guarantee rehabilitation of the Project in the event the Proponent cannot pay for mine rehabilitation.

Providing Financial Assurance for a Project and the security of guaranteed rehabilitation is in accordance with inter-generational equity, one of the five major tenets of Ecologically Sustainable Development. By re-creating the landscape, post-mining, to as close to the original as possible, rehabilitation works enable future generations to have access to and benefit from the land where necessary. In addition, by placing monitoring and mitigation conditions on the Project prior to mining, using the information from environmental baseline studies, the precautionary principle is being endorsed. By carefully monitoring the environment prior to disturbance, and compiling scientific data, the areas to be disturbed, and the impact of the Project can be better understood, and this limits the risk of unforseen damage or unnecessary environmental harm.

3.0 DESCRIPTION OF THE PROJECT

3.1 LOCATION

3.1.1 Regional Context

The Project is located approximately 85 km north-east of Mt Isa and 65 km north-west of Cloncurry (Figure 3.1), in north-western Queensland. The Project is located adjacent to the proposed Roseby Copper Project.



Figure 3.1 Project Regional Location

3.1.2 Local Context

The Project is located in an area characterised by mineral exploration, mining and pastoral activities. As evidenced in Figure 3.2 there are many major mineral deposits in the region and operating mines.

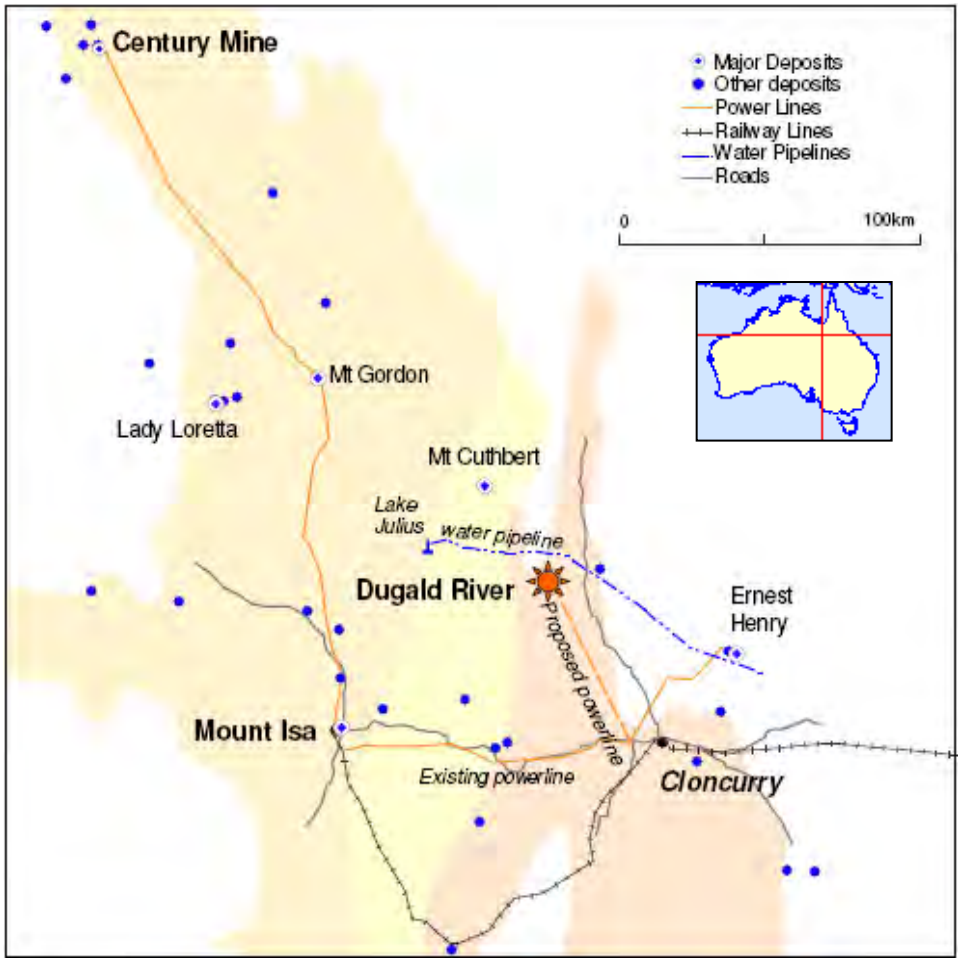


Figure 3.2 Local Context Map

Figure 3.3 and Figure 3.4 show the pastoral holdings and Lots and Plans that underlie and surround the Project site as well as associated infrastructure corridors. The surrounding pastoral holdings are mostly used for cattle breeding and fattening. The full details of the Lots and Plans underlying the Project's mining tenures are described in Section 3.3.1, and Table 3.3 and Table 3.4.

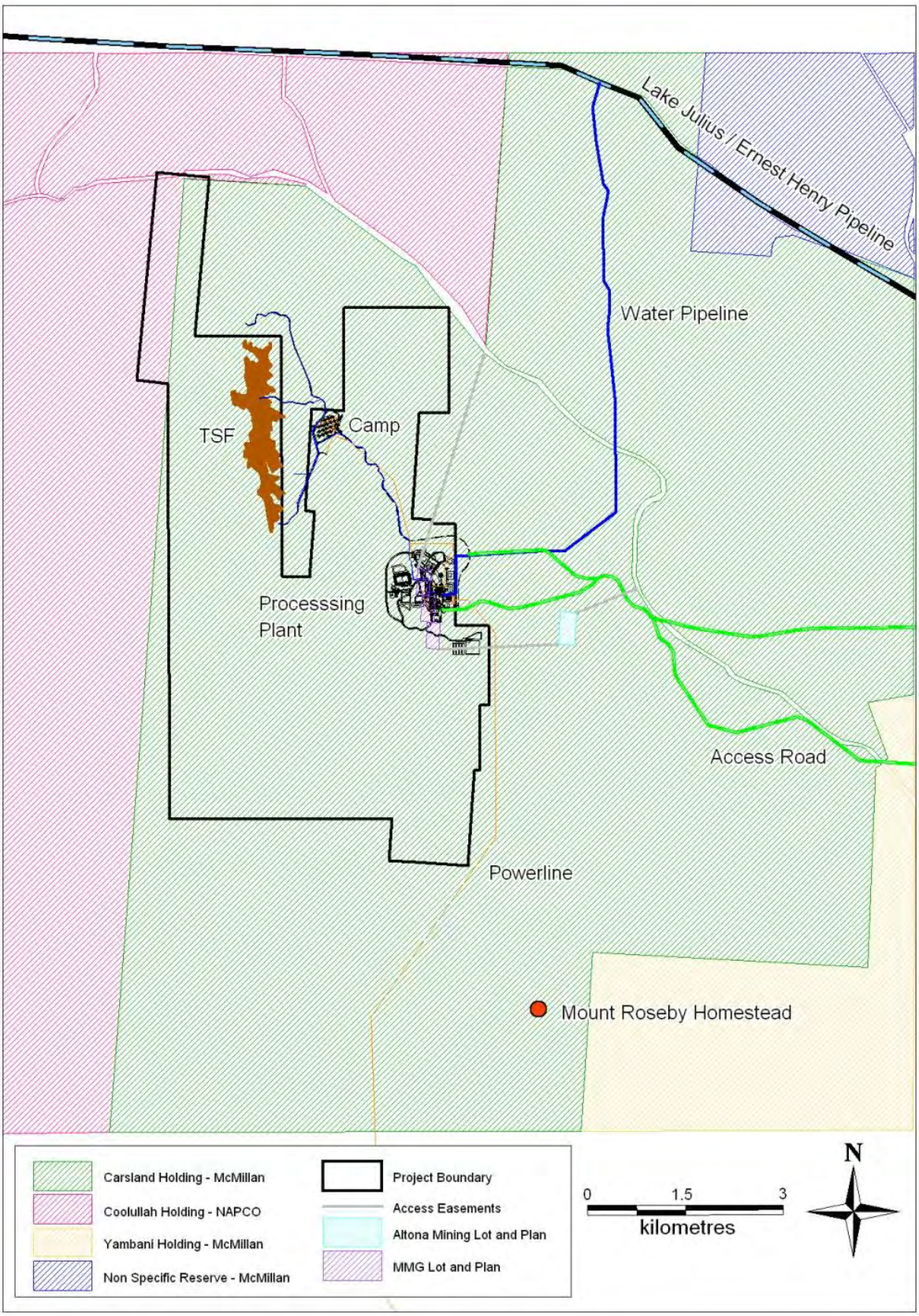


Figure 3.3 Cadastral Map with Project Site

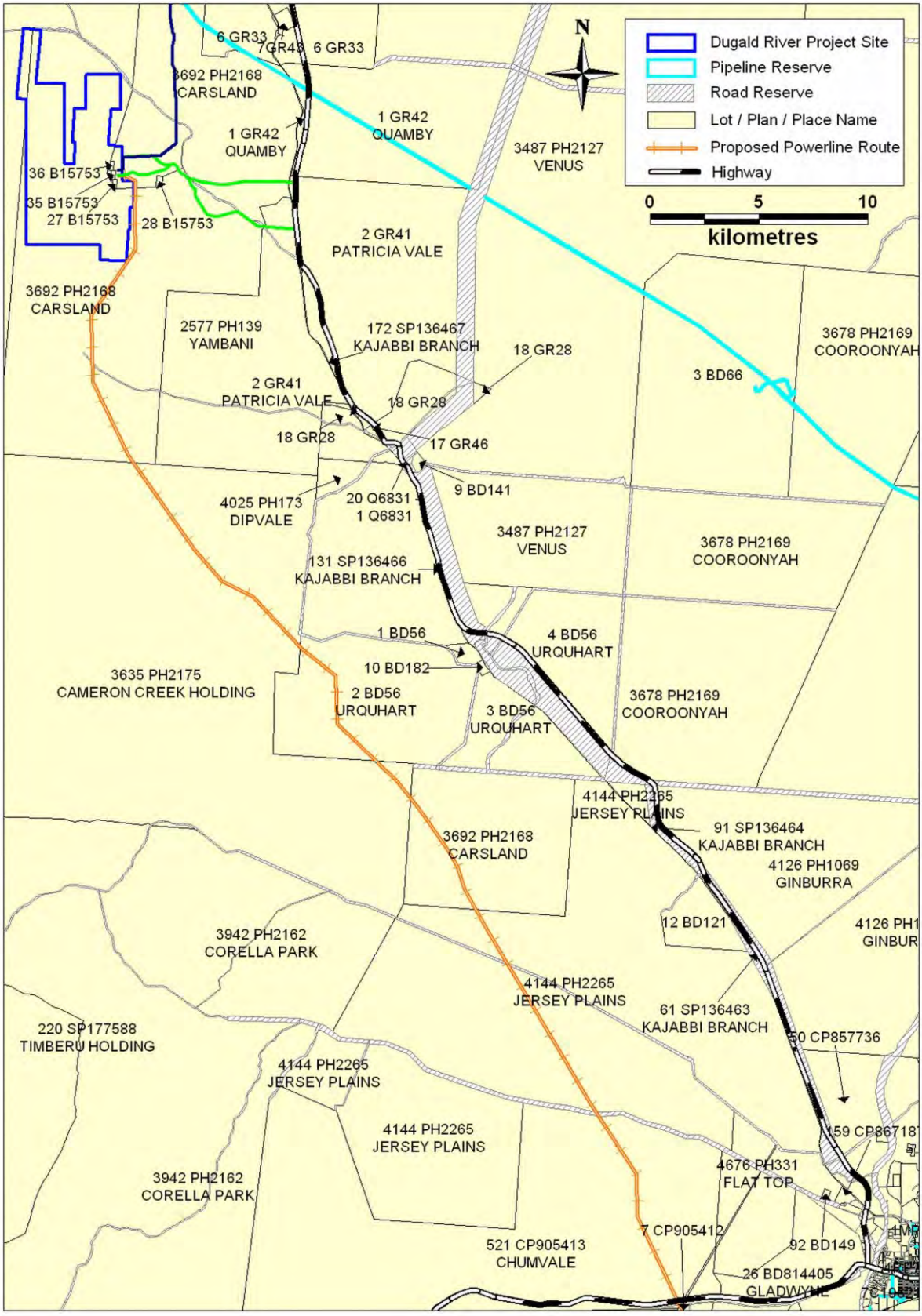


Figure 3.4 Cadastral Map with Powerline Corridor

The Dugald River lies to the east of the Project Site, and Cabbage Tree Creek is located to the west of the site. Several minor tributaries of these two major waterways flow off the Project site to join these systems (Figure 3.5).

Figure 3.6 shows the proposed layout of the Project's infrastructure and existing infrastructure in relation to the Roseby Copper Project's tenure. The mining and processing plant area will be located on the central eastern portion of the Project site. The extent of this area is constrained to the east by the Project site boundary, to the west by the Knapdale Range and minor creek systems to the north (Tributary 'A') and south (Silvermine Creek) (Figure 3.5). The TSF will be located on the western side of the Knapdale Range in the north-western portion of the Project site (Figure 3.6). The accommodation camp is proposed to be located on a plateau of the Knapdale Range in the central area of the Project site.

Adjacent to the Dugald River Project is the proposed Roseby Copper Project owned by Altona Mining Limited (Figure 3.6). This Project plans to mine 20 Mt of copper ore and waste per year from up to nine open cut pits. Roseby Copper Project will produce 85,000 tpa of copper concentrate filter cake. The mine life of the Roseby Copper Project is expected to be nine plus years.

In close proximity to both these projects lies the Roseby Homestead which is the operational centre for the Roseby pastoral property (Figure 3.6). This Homestead is located approximately 2.5 km southeast of the Dugald River Project southern boundary and less than 1 km from Altona Mining Limited's tenements. The Roseby pastoral property is a cattle grazing property and has several houses, sheds, groundwater bores, windmills, fencing, an airstrip, helicopter facilities and tracks.

The Burke Developmental Road is the current major highway providing access past the Project site. This road connects Cloncurry with Normanton and Karumba in the Gulf of Carpentaria. The Burke Developmental Road runs north/south past the Project site approximately 10 km to the east of the site. It is proposed to access the Project site via the Project access road which will run in a north-westerly direction off the Burke Developmental Road (Figure 3.6).

The Lake Julius / Ernest Henry pipeline runs in an east/west direction to the north of the Project site (Figure 3.6). This pipeline currently supplies water to the Ernest Henry Mine, which is located to the south-east of the Project site, from the Lake Julius dam, which is located north-west of the site. The Lake Julius / Ernest Henry pipeline is the proposed major water source for the Project and will be supplied by a proposed pipeline from the main line.

The proposed on site Project infrastructure is shown overlain on an aerial photograph in Figure 3.7.

MMG propose to construct a powerline from the Project site to Chumvale Substation, which is located approximately 10 km west of Cloncurry on the Barkly Highway. The powerline will be approximately 60 km in length and will traverse six pastoral lots from the Project site to Chumvale Substation (Figure 3.8).

The area surrounding the Project site is also currently used for mineral exploration activities (Figure 3.9). Adjacent to the Project site and underlying the powerline, water pipeline and access road corridors, MLs and EPMs are held by Altona Mining Limited, China Yunnan Copper Limited, Exco Resources Limited, Elementos Limited and Mount Isa Mines Limited (Figure 3.9).

There are no features of State or National Environmental Significance on the Project site. Sensitive environmental areas will be discussed in Section 4.2.1.9.

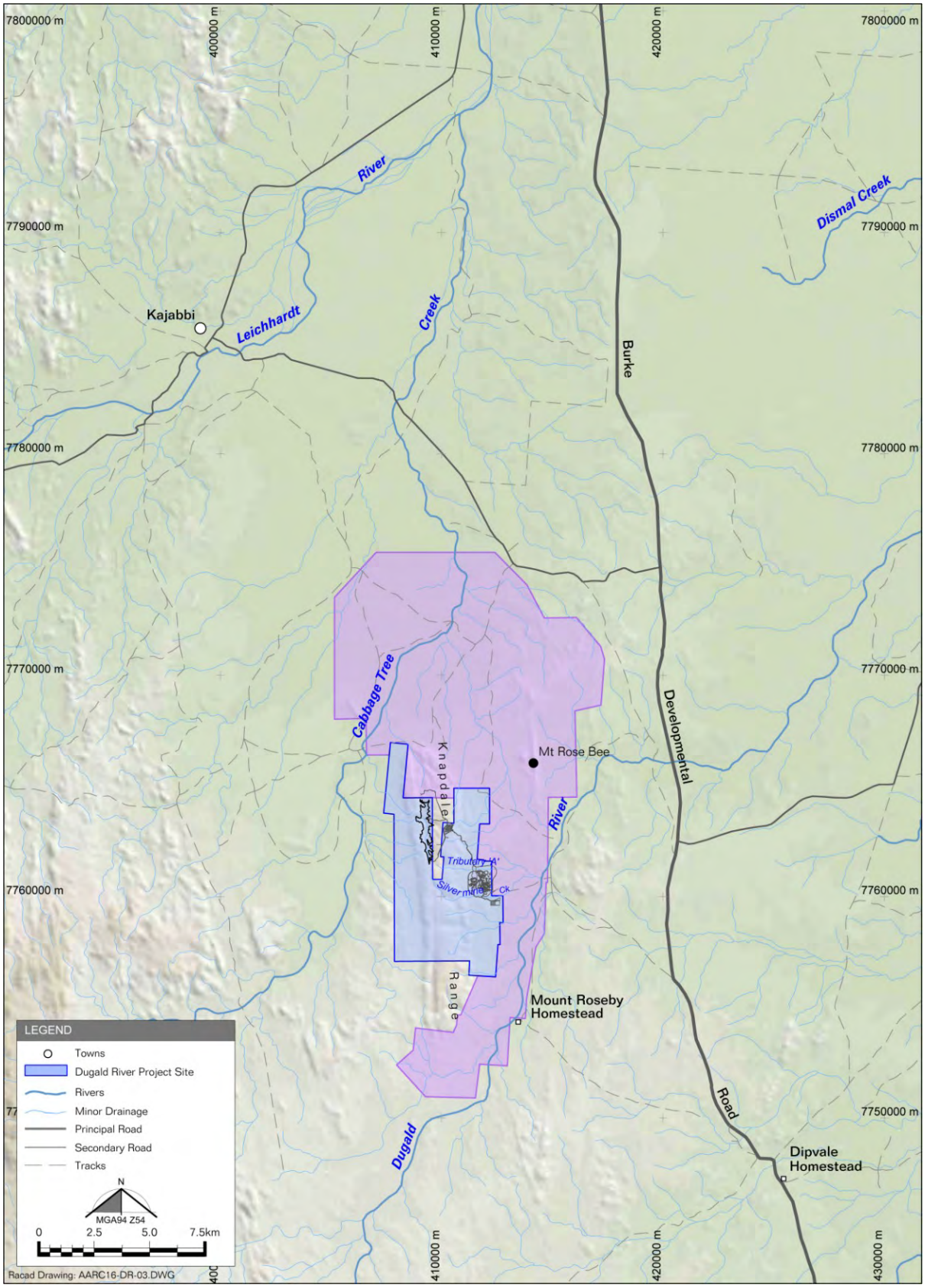


Figure 3.5 Watercourses on the Project Site

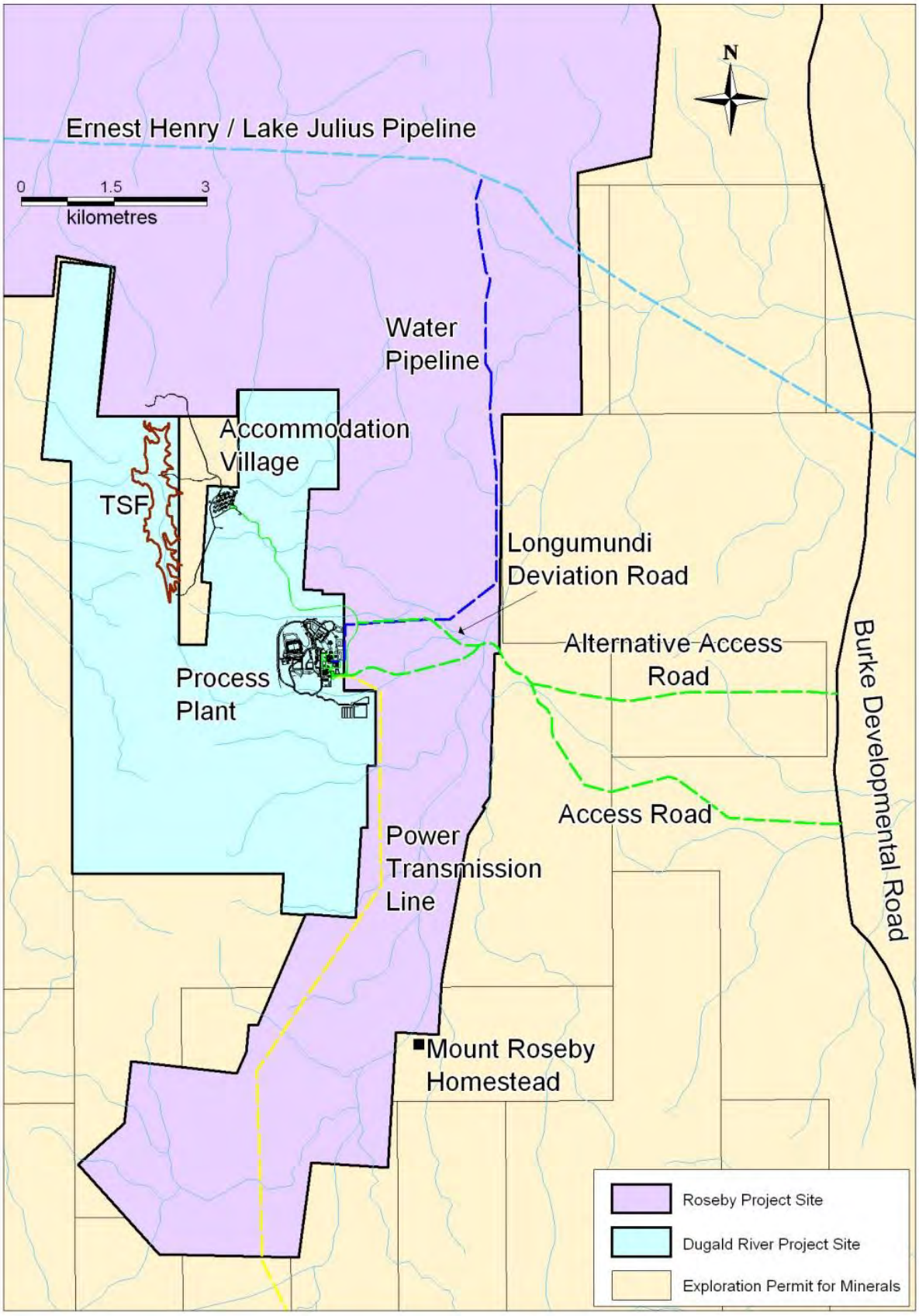


Figure 3.6 Project Infrastructure Layout

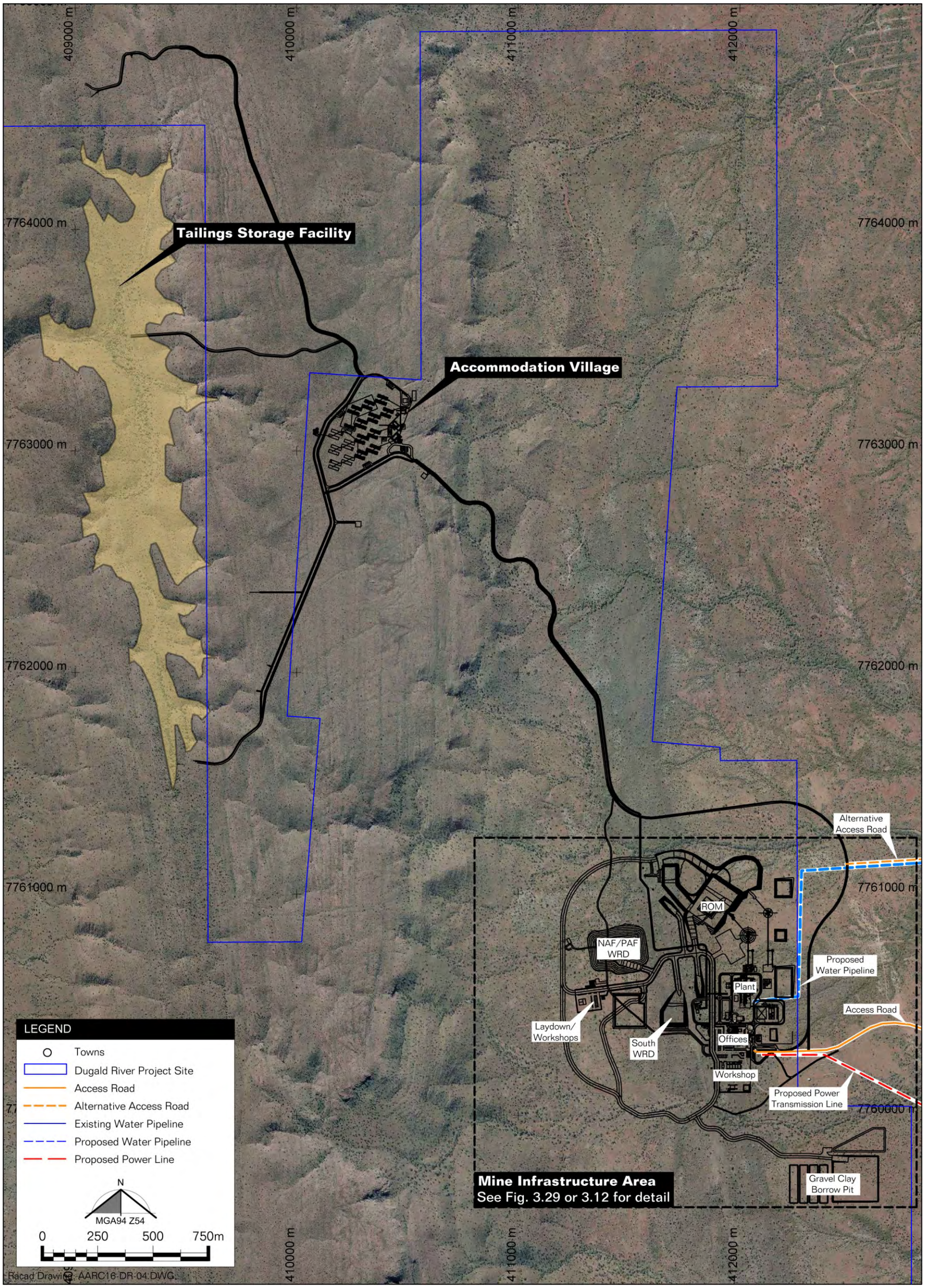


Figure 3.7 Project Infrastructure Layout over Aerial Photograph

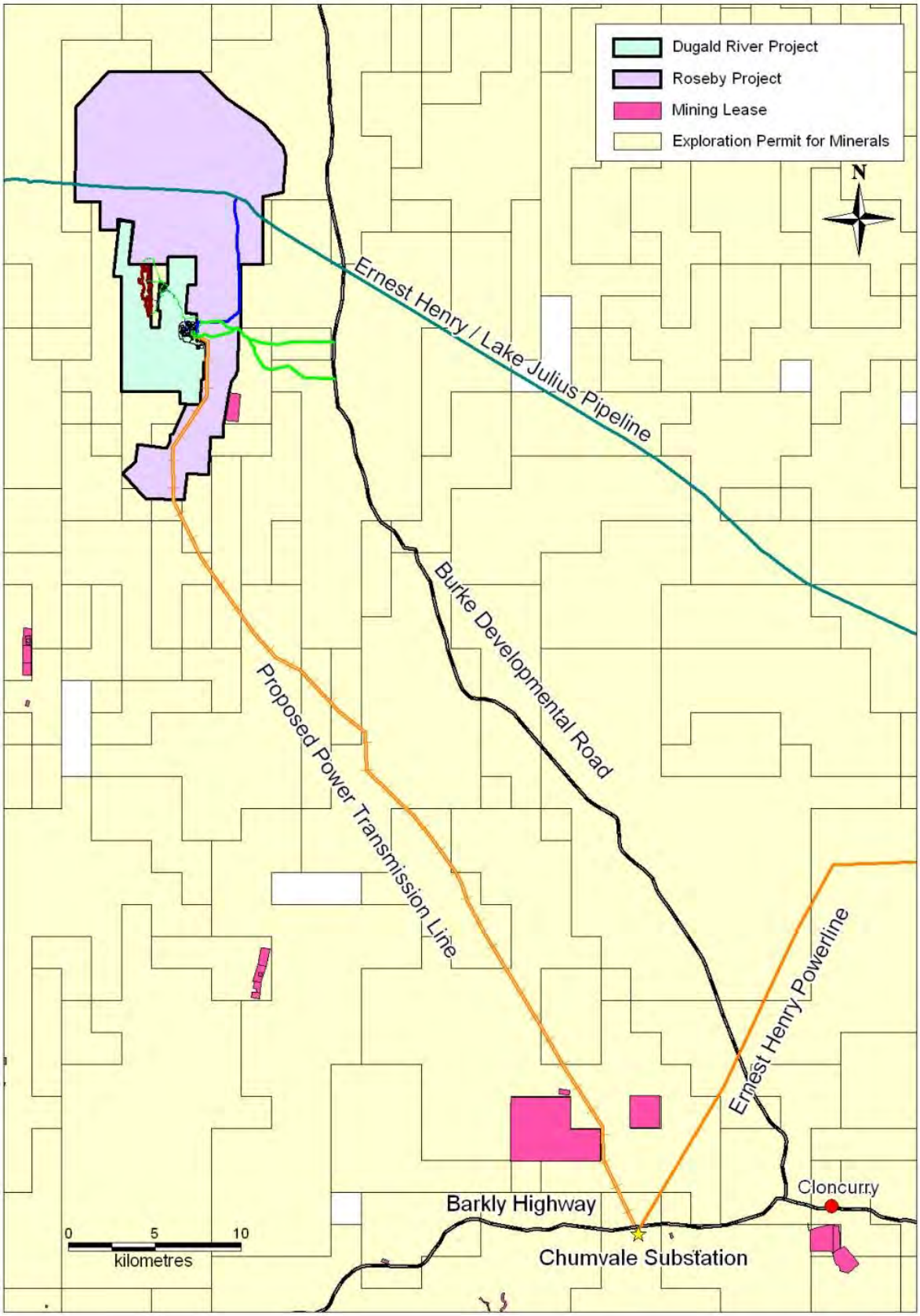


Figure 3.8 Proposed Power Line Location

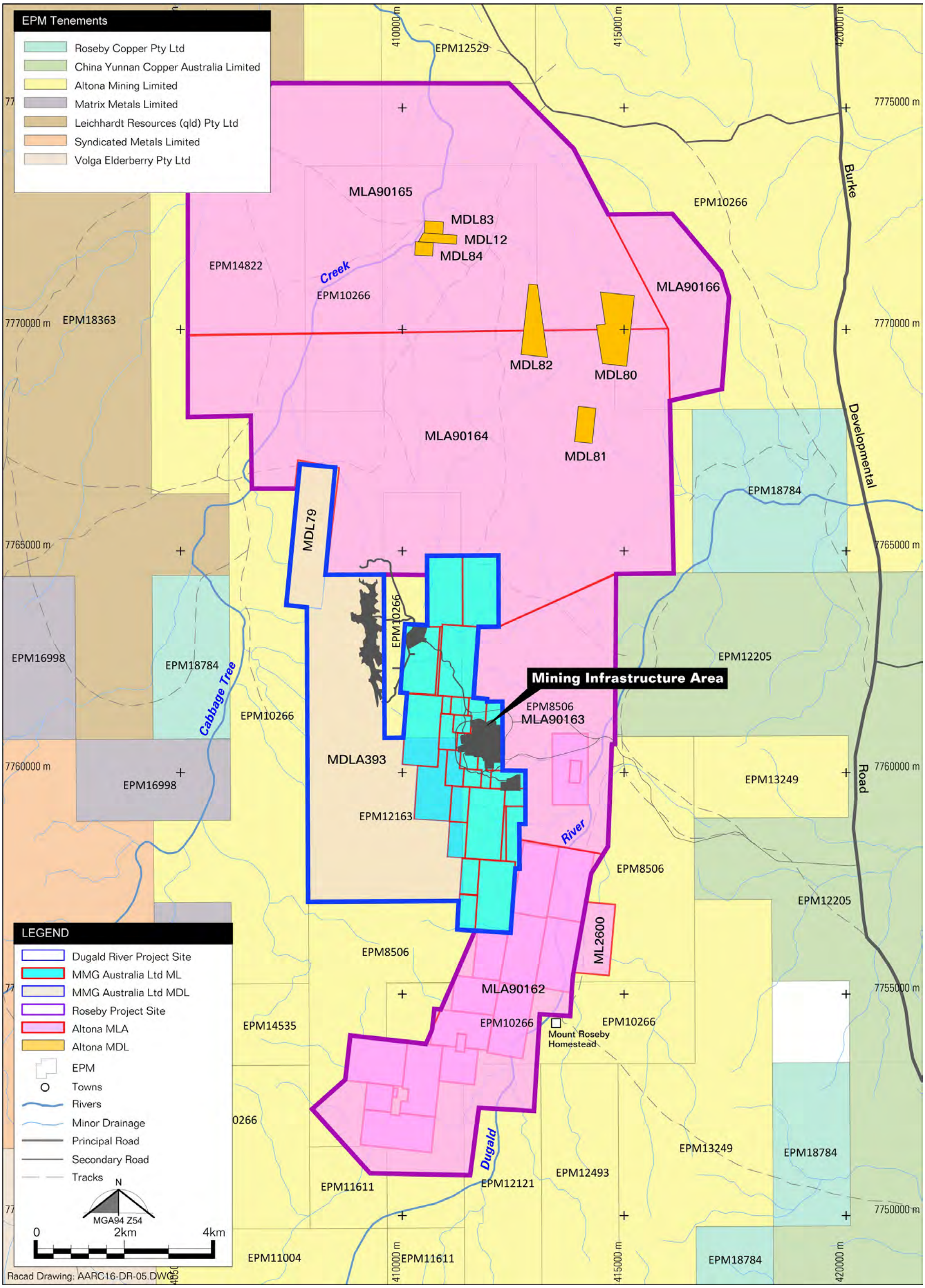


Figure 3.9 Adjacent Mining Tenements

3.2 CONSTRUCTION

The Project's main construction phase will have seven discreet components. Construction and commissioning of the Project is likely to commence in early 2012 and take approximately 2 years.

The construction components will be staged to a certain extent but will also be undertaken concurrently when appropriate. The major elements of the construction phase are:

- Early works;
- Construction of the accommodation camp;
- Construction of the water supply pipeline;
- Mine Establishment;
- Lead/zinc/silver process plant construction;
- Power line construction; and
- Construction of the TSF.

Descriptions of the elements of construction are provided in Section 3.2.1 to 3.2.7. Information on the items of plant or materials to be transported to the Project site during construction is covered by Table 3.13 in Section 3.5.1.6.

The main construction phase will be followed by a short commissioning phase of approximately six months which will bring the new infrastructure and Project into operation. The commissioning phase is likely to commence in early 2014 and be complete by mid 2014.

As detailed above, the lead/zinc/silver processing plant will be constructed during the main Project construction phase. The copper processing plant will be constructed at a later date, which is expected to be some time during 2015. The copper processing plant will be very similar to the lead/zinc silver processing plant and therefore this construction component will be the same as what is described in Section 3.2.5. Installation of the copper processing circuit will be subject to the successful proving up of sufficient additional resources from currently identified areas of copper mineralisation. Additional feed may also be sourced by toll treatment of third party ores.

3.2.1 Early Works

Early works can be defined as the following activities:

- Fly Camp construction for the initial construction crew at the current exploration camp;
- Installing a truck-loading stand pipe at the Lake Julius / Ernest Henry water pipeline connection to provide an initial water supply for the Project;
- Upgrading the access road to site from the Burke Developmental Road;
- Establishing borrow pits for construction materials and establishing a crusher to process the materials; and

- Upgrading the site's short-term Project communications.

These activities are discussed in Sections 3.2.1.1 to 3.2.1.5.

3.2.1.1 Fly Camp

The existing exploration camp currently provides accommodation for up to 25 people (Figure 3.10). On Project commencement, this exploration camp will be expanded to allow up to 50 people to be accommodated. This will be achieved by the addition of five additional crew quarters and an additional canteen unit. This Fly Camp will be used temporarily until the main accommodation camp is established.

Water is currently supplied to the exploration camp from groundwater bores and this water source will continue to be utilised for the Fly Camp. The Fly Camp will utilise the existing diesel generators and sewage treatment system that has been put in place for the exploration camp.

Prior to establishment of an on-site rubbish landfill site, rubbish will be transported offsite and disposed of at the Cloncurry Shire waste disposal facility.

The Fly Camp construction is likely to be the first construction task undertaken so that an initial construction crew can be accommodated. This construction task is therefore likely to be undertaken immediately on Project commencement in early 2012.

The areas for the additional quarters and canteen will be cleared of vegetation using a grader or dozer, with topsoil being left in place. The additional crew quarters and canteen unit will be delivered to site by road trains and lifted into place using cranes. Services to the new buildings will then be connected. It is anticipated that the Fly Camp construction will take approximately one month to complete.

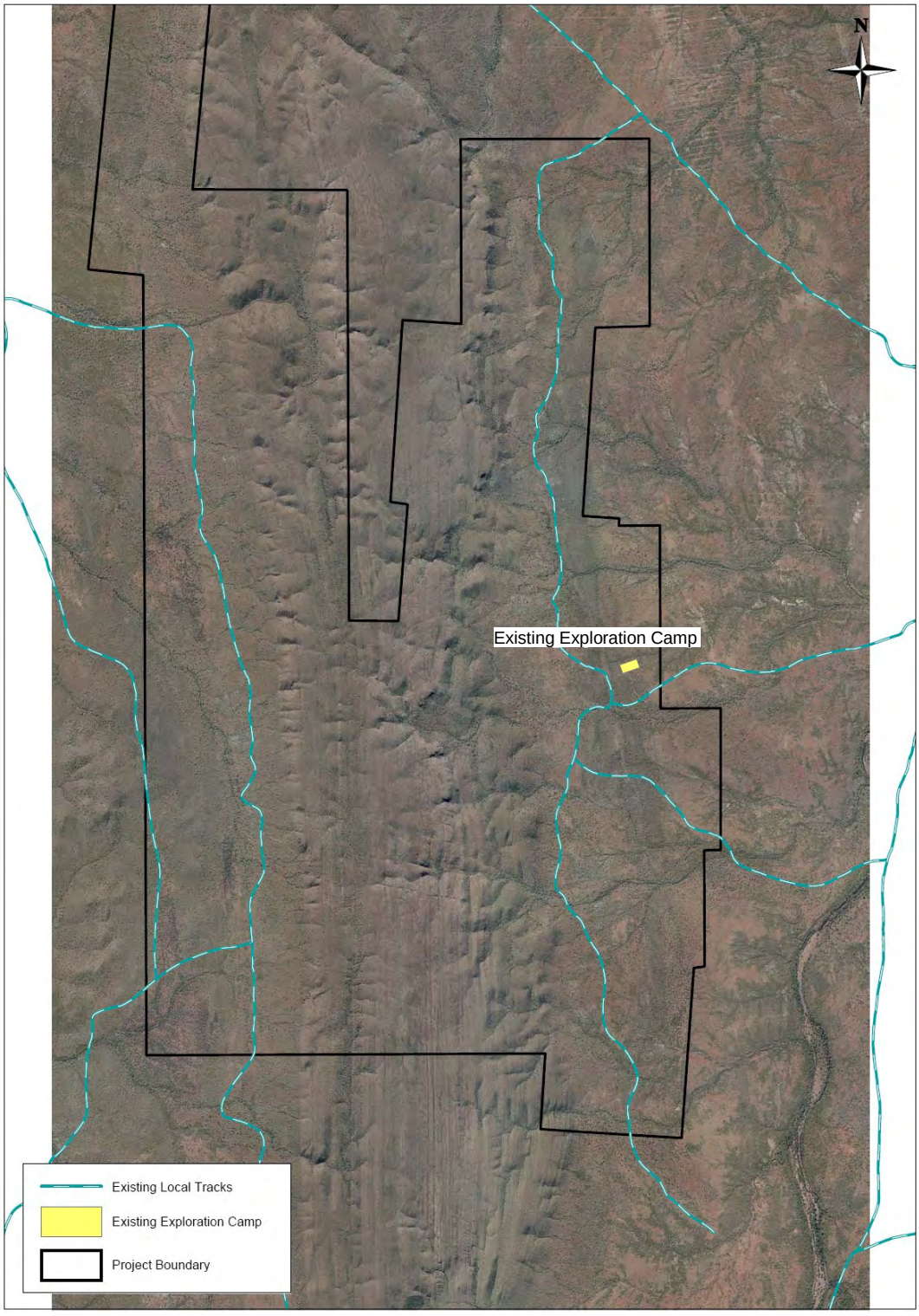


Figure 3.10 Location of Current Exploration Camp

3.2.1.2 Initial Water Supply

An initial water supply will be required for earthworks and construction activities to be conducted on site, prior to the proposed Project pipeline from the Lake Julius / Ernest Henry pipeline being completed. To facilitate this, a water truck stand pipe will be located at the Green Hills valve station on the Lake Julius / Ernest Henry pipeline. A road corridor will be cleared along the proposed route for the water pipeline to site and initially used as a road to allow transport of water to the site by road water tankers. This will be a temporary road and will not be utilised under wet conditions.

Usage requirements will be calculated to ensure adequate quantities of delivery are met. Water will be stored on site in water tanks. A water-treatment plant will also be constructed.

The works involved in the initial water supply for the Project site will commence as soon as the Fly Camp is operational and will take approximately three months to complete. Earthmoving equipment to be employed will include dozers and graders for clearing the access track along the proposed route for the permanent water pipeline which will be installed later.

3.2.1.3 Access Roads

The preferred access road to the site is off the Burke Developmental Road and follows the existing access road to the Project over much of it length (Figure 3.6). It is planned to construct a new turnoff approximately 1.6 km north of the current turnoff and redirect the road on a straighter alignment for a distance of approximately 1,000 m to join the current dirt road. This new intersection on the Burke Developmental Road will require negotiations with the local road authorities to ensure safe and appropriate design. Except for the initial 1,000 m length, the access road follows an existing track that will be upgraded and straightened for better access. The upgraded access road heads west from the Burke Developmental road to the Project site and is approximately 10 km in length.

The new intersection from the Burke Developmental Road to the Project site road will require complete roadwork, subgrade preparation, sub-base and base course. The existing alignment will only require local widening, creek crossing upgrades, and a new base course. Specifications for geometric design of access roads are summarised in Table 3.1. The road works amount to approximately 4.62 ha of clearing and grubbing, 7,220 cubic metres (m^3) of top soil stripping, 9,625 m^3 of sub-base aggregate, 14,648 m^3 of road base aggregate, and 4,000 square metres (m^2) of bitumen surfacing.

The area of the turn-off from the Burke Developmental Road will be widened to Type C so the MMG traffic does not interfere with the normal flow of traffic along the highway. The access road will have a bitumen surface immediately after the turn-off and on the approaches to the major creek crossing.

Plant site roads are generally divided in two categories.

1. The process plant roads, which will receive a mix of regular traffic and concentrate hauling around the process plant and general administration area. These roads will be:
    - Sealed to restrict dust emission; and
    - Constructed according to the specifications in Table 3.1.
2. The mining services roads, around the heavy vehicle workshop and fuel station will be:
    - Built according to mining haul road criteria.

The 2.34 km network of in-plant roads will require 8,500 m^3 of sub-base material, 2,500 m^3 of base course material, and 12,700 m^2 of bitumen. Site drainage will consist mainly of open vee drains, grated box culverts when access is required, and pipe crossings at intersections.

Table 3.1 Dugald River Roads Geometric Design Criteria

Feature	Site Access Roads	In-Plant Roads	Minor Access Roads
Design speed	80 km/h	20 km/h	40 km/h
Formation width	8 m	8 m	5 m
Pavement width	6 m	6 m	4 m
Normal cross-fall for gravel pavement	4%	4%	4%
Normal cross-fall for hot mixed asphalt pavement (if required)	3%	3%	
Maximum grade	6%	8%	10%
Maximum superelevation on horizontal curves	6%	6%	6%
Minimum horizontal curve radius to centreline of gravel paved formation	215 m	15 m	30 m
Minimum rate of crest vertical curvature K = length required for 1% change in grade	25 m	n.a.	4 m
Minimum rate of sag vertical curvature K	10 m	n.a.	3 m

River crossings will be installed across the Dugald River, Silvermine Creek, and various tributaries where necessary along the access road and road to the accommodation camp. The Dugald River crossing and other significant crossings were investigated by WRM Water & Environment Pty Ltd (WRM) in the Surface Water Assessment (Appendix G). WRM has recommended designs using inverted box and pipe culverts. Detailed specifications of the crossings are provided in Section 3.5.4.4. The main access road crossings have been designed as low level (causeway) crossings with minimum loss of waterway area and floodplain storage to minimise any potential impacts on the waterways. This will result in these crossings being overtopped whenever a significant runoff event occurs in the above catchments. During major flood events, the Dugald River crossing would be overtopped intermittently for periods varying from a few hours up to about two weeks. The Silvermine Creek and other minor tributary floods would overtop their respective road crossings for periods varying from a few hours up to one or two days depending on the magnitude and duration of the flood event.

The major and minor creek crossings along the road connecting the mine operations area to the accommodation camp area have been designed to provide flood immunity up to the 100 Year Average Recurrence Interval (ARI) flood event. The impact of these crossings on flooding behaviour in these waterways would be minimal. The road between the process plant and the accommodation camp, will also serve as the power and water corridor to the camp and possibly the TSF.

The locations of the river and creek crossings are shown in Figure 3.11.

Gravel and material for construction of the main Project access road will be sourced from a series of borrow pits along the length of the roads, within the approved road corridor, or from larger borrow pits located south-east of the process plant site

The Longamundi deviation road that is proposed for the access road will only be constructed if and when the Longamundi pit is developed for the Roseby Copper Project. As this pit is not planned to be

developed until 7 to 9 years after the Roseby Copper Project becomes operational, the creek crossings on the deviation road will be designed prior to construction of the road to take into account the actual pit and waste rock dumps' designs. Similarly, the alternative access road to the north of the preferred access road at the eastern end of the route, will only be constructed if and when the Longamundi pit is developed.

The Lake Julius / Ernest Henry water pipeline access corridor will provide an emergency access route and will therefore require upgrading.

It is expected that construction works on the access roads will commence once the Fly Camp is operational. It is anticipated that the access roads will take approximately three months to complete. Earthmoving equipment likely to be utilised in the construction of the access roads will include dozers, scrapers, graders, excavators, trucks, compactors/rollers and water trucks.

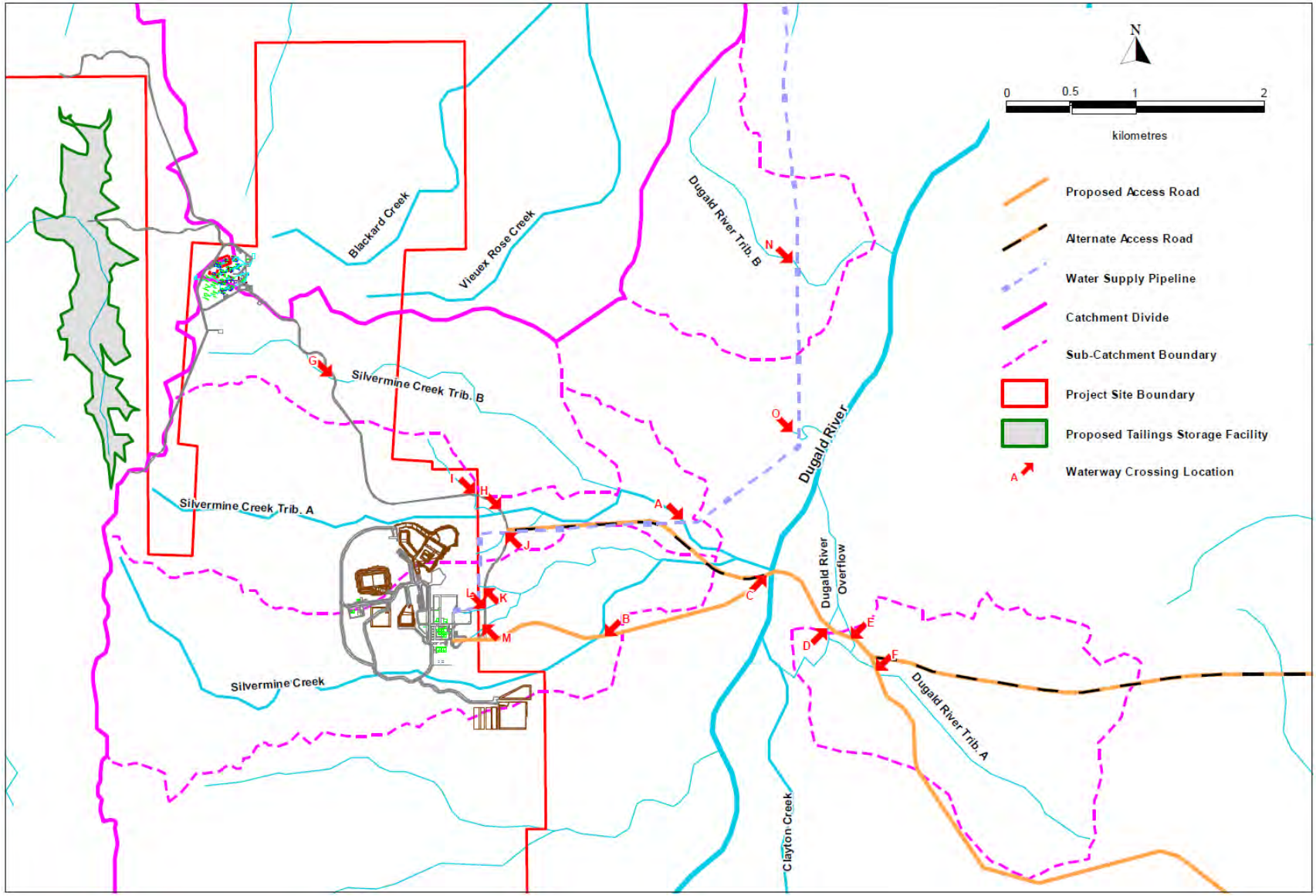


Figure 3.11 Location of Waterway Crossings on Access and Accommodation Camp Roads and the Water Pipeline

3.2.1.4 Borrow Pits

Borrow pits will be developed on the Project to source clay, gravel, sand, course rock and aggregate for road construction and fill for the development of the processing plant and mining areas. These materials may also be sourced from the processing plant area itself during the excavation of the numerous pond areas required or later from the underground mine development works. The main borrow pit area for gravel will be located to the south-east of the proposed processing plant area as shown in Figure 3.12. Coarse rock and aggregate will be sourced from the cut material excavated during construction of the access road to the accommodation village and also from a rock quarry. The location of the rock quarry will be located on MMG's controlled tenure and will be identified following a geotechnical materials survey of the area. Borrow pits for construction of the TSF are discussed in Section 3.2.7.

Some borrow pit materials will require crushing and screening prior to use and therefore a crushing and screening plant will be established at some borrow pit locations. Temporary stockpiles of the various materials will also be located adjacent to crushing and screening plants.

Where required a small bund wall will be established around the borrow pits and stockpile area to direct surface water flow away from these areas and prevent sediment leaving the site.

It is expected that construction works on accessing materials from borrow pits will commence once the Fly Camp is operational. Borrow pits are likely to remain open for sourcing material during the entire construction phase of the Project and some may remain open into the operational phase. Should a borrow pit be exhausted of suitable materials they will be rehabilitated.

Earthmoving equipment likely to be utilised in the construction of the borrow pits and removal of borrow pit materials will include dozers, scrapers, excavators, trucks, water trucks and crushing and screening plants.

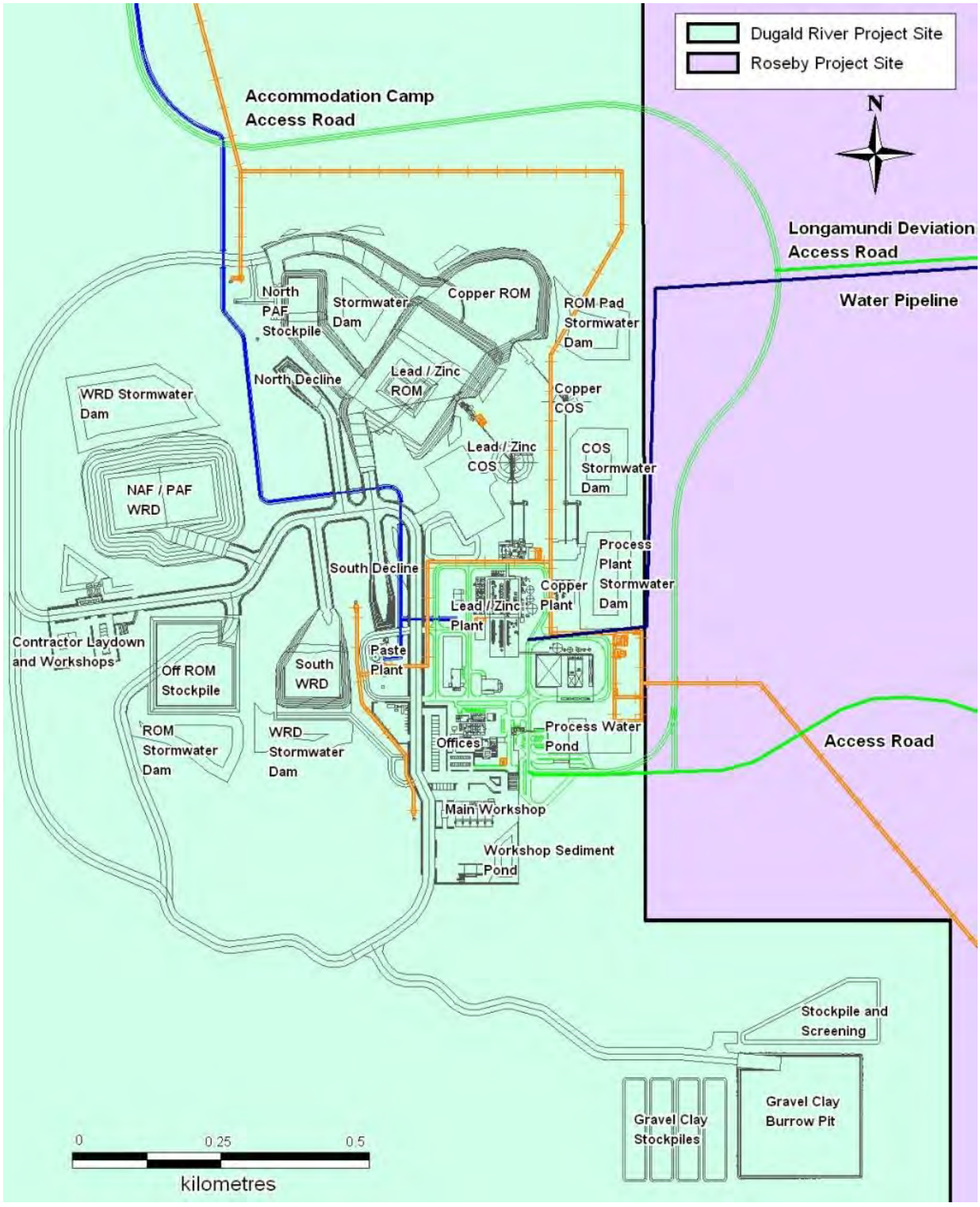


Figure 3.12 Mine, Processing Plant and Borrow Pits Layout

3.2.1.5 Upgrade to Communications

A communications tower will be established adjacent to the proposed site of the construction and operations accommodation camp. This work will be undertaken once an access track to the

accommodation camp location has been established. These works are expected to take approximately three months to complete. Earthmoving equipment to be employed may include a dozer and grader to clear the site of the communications tower.

A RAWsat communications system will be established to provide stable communications during the Early Works phase and up to the establishment of permanent communications for the site.

3.2.2 Accommodation Camp

It is planned that work on the accommodation camp will commence as soon as possible, so that as units become available, the construction crew will transfer there to allow the existing Fly Camp facilities to be moved and modified. The accommodation camp is likely to take approximately six months to construct with construction commencing in 2012. The initial accommodation camp will be designed to have approximately 502 - 622 rooms, with further capacity to expand to 766 rooms if required.

Figure 3.13 shows a plan view of the layout of the accommodation camp. The accommodation units will be clustered in groups of six (three units back-to-back with each unit containing four rooms). A total of 21 clusters will be initially required. There is space within the accommodation camp layout for expansion by another 66 four-room units (a total of another 264 rooms), if necessary. Six small laundries will be spread throughout the accommodation area, while the non-residential buildings and recreational facilities will be located on the eastern side of the village.

The layout of the accommodation camp has attempted to minimise the amount of trenching required, as this is likely to need rock-trenching devices. Electricity and other communications cables will be overhead, also to reduce trenching.

The accommodation camp area will be cleared of vegetation using a grader and/or dozer, with topsoil being stripped by scrapers or dozers and trucks and placed nearby. The accommodation units will be delivered to site by road trains and lifted into place using cranes. Services to the buildings will then be connected. The accommodation camp will run off two diesel generators for up to two years until the permanent grid connection is constructed and operational.

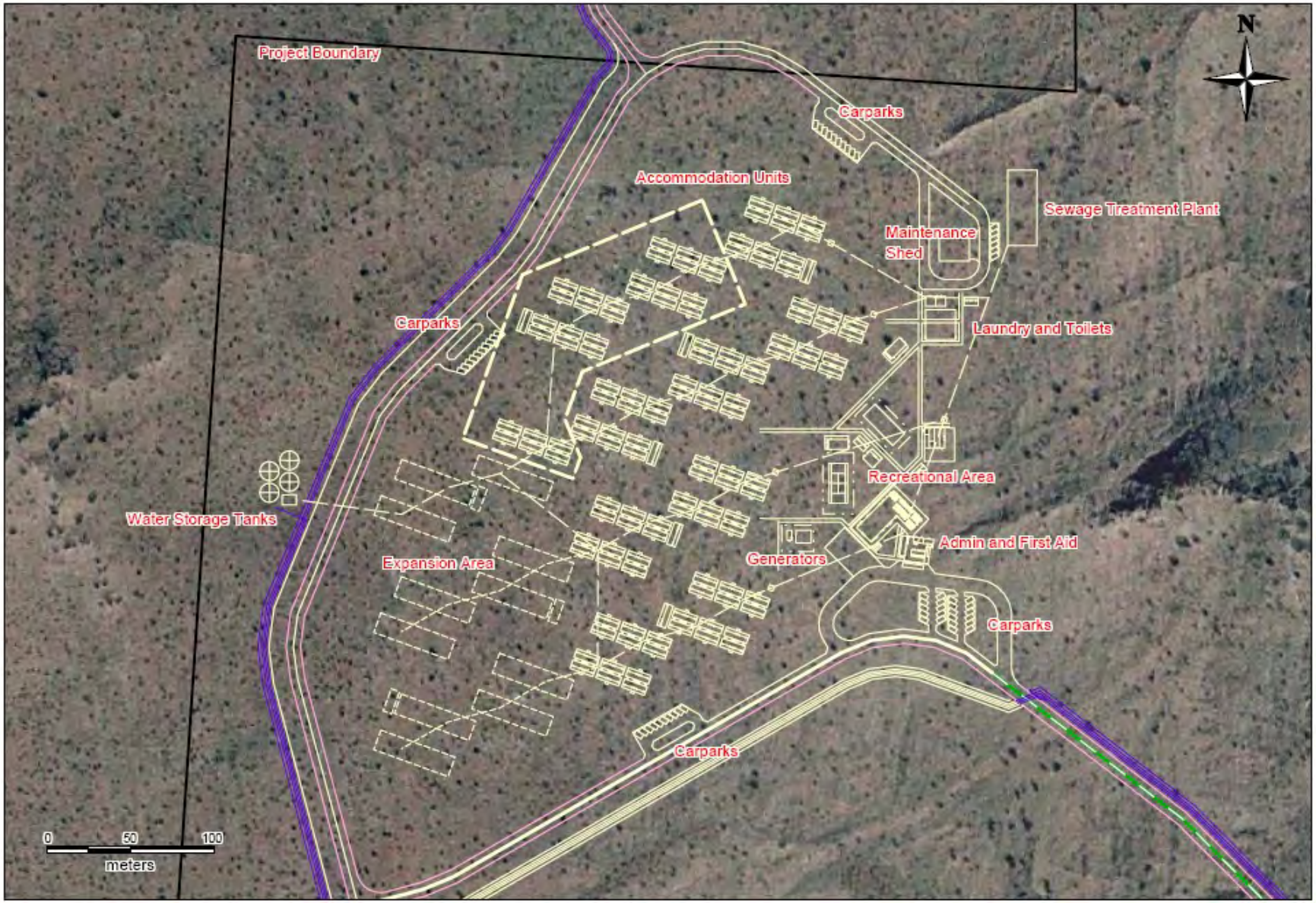


Figure 3.13 Accommodation Camp Layout

3.2.2.1 Accommodation Camp Sewage Treatment

A modular waste water treatment plant consisting on independent sewage and grey-water treatment facilities will be constructed at the accommodation camp. The first facility will process the sewage stream only and the second facility will process grey-water waste. This allows the treated grey water from the second facility to be used for either subsurface irrigation and/or disposal to the TSF. Sub-surface irrigation of grey water will be used to water the gardens at the accommodation camp.

The sewage treatment plant at the accommodation camp will discharge to the TSF during the operational phase of the Project only. As the TSF will still be under construction during the construction phase of the Project, the sewage treatment during this time will discharge to a series of absorption trenches.

The accommodation camp sewage and grey water treatment facilities will each require an area of approximately 20 m x 20 m. The Turbo-Bioreactor (TBR™) units will be housed in a 20 m x 8 m painted steel container. Storage tanks, transfer pumps, and control panels will be located outdoors, next to the TBR™ unit. Chemicals will be stored near-by in a cladded steel-framed enclosure.

The plants require a continuous minimum flow of waste water to sustain the micro-organisms that process the waste. Chatoyer have indicated that if there are fewer than 150 people using the system for more than one week, the biological processes in the TBR™ unit could be interrupted.

Figure 3.14 shows a typical layout of a Chatoyer wastewater treatment plant.

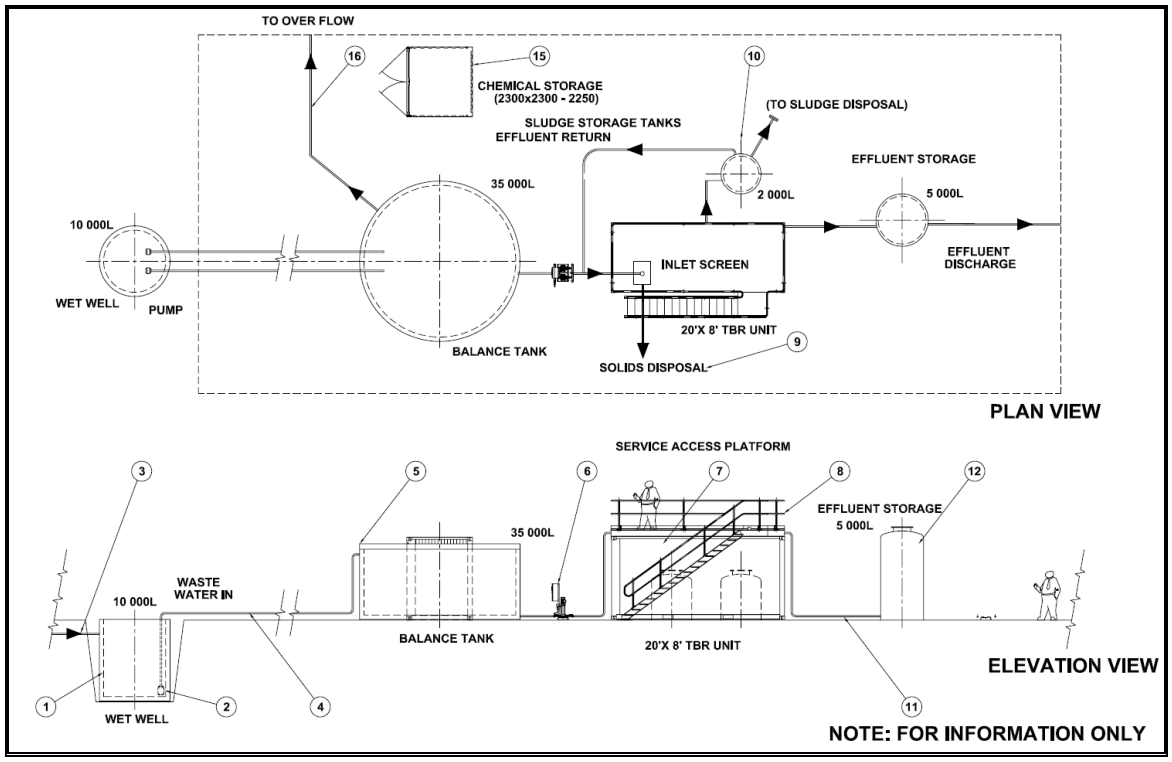


Figure 3.14 Typical Chatoyer Wastewater Treatment Plant Layout

3.2.2.2 Construction Phase Rubbish Disposal Site

Prior to establishment of an on-site rubbish landfill site, rubbish will be transported offsite and disposed of at the Cloncurry Shire waste disposal facility.

3.2.3 Water Supply Pipeline

The water pipeline will be constructed as soon as possible to reduce the cost of water hauling by water trucks. Construction is likely to commence in early 2012 and take approximately six months to complete.

The pipeline will be approximately 10.1 km in length and will be an above ground pipe, mounted on concrete pedestals. The earthwork required for installation of the pipeline will be clearing and grubbing of the route, localised cut and fill to eliminate any isolated obstructions, and a road sub-base layer to shape the access road forming part of the corridor alongside the pipe. Heavy equipment to be utilised in the construction of the water supply pipeline will include dozers and graders for clearing vegetation and topsoil and creating access, and cranes for pipeline installation.

The water supply will be split so that some of the water is pumped to a raw-water tank at the accommodation camp and the bulk of the water will flow to a 1,915 m^3 raw-water tank near the process plant. There will be sufficient pressure in the Lake Julius / Ernest Henry line for the water to flow to the plant site.

The water pipeline from the T-piece is 225 mm nominal outside diameter (OD), co-extruded high-density polyethylene (HDPE) aboveground pipe. The pipe will be wrapped to protect it from the sun.

The pipeline will cross tributaries of Dugald River and Silvermine Creek at three locations (see Figure 3.11). These crossings have been investigated WRM in the Surface Water Assessment (see Appendix G). Detailed specifications of the crossings are provided in Section 3.5.4.4. The route selected for the water pipeline runs east from the Project Site then travels north along the eastern side of the Mount Rose Bee range of hills (see Figure 3.7).

3.2.4 Mine Establishment

Mine establishment will commence with the development of the north and south portals and declines and the removal of waste rock. Waste rock will be brought to the surface with Non Acid Forming (NAF) waste rock used to construct infrastructure such as the ROM Pads, mine roads, and the bases of waste rock dumps. Potentially Acid Forming (PAF) waste rock will be brought to the surface and either encapsulated in a waste rock dump or temporally stockpiled on a NAF waste rock pad for disposal underground at a later date.

Once ore is intercepted in the underground mine this will be removed and stockpiled on the surface on either the ROM Pads or the Off ROM Ore Stockpile. This ore will only be stockpiled until the processing plant is commissioned in mid 2014, at which time it will be processed. Stormwater Ponds downstream of these ROM Pads will capture any runoff from these areas and have been sized for 1:100 Year ARI, 2 month wet season so that overflows do not occur except in extreme circumstances.

The proposed layout of the mining area is shown in Figure 3.15.

Mine establishment will commence in mid 2012 once the Early Works described in Section 3.2.1 have commenced and the Fly Camp is complete. The lead/zinc/silver ROM ore production from the underground mine will gradually increase over a three year period up to full production of 2 Mtpa in

2015. Mine production from the underground mine for copper ore is predicted to commence in 2017 at a production rate of 1 Mtpa.

Earthmoving and heavy equipment to be utilised in underground mine establishment, will include underground loaders (boggers), dump trucks, development drill jumbos, production drills, graders and water carts.

3.2.4.1 Mining Area Stormwater Dams and Sediment Ponds

Stormwater dams and sediment ponds will be constructed downstream of the ROM Pads, Off ROM Ore Stockpile, waste rock dumps and other disturbed areas to capture rainfall runoff. Where this runoff is expected to be contaminated these ponds will be HDPE lined and include a Design Storage Allowance for a 1:100 Year, ARI 2 month wet season or a 1:20 Year, ARI 2 month wet season depending on their expected water quality and hazard rating. Sediment ponds for non-contaminated run-off will be designed to contain a 1:10 Year ARI, 24 hour event. These stormwater dams and sediment ponds are discussed further in Section 3.5.4.1.

Excavated material from constructing the stormwater ponds and sediment ponds will be used for constructing the ROM Pads, mine roads and used for fill underground where required.

3.2.5 Processing Plant

The lead/zinc/silver processing plant is likely to take approximately 2 years to construct with construction commencing in 2012. Commissioning of the lead/zinc/silver processing plant is likely to be complete by mid 2014. The copper processing plant will be constructed at a later date, which is expected to be some time during 2015. The copper processing plant will be very similar to the lead/zinc silver processing plant and therefore this construction component will be the same as what is described above. Once the copper processing plant has been commissioned copper ore mining and processing will commence, which is currently proposed for during 2017.

3.2.5.1 Bulk Earthworks

The process plant bulk earthworks will be undertaken to create a flat area encompassing the whole plant site and following the general natural drainage path. Bulk earthworks will be undertaken using earthmoving equipment including dozers, scrapers, graders, excavators and trucks.

As shown in Figure 3.15 the mining and plant site is bounded to the west by the Knapdale Range, to the east by the boundary of MMG's MLs, to the south by Silvermine Creek and to the north by a northern tributary of Silvermine Creek (Tributary 'A'). The land to the east of the deposit slopes gently toward the Dugald River.

The design levels of the bulk earthworks were laid-out according to the general natural ground slope, in the west-east direction, to reduce earthworks. A flat one-level bulk earthwork platform was preferred for ease of construction and operation. Figure 3.16 shows the plant site bulk earthworks design levels.

The bulk earthworks for the plant area will result in 41,350 m^3 (compacted cubic meters) of cut soil being backfilled into the small creek in the middle of the plant area, and excess of 180,000 m^3 (bulk cubic meters, 25% bulking factor added) of loose material that will be ripped by heavy machinery into gravel. The top clayey or silty gravel may be reused for bulk or engineered fill, whereas the deeper very weathered rock may be suitable for road and concrete aggregate.

The geotechnical investigation found a hard rock zone about five metres below the surface of the proposed plant area. The earthwork cut depths will be limited to 4.5 m to avoid blasting in this hard rock zone. The areas with the deepest cuts are in the administration and workshop areas, where there are two small hills. The bulk earthwork design levels will result in a main fill area of up to 3.5 m deep at the creek bed in the middle of the plant, and two large areas of cutting on either side, with excavation down to 4 m below ground level at the mine services area, as shown on Figure 3.17. The depth of the cut in the process plant area is typically 1 m below the existing ground level.

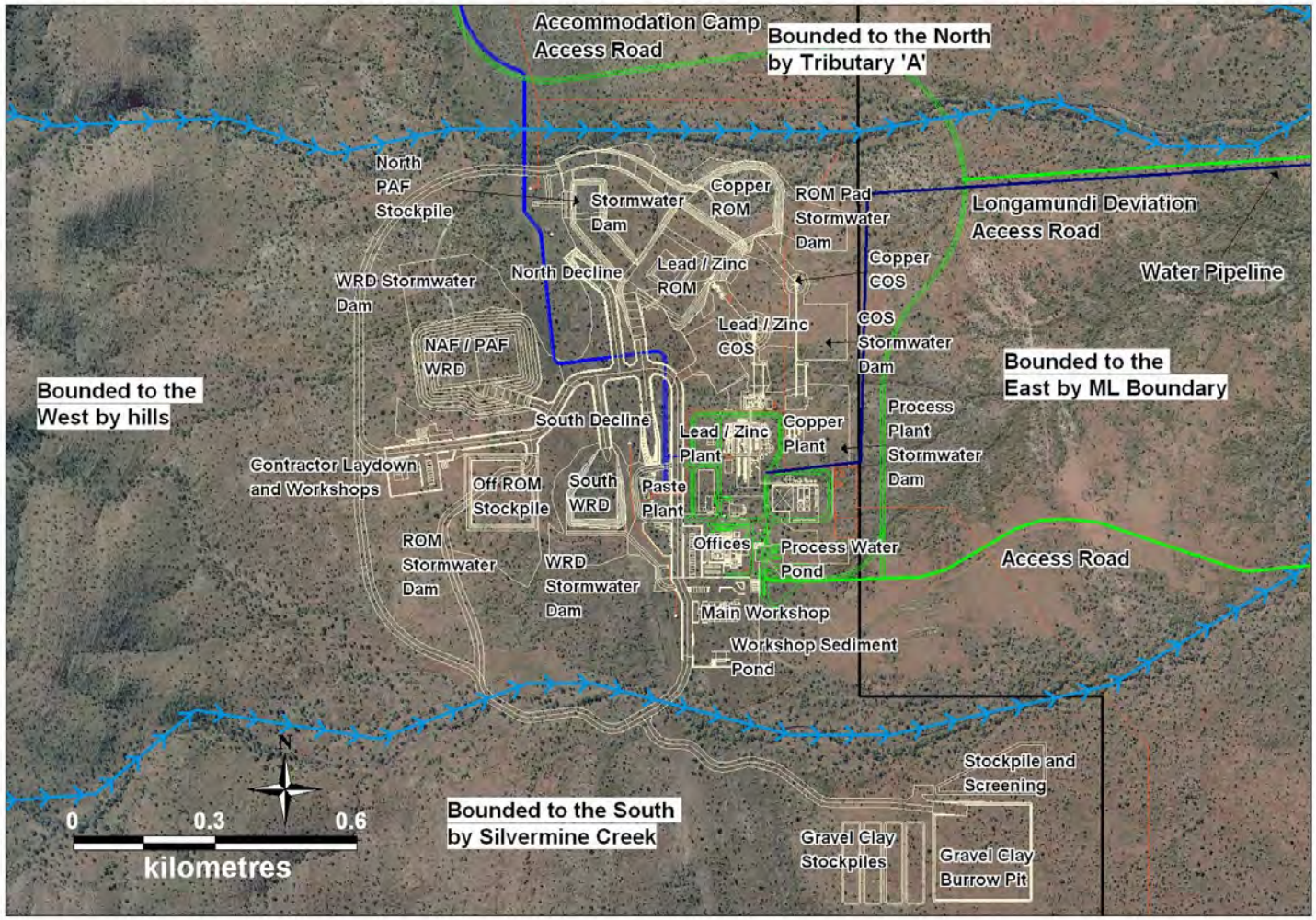


Figure 3.15 Processing Plant and Mine Location

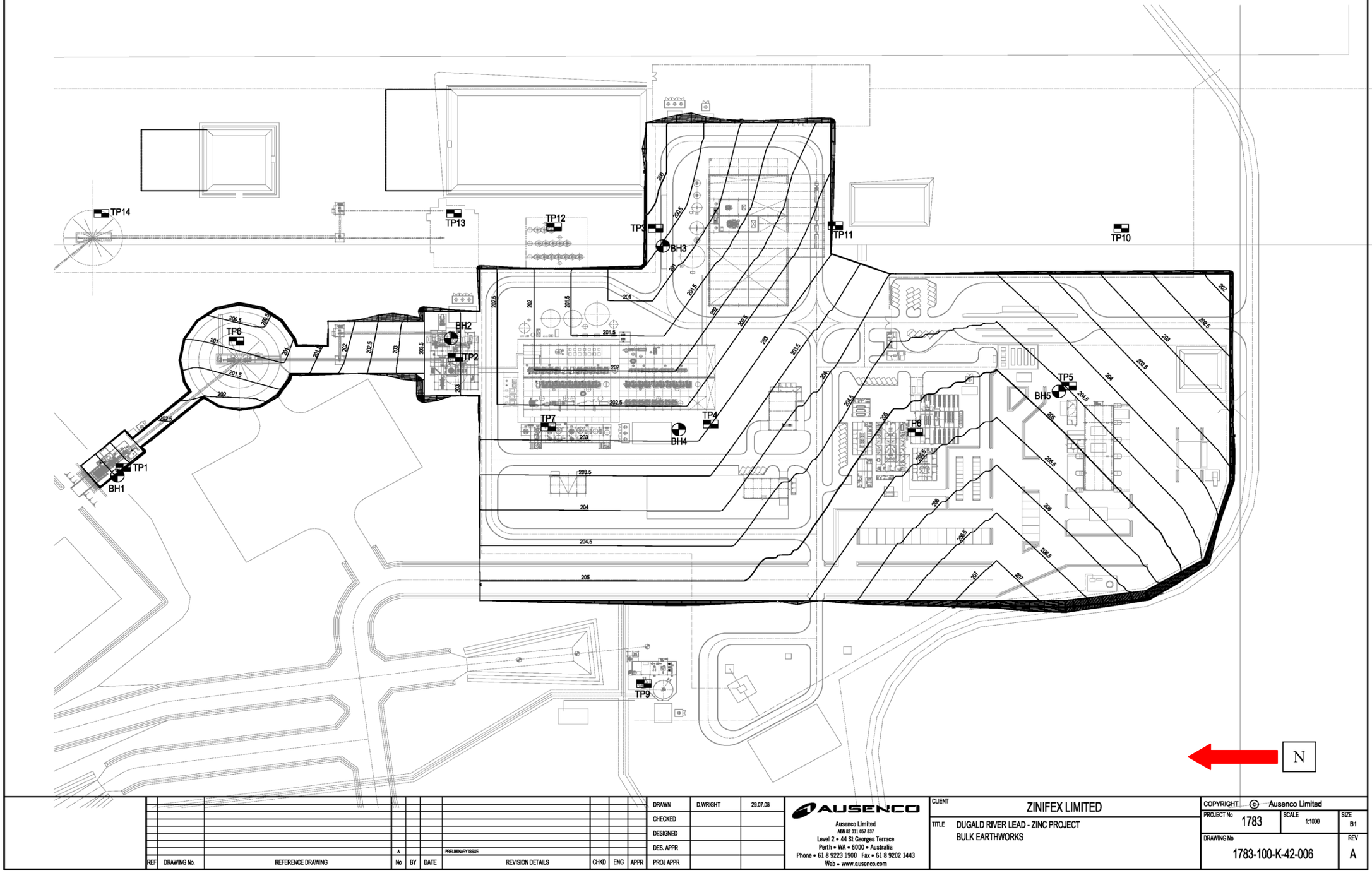
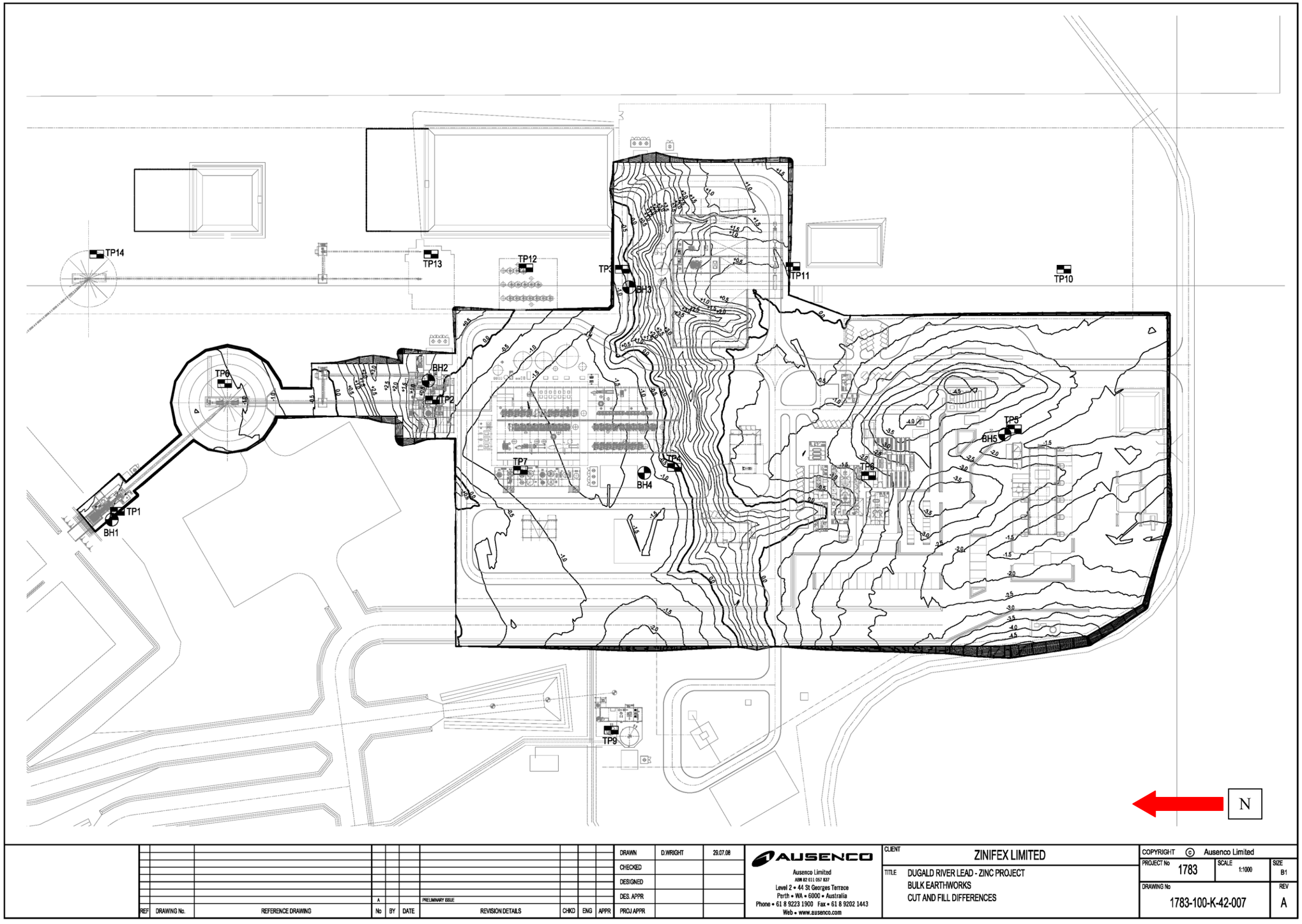


Figure 3.16 Plant Site Design Earthwork Levels



											DRAWN	D.WRIGHT	29.07.08
											CHECKED		
											DESIGNED		
											DES. APPR		
				A			PRELIMINARY ISSUE						
REF	DRAWING No.	REFERENCE DRAWING	No	BY	DATE	REVISION DETAILS	CHKD	ENG	APPR	PROJ APPR			

AUSENCO
Ausenco Limited
ABN 82 011 057 837
Level 2 • 44 St Georges Terrace
Perth • WA • 6000 • Australia
Phone • 61 8 9223 1900 Fax • 61 8 9202 1443
Web • www.ausenco.com

CLIENT: ZINIFEX LIMITED

TITLE: DUGALD RIVER LEAD - ZINC PROJECT
BULK EARTHWORKS
CUT AND FILL DIFFERENCES

COPYRIGHT © Ausenco Limited

PROJECT No	SCALE	SIZE
1783	1:1000	B1

DRAWING No	REV
1783-100-K-42-007	A

Figure 3.17 Plant Site Cut and Fill Contours

3.2.5.2 Processing Plant Construction Methods

The processing plant will be transported to the Project site from Townsville in segments using B-double and the occasional oversized vehicles. Plant segments will be assembled onsite as presented in Figure 3.15 and will include structural, mechanical, piping and electrical works.

3.2.5.3 Process Area Stormwater Dams and Sediment Ponds

Stormwater dams will be excavated for the processing plant area, concentrate storage shed and the crushed ore stockpile areas. These stormwater dams will be HDPE lined and designed for a 1:20 Year ARI, 2 month wet season. See Section 3.5.4.1 for further details.

Sediment ponds will also be provided for disturbed areas at the workshops, backfill plant, chemical storage facilities, roads and office areas. Sediment ponds for non-contaminated run-off will be designed for a 1:10 Year ARI, 24 hour event. These sediment ponds are discussed further in Section 3.5.4.1.

Excavated material from the stormwater dams and sediment ponds will be used for constructing the ROM Pads, mine roads and for fill underground where required.

3.2.5.4 Other Associated Infrastructure

The following infrastructure will be trucked to site and assembled during construction of the processing plant:

- The plant workshop will be a pre-engineered steel structure with colour-bond cladding and a concrete-slab floor. It will be located between the flotation area and the administration offices;
- The administration building will be of modular transportable construction, approximately 36 m long x 20 m wide with a 12 m long x 3.3 m wide computer room annexe. It will include 24 enclosed offices, a reception area, a conference room, a meeting room, a filing room and a kitchen; and
- The mining office building will be of modular transportable construction, approximately 24 m long x 16.5 m wide. It will include 15 enclosed offices, eight open-plan workstations, a large planning and meeting area, a kitchen and male and female toilets. Reverse-cycle air-conditioning will be provided.

3.2.6 Power line Construction

The permanent power supply for the Project will be via a 220 kV power line from Chumvale to the Project site. Power will be sourced from a gas fired power station in Mount Isa. The power line is likely to take about 18 months to construct with construction commencing in 2012.

Construction of the powerline may be by one of two possible options:

- Two Pole H Type Structure Arrangement; and
- Steel Tower Type Structure Arrangement.

It is proposed that the two pole H type structure be adopted in lieu of the steel tower as it is anticipated that steel tower construction will be more expensive. During the preliminary design it is suggested that indicative costs for steel tower construction would be obtained to establish whether

steel towers or the two pole H type structure is the more economical form of construction. Both structures are designed to be single circuit.

At major creek/river crossings, the vegetation along the banks is environmentally sensitive and there are conditions imposed by the DERM which require structures to be significantly higher so as to minimise the impact or disturbance on vegetation. This may potentially result in steel towers being the only suitable option at these locations.

The poles for the two pole H type arrangement are likely to be concrete, which, if selected, will be direct buried with suitable surrounding soils being used as material for foundations. If the steel towers are selected, they will require concrete footings.

Due to the landscape, and the potential for bushfires during the dry season, the above-ground clearance of the conductors will be a meter higher than is required by law. In addition, since the region has high lightning strike density and currents, the earth resistance at each pole will be limited to 5 ohms rather than the 10 ohms usually specified.

Corona discharge (discharge of electricity between two conductors that often causes a loss of power) has been an issue on the entire 220 kV network in the north-west mineral province. This has been attributed to a poor selection of powerline fittings, rather than the choice of conductor. Therefore, during the tendering process, prior to the appointment of a Construction Contractor, technical evaluation of the powerline fittings will be required so corona discharge does not become an issue for this powerline.

Heavy equipment to be used in construction of the powerline will include dozers and graders for clearing vegetation and topsoil and creating access, and cranes for pole and line installation.

Whilst the power line is being constructed, power for the Project will be supplied by diesel generators located on site. There will be four main generators in total, a 1.5 Megavolt Amperes (MVA) and a 1.0 MVA generators will be located near the accommodation camp and two 1.0 MVA generators to be located at the mine and processing area.

3.2.7 Tailings Storage Facility

The TSF will be located in a long, narrow bifurcated valley running north-south on the western side of the Knapdale Ranges. The valley is approximately 4 km north-west of the processing plant. The TSF concept will involve down-valley discharge of tailings, with all decant and runoff water being stored centrally within the tailings impoundment (i.e. no secondary water storage pond). Containment will almost entirely be provided by the valley topography, with the main tailings retaining features being the Main Embankment on the west side, the Eastern Decant Access Embankment, and the Northern Discharge Bunds. The location of the TSF, the corridors for the decant and discharge lines, and roads are shown in Figure 3.6.

An access road to the TSF wall location will be constructed from the existing track on the western side of the Knapdale Range to allow for construction vehicle access.

Construction of the TSF will be from the inside of the valley floor. Clearing and grubbing will be undertaken as soon as access is granted by environmental approvals. Construction of the TSF is likely to take approximately 12 months and commence in 2012. Equipment that is likely to be utilised in the construction of the TSF will include scrapers, graders, excavators, trucks, water trucks and compactors.

A full description of TSF design is contained in Appendix K.

3.2.7.1 Construction of the Main Embankment

An embankment will be constructed over the major opening in the TSF valley to enclose it (Figure 3.18). The embankment design will include an exposed PVC geocomposite liner anchored to a base layer of extruded porous concrete curbs.

The PVC geocomposite will be attached to the upstream face of the embankment using a method that incorporates a base layer of porous extruded concrete curbs and continuous vertical lines of PVC anchor strips. The general layout of the face anchorage system is shown in Figure 3.19. The PVC geocomposite will be anchored to the dam by heat-welding it to anchor strips embedded in the curbs during curb construction. The PVC anchor strips will be placed over each line of extruded curbs at a maximum spacing of 6 m.

The rectangular anchor strips will be 0.5 m wide and of sufficient length so as to cover completely the curbs (upstream and downstream sides) and overlap the anchor strip placed underneath. Each strip will be heat-welded to the underlying strip, resulting in continuous vertical anchorage lines at 6 m spacing, embedded in the face of the embankment.

Perimeter anchorage of the PVC geocomposite will be of the mechanical tie-down type on the abutments and crests of the raise. At the crests of each stage, the geocomposite will be anchored using mass concrete anchor beams, with tie-down fastening for Stage I and III, and embedment beneath a mass concrete anchor beam for the final Stage III.

Anchorage to the abutments will be via stainless steel batten strips bolted to a reinforced concrete plinth. The plinth will be 3 m wide, 0.4 m deep, with a final (Stage III) length of some 295 m. The plinths will be constructed of 32 Megapascals (MPa) reinforced concrete, with 2 m anchor dowels at 2 m centres.

A programme of foundation curtain grouting will be required prior to the construction of the main embankment as despite the shallow weathering profile, rock mass permeability was found to be mostly influenced by the degree of jointing and fracturing. A supplementary geotechnical investigation will be required to better define the actual extents of this programme. Preliminary indications are that the curtain will need to extend to a depth of 10-15 m in areas of moderate permeability.

The TSF civil works layouts for Stages I, II and III are shown in Figure 3.20, Figure 3.21 and Figure 3.22. Embankment rockfill (Zones 3A and 3B) will be locally quarried from designated areas upstream and downstream of the embankment, with nominal areas shown in the Figures. It is proposed that geotechnical investigations be done in these areas during detailed design to confirm material suitability.

It is possible that the granular drainage/GSS support layer material (Zone 2), consisting of a well graded sand-gravel-cobble mix, may be selectively won from the rockfill quarries. This would likely require screening to produce the required blend with a maximum particle size of 150 millimetres (mm). Alternatively, material could be produced elsewhere on site, or imported from commercial quarry operations.

During the construction of Stage I, rockfill will be quarried in the area to the north of the embankment to create a saddle cut for the purpose of future tailings beach management. The Stage I civil works will also involve the stripping and stockpiling of topsoil and all potentially seed-bearing materials from the floor of the TSF valley, for the purposes of final closure and rehabilitation of the facility. The side slopes of the TSF embankment will be constructed to have 1.5:1 (horizontal: vertical) upstream slope, and 1.75:1 (overall) downstream slope, made up of 1.5:1 slopes and 5 m wide benches. Due to the

shorter construction period and increased resilience to damage from overtopping, the Stage 1 embankment will not require a diversion pipe during construction.

The construction works for Stages II and III will be the same as those applied for Stage I.

3.2.7.2 Construction of the TSF Perimeter

In addition to the Main Embankment, civil works will also be required on the northern and eastern sides of the TSF, in order to constrain the tailings extents to within MMG's controlled tenure. Where necessary, these works will be constructed within transportation corridors, although no actual storage of tailings is permitted, or planned, in these areas.

On the eastern side, Decant Access Embankments 1 and 2 will be constructed of general rockfill during Stage I, as shown in Figure 3.20. The Embankment 1 crest height of Reduced Level (RL) 243 m will be coincident with the final tailings level, and will infill the steep gully to provide a platform for the construction of Embankment 2 and drain catchment runoff into the TSF. Embankment 2 will have a crest level of RL 242 m, and will be the formation upon which the Decant Access and return pipeline will be constructed.

The Stage II civil works program during Year 5 will include the construction of the North-West and North-East Discharge Bunds, as shown in Figure 3.21. The bunds will be between 8 m and 15 m high and will be constructed using Zone 3A rockfill. The North-East Bund will also include general rockfill infilling of the valley behind it, in order to provide catchment drainage and a formation for the access road and tailings discharge pipeline.

The Stage III civil works will include the raising of the North-West and North-East Discharge Bunds to a final crest level of RL 248.75 m, as shown in Figure 3.22. The total quantity associated with the TSF Perimeter civil works is estimated to be 153,900 m^3. A summary of the quantities is provided in Table 3.2.

Table 3.2 Summary of TSF Perimeter Works Quantities

	Eastern Decant Access Embankment (m^3)		Northern Discharge Bunds (m^3)	
	Zone 3A	**General (Bulk) Rockfill**	**Zone 3A**	**General (Bulk) Rockfill**
Stage I	22,100	54,000	-	-
Stage II	-	-	19,500	10,100
Stage III	-	-	26,200	32,000
Total	22,100	54,000	35,700	42,100

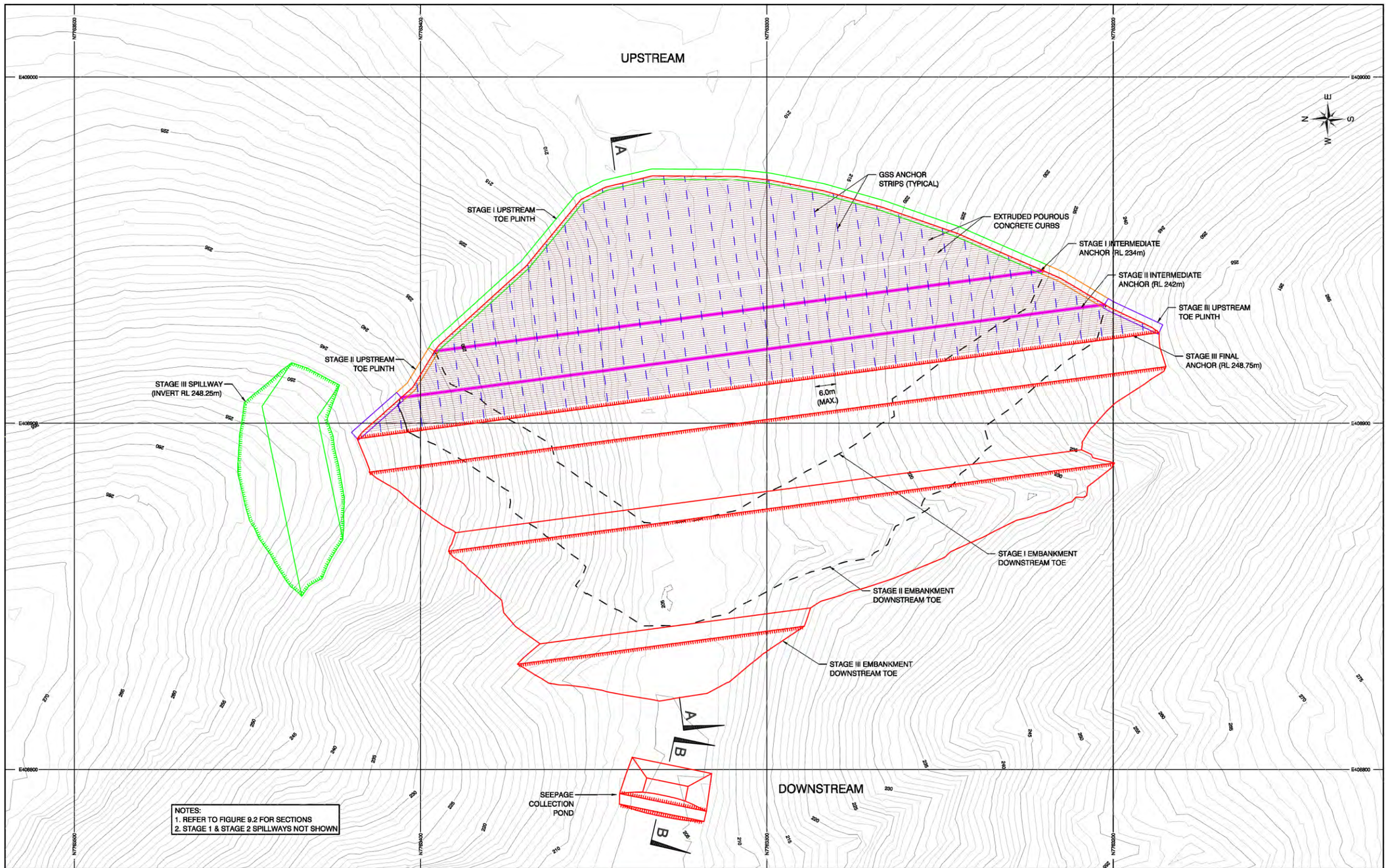
3.2.7.3 Construction of Seepage Collection Pond

A small, clay lined seepage collection and evaporation pond will be constructed downstream of the Main Embankment, in order to monitor and prevent embankment or foundation seepage from discharging off-site. The nominal location of the collection pond is shown in Figure 3.18.

Construction of the collection pond will require detailed excavation of surface gravels and weathered rock, to form a basin nominally 0.9 m deep and 4 m wide across the base of the gully. Inlet and side

slopes will be gently graded. A retaining bund with a nominal crest at RL 206 m will be constructed at the downstream side.

Zone 1 clayey earthfill will form the pond liner and the core of the retaining bund. This material will need to be imported from the eastern side of the Knapdale Ranges, moisture conditioned and compacted. A cover of Zone 2 granular material will be placed over the liner to prevent it from drying out or eroding.



No.	DESCRIPTION	DATE	DRAWN	CHECKD	APPRD
1	2010 UPDATE	9/7/2010	DMR		

SCALE	1:1000
JOB No.	108003.02
DATE	23.09.08
DESIGN	CN
DRAWN	TR
CHECKED	
APPROVED	

ATC Williams
GROUNDED IN DESIGN

Melb T +61 3 8587 0900
melb@atcwilliams.com.au

A.B.N. 64 005 931 288
www.atcwilliams.com.au

Perth T +61 8 9361 4664
perth@atcwilliams.com.au

MMG DUGALD RIVER
DUGALD RIVER PROJECT FEASIBILITY STUDY

KNAPDALE VALLEY TAILINGS STORAGE FACILITY
MAIN EMBANKMENT
GENERAL LAYOUT

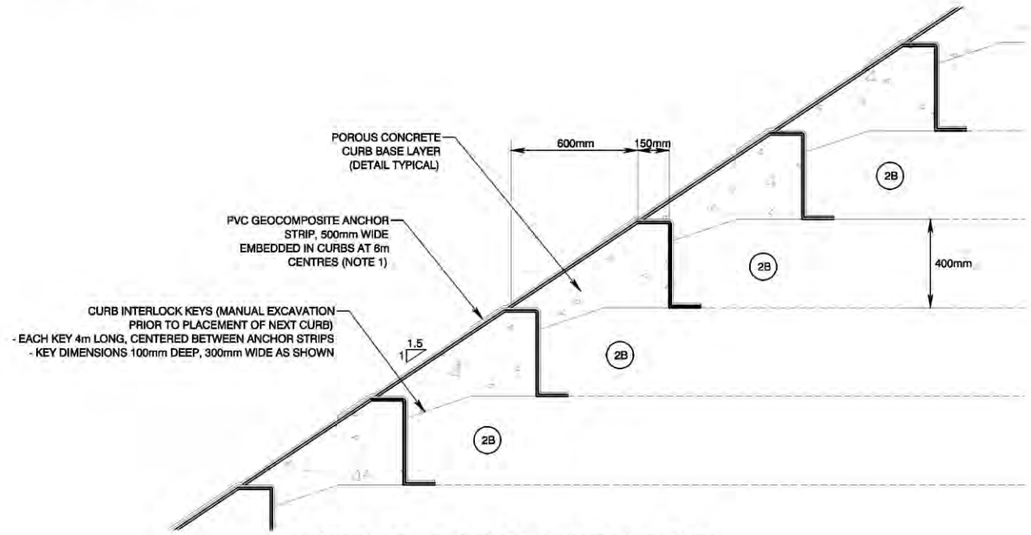
FIGURE 12.1

CLIENT No.
CAD REF. 108003
REV. No. 1 | SHT SIZE A3
SHEET 1 OF 1

Figure 3.18 Main Embankment General Layout

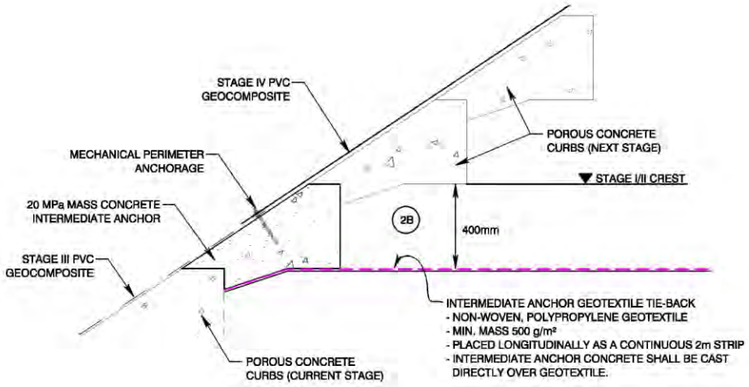
NOTES

1. THE ANCHORING METHODOLOGY FOR THE GSS SHOWN IN THE DRAWINGS, HEREAFTER REFERRED TO AS THE CARPI SYSTEM, HAS A PATENT OWNED BY THE CARPI TECH ITALIA SRL (FORMERLY KNOWN AS SIBELON SRL,) ARONA, ITALY OF THE CARPI GROUP.



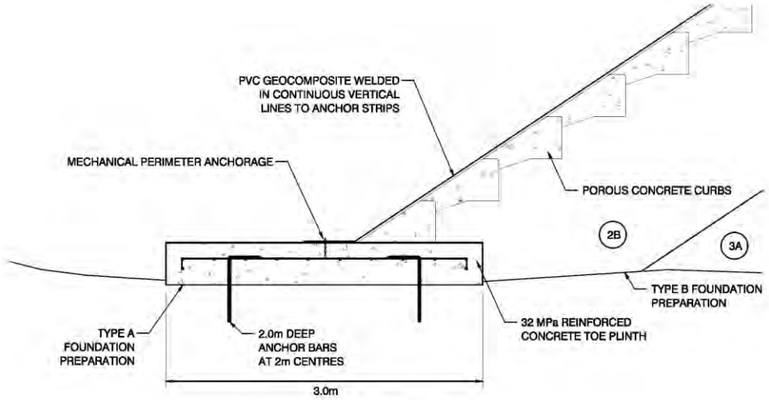
UPSTREAM FACE - GEOCOMPOSITE BASE LAYER

SCALE 1:25



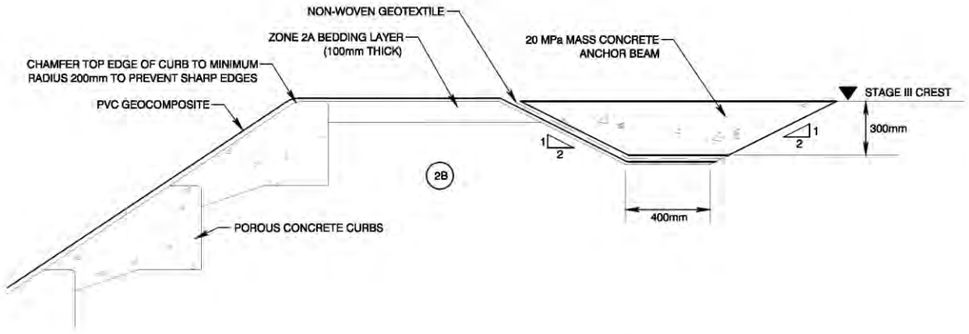
STAGE I & II INTERMEDIATE ANCHOR

SCALE 1:25



UPSTREAM TOE - PLINTH

SCALE 1:50



STAGE III CREST ANCHOR BEAM

SCALE 1:25

						SCALE AS SHOWN	
						JOB No.	108003.01
						DATE	23.09.08
						DESIGN	CN
						DRAWN	TR
						CHECKED	
1	2010 UPDATE	9/7/2010	DMR			APPROVED	
No.	DESCRIPTION	DATE	DRAWN	CHECKD	APPRD		

ATC Williams GROUNDED IN DESIGN

Melb T +61 3 8597 0300 melb@atcwilliams.com.au

A.B.N. 64 005 931 288 www.atcwilliams.com.au

Perth T +61 8 9361 4644 perth@atcwilliams.com.au

MMG DUGALD RIVER
DUGALD RIVER PROJECT FEASIBILITY STUDY

KNAPDALE VALLEY TAILINGS STORAGE FACILITY
MAIN EMBANKMENT
GSS ANCHORAGE AND FACE DETAILS

FIGURE 12.2

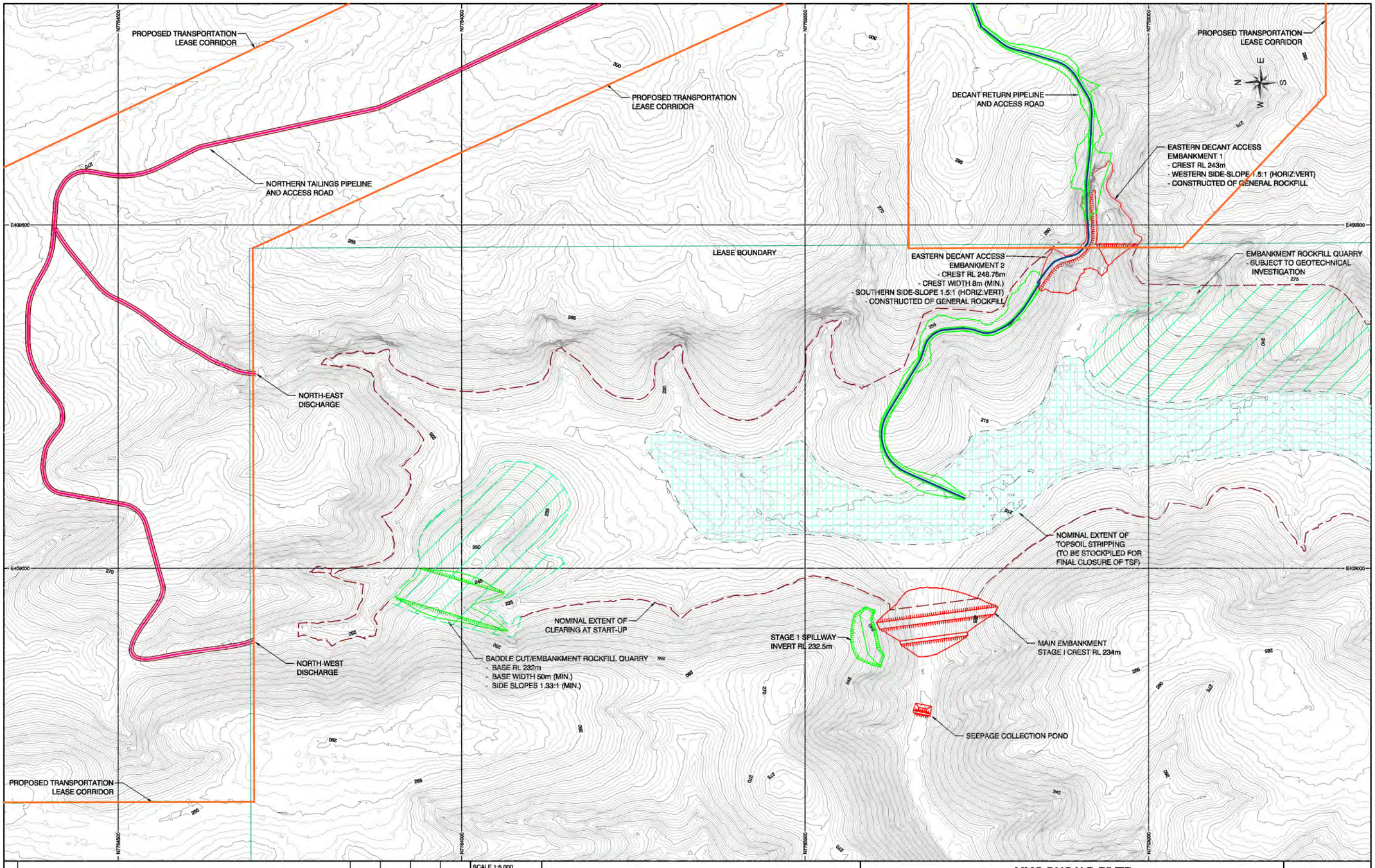
CLIENT No.

CAD REF. 108003

REV. No. 1 | SHT SIZE A3

SHEET 1 OF 1

Figure 3.19 Anchorage and Main Embankment Face Details



						SCALE 1:5,000	
						JOB No.	108003.02
						DATE	22.10.08
						DESIGN	CN
						DRAWN	TR
						CHECKED	
1	2010 UPDATE	9/6/2010	DMR			APPROVED	
No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APP'D		

ATC Williams
GROUNDED IN DESIGN

Melb T +61 3 8587 0900
melb@atcwilliams.com.au

A.B.N. 64 005 931 288
www.atcwilliams.com.au

Perth T +61 8 9361 4664
perth@atcwilliams.com.au

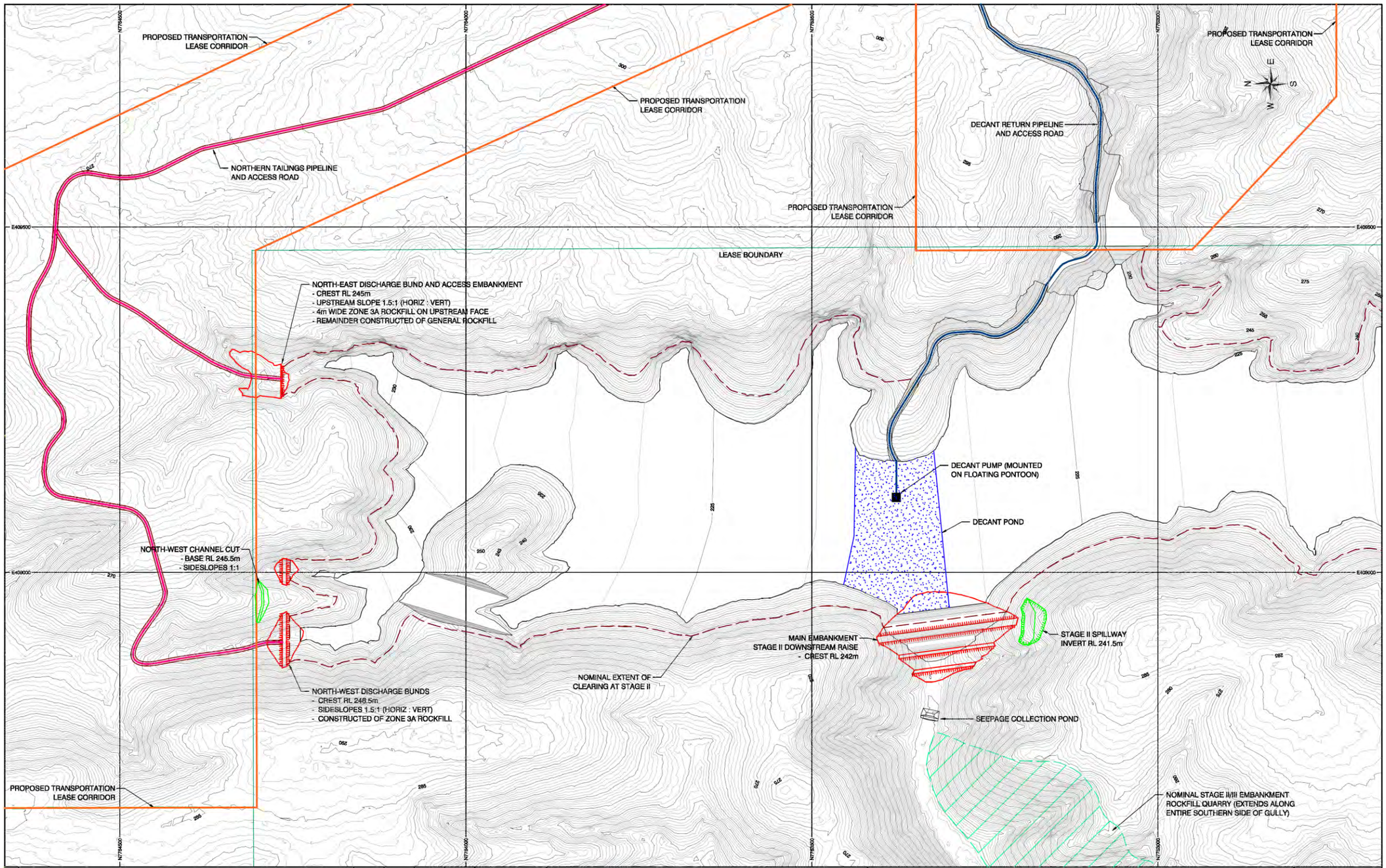
MMG DUGALD RIVER
DUGALD RIVER PROJECT FEASIBILITY STUDY

KNAPDALE VALLEY TAILINGS STORAGE FACILITY
STAGE I CIVIL WORKS

FIGURE 13.1

CLIENT No.
CAD REF. 108003
REV. No. 1 | SHT SIZE A3
SHEET 1 OF 1

Figure 3.20 Stage I Civil Works



No.	DESCRIPTION	DATE	DRAWN	CHECKD	APPR'D
1	2010 UPDATE	9/6/2010	DMR		

SCALE	1:5,000
JOB No.	108003.02
DATE	22.10.08
DESIGN	CN
DRAWN	TR
CHECKED	
APPROVED	

ATC Williams
GROUNDED IN DESIGN
Melb T +61 3 8587 0900
melb@atcwilliams.com.au
A.B.N. 64 005 931 288
www.atcwilliams.com.au
Perth T +61 8 9361 4664
perth@atcwilliams.com.au

MMG DUGALD RIVER
DUGALD RIVER PROJECT FEASIBILITY STUDY

KNAPDALE VALLEY TAILINGS STORAGE FACILITY
STAGE II CIVIL WORKS

FIGURE 13.2

CLIENT No.
CAD REF. 108003
REV. No. 1 | SHT SIZE A3
SHEET 1 OF 1

Figure 3.21 Stage II Civil Works

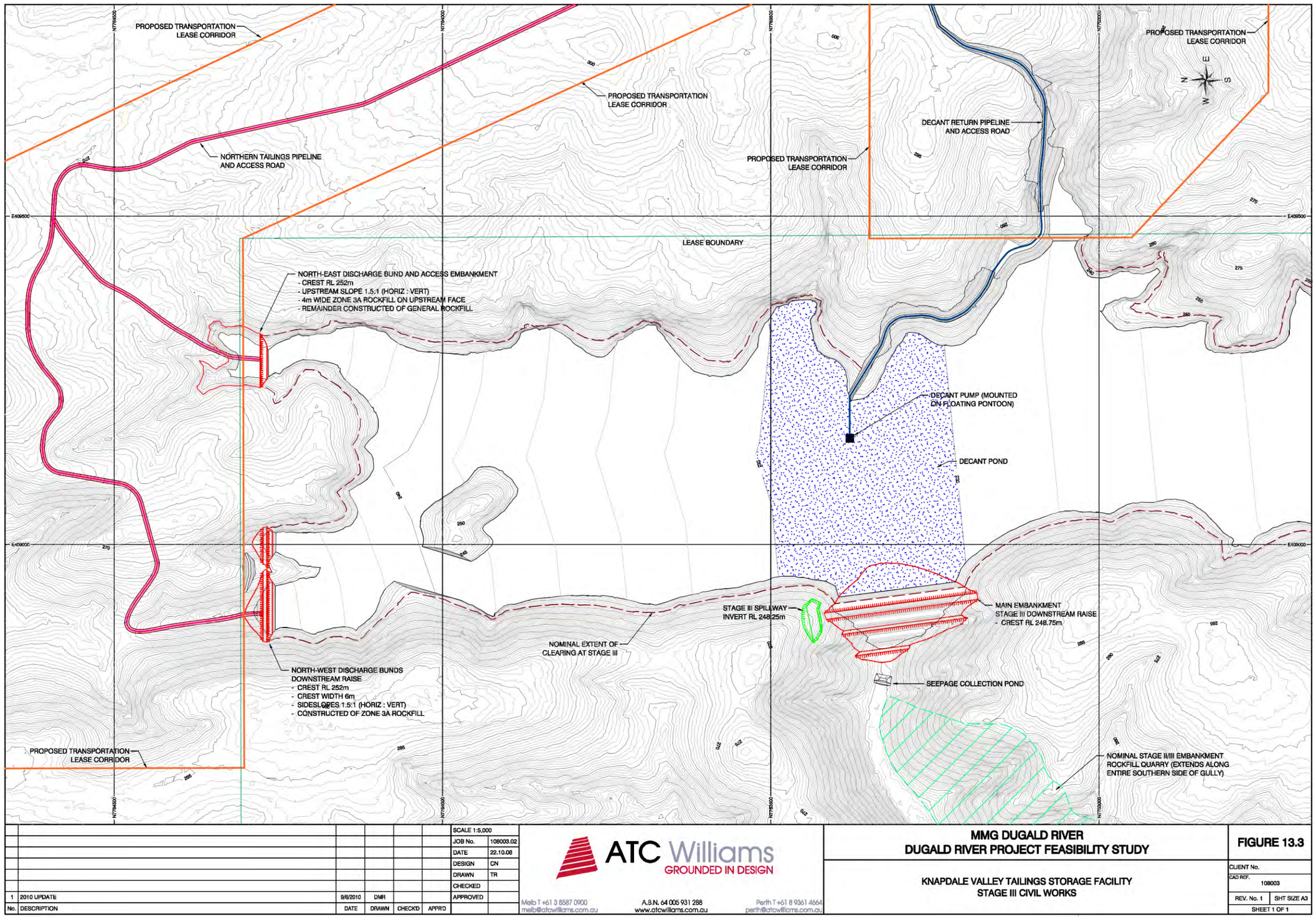


Figure 3.22 Stage III Civil Works

3.3 OPERATIONS

3.3.1 Location and Tenure

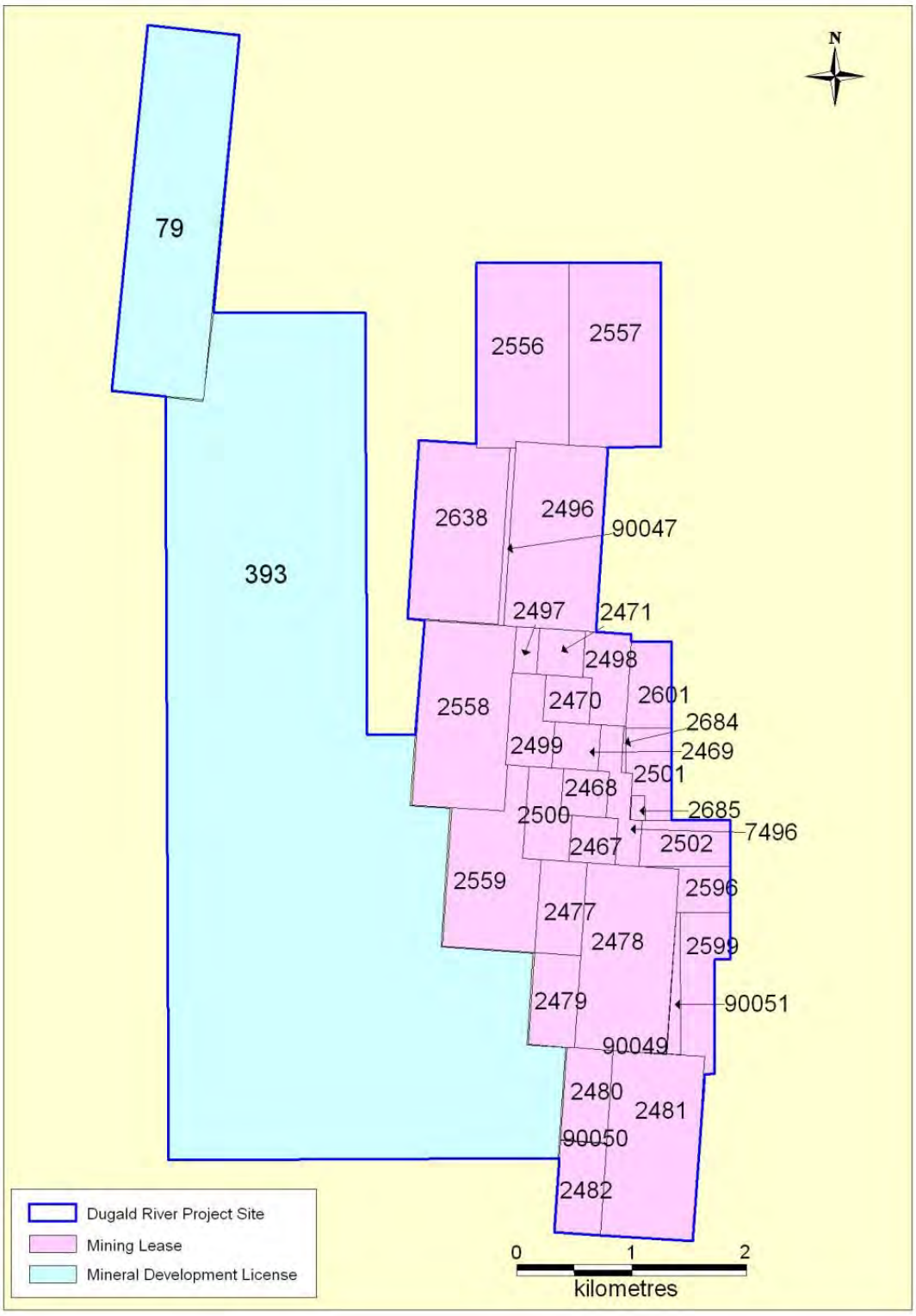
The Project area currently consists of 33 existing MLs, one MDL (MDL79) and one MDL Application (MDL393) (Figure 3.23 and Table 3.3). An EPM (EPM12163) underlies parts of the MDLs and MLs.

MMG currently holds a Standard Level 2 EA for mining activities on the existing MLs. MMG have submitted a Plan of Operations for exploration activities on these tenements.

A Mining Lease Application (MLA) will be applied for over the area proposed to be occupied by the TSF on part of MDL393, although this application is yet to be finalised.

In addition, MLs for Transport will be applied for in the near future over the corridor areas where the water pipeline, tailings pipelines and power transmission line will be located. At present, parcel prospecting permits have been applied for over these areas, which will allow MMG to peg the areas required for the MLs for Transport. The landholders and EPM holders under the powerline corridor have been engaged by MMG and agreements are in place with the owners of the Roseby Copper Project for the access road and water pipeline corridors. Details are provided in Table 3.4.

The Project layout showing the locations of tenement boundaries, watercourses, and proposed infrastructure on a rectified aerial photograph is provided in Figure 3.24.



Note: MDL393 is in the application stage only and not currently granted. EPM12163 underlies this tenure.

Figure 3.23 Current Project Tenement Locations

Table 3.3 Current Project Tenements Details

Tenement ID	Expiry Dates	Tenure Holder / Applicant Name & Contact Details	Operational Land (i.e. Lot on Plan)
MDL 393	Under Application	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
MDL 79	30th September, 2011	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168 Lot 59 Plan TG40
ML 2467	30th November, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2478	31st December, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2497	31st December, 2010 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2556	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2601	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 90047	31st January, 2010	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2468	30th November, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2479	31st December, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2498	31st December, 2010 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 36 B15753 Lot 3692 PH2168
ML 2557	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2638	30th September, 2014	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 90049	31st December, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168

Tenement ID	Expiry Dates	Tenure Holder / Applicant Name & Contact Details	Operational Land (i.e. Lot on Plan)
ML 2469	30th November, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2480	31st December, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2499	31st December, 2010 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2558	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2684	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 35 B15753 Lot 36 B15753
ML 90050	31st December, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2470	30th November, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2481	31st December, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2500	31st December, 2010 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2559	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2685	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 27 B15753 Lot 35 B15753 Lot 3692 PH2168
ML 90051	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2471	30th November, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2482	31st December, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2501	31st December, 2010 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 27 B15753 Lot 35 B15753 Lot 3692 PH2168

Tenement ID	Expiry Dates	Tenure Holder / Applicant Name & Contact Details	Operational Land (i.e. Lot on Plan)
ML 2596	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 7496	31st July, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 27 B15753 Lot 35 B15753 Lot 36 B15753 Lot 3692 PH2168
ML 2477	31st December, 2006 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2496	31st December, 2010 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 27 B15753 Lot 3692 PH2168
ML 2502	31st December, 2010 Under Renewal	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168
ML 2599	31st January, 2012	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3692 PH2168

Table 3.4 Infrastructure Corridor Tenement Details

Tenement ID	Expiry Date	Tenure Holder / Applicant Name & Contact Details	Operational Land (i.e. Lot on Plan)
PPP90520	17th December 2010	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 7 CP905412
PPP90521	17th December 2010	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 4144 PH2265
PPP90522	17th December 2010	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 3635 PH2175
PPP90523	20th December 2010	MMG Australia Limited Level 23, 28 Freshwater Place Southbank VIC 3006	Lot 2 BD56

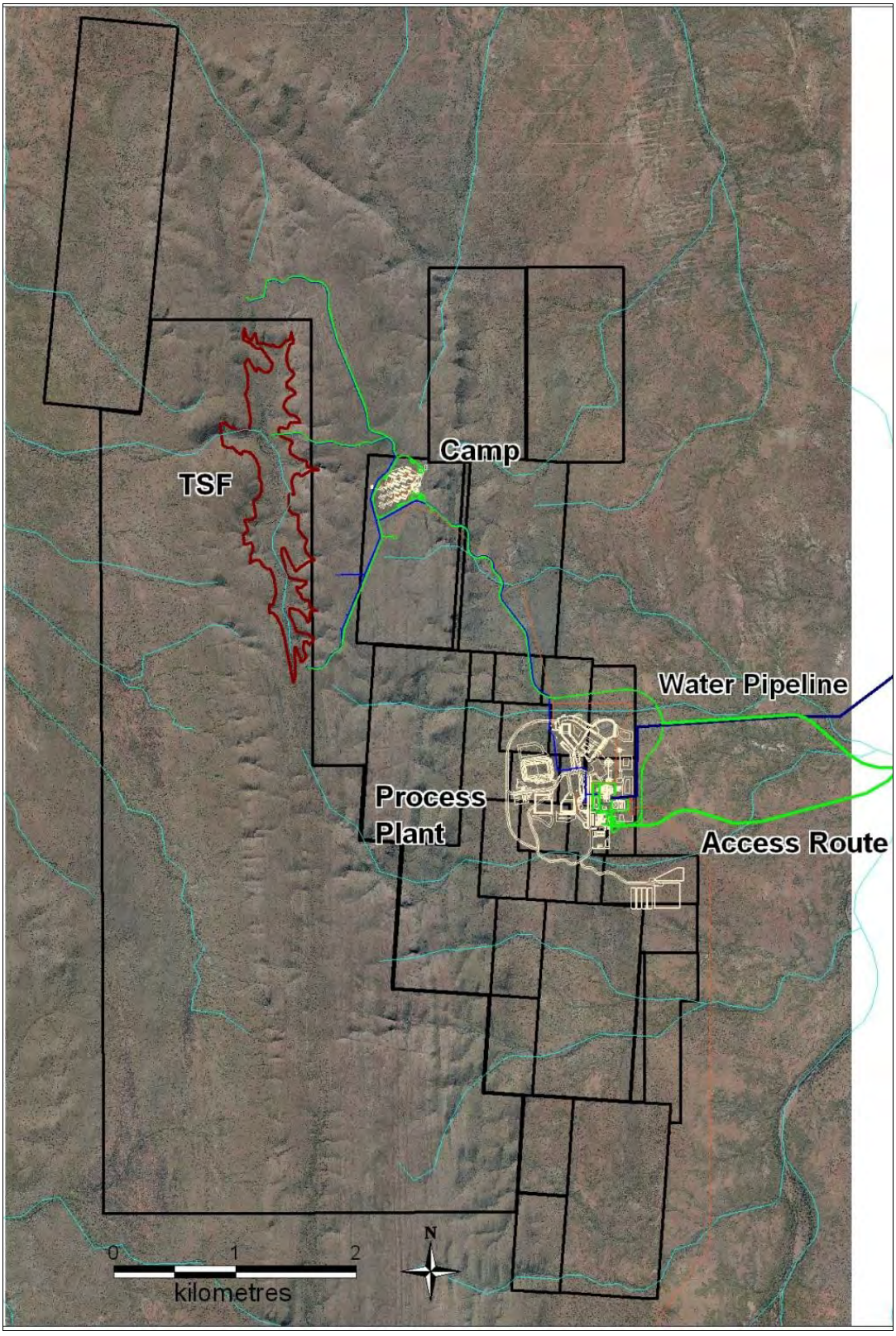


Figure 3.24 Project Layout and Tenements over Aerial Photograph

3.3.2 Mine Life and Resource Base

The zinc/lead/silver resource estimate defined for the Project totals 53.0 Mt (as of June 2009) at a cut off grade of 6 % zinc. The resource grade is 12.5% zinc, 1.9 % lead and 36 ppm silver. The copper resource defined for the Project totals 4.4 million tonnes (as of June 2010) at a cut off grade of 1 % copper. The resource grade is 1.8% copper, 0.2 ppm gold, 147 ppm cobalt and 50 ppm molybdenum. Installation of the copper processing circuit will be subject to the successful proving up of sufficient resources from currently identified areas of copper mineralisation. Additional feed may also be sourced by toll treatment of third party ores. Table 3.5 and Table 3.6 describe the resource for the Project in detail. [1]

Table 3.5 June 2009 - JORC Compliant Resource at a 6% Zinc Cut Off

Classification	Tonnes M	Zn %	Pb %	Ag ppm
Measured	20.6	13.1	1.9	56
Indicated	23.0	12.6	2.0	28
Inferred	9.4	10.7	1.4	14
Total	**53.0**	**12.5**	**1.9**	**36**

Table 3.6 June 2010 - JORC Compliant Resource at a 1% Copper Cut Off

Classification	Tonnes M	Cu %	Au ppm	Co ppm	Mo ppm
Inferred	4.4	1.8	0.2	147	50
Total	**4.4**	**1.8**	**0.2**	**147**	**50**

The mine life is approximately 23 years plus. Figure 3.25 shows the annual quantities of ore to be mined over the first 18 years of life of the mine.

[1] "The information in this report that relates to Mineral Resources is based on information compiled by Peter Carolan, who is a member of the Australasian Institute of Mining and Metallurgy. Peter Carolan is a full-time employee of the company. Peter Carolan has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the 2004 Edition of the '*Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves*'. Peter Carolan consents to the inclusion in the report of the matters based on his information in the form and context in which it appears."

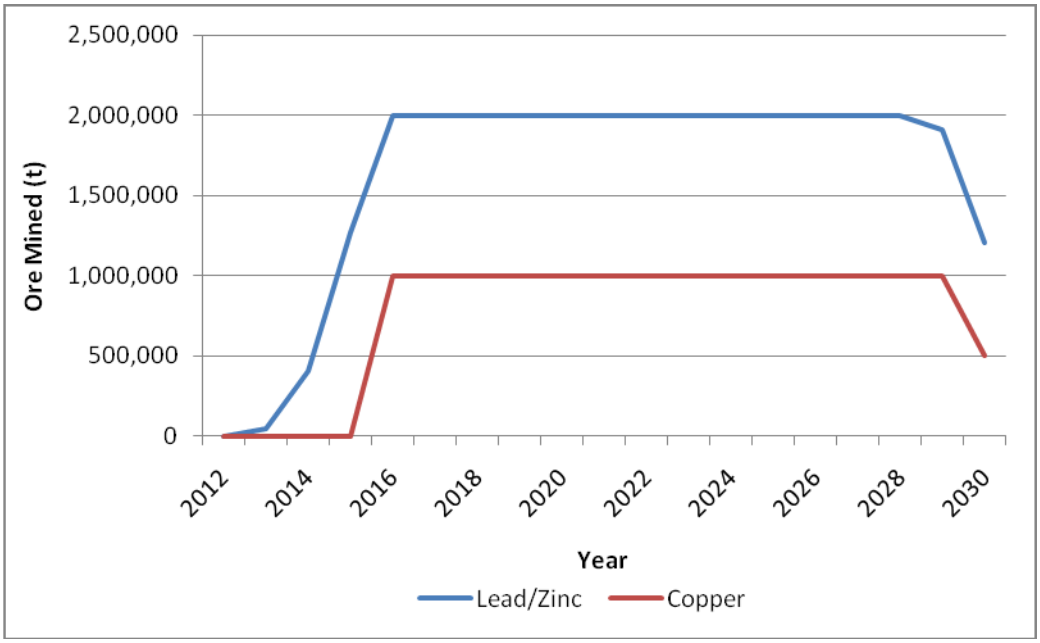


Figure 3.25 Annual Ore to be Mined

3.3.3 Mining Methods and Equipment

3.3.3.1 Underground Mining Method

The deep zinc/lead/silver ore will be mined from underground by conventional mechanised methods (longhole open stoping). The mine will be approximately 1.6 km along strike and 1,000 m deep. It will be accessed by twin declines that will also be used to haul ore and waste from the mine in diesel trucks. All ore and waste will be drilled and blasted. The mine will be ventilated via 5 vertical shafts.

Where possible, waste rock from mine development will be used to backfill underground voids, although this may not be possible during the early stages of development. Other underground voids will be filled with paste backfill from plant tailings.

The two declines will separate the mine into two distinct operating areas, the South Mine and the North Mine. Each area will have independent networks for ventilation, power, water and drainage and they will be joined by a single link drive approximately 300 m below surface.

The South Mine is located in the thicker part of the orebody and will produce at a rate of 1,300 kilotonnes per annum (ktpa) and the North Mine, where the orebody is narrower will produce 700 ktpa or ore.

The copper ore will be mined from underground by conventional mechanised methods and accessed via the decline in the North Mine.

3.3.3.2 Mining and Processing Fleet

The mining fleet listed in Table 3.7 will be required for the underground mine operations during full production when both the underground lead/zinc/silver and copper mine are being operated.

Table 3.7 Underground Mining Fleet

Machine	Model (nominal)	Capacity	Engine	Number of Pieces of Equipment
Underground Mining Fleet Lead/Zinc 2 Mtpa:				
Trucks:	Cat AD55	50 t	485 kW	10
Boggers (large):	Cat R2900G	17 t	269 kW	4
Boggers (small):	Cat R1700G	12 t	231 kW	2
Dev't Jumbo's:	Tamrock Axera 7	N/A	110 kW	4
Prod Drills:	Tamrock Solo 7	N/A	110 kW	3
Graders:	Cat 140H	N/A	123 kW	2
Water Cart:	20t Truck	N/A	165 kW	1
Light Vehicles	Landcruiser	N/A	85 kW	25
Underground Mining Fleet Copper 1 Mtpa:				
Trucks:	Cat AD55	50 t	485 kW	5
Boggers (large):	Cat R2900G	17 t	269 kW	2
Boggers (small):	Cat R1700G	12 t	231 kW	1
Dev't Jumbo's:	Tamrock Axera 7	N/A	110 kW	2
Prod Drills:	Tamrock Solo 7	N/A	110 kW	2
Graders:	Cat 140H	N/A	123 kW	1
Water Cart:	20t Truck	N/A	165 kW	1
Light Vehicles	Landcruiser	N/A	85 kW	13
ROM Operations				
Loader 1:	Cat 988H	11.4 t	414 kW	1
Loader 2:	Cat 988H	11.4 t	414 kW	1
Loader 3:	Cat 988F Series II	10.7 t	357 kW	1

The processing plant mobile equipment fleet is shown in Table 3.8.

Table 3.8 Processing Plant Mobile Equipment List

Department	Vehicle	Number
Commercial, General and Sustainability	Fork lift	3
	Semitrailer (and prime mover)	1
	Light vehicle	11
	Bus	2 x 21 seat and 1 x 45 seat
	Light truck	1
Maintenance	Light truck	1
	Cranes	1 x 15 t and 1 x 80 t all terrain
	Light vehicles	11
Processing	Light truck	1
	Front end loaders	4
	Excavator	1
	Wheel dozer	1
	Wheel grader	1
	Fork lift	1
	Skid-steer loader	3
	Water cart	1
	Elevated work platforms	3
	Light vehicles	6

3.3.3.3 Fuel Storage and Hydrocarbon Storage

The diesel fuel storage facility will be owned and installed by one of the local fuel suppliers. It will consist of several double-walled modularised fuel tanks (self bunded) with a fuel management system and light vehicle and heavy vehicle bowsers.

It will be located in an area that allows light vehicles and heavy mine vehicles to access the facility on opposite sides, ensuring that they are always kept apart. Tanker trucks will unload diesel and light vehicles will refuel via a bowser on one side, while mine vehicles will refuel via a high capacity bowser on the opposite side. Separate road access is also provided. A flat concrete slab and electrical power supply will be provided. The supplier will supply and install the complete stand-alone facility including lighting.

Bulk storage will also be provided for oil and waste oil in a bunded area. Grease and other hydrocarbons will be supplied in bulk were possible to limit the number of drums brought onto the Project site.

All fuel and hydrocarbon storage will be bunded and will meet the requirements *Australian Standard 1940 – The Storage and Handling of Flammable and Combustible Liquids*.

The predicted fuel usage by the mining fleet is shown in Figure 3.26.

3.3.3.4 Explosives Magazine

Explosives will initially be stored in a surface magazine which will comply with AS 2187.1. Once mine development is sufficiently advanced, an underground magazine will be excavated and installed. Following this, all explosives will be stored underground and the surface magazine will be decommissioned.

Mixing of bulk explosives may occur in a plant on the surface. Bulk oxidising agents will be stored on the surface in accordance with the appropriate Australian Standard. Any mixed materials classed as explosives will be appropriately stored in a magazine.

The number of underground blasts per year and details of blasting design are shown in Table 3.9 and Figure 3.27.

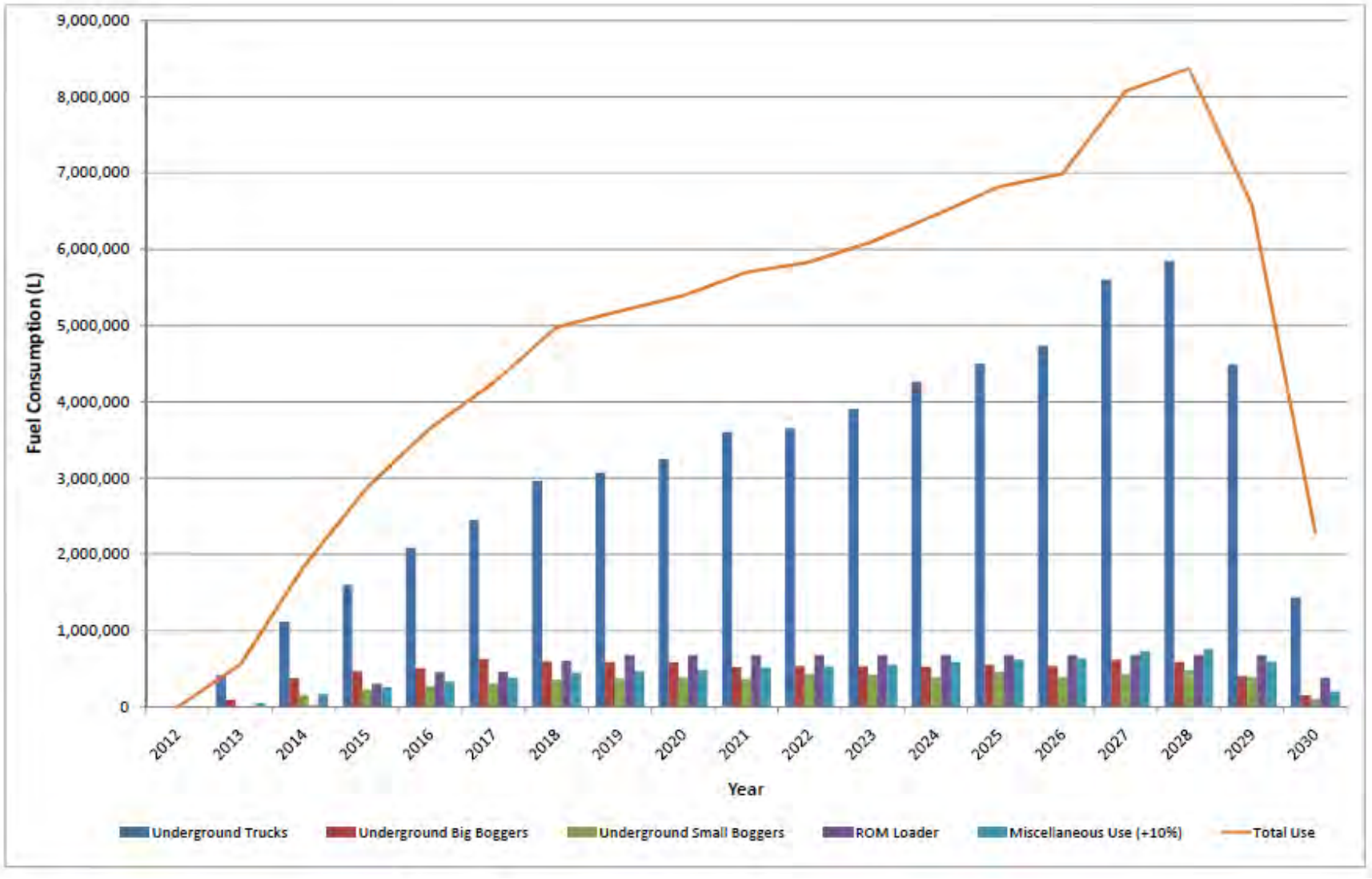


Figure 3.26 Predicted Fuel Consumption Zinc/Lead and Copper Mining Equipment

Table 3.9 Underground Blasting Details

	TOTAL	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Firing Times per Day	2.00																			
Total Blasts	74 258	-	755	3390	3720	4838	4700	4827	4641	4748	4716	4769	4782	4748	4884	4785	4842	4758	3397	961
Blasts per Firing Time	5.65	-	1.03	4.64	5.10	6.63	6.45	6.61	6.36	6.51	6.46	6.54	6.55	6.51	6.70	6.57	6.64	6.52	4.65	1.32
Total ANFO used (t)	26 347	-	200	927	1143	1705	1705	1705	1705	1705	1705	1705	1705	1705	1705	1705	1705	1705	1352	561
Av. ANFO per Blast (kg)	355	-	265	273	307	352	363	353	367	359	362	358	357	359	349	356	352	358	398	584

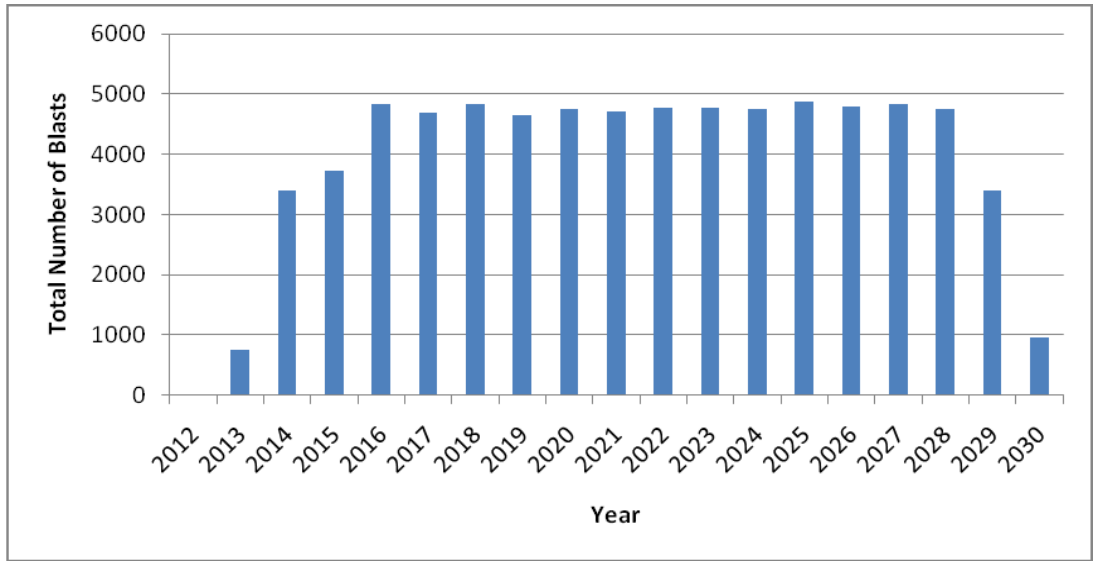


Figure 3.27 Total Blasts Per Annum

3.3.4 Mine Sequencing

Figure 3.25 in Section 3.3.2 shows the annual ore to be mined from the underground workings. Lead/zinc/silver ore will be mined throughout the entire mine life, however copper ore will be mined starting 2015, upon proving of a sufficient copper resource and after obtaining approval of any necessary environmental permits. At full production 2 Mtpa of lead/zinc/silver ore will be mined and 1 Mtpa of copper ore.

The ore will be extracted from the underground mine workings from top to bottom. The South and North Mines will be split into different sections so that there are sufficient working faces to maintain the planned production rate. The South Mine will consist of Red, White and Blue Sections, and the North Mine will consist of Green and Yellow Sections (Figure 3.28).

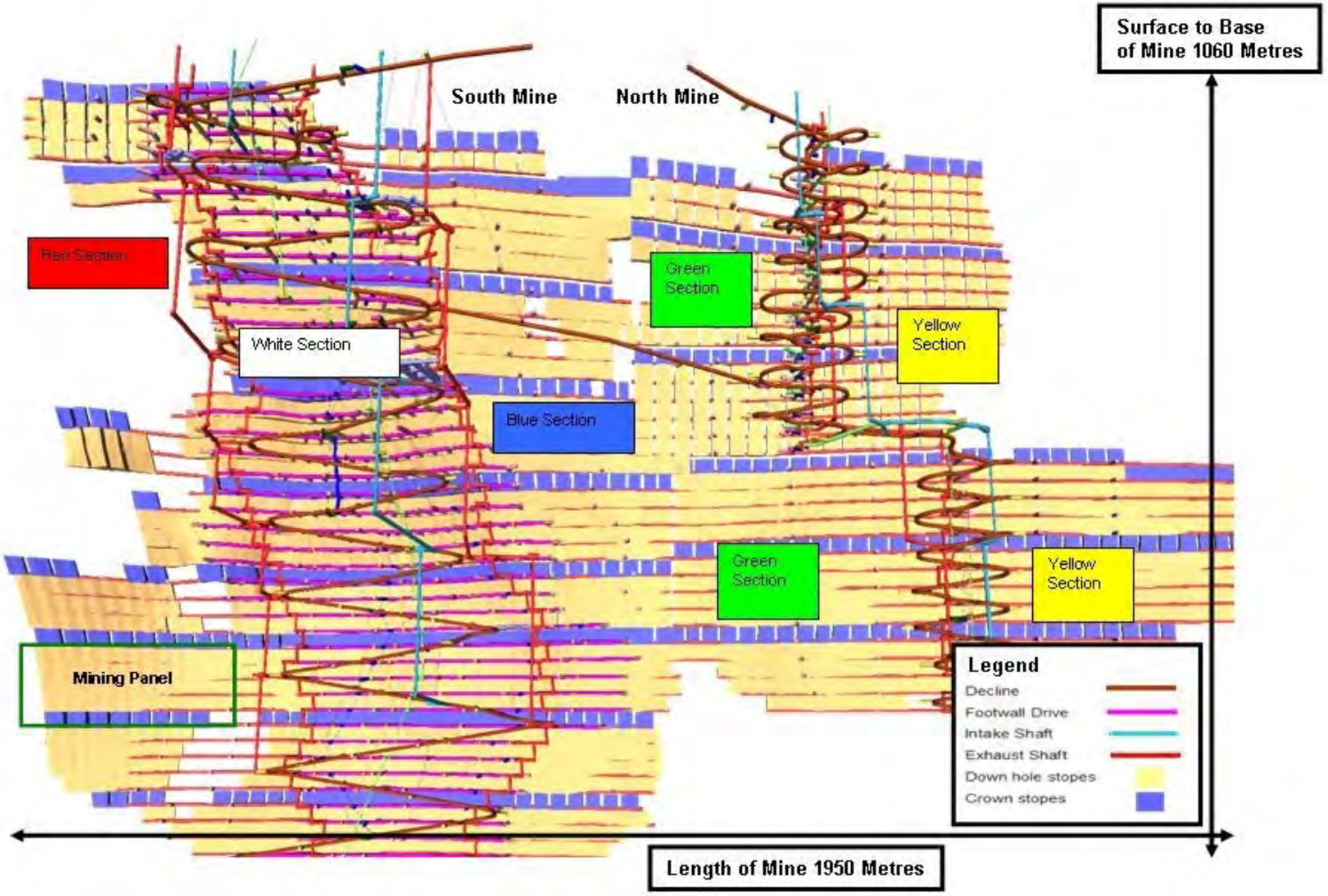


Figure 3.28 Longitudinal View of Underground Mine showing Mining Sections

With extraction progressing from top to bottom, each section will be split into panels which will consist of five levels at 25 m spacing, giving a total of 125 m vertical. There will be eight panels in total, meaning that a new panel will be brought into production every two to three years, depending of the ore contained in that panel.

The mine schedule is such that, when in full production, there will be four vertical panels operating at different stages. Working from top to bottom, these are:

- Uppermost active panel: remnants and pillars being extracted to extract the final ore at the end of the life of the panel;
- Main production panel: stoping fronts are in full production and the majority of ore tonnes are being produced from this area;
- Ore development panel: lateral development is being completed ahead of the commencement of stoping; and
- Capital development panel: the decline and other infrastructure (e.g.: ventilation) are being developed, but ore development has not yet commenced.

This pattern of activity in each panel will progress deeper as old panels are completed and new ones commence.

Mined out voids will be backfilled with either rock fill, using waste rock, or paste fill, using process plant tailings.

Rock fill will be used for the following applications:

- The upper mining blocks (down to the 10,075 m RL) where there is insufficient vertical head to push paste fill along levels to the stope voids without pumping;
- The North Mine down to the 9,800m RL, where paste fill is unlikely to flow across the surface to the borehole collar without pumping. The North Mine orebody is narrow and amenable to rock fill, which provides the opportunity to dispose of waste rock underground, reducing haulage costs and minimising surface dumps containing PAF material; and
- Co-disposal with paste fill into open paste fill voids when development waste is generated. Use of rock fill reduces costs by reducing haulage distances to dispose of waste rock and reducing the volume of cemented paste fill required to fill a void. To maintain the required strength of the fill mass, the amount of rock fill that can be tipped into a nominated paste fill void is capped at 10%.

Rock fill will be used in all stope voids not filled with paste fill, including fill masses that are to be exposed by later mining and where access for tipping is restricted (e.g. crown pillar voids).

The timing and design of waste rock dumps and stockpiles is discussed in Section 3.6.3.

The disturbance footprint of the Project is described in Table 3.10. The Project will disturb in total approximately 792 ha of land in the first two to three years of construction and operation. This includes 234 ha on the main Project site and 557 ha on the surrounding infrastructure corridors and access roads.

There is limited opportunity for progressive rehabilitation on the Project as the surface footprint area is mostly for infrastructure required throughout the entire life of the mine. Some areas of the NAF/PAF waste rock dump will be available for progressive rehabilitated in the later mine life. The post closure rehabilitation schedule is discussed in Section 3.7.

Table 3.10 Disturbance Footprint of the Project

Disturbance Type	Area (ha)
NAF/PAF Waste Rock Dump	6
South Waste Rock Dump	2.5
North PAF Stockpile	4.5
Lead/Zinc and Copper ROM Pads	5
Off ROM Ore Stockpile	3
Crushed Ore Stockpiles and Conveyors	6
Underground Declines	3
Process Plant Areas (includes chemical and concentrate storages)	28.5
Tailings Storage Facility	91
Longamundi Alternative Route	4
TSF Topsoil Stockpiles	5
Paste Fill Plant	1
Stormwater Dams and Sediment Ponds	12.3
Process Water Pond	0.4
Roads and Tracks (on Main Project Mining Leases)	5
Accommodation Camp	20
Heavy Vehicle Workshop and Go Line	0.2
Contractor Laydown Area and Workshops	2.5
Offices and Workshops	4
Rubbish Disposal Site	3
Gravel/Clay Borrow Pits and Stockpiles	12
Coarse Aggregate Borrow Pits and Stockpiles	0.4
Topsoil Stockpiles (Processing and Mine Area)	10
Exploration pads and Roads	5
Total	**234.3**
Corridors	
Power line (assume 80 m width)	497.3
Water Pipeline (assume 40 m width)	40.4
Access Road (assume 8 m width)	13.6
Access Road Borrow Pits	3
TSF Pipelines and Roads	3
Total	**557.3**
TOTAL	**791.61**

3.3.4.1 Workforce During Construction Stage (2012 -2013)

The construction workforce at site will build up to a peak of approximately 380 persons by June 2013. Of the peak labour force, approximately 320 persons will be construction contractor workers composed of skilled (trades persons), semi skilled (trades assistants) and labourers plus a small group of supervisors and clerical staff. Forty (40) persons will be EPCM Contractor's construction management staff who will manage the work of the construction contractors. The EPCM Contractor's staff will comprise professional, sub professional and administration personnel.

The remaining 20 persons will be the MMG personnel and casual visitors who will direct the services of the EPCM Contractor's construction management team. Like the EPCM Contractor this group will be composed of professional, sub professional and administration staff.

Mine development during the construction period will require an additional 240 persons made up of 15% permanent MMG management staff, 35% contractor maintenance and support staff and 50% contractor mining resources.

The maximum number of people onsite at any one time will be 500 consistent with the number of rooms in the initial camp.

3.3.4.2 Workforce during Operations Stage 2014 - 2037

Following commissioning of the process plant in the first quarter of 2014 it is expected that the mine development and ore processing operations will proceed using permanent staff resources through life of mine. This will require a total of 561 persons. The permanent MMG operational workforce will be 100% staff made up of 15% operations management and administration staff, 55% permanent mining and processing staff and 30% maintenance and support staff. Copper mining and processing operations are expected to require an additional 396 permanent staff starting in 2017 conditional on additional copper ore resources being proven up.

The peak number of personnel working onsite at any one time will be 264 persons for the zinc/lead/silver operations and a total of 396 persons once copper mining and processing starts with the rest of staff being offsite on rest and recuperation days.

3.3.4.3 Workforce during Decommissioning Phase 2038

Following the cessation of mining and processing operations it is envisaged only a small number of permanent MMG staff will remain onsite, who will direct the services of varying number of contractor personnel engaged in rehabilitation works.

3.3.5 Processing and Products

3.3.5.1 Processing

The processing plant will be located immediately to the east of the Dugald River deposit, near the eastern boundary of the Project site. Figure 3.29 show the location of the processing plant and associated administration offices and workshops. The site was selected so that the ROM Pads are close to the mine portals to minimise the distance the haul trucks have to travel, and to keep the ROM pad activities downwind of the terminal switchyard and administration area. MMG has undertaken a sterilisation drilling program for the process plant area.

The key criteria for the processing plants are:

- Treating 2 Mtpa lead/zinc/silver and/or 1 Mtpa copper ore;
- Operating the plant 24 hours per day, 7 days per week;
- A design availability of 91.3% (after ramp-up), equating to 8,000 operating hours per year;
- Including standby equipment in critical areas within the circuit;
- Sufficiently automated plant control to minimise the need for continuous operator attention, with provision for manual override and control if required; and
- Covering the flotation and concentrate regrind circuits with an open sided building.

There will be a separate processing plant circuit for the lead/zinc/silver ore and copper ore. The processing plant designs for each type of ore have a single processing line that includes a jaw crusher, stockpile conveyor, coarse ore stockpile, semi-autogenous grinding (SAG) and ball mill grinding circuit, flotation circuits that include regrinding mills, and concentrate dewatering, concentrate loading and tailings thickening facilities.

The concentrators will use a conventional processing flow sheet and industry standard equipment. Concentrator operation will be monitored using a control system from a centrally-located control room. Product streams will be sampled and assayed, with monitoring by an automated system linked to the control system.

Lead/zinc/silver and copper concentrates will be recovered from the ore using the froth flotation process. The concentrates will be transported to smelting facilities in Australia and overseas. The processing plants will have an annual throughput of 2 Mtpa of zinc/lead/silver ore and 1 Mtpa of copper ore. Lead/zinc/silver processing will commence in mid 2014 with copper processing commencing in 2017, upon proving of a sufficient copper resource and after obtaining approval of any necessary environmental permits. Below is a summary of the processing circuits for the lead/zinc/silver and copper processing plants which are very similar.

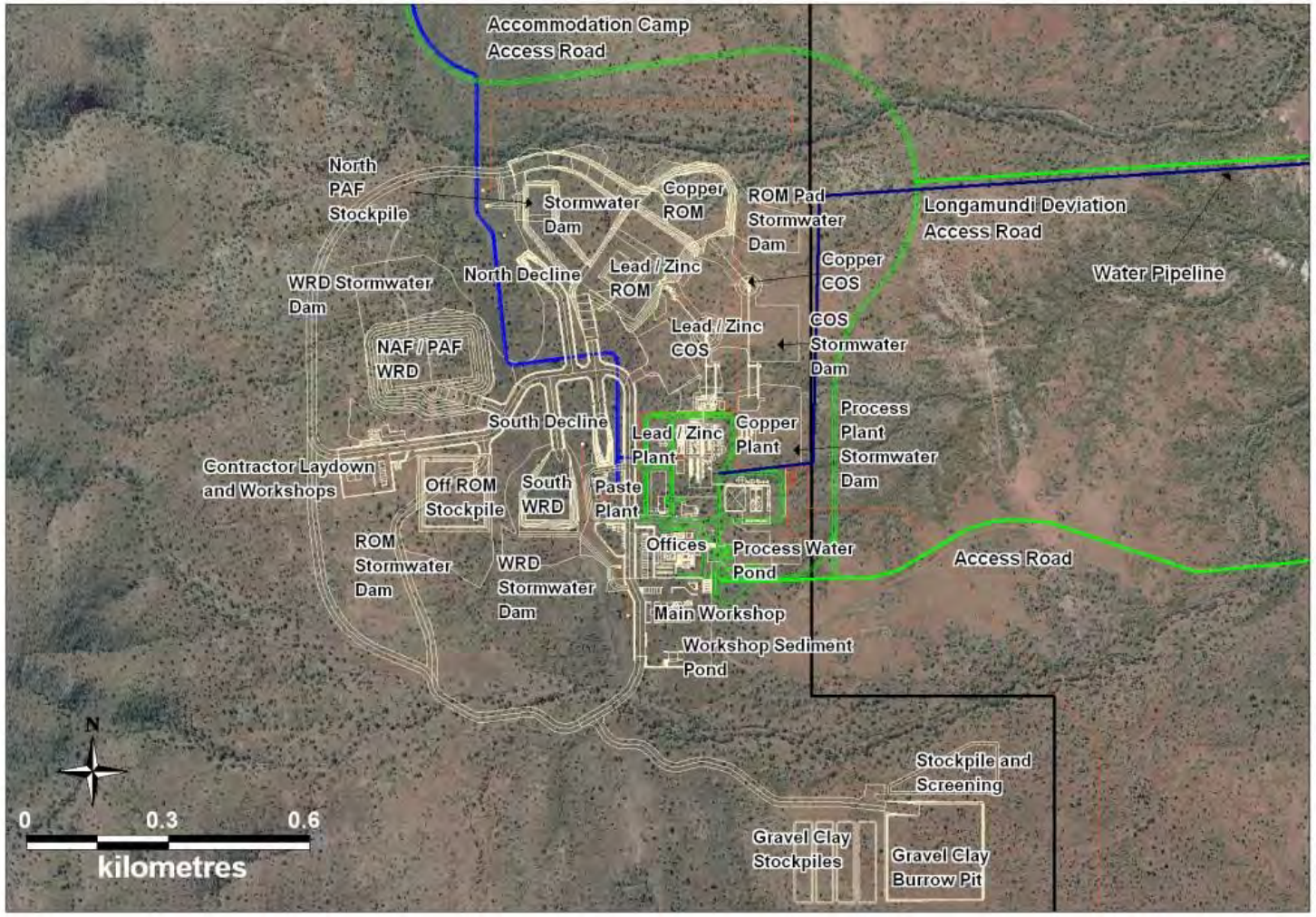


Figure 3.29 Process Plant Layout

3.3.5.2 ROM Stockpile and Crushing

Low-profile trucks will haul the ore from the underground mine to either the; lead/zinc/silver ROM pad or the copper ROM Pad. The lead/zinc/silver ROM Pad is the western most pad and the copper ROM Pad the eastern pad as shown on Figure 3.29. The ROM stockpiles will provide 14 days of ore storage based on a processing rate of 3 Mtpa.

There will be a separate crushing plant for the lead/zinc/silver ore and the copper ore. The crushing plants will be a single stage jaw crusher that discharges ore to two separate crushed-ore stockpiles (COS). The primary crushers will be at the edge of the ROM pad. Trucks from underground will dump ore into a 150 t ROM bin. Alternatively, ROM ore can be rehandled and fed to the ROM bin by front end loader (FEL) for blending on an operational-needs basis.

A static 800 mm x 800 mm aperture grizzly above each ROM bin prevents oversized material from entering the ROM bin. The oversize is removed by FEL and returned to the ROM stockpile for breaking by a mobile rock breaker.

An apron feeder draws the ore from the ROM bin and discharges via a vibrating grizzly (with 100 mm spacing) into a Jaques 1,220 mm x 1,065 mm single-toggle jaw crusher operating with a closed side setting of 100 mm. Crushed ore is delivered to the COS via a primary crusher discharge conveyor and then a stockpile feed conveyor. A self-cleaning magnet is located at the transfer point from the crusher-discharge conveyor to remove magnetic tramp metal. A weightometer is installed on the stockpile feed conveyor to provide indication of the production rate in the crushing circuit. The primary crushing circuit is shown in Figure 3.30.

To minimise airborne dust, an induced-draft dust collector with reverse-pulse baghouse maintains a suction draft in the primary crusher and crusher discharge chute. The dust discharges from the dust collector onto the stockpile feed conveyor. Water sprays are used at the ROM bin, primary crusher and transfer chutes to prevent fines from becoming airborne.

Figure 3.31 shows the COS and its reclaim system. The COS provides a minimum of 12 h live capacity at a SAG mill feed rate of 250 tonnes per hour (tph), with a total (live plus ‘dead’) capacity of 15,000 t or 60 h of nominal SAG feed capacity. In the event of extended crusher downtime, ‘dead’ ore can be reclaimed from the COS using a bulldozer.

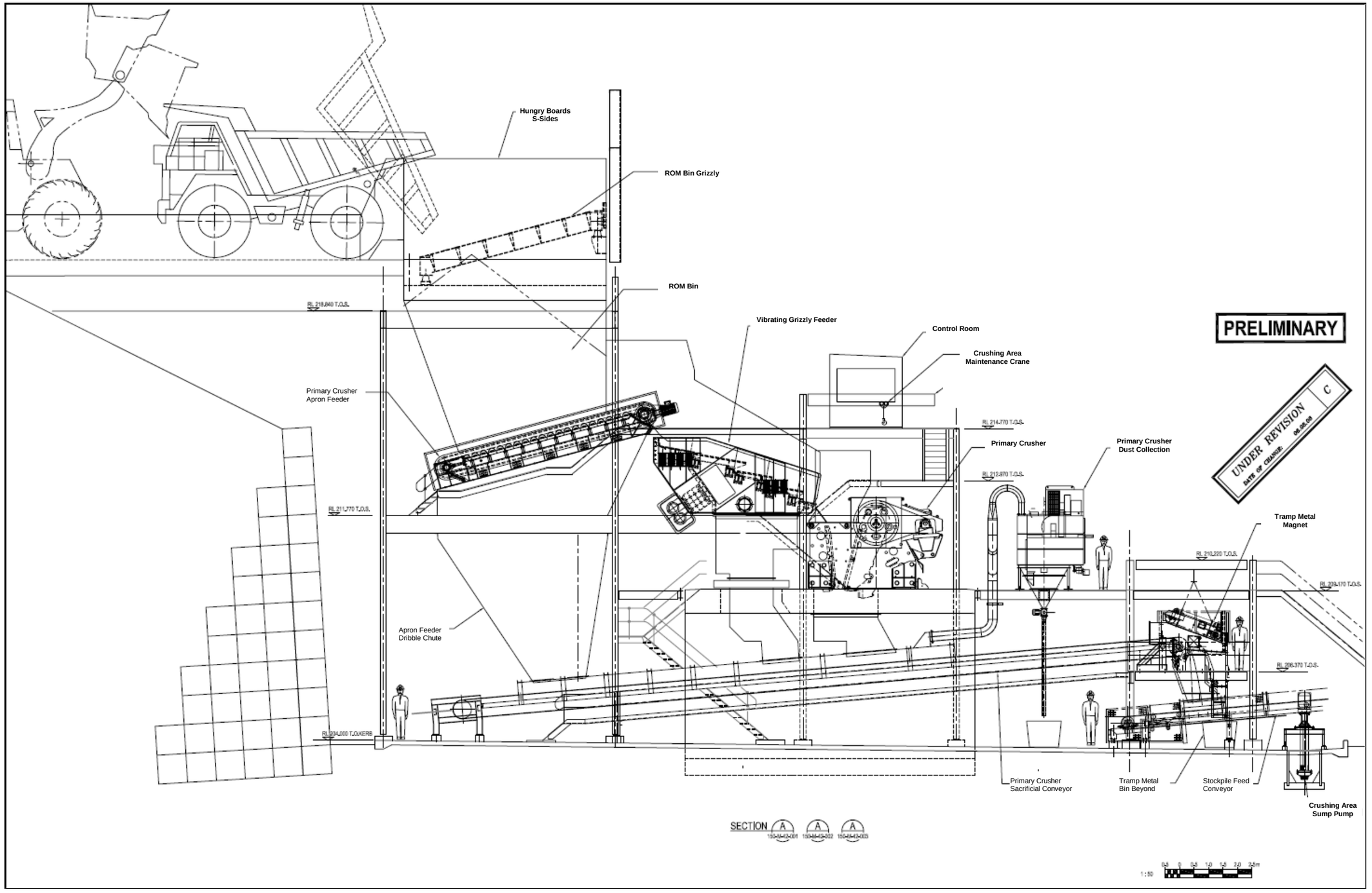


Figure 3.30 Primary Crushing Circuit

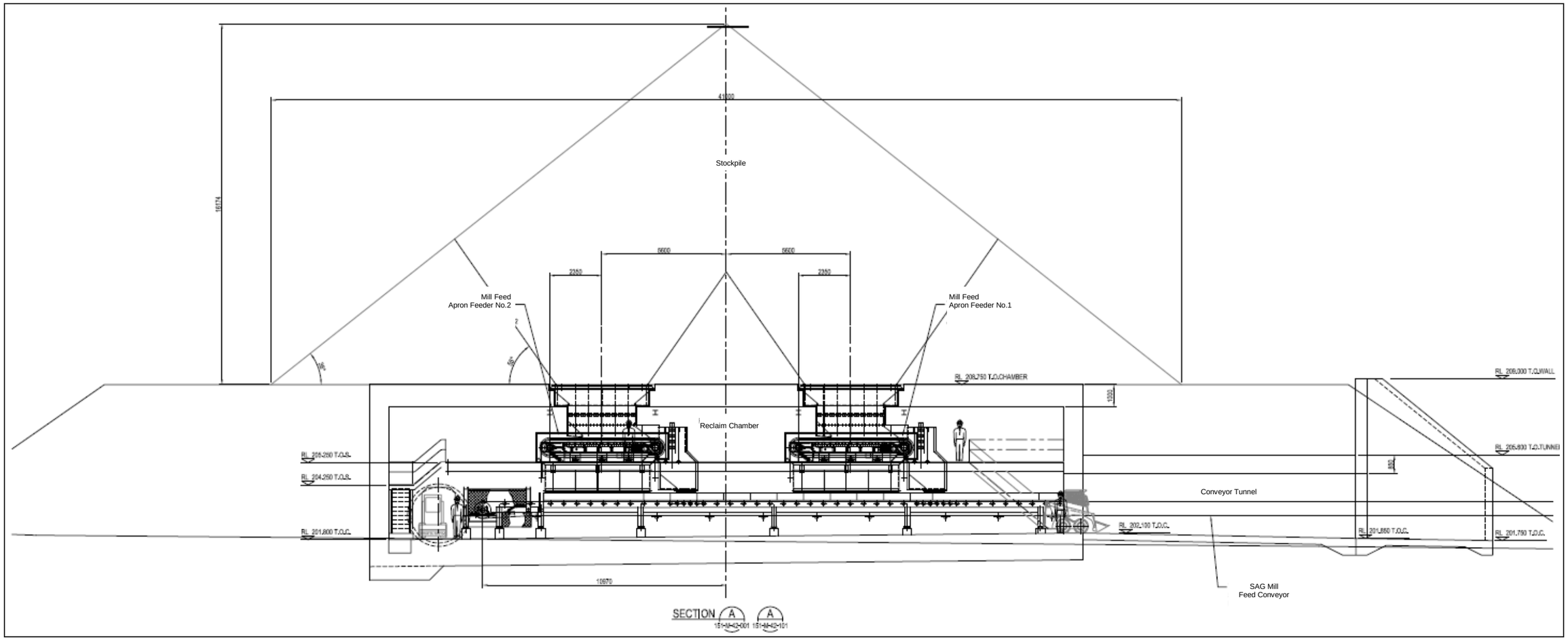


Figure 3.31 Course Ore Stockpile and Reclaim System

3.3.5.3 Pre-Flotation

Zinc/Lead/Silver Process

Ore will be reclaimed from each of the COS and fed to a SAG mill operating in closed-circuit with a screen. The SAG mill will be followed by a ball mill operating in closed circuit with cyclones. The ball-mill feed will be slurried and ground to a product P_{80} size of 60 µm (i.e. 80% finer than 60 µm).

The ball mill's cyclone overflow will flow to a carbon pre-flotation circuit, where carbonaceous gangue and activated pyrite will be removed and pumped to tailings. The carbon pre-flotation circuit will consist of tank cells for rougher flotation and a Jameson Cell for cleaning.

A conceptual diagram of the lead/zinc processing circuit is shown in Figure 3.32.

Copper Process

The copper processing plant will consist of the following basic unit processes:

- Primary crushing, comprising feed bin apron feeder, crusher and dust suppression;
- Grinding in a single stage SAG mill and classification in cyclones;
- Stockpiling of crushed ore;
- Rougher and scavenger flotation;
- Cleaner flotation; and
- Tailings thickening and disposal to TSF.

A conceptual diagram of the copper processing circuit is shown in Figure 3.33.

3.3.5.4 Froth Flotation

The carbon pre-flotation tailings from the lead/zinc/silver pre-flotation plant will be the pumped to the lead flotation circuit. The lead flotation circuit will consist of rougher flotation, an IsaMill^{TM} to grind the rougher concentrate to a P_{80} of 12 µm, followed by three stages of cleaning. A Jamseon cell will be used to scalp a final concentrate grade before the first of the cleaner flotation stages. The final lead concentrate will be thickened, filtered and stored on site before transporting off the Project site.

Lead circuit tailings will report to the zinc flotation circuit. A zinc rougher concentrate and a scavenger concentrate will be produced from the first stage of flotation. The rougher concentrate will be fed to a Jameson cell to scalp a final concentrate product. Jameson cell tails will be combined with scavenger concentrate, which will both be reground to a P_{80} of 12 µm and then upgraded by three stages of cleaning. Final zinc concentrate will be thickened, filtered, and stored on site before transport for sale.

3.3.5.5 Tailings

Zinc and copper circuit tailings will be combined with the carbon pre-flotation cleaner concentrate and pumped to the tailings thickener. The slurry will be thickened, then pumped to either the TSF or to the paste-fill plant for use in the underground mine operations. Tailings thickener overflow water will be recycled through to the process-water circuit. Water that is decanted from the TSF will also be recycled through plant process-water circuit.

The paste for back fill will equal approximately 620,800 tpa and final tailings will equal approximately 931,200 tpa from processing of zinc ore.

The Paste Fill Plant and TSF are described in Sections 3.6.4.1 and 3.6.4.2 respectively.

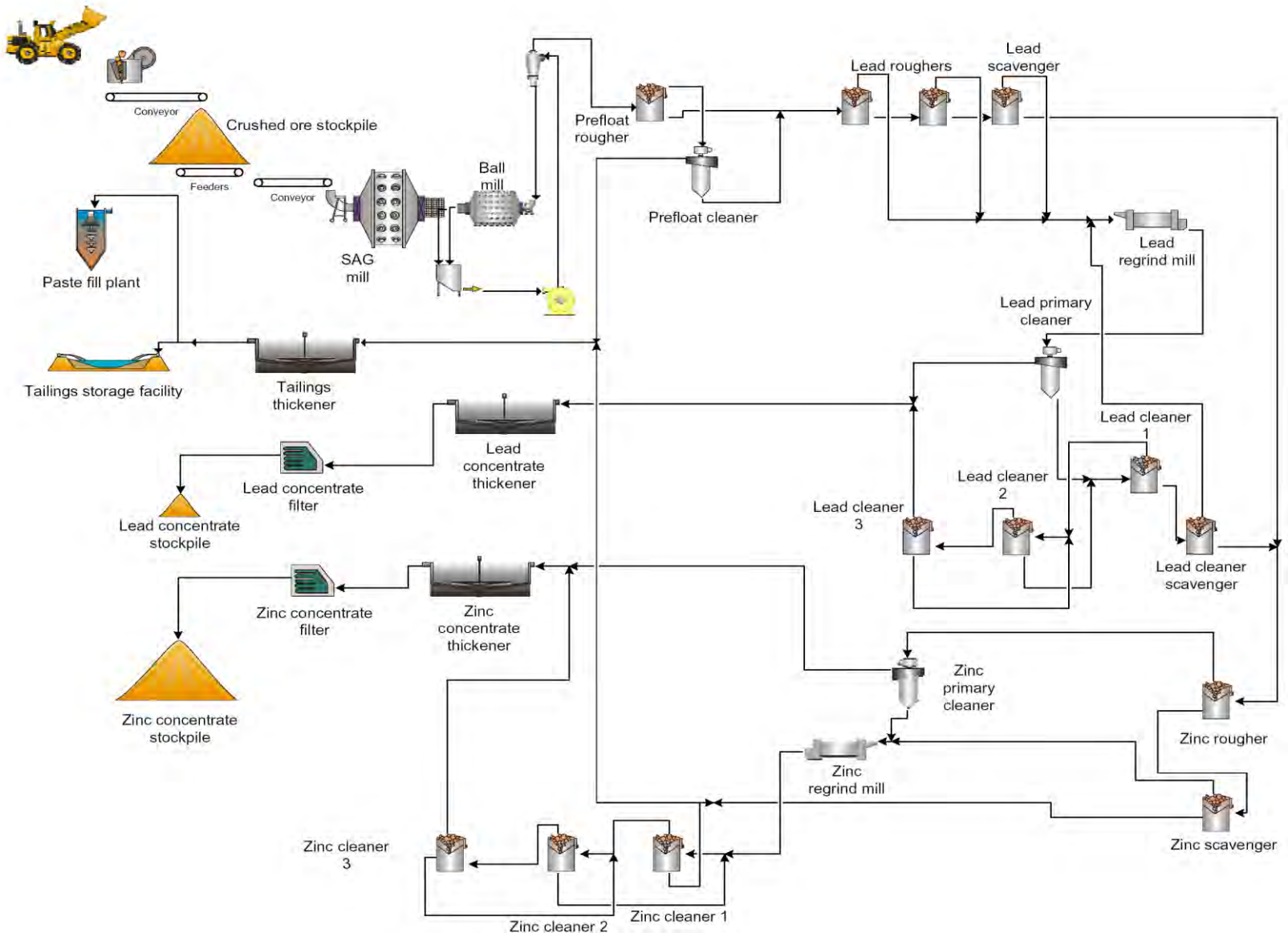


Figure 3.32 Conceptual Lead/Zinc/Silver Process Flowchart

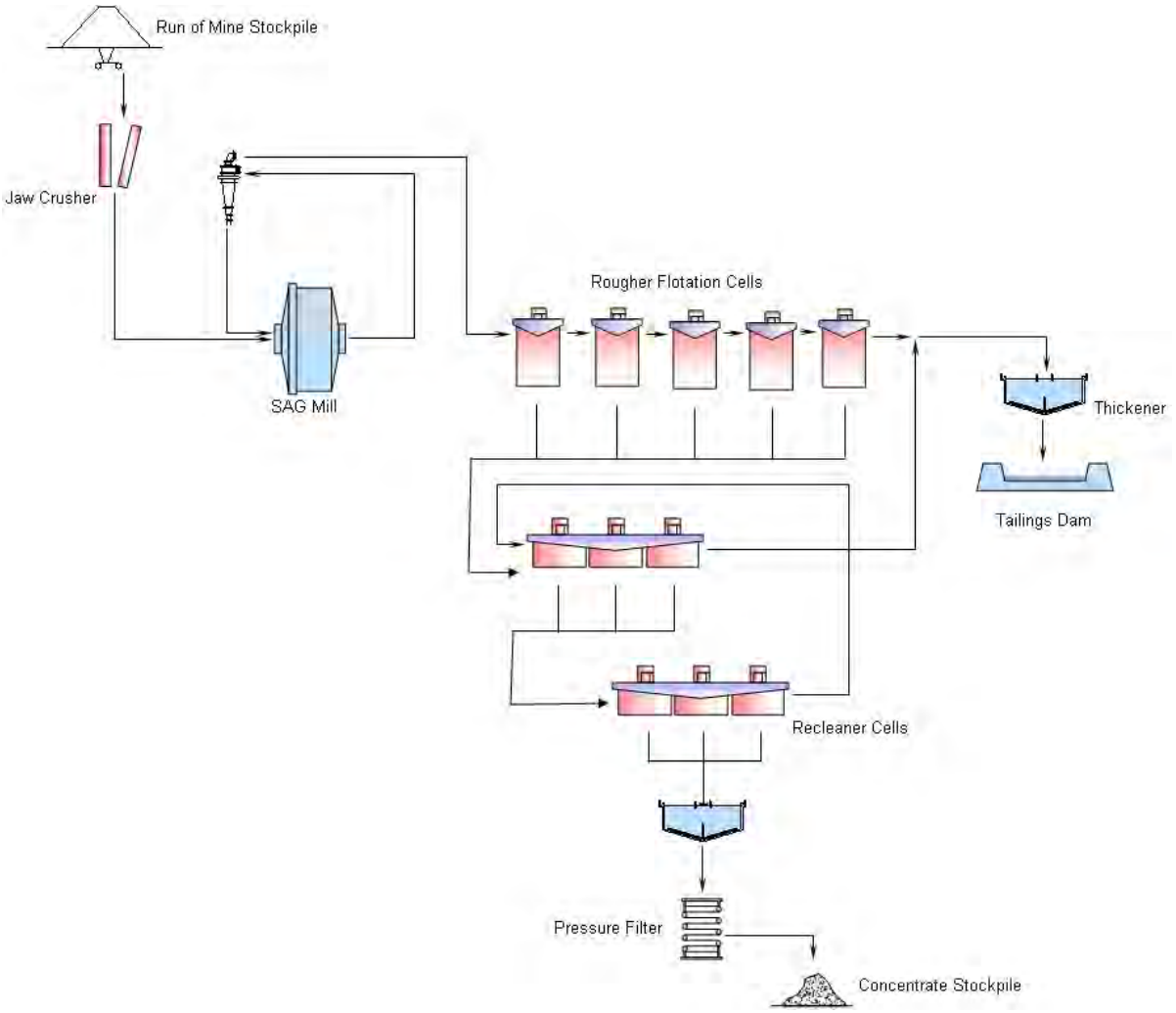


Figure 3.33 Conceptual Copper Process Flowchart

3.3.5.6 Major Inputs

The following will be the major inputs to the processing plants:

- Zinc/lead/silver ore (2 Mtpa);
- Copper ore (1 Mtpa);
- Raw water;
- Reagents; and
- Grinding media.

Water from all thickeners and filters will be recycled (approximately 100%) into the plant process water circuit to minimise overall site water requirement.

Reagents used in both processes will include: soda ash, lime, sodium isobutyl xanthate (collector), methyl isobutyl carbinol (frother), copper sulfate (activator), zinc sulfate (depressant), sodium cyanide (depressant), dextrin (dispersant) and flocculant.

Reagents will be stored in either a warehouse or in dedicated reagent handling facilities located within the processing plant. Table 3.11 details the consumption of reagents and media. Table 3.12 details the storage and use of reagents in the processing plant.

Table 3.11 Reagents and Media Consumption Summary

Reagents	**Consumption**	
	g/t (new feed)	**t/a**
Process Reagents		
pH Modifiers		
Lime	1950	4080
Soda Ash	2100	4200
Collector - SIBX	480	990
Activator - Copper Sulphate	1650	3300
Flocculent - SNF AN905VHM	20.63	44.25
Pyrite depressant - Sodium Cyanide	375	750
Carbon Dispersant - Dextrin	52.5	105
Frother - MIBC	37.5	127.5
Zinc Depressant - Zinc Sulphate	1125	2250
Primary Milling Circuit		
Grinding Media	**Steel Consumption**	
	g/t (need feed)	t/a
SAG Mill	600	1200
Ball Mill	1770	3540
Concentrate Regrind Circuit		
Grinding Media	**Ceramic Media Consumption**	
	g/t (mill feed)	t/a
Lead Regrind	1425	270
Zinc Regrind	1695	1080

Table 3.12 Reagents Storage and Use

Reagent	Use	Storage	Processing Concentration and Release	Requirement in Processing
Lime	Lime is used in processing as a pH modifier. The quick-lime system consists of a vendor-supplied proprietary slaking system, a dedicated storage tank and ring-main system.	Quick lime is delivered in 20 t bulk tankers and pneumatically conveyed directly to a 200 t lime silo.	The lime is released from the silo at a controlled rate by a rotary valve and fed to the vertical slaking mill where it is slaked with water to achieve a consistent lime mixture concentration of 15-20% w/w solids A lime circulating pump is used to deliver milk-of-lime slurry via a pressurised ring main to unit processes requiring lime addition. At each dose point, an off-take from the top of the ring-main pipe is used to dose milk-of-lime slurry as required via pinch valves.	The milk-of-lime slurry addition is required at the following points: • zinc conditioning tank; • zinc regrind mill; and • zinc cleaner 3 cell 1. Lime is also required in the copper processing circuit.
Soda ash	Soda ash is used in processing as a pH modifier.	Powdered soda ash is delivered to site in 20 t bulk tankers. The soda ash is pneumatically offloaded into a 53 m^3 silo.	The soda ash powder is fed by a variable-speed rotary feeder to the mixing tank where water is added. The mixed solution is transferred to the storage tank with 30 h capacity. The soda ash solution is reticulated in a ring-main system to various user points using the soda ash ring main pump (one duty pump and one standby). Line pressure is maintained by a manually-operated diaphragm valve. Dosing to each point is by timer-operated pulsing-diaphragm valve.	Soda ash is added to: • lead conditioner; and • lead cleaner 3.
Collector SIBX	Collector chemicals are used to render mineral ore particles hydrophobic so they are repelled from water. They collect together in clumps. When the mixture is aerated, the hydrophobic particles adhere to air bubbles and form a froth.	SIBX is delivered in 850 kg bulka bags as a dry solid. After a preset mixing duration, the SIBX solution is transferred from the mixing tank to the storage tank. The storage tank is designed to store approximately 72 hours of solution.	During a mixing cycle, the bulka bags are hoisted to a bag splitter situated above the mix tank. Raw water is added to the mixing tank to achieve a 20% w/v solution concentration. SIBX is dosed from the storage tank to the flotation circuit using a ring main with actuated on/off valves.	SIBX addition is required at the following points: • lead conditioning tank; • lead rougher cell 1; • lead rougher cell 3; • lead primary cleaner; • lead cleaner 1 cell 1; • lead cleaner 2 cell 1; • lead cleaner 3 cell 1; • zinc conditioning tank; • zinc rougher cell 1; • zinc rougher cell 3; • zinc rougher cell 5;

Reagent	Use	Storage	Processing Concentration and Release	Requirement in Processing
				• zinc rougher cell 7; • zinc cleaner 1 cell 1; • zinc cleaner 2 cell 1; and • zinc cleaner 3 cell 1. Xanthates are also required in the copper processing circuit.
Activator (copper sulfate pentahydrate 'CSPH')	Activators may be added to chemically resurface the solid to increase the interaction with collectors that are ineffective alone.	CSPH is delivered in 1200 kg bulka bags. After a preset mixing duration, the CSPH solution is transferred from the mixing tank to the storage tank. The storage tank is designed to store 40 hours of solution.	During a mixing cycle, the bulka bags are hoisted to a bag splitter situated above the mix tank. Raw water is added to the mixing tank to achieve a 15% w/v solution concentration. CSPH is dosed to the zinc flotation circuit using variable-speed progressive-cavity reagent-dosing pumps running to an operator-set addition rate.	CSPH is added to: • lead circuit tailings hopper; and • zinc regrind mill product hopper
Flocculant	Flocculant is added during processing to forms 'flocs' or colloids. The flocculant system consists of a vendor-supplied proprietary mixing package, a dedicated storage tank and distribution pumps.	Flocculant is delivered in 1000 kg bulka bags as a dry powder and dilute flocculant solution is mixed using the proprietary wetting system designed specifically for use on flocculant powders. The flocculant storage tank has 18 hours of storage capacity.	The 0.25% w/v flocculant solutions are transferred from the mixing tanks to the respective storage tanks and then to each of the thickeners using dedicated variable speed progressive-cavity reagent-dosing pumps.	Flocculent is required in the lead/zinc processing circuit and the copper processing circuit.
Depressant (sodium cyanide)	Depressants form a polar chemical envelope around the solids particles that enhances hydrophilicity or selectively prevents interaction with collectors that may induce unwanted hydrophobicity.	Solid sodium cyanide is delivered to site in 20 tonne ISO containers. The 80 t crane in the mobile equipment list will be needed to lift the cyanide containers.	Cyanide is flushed from the ISO container with raw water to the required concentration of approximately 20%w/w. Stock cyanide solution is distributed to the flotation circuits via a ring-main with take-offs to the required locations.	Cyanide is added to: • lead conditioning tank; • lead regrind mill product hopper; and • Note that cyanide needs to be kept separate from copper sulphate because the two can react to produce hydrogen cyanide gas

Reagent	Use	Storage	Processing Concentration and Release	Requirement in Processing
Zinc depressant (zinc sulphate)	Depressants form a polar chemical envelope around the solids particles that enhances hydrophilicity or selectively prevents interaction with collectors that may induce unwanted hydrophobicity.	Zinc sulfate will be delivered in 1000 kg bulka bags. After a preset mixing duration, the zinc sulphate solution is transferred from the mixing tank to the storage tank. The storage tank is designed to store 30 hours of solution.	During a mixing cycle, the bulka bags are hoisted to a bag splitter situated above the mixing tank. Raw water is added to the mixing tank to achieve a 15% w/v solution concentration. Zinc sulphate is dosed to the flotation circuit using variable-speed progressive-cavity reagent-dosing pumps running to an operator set addition rate.	Zinc depressant is added to: • lead conditioner ; and • lead regrind mill product hopper.
Carbon dispersant (dextrin)	Dextrin is used as a carbon dispersant. Dextrin is a matrix for separation of hydrophobic substances.	Dextrin is delivered in 1000 kg bulka bags. After a preset mixing duration, the dextrin solution is transferred from the mixing tank to the storage tank. The storage tank is designed to store 2.5 batches of mixed solution	During a mixing cycle, the bulka bags are hoisted to a bag splitter situated above the mixing tank. Raw water is added to the mixing tank to achieve a 10% w/v solution concentration. Dextrin is dosed to the zinc flotation circuit using variable-speed progressive-cavity reagent-dosing pumps running to an operator-set addition rate.	Dextrin is added to: • lead conditioning; • lead regrind mill product hopper; and • zinc regrind mill product hopper.
Frother – Methyl Isobutyl Carbinol (MIBC)	Used in processing to aid the formation of a stable froth. MIBC is particularly good for small particles.	Frother (methyl isobutyl carbinol or 'MIBC') solution is delivered in 20 t bulk tankers.	The tankers are unloaded by a dedicated unloading pump into a 29 m3 frother-storage tank Frother is pumped to a day tank located in the flotation circuit and distributed to various sections of the plant by dedicated reagent-dosing pumps.	Frother is added to: • preflotation cell 1; • lead rougher cell 1; • lead rougher cell 3; • lead cleaner 1 cell 1; • zinc rougher cell 1; • zinc rougher cell 3; • zinc rougher cell 5; and • zinc cleaner 1 cell 1. Frother is also required in the copper processing circuit.

Management of Cyanide and other Chemicals

Cyanide and other chemicals used in the Project will be managed in accordance with MMG's internal environmental standards for the management of cyanide and chemicals. These standards have been developed to be protective of human health and wildlife, and prevent spills, releases, leaks, overflows and unplanned chemical reactions, such that environmental impacts are managed and minimised.

MMG Standard for Management of Chemicals

The MMG standard for management of chemicals applies to the selection, transportation, storage and use of chemicals during the design, construction, operation and rehabilitation and closure phases of MMG operated sites. The standard also applies to operations by contractors and involves:

- Managing chemicals in compliance with applicable laws, regulations and other obligations and requirement;
- Review and approval by Environmental, Health and Safety and Materials Management Departments, of the selection of chemicals to be used at site prior to purchase;
- Designing and constructing chemical use, transfer, distribution, and storage facilities (pads, tanks, pumps and piping) above ground (not buried);
- Installing corrosion protection or passive systems to detect leaks or active mechanisms such as visual inspections or annual integrity testing in any piping which needs to be installed underground (e.g. road crossings);
- Providing chemical storage facilities with systems to detect leaks and recover product;
- Providing secondary containment with permeability equivalent to untreated concrete for chemical storage and transfer systems. Secondary containment will be designed and constructed to contain a minimum of 110% of the volume of the largest container/tank in the containment area;
- Equipping chemical storage tanks with engineered overfill/overpressure protection devices;
- Designing chemical use, transfer, distribution and storage facilities to control rainfall runoff, including drainage within and around containment areas;
- Using containment and collection systems in areas around chemical delivery pumps to protect against spills and releases;
- Requiring transporters of chemicals to demonstrate the competencies required to transport chemicals based on statutory and organizational requirements and that are licensed by the appropriate authority;
- Requiring transporters of chemicals to carry out a documented qualitative risk assessment including route evaluation and selection prior to establishing transportation activities;
- Including contractual obligations for the responsible management of chemicals into applicable contracts for construction, operations and on-site activities;

- Conducting environmental audits of vendor chemical transportation every three years;
- Conducting observations of bulk transfer of chemicals during delivery;
- Conducting routine inspections of ground storage tanks and piping;
- Using proper labeling and placarding on chemical product containers and tanks;
- Storing incompatible chemicals (e.g. acid and cyanide) in separate containment areas; and
- Managing chemicals according to the applicable Material Safety Data Sheet (MSDS).

MMG Standard for Management of Cyanide

The MMG standard for management of cyanide is largely derived from the International Cyanide Management Code and applies to the purchase, transportation, handling, storage and the operation and decommissioning of cyanide facilities during the design, construction, operation and rehabilitation and closure phases of MMG operated sites. The standard also applies to operations by contractors and involves:

- Designing and constructing unloading, storage and mixing facilities according with sound, accepted engineering practices, quality control and quality assurance procedures, release prevention and release containment measures;
- Providing secondary containment with permeability equivalent to untreated concrete for bulk cyanide containers, process solution tanks and pipelines so that potential releases drain into a sump. The containment area shall have the capacity of at least 110% of the capacity of the largest tank;
- Designing and constructing storage areas for solid cyanide to prevent contact of solid cyanide with water. The area surrounding the secondary containment of each bulk cyanide storage area shall be suitably sloped and drained to prevent the entrance and accumulation of storm water in the storage area;
- Designing adequate containment or deflection systems for piping/vessels under pressure to avoid releases;
- Designing, constructing and operating sites to protect birds; other wildlife and livestock from adverse effects of cyanide process solutions;
- Designing, constructing and operating facilities to protect aquatic resources and wildlife from direct and indirect discharges of cyanide process solutions to surface water;
- Designing, constructing and operating facilities to manage seepage from cyanide and protect groundwater resources;
- Establishing in contractual agreements with cyanide producers clear lines of responsibility for safety, security, release prevention, training, emergency response, releases/spills clean up, compensation and liabilities of potential cyanide releases;

- Ensuring transportation personnel have appropriate hazardous materials training;
- Verifying that cyanide transporters have in readiness emergency response plans and capabilities;
- Ensuring contractors involved with the transportation and delivery of cyanide carry out a risk assessment including route evaluation and selection prior to establishing transportation;
- Verifying that cyanide transporters are licensed by the appropriate authority;
- Operating unloading, storage and mixing facilities using inspections, preventative maintenance and contingency plans to prevent releases;
- Implementing management and operating systems designed to protect human health and the environment including contingency planning;
- Planning and implementing procedures to decommission cyanide facilities to protect surface and groundwater, wildlife and livestock; and
- Implementing monitoring programs to detect any adverse effects to wildlife, surface and groundwater quality due to the use of cyanide.

3.3.5.7 Miscellaneous Reagents

Additional reagents will be required within the plant site; however, these will used in relatively minor quantities. These reagents include anti-scale chemicals, water chlorination, lubricants and laboratory chemicals.

Anti-scale chemicals will be dosed into the suction side of the process water pumps to reduce the formation of gypsum scale resulting from saturated calcium levels in sulphate-bearing solutions.

3.3.5.8 Grinding Media

Forged carbon steel grinding balls will be delivered to site in 200 Litre (L) drums. The steel grinding medium will be loaded into the SAG and ball mills manually by kibble.

A ceramic-bead grinding medium will be used in the regrind mills. It will be delivered to site in 2 t bulka bags in 20 t containers. The regrind medium will be hoisted by the respective flotation area overhead cranes and emptied into mills' vendor-provided medium handling systems, which consist of a hopper and screw feeder. Medium addition can be controlled by the plant computer system.

3.3.5.9 Products

Three products will be produced: zinc concentrate (408,000 tonnes per annum (tpa)), lead concentrate (40,000 tpa) and copper concentrate (75,000 tpa). The storage of these products will be discussed in Section 3.4.1 – Onsite Handling.

3.3.5.10 Other Major Wastes

Ore of a critical mid-size fraction will form an oversize product at the discharge of the grinding mills. This material is known as scats and will be stored next to the coarse ore stockpile. Intermittently, scats will be fed back into the ore feed stream, either through the primary crusher, or directly onto the

coarse ore stockpile with a front end loader. As such, scats will not need a specific disposal method as they will become part of the ore stream and its associated disposal methods.

3.3.6 Ongoing Evaluation and Exploration Activities

Ongoing exploration activities will occur throughout the life of the Project particularly in regards to the potential copper deposits on site.

Future works will likely consist of:

- In-fill drilling of the main zinc-lead orebody to confirm orebody position and quality prior to mining;
- Extension drilling to increase the main zinc-lead orebody, which is still open at depth;
- Drilling to improve understanding of the copper resources in the hanging wall of the main orebody, with the intention to define a mineral resource;
- Exploration drilling of areas that are prospective for copper, including areas to the south of the main orebody around Patti's Workings and Godikin; and
- Exploration drilling on the area to the west of the Knapdale Range for both zinc-lead and copper mineralisation.

3.4 PRODUCT HANDLING

3.4.1 On Site Product Handling

Lead, zinc and copper concentrates will be filtered and stored in the concentrate storage shed on site in preparation for transport. Concentrate will be loaded onto quad road trains by front-end-loaders and transported off site.

The concentrate-storage building (Figure 3.34) will have a two-week storage capacity. It will have a design storage capacity of approximately 8,400 t of zinc concentrate and 1,100 t of lead concentrate. The building will contain vertical filter presses to remove water from the concentrate prior to transport and areas to store different concentrates in segregated areas. The building will be fully enclosed with a concrete floor, including the truck loading area, to prevent contamination by metal concentrates to the outside environment, as well as ensuring concentrates remain free from external contaminants. This facility will also keep the concentrate trucks dry during loading operations.

The concentrate storage shed will have a 4 m high concrete wall against which to stack the concentrate to a design height of 3.5 m. The building will be clad inside the frame to limit dust collection on, and consequent corrosion of, the frame. The cladding will not extend to ground-level as the concrete will serve as the wall in the lower portion.

The concentrate storage shed will be located in the centre of a road loop that the trucks drive around clockwise as part of the loading process. The truck wash will be located on the route the trucks take when they are loaded (Figure 3.35). The truck wash includes shaker bars to help dislodge concentrate.

All concentrate trucks will be required to go through the truck wash before leaving site. The truck wash is expected to be similar to the truck wash located at the Yurbi Rail Loading Facility. It will be a relatively simple unit with two standing pipes fitted with spray nozzles to wash the sides of the trucks, and sprays in the floor to wash the underneath of the trucks. The spray system will be manually operated, and there will be two high-pressure water sprays to remove stubborn materials.

Approximately 70% of the water used by the truck wash will be recovered for reuse. The water will be cleaned in an oil–water separator and stored in tanks for further use.

Water runoff will be separated into clean and potentially contaminated water. Potentially contaminated run off will be contained in a combination of lined stormwater dams and pumped back to the TSF. Management of clean and potentially contaminated water management is further described in Section 3.5.4.

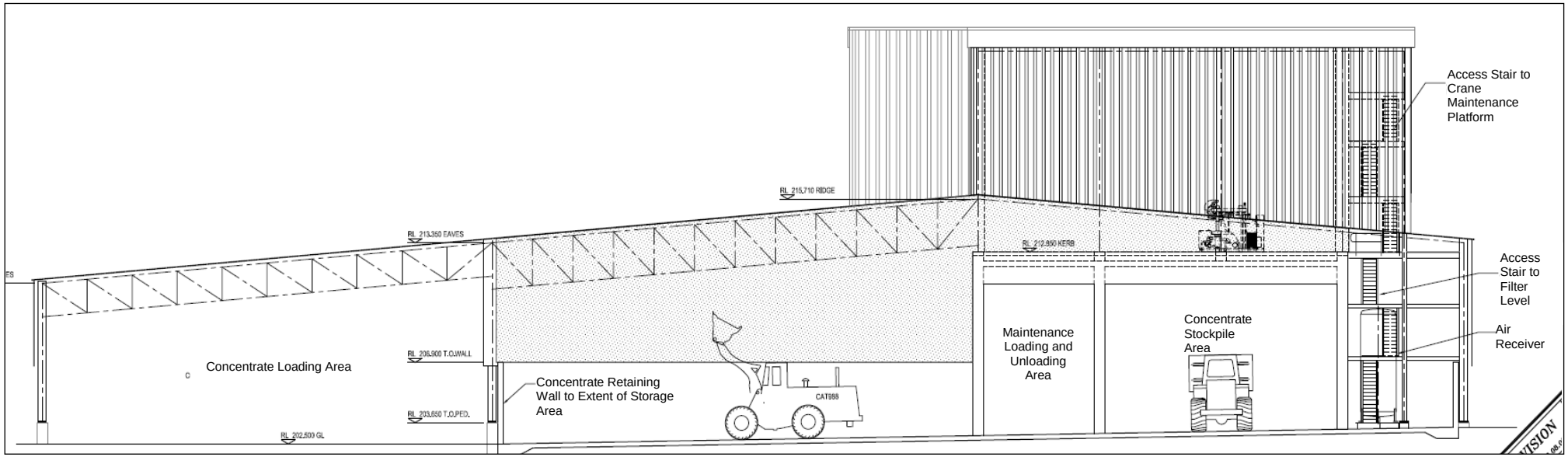


Figure 3.34 General Arrangement of the On-site Concentrate-Storage Building

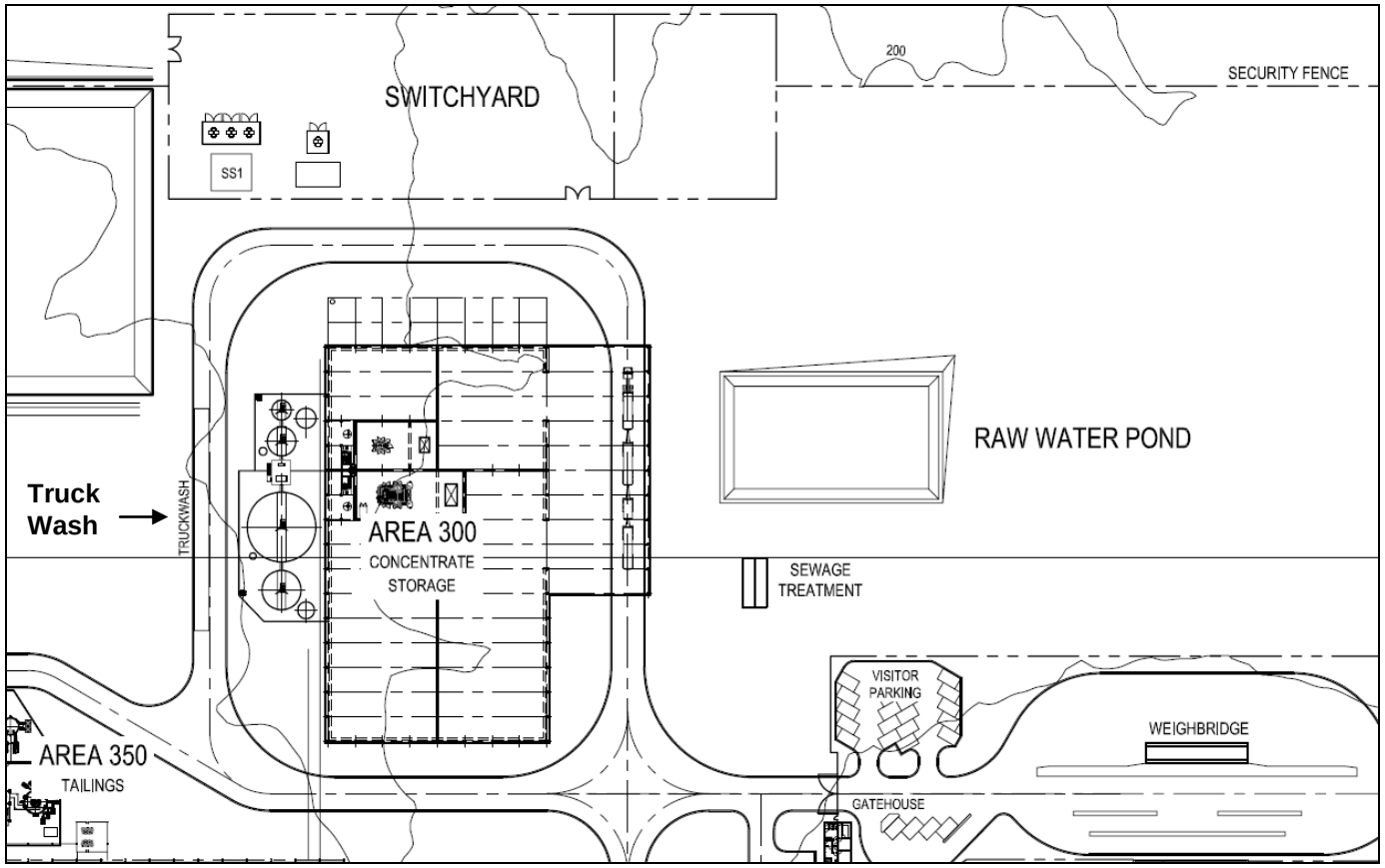


Figure 3.35 Truck Wash Location

3.4.2 Off Site Product Handling

Concentrate produced onsite will be trucked from the Project site to BHP Billiton's Yurbi Rail Loading Facility via the Burke Developmental Road, Hensley Drive, Railway Street and then the Flinders Highway. The loads of all trucks carrying concentrate will be covered to minimize dust lift-off. From here the concentrate will be transported 800 km by rail along to the Port of Townsville where it will be unloaded. The transportation of concentrate from the Project site to the Yurbi Rail Loading Facility and onto Townsville is further described in Sections 3.5.1.7 and 3.5.1.8.

MMG intend to negotiate a commercial agreement with BHP Billiton Cannington to expand capacity at their existing Yurbi Rail Loading Facility and port facilities to allow the storage and handling of the additional Dugald River concentrates. Therefore, off site product storage is not covered under this EIS and BHP Billiton will be responsible for gaining any additional approvals required.

3.5 INFRASTRUCTURE REQUIREMENTS

3.5.1 Transport—Road/Rail/Ship

This Section describes the existing transport infrastructure, including road, rail, ship and air, required by the Project. This Section includes a description of the transportation of the workforce and commodities during the construction and operation of the Project.

The potential impacts of the Project on the existing transport infrastructure during construction and operation of the Project are described in Section 4.2.2.8.

The detailed Transportation Assessment report is provided in Appendix F.

3.5.1.1 Road Infrastructure

The region is served by the National Highway 78 (Flinders Highway), which provides an east-west arterial traffic route connecting Cloncurry to the eastern Queensland coast at Townsville, passing through Hughenden and Charters Towers. The National Highway 66 (Barkly Highway) runs west from Cloncurry to Mt Isa, whilst the National Highway 83 (Burke Developmental Road) runs in a north-south direction connecting Cloncurry to Normanton in the north (Figure 3.36). The Railway Street/Hensley Drive bypass is a local government road developed to traffic heavy vehicles from the Flinders Highway to the Burke Developmental Road without travelling through the Cloncurry town centre (highlighted red in Figure 3.36).

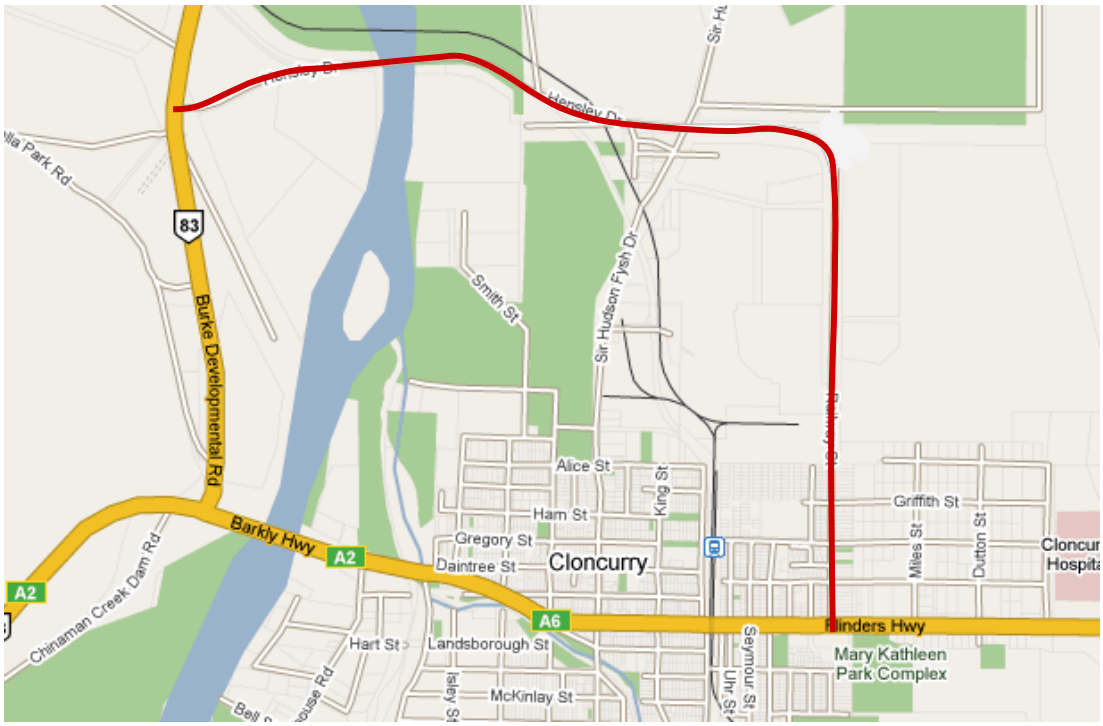


Figure 3.36 National Highways and Roads of Cloncurry

The Project site is accessed via the Burke Developmental Road, approximately 62 km north of Cloncurry. Access to the site will be via unsealed road constructed specifically to service the Project. This road stretches approximately 10 km between the Burke Developmental Road and the Project boundary.

3.5.1.2 New Accesses onto State Controlled Roads

The Project site is currently accessed by a road that uses the Mount Roseby homestead turn-off from the Burke Developmental Road. It diverges from the homestead road about 100 m from the Burke Developmental Road and runs parallel with the Burke Developmental Road for several hundred metres before travelling west toward the Project.

Figure 3.37 shows the proposed preferred access road alignment and the alternative access roads. The majority of the preferred route follows the current road alignment crossing the Dugald River and Silvermine Creek. The only major deviation from the existing alignment is the construction of a new intersection with the Burke Developmental Road 1.6 km north of the current intersection. A deviation around Roseby Copper Project's proposed Longamundi mineral deposit (Longamundi Deviation), which is currently bisected by the preferred access road, may be required in the foreseeable future. It is not envisaged that the Longamundi Deviation road will be constructed for several years after the commencement of operations as the mining of the pit is scheduled for approximately seven to nine years after the commencement of Roseby Copper Project operations. Therefore the current access road alignment will continue to be used until that time. An alternative to the preferred access road is located to the north of the existing access road and may be developed instead if required.

The new section of access road will need complete roadwork, subgrade preparation, sub-base and base course. The existing alignment will only require local widening, creek crossing upgrades, and a new base course. The construction requirements for the access road and specifications for geometric design are described fully in Section 3.2.1.3 and Table 3.1.

The area of the turn-off from the Burke Developmental Road will need to be widened to a Type C so that MMG traffic does not interfere with the normal flow of traffic along the highway. The access road will have a bitumen surface immediately after the turn-off and on the approaches to the major creek crossing.

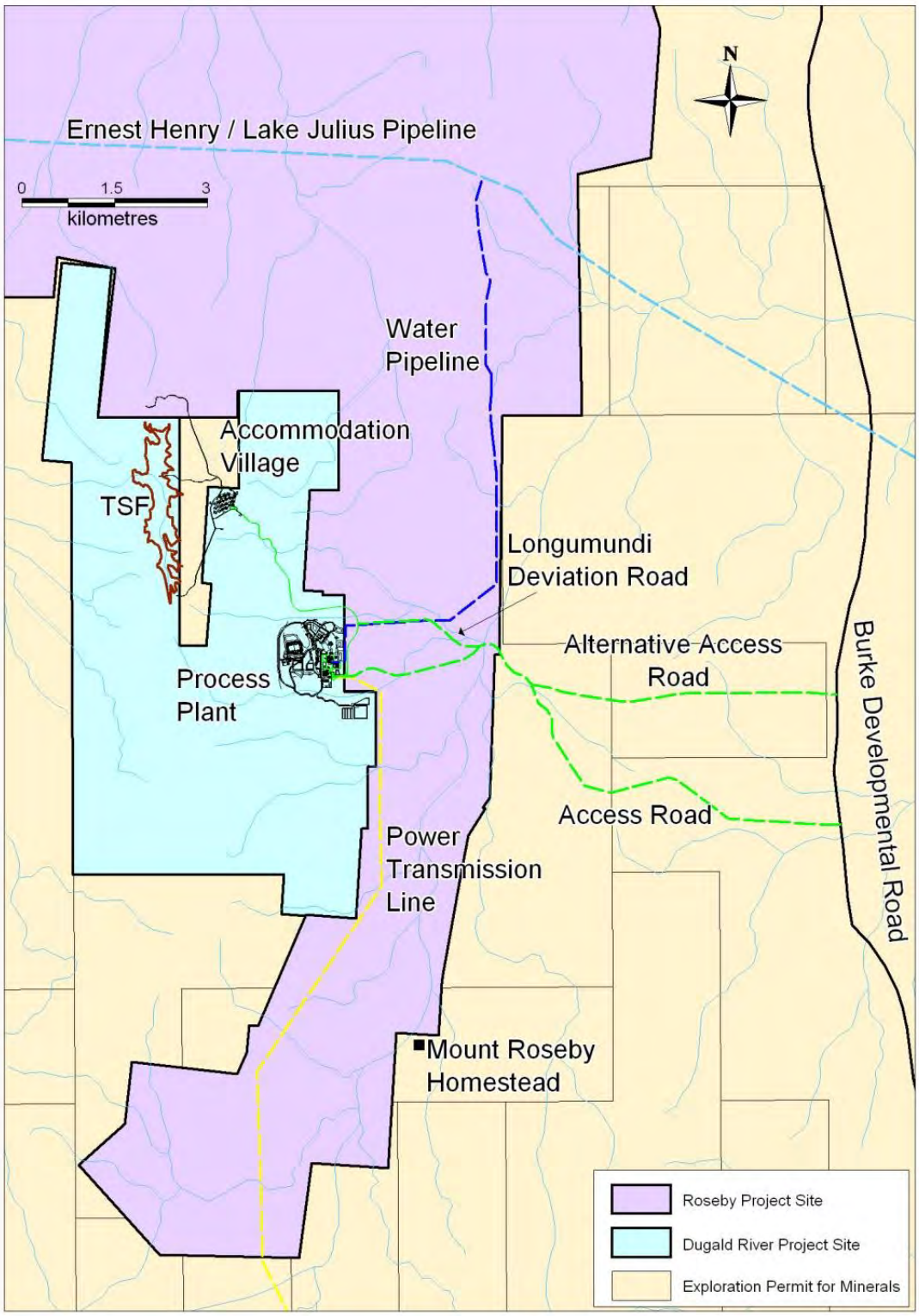


Figure 3.37 Location of the Project Access Road

The Dugald River crossing and other significant crossings were investigated by WRM in the Surface Water Assessment (Appendix G). Full details of the design specifications of the creek crossings are provided in Section 3.5.4.4.

3.5.1.3 Traffic Generated

Transport vehicles to be utilised in the operation of the Project will range from a fleet of Toyota Land Cruisers through to Quad trailer Road trains (Figure 3.38). Land Cruisers will service the majority of personnel movements required within the Project site. Coaster buses, with a 21 seat capacity, and coaches, with a 45 seat capacity will move personnel between the Project site and Cloncurry airport. Triple Road trains, B-double Road trains, Single Trailer Trucks, and Single Trucks will be used to traffic supplies from Cloncurry, Townsville Port and Yurbi Rail Loading Facility. Haulage of concentrate between the on-site concentrating plants and the Yurbi Rail Loading Facility will be handled by 105 t capacity Quad Road Trains, which will be covered to prevent loss of concentrate and dust emissions (Figure 3.38).

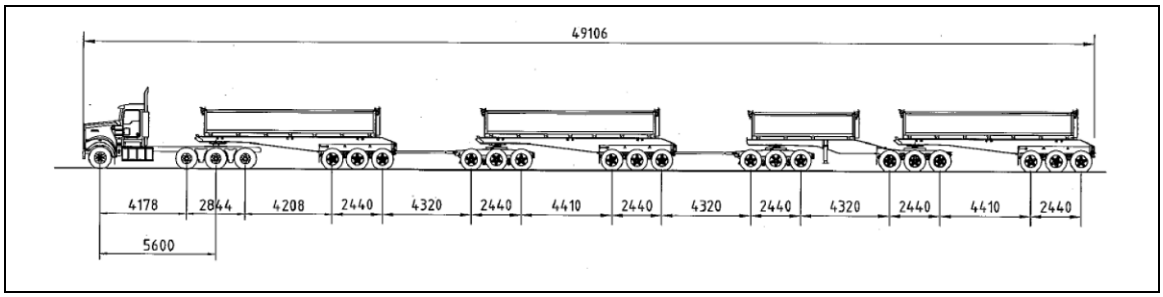


Figure 3.38 Concentrate Transport Trucks

3.5.1.4 Police Escort

AMF Project Service Pty Ltd (AMF) conducted a route survey as part of the Dugald River Project Options Study (Ausenco 2008). AMF recommended a maximum transport envelope of 46 m (length) x 6.6 m (width) x 5.5 m (loaded height) for materials being transported from Townsville. Anything over 5.5 m in width or 35 m in length will require a police escort. It is estimated that the number of planned loads that will require a police escort are less than 60 during the construction period with only intermittent loads (one or two per year) expected to require an escort once the Project is in operations.

A permit will be required under Section 46 of the *Transport Operations (Road Use Management – Mass, Dimension and Loading) Regulations 2005* to transport oversize loads on public gazetted roads, this permit will outline requirements for transport including specific times that certain oversize loads can be transported. It is anticipated that transportation of staff, concentrate and materials will only occur during daylight hours and will occur 7 days a week,

3.5.1.5 Current Road Usage

Transportation Movements

Traffic count data has been provided by the Department of Transport and Main Roads (DTMR) based on their annual traffic counts for the Flinders Highway, Barkly Highway and the Burke Development Road for 2009. These roads have been described in Section 3.5.1.1.

Data in this Section is presented as Annual Average Daily Traffic (AADT) counts and represent varying classes of vehicles. Each passing of a vehicle at a traffic count location is recorded as a 'vehicle movement'. As such, two vehicle movements may represent either two one-way journeys or a single return journey.

Vehicles have been classified as either light or heavy vehicles. The data is presented as averages for a given section of road, period of time and type of vehicle. Traffic count data has been collected from single monitoring events that were undertaken from 2003 to 2009.

Traffic data provided suggests that at present, road usage from Townsville to Cloncurry along the Flinders Highway is significantly heavier between Townsville to Charters Towers compared to the remaining journey from Charters Towers to Cloncurry. A total of 4,979 vehicles (approximately 82% light vehicles) were recorded for this first leg, while an average of approximately 545 vehicles (approximately 72% light vehicles) were recorded for the remainder of the journey.

Traffic data along the Burke Developmental Road indicates annual average daily traffic of 301 vehicles. The main transport types that utilise the Burke Developmental Road can be broken down into light vehicles (74%) and heavy vehicles (26%). Road usage for the Barkly Highway, from Cloncurry to Mt Isa, consists of predominantly light vehicles (77%) compared to heavy vehicles (23%) and totals approximately 1,823 vehicles. This road has experienced an average growth rate over the last 10 years of 1.7%.

Cloncurry Shire Council estimates that the Railway Street/Hensley Drive traffics between 60 and 115 vehicles daily. Given that these figures are estimates, they should be used as a guide only.

3.5.1.6 Proposed Increase in Road Use During Construction

During the construction phase of the Project, the majority of equipment will be transported from Townsville via the Flinders Highway, Railway Street, Hensley Drive and then the Burke Developmental Road to the Project site or from Mount Isa, via the Barkly Highway and the Burke Developmental Road. Transport of equipment and materials will be via semi-trailer, low loaders, haul tankers and on occasion, escorted oversize trips on semi-trailers. Some equipment, such as tip trucks and fuel trucks will not require transport assistance and will make the journey as individual heavy vehicles.

Table 3.13 shows the transport envelope maximum dimensions determined by the route survey conducted by AMF.

Table 3.13 Townsville Transport Envelope Maximum Dimensions

Dimension	Townsville Maximum Value
Length	30 m plus
Width	8 m, with up to 10 m possible with some effort to clear the way
Height	8 m from the road surface (includes trailer), with over 10 m possible if more overhead wires are lifted
Weight	Determined by axle loading, with over 400–500 t conceivable if the module weight can be distributed over enough axles

Equipment and Materials Transportation

Throughout the two year construction period, approximately 3,779 loads of equipment and materials will be supplied to the Project site. The breakdown of heavy vehicles loads per construction supply is shown in Table 3.14. Two vehicle movements are required (one in each direction) for each indicated load. Construction loads pertain to the movement of Containers and Break Bulk Traffic.

Table 3.14 Vehicles Loads during Construction

Construction Supply	Heavy Vehicles Loads
Structural Steel and Platework	465
Cement	654
Coarse Aggregate	900
Fine Aggregate	510
Prefabricated Buildings	150
Construction Loads	1,100
Total	**3,779**

There are currently investigations underway to source aggregate (both course and fine) from on-site borrow pits. Sourcing this material on-site would result in a significant reduction to total number of loads supplied to the Project site over the 2 year construction period.

Cement transport will be the responsibility of the cement supplier, not MMG. MMG have received a budget proposal from Cement Australia in which they have indicated that they would transport cement to site in triple road trains from the Port of Townsville.

Flinders Highway

The Flinders highway will have an additional 2,369 heavy vehicle trips due to the Project over the two year construction period. These loads will consist of the structural steel and platework required for the Project, cement, prefabricated buildings and construction loads (Table 3.14). The traffic count data is bi-directional so this equates to an additional 4,738 heavy vehicle movements, or an average increase of 7 heavy vehicles movements per day, for the construction period. The percentage increase of heavy vehicle movements is shown in Table 3.15. Percentage increases range from 0.14 – 2.00% along the 800 km of the Flinders Highway. According to the Guideline *for Assessment of Road Impacts of Development Applications* (DTMR 2000), traffic increases of less than 5% are considered insignificant with regard to road capacity.

Table 3.15 Expected Increase in Vehicle Movements during Construction Flinders Highway

Start - End	Average Existing Vehicle Traffic (movements per day)	Average Vehicle Traffic during Construction Phase (movements per day)	Percentage Increase (%)
Townsville – Charters Towers	4,979	4,986	0.14
Charters Towers - Hughenden	465	472	1.50
Hughenden – Richmond	640	647	1.09
Richmond – Julia Creek	350	355	2.00
Julia Creek - Cloncurry	724	731	0.96

Burke Developmental Road

Over the two year construction period an additional 2,369 heavy vehicle trips will be made along the Burke Developmental Road. These loads will consist of the structural steel and platework, cement, prefabricated buildings, and construction loads (Table 3.14). In total this equates to an additional 4,738 heavy vehicle movements, or an average increase of 7 heavy vehicles movements per day for the construction period. The percentage increase in vehicle traffic is shown in Table 3.16 with a total increase of up to 3.28%. According to the G*uideline for Assessment of Road Impacts of Development*

Applications (DTMR 2000), traffic increases of less than 5% are considered insignificant with regard to road capacity.

Table 3.16 Expected Increase in Vehicle Movements during Construction Burke Developmental Road

Chainages – Burke Developmental Rd (km)	Average Existing Vehicle Traffic (movements per day)	Average Vehicle Traffic during Construction Phase (movements per day)	Percentage Increase (%)
0-2.69	389	396	1.79
2.69-105.482	213	220	3.28

Staff Transportation

Staff transportation during the construction phase (290 persons on site) will be minimal as the majority of the construction workforce will be housed on-site in the construction accommodation camp (capacity 500). It is intended that a small 21 seat coaster bus will make an average of one vehicle movement per day to Cloncurry. From Cloncurry flights will be provided by a third party commercial charter, in agreement with MMG, to Brisbane, or via charter, to Townsville. The impact of this single vehicle movement is considered negligible.

3.5.1.7 Proposed Increase in Road Use During Operations

In the operation phase of the Project, concentrate product will be transported to the Yurbi Rail Loading Facility, approximately 15 km east of Cloncurry, by quad road trains hauling 105 t of product per trip. At the peak of operations, approximately 1,432 t of concentrate will be transported per day, equating to approximately 14 round trips per day or 28 vehicle movements. The heavy vehicles will use the Burke Development Road, to the junction with Hensley Drive, before following the heavy vehicle bypass north of the town centre and rejoining the Flinders Highway via Railway Street. This junction is shown in Figure 3.36.

Other items to be transported to the Project site on a regular basis will include fuel, explosives, lime, reagents, grinding balls, spares and general consumables and fresh produce for the accommodation camp. At peak production these loads are expected to account for a further 6 vehicle movements per day on the Burke Developmental Road.

The Project's staff will be travelling mainly to and from Cloncurry to the Project site by coaster bus or coach using the Burke Developmental Road and Flinders Hwy. The majority of personnel will be travelling to and from Cloncurry (and potentially Mt Isa) via airplane.

Burke Developmental Road

The transport of concentrate and other supply items will result in an additional 34 heavy vehicle movements along the Burke Developmental Road per day (Table 3.17).

Table 3.17 Expected Heavy Vehicle Increases For Burke Developmental Road

Chainages – Burke Developmental Rd (km)	Average Existing Vehicle Traffic (movements per day)	Average Vehicle Traffic during Operation Phases (movements per day)	Percentage Increase (%)
0-2.69	389	423	8.74
2.69-105.482	213	247	15.96

The DTMR completed upgrading the Burke Developmental Road from Cloncurry to the Burke and Wills Junction, which is some distance north of the MMG Project site, in June 2008 at a cost of $28 million.

Given the number of mining operations serviced by the Burke Developmental Road it is considered that this upgrade to a two lane, 8 m wide sealed bitumen road will be capable of adequately servicing the Project. However, consultation is required with DTMR to ensure that the road is suitable for the intended volume of haulage.

According to the *Guideline for Assessment of Road Impacts of Development Applications* (DTMR 2000), traffic increases of less than 5% are considered insignificant with regard to road capacity. Given that the increase in traffic is on the Burke Developmental Road greater than 5% and most of this will be by large multi-axle vehicles, consultation with DTMR will be required to determine if a further mitigation measures are required.

Flinders Highway

The transport of concentrate and supply items will result in an additional 28 heavy vehicle movements per day along the Flinders Highway between Cloncurry and Yurbi (Table 3.18). This constitutes a 2.88% increase from the existing volume of traffic. According to the *Guideline for Assessment of Road Impacts of Development Applications* (DTMR 2000), traffic increases of less than 5% are considered insignificant with regard to road capacity.

Table 3.18 Expected Heavy Vehicle Increases For Flinders Highway (Cloncurry to Yurbi)

Average Existing Vehicle Traffic (movements per day)	Average Vehicle Traffic during Operational Phase (movements per day)	Percentage Increase (%)
969	997	2.88

Staff Transportation

For the commuting day staff, MMG will provide a 21 seater coach that will make up to two round trips (four vehicle movements) per day from Cloncurry to the Project site. MMG will also transport other workers to and from the airport via either a 21 seater coach or a 45 seater coach on Tuesday and Wednesday changeover days. It is expected that most staff will travel via the provided bus services, with a minimal number of light vehicles being used to travel to and from the site. Overall, this represents an increase of up to 8 vehicle movements per day or a percentage increase of up to 3.75% (Table 3.19). According to the Gu*ideline for Assessment of Road Impacts of Development Applications* (DTMR 2000), traffic increases of less than 5% are considered insignificant with regard to road capacity.

Table 3.19 Expected Vehicle Increases due to Staff Movement

Chainages – Burke Developmental Rd (km)	Average Existing Vehicle Traffic (movements per day)	Average Vehicle Traffic during Construction Phase (movements per day)	Percentage Increase (%)
0-2.69	389	397	2.05
2.69-105.482	213	221	3.75

3.5.1.8 Rail Infrastructure and Proposed Increases During Operations

Concentrate will be trucked from the Project site to the Yurbi Rail Loading Facility, where it will be stored in an enclosed shed and then loaded into rail wagons. Yurbi Rail Loading Facility is located about 15 km east of Cloncurry and is a spur loop off the Mount Isa System rail line that extends from Townsville to Mt Isa. The Yurbi concentrate loading facility is currently owned by BHP Billiton. The site has a fully enclosed storage facility with capacity for 10,000t of lead and zinc concentrates. MMG intend to negotiate a commercial agreement with BHP Billiton to expand the Yurbi facility to provide sufficient capacity for concentrates from Dugald River to be stored and handled at the loading facility.

The Mount Isa System rail line extends from Townsville to Mt Isa, via Hughenden and Charters Towers. The stretch from Cloncurry to Townsville covers 771 km of single line, with a maximum speed for freight of 80 km/h and a load rating of 20 t per axle.

Rail operators have indicated a nominal train set will consist of 52 wagons with capacity of 3,198 t per train. Rail wagons will be covered to prevent dust emissions to the surrounding environment.

At the peak of mining operation, approximately 523,000 tpa of concentrate will be delivered to the Yurbi Rail Load Facility ready for transportation to Townsville via rail. Concentrate transportation will increase line usage by three trains per week. Annually this will lead to a 13% increase in hauled freight on the Cloncurry-Townsville rail line.

MMG will negotiate a commercial agreement with a rail haulage provider for the transport of Dugald River concentrates. The agreement will cover both ‘above-rail’ and ‘below-rail’ components. MMG have had preliminary discussions with Queensland Rail (QR) Network Access (the controlling entity of the rail line who are responsible for the ‘below-rail’ component) and they have indicated that there is sufficient capacity in the existing line configuration to handle the additional haulage requirements of Dugald River.

3.5.1.9 Shipping Infrastructure and Proposed Increase During Operations

MMG intend to negotiate a commercial agreement with BHP Billiton to expand capacity at their existing port facilities to allow the storage and handling of the additional Dugald River concentrates. Permits and approvals for extension of the existing facility will be dealt with independently to this study and will be subject to any agreement with BHP Billiton.

The existing port facility consists of the following:

- Rotary Tippler to unload rail wagons (1,500 tpa);
- Fully enclosed transfer conveyors;
- Fully enclosed storage shed;
- Front end loader to feed ship loading conveyor system (fully enclosed); and

- Ship loader on Wharf 11 with dust management system (1,200 tph) capable of loading Handymax sized bulk carriers (up to 45,000 deadweight-tonne).

MMG intend that mineral concentrates will be stored in the extended facilities of BHP Billiton's Townsville Port facility (subject to successful negotiation of a commercial agreement) and use the same facility's existing infrastructure for loading of ships.

It is envisaged that concentrates will be shipped in 25,000 – 30,000 t parcels. With 20% of the concentrates being sold to domestic customers, the remaining approximately 385,000 tpa of concentrates will require approximately 13 to 15 ship loads per year. This additional throughput would be able to be handled through BHP Billiton's existing tipping and ship loading infrastructure at the Port of Townsville. However, as discussed previously, the storage facility will require extending.

3.5.1.10 Current Aviation Usage

The Cloncurry Airport is located approximately 4 km north of the Cloncurry Township. Qantas Airways services Cloncurry airport several times each week. The Airport has the capacity to handle a variety of aircraft including the 48 seater Embraer ERJ-145, the 50 seater ATR 42-500 and the 74 seater Dash 8- Q400 Series. It has been assumed for this assessment that the majority of employees will fly in and out of the Cloncurry Airport.

The Mount Isa Airport is situated to the north of the Mount Isa Township and is currently serviced by major airline operator Qantas Airways. The airport has suitable facilities to handle a variety of aircraft ranging from light craft through to Boeing 737.

Current air transportation data shows that there are a total of 10 flights servicing Cloncurry each week with an availability of 740 seats. Table 3.20 displays a complete data breakdown, showing air carrier, number of flights, and number of seats available. Given that Cloncurry airport is the intended port for the FIFO operations, it has been the focus of this review. It must also be noted however, that Mount Isa airport, a further 85 km to the north-west of Cloncurry, is serviced by significantly more flights, with Qantas operating 11 flights per week, each with a seating availability of 142 seats.

Table 3.20 Flights Servicing Cloncurry Airport

Carrier	Route	Approx. Seat Availability	No. of Services per Week	Total Seat Available Per Week
Qantas Airways	Mt Isa - Cloncurry	74	2	148
	Cloncurry – Mt Isa	74	3	222
	Townsville - Cloncurry	74	3	222
	Cloncurry - Townsville	74	2	148
		Total	10	740

[#]*Seat availability is determined by plane model and configuration and as such may vary for certain flights or over time.*
Note: This data is current as at the 22/06/2010 but as it is obtained from a private company, this information may change without notice and as such should be used as a guide only.

3.5.1.11 Proposed Increase in Aviation Usage due to Operations

Flight availability is likely to fluctuate with demand. Aviation companies have recently identified the Cloncurry region as an underserviced area and services were increased with the introduction of SkyAirWorld in 2008. However, these services ceased when the company was placed in voluntary administration in March 2009. The existing aviation services are insufficient to support the transport of the Project's personnel during either the construction or operations phases.

The total number of mining personnel that are likely to be flying in and out of Cloncurry Airport for a given seven day week is shown in Table 3.21. As the proposed mine begins construction and then operation, personnel flying in and out will gradually increase.

MMG intend to negotiate a commercial agreement with an air services provider for dedicated charter flights between the commute base (nominally Townsville) and Cloncurry. These flights will service the operations workforce using a 56 seat capacity Fokker F50 aircraft. The proposed flight schedule required to service staff rosters is shown in Table 3.22. In addition to the charter flights, during construction and intermittently during operations, existing commercial flights that currently service Cloncurry will be used. Impact on the existing aviation industry will therefore be minimal.

Table 3.21 Projected Number of Personnel Requiring Air flights Per Week for the Duration of the Project

Year	Personnel Flying In	Personnel Flying Out	Total
2012	67	67	134
2017	243	243	486
2022	255	255	510
2027	258	258	516

Table 3.22 Proposed Charter Flight Schedule

Day of Week		Mon	Tue	Wed	Thur	Fri	Sat	Sun
Flights Scheduled	AM	X	X	X	X			
	PM		X	X	X	X		

3.5.2 Energy

The main energy supply for the Project during the operational phase will be via the Mount Isa electricity grid system which is provided by gas fired power stations. Diesel generators will power the Project during the construction phase. Mobile equipment on the Project (discussed in Section 3.3.3.2) will be powered by diesel. Natural gas will also be used on the Project site in change rooms for water heating. Natural gas will be supplied to site by a local LPG supplier.

3.5.2.1 Power Transmission Line and Connection to the Grid

The permanent electricity supply for the mine will be via a connection to the Mount Isa gas fired power station electricity grid. MMG propose to construct a 220 kV line running south-east from the Project site and meeting the Chumvale Substation west of Cloncurry to connect to the Mount Isa electricity grid.

The powerline may be one of two possible options:

- Two Pole H Type Structure Arrangement; and
- Steel Tower Type Structure Arrangement.

Both structures are designed to be single circuit.

At major creek/river crossing the vegetation along the banks is environmentally sensitive and there are conditions imposed by DERM which require structures to be significantly higher so as to minimise

the impact or disturbance on vegetation. This may potentially result in steel towers being the preferred option in these locations.

The poles for the two pole H type arrangement are likely to be concrete, which, if selected, will be direct buried with suitable surrounding soils being used as material for foundations. If the steel towers are selected, they will require concrete footings.

A ML for Transportation will be applied for over the proposed power transmission line corridor (Figure 3.39). Parcel Prospecting Permits have been applied for in order to peg the ML for Transportation.

The electrical system which will accommodate the Project's power needs is based on an 11 kV distribution voltage. There will be two 220/11 kV, 45/55 MVA oil natural, air forced transformers at the main substation on the Project site. The transformers will be fully redundant so that one transformer can supply the total site load in the event of failure of one transformer or one 220 kV circuit breaker. The 11 kV option was chosen due to mills comprising a large proportion of load and because the design for the accommodation camp distribution system was 11 kV. The 11 kV option reduces the number of transformers in the plant area.

The load for the Dugald River Project is estimated at approximately 41 MVA. It is essential that the transformer size significantly exceeds this value to ensure that the final load from the detailed design is accommodated, and to allow for any unforeseen requirements during typical plant ramp-up and operation. A 2 MVA standby diesel generator will provide power supply for critical loads of the process plant in the event of a major power failure from the 220 kV power line.

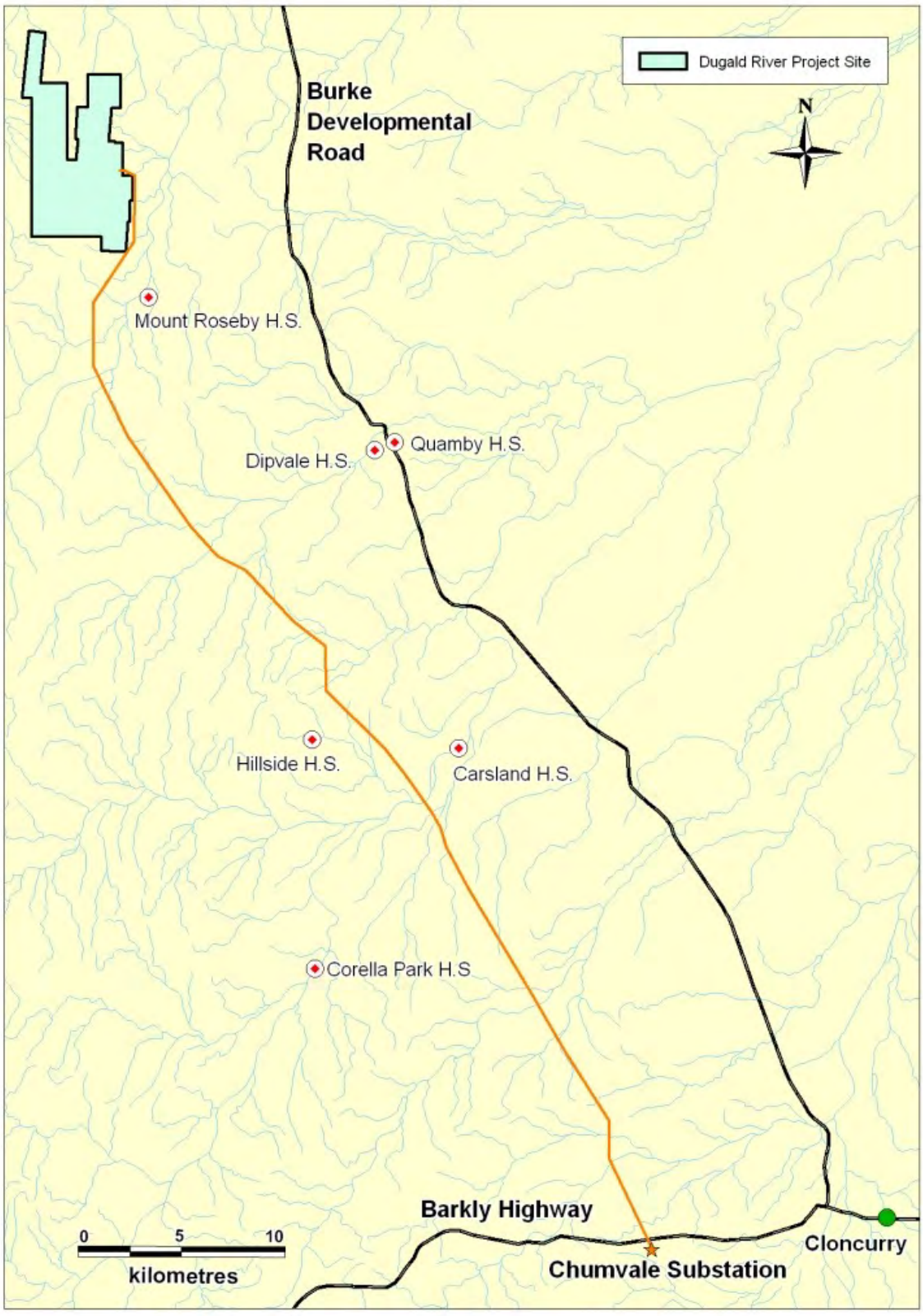


Figure 3.39 Proposed Power Transmission Line

3.5.2.2 Energy Consumption During Construction and Operation

Until the powerline is constructed and operational, power for the Project will be supplied by diesel generator sets located on the Project site. There will be four generators in total. 1.5 MVA and 1.0 MVA units will be located near the accommodation camp and two 1.0 MVA units will be located at the mine and processing area. These diesel generator sets are proposed to only be used in the first two years of construction and start up until the site is added to the Mount Isa electricity grid.

The peak power requirement for the Project is anticipated to be 33 MW of installed electrical power. The consumption of energy from components of the Project is shown in Table 3.23 and is displayed graphically in Figure 3.40. The processing plants and the underground mine draw the majority of the power with offices, workshops, the accommodation camp and other usage, minor in comparison. The total electrical energy requirement per year in Gigawatt hours (GWh) ranges from 8.4 GW hours in the first year of construction to 326.9 GW hours in the later years of operations.

3.5.2.3 Greenhouse Gas Management and Energy Conservation

As part of the Australian Government's comprehensive Climate Change Strategy, the NGER Act was passed in September 2007 and establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production. Under the NGER Act corporations are required to register and report if they emit greenhouse gases, produce energy or consume energy at or above the specified thresholds if:

- They control facilities that emit 25 kilotonnes or more of greenhouse gas, or produce/consume 100 terajoules or more of energy; or

- Their corporate group emits 50 kilotonnes or more of greenhouse gas, or produce/consume 200 terajoules (55.6 GWh) per year, or more of energy by 2010/2011.

The Dugald River Project will exceed these thresholds.

The *Energy Efficiency Opportunities Act 2006* was passed in April 2006 with the object of improving the identification and evaluation of energy efficiency opportunities by large energy using businesses and, as a result, to encourage implementation of cost effective energy efficient opportunities. The Act requires large energy using businesses to undertake an assessment of their energy efficiency opportunities and to report publicly on the outcomes of that assessment. MMG is a registered organization under the *Energy Efficiency Opportunities Act 2006*.

MMG have developed a Greenhouse Gas Management Plan for the Project which is contained in Appendix O and further discussed in Section 4.5. The specific management objectives for the Greenhouse Gas Management Plan include the following:

- To design and construct the Project, where practicable, utilising best practice technologies to reduce energy consumption and subsequent greenhouse gas emissions;

- To improve operations, where practicable, by implementing best practice technologies to reduce energy consumption and subsequent greenhouse gas emissions;

- To regularly measure, monitor, audit and review the effectiveness of greenhouse gas emission reduction strategies;

- To undertake reporting responsibilities under the NGER Act; and
- To undertake reporting responsibilities under the *Energy Efficiency Opportunities Act 2006*.

Table 3.23 Energy Consumption per Year (GWh)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Process Plant	0.0	0.0	90.0	180.0	180.0	213.8	247.5	247.5	247.5	247.5	247.5	247.5	247.5	247.5	247.5	247.5	247.5	247.5	247.5
U/G Mine	5.0	17.8	30.5	37.8	49.7	57.2	62.0	64.3	65.1	65.7	66.1	66.2	66.2	66.2	66.2	66.2	66.2	66.2	66.2
Village	2.2	5.2	5.4	4.6	6.9	7.1	6.7	6.6	6.7	6.8	6.8	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Workshop & Offices	1.1	2.3	2.3	2.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Other	0.1	0.2	1.1	2.0	2.1	2.5	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
TOTAL	8.4	25.5	129.3	226.7	242.1	284.0	322.6	324.8	325.7	326.3	326.8	326.9	326.9	326.9	326.9	326.9	326.9	326.9	326.9

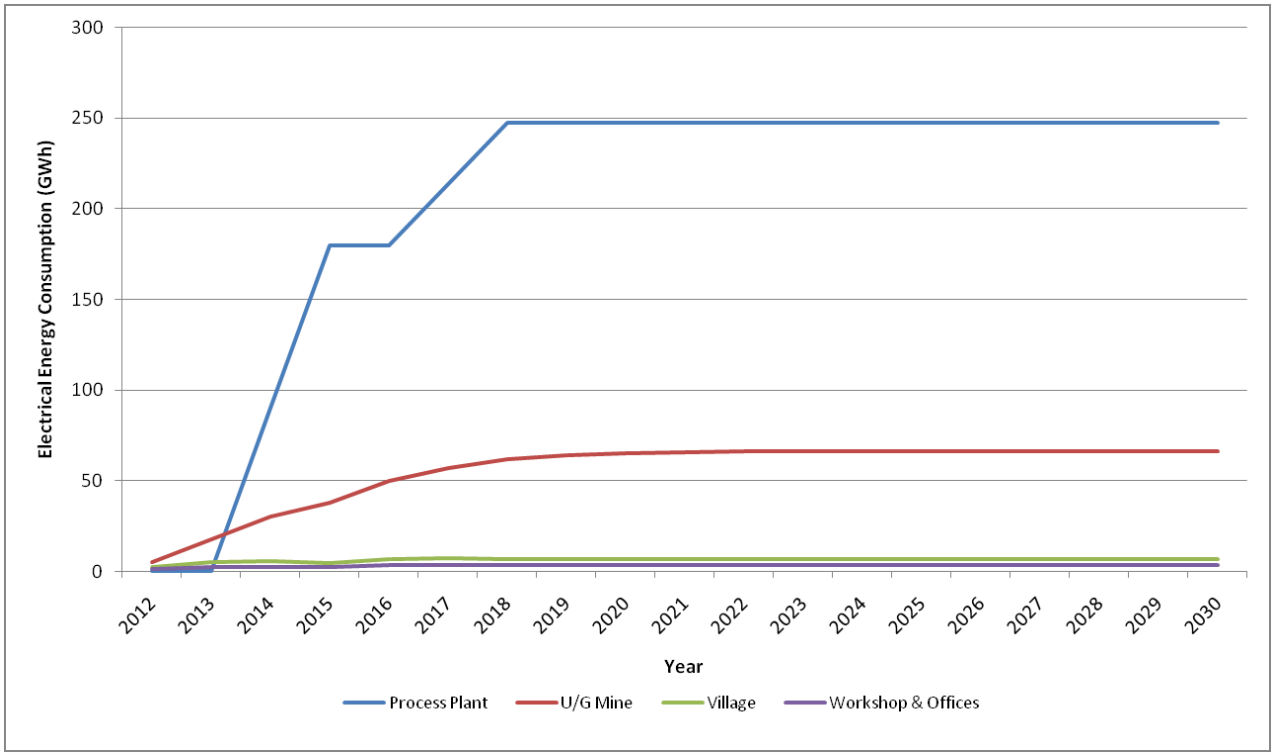


Figure 3.40 Energy Consumption per Year (GWh)

3.5.3 Water Supply and Storage

3.5.3.1 Water Supply and Water Balance

The raw water supply for the Project will be supplied from the Lake Julius / Ernest Henry pipeline. The pipeline passes to the north of the Project's mining leases. A take off point was included during construction of the line to allow water to be taken for future mining operations in the area around Dugald River.

Figure 3.41 shows the Lake Julius / Ernest Henry pipeline and the proposed Project pipeline route to the east of a Mount Rose Bee range of hills.

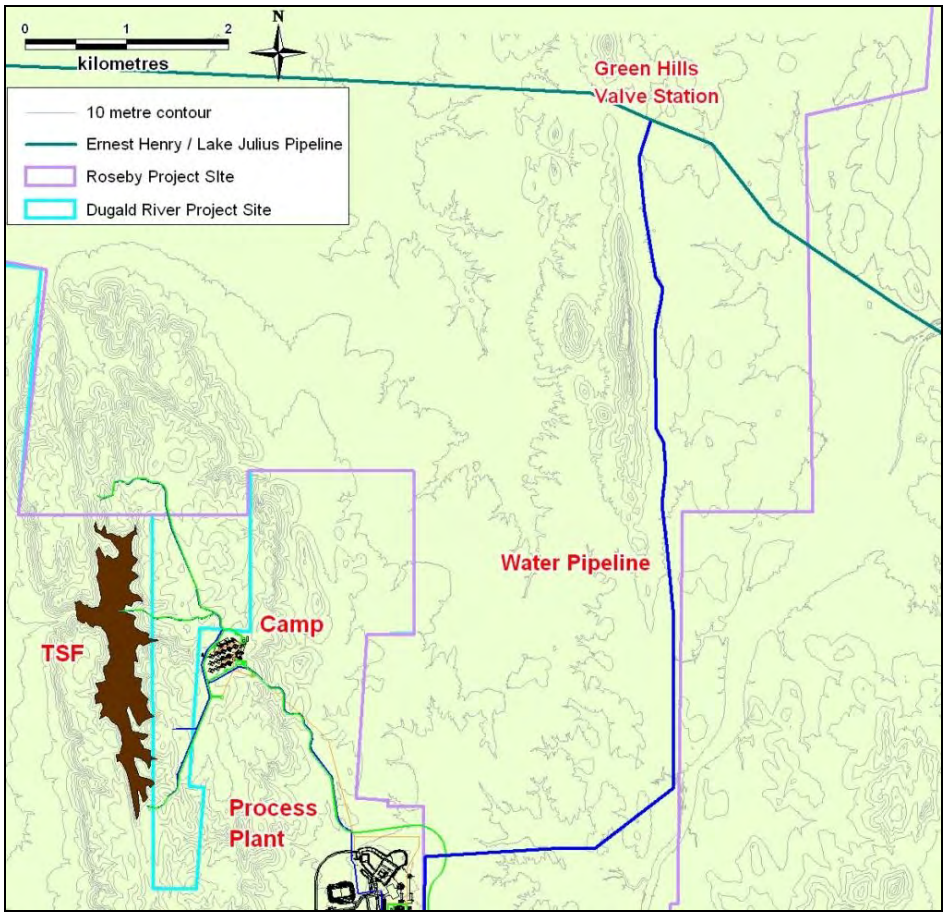


Figure 3.41 Proposed Water Supply Route

A conceptual water balance is depicted in Figure 3.42. The average raw water demand from Lake Julius will be 692 Ml/yr (86 m^3/h). This assumes that approximately 50% of the water sent out to the TSF in slurry will be able to be decanted and returned at an average rate of 51 m^3/hr or 549 Ml/y. There will be times when there is no decant return available from the TSF and during these times the total water requirement for the Project will need to be supplied from Lake Julius (1,094 Ml/yr). The connection to the Lake Julius / Ernest Henry pipeline has been designed with sufficient capacity (136 m3/h) to provide for this supply. It is planned that water from the stormwater ponds will be evaporated and will not be fed into the process circuit or the TSF. However, in extreme circumstances following extraordinary rainfall, water from the stormwater ponds may be fed into the process circuit or pumped to the TSF to maintain water levels at or below MRL.

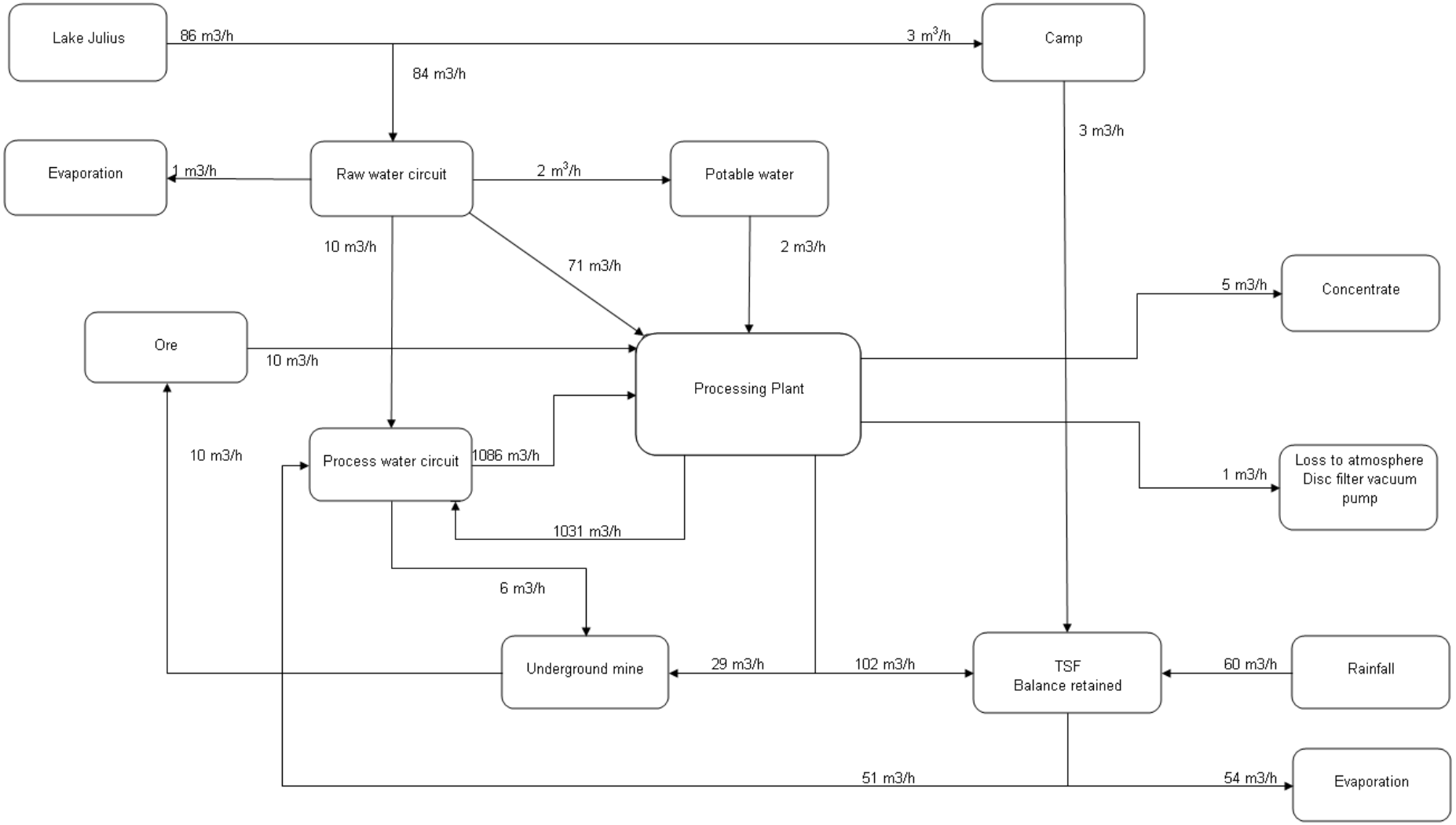


Figure 3.42 Conceptual Schematic Diagram of Average Project Water Balance

3.5.3.2 Water Use and Storage

Raw Water

Raw water will consist of fresh water that has not been used in the process and does not contain process reagents, salts or fine particulates. Raw water will be drawn from the Lake Julius / Ernest Henry water pipeline into the raw water tank (see Figure 3.42). The bottom section of the raw-water tank will be reserved for fire-water supply. Raw water for the following duties will be stored in the remainder of the tank:

- Reagent mixing;
- Pump shaft gland seal water;
- Flocculent mixing;
- Potable water treatment plant feed stock;
- Paste plant service water;
- Service points; and
- Process water make-up.

Any excess water overflows from the raw-water tank will be stored in a storage pond. The combined storage capacity of the raw-water tank and pond will be 48 hours at maximum raw water demand.

The fire-water reserve at the base of the tank will be connected to a dedicated electric fire-water pump (with a diesel back-up fire-water pump) to supply water to the fire-water mains distributed throughout the plant site.

Two gland water circuits will be required, medium-pressure and high-pressure. Each will have its own dedicated duty and standby pump sets with distribution to the various centrifugal slurry pumps as required.

A dedicated pump will supply water to the potable-water treatment plant that will consist of ultra-filtration, chlorination and activated carbon prior to delivery to the potable water storage tank. Potable water will be distributed as required using dedicated potable-water pumps. A dedicated pump set will transfer raw water from the pipeline to a storage tank at the accommodation village. Raw water will service the accommodation camp needs, including potable water production.

Process Water

Process water will consist of recycled and other water streams used in the process plants, including all thickener overflow streams, water return from the TSF and paste plant, make-up water coming from the raw-water supply in any combination (Figure 3.42). Tailings and concentrate thickener overflows will be transferred to the process water standpipe and raw-water make-up. Decant-return water from the TSF will be delivered to the process-water tank.

The process-water tank and standpipe will be interconnected. This configuration is preferred since any solids contained in the thickener overflow solutions will be pumped into the distribution piping and to the process water supply points. This will minimise solids build-up in the process-water tank. The process-water pumps will be fed from the standpipe and supply dilution water to the grinding and flotation circuits.

The process-water tank will have a 1,600 m^3 capacity and provide approximately 1.5 hours of water at normal consumption from full.

Mine Water

The underground mine will be relatively dry as very minor supplies of groundwater occur in the Dugald River Slate (see Section 4.4.1.2 and Groundwater Report in Appendix R). The underground mine will be a net consumer of water despite an estimated groundwater inflow of 2.5 litres/second. The underground mine will require approximately 6m^3/h of raw water due to usage by the mining equipment and seepage and evaporation losses. An additional 29 m^3/h of water will be contained in the paste fill used in the underground mine.

Water collected underground will be either passed through a clarifier/settling pond built underground with a portion returned to a mine water tank or will be sent to the tailings thickener, where it will be clarified and incorporated into the process water such that the solids density of the tailings sent to the TSF remains unchanged.

Potable Water

The potable water treatment plant at the process plant site will employ ultra-filtration, chlorination and activated carbon filtration to produce potable water at a rate of 6 m^3/h. The activated carbon filters will guard against blue-green algae outbreaks that are known to occur at Lake Julius. Potable water will be plumbed to all kitchens, toilets, ablution and laundry facilities and safety showers.

The 6 m^3/h potable water treatment plant for the accommodation village will be identical to that at the process plant site. The potable water tank will have a capacity of 70 m^3, which will provide 28 hours of water supply. The relatively low retention time ensures the water will not go stale. Potable water will be plumbed to all kitchen and wet mess facilities, accommodation showers, hand basins and toilets and communal ablution and laundry facilities.

Potable water will be monitored weekly at principal outlets such as kitchens and bathrooms for pH, chlorine, thermotolerant and total coliforms. Samples from the potable water tanks will be taken monthly and analysed for the following parameters: iron, copper, lead, zinc, manganese, dissolved oxygen, hydrogen sulphide, nitrate, nitrite, trihalomethanes, heterotrophic bacteria and ammonia. Quarterly potable water testing will be carried out for cadmium, nickel, antimony, hardness, Total Dissolved Solids (TDS), sodium, sulphate, acyrlamide, carbon tetrachloride and chromium. This water sampling schedule is designed in accordance with Sampling parameters and frequencies as prescribed in the Australian Drinking Water Guidelines for Small Water Supplies 2004 (NHMRC).

3.5.3.3 Water Conservation and Recycling

Water on the Project will be conserved as much as possible by recycling stormwater run-off and decant water from the TSF to the process water tank. A floating pump at the TSF pumps will decant water to the process water tank via a head tank located near the accommodation village on top of the Knapdale Range. Water will be gravity-fed from the tank to the plant site.

On average, the TSF will produce 51 m^3/h of decant water, representing 50% of the 102 m^3/h of water carried to the TSF in the tailings slurry. The balance indicates that the process water circuit has a deficit of only 10 m^3/h that must be supplied from Lake Julius, equating to a total average Lake Julius demand of 86 m^3/h or 692 Ml/yr.

The theoretical maximum and minimum demand will be 613 Ml/yr and 1,098 Ml/yr, depending on the annual rainfall.

3.5.4 Stormwater Drainage

A Surface Water Assessment has been undertaken by WRM for the Project. This section describes the proposed stormwater drainage system and the stormwater disposal arrangements for Project (Section 3.5.4.1 and 3.5.4.2). Section 3.5.4.3 summaries the results of modelling undertaken to determine the behaviour of the proposed storages under different runoff conditions. The creek crossings along the access roads, road to the accommodation camp and the water pipeline are described in Section 3.5.4.4. The full report of the Surface Water Assessment is provided in Appendix G.

The general principles for the management of surface water are as follows:

- The fullest possible separation of 'clean', 'dirty' and 'contaminated' water runoff;
- Minimise the area of disturbance, thus minimising the volume of dirty or contaminated runoff;
- Clean surface runoff is from areas of the Project site where water quality is unaffected by mining operations. Clean water includes runoff from undisturbed areas. Clean water diversions are described in Section 3.5.4.2;
- Contain all dirty (non-toxic) water onsite (via sediment ponds) whenever possible. If not, release it in a controlled manner in compliance with adopted water quality criteria.
- Contain all dirty (low toxicity) water on site via low hazard dams. If necessary pump this water to the process plant without releasing it to the natural watercourses. This water will only be released downstream during an extreme rainfall event and after notification to the DERM.
- Segregate, collect and contain all potentially contaminated (toxic and sub-lethal) water onsite via significant and high hazard dams. If necessary pump this water to the process plant without releasing it to the natural watercourses. This water will only be release downstream during an extreme rainfall event and after notification of DERM.

3.5.4.1 Stormwater Dams and Sediment Ponds

Each catchment area of the processing and mining area has been segregated into either a potentially contaminated or dirty catchment status (Table 3.24 and Figure 3.43). The storages have been classified as sediment ponds, low, significant or high hazard storages in accordance with *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995). Sediment ponds correspond with non-toxic runoff, low hazard dams with low-toxicity runoff, significant hazard dams contain sub-lethal runoff and high hazard dams control toxic runoff. The definitions for toxic, sub-lethal and low-toxicity have been taken from the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995) as follows:

- Toxic - potentially greater than 100 times the drinking water standard;
- Sub-lethal - greater than 10 times but less than 100 times drinking water standard; and
- Low-Toxicity – less than 10 time the drinking water standard.

The following describes the catchment status of each of the mining and processing areas, the potential water quality run-off and how it will be managed.

Dirty (Non-toxic) Catchment Areas – Sediment Ponds

Dirty (non-toxic) sediment laden runoff will contain no potential contaminants. Catchment areas will include offices, the go line, the portals and surrounds and roads. This runoff will be drained by sediment ponds and runoff must be of sufficient quality prior to discharge into natural watercourses, if required.

Proposed sediment ponds will have a sufficient capacity to capture runoff from a 1:10 year ARI, 24 hour duration storm event (160 mm rainfall across the catchment).

Dirty (Low Toxicity) Catchment Areas – Low Hazard Dams

Potentially dirty (low toxicity) surface water runoff water may be associated with areas such as the mine and contractors workshop areas and surrounds. This runoff may contain silt /sediment and hydrocarbons. The surface water storages for these catchment areas will be designed as low hazard dams and contain a Design Storage Allowance (DSA) volume of a 1:10 Year ARI, 2 month wet season (567mm of rainfall across the catchment).

The storages will be operated to ensure the DSA in each of the storages is available at November 1 every year. The Mandatory Reporting Level (MRL) for each low hazard storage is calculated based on the storage volume required to capture runoff from a 10 year 72 hour design storm (210mm rainfall depth) using a runoff coefficient of 1.0.

It is of note that the Full Supply Level (FSL) of the low hazard dams is greater than the required DSA volume (Table 3.24). This additional volume is required in order to ensure the DSA volume is available in each storage at November 1 each year, as no pumping or extraction has been modelled from any storages in the mine water management system. The DSA volume is contained within the FSL volume for each storage.

Contaminated (Sub-lethal) Catchment Areas – Significant Hazard Dams

Potentially contaminated (sub-lethal) surface water runoff may be associated with areas affected by mining and processing operations and contain chemicals of various types used in the operations. Storages for these catchment areas will be designed as significant hazard dams and to contain a DSA of a 1:20 Year ARI, 2 month wet season (707 mm of rainfall across the catchment). Significant hazard dams will be provided with HDPE liners.

The FSL of these dams will exceed the calculated DSA volume and provides additional spill protection above the 1:20 Year, 2 month wet season design criteria (see Table 3.24). Significant hazards dams will be operated to maintain water levels at or below the MRL. The MRLs for each significant hazard storage have been calculated to capture runoff from 1:100 Year ARI, 72 hour event (350 mm rainfall depth).

Potentially contaminated (sub-lethal) catchment areas on the Project include:

- NAF waste rock dump (south rockfill area) due to the potential for run-off to contain low levels of metals, although this is a precautionary measure only as waste rock testing has shown no contaminants at levels of concern;
- Areas where copper ore is stockpiled (copper ROM Pad) due to the potential for this material to oxidise and produce leachate with a low pH and high levels of metals. MMG has advised that they expect the water quality off the copper ROM pad to be of better quality that the runoff from the lead/zinc ROM pad, as the average sulphur content of copper ore is significantly lower than that of zinc ore. Additional geochemical characterisation work would be completed prior to development of the

copper mine or processing circuit, and the design of the stormwater dam may be modified if required;

- Areas where crushed lead/zinc and copper ore is stored or transferred (lead/zinc crushed ore stockpile and copper crushed ore stockpile) due to the potential for this material to oxidise and produce leachate with a low pH and high levels of metals. Metals and contaminants that may be found in the runoff from the crushed ore stockpiles may be similar to the runoff from the ROM pads. However materials in the crushed ore stockpile will be processed quickly before oxidation processes can take place so the water should be of better quality;

- Lead/Zinc and Copper Processing Plants - areas where ore is processed and concentrates produced, transferred or stored due to the use of process reagents and the fine particle size and high concentrations of metals in the concentrate material including copper, zinc and lead;

- Paste Fill Plant area - where tailings are treated for backfill underground due to the fine particle size and potential to oxidise and produces leachate with a low pH and high levels of metals; and

- Reagents storage areas and warehouse storage - where chemicals are stored and transferred.

Significant hazard dams will be licensed as hazardous dams in the Project's Environmental Authority and therefore a suitable mitigation and control system will be put in place for their management. Should the water quality in these dams be worse than expected or the level of water in the dam reach the MRL, the water will be pumped to the processing plant for re-use. These dams will have overflow spillways which will only be breached in emergency situations and after notification of the DERM.

Contaminated (Toxic) Catchment Areas – High Hazard Dams

Potentially contaminated (toxic) surface water runoff may be associated with certain mining operation catchment areas. Storages for these catchments will be designed as high hazard dams and contain a DSA for a 1:100 Year ARI, 2 month wet season (1,082 mm of rainfall across the catchment area).

High hazard dams will be operated at or below the MRL. The MRLs for each storage have been calculated to capture runoff from 1:100 Year ARI, 72 hour event (350 mm rainfall depth). High hazard dams will also be HDPE lined.

Potentially contaminated (toxic) catchment areas on the Project include:

- Areas where PAF waste rock is disposed of and encapsulated in NAF waste rock in a waste rock dump (NAF/PAF waste rock dump);
- Areas where PAF waste rock is disposed of temporarily before being disposed of back underground (Temporary PAF Stockpile);
- Areas where lead/zinc ore is stockpiled (lead/zinc ROM Pad and Off ROM Storage) due to the potential for this material to oxidise over time (months rather than years) and produce leachate with a low pH and high levels of metals;

The waste characterisation (see Section 3.6.3.3 and Appendix H) determined that elements of concern in the PAF material include, zinc, manganese, lead, nickel, copper, and cobalt, and trace amounts of other metals including arsenic. The lead/zinc ore on the ROM pad is likely to be similar in leaching characteristics to the PAF waste rock. The waste management strategy for PAF material is described in Section 3.6.1.2 and details how PAF material will be compacted and encapsulated by NAF material within the dump to minimise oxidation.

It is of note that a nominal FSL volume has been adopted for each storage, based on the available space for construction of the dam within the mine layout. The storage capacity of the adopted FSL exceeds the calculated DSA volume, increasing the potential for each storage to have the DSA volume available at the 1st November each year without the need for pumping water to the processing plant.

The high hazard dams will be licensed as hazardous dams in the Project's Environmental Authority and therefore a suitable mitigation and control system will be put in place for their management. These dams will have overflow spillways which will only be breached in emergency situations and after notification of the DERM.

Table 3.24 Proposed Mining and Processing Area Stormwater Storages

Pond ID	Location	Catchment Area (ha)	Dam Category	Runoff Classification	Storage Volume (Ml)		Storage Design Criteria	Mandatory Reporting Level (Ml)	Overflow	Notes
					Full Storage Level	Design Storage Allowance				
2	Between portals and processing plant	4.99	Sediment Pond	Dirty (Non-toxic)	7.98	-	-	-	Pond 11	Collects runoff from road and natural catchment areas between portals and processing plant.
3	Contractor's workshop area	3.63	Low	Dirty (Low Toxicity)	22.84	20.55	1:10 year, 2 month	15.23 (1:10 year 72 hour)	DB3 (Silvermine Creek Tributary A)	Collects runoff from contractor's workshop area and road between Off-ROM ore stockpile and PAF dump
5	Off-ROM stockpile	4.14	High	Toxic	48.50	44.82	1: 100 year 2 month	34.01 (1:100 year 72 hr)	Silvermine Creek	Collects runoff from the Off-ROM stockpile area
6	South rockfill area (NAF waste rock dump)	3.59	Significant	Sub-lethal	31.70	25.35	1:20 year 2 month	22.70 (1:100 year 72 hr)	Silvermine Creek via DB6	Collects runoff from the south rockfill area
9	Zinc ROM pad	7.97	High	Toxic	101.50	86.18	1: 100 year 2 month	73.63 (1:100 year 72 hr)	Silvermine Creek Tributary A over the copper ROM pad ramp	Collects runoff from the zinc ROM pad area. A number of smaller interception storages will be constructed along the south-eastern edge of the zinc ROM pad. These will be pumped to Pond 9 as required
10	Mine workshop area	3.55	Low	Dirty (Low Toxicity)	24.80	20.12	1:10 year, 2 month	17.35 (1:10 year 72 hour)	Silvermine Creek	Collects runoff from mine workshop area
11	South of Lead/Zinc ROM Pad	2.42	Sediment Pond	Dirty (Non-toxic)	3.87	-	-	-	Minor tributary of Silvermine Creek	Collects runoff from road and natural catchment area south of the Zinc ROM pad. Overflows to minor tributary of Silvermine Creek. Overflow channel passing beneath ore conveyors to be constructed to drain overflows to tributary.

Pond ID	Location	Catchment Area (ha)	Dam Category	Runoff Classification	Storage Volume (Ml)		Storage Design Criteria	Mandatory Reporting Level (Ml)	Overflow	Notes
					Full Storage Level	Design Storage Allowance				
13	Zinc and copper stockpiles and conveyors	5.26	Significant	Sub-lethal	47.37	37.21	1:20 year 2 month	34.27 (1:100 year 72 hr)	Silvermine Creek Tributary A	Collects runoff from zinc and copper stockpile areas and conveyors
14	Processing Plants, Reagents Shed and Paste Fill Plant	9.97	Significant	Sub-lethal	99.91	70.52	1:20 year 2 month	74.88 (1:100 year 72 hr)	Minor tributary of Silvermine Creek	Collects runoff from zinc and copper process plant areas, reagent storage shed, warehouse, paste plant and concentrate storage shed.
16	Copper ROM pad and ramp	5.24	Significant	Sub-lethal	49.90	37.03	1:20 year 2 month	36.75 (1:100 year 72 hr)	Silvermine Creek Tributary A	Collects runoff from the copper ROM pad area. A number of smaller interception storages will be constructed along the northern edge of the copper ROM pad. These will be pumped to Pond 16 as required
18	Offices and Go line	4.77	Sediment Pond	Dirty (Non-toxic)	7.64	-	-	-	Minor tributary of Silvermine Creek	Collects runoff from Go-line, offices, roads and natural catchment east of the south rockfill dump. Overflows to minor tributary of Silvermine Creek.
19	NAF/PAF dump	8.47	High	Toxic	93.50	91.62	1: 100 year 2 month	63.97 (1:100 year 72 hr)	Silvermine Creek Tributary A	Collects runoff from the NAF/PAF dump area

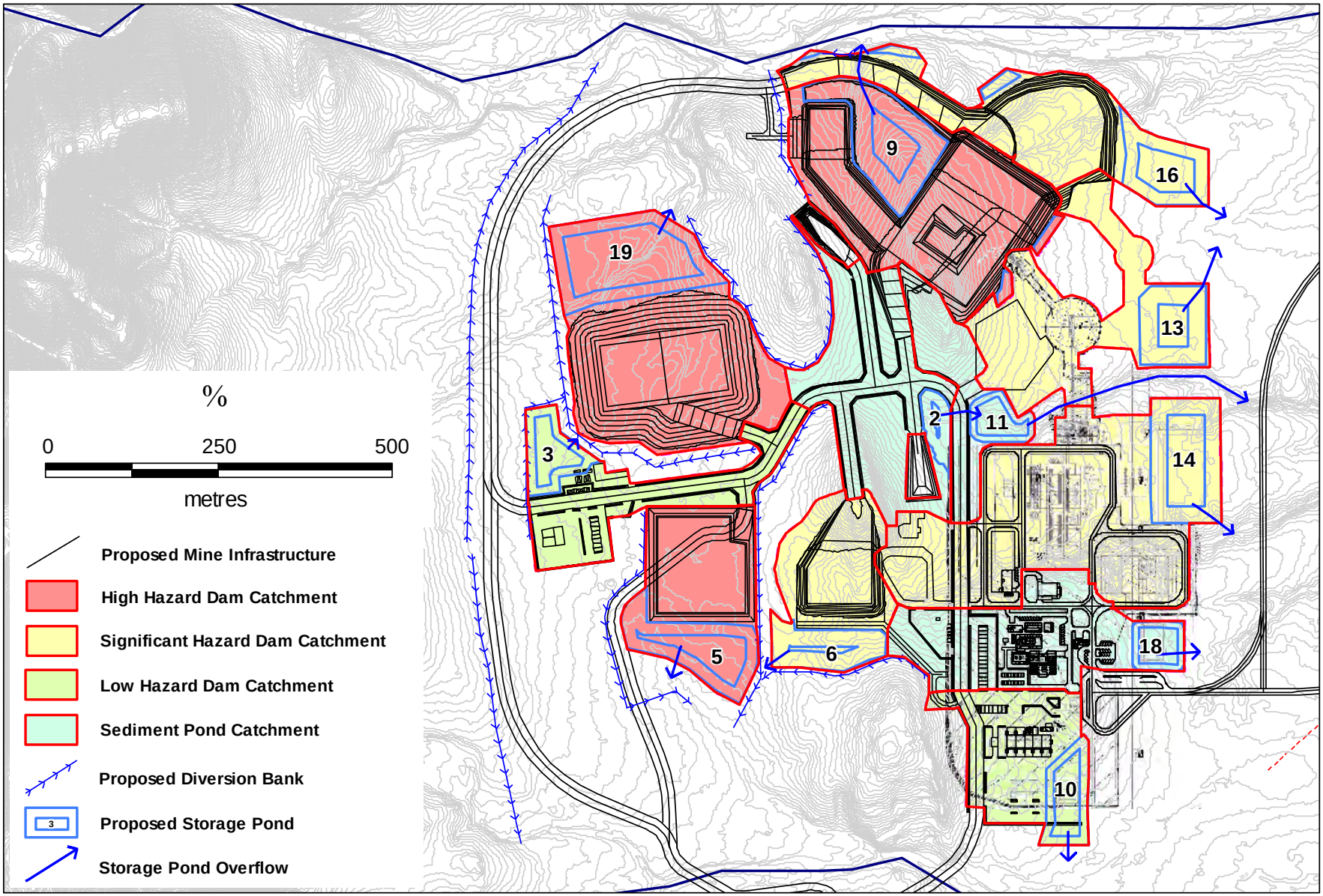


Figure 3.43 Proposed Dirty and Contaminated Stormwater Storages

3.5.4.2 Clean Water Diversions

Clean water diversion drains are required to the west of the processing plant and mining area to divert clean stormwater from the western catchment area to the north and south of the processing and mining area. The diversion that flows to the south will discharge to Silvermine Creek and the diversion to the north to a northern tributary of Silvermine Creek (Tributary 'A"). Figure 3.44 shows the standard design dimensions for the clean water diversion banks and channels to be constructed on the Project. Figure 3.45 shows the location and catchment areas and clean water diversions around the processing and mining area.

The following is of note:

- All clean water diversion channels will be constructed to contain the 50 year ARI design discharge;
- Where possible, clean water diversion drain structures have been designed to limit flow velocities to 1.8 metres per second (m/s) or less for the 50 year ARI design event, however due to the steep topography and lack of groundcover vegetation around the mine operations area, rock check dams and other energy dissipation and sediment trapping structures will be required at regular intervals to limit erosion;
- All structures should be inspected following significant storm events to ensure the structures have been able to sustain flow velocities without causing significant scour; and
- The construction of DB3-E will depend on the extent of earthworks considered viable for construction of diversion banks. If extensive cut and fill is required to form this diversion bank then the catchment area of DB3-E will be added to Pond 9.

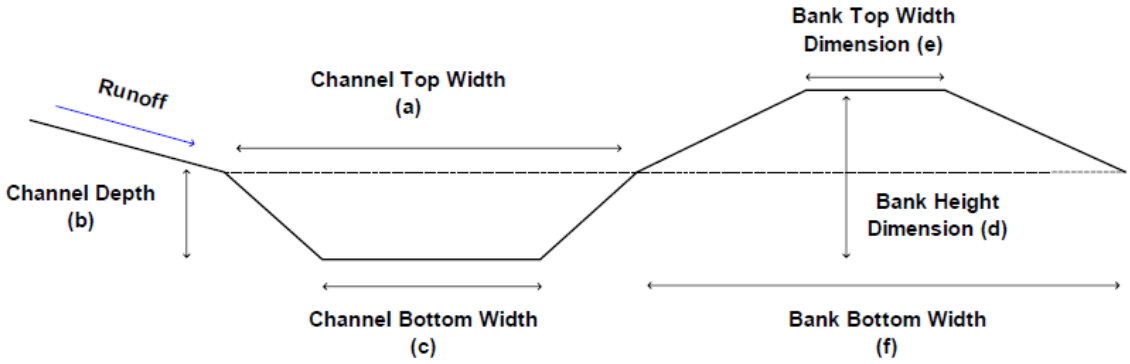


Figure 3.44 Conceptual Design of Clean Water Diversion Drains

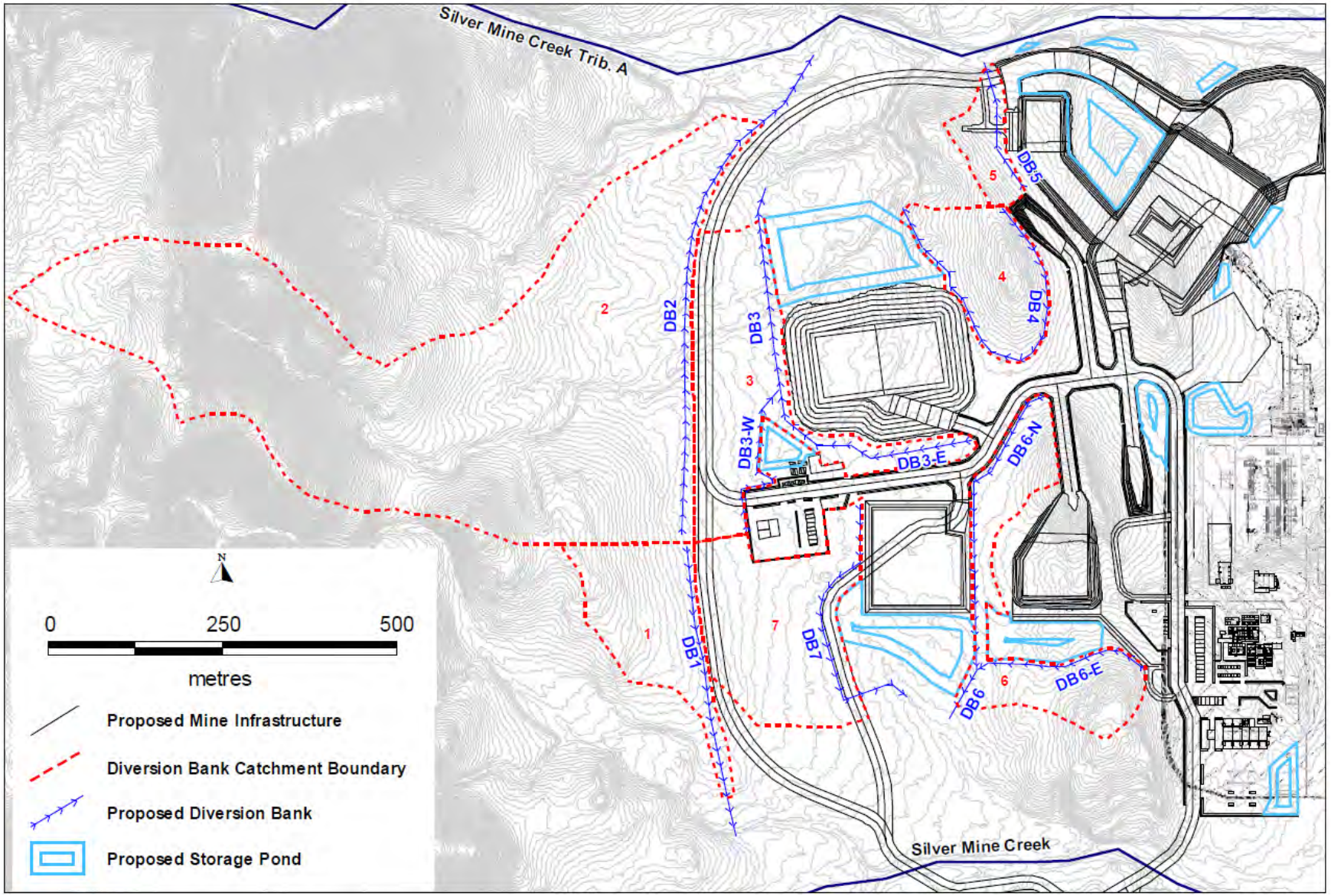


Figure 3.45 Proposed Clean Surface Water Management Controls

3.5.4.3 Stormwater Run-off Modelling

In the Surface Water Assessment (WRM 2010), two models were used to (a) determine runoff volumes from hardstand, stockpile and natural catchment areas, and (b) determine the behaviour of the proposed water storages described in Section 3.5.4.1. The full report by WRM is provided in Appendix G.

Meteorological Data

Rainfall and evaporation data was considered from two long-term and one short-term source: Bureau of Meteorology stations, DERM SILO Drill Data and an onsite automatic weather station respectively.

The SILO Drill Data is a synthetic, continuous daily climate dataset, derived from spatial interpolation of observational data. Data from SILO is corrected for missing data and accumulated totals, hence the data is more reliable and representative of rainfall and evaporation at the Project Site. The use of such a long period of continuous data provides a good indication of the behaviour of various storages over extended wet and dry periods. The SILO Drill Data has been used in the surface water balance modelling.

The following is of note from the SILO Drill Data:

- The average annual rainfall is estimated at 514.3 mm, however the annual rainfalls on the Project can vary considerably from year to year. Based on the synthesised 121 years of record, the minimum and maximum annual rainfalls are 160.0 mm and 1,410.8 mm respectively;

- A comparison between the average annual rainfall totals obtained from the Cloncurry BOM station and the SILO Data Drill indicate that the Project site receives slightly more rainfall than Cloncurry;

- The average monthly rainfalls at the Project site exhibit distinct wet (November to April) and dry (May to October) seasons during the year, with a dry season low of 2.4 mm in August to a wet season high of 139.9 mm in January. The average number of 'rain days' in each month also follow a pattern similar to the average monthly rainfalls. There is little or no rainfall occurring at the Project site during the dry season months; and

- The average annual potential evaporation at the Project site is estimated at 3,182 mm which is about 6.2 times the average annual rainfall. Evaporation rate varies seasonally, with high evaporation rates occurring in the months between October and March. Further, the potential evaporation rates during the hotter months are about twice the evaporation rate during the cooler months. In addition, average potential evaporation significantly exceeds average rainfall for all months of the year. The potential evaporation rates during the cooler months are significantly greater (up to 25 - 50 times) than the equivalent average monthly rainfalls.

The models were run over a 120 year period (1889 to 2010) of daily rainfall data obtained from the DERM SILO Data Drill.

Model Configuration

The surface water balance modelling considered the following components:

- Rainfall and evaporation data from the SILO Drill Data – a summary is provided above and more detail is available in Appendix G;

- Catchment runoff from natural, stockpile and hardstand surfaces – the runoff coefficients were calculated to be 0.08 (natural), 0.2 (stockpile) and 0.3 (hardstand);

- Process water demands – there will be no process water demands on the stormwater dams or sediment ponds. All process water demands will be met through a combination of water from Lake Julius and the TSF (see Section 3.5.3.1); and

- Full Supply Level (FSL) volume of storages – the model was configured such that any excess volume above the FSL volume would spill from the storage instantaneously.

Table 3.25 details the parameters used in the modelling for each of the storages.

Table 3.25 Surface Water Balance Model Configuration

Storage ID	Catchment Area (ha)				FSL Volume (Ml)
	Natural	Stockpile	Hardstand	*Total*	
Pond 2	2.54	0.70	1.75	*4.99*	7.98
Pond 3	0.23	0.86	2.54	*3.63*	22.84
Pond 5	0.0	4.14	0.00	*4.14*	48.50
Pond 6	0.79	2.56	0.24	*3.59*	31.70
Pond 9	0.30	7.58	0.10	*7.97*	101.50
Pond 10	0.00	0.84	2.71	*3.55*	24.80
Pond 11	1.26	0.59	0.57	*2.42*	3.87
Pond 13	0.81	3.19	1.26	*5.26*	47.47
Pond 14	0.90	2.61	6.46	*9.97*	99.91
Pond 16	0.00	5.24	0.00	*5.24*	49.90
Pond 18	0.68	1.10	2.99	*4.77*	7.64
Pond 19	0.98	7.49	0.00	*8.47*	93.50

The modelling assumed the following:

- There will be no reuse of any water from the proposed storages for processing, or transfer of water between any of the storages, except Pond 2 which overflows into Pond 11;

- Each storage would operate an as individual evaporation pond with the only inflows being catchment runoff and direct rainfall, and the only outflows being evaporation and spills; and

- Seepage into and out of each storage is insignificant.

There will be infrastructure in place to facilitate the pumping of water from significant and high hazard dams to the process plant, however this would only be used to manage water levels to ensure provision of DSA volumes on 1 November each year, and to address water levels exceeding MRLs. The option of transferring water to the process plant has not been included in the surface water balance, and is viewed as a 'last resort' option for managing contaminated water on site.

Model Results

Results from the modelling were broken down based on dam hazard category. The following key points were noted:

- Sediment Ponds:
    - The sediment ponds are predicted to spill for 25 to 33 out of the 120 water years included in the simulation. This represents a probability of spills from the sediment ponds of 1 spill every 3 to 4 years;
    - The sediment ponds would have an average of 2.3 to 2.5 spill events per spill year, and a maximum of 7 spill events per spill year;
    - The average spill volume per spill year from the sediment ponds is between 6ML and 9ML. The maximum spill volume per spill year ranges from 26ML to 40ML; and
    - When compared to expected flow volumes in Silvermine Creek and Dugald River (downstream of the sediment ponds) during significant rainfall events, the predicted spill volumes are not significant.

- Low Hazard Dams:
    - The low hazard dams are predicted to spill for 2 to 3 out of the 120 water years included in the simulation. This represents a probability of spills from the low hazard dams of 1 spill every 40 to 60 years;
    - The low hazard dams would have an average of 1.3 to 1.5 spill events per spill year, and a maximum of 2 spill events per spill year;
    - The average spill volume per spill year from the sediment ponds is between 4ML and 6ML. The maximum spill volume per spill year ranges from 9ML to 10ML; and
    - When compared to expected flow volumes in Silvermine Creek and Dugald River (downstream of the low hazard dams) during significant rainfall events, the predicted spill volumes are not significant.

- Significant Hazard Dams
    - None of the significant hazard dams are predicted to spill over the 120 years of simulation;
    - The DSA volumes in all storages will be available on 1 November for at least 104 out of 120 years of simulation; and
    - The storages are predicted to exceed the MRL in only 1 years out the 120 years of simulation.

- High Hazard Dams

- None of the high hazard dams are predicted to spill over the 120 years of simulation;
- The DSA volumes in all storages will be available on 1 November for at least 101 out of 120 years of simulation; and
- The storages are predicted to exceed the MRL in only 1 year out the 120 years of simulation.

Sensitivity Analysis

A sensitivity analysis was also conducted to model the behaviour of the proposed storages to under higher runoff conditions. Runoff from each surface area (natural, stockpile and hardstand) was increased by 25% for the analysis.

- Sediment Ponds
    - The additional runoff results in an increase in spills from the sediment ponds, with the predicted spill frequency increasing to 1 spill in every 3 to 4 years;
    - The predicted average and maximum number of spills per spill year is generally unchanged; and
    - The average spill volume per spill year from the low hazard storages is predicted to increase to between 7ML and 11ML. The maximum spill volume per spill year increases significantly to between 34ML to 51ML.
- Low Hazard Dams
    - Increased spills, with a predicted spill frequency increase to 1 spill every 24 years;
    - The predicted average and maximum number of spills per spill year is generally unchanged;
    - The average spill volume per spill year from the low hazard storages is predicted to increase to 6ML. The maximum spill volume per spill year increases significantly to between 15ML and 17ML;
    - The availability of the DSA volume in each significant hazard storage on 1st November each year is reduced to 75 years out of the 120 year simulation period; and
    - The number of years when the MRL is exceeded also increases to 15 years out of the 120 year simulation period.
- Significant Hazard Dams
    - Increased spills, with predicted spill frequency increasing to 1 spill over the 120 years of simulation;
    - For the sole spill year, the model predicts spill volumes of between 3ML and 24ML from each storage;
    - The availability of DSA volumes on 1 November is reduced out to 79 years of 120 years of simulation; and
    - The predicted exceedance of the MRL is increased to 6 years out the 120 years of simulation.
- High Hazard Dams

- None of the high hazard dams are predicted to spill with increased runoff;
- The availability of DSA volumes on 1 November is reduced to 85 years out of 120 years of simulation; and
- The predicted exceedance of the MRL is increased to 2 years out the 120 years of simulation.

The modelling results indicate that the proposed surface water management system is robust and has more than adequate storage capacity for managing runoff and rainfall within the Project site.

3.5.4.4 Creek Crossings

The Dugald River crossing and other significant creek crossings were investigated by WRM for the access road, accommodation camp road and water pipeline (see Appendix G). The construction the culverts for the creek crossings on the access road and accommodation camp road are discussed in Section 3.2.1.3.

The road between the process plant and the accommodation camp, will also serve as the power and water corridor to the camp and possibly the TSF.

The flood design specifications for creek crossings along the access road, accommodation camp road and water pipeline route are shown in Table 3.26 and Table 3.27, and the locations are depicted in Figure 3.46. The pipeline will be located above the 100 year ARI flood level.

Details of the flood study are provided in Section 4.4 and Appendix G.

Table 3.26 Configuration of Creek Crossings (Access Accommodation Camp Roads)

Crossing Location	Culvert Size	No. of Culvert Barrels	Upstream Culvert Invert Level (m AHD)	Downstream Culvert Invert Level (m AHD)	Deck Elevation (m AHD)	Height of Deck above Channel Invert (m)	Length of Causeway Deck (m)
B	4.2 m W x 1.2 m H	1	188.6	188.35	190.1	1.5	25
	1.8 m W x 0.3 m H	2	189.5	189.25			
C	4.2 m W x 1.5 m H	7	176.5	176.3	178.5	2	40
D	0.3 m Diameter	1	183.93	183.73	184.25	0.55	99
	0.45 m Diameter	2	183.7	183.5			
E	1.8 m W x 0.6 m H	2	183.34	183.14	184.25	0.91	42
F	1.8 m W x 0.3 m H	2	183.9	183.5	184.5	1	27
G	4.2 m W x 1.2 m H	5	211.03	210.84	212.7	1.67	55

Crossing Location	Culvert Size	No. of Culvert Barrels	Upstream Culvert Invert Level (m AHD)	Downstream Culvert Invert Level (m AHD)	Deck Elevation (m AHD)	Height of Deck above Channel Invert (m)	Length of Causeway Deck (m)
H	4.2 m W x 1.5 m H	5	192.65	192.07	194.65	2	25
I	4.2 m W x 1.2 m H	4	195.93	195.62	197.53	1.6	20
J	1.8 m W x 0.6 m H	8	195.5	195.33	196.3	0.8	100
K	4.2 m W x 1.2 m H	2	194.86	194.68	196.7	1.84	15
L	4.2 m W x 1.5 m H	2	195.04	194.9	197	1.96	25
M	4.2 m W x 1.2 m H	2	196.88	196.59	198.8	1.92	40

Table 3.27 Estimated 100 Year Flood Levels at Pipeline Crossings

Crossing Location	Channel Bed Level (m)	Channel Slope (%)	100 Year ARI Discharge (m^3/s)	100 Year ARI Flood Level (m)	100 Year ARI Flood Depth (m)
A	181.36	0.3	165.4	184.94	3.6
N	172.72	0.5	64.0	182.06	2.3
O*	178.00	0.6	NA	182.76	4.8

* Peak Flood Level at Location O is from Dugald River backwater flooding.

The following is of note in regards to the creek crossings:

- The proposed crossings at Locations B, C and F are configured as low level causeways, and are designed to be overtopped during relatively minor flood events;
- The Silvermine Creek crossing at Location B is designed to be overtopped for discharges greater than 13 cubic metres per second (m^3/s);
- The Dugald River crossing at Location C is designed to be overtopped for discharges greater than 32 m^3/s;
- The Dugald River Overflow crossings at Locations D and E would only be overtopped for discharges in excess of the 50 Year ARI flood in Dugald River (1,250 m^3/s);
- The Dugald River Tributary A crossing at location F is designed to be overtopped for discharges greater than 4 m^3/s;
- The proposed crossings at Locations G and H have been configured to provide the Accommodation Camp road with immunity from the 100 Year ARI flood events in Silver Mine Creek Tributaries A and B (84.4 m^3/s and 32.3 m^3/s respectively);

- The proposed crossings at Locations I, J, K, L and M also have been configured to provide 100 year ARI flood immunity from local creek flooding. The proposed crossing at Location O has been configured to provide 100 Year ARI flood immunity from Dugald River backwater flooding;

- In order to maximise available flow area the crossings proposed for Locations B and D include high and low level culverts with different invert levels; and

- All proposed waterway crossings will require erosion and scour protection on the upstream and downstream road embankments. Particular attention should be paid to erosion and scour protection for the low level crossings proposed at locations B, C and F.

Based on historical flood records for the Dugald River, the periods of overtopping would be a few hours to a few days. During large flood events the causeways may overtop intermittently over periods of up to two or three weeks, but there will be sufficiently long dry periods for the crossings to be trafficable at times by general traffic and concentrate transport trucks, unless the causeways get badly damaged. This low-immunity solution is the most sensible and economic solution, as higher immunity would mean significantly-higher costs and natural creek bed disruption, with potential environmental permitting issues. These designs also satisfy the maximum two-week road closure requirement for the Project.

The major and minor creek crossings along the road connecting the mine operations area to the accommodation camp area have been designed to provide flood immunity up to the 100 Year ARI flood event. The impact of these crossings on flooding behaviour in these waterways would be minimal. The road between the process plant and the accommodation camp, will also serve as the power and water corridor to the camp and possibly the TSF.

The alternative access road has been designed over an easement agreed with Altona Mining to avoid infrastructure associated with the proposed Roseby Copper Project and will only be built if the proposed intersection with the Burke Developmental Road of the preferred access road is not developed.

The Longamundi pit deviation that is proposed for the access road will only be constructed when the Longamundi pit is developed for the Roseby Copper Project. As this pit is not planned to be developed until seven to nine years after commencement of Roseby Copper Project operations, the creek crossings on the deviation road will be designed prior to construction of the road to take into account the actual pit and waste rock dumps designs, which will disrupt the existing surface water flows.

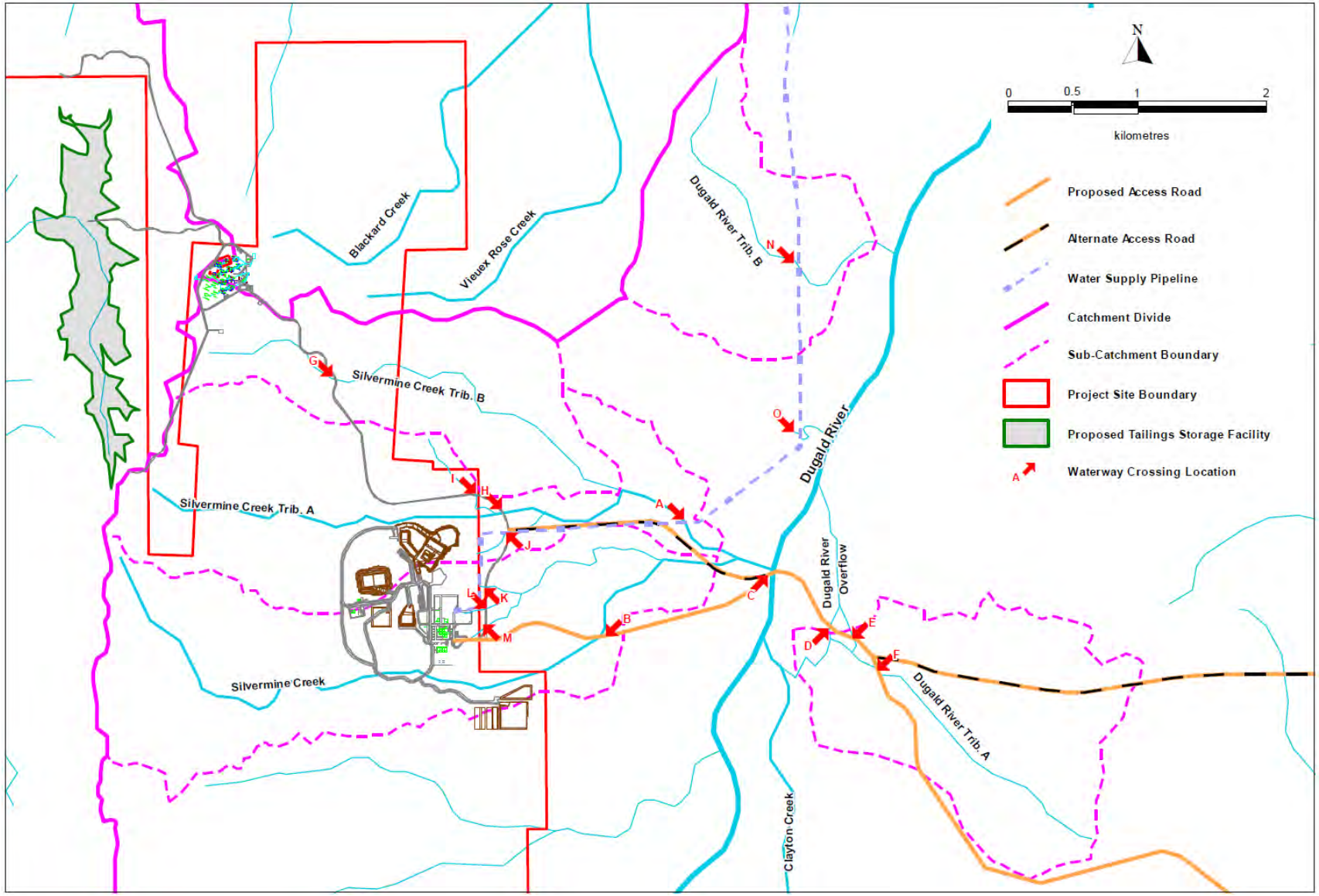


Figure 3.46 Location of Creek Crossings

3.5.5 Sewerage

A modular waste water treatment plant will be located at the process plant, and another will be located in the accommodation camp. Each waste water treatment plant will consist of independent sewage and grey water treatment facilities, each fed by separate drainage systems.

The process plant waste water treatment plant will have capacity for the requirements of up to 192 mining and plant operations personnel. A major ablution block will be located at the site for personnel to shower and change into clean clothing at the end of shift. The sewage from toilets, urinals and kitchen sinks will be processed to produce a high quality effluent of and discharged to the TSF. Sludge from the treatment plant will be temporarily prior to removal from site by a licensed contractor.

Site greywater from hand basins, showers and washing machines will be processed according to the *Water Quality Guidelines for Recycled Water Schemes – November 2008* and the *Public Health Regulation 2005* but will be discharged to the tailings due to potential lead contamination. The *Water Quality Guidelines for Recycled Water Schemes – November 2008* recommends that discharged sewage effluent and greywater is of an equivalent quality to the receiving water.

The accommodation camp waste water treatment plant will have capacity for the requirements of up to 290 people during construction of the process plant. After construction is complete the camp will house up to 400 personnel at any one time. Each accommodation unit will have a toilet, shower and hand basin. Sewage from the accommodation camp toilets, urinals, kitchen sinks and industrial dishwashers will be processed to produce a high quality effluent that will be discharged to the TSF. The *Water Quality Guidelines for Recycled Water Schemes – November 2008* recommends that effluent is of an equivalent quality to the receiving water. Sludge will be temporarily stored for periodic tanker truck disposal.

Greywater from hand basins, laundry sinks, showers, and washing machines will be processed according to the *Water Quality Guidelines for Recycled Water Schemes – November 2008* and the *Public Health Regulation 2005* and used for sub-soil irrigation around the accommodation camp gardens. There are no predetermined water criteria for greywater in the *Water Quality Guidelines for Recycled Water Schemes – November 2008* however, regular testing of the receiving soil will be undertaken to ensure there is no build-up of chemicals, metals or bacteria.

Each sewage and grey water treatment facility will consist of the following:

- Prefabricated FRP wet well with submersible macerator pumps;
- Baffled FRP influent equalisation tank with constant flow transfer pump station;
- Packaged sewage treatment unit or TBR™ for removal of organic matter and nitrogen reduction;
- FRP sludge storage tank;
- Chemical dosing pump station for addition of Chlorine (sodium hypochlorite) into the sludge storage tank;
- Multimedia filter for removal of fine particulates;
- High quality effluent transfer pump station;

- FRP effluent storage tank and disposal pump station; and
- Associated electrical controls.

An example of the treatment facility is provided in Figure 3.14 in Section 3.2.2.1.

A number of portable toilets will be utilised in the underground mine. These will be regularly serviced and all waste removed. Waste will be either transported to the onsite treatment plant or removed off site by licensed contractors. The use of these portable toilets is not expected to have a significant impact on the waste treatment plant or the environment.

3.5.6 Telecommunications

The Project will not impact on any existing telecommunications infrastructure.

It is proposed that a standalone temporary communications system (RAWsat) be utilised for approximately six months while permanent communications systems are established.

The permanent communications system will be constructed around a Telstra Next-G mobile tower and associated data link (backload) which will be installed by Telstra. Site telecommunications will include:

- Integrated fixed line voice and data services to workstations providing voice and broadband data services via the corporate network;
- Mobile voice and broadband data services via a Telstra Next G network service providing private internet access and mobile voice services to work and accommodation areas;
- Accommodation camp recreational communications services;
- Mobile radio coverage on site and underground;
- Security and emergency services; and
- Airport communications.

To support these services, five communications networks are proposed for the Project:

- Two Local Area Network (LAN) fibre optic data networks, one for the plant control system and one for the admin system, will run to all locations on the site, both surface and underground;
- Cables (optic fibre) will run down the intake shafts (VR2 and VR4) for each mine section (North and South) with access points at each plate;
- A surface UHF mobile radio system with three separate duplex channels and repeater stations as required and up to five simplex point to point channels;
- An underground UHF mobile radio (leaky feeder) throughout the mine workings; and
- A Telstra NextG mobile voice and data phone service for the plant and camp areas.

3.5.7 Accommodation and Other Infrastructure

3.5.7.1 Accommodation Camp

The accommodation camp will be located on a plateau on the Knapdale Range, approximately 3.3 km from the administration area (Figure 3.47). The accommodation camp is to house both the construction and permanent workforces. With the exception of two units set up for disabled visitors, all the units are of the same size and standard. The accommodation camp will have approximately 502 - 622 rooms, with further capacity to expand to 766 rooms if required.

The accommodation units will be clustered in groups of six (three units back-to-back with each unit containing four rooms). A total of 21 clusters will be initially required. There is space within the accommodation camp layout for expansion by another 66 four-room units (a total of another 264 rooms), if necessary. Six small laundries will be spread throughout the accommodation area, while the non-residential buildings and recreational facilities will be located on the eastern side of the village.

The initial accommodation camp built with approximately 500 rooms will include the following facilities:

- 124 single-person en suited accommodation buildings (four units per building), approximately 3.3 m x 14.4 m with 2 m x 14.4 m awnings;
- One single-person en suited accommodation building (two units per building) with both rooms fitted for disabled access, approximately 3.3 m x 14.4 m with 2 m x 14.4 m awnings;
- Six laundry buildings;
- One central laundry facility for the contractor to wash sheets, etc;
- One kitchen with food storage facilities;
- One dining facility attached to the kitchen;
- One wet mess with covered outdoor area;
- Two indoor recreation rooms;
- One gymnasium;
- One village administration building;
- One First Aid and medical building;
- One above-ground swimming pool;
- One pool chemical storage building;
- One multi-function sports court;
- Three ablution blocks;
- One maintenance shed;

- One bus shelter; and
- One communications infrastructure building.

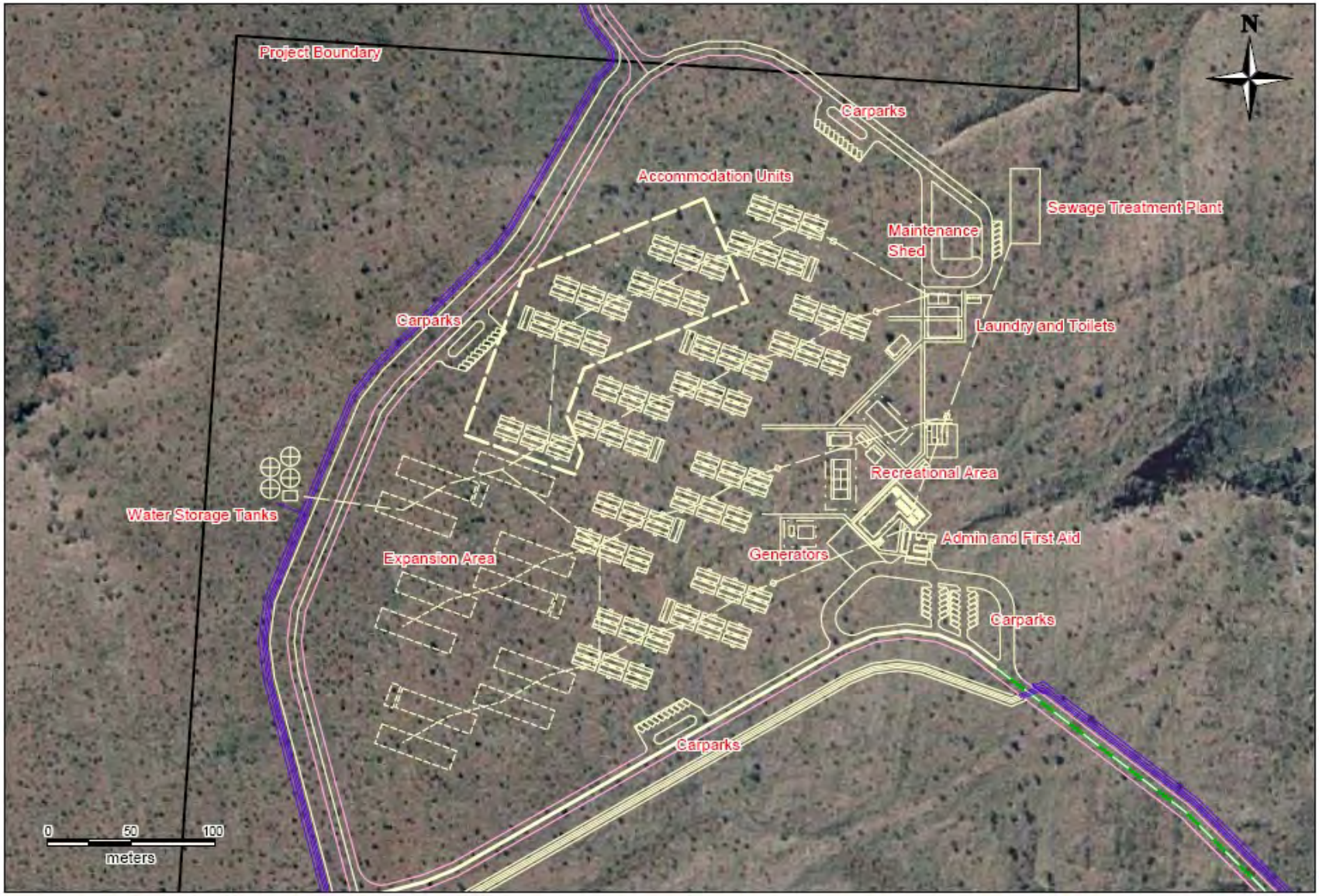


Figure 3.47 Accommodation Camp Layout

Whilst a detailed geotechnical investigation has not been carried out on the Project site, preliminary investigations indicate that the surface of the Knapdale plateau, where the accommodation camp is to be located, is very rocky with some vegetative cover. Photo Plate 3.1 shows typical ground conditions at the site.



Photo Plate 3.1 Ground Conditions at the Accommodation Camp Site

3.5.7.2 Work Shops and Laboratories

Workshops and laboratories will include:

- Mine Heavy Vehicle Maintenance workshop of approx 1,116 m^2, enclosed building with overhead crane:
    - The heavy-vehicle workshop will be a pre-engineered steel structure with colour-bond cladding and a concrete-slab floor. It will be located among the mine services facilities that have direct access from the mine via a full-size haul road; and
    - The workshop will be 62 m long x 18 m wide with a 14.8 m eave height. It will consist of five vehicle bays and a 16.5 m x 12 m lean-to to house five offices and three storerooms. A 10 t safe-working-load ('SWL') overhead electric travelling crane will service the entire workshop area.
- A stand-alone electrical workshop will be provided adjacent to the heavy vehicle workshop. It will be 18 m x 6 m with an internal office and two 3.5 m-high roller doors and a 1 t SWL jib crane;
- Technical workshops and laboratories. There will be one plant laboratory and metallurgical testing facility. The current plan is for wet and dry areas totalling 130 m^2; and
- The plant workshop will be a pre-engineered steel structure with colour-bond cladding and a concrete-slab floor. It will be located between the flotation area and the administration offices. The building will be 28 m long x 18 m wide. It will include four building bays and three offices, a kitchen and a tool store are located in a lean-to on the end of the building. A 5 t SWL overhead electric travelling crane services the entire workshop area.

Any wash down pads at the workshops will be serviced by oil-water separators. The oil will be collected and transferred to the waste oil tank for removal from site by a licensed waste contractor. The clean water from the separator will be discharged to a pond for evaporation. If the water quality in this pond meets the discharge criteria for the site it may be released to the environment.

3.5.7.3 Other Infrastructure/Ancillary Buildings

Other infrastructure on site will include:

- Administration buildings - The administration building will be approximately 36 m long x 20 m wide with a 12 m long x 3.3 m wide computer room annexe. It will include 24 enclosed offices, a reception area, a conference room, a meeting room, a filing room and a kitchen. Reverse-cycle air-conditioning will be provided. A 12 m long x 3.3 m wide male and female toilet block will be provided adjacent to the building and connected by a covered breezeway;

- Mining Offices – The mining offices will be approximately 24 m long x 16.5 m wide. It will include 15 enclosed offices, eight open-plan workstations, a large planning and meeting area, a kitchen and male and female toilets. Reverse-cycle air-conditioning will be provided;

- Plant Offices - The plant office building will be approximately 24 m long x 13.2 m wide. It will includes ten enclosed offices, ten open-plan workstations, a large meeting room, a kitchen and male and female toilets. Reverse-cycle air-conditioning will be provided;

- Security and Gatehouse - The security and gatehouse building will be approximately 12 m long x 12 m wide. It will include a gate security station, office, induction room and male and female toilets. Reverse-cycle air-conditioning will be provided;

- First-aid building - The First Aid building will be approximately 12 m long x 12 m wide. It will include an emergency delivery area, waiting room, treatment room, Nurses station and a toilet. Reverse-cycle air-conditioning will be provided;

- Laboratory - A fully-functioning sample preparation and assay laboratory will be provided. It will include facilities for metallurgical test work. The laboratory will be designed to handle an average of 30 mine samples and 63 metallurgical samples per day. The laboratory will service the assaying requirements for the mine and processing plant and provide metallurgical test work capability, approximately 90–100 samples per day;

- Crib and ablutions building - The crib and ablutions building will be located in a central position to maximise easy access for most people working on the surface at the site. It will be of modular transportable construction, approximately 13.2 m long x 12 m wide. It will include kitchen facilities, tables and seating for 54 people, and male and female toilets. Reverse-cycle air-conditioning will be provided;

- Change-house and mine services - The change-house building will be approximately 36 m long x 33 m wide. It will be used by both process plant and mining personnel. Change rooms will be divided into 'Dirty' and 'Clean' sides with the showers located in-between. Male facilities will include 300 dirty and 300 clean side lockers, 28 shower cubicles, and toilet, urinals and hand basins. Female facilities will include 36 dirty and 36 clean side lockers, six shower cubicles, and toilet and hand basins. The building will also house some of the mine services facilities. These will include:
    - 12 m x 6.6 m emergency-response room;
    - 12.4 m x 8.5 m emergency vehicle covered parking area;
    - 12 m x 6.6 m training room;
    - 12 m x 9.9 m shift-change room with kitchen facilities;
    - Personal protective equipment ('PPE') and cap-lamp rooms;
    - Blast and mine control rooms;
    - Three supervisors' offices; and
    - Reverse-cycle air-conditioning will be provided, along with gas heating in the change-room areas to keep this area dry and sanitary.
- Warehouse - The warehouse will be located to the west of the process plant workshop. It will be a pre-engineered steel structure with colour-bond cladding and a concrete-slab floor. It will measure 30 m long x 14 m wide with a 6.8 m eave height and include two large roller doors with concrete access ramps and a service counter. A security-fenced area of approximately 2,600 m^2 will be provided adjacent to the warehouse for outdoor storage. A 12 m long x 3.3 m wide office block will be located adjacent to the building, connected by a covered breezeway. It will include three offices and a kitchen and reverse-cycle air-conditioning;
- Reagents store - The reagents store will be a pre-engineered steel structure with colour-bond cladding and a concrete-slab floor. It will measure 24 m long x 12 m wide with a 4.8 m eave height and includes wall cladding on the two shortest sides of the building only. The front and back of the building will be completely open with two forklift access ramps. The roof will overhang the front and rear edge of the floor slab by 1.5 m to afford additional protection from rain. Minor quantities of reagents including anti-scale chemicals, water chlorination chemicals, lubricants and laboratory chemicals will be stored in this building;
- Survey shed - The survey shed will be a simple pre-engineered light steel structure with colour-bond cladding and a concrete-slab floor. It will measure 7 m long x 6 m wide with an eave height of 3.3 m and provides secure parking for one light vehicle and a storage area for surveyors' equipment; and
- Control rooms - Three control rooms will be provided, one at the primary crushing station, one inside the flotation building and one at the paste plant.

3.6 WASTE MANAGEMENT

3.6.1 Character and Quantities of Waste Materials

This section addresses the generation and management of wastes for construction, operation and decommissioning activities at the Project site. A waste management plan will be created for the Project site and included in the relevant Plan of Operations.

The goal of waste management on site will be to reduce potential health and environmental hazards which may occur from waste generation and disposal. Disposal of waste will be considered when no other economically feasible option for reuse or treatment exists. The disposal method will seek to minimise environmental effects and the potential for land contamination.

The following principles, in preferential order, will be applied to management of waste at the Project:

- Waste avoidance and minimisation;
- Waste reuse/recycling;
- Waste treatment; and
- Waste disposal.

Waste minimisation includes practices which prevent or reduce the generation of waste. This can be achieved either by a reduction in the volume of waste generated, or by using only products which can be reused or recycled. All staff and contractors working at the Project will be informed of policies on waste management through a site induction. All staff will have a duty of care to ensure that waste generation is either avoided or minimised on the Project site.

The main area where waste may be recycled and reused will be in the maintenance areas of the Project. Due to the remote location of the site, domestic waste recycling such as paper and plastic recycling may not be possible. Waste reuse and recycling involves direct reuse of a waste material or incorporation of that material into another process or product. Sorting, separation and/or refining of waste materials is generally required.

3.6.1.1 Construction and Commissioning Phase

The main waste sources from the Project during the construction and commissioning phase and the proposed methods for reuse or disposal are shown in Table 3.28.

Table 3.28 Waste Produced in Construction Phase

Waste	Method of Re-use/Disposal
Vegetation from clearing activities	Vegetation will be chipped/mulched if required and stockpiled for use in landscaping and rehabilitation
Topsoil	Stockpiled for re-use in rehabilitation
NAF Waste rock	Used for constructing ROM Pads and mine roads or stored in waste rock dumps near processing plant.

Waste	Method of Re-use/Disposal
PAF Waste rock	Some PAF material will be disposed of directly underground as rock fill. PAF waste rock brought to the surface will either be encapsulated in NAF waste rock in a waste rock dump or stored on temporary NAF waste rock pads for later disposal underground.
Civil cut material	Used for constructing ROM Pads and mine roads.
General waste from village	Disposed of to rubbish disposal area to be established on-site, or trucked to Cloncurry waste disposal site prior to establishing a site based facility.
Sewage	Sewage treatment plant on-site with treated water disposed of via absorption trenches. Sewage sludge removed from site via a licensed contractor.
Scrap metal, building materials	Scrap steel sold for recycling, general refuse disposed of in landfill.
Waste oil and grease	Collected from site by licensed contractor.
Waste tyres	Used as road markers, excess tyres stockpiled for later disposal in waste rock dumps.
Vehicle batteries	Collected from site by licensed contractor.

3.6.1.2 Operational Phase

The major wastes to be produced in the operational phase of the Project and proposed methods of reuse or disposal are described in Table 3.29.

Table 3.29 Waste Sources During Operation

Waste	Estimated Quantity	Method of Re-use/Disposal
Waste Rock	Total waste from lead/zinc ore for the life of the mine is 7,111,193 t.	NAF waste rock will be disposed of in surface waste rock dumps, used for encapsulating PAF waste rock or disposed of underground as rock fill. On mine closure the majority of NAF material remaining on the surface will be used in TSF rehabilitation. PAF waste rock will be prioritised for disposal to underground as rock fill. PAF waste rock brought to the surface will be encapsulated in a purposed built waste rock dump where it will remain on mine closure or be stockpile temporarily prior to disposal underground.

Waste	Estimated Quantity	Method of Re-use/Disposal
Tailings	928,500 tpa of solids (1.6 Mt slurry) from Zn/Pb processing, 887,500 tpa of solids (1.7 Mt slurry) from Cu processing (when commissioned)	Piped to TSF or used as paste backfill underground.
Water including reagents and flocculants	102 m^3/h to TSF (50% recycled) 35 m^3/h to UG Mine	Pumped to TSF, used in Paste Fill, used for dust suppression and reused as process water.
Sewage	7.3 – 18.3 Ml/yr	Treated in two on-site sewage treatment plants (accommodation camp and process plant). Sewage waste will be discharged to the TSF and grey-water from the accommodation camp used for sub-soil irrigation of the gardens and lawn. Grey water form the process plant area will be discharged to the TSF.
General Waste from accommodation camp	1.5 t per person per year. With up to 400 personnel on site at any one time that equates to 600 tpa	The rubbish disposal site will consist of mound design above ground where all putrescibles wastes will be deposited. The face of the landfill will be covered or a regular basis (at least weekly) to prevent the dispersal of wind borne rubbish, control scavenging by feral animals and deter insect breeding.
Consumables: Steel balls Steel liners	At a consumption rate of 0.96 kg per tonne of ore milled and a milling rate of 2 Mtpa. Considering 30% of steel is not worn, a maximum of 576 tpa of steel will be disposed each year from grinding media. At a consumption rate of 1.8 sets per year and a residual weight of 75 t each, a maximum of 135 tpa of steel liners will be scrapped.	Steel ball scats and worn liners will be salvaged from site by scrap metal merchants.
Waste oil, grease, vehicle batteries, scrap steel	50 tpa	Collected by a licensed regulated waste contractor.
Tyres	At a usage rate of 2 sets/truck/year and 3 sets/loader/year and 8 tyres/set for trucks and 4 tyres/set for loader and an average of 8 trucks and 3 loaders during the mine life. A maximum of 128 truck tyres and 48 loader tyres will be disposed of every year	Waste tyres will be stockpiled and buried in waste rock dumps in a manner to maintain long-term dump stability.

Figure 3.49 shows the conceptual waste streams including solid and liquid wastes from the operational phase of the Project. The main wastes are waste rock, tailings and waste water (most of which is reclaimed). Details of the processing activities are provided in Section 3.3.5.

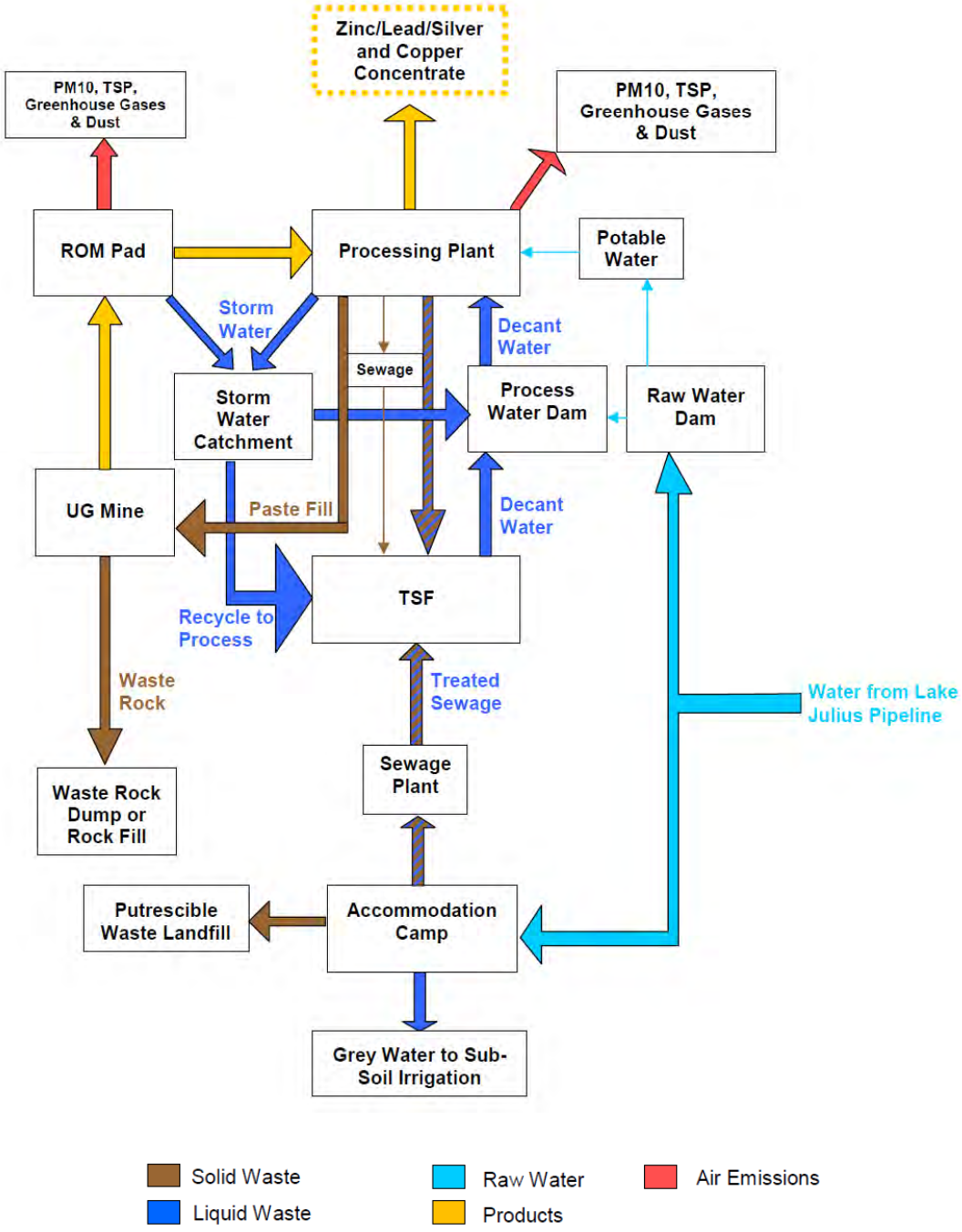


Figure 3.49 Waste Streams in the Operational Phase of the Project

The physical and chemical properties of the wastes from the processing plant are discussed in Section 3.6.4 - Tailings Disposal and Appendix I. The physical and chemical properties of waste rock are described in Section 3.6.3 and Appendix H.

During operations the zinc/lead processing circuit will process up to 2 Mtpa of ore and produce 448,000 tpa of zinc/lead concentrate. The copper processing circuit will process up to 1 Mtpa of ore and produce 75,000 tpa of copper concentrate.

When only the zinc-lead processing circuit is operating, for every one tonne of mineral concentrate produced:

- 0.3 t of waste rock will be produced; and
- 3.6 t of tailings slurry will be produced.

When the copper processing circuit is commissioned and both circuits are operating, 5.5 t of tailings slurry will be produced, per tonne of all mineral concentrates produced.

The main re-usable input in circulation in the processing plant will be water. As discussed in Section 3.5.3.2 the water processing water circuit will recycle 1,031 m^3/h directly from the processing plant and 51 m^3/h from the TSF. Make-up water will be sourced from the Lake Julius / Ernest Henry Pipeline and will augment the supply. 100% of water will be recycled from the thickening circuit.

In addition grey water from the accommodation camp ablutions facilities will be recycled and drip fed to sub-surface to irrigate the gardens around the accommodation areas.

3.6.1.3 Decommissioning Phase

During the decommissioning phase all non-permanent structures including accommodation units, offices, administration buildings, laboratories, ablutions and recreational buildings will be on-sold, packed down and removed from site. Any permanent structures remaining will be demolished and scrap materials will be recycled where practicable. Concrete footings will be broken down and removed from site. Roads may remain at the discretion and agreement of the landholder. If site or access roads are not needed post decommissioning the concrete/bitumen base at creek crossings will be removed and the area will be ripped, topsoiled and revegetated.

3.6.2 Air Emissions

The main air borne wastes emitted from the Project will be:

- Particulate matter with equivalent aerodynamic diameters of 10 µm or less (PM_{10});
- Particulate matter with equivalent aerodynamic diameters of 2.5 µm or less ($PM_{2.5}$);
- Carbon Monoxide;
- Nitrogen Dioxide;
- Total suspended particulate matter (TSP); and
- Greenhouse gases.

The predicted ground-level concentrations of $PM_{2.5}$, PM_{10}, carbon monoxide and nitrogen dioxide for the construction phase are summarised as follows:

- 24-hour $PM_{2.5}$ concentration of 0.2 micrograms per cubic metre (µg/m^3) and annual $PM_{2.5}$ concentration of 0.01 µg/m^3
- 24-hour PM_{10} concentration of 0.2 µg/$m^{3;}$;
- Carbon Monoxide 8-hour concentration of 7.6 µg/m^3;

- Nitrogen Dioxide 1 hour concentration of 50.6 µg/m^3; and
- Nitrogen Dioxide annual concentration of 0.3 µg/m^3.

The modelling results indicate that all ground-level concentrations are well below the EPP(Air) objectives for the construction phase. The results for nitrogen dioxide are conservative, as a 100% conversion of oxides of nitrogen to nitrogen dioxide has been assumed. In reality, this ratio is likely to be 30-50%.

The emission rates for $PM_{2.5}$, PM_{10} and TSP for the operations phase are described in Table 3.30.

Table 3.30 Emission Rates of $PM_{2.5}$, PM_{10} and TSP for the Dugald River Project

Activity	Emission rate (g/s)		
	TSP	PM10	PM2.5
Graders	0.13	0.04	0.004
Waste stockpile – dumping, wind erosion and dozer	0.46	0.15	0.041
Trucks on unpaved road from portal to ROM	1.76	0.50	0.050
ROM - trucks dumping ore, wind erosion and loader	1.86	0.88	0.043
Primary crusher	0.95	0.38	0.071
Crushed ROM copper and processing – material handling, wind erosion, dozer and	2.75	1.20	0.213
Crushed ROM lead/zinc and processing – material handling, wind erosion, dozer and conveyor	2.59	1.09	0.201
Concentrate shed – loader and conveyor	0.65	0.30	0.048

These emissions were based on the following control measures in Table 3.31.

Table 3.31 Emission Control Factors for Dust Control Measures

Source	Control measure	Level of control	Reference
Haul roads	Watering	50%	NPI for Mining Version 2.3 (2001) – Level 1 watering assumed
Loader in concentrate shed	Full enclosure	99%	NPI for Mining Version 2.3 (2001)

Total emission rates for the Project can be summarised as follows:

- The main sources of dust emissions from the mine will be from the stockpiles and the transport of ore and waste rock on haul roads;
- The contribution from the Dugald River Project to air pollutant concentrations at the location of sensitive receptors is predicted to be minor compared with background levels and the contribution from the Roseby Copper Project;

- There is compliance with the EPP(Air) objectives for predicted 24-hour and annual average ground-level concentrations of $PM_{2.5,}$ annual average ground-level concentrations of TSP and annual average dust deposition rates at the nearest homestead residence and the Roseby Accommodation Camp due to operations at the Dugald River Project, Roseby Copper Project and ambient background levels;

- The EPP(Air) objective for 24-hour average ground-level concentrations of PM_{10} is predicted to be exceeded at the nearest homestead residence in the later years of the Roseby Copper Project when the Roseby Copper Project operations are closer to the location of the homestead. However, levels at the Roseby Accommodation Camp are predicted to comply with the EPP(Air) objective; and

- Predicted annual average ground-level concentrations of lead, arsenic, cadmium, manganese and nickel due to the Dugald River Project as an increment are well below the EPP(Air) objectives at the nearest homestead residence and the Roseby Accommodation Camp. Concentrations at these sites are unlikely to exceed the EPP(Air) objectives even with inclusion of a background level.

Power Generation Assessment

- Predicted concentrations of 24-hour average $PM_{10,}$ 8-hour average carbon monoxide and annual average nitrogen dioxide from the gensets operating in isolation is predicted to be less than 1 % of the EPP(Air) objectives at the nearest homestead. The maximum predicted concentration of 1-hour average nitrogen dioxide is approximately 20.2% of the EPP(Air) objective at the nearest homestead and was modelled conservatively assuming 100% conversion of oxides of nitrogen to nitrogen dioxide. These concentrations are well below the objectives and are unlikely to exceed the objectives with the inclusion of background levels.

The greenhouse gas emissions have been calculated for the ultimate mining capacity of 2 Mtpa of lead/zinc ore and 1 Mtpa of copper ore with four generator sets giving a total output of 4.5 MVA. The generator sets will power the mine operations as well as the onsite accommodation facilities for workers for the first two years of operations. Electricity will be consumed from the grid after the first two years. A summary of the greenhouse gas emissions calculated for the consumption of diesel fuel by the generators and the vehicles, and electricity is shown in Table 3.32.

Table 3.32 Greenhouse Gas Emissions

Year	Transport – diesel ($t CO_{2-e}$)	Gensets – diesel ($t CO_{2-e}$)	Electricity consumption ($t CO_{2-e}$)	Explosives ($t CO_{2-e}$)	Landfill emissions ($t CO_{2-e}$)	Total ($t CO_{2-e}$)
2012	-	19,991	-	-	-	19,991
2013	1,513	19,991	-	34	910	22,447
2014	4,972	-	84,032	157.59	910	90,071
2015	7,771	-	147,328	194.31	910	156,203
2016	9,865	-	157,391	289.85	910	168,457
2017	11,462	-	184,575	289.85	910	197,236
2018	13,439	-	209,700	289.85	910	224,339
2019	14,005	-	211,136	289.85	910	226,340
2020	14,549	-	211,695	289.85	910	227,444
2021	15,372	-	212,126	289.85	910	228,698
2022	15,740	-	212,397	289.85	910	229,337

Year	Transport – diesel (t CO_{2-e})	Gensets – diesel (t CO_{2-e})	Electricity consumption (t CO_{2-e})	Explosives (t CO_{2-e})	Landfill emissions (t CO_{2-e})	Total (t CO_{2-e})
2023	16,469	-	212,487	289.85	910	230,157
2024	17,404	-	212,505	289.85	910	231,109
2025	18,405	-	212,505	289.85	910	232,110
2026	18,857	-	212,505	289.85	910	232,562
2027	21,780	-	212,505	289.85	910	235,485
2028	22,583	-	212,505	289.85	910	236,288
2029	17,731	-	212,505	229.84	910	231,376
2030	6,164	-	212,505	95.37	910	219,674

The highest annual total greenhouse gas emission for the mine is 236,288 t CO_2-e. Australia's assigned amount of greenhouse gas emissions for the period 2008 – 2012 under the Kyoto Protocol is 108% of Australia's estimated emissions for 1990 of 598,075.71 greenhouse gas (Gg) (598 $MtCO_2$-e). The highest annual total emissions from the mine are 0.04 % of Australia's assigned amount under the Kyoto Protocol.

For a full description of the mitigation strategies for reducing green house gas emissions see Section 4.5 of this EIS.

3.6.3 Excavated Waste

The main form of excavated waste created by the Project is waste rock from the underground workings. Waste rock is either categorised as NAF or PAF as described in Section 3.6.3.3.

During the construction phase of the Project NAF waste rock material will be mainly used for constructing the ROM Pads and mine roads. Some NAF waste rock will also be used for encapsulating PAF material in a specifically designed waste rock dump. PAF waste rock during the construction phase of the Project will be prioritised for disposal underground where possible, but as stoping will not have commenced underground, most of this material will be required to be disposed of to the surface. PAF waste rock on the surface will either be encapsulated in a specifically designed waste rock dump or temporally stockpiled awaiting disposal underground.

The other excavated waste during the construction phase will be in the form of civil cut materials which will be removed from the stormwater dam and sediment pond areas at the mine and processing area during construction. This civil cut material will be NAF material and used for constructing the ROM Pads and mine roads during the construction phase.

During the operating phase of the Project, the majority of PAF waste rock will be prioritised for disposal underground as rock fill or co-disposed with paste fill. The remaining PAF waste rock will be encapsulated in a specifically designed waste rock dump on the surface or temporarily stockpiled awaiting disposal underground.

During the operating phase of the Project, NAF waste rock will be disposed of in surface waste rock dumps and used for encapsulating PAF waste rock or disposed of underground as rock fill or with paste fill. On mine closure the majority of NAF material remaining on the surface will be used in TSF rehabilitation.

3.6.3.1 Waste Rock Dump Design

Based on the waste rock characterisation results, MMG have produced an estimate of the quantities of PAF and NAF materials to be produced for the life of the Project (Table 3.33). Over the mine life approximately 81% of the waste rock produced by the underground mine will be NAF with 19% being PAF. Of the total waste rock mined 63% of all waste will be disposed of underground, leaving only 37% to be stockpiled on surface. By making disposal of the PAF to underground voids a priority, at the end of the Project life, the portion of material remaining on the surface that will be PAF will only be 11%. With these amounts of materials there is more than sufficient NAF material to fully encapsulate the PAF material that is dumped on the surface. The waste rock production schedule and NAF and PAF volumes generated each year are described in Section 3.6.3.2.

Table 3.33 Estimate of PAF/NAF Materials

	Tonnes	Percentage
Total Waste Produced		
PAF	1,362,361	19.2%
NAF	5,748,832	80.8%
Subtotal	**7,111,193**	**100%**
Waste Disposed of Underground		
PAF	1,073,083	24.0%
NAF	3,404,455	76.0%
Subtotal	**4,477,538**	**63.0%**
Waste Stockpiled on Surface		
PAF	289,278	11.0%
NAF	2,344,377	89.0%
Subtotal	**2,633,655**	**37.0%**

PAF waste rock from the Project's underground workings has the potential to produce contaminated leachate if left to oxidise on the surface (Section 3.6.3.3). Therefore special mitigation strategies for the disposal of this waste have been proposed. As NAF waste rock does not have the potential to produce contaminated leachate, this material does not require special disposal strategies. NAF waste rock is also suitable as an outer layer on the waste rock dumps as it has been shown through testing that this material is non-dispersive and resistant to erosion (Section 3.6.3.3).

Waste rock excavated from the underground workings will either be disposed of as rockfill or co-disposed with paste fill underground, or brought to the surface. PAF waste rock brought to the surface will be either encapsulated immediately in the NAF/PAF waste rock dump or stored temporarily in a waste rock stockpile (North PAF waste rock dump) prior to being disposed of underground as rockfill (Figure 3.50). NAF waste rock brought to the surface will be either used to construct infrastructure such as the ROM Pads and mine roads the construction phase, returned underground as rockfill, disposed of to the waste rock dumps or used for PAF encapsulation. The breakdown of the different quantities of waste rock disposed to these different locations throughout the mine life is shown in Table 3.33.

The NAF/PAF waste rock dump is the only waste rock dump that will be used for encapsulation of PAF material on the surface (Figure 3.51) and the only place PAF waste rock will remain on the surface on mine closure. Stringent engineering and surface water drainage control will be employed in the construction of this dump to ensure that the generation of contaminated leachate is avoided or minimised and that no discharges occur to surface water or groundwater resources. On completion, the dump will contain approximately 57000 m^3 of PAF material and 392,000 m^3 of NAF, or 13% PAF material and 87% NAF. This percentage of PAF to NAF waste rock is more than adequate to provide

encapsulation of the PAF material and provides a significant volume of NAF material within the dump to neutralise any acid leachate should it form.

The conceptual design of the NAF/PAF waste rock dump is shown in Figure 3.51. PAF material will not be stored in the base or slopes areas of the waste rock dump, only in the central core of the dump. The waste rock dump will be constructed with at least a 1 m layer of well compacted NAF waste rock at the base of the dump. The outer walls of the dump and areas under the outer slopes will be built exclusively from NAF material to produce an outer NAF encapsulation wall. The final slope of the outer waste dump walls will be approximately 15 degrees and will have a concave type profile, so as to resemble a natural hill. The outer walls of the dump will be built up progressively around the inner PAF core so that no rainfall runoff from the PAF material can exit the facility. PAF material in the centre of the dump will be built up in layers of 1 – 1.5 m thick to aid compaction of the material and minimise rainfall infiltration. Intermediate barrier layers of NAF rock will be used to encapsulate PAF lifts, especially prior to the wet season. PAF waste rock may be co-disposed of with high acid consuming NAF material within the core of dumps if necessary.

The waste rock dump will be constructed mainly of fresh waste rock, not containing clays or weathered material. The dump batters are much flatter (15 degrees) than the standing angle of repose of the material (approximately 39 degrees). There are no significant geological structures or known zones of weakness immediately beneath the waste dump. For these reasons, the waste rock dump will be geotechnically stable. The final height of the waste rock dump will be approximately 12.5 m.

On completion of the waste rock dump, the top of the dump will be sealed with a compacted low permeability layer of suitable NAF waste rock or other material (of at least 0.5 m depth) and then covered with at least 1 m of NAF waste rock as a rainfall shedding cover. The top of the dump will slope gently to the north so that during large rainfall events water will not pool on the top of the dump as this may increase the chances of infiltration through the compacted low permeability layer. Rainfall will be directed off the dump via a series of rock lined drains.

The final rehabilitated design of the PAF/NAF waste rock dump is described in Section 3.7.3. Stormwater drainage off the rehabilitated NAF/PAF waste rock dump is expected to be non-contaminated due to the above encapsulation strategy, although may contain levels of suspended sediment. Therefore the stormwater dam downstream of the PAF/NAF waste rock dump will remain on rehabilitation to remove entrained sediment prior to stormwater discharge (which will only occur in extreme rainfall events). This stormwater dam and its location are described in Section 3.5.4.1.



Figure 3.50 Waste Rock and Stockpile Location and Design

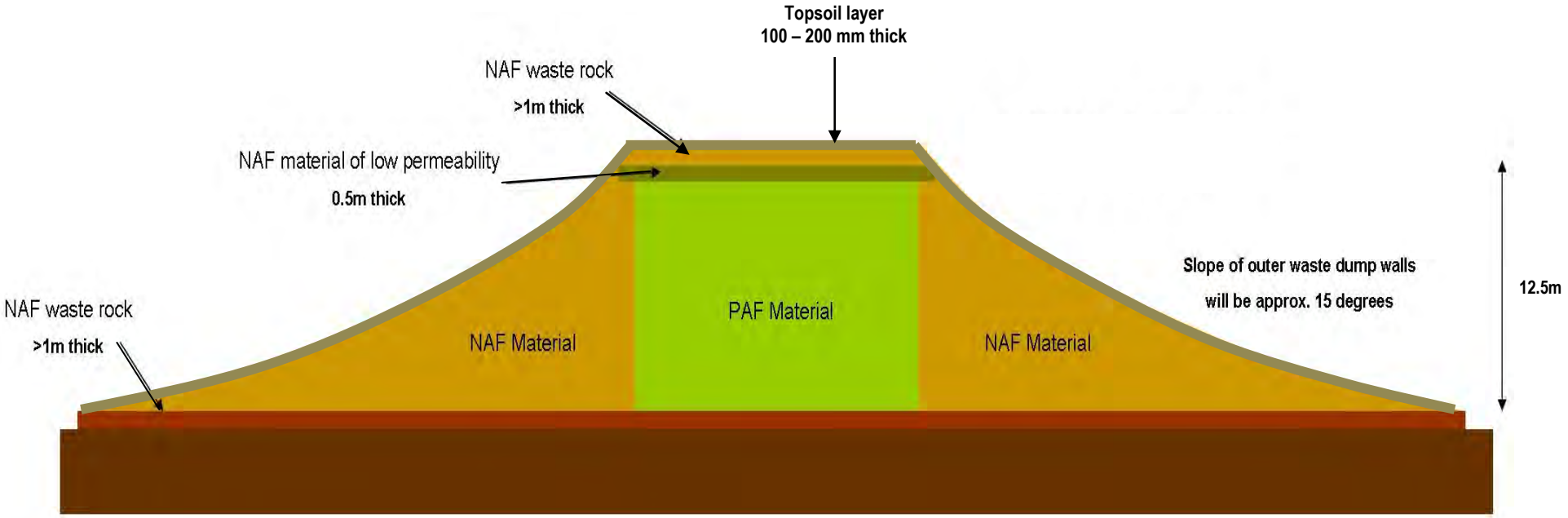


Figure 3.51 Conceptual NAF/PAF Waste Rock Dump Design

The south waste rock dump (Figure 3.50) will only contain civil cut material excavated from the mining and processing area ponds or NAF waste rock material brought up from the underground mine. NAF waste rock that is stockpiled in this dump will be also be returned underground as rock fill or paste fill as required. On completion of the mine, this waste rock dump is only likely to contain the civil cut material with all NAF waste rock returned underground. In addition this civil cut material is likely to be removed to the TSF on mine closure for use as a cover media as described in the rehabilitation Section 3.7.3. During the construction and operating phase of the mine this waste rock dump will be drained by a stormwater dam as described in Section 3.5.4.1.

The North PAF Stockpile area will act as a temporary stockpile for PAF material that will be disposed of back underground. This stockpile area is an extension of the lead/zinc ROM Pad as shown in Figure 3.50. The base of this area will be constructed from compacted NAF waste rock with all stormwater drainage off the area being directed to a HDPE lined stormwater dam as described in Section 3.5.4.1. The outer extent of the top of the stockpile area will be bunded so that no contaminated stormwater can enter the environment. Once the Project is in the operating phase PAF waste rock will only remain on the surface for a few months before being disposed of underground. On closure of the mine, there will be no PAF waste rock left on this pad. The NAF waste rock that formed the base of the stockpile will be consumed as underground rock fill.

The NAF waste rock and civil cut material that will remain in the Lead/Zinc ROM Pad, Copper ROM Pad, Off ROM Pad and mine road areas on completion of mining is likely to be removed to the TSF on mine closure, for use as a cover material on the TSF. This process is described in Section 3.7.3.

Regular surface water and groundwater sampling programs will occur downstream of all waste rock dumps and ROM Pads to detect any contamination. Should any contaminated runoff occur this would be captured by the downstream stormwater dams or sediment dams and either evaporated or reused through the process plant water system. The base of the NAF/PAF waste rock dump and North PAF Stockpile area will be constructed from compacted NAF material which will provide both a barrier to the downward infiltration of any contaminated leachate and a neutralisation medium. Should contaminated leachate be detected in the groundwater aquifer around these areas a groundwater pump back system to the process plant water system would need to be initiated.

3.6.3.2 Waste Rock Disposal Schedule

The scheduling for the final destination of waste rock excavated from the underground operations is provided in Figure 3.52 for each year of the mine life. This figure details the tonnage of waste rock to be deposited underground as either rock fill or with paste fill and the waste rock that will be deposited on the surface in purpose built waste rock dumps or temporary stockpiles. In the initial period of mining rock fill and stockpiling on the surface are the more prominent disposal methods. In the later years of mining, co-disposal with paste fill becomes more common.

Table 3.34 differentiates the tonnages of NAF or PAF material that will be stockpiled on the surface each year. PAF material stockpiled on the surface ranges from 2.1% of the total waste rock material stockpiled in 2012 to 59% of material stockpiled in 2035, due to the location of where mine development is occurring at that time.

Table 3.35 details the amount of waste rock to be left in the surface stockpiles at the end of the mine life. The NAF/PAF waste rock dump will be the only place PAF waste rock will remain on the surface on mine closure, all other remaining stockpiles of PAF will be disposed of underground. On completion, the NAF/PAF waste rock dump will contain approximately 57,000 m^3 of PAF material and 392,000 m^3 of NAF, or 13% PAF material and 87% NAF, which is more than adequate to provide for

encapsulation. The NAF waste rock and civil cut materials in the other stockpiles remaining on the surface at the end of the mine life will be removed to the TSF for use in rehabilitation of this facility.

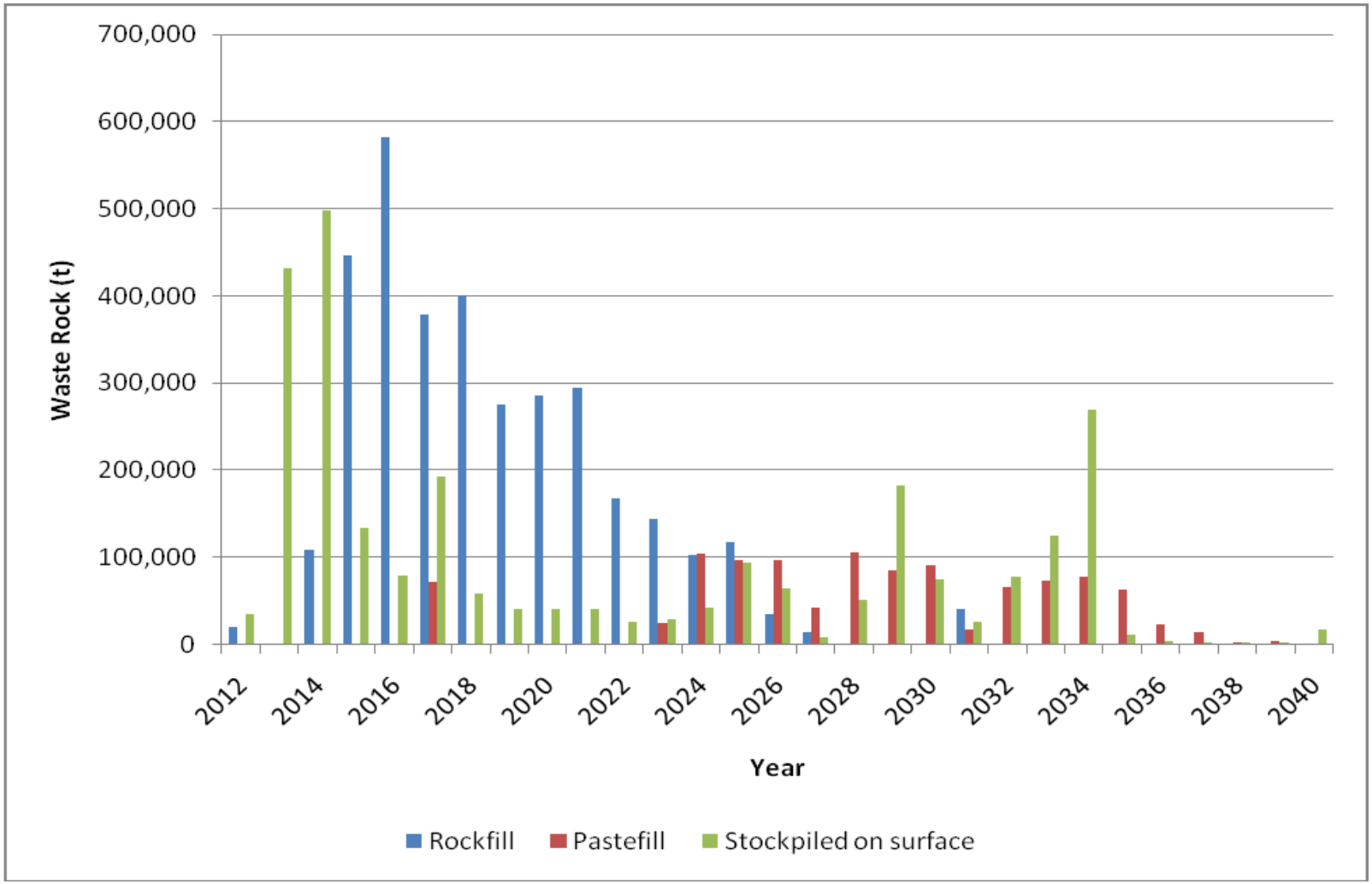


Figure 3.52 Waste Rock Schedule and Disposal Methods

Table 3.34 Waste Stockpiled on Surface (tonnes) Each Year

Year	PAF		NAF		Total NAF/PAF
	Tonnes	%	Tonnes	%	
2012	715	2.1%	34,105	97.9%	34,820
2013	19,450	4.5%	412,247	95.5%	431,696
2014	19,749	4.0%	478,388	96.0%	498,137
2015	17,663	13.3%	115,324	86.7%	132,986
2016	22,794	29.4%	54,712	70.6%	77,506
2017	20,846	10.8%	171,713	89.2%	192,559
2018	19,726	35.4%	35,985	64.6%	55,711
2019	13,998	36.3%	24,544	63.7%	38,543
2020	12,602	32.4%	26,312	67.6%	38,915
2021	10,264	26.7%	28,240	73.3%	38,504
2022	10,598	42.9%	14,110	57.1%	24,708
2023	13,723	51.8%	12,777	48.2%	26,500
2024	8,165	19.6%	33,481	80.4%	41,646
2025	12,870	13.9%	80,027	86.1%	92,897
2026	8,130	12.8%	55,538	87.2%	63,668
2027	2,173	29.0%	5,320	71.0%	7,493
2028	3,276	6.5%	47,296	93.5%	50,572
2029	13,214	7.2%	169,253	92.8%	182,467
2030	8,887	12.0%	65,330	88.0%	74,217
2031	2,640	10.4%	22,777	89.6%	25,417
2032	7,115	9.2%	69,875	90.8%	76,990
2033	11,925	9.5%	113,395	90.5%	125,319
2034	19,510	7.3%	249,208	92.7%	268,718
2035	6,078	58.7%	4,280	41.3%	10,358
2036	1,151	35.7%	2,069	64.3%	3,220
2037	892	42.8%	1,194	57.2%	2,087
2038	27	33.3%	53	66.7%	80
2039	149	36.0%	264	64.0%	413
2040	947	5.4%	16,559	94.6%	17,506
Total	**289,278**		**2,344,377**		**2,633,655**

Table 3.35 Volumes of Waste Rock to Remain on Surface at End of Mine Life

Name	Volumes at Closure to Remain on Surface (m^3)			
	From Civil Cut (NAF)	From U/G Mine (PAF)	From U/G Mine (NAF)	TOTAL
Lead/Zinc ROM Pad	250,942	-	-	250,942
Copper ROM Pad	-	-	134,183	134,183
Off ROM Stockpile			246,493	246,493
ROM Pad Pond Walls	38,677	-	-	38,677
Mine Roads	38,791	-	22,224	61,015
South Waste Rock Dump	-	-	19,191	19,191
NAF/PAF Waste Rock Dump	-	57,291	392,376	444,865
Total	**328,410 m^3**	**57,291 m^3**	**814,467 m^3**	**1,200,168 m^3**

3.6.3.3 Waste Rock Characterisation

A Waste Rock Characterisation Report for the Project was prepared by Environmental Geochemistry International Pty Ltd (EGi) and is contained in Appendix H. EGi reviewed the findings of two previous geochemical studies (AARC 2008; AGC Woodward-Clyde 1991) and undertook an additional program to assess the geochemical characteristics of samples representing waste rock that will be produced during the development of the Dugald River underground mine.

Methodology

Overall, three geotechnical studies of waste rock on the Dugald River project have been conducted.

The first study was of a preliminary nature carried out by AGC Woodward-Clyde (1991) as part of pre-feasibility studies. This study involved the assessment of the acid forming potential of 18 drill core samples representing waste rock and another five samples representing ore grade material within the lead/zinc lode. The samples were taken from seven drill holes and the lithologies represented by the waste samples were hanging wall slate (6 samples), footwall slate (8 samples) and limestone (4 samples).

A second, more detailed investigation of waste rock geochemistry was undertaken by AARC (2008). This study included static geochemical analysis of 121 drill core samples and also establishment of a series of kinetic leach column tests. The samples were taken from 12 diamond drill holes and were

representative of the following lithologies: calc-silicate (23 samples), mafic feldspar porphyry (3 samples), white mica schist (13 samples) hanging wall slate (38 samples), lode waste (10 samples), footwall slate (16 samples) and foot wall limestone (18 samples).

The testing programs for both studies involved measurements of existing pH, Total Sulphur content, Acid Neutralising Capacity (ANC) and Net Acid Producing Potential (NAPP). Investigations conducted by AARC (2008) also included measurement of Net Acid Generation (NAG) capacity.

During the assessment of geochemical characteristics and Acid Rock Drainage (ARD) potential of waste rock carried out by AARC (2008) column leach tests were also conducted. These were undertaken to quantify the longer-term geochemical behaviour of different waste rock lithologies at real time under conditions that are conducive to sulphide oxidation and metals leaching. The column tests commissioned by AARC operated for either 44 or 68 weeks and involved composites of drill core samples representing the following waste rock types:

- Column 1 - hanging wall slate (uncertain),
- Column 2 - footwall limestone (NAF),
- Column 3 - PAF waste mixture (comprising lode waste and pyritic/mineralised footwall slate)
- Column 4 - footwall slate (NAF),
- Column 5 - calc-silicate (NAF),
- Column 6 - calc-silicate & mafic feldspar porphyry mix (NAF),
- Column 7 - mica schist (NAF).

The most recent characterisation program, undertaken by EGi (2010), comprised of 72 drill core samples selected by MMG. When combined with the previous geochemical investigations, this represents a total of 211 samples representing Dugald River waste rock. The samples were distributed between the seven lithologies as presented in Table 3.36.

Table 3.36 Distribution of Waste Rock Samples Across Lithologies

Lithology	Waste Rock Characterisation Program			Combined
	AGC Woodward-Clyde (1991)	AARC (2008)	EGi (2010)	
Calc-silicate	0	23	8	31
Mafic feldspar porphyry	0	3	4	7
White mica schist	0	13	4	17
Hanging wall slate	6	38	8	52

Lithology	Waste Rock Characterisation Program			Combined
	AGC Woodward-Clyde (1991)	AARC (2008)	EGi (2010)	
Lode waste	0	10	8	18
Footwall slate	8	16	20	44
Footwall limestone	4	18	20	42

The guideline on *Assessment and Management of Acid Drainage* (DERM 1995) provides minimum numbers of samples that should be collected from each rock type based on the tonnage that will be mined. The tonnages of the various waste rock units generated by the Dugald River zinc/lead underground development will be 0.46 Mt of hanging wall slate, 0.66 Mt of lode waste, 2.88 Mt of footwall slate, and 3.11 Mt of footwall limestone. The corresponding minimum number of samples for each tonnages based on interpolation of the DERM guideline are 18, 21, 43 and 45, respectively. Therefore, over the three geochemical assessment programs the numbers of samples tested were comparable to the DERM guideline.

During the EGi (2010) geotechnical program, samples underwent a period of preparation during which the samples were crushed and milled. Core pulps were subsequently put through a static testing program which conformed to that used during previous studies (AARC 2008; AGC-Woodward Clyde 1991). Parameters assessed were:

- Existing pH and conductivity
- Total Sulphur content
- Maximum Potential Acidity (MPA)
- Acid Neutralising Capacity (ANC)
- Net Acid Producing Potential (NAPP)
- Net Acid Generation (NAG) capacity

The NAPP and NAG test results were reviewed then some samples were selected for more detailed analysis to either clarify the ARD classifications, assess sulphide or carbonate reactivity, and/or identify elemental enrichments and their potential leachability. The detailed testing of selected drill core samples included one or more of the following:

- Sulphur forms - 15 samples
- Sequential NAG test - 2 samples
- Kinetic NAG tests - 5 samples
- Acid buffer characteristic curves - 5 samples

- Solids multi-element analyses - 15 samples
- Water extractable elements - 15 samples
- Acid extractable elements - 15 samples
- Peroxide extractable elements - 15 samples

Certain NAF samples were also analysed for erosion potential as these lithologies may be used to encapsulate PAF materials and therefore be exposed to erosional forces on the outside of the waste rock dumps. Testing included:

- • Cation Exchange Capacity; and
- • Exchangeable Sodium Percentage.

Acid Forming Potential

The acid forming potential of the waste rock samples was assessed by examining the sulphur content, ANC and NAPP.

The sulphur content distribution of the seven lithologies is shown in Table 3.37. The sulphur content in calc-silicate, mafic feldspar porphyry and white mica schist samples was generally low, whereas the sulphur content in lode waste, hanging wall slate, footwall slate and footwall limestone had moderate to high sulphur content.

Table 3.37 Sulphur Content

Lithology	%S Median	%S Range
Calc-silicate	<0.01	<0.01-1.57
Mafic feldspar	<0.10	<0.01-0.77
White mica schist	0.03	<0.01-0.29
Hanging wall slate	1.8	<0.01-14.4
Lode waste	6.4	1.2-16.6
Footwall slate	1.1	0.45-14.6
Footwall limestone	1.0	0.1-2.12

The ANC distribution of the seven lithologies is shown in Table 3.38. Footwall limestone, calc-silicate and footwall slate samples had high to very high ANCs. Hanging wall slate and white mica schist samples had noticeably lower ANCs. The ANCs of the lode waste samples were bi-modal.

Table 3.38 Acid Neutralising Capacity

Lithology	Median (kg H_2SO_4/t)	Range (kg H_2SO_4/t)	Percent with ANC >100kg H_2SO_4/t
Calc-silicate	169	9-688	81
Mafic feldspar	79	21-401	43

Lithology	Median ($kg\ H_2SO_4/t$)	Range ($kg\ H_2SO_4/t$)	Percent with ANC >100$kg\ H_2SO_4/t$
White mica schist	32	9-252	24
Hanging wall slate	31	5-455	27
Lode waste	13	5-398	28
Footwall slate	108	11-548	55
Footwall limestone	235	10-552	90

The calculation of NAPP represents the balance between a sample's acid potential and neutralisation capacity; this is sometimes also referred to as an acid-base account. The NAPP distribution for each of the lithologies is shown in Table 3.39. Samples representing calc-silicate, mafic feldspar porphyry, white mica schist and footwall limestone had a neutralising capacity that exceeded the acid potential, in many cases by large amounts (i.e. strongly NAPP negative). Footwall slate samples were NAPP negative, lode waste samples were predominantly NAPP positive and hanging wall slate samples were evenly divided.

Table 3.39 Net Acid Producing Potential

Lithology	Median ($kg\ H_2SO_4/t$)	Range ($kg\ H_2SO_4/t$)	Percent with +ve NAPP
Calc-silicate	-161	-688 to -9	0
Mafic feldspar	-72	-401 to -21	0
White mica schist	-31	-246 to 0	0
Hanging wall slate	10	-423 to 421	58
Lode waste	104	-187 to 500	78
Footwall slate	-71	-512 to 390	20
Footwall limestone	-195	-513 to 18	2

Acid Rock Drainage (ARD) Classification

The ARD classification criteria were as follows:

- ***Non-Acid Forming (NAF)*** – A sample was considered to be NAF it if had a negative NAPP and the sample did not acidify to any significant extent when oxidised with peroxide in the NAG test (i.e. NAG=0 or NAG=≥4.5). Although sulphides may be present in such samples, the inherent ANC is generally sufficient to neutralise any acid that might have been produced by sulphide oxidation.

- ***Potentially Acid Forming (PAF)*** – A sample was considered to be PAF if the NAPP and NAG were both positive. The exposure of such rock to atmospheric conditions is likely to result in sulphide oxidation, which in turn could result in tailings acidification.

- ***Uncertain (UC)*** – With some samples there was a disparity between the NAPP and NAG test results, and un such cases an *uncertain* (UC) classification was assigned. A disparity may

occur if the NAPP is negative but the sample acidifies to less that pH 4.5 in the NAG test, or when the NAPP is positive but it does not acidify under NAG test conditions. The former may occur when the ANC within a sample is not readily available, and the latter may occur when some sulphur occurs as sulphate or as sulphides that do not generate acid when oxidised. The ARD classification considered most likely was indicated in brackets e.g. UC(NAF) or UC(PAF).

The results of the ARD classification are shown in Figure 3.53, excluding the 18 samples from the AGC-Woodward Clyde (1991) study which did not include NAG testing. The ARD classification plot illustrates the concurrence of the NAPP and NAG test results. The majority of samples were plotted as either NAF or PAF. Only 5 samples could not be definitively classified due to conflicting NAG and NAPP test results. These five samples were tentatively classified as 3 PAF samples and 2 NAF samples.

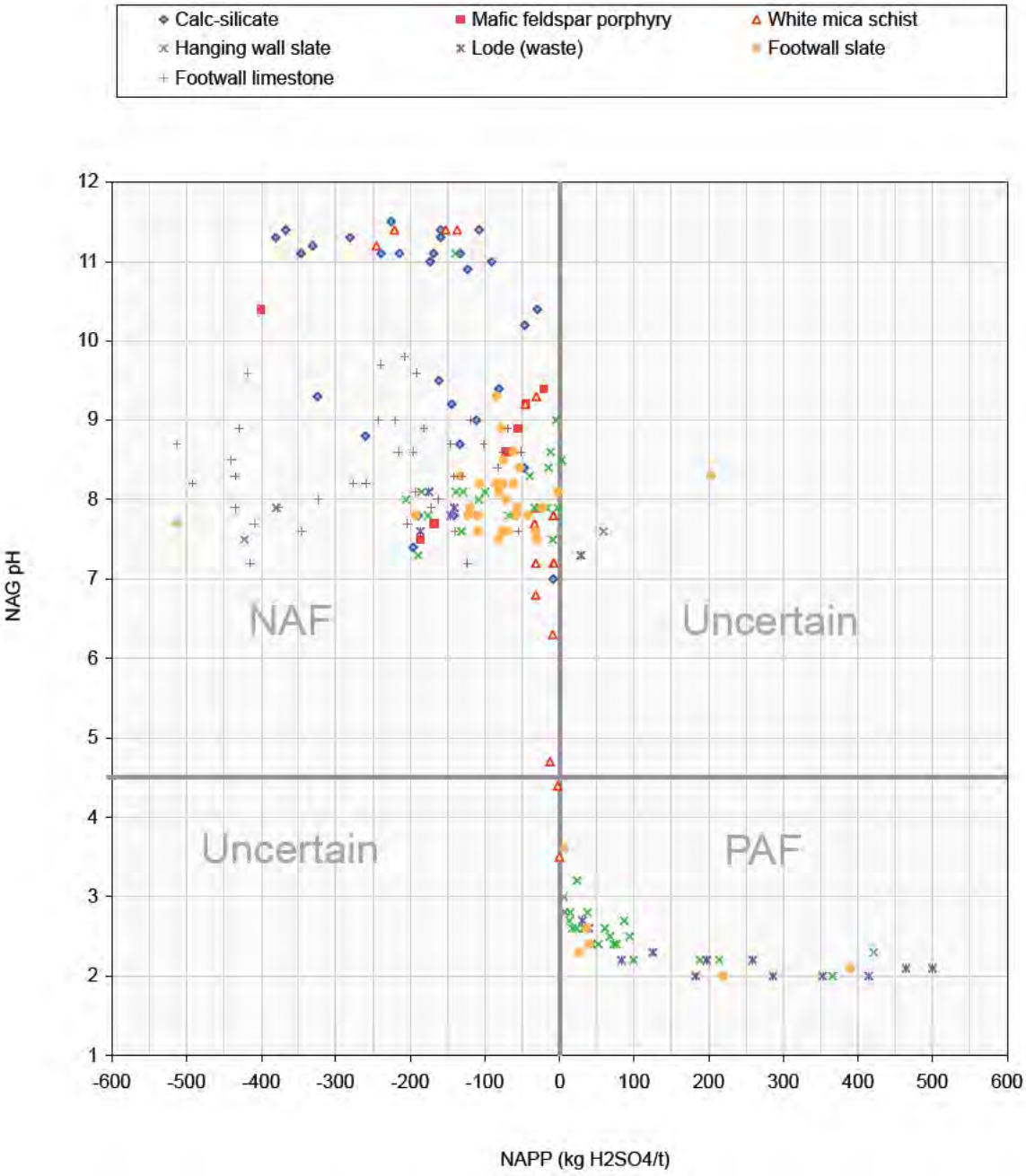


Figure 3.53 ARD Classification Plot for Dugald River Waste Rock

The distribution of the lithologies following classification is shown in Table 3.40 below.

Table 3.40 ARD Classification of Lithologies

Lithology	Total Samples	PAF		NAF	
		No.	%	No.	%
Calc-silicate	31	0	0	31	100
Mafic feldspar porphyry	7	0	0	7	100
White mica schist	17	2	12	14	88
Hanging wall slate	52	28	54	24	46
Lode waste	18	13	72	5	28
Footwall slate	44	9	20	35	80
Footwall limestone	42	1	2	41	98

The key acid forming characteristics of each lithology can be summarised as follows:

- Calc-silicate
    - Negligible sulphur and high to very high ANC
    - Virtually all likely to be NAF and most will have large excess of neutralising capacity due to high carbonate content
- Mafic feldspar porphyry
    - Low sulphur and moderate to high ANC
    - Only a small number of samples tested but results indicate this waste rock will be NAF, most with a considerable excess of neutralising capacity
- White mica schist
    - Low sulphur and variable ANC (from low to high)
    - Results suggest this waste rock will be predominantly devoid of sulphur and hence will be NAF but there is a possibility of some material with low ANC and slightly elevated sulphur to be PAF, albeit with a low capacity for acid generation
- Hanaging wall slate
    - Moderate to high sulphur content and variable ANC
    - Results indicate a major portion of this waste rock will be PAF, some with very high capacity for acid generation
    - There will also be some NAF rock which will be distinguished by having a high to very high ANC

- Lode waste
    - High to very high sulphur and variable ANC
    - Majority will be PAF with very high capacity for acid generation
    - Some NAF rock which will be distinguished by having a high to very high ANC
- Footwall slate
    - Moderate to high sulphur content and moderate to high ANC
    - Predominantly NAF but some rock with low ANC is likely to be PAF
- Footwall limestone
    - Moderate sulphur content and moderate to high ANC
    - Virtually all of this waste rock is likely to be NAF and will have a large excess of neutralising capacity

Main Findings

Overall, results for 211 samples were assessed. They included 31 samples representing calc-silicate, 7 mafic feldspar porphyry, 17 white mica schist, 52 hanging wall slate, 18 lode waste, 44 footwall slate, and 42 footwall limestone. The results for these samples suggest that:

- Waste rock from the calc-silicate, mafic feldspar porphyry, white mica schist lithologies associated with the mining of copper ore, and also waste rock from the footwall limestone lithology will be NAF, with the calc-silicate and footwall limestone likely to have high to very high neutralisation capacity.
- Waste rock from within the lode zone will almost invariably be PAF and have a high to very high capacity for acid generation if exposed to atmospheric conditions. It is also likely that some slate waste rock from the adjoining hanging wall and footwall will be pyritic and strongly PAF. Approximately 54% of the hanging wall slate samples tested, and 20% of the footwall slate samples tested were classified as PAF.

Elemental analyses of selected samples were also carried out to identify any enrichments that might be environmentally significant in terms of impacting on the quality of mine water and waste dump seepage. No significant metal or metalloid enrichments were identified in the calc-silicate, mafic feldspar porphyry and white mica schist but many of the hanging wall slate, footwall slate and lode waste samples were highly enriched with one or more of a range of environmentally important elements on comparison to concentrations typically occurring in background soils. The most prevalent enrichments were arsenic, cadmium and zinc. There was also less frequent enrichment with copper, lead, mercury, and selenium.

The enriched elements listed above form an elemental association that is commonly reported for a hydrothermal base metal deposit; hence their occurrence within the lode waste and the hanging wall and footwall slate adjoining the lode is expected. However, they are all regarded as environmentally important in terms of water quality, human health and/or aquatic life.

A series of batch extraction tests were carried out on selected samples to assess the potential for mobilisation of environmentally important elements under both acidic and neutral mine drainage conditions. Also, the results of column leach tests previously commissioned by AARC were reviewed to identify elements that might be released from different waste rock lithologies when exposed to atmospheric conditions. Elements that exhibited a higher propensity for release under oxidising conditions included zinc, lead, nickel, manganese, copper, cobalt, and to a lesser extent arsenic. However, significant releases of these elements were almost exclusively confined to PAF waste once acidification had occurred. With the NAF rock producing neutral drainage, the concentrations of environmentally important elements were typically at trace values only. Elements that showed little or no propensity for release regardless of pH included mercury, tin, chromium, selenium and antimony.

Erosion Testing

All NAF samples that were tested for Exchangeable Sodium Percentage showed low levels, indicating the materials are non-sodic and therefore non-dispersive. As the Electrical Conductivity of the samples was also very low these materials are unlikely to be susceptible to erosion. The Cation Exchange Capacity of the NAF materials were all high meaning the materials are relatively un-weathered and have a capacity to retain large amounts of cations against potential loss by leaching. These results indicate that all NAF materials are suitable for encapsulating PAF materials and for use on the outer slopes of the waste rock dumps.

Proposed Mitigation Strategies and Implications for Waste Rock Management

The results of waste rock studies suggest that most lode waste and some pyritic slate in the hanging wall and footwall adjoining the lode will have a high acid generating potential and consequently a high level of management will be required to limit sulphide oxidation and minimise the risk of ARD generation occurring if such material is brought to the surface and exposed to atmospheric conditions. Clearly, highly PAF waste should be preferentially used as underground fill where possible. For PAF waste that needs to be stockpiled temporarily at the surface, or permanently placed within a dump, it is recommended that mining and handling procedures are developed that will allow selective placement of PAF waste in a manner that minimises rainfall infiltration (to limit leaching) and oxygen ingress (to limit oxidation). Prevention or control of acid rock drainage within stockpiles or dumps of pyritic waste rock will require adoption of strategies that involve one or more of the following:

- In-situ neutralisation of acid generation via blending of PAF rock with other materials that are non-acid forming, in particular high carbonate materials such as the footwall limestone or hanging wall calc-silicate;
- Minimisation of pyrite oxidation processes within dumped PAF waste via:
    - Isolation and encapsulation of PAF rock within cells within the core of a dump or stockpile.
    - Prevention of convective air movement by constructing dumps in small, compacted lifts,
    - Excluded PAF rock from the area under the outer slope of dumps where convective air movement tends to be greatest;
    - Excluded PAF rock from the base layer of the waste rock dump and from existing drainage lines so that the under-drainage is not in contact with sulphidic mineralised

rock. To the extent possible, limestone or calc-silicate should be placed in drainage lines to impart some alkalinity to drainage prior to emergence at the dump toe.

  - Construction of intermediate or final barrier layers which limit oxygen diffusion. Progressive encapsulation of PAF rock using intermediate cover layers would reduce leaching of PAF rock during dump construction, and in the longer term such layers would also provide a source of alkalinity to any pore water moving down into PAF rock zones within a dump.

- Minimisation of acid drainage migration via:
  - Controls on surface drainage,
  - Incorporation of layers of low hydraulic conductivity.

The two key ingredients for pyrite oxidation are water and oxygen. Whilst it is generally best practice to divert surface waters away from dumps, and to place final cappings that minimise rainwater ingress, such measures are unlikely to produce a dump in which the moisture content is low enough to prevent sulphide oxidation. In the wet-dry climatic setting that occurs at the Dugald River site, the only practical mechanism for controlling sulphide oxidation will be to limit the movement of atmospheric oxygen into stockpiled material. This can generally be achieved by either burial and isolation of PAF rock within cells within the core of a dump, or by construction of an outer cover that incorporates a layer with a low air-filled porosity which will act as a barrier to inward gaseous movement. It is essential that any stockpiled waste rock remaining at the surface at mine closure has a final cover layer comprising only NAF material. Such a cover would serve as a revegetation layer and provide circum-neutral surface runoff.

3.6.4 Tailings Disposal

The thickener underflow slurry from the process plant will discharge at a solids density of approximately 50% to 55% w/w solids, and will be pumped to an intermediate storage tank. A pump-set consisting of four centrifugal pumps operating in a series configuration will transfer thickened tailings slurry to the TSF. Alternatively, if the mine requires the tailings for use as underground paste fill, the slurry will be redirected to a second tailings storage tank located at the paste plant facility.

3.6.4.1 Paste Fill Plant

The total tailings flow will be transferred to the paste plant (located as per Figure 3.54) whenever there is a requirement for paste fill underground. This will result in the tailings line being idle for periods between 8 hours and 55 hours, depending on the back fill requirement. The section of tailings line between the top of Knapdale Range and the TSF will free drain when the line is idle, so the system design will have capacity for any water or slurry which flows back down to the process plant.

The paste plant facility will be a stand-alone plant located on the surface near the mine's southern portal entry, to the west of the process plant. Paste backfill will be supplied to the mine via a borehole.

The paste plant will be required to provide a slow paste fill rate and a fast paste fill rate; these are equivalent to approximately 38% and 100% of instantaneous flotation tailings production. When the mine does not require paste fill, process plant tailings will be directed to the TSF. The peak solids feed flow treated by the paste filter will be approximately 185 tph. The two speed production will be achieved by operating either one or both the paste disc filters.

According to ATC the particle size distribution of the tailings stream is suitable to produce paste and no pre-treatment of the tailings stream such as size classification or addition of sand or aggregate is required.

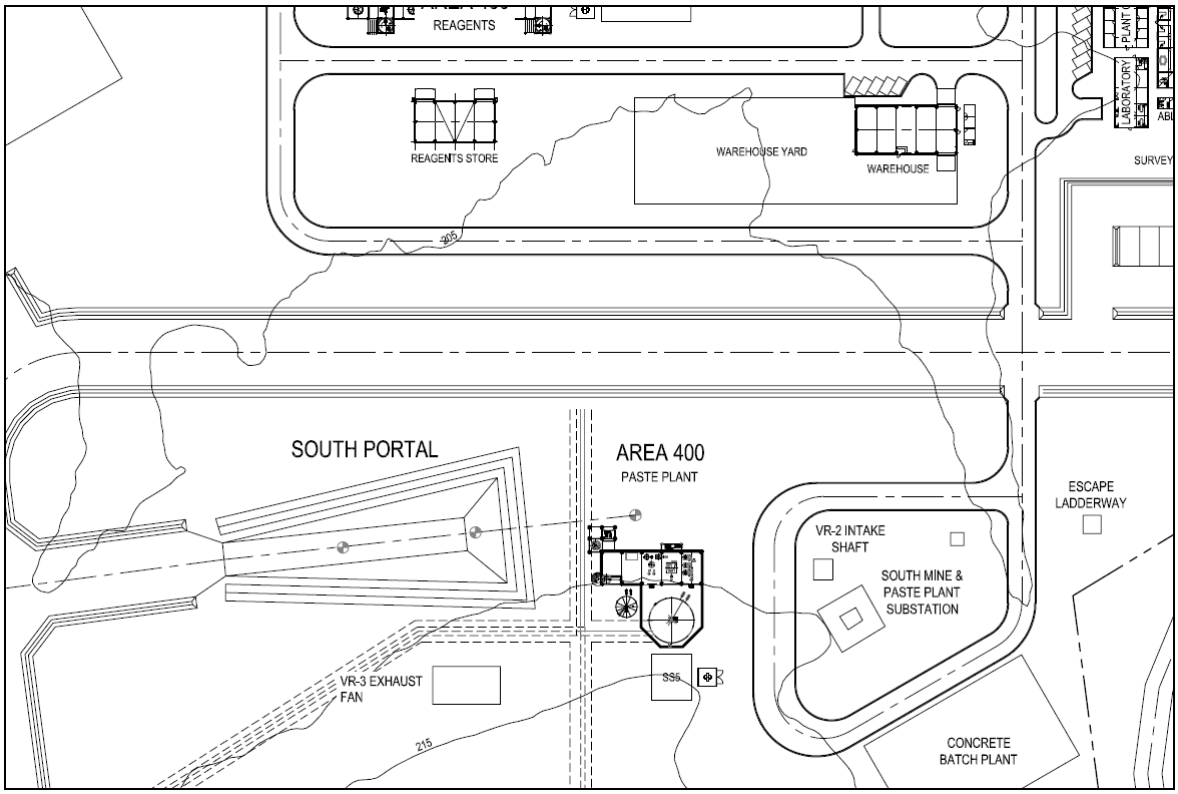


Figure 3.54 Paste Plant Location

A description of the paste plant process is described hereafter and the paste plant layout is shown in Figure 3.55.

Tailings Receipt

Thickened process plant tailings will be pumped from the from the process plant to a 1,575 m^3, agitated storage tank located at the paste fill production plant. The storage tank will be sized to provide sufficient tailings for the average first fill of each stope that needs a slow fill rate.

Tailings Filtration

Tailings slurry will be pumped from the agitated storage tank to two disc filters. The filter baths will be fitted with an internal overflow weir that ensures a constant slurry level in the filter bath.

The disc filters will consist of a slurry tank through which the discs rotate. A vacuum pump will produce a vacuum across the filter cloth fitted over the disc sectors and as the disc passes through the slurry tank, a cake will form on the surface of the disc cloth. The disc sector, complete with cake, will then cycle out of the bath. A vacuum will be maintained on the disc through to discharge. An air pulse will be applied to the disc ahead of the discharge point to expand the cloth and force the cake from the disc. The disc will then continue to travel back into the bath and the cycle is repeated.

Each filter will have a dedicated vacuum pump and filtrate-collection system. Each filtrate-collection system will consist of two filtrate receivers, one that collects liquid from the forming filter cake and a second that collects filtrate during cake drying. The filtrate will discharge from the filtrate receivers via barometric legs to a single seal tank that overflows to the filtrate tank.

Paste-mixing dilution water will be supplied from the filtrate tank, with excess water pumped to the process water tank.

Filter cake will discharge from the filter and fall onto a conveyor located beneath each filter. The conveyor will transport the filter cake to the feed end of a double screw pug mixer.

Cement Storage and Metering

Cement will be stored in two cement storage silos located next to the paste backfill plant. The cement will be pneumatically discharged from the cement transport tankers using an on-board dedicated air blower system.

Each cement silo will be fitted complete with dedicated rotary valve, weigh feeder and screw feeder to meter cement at the required rate to the double screw pug mixer.

Paste Mixing

The double-screw paste mixer (also known as a 'pug mixer') combines the filter cake, dilution water and cement to a homogenous mixture. The paste ingredients will be added at the feed end of the mixer and discharge as paste at the discharge end of the mixer.

Surface Paste Distribution

Paste discharging from the paste mixer will be collected in a hopper from where it will flow to the stopes that require filling. The current design does not include a paste-transfer pump and assumes that there is sufficient fall to allow adequate gravity transfer of paste. Should there be insufficient fall, a transfer pump will need to be added.

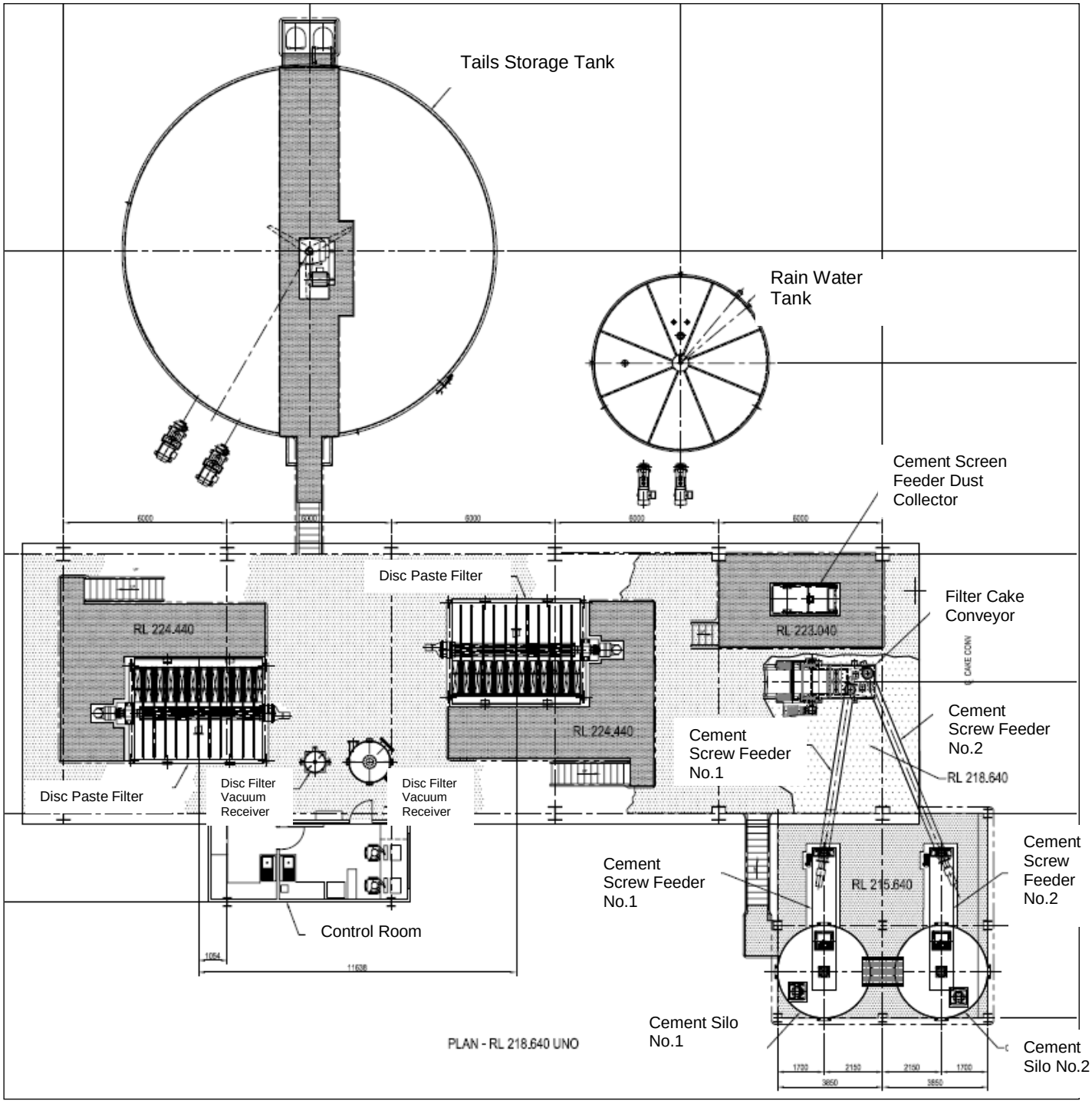


Figure 3.55 Paste Plant Layout

3.6.4.2 Tailings Storage Facility

ATC were commissioned to conduct the TSF study, with the objective being the investigation of storage options, analyses, design, costing and documentation of a working life of mine tailings storage scheme (Appendix K). Rehabilitation of the TSF will be discussed in Section 3.7.2.

The TSF design has been based on lead/zinc/silver ore reserves of approximately 47 Mt, processing up to 2 Mt per annum over a 26 year mine life. The total lead/zinc/silver tailings quantity for the TSF is 22.8 Mt of solids (41.6 Mt of slurry), assuming an overall proportion to underground paste backfill of 36.8%.

For a full description of the TSF construction and detailed TSF design drawings see Section 3.2.7.

The copper concentrator will produce approximately 19.5 Mt of copper tailings solids (35.5 Mt of slurry) over the anticipated mine life. The addition of copper tailings to the TSF starting in 2017 will therefore reduce the life of the current TSF design from 26 years to 15 years, meaning that before 2026, additional design work and permitting would be needed to increase the capacity of the facility. Any expansion of the TSF can be accommodated by the current location by raising the embankment walls and additional approvals would be sought for these works at the appropriate time. Tailings from copper ore are expected to have a lower MPA based on the lower average sulphur content of the copper ore (3.14%) resulting in lower sulphur content in copper tailings than in zinc/lead tailings. In addition, copper tailings geochemical testing would be conducted and the results submitted to the DERM prior to using the TSF for copper tailings disposal.

Knapdale Ranges Site

The chosen TSF site is a long, narrow bifurcated valley running north-south on the western side of the Knapdale Ranges (Figure 3.56 and Figure 3.7 in Section 3.1.2). The valley is approximately 4 km north-west of the processing plant. Tailings containment is almost entirely provided by the valley topography. The TSF will consist of a single large embankment on the western side, a down-valley discharge of tailings, and all decant and runoff water being stored centrally within the tailings impoundment (i.e. no secondary water storage pond).

Tailings will be pumped up into the Knapdale Ranges from the process plant, running alongside the access road to the accommodation camp. Discharge will occur on a rotational basis from both the southern and northern ends of the valley, such that the tailings beach low point is maintained in the centre of the valley, where the decant pond will form. Decant return will be via a floating pontoon tethered on the eastern side of the valley. A decant return pipeline and access road will be required to link the eastern side of the TSF to the Mine Camp. A self-shedding profile will be developed for rehabilitation and closure.

The Knapdale Ranges consist of competent, hard quartzite rock of low permeability. No significant groundwater resource is present, and there is no practical means of hydrogeological connectivity with the Cabbage Tree Creek catchment area to the west.

Alternative options for tailings disposal and a full justification for the chosen site are provided in Section 2.2.4.6.

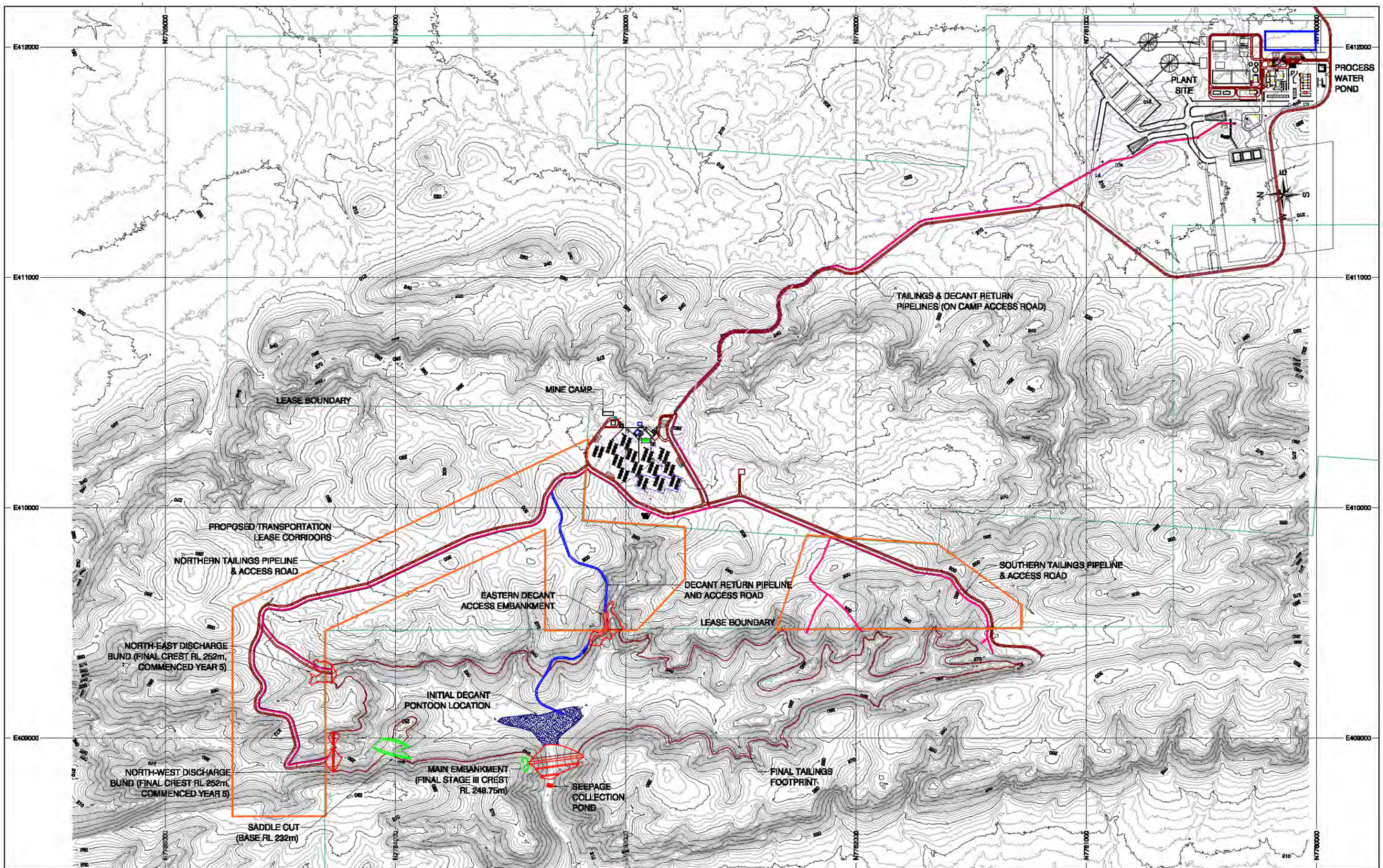


Figure 3.56 Overall Site Plan of Tailings Storage Facility

TSF Site Seismicity and Embankment Stability

A seismic analysis of the Dugald River TSF main embankment was undertaken and stability analyses performed. The governing design principle is that the embankment must be designed in a manner such that the integrity of the structure with respect to stability under static and seismic loading conditions is preserved. This assessment also included a probabilistic seismic hazard assessment of the region, conducted by the Seismology Research Centre in Australia. All identified faults where incorporated into the seismotectonic model.

Using the design criteria and the USCE seismic screening approach, the proposed embankment design was found to comply in terms of all static and seismic loading cases.

The observed basis earthquake (serviceability loading) minimum factor of safety for the upstream slope was found to be 1.41 during Stage 1, whilst for the downstream slope a minimum factor of safety of 1.41 was also obtained when the embankment is raised to Stage III. Given that a FS of 1.0 using the USCE method indicates negligible rockfill deformation, these results are considered satisfactory.

The results for the maximum design earthquake cases are all greater than 1.0, indicating that deformations would not be expected during the extreme loading case. As a result, no further analyses would be required for this embankment option.

Physical Properties of Lead/Zinc/Silver Tailings

Prototype, bulk floatation tailings samples were prepared at Amdel Mineral Laboratories, and shipped in May 2008 to the National Association of Testing Authorities (NATA) accredited ATC laboratory in Melbourne for the characterisation of their physical properties. Test work has included basic characterisation tests (particle density, plasticity) and specialised tailings testing (initial and shrinkage limit density, rheology, Rowe Cell consolidation).

The following is a summary of the tailings physical properties resulting from the test work:

- Specific Gravity (SG) – 2.96;
- Particle Size Distribution – P_{80} approximately 50 µm;
- Atterberg Limits:
    - Liquid Limit = 21; and
    - Plasticity Index = 6.
- Unified Soil Classification – Low plasticity Silt; and
- Segregation Threshold – 46% solids.

The adopted tailings design density parameters are presented in Table 3.41.

Table 3.41 Adopted Tailings Density Parameters

Discharge Solids Content (%)	Sedimented Density		Shrinkage Limit Density (t/m^3)
	Solids Content (%)	Density (t/m^3)	
50	66	1.18	1.63
55	67	1.20	

Settling and Consolidation Characteristics

In general, the density of tailings increases with time. The increase in density is a result of three processes: sedimentation, consolidation and desiccation.

Sedimentation occurs soon after discharge and results in the liberation of free water, which is referred to as bleed water.

Consolidation is a time dependent process whereby water is "squeezed" from the pore spaces in the tailings due to their self weight.

Desiccation occurs when the rate of evaporation exceeds the rate at which consolidation water is expelled from the tailings surface. The dry density caused by desiccation, at the tailings surface, can be estimated from laboratory testing and is called the shrinkage limit density. This density has been estimated at 1.63 t/m^3 for Dugald River tailings.

As deposition continues, the addition of tailings will eventually lead to further consolidation and resultant increase in density.

Consolidation modelling has been carried out for the Knapdale Valley TSF. The major inputs to the model are:

- Tailings discharge rate;
- Discharge solids content;
- Sedimented solids content;
- Impoundment geometry;
- Consolidation parameters; and
- Boundary conditions;

Figure 3.57 presents the computed dry density profile for the tailings adjacent to the Main Embankment at the end of mine life. The shrinkage limit density is also shown in Figure 3.57.

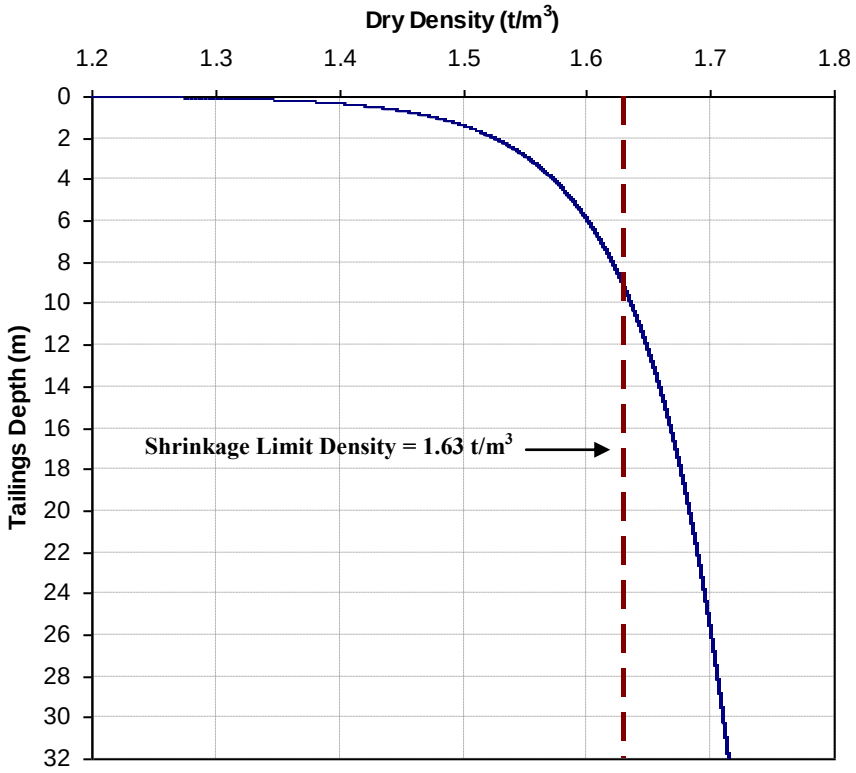


Figure 3.57 Normally Consolidated Tailings Density Profile

Points of note include:

- The tailings will be at least normally consolidated during the majority of the deposition period, and that there will be minimal post deposition settlement. This is due to the following:
    - The typical depth of tailings required to exceed the shrinkage limit density is approximately 9 m. Under normal operating conditions the dry beach area will develop a crust relatively quickly, and desiccation, accompanied by surface cracking, will commence.
    - It is important to note that the consolidation profile shown in Figure 3.57 neglects the desiccation effects of evaporative drying on the exposed beach. If the Shrinkage Limit Density is superimposed on the profile shown in Figure 3.57, it can be expected that most of the shallow tailings will achieve a significantly higher density than the normally consolidated profile, as a direct consequence of evaporative drying.

TSF Water Balance

Water modelling was done for the TSF using the full set of all annual rainfall data recorded for Cloncurry (121 years). Various 26 year periods were selected to model different scenarios. Sets selected include the 26 year periods with the:

- Highest total rainfall over the period (1987-2002);
- Lowest total rainfall over the period (1957-1972);

- Highest single year rain fall over the period (1974 – 1175.4mm);
- Lowest single year rainfall over the period (2008 – 128.8mm); and
- Average total rainfall over the period.

The modelling indicated that the maximum wet season excess water volume accumulating in the TSF is approximately 2,000 Ml, which will pond for extended durations to depths of up to 10 m at the main embankment. This result is driven by two extremely wet five year sequences in the rainfall database. The frequency and duration of a more realistically expected volume of 600 Ml was assessed, revealing an average of five occurrences for a total duration of between 10% and 20% of the 26 year mine life.

From tailings consolidation modelling, the tailings are expected to have relative rapid consolidation characteristics, even when sub-aqueous deposition over the life of mine is assumed. Given the conservative design density adopted for sizing the TSF and staging the Main Embankment construction, the possibility of sustained flooding of the beach is not expected to have any long term effect on the tailings storage concept or the overall tailings insitu density.

Design Storage Allowance and Emergency Spillway

The TSF study has been based on the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995). These guidelines state that the TSF must have available a sufficient volume on November 1st of any year to store the DSA, which in this case is due to rainfall totalling 1,083 mm, plus the process water inputs.

The TSF will have a catchment of 335 ha, with no diversion drains. This large catchment is however a benefit of the site, in that it can be used to collect and temporarily store runoff during the wet season for use in the process plant. Assuming no runoff losses in the 335 ha catchment, two month's average wet season pond evaporation, plus two month's tailings bleed water, the Knapdale Valley TSF DSA is estimated to be 3,250 Ml.

In accordance with the specifications for a High Hazard TSF, the design criteria for an emergency spillway is that it has sufficient capacity to pass the critical duration, 1 in 10,000 year Annual Exceedence Probability (AEP) flood, assuming that the tailings are at the minimum freeboard level at the end of the particular stage.

However the flood capacity of each Stage of the TSF is dominated by the DSA management requirements. The minimum freeboard for each Main Embankment stage is between 8 m and 11 m, in order to provide storage for the 3,250 Ml DSA volume.

The 1 in 10,000 year rainfall for various durations is shown in Table 3.42, together with the DSA and the resultant volumes generated from the TSF catchment.

Table 3.42 Comparison Of 1 In 10,000 Year And DSA Flood Data

Event	1 in 10,000 Year AEP						DSA (1 in 100 Year)
Duration	2 hr	6 hr	12 hr	24 hr	48 hr	72 hr	2 month
Rainfall (mm)	316	470	580	675	810	920	1,089
Runoff Volume (MLl	1,058	1,574	1,943	2,261	2,696	3,082	3,250

It is considered that the critical duration flood for the TSF would be in the range 6 to 12 hours, depending on what pond level was assumed at the beginning of the storm event.

Significant capacity exists beyond the DSA at minimum freeboard level for each stage. This can be demonstrated by assuming the critical duration spillway design event was 12 hours. From Table 3.42 and Figure 3.58 it is evident the TSF would have sufficient flood capacity to store the resultant runoff volume, even if the initial pond volume was as high as 1,500 Ml.

However, for the purposes of this study, it is considered a sound defensive design policy to include an emergency spillway for each stage, to prevent the embankment from overtopping during a flood event exceeding the design AEP. These spillways will consist of 15 m wide channels cut into the Main Embankment abutments. The spillway discharge capacity at a peak flood height of 0.5 m is estimated to be 10 m^3/s.

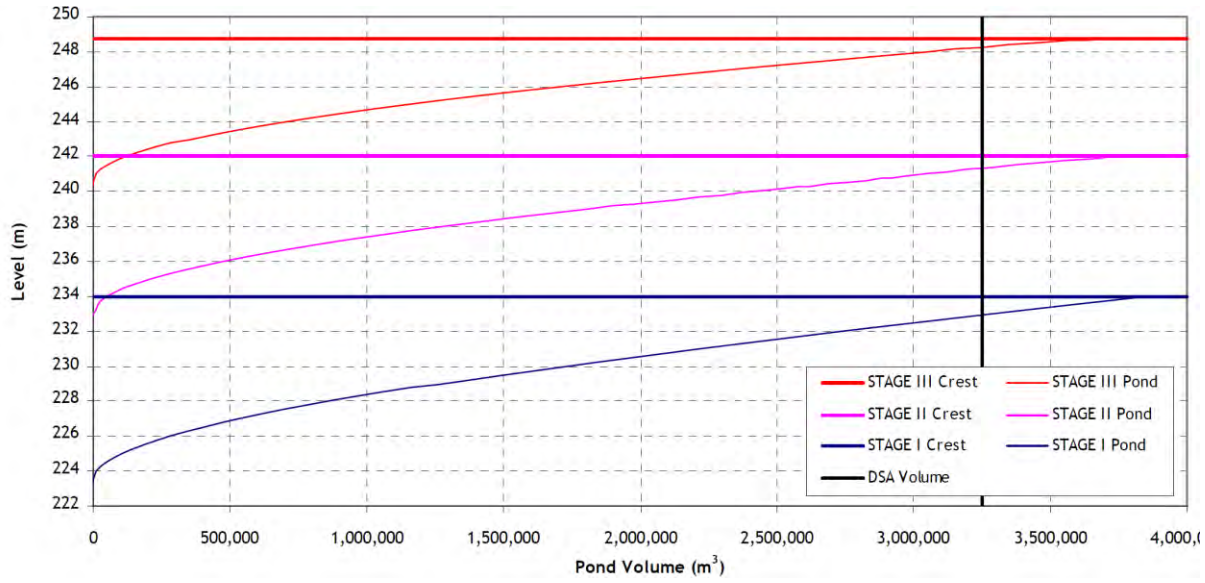


Figure 3.58 TSF Decant Pond Storage at End of Each Stage

TSF Design and Operation

Based upon total tailings tonnage of 22.8 Mt at an overall insitu dry density of 1.5 t/m^3 at the end of filling, the required life of mine TSF capacity is 15.2 million m^3.

In addition to the main embankment, additional structures are required in the northern and eastern sides of the TSF. These structures are designed to constrain the stored tails to within tenure controlled by MMG. MLs for Transportation will be applied for so that pipes and roads can be installed on the tenure not controlled by MMG, but the actual storage of tailings cannot occur on these leases.

On the eastern side, Embankments 1 and 2 will be constructed of rock fill and are designed such that surface runoff water will not pond behind these structures, rather, water will flow over them to collect in the main tailings storage area. Embankment 2 will also be used as the access from the top of the Knapdale Range, down to the floor of the tailings storage area to access the decant pumps and for locating the decant return pipeline.

Embankments at the northern end of the TSF will be required in later years when the tailings surface has risen sufficiently. The embankments are saddle dams and both will have the potential to pond runoff water behind them. For the western dam, a deviation trench will be constructed so that runoff can drain away to the north, whereas for the eastern structure, a pump will be installed to pump the ponded water over the embankment, into the main tailings storage area.

Tailings will be discharged down-valley from outfalls at both the north and south ends. Switching between the two discharges will need to be managed so that the beach and pond location remains centrally located against the main embankment wall. Multiple discharge points at both ends will permit discharging into different small valleys so that the surface of the solids tailings is kept free draining toward the centre and areas of ponding are not developed up blind valleys.

With the decant pond staying relatively in the same position against the main embankment, only a single decant pumping location is required. Decant return to the plant will be from a centrally located floating pontoon and pipeline.

Although no seepage is anticipated, a seepage collection pond and monitoring bores (already installed) will be constructed in the creek downstream of the main embankment to provide a monitoring location for any potential seepage, either through the main embankment or by groundwater.

TSF Geotechnical Investigation

A geotechnical investigation was carried out on the TSF site in November 2008 by ATC (see Appendix J for full report) and following is a summary of the study's findings.

General Foundation Conditions

The alignment of the TSF main embankment was found to have a subsurface stratigraphy consisting of moderate to high strength, highly weathered to moderately weathered quartzite (metamorphosed fine grained sandstone).

The rock was typically highly fractured within the upper 5-10 m with a weathering profile that was generally shallower on the abutment slopes and became deeper towards the gully floor. The highly

weathered quartzite rock was considered a satisfactory foundation material for the proposed embankment in terms of strength and deformability.

At the entrance to the gully in the vicinity of the embankment upstream toe, up to 1.5 m of colluvial-alluvial clayey, sandy gravel was found to overly the quartzite. Test pit excavation in this area penetrated up to 2.6 m in depth which is the likely maximum foundation stripping depth that will be necessary to reveal competent rock, although it is likely that the depths will decrease to a minimum of 1 m on the abutments and towards the downstream toe.

Stability studies were conducted to which show that the embankment structure will maintain its integrity under static and seismic loading conditions and that factors of safety will meet or exceed the allowable factors.

Although a geotechnical investigation of the site is ongoing, reconnaissance indicates it is well suited to the proposed TSF. The floor and sides consist of competent, hard quartzite rock of low permeability and no significant underlying groundwater resource is expected.

Permeability and Groundwater

The rock mass permeability of the quartzite rocks were generally considered low to moderate beneath the gully floor and at the south abutment of the main embankment, and low at the north abutment. It was evident from the results of the investigation that the rock mass permeability is independent of the weathering profile but is mostly influenced by the degree of jointing and fracturing.

With these results, a programme of foundation curtain grouting will be required prior to the construction of the main embankment. A supplementary geotechnical investigation will be required to better define the actual extents of this programme. Preliminary indications are that the curtain will need to extend to a depth of 10-15 m in areas of moderate permeability.

The groundwater conditions at the embankment site were difficult to establish but it is considered likely that groundwater can flow locally in the joints and defects within the rock mass, typically within 10 m below the surface of the gully floor. A series of monitoring bores have been installed downstream of the main embankment and these will be used to establish the local groundwater table.

3.6.4.3 Geochemical Characterisation of Tailings

The geochemical characterisation of the Dugald River tailings has been completed by EGi (contained in Appendix I) and the results are summarised below. The characterisation of the tailings included testing of the following parameters:

Tailings Liquors

- pH, alkalinity and electrical conductivity (EC);
- Multi-element analysis;

Tailings Solids

- Multi-element composition;
- Total sulphur content;

- Sulphur and carbon forms;
- Maximum potential acidity (MPA);
- Acid neutralising capacity (ANC);
- Carbonate neutralising value (CNV);
- Net acid producing potential (NAPP);
- Net acid generation (NAG) capacity; and
- Acid buffer characteristic curve.

The full description of analytical procedures, methodologies and results is contained in the full report in Appendix I. A summary of the geochemical characteristics of the tailings is summarised herafter.

Composition of Tailings Liquor

The tailings liquor was circum-neutral (pH 7.3) and moderately alkaline (53 mg $CaCO_3$/L). The major ion chemistry was dominated by sulphate (1,310 mg/L), chloride (714 mg/L) and sodium (175 mg/L). There were also high concentrations of calcium, magnesium and potassium.

Amongst the trace elements there was some soluble manganese, lead and zinc, but the concentrations of other environmentally important elements were relatively low. The low concentrations of dissolved metals are consistent with solubility constraints commonly observed under pH neutral conditions.

Composition of Tailings Solids

Geochemical Abundance Indices (GAIs) were calculated for each element. The GAI compares the actual concentration of an element in a sample with the median soil abundance (Bowen, 1997; Berkman, 1976) for that element. The main purpose of the GAI is to provide an indication of any elemental enrichment that may be of environmental importance.

The GAI are integer increments (0 through to 6) and as a general rule, a GAI of 3 or above is considered significant and may warrant further examination.

The assay results confirm the presence of high concentrations of sulphur (7.9%), lead (0.99%) and zinc (2.6%) within the tailings solids.

In addition to the resource metals, the tailings were also significantly enriched (i.e. GAI≥3) with a number of non-resource elements including antimony, arsenic, bismuth, cadmium, mercury and molybdenum. All of these elements are part of the general elemental association reported for hydrothermal sulphide ores, hence their occurrence within the tailings is not remarkable.

There was also minor enrichment (GAI = 1 or 2) relative to background soil with chromium, copper, nickel, selenium and uranium.

Metals such as copper, cadmium, nickel and zinc are highly mobile under acidic conditions and elevated concentrations of these metals would be expected within tailings pore water if the tailings

were to acidify below pH 6.5. There is also potential for mobilisation of semi-metals such as arsenic and antimony, although the geochemical behaviour of such elements are more difficult to predict as their solubilities in geological systems are usually controlled by adsorption or co-precipitation reactions involving other elements such as iron at lower pHs and calcium at higher pHs.

Acid Forming Characteristics of Tailings Solids

The results (shown in Table 3.43) confirm that the tailing solids have high pyritic-S content and a correspondingly high capacity for acid generation. Based on the NAPP and NAG test results the Dugald River tailings were classified as PAF.

Table 3.43 Acid Forming Characteristics of Tailings

Parameter	Unit	Result
Total Sulphur	%S	7.9
- Acid Soluble Sulphur	%S	6.9
- Acid Insoluble Sulphur	%S	1.0
Total Carbon	%C	4.7
- Carbonate Carbon	%C	4.1
- Acid Insoluble Carbon	%C	0.6
Carbonate Neutralising Capacity	kg H_sSO_4/t	47
Acid Neutralising Capacity	kg H_sSO_4/t	54
Maximum Potential Acidity based on Total-S	kg H_sSO_4/t	241
Total Acid Generated using modified NAG test	kg H_sSO_4/t	140
Net Acid Producing Potential	kg H_sSO_4/t	86
ARD Classification	kg H_sSO_4/t	PAF

The results indicate that the ANC of the Dugald tailings is considered to be within the low to moderate range for process tailings.

The neutralising characteristics of the tailings solids were investigated further by defining the acid buffer curve. The curve provides a measure of the buffering provided by more soluble carbonates within a sample, with the readily available fraction typically defined as the amount of acid neutralised by a sample above pH 6. The acid buffer curve indicated that some of the ANC is not readily available and may only react once the tailings have acidified. This means that the actual capacity of the ANC to delay the onset of acid conditions in the event that the tailings are exposed to atmospheric conditions is likely to be considerably less than what would normally be expected.

The tailings had a strongly positive NAPP result and it is expected that the tailings will be potentially acid forming.

Column Leach Test

A column leach test was set-up to assess the geochemical behaviour of the tailings over the longer term. Photo Plate 3.2 shows the setup of the column leach test. The column comprised approximately 2 kg of tailings and was leached under free-draining conditions on a four-week leach cycle.

The column leach test ran for 52 weeks and comprised a total of 13, four-week cycles.



Photo Plate 3.2 Column Leach Test Setup

The ANC of the tailings determined in the static testing would normally be expected to delay the onset of acid conditions by at least several years. However, the column test results indicate that the reactivity of some sulphides within the tailings is of such high magnitude that the rate of acid generation when tailings are first exposed to atmospheric conditions exceeds the reactivity of the carbonates contributing to the ANC. The tailings returned to pH neutrality toward the end of the 52 week test period, however, given the strongly positive NAPP and NAG values, it is expected that the tailings would eventually re-acidify with long-term exposure to atmospheric conditions. This lag period is estimated at 7 years before the tailings would re-acidify and then continue to generate leachate with elevated sulphate for a number of decades.

The main environmentally important metals that were release from the tailings during the column leach test were zinc, manganese, lead and cadmium. The concentrations of these metals were typically one or two orders of magnitude high that corresponding metal concentrations in the tailings

liquor. This represents significant mobilisation from the solid phase as a consequence of sulphide oxidation and the initial acidification of the tailings.

3.6.4.4 TSF Monitoring and Management

Monitoring

Monitoring requirements for the Knapdale Valley TSF would be relatively straight-forward due to the configuration of the storage. A system of sub-regional groundwater monitoring bores have already been installed downstream of the main embankment to the west of the TSF, as part of a site-wide groundwater monitoring strategy. It is proposed that these will be monitored on a monthly basis.

The purpose of these bores will be to:

- Initially, provide data on the presence, depth, quality and flow direction of groundwater in the area; and

- During TSF operation, provide an indication of broad scale groundwater fluctuations, such that any impacts on the groundwater regime brought about by the TSF can be monitored.

Given that the main embankment will be constructed of free-draining rock fill with a GSS on the upstream face, a phreatic surface will not develop, even if a concentrated leak in the GSS were to occur.

Standpipe piezometers will hence not be required in the completed main embankment, as any seepage would flow along the foundation, and accumulate in the collection pond downstream of the embankment. The collection pond would be inspected as part of routine weekly surveillance, however it is expected to remain dry (i.e. not register any seepage) under design conditions, except for collected uncontaminated surface runoff from the catchment outside the TSF.

Survey monuments would be installed on the crest and downstream berms of each stage of the Main Embankment to monitor settlement of the fill materials.

Observations

Observation requirements for the Knapdale Valley TSF would involve routine daily and weekly inspections, as well as mandatory annual audits. The focus of such surveillance will be as follows:

- Daily Inspections – Focus on operational issues to do with the TSF, including inspections of the tailings pipelines, discharge point management, decant pond location and decant system operation;

- Weekly Inspections – Focus on issues that may develop over time and may impact on the safety of the TSF or the environment. These include detailed inspections of the Main Embankment and all appurtenant structures, tailings beach development and decant pond level, and surveillance of all monitoring installations; and

- Annual Audits – These are conducted by a qualified dam engineer, and focus on the identification of deficiencies by visual examination of the TSF embankments and all appurtenant structures, as well as a review of all surveillance and monitoring data.

Operation and Maintenance Manual

An Operation and Maintenance Manual would be prepared for the TSF in accordance with the regulatory requirements for High Hazard tailings facilities. This would include instructions and forms to cover all necessary monitoring, daily and weekly routine inspections and surveillance activities.

Tailings deposition and decant management procedures would also be documented. The Manual would contain a section on emergency response, and would be an integral part of the overall risk management plan for the facility itself and the mine overall.

3.6.5 Solid Waste Disposal

3.6.5.1 Rubbish Disposal Site

The rubbish disposal site (landfill) for general waste will be located in the area west of the gravel/clay borrow pit, which will initially be cleared for stockpile fingers of screened materials. These piles will not be required upon the completion of construction. The location is shown in Figure 3.59.

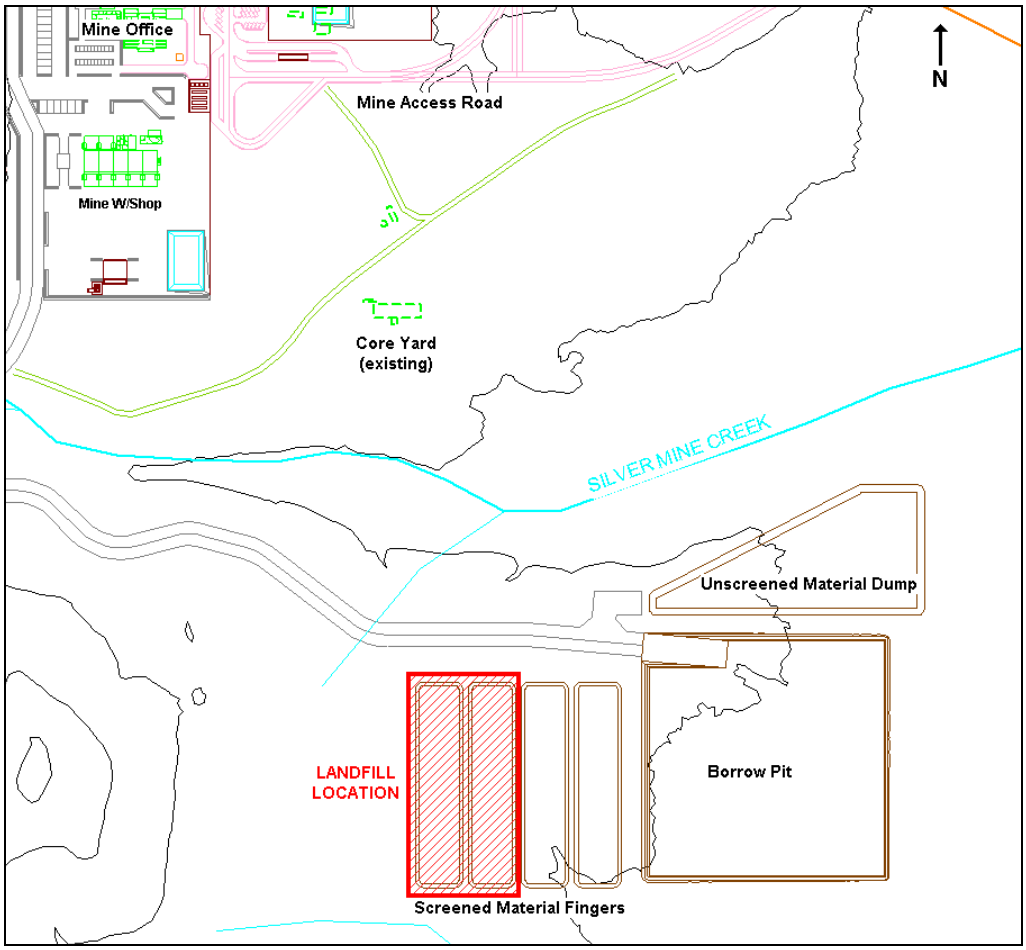


Figure 3.59 Location of Rubbish Landfill

The rubbish disposal site will meet the following location criteria in accordance with the DERM Ecoaccess Guideline *Landfill Siting, Design, Operation and Rehabilitation*:

- Located at least 100 m from surface waters and the 100 year flood plain;
- Located at least 500 m from a noise, dust or odour sensitive place;
- Located at 100 m from any unstable areas;
- Located at least 1,500 m from an aerodrome for piston-engines propeller-driven aircraft; and
- Located at least 3,000 m from an aerodrome with jet aircraft.

The rubbish disposal site will not be placed:

- Within 100 m of geologically unstable areas such as fault lines displaced in the Holocene period;
- In areas of slopes greater than 10%; or.
- In an area prone to subsidence in underground mining areas.

The odour at the rubbish disposal site will be controlled by covering the waste with soil or rock on a regular basis (at least weekly). To reduce the active face of the rubbish disposal site, that site will be developed in a series of cells to be compacted and covered on a weekly basis.

Leachate management will include a liner and leachate drainage layer, and leachate collection and evaporation ponds to stop potential contaminants reaching the groundwater table. An earthen liner consisting of a prepared sub-base, compacted clay layer and leachate drainage layer will be used. The following specifications will be used for liner layers:

- Clay Layer should equal at least 600 mm thickness, placed in at least two lifts on a prepared sub-base, achieving a maximum permeability of not greater than 1×10^{-9} m/s;
- A leachate drainage layer capable of maintaining the level of leachate over the upmost layer in the liner at not greater than 300 mm; and
- The sub-base layer should consist of hard-fill material such as clean rock and soil (possibly from earthmoving in the construction stages of the Project). The sub-base should be well-consolidated and geo-technically stable ready for the compaction of the clay layer above it.

Leachate draining out of the rubbish disposal site will be collected and evaporated in a pond or disposed of to the TSF.

It is assumed that each person will create 1.5 t of general waste for disposal at the rubbish disposal site per annum. With a maximum of 400 personnel on site at any one time the amount of general waste created will be approximately 600 tpa. The rubbish disposal site will be monitored through visual assessments and groundwater quality monitoring. Groundwater monitoring bores will be located in close proximity to the landfill site and regular monitoring will ensure any leachate in groundwater will be detected.

The landfill cells will replace the two western fingers for screened material. Each cell will be 135 m long x 35 m wide and 2.5 m high. Assuming that 80% of the total volume will be able to be used for landfill storage (the remainder will be consist of the material used to construct and cap each cell), the two cells will provide capacity for 23,800 m^3 of rubbish. This is sufficient for the maximum expected volume over the life of the Project.

In the event that the current assumptions made to determine required volumes are imprecise, the landfill could easily be extended to take in a third stockpile finger if and when required.

3.6.6 Liquid Waste

The main liquid wastes created by the Project are:

- Truck washdown water;
- Sewage and grey water;
- Dewatering water from underground;
- Stormwater runoff from disturbed area; and
- Contaminated process and tailings water.

3.6.6.1 Truck Washdown

A sediment pit will remove solids from wash down water at the vehicle washdown pad which will be periodically cleaned out and the sediment disposed of in an area in the NAF/PAF waste rock dumps. An oil-water separator pad will remove oils and petroleum products from the washdown water with the clean water being collected in an evaporation pond.

Waste oil from the oil-water separator pad will be collected in a bulk waste oil storage tank and removed from site by a licensed waste contractor.

3.6.6.2 Sewage and Grey Water

A modular waste water treatment plant will be constructed at the process plant to treat effluent from ablution, crib room and toilet facilities. A second modular waste water treatment plant will be constructed at the accommodation camp to process sewage and grey-water waste in independent facilities. Waste from the waste water treatment plants will be discharged to the TSF or the grey-water may be used for subsurface irrigation of the gardens at the accommodation camp.

Sewerage treatment and waste water management during construction is described in Section 3.2.2.1 whilst operational plans are further described in Section 3.5.5

3.6.6.3 Dewatering Water

Water from the dewatering operations underground will be discharged into the tailings thickener. From this point, the solid and water components will be managed as per the tailings stream, with solids and some water being sent to the TSF or underground as paste fill, and the remaining water being recycled in the process water stream.

3.6.6.4 Contaminated Stormwater, Process and Tailings Water

Contaminated process and tailings water will be recycled into the process water circuit for re-use as discussed in Section 3.5.3.2. The processing water circuit will recycle 1,031 m^3/h directly from the processing plant and 51 m^3/h from the TSF.

Water will be conserved as much as possible by recycling decant water from the tailings storage facility to the process water tank. A floating pump at the TSF pumps decant water to the process water tank via a head tank located near the accommodation village on top of the Knapdale Range. Water is gravity-fed from the tank to the plant site

A conceptual water balance diagram is provided in Figure 3.42.

The quality of water collected from the TSF is discussed in Section 3.6.4.3 in relation to pore water quality in tailings.

The stormwater management system (discussed in Section 3.5.4) will separate clean, dirty and contaminated stormwater run-off. Dirty and contaminated run-off will be directed to purpose built ponds and dams. If necessary contaminated stormwater can be re-used in the processing circuit or pumped to the TSF for disposal.

Any run-off from the landfill will be collected in drainage channels and directed to an evaporation pond.

3.7 REHABILITATION AND DECOMMISSIONING

The Final Land Form and Rehabilitation Plan (AARC 2010) is provided in Appendix L and full details of rehabilitation procedures, and pre and post mining land forms are described in that plan. A summary is provided in this Section.

The Final Land Use and Rehabilitation Plan has been developed with reference to *Guideline 18: Rehabilitation Requirements for Mining Projects* (QEPA 2008). The *Leading Practice Sustainable Development Program for the Mining Industry* series of booklets have also been used in developing specific rehabilitation strategies, especially the following booklets:

- *Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure and Completion* (Commonwealth of Australia, 2006a);
- *Leading Practice Sustainable Development Program for the Mining Industry – Mine Rehabilitation* (Commonwealth of Australia, 2006b); and
- *Leading Practice Sustainable Development Program for the Mining Industry – Tailings Management* (Commonwealth of Australia, 2007).

The following are proposed as the rehabilitation objectives for the Project:

- Return the majority of disturbed land to a condition similar to the pre-existing condition of low intensity grazing or native habitat or to an agreed beneficial use;
- On rehabilitation of the Project, make disturbed areas stable to ensure that the proposed subsequent land use is not compromised by surface instability or erosion; and
- Ensure that constructed landforms are geo-chemically stable to the extent that they do not impact on surface water or groundwater quality.

Rehabilitation trial work during the operational phase of the Project will be conducted to provide further information to select the most appropriate rehabilitation techniques suited to the local environment and landforms. The rehabilitation strategy will remain flexible and will be amended as new rehabilitation techniques become available.

Progressive rehabilitation on the Project site may be constrained by the operational requirements of the Project. There may be some areas that can be rehabilitated after construction works are finalised, but due to the nature of underground mining there is likely to be only small area available for progressive rehabilitation during the operational phase of the Project. These areas are mainly likely to be associated with the outer slopes of the NAF/PAF waste rock dump. Most of the NAF waste rock will be removed on closure for use in rehabilitating the TSF.

The final rehabilitated landforms to remain on closure are shown in Figure 3.60, 3.61 and 3.62. The NAF/PAF waste rock dump and TSF will require specific rehabilitation earthworks prior to revegetation. These earthworks are described in Sections 3.7.2 and 3.7.3. For other disturbed areas of the Project site all infrastructure will be removed (where not required by the landholder), any contamination removed, the area re-shaped if required and topsoiled, ripped, seeded and fertilised. Sections 3.7.2 to 3.7.14 describe the conceptual rehabilitation methods that will be used for the different land disturbance areas.

Topsoil stripping and stockpiling during construction and operations will be conducted as described in Section 4.2.2.2.

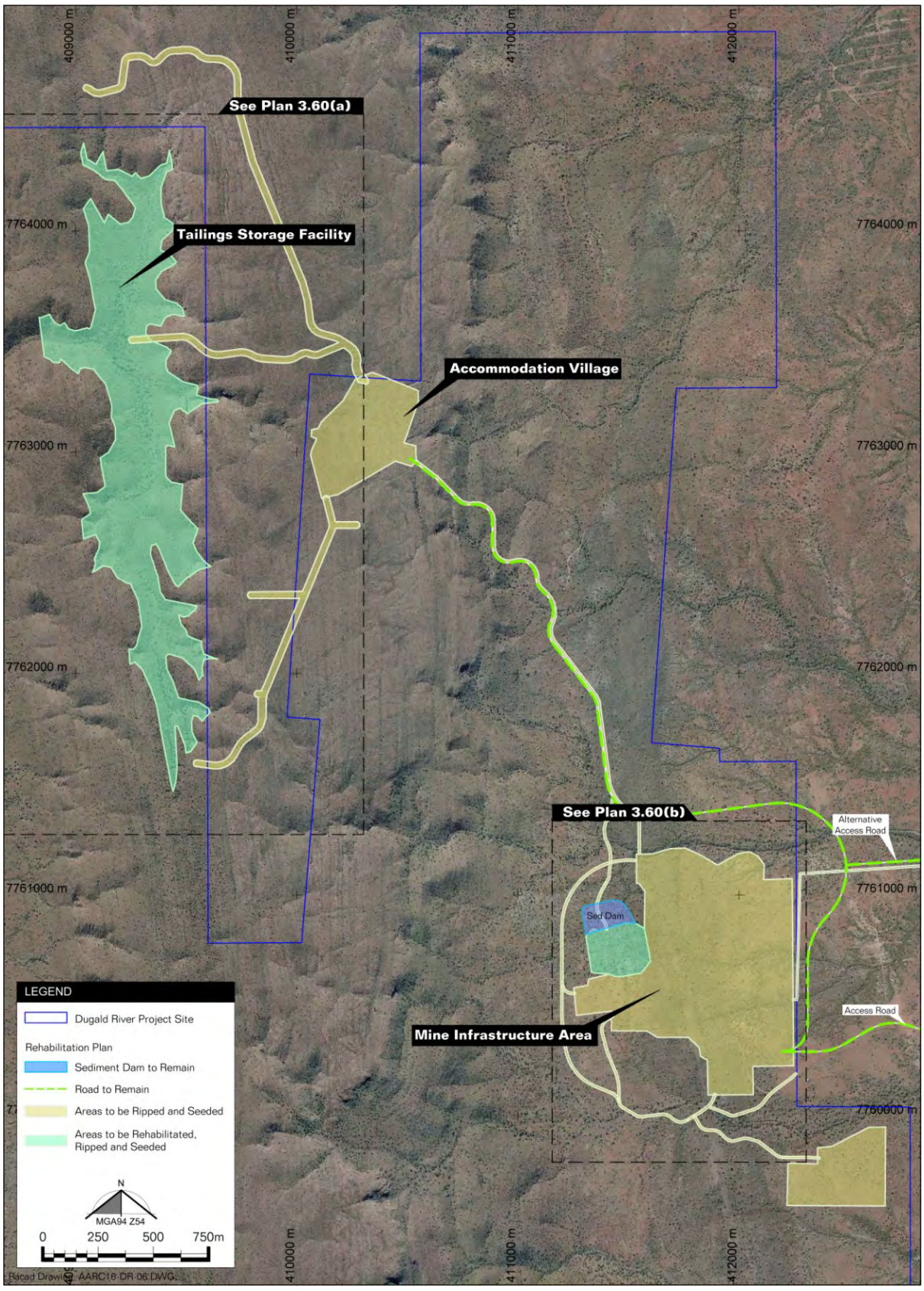


Figure 3.60 Overview of Rehabilitated Landforms

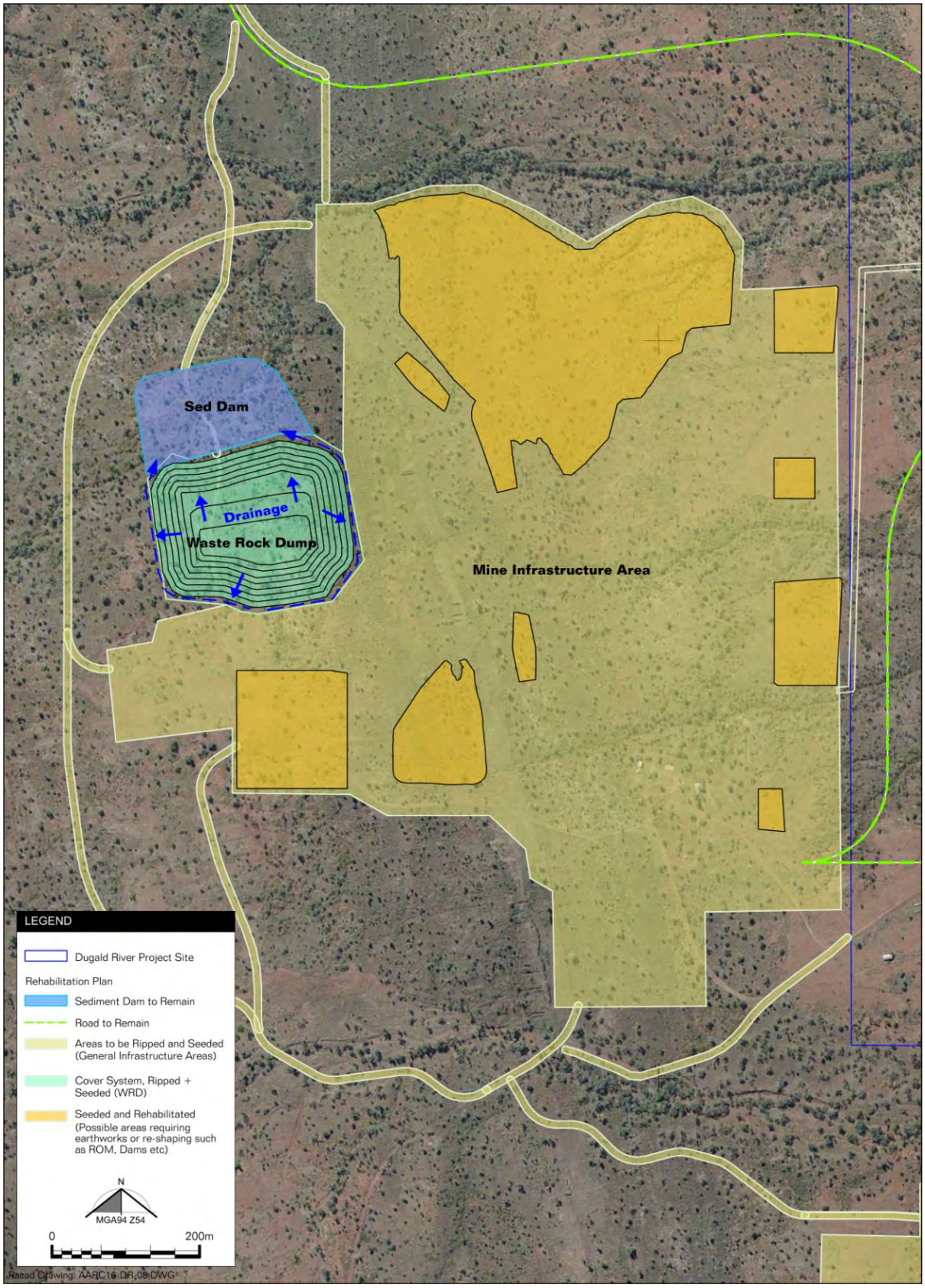


Figure 3.61 Mining and Processing Area – Rehabilitated Landforms

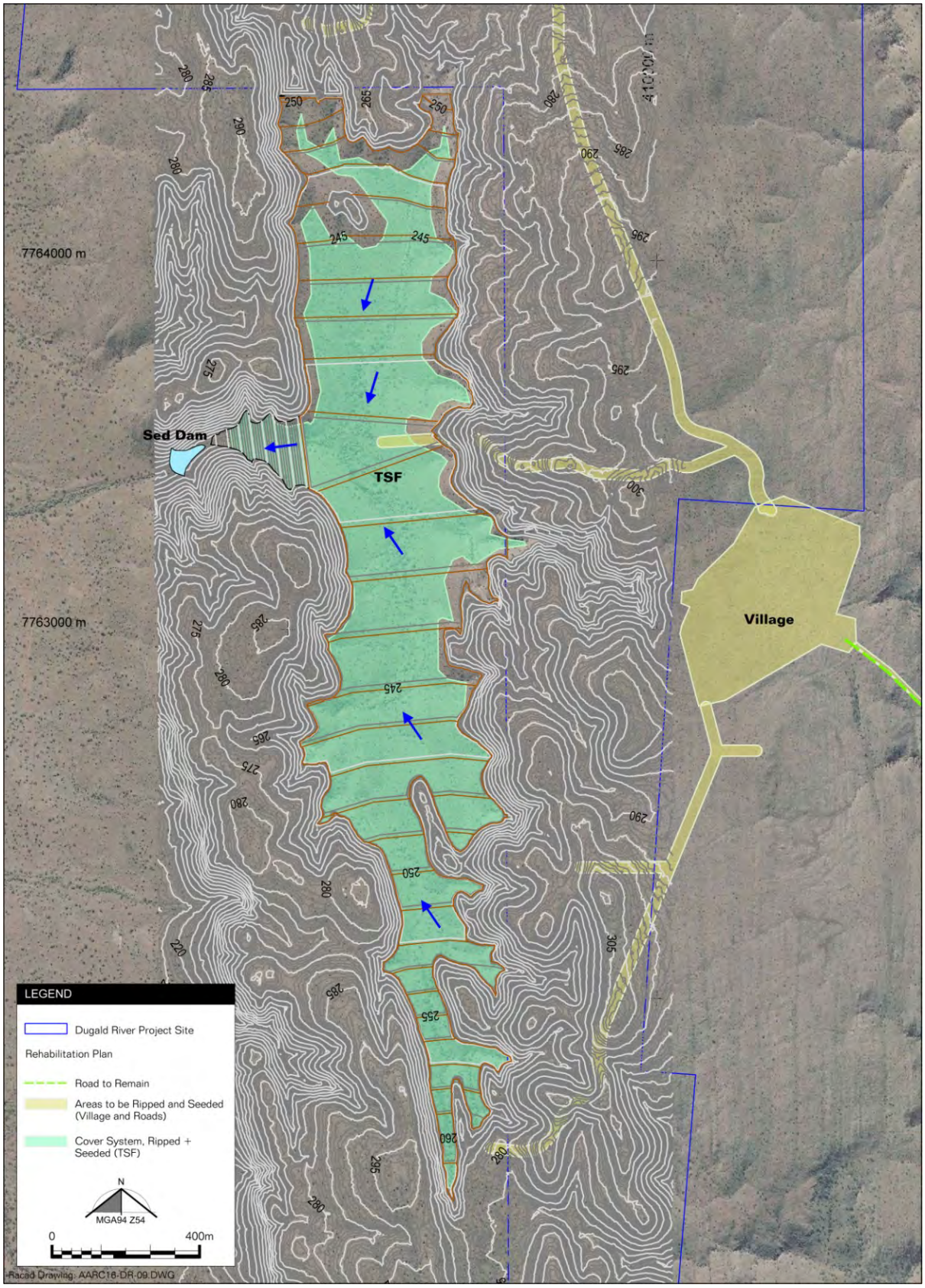


Figure 3.62 TSF – Rehabilitated Landform

3.7.1 Pre and Post Mining Land Suitability

The pre-mining land suitability of the Project site is described in Section 4.2.2.1. In summary the majority of the site is of unsuitable topography and slope for beef cattle grazing (Class 5), due to the Knapdale Ranges, however in the flatter areas, a low intensity cattle grazing may be possible. Areas that can be used for low intensity cattle grazing are defined as Class 4 which is marginal land. This type of land has severe limitations which make it doubtful whether the inputs required to achieve and maintain production outweigh the benefits in the long term.

All soil types on the Project site have been rated as Class 5 for rainfed broadacre cropping and Class 4 for conservation. There would be severe to extreme limitations to attempting either of these land uses on the Project Site.

On closure and decommissioning of the Project, it is proposed to return the majority of disturbed land to a condition similar to the pre-existing condition of low intensity grazing, native habitat or an agreed beneficial use. Table 3.44 described the proposed land disturbance types for the Project and their related pre and post mining land suitability and pre and post mining land uses.

The three main areas that will be disturbed on the main Project mining leases are the processing plant/mining area, the accommodation camp area and the TSF. Other corridor areas that will be disturbed include roads, the power transmission line, water pipeline and tailings pipelines. The construction and operational phases of the Project necessitates the disturbance of approximately 234.3 ha of low intensity grazing lands and native habitat areas on the main mining leases and 557.3 ha on the corridor mining leases and access road (Table 3.44).

As discussed above, and shown in Table 3.44 the majority of land disturbance on the Project site will be returned to its pre-mining land use and suitability on closure and decommissioning. The exception to this is the TSF area and NAF/PAF waste rock dump which will be returned to native habitat area only rather than a mix of native habitat and low intensity grazing. This is because these areas may be susceptible to increased erosion if grazing is allowed to occur on these final landforms.

Most of the stormwater dams, sediments ponds and roads on site will be returned to their pre-mining land use and suitability unless the landholder wishes to retain these structures for grazing proposes through a written agreement with MMG. The stormwater dam downstream of the rehabilitated NAF/PAF waste rock dump will be retained to remove sediment from rainfall runoff from this permanent land form. The water pipeline and power transmission line will be retained on mine closure as this infrastructure may be of beneficial use to the region or future mining operations. The access road may also be retained through written agreement with the landholder.

Table 3.44 Pre and Post Mining Land Use Suitability

Disturbance Type	Area (ha)	Pre-Mining		Post Mining	
		Land Use	Suitability Class	Land Use	Suitability Class
NAF/PAF Waste Rock Dump	6	Low Intensity Grazing/Native Habitat	4-5	Native Habitat	5
South Waste Rock Dump	2.5	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
North PAF Stockpile	4.5	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Lead/Zinc and Copper ROM Pads	5	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Off ROM Ore Stockpile	3	Low Intensity Grazing	4	Low Intensity Grazing	4
Crushed Ore Stockpiles and Conveyors	6	Low Intensity Grazing	4	Low Intensity Grazing	4
Underground Declines	3	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Process Plant Areas (includes chemical and concentrate storages)	28.5	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Tailings Storage Facility	91	Low Intensity Grazing/Native Habitat	4-5	Native Habitat	5
Longamundi Alternative Route	4	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
TSF Topsoil Stockpiles	5	Low Intensity Grazing	4	Low Intensity Grazing	4
Paste Fill Plant	1	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Stormwater Dams and Sediment Ponds	12.3	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat or Water Storage[1]	4-5
Process Water Pond	0.4	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat or Water Storage[1]	4-5
Roads and Tracks (on Main Project Mining Leases)	5	Low Intensity Grazing/Native Habitat/ Existing tracks	4-5	Low Intensity Grazing/Native Habitat or Roads[2]	4-5

Disturbance Type	Area (ha)	Pre-Mining		Post Mining	
		Land Use	Suitability Class	Land Use	Suitability Class
Accommodation Camp	20	Native Habitat	4- 5	Native Habitat	4-5
Heavy Vehicle Workshop and Go Line	0.2	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Contractor Laydown Area and Workshops	2.5	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Offices and Workshops	4	Low Intensity Grazing	4	Low Intensity Grazing	4
Rubbish Disposal Site	3	Low Intensity Grazing	4	Low Intensity Grazing	4
Gravel/Clay Borrow Pits and Stockpiles	12	Low Intensity Grazing	4	Low Intensity Grazing	4
Course Aggregate Borrow Pits and Stockpiles	0.4	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Topsoil Stockpiles (Processing and Mine Area)	10	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Exploration pads and Roads	5	Low Intensity Grazing/Native Habitat	4-5	Low Intensity Grazing/Native Habitat	4-5
Total	**234.3**				
Corridors					
Power line (assume 80 m width for clearing)	497.3	Low Intensity Grazing/Native Habitat	3-5	Retained for future use	5
Water Pipeline (assume width for clearing 40 m wide)	40.4	Low Intensity Grazing	3	Retained for future use	5
Access Road (assume 8 m wide width)	13.6	Low Intensity Grazing/ Existing Track	3 or 5	Access Road[2]	4-5
Access Road Borrow Pits	3	Low Intensity Grazing	3	Low Intensity Grazing	3
TSF Pipelines and Roads	3	Native Habitat	5	Native Habitat	5
Total	**557.3**				
TOTAL	**791.61**	**Project Site plus Corridors**			

[1] The sediment dams downstream of the PAF/NAF waste rock dump will be retained on closure. Other Stormwater Dams or Sediment Ponds may also be retained on closure if a written agreement with the landholder allows.

[2] Some roads may be retained on closure for access by the landholder, if a written agreement with the landholder allows.

3.7.2 Tailings Storage Facility

Section 3.2.7 details the construction of the TSF and Figures 3.20 - 3.22 present the design of the TSF at various periods during the mining operation (Stages I, II and III). For a detailed description of the TSF operation see Section 3.6.4.2.

The rehabilitation strategy for the proposed TSF is still conceptual but given that the tailings are potentially acid forming a capping strategy for the surface of the TSF is considered necessary. The actual final depth of the capping layers and materials required will be determined by numerical infiltration modelling and/or field/column trials. Such modelling and trials are likely to be conducted during the operational phase of the project when there will be a better understanding of the types of cover materials available on site.

The intent of tailings deposition management will be to form a final low point at the Main Embankment, and hence a self-shedding profile for closure. The surface of the rehabilitated TSF will drain at a slope of approximately 1% to a low point at the Main Embankment where it will discharge through a spillway to a sediment pond and then to a natural creek line. The final slope on the TSF surface will allow excess rainfall to runoff the TSF during large rainfall events, thereby preventing ponding on the TSF surface.

The general approach to TSF closure will incorporate the following (in sequence from the tailings surface):

- A capillary break layer (0.3 m depth) of mainly coarse, NAF waste rock placed directly over the tailings. The purpose of this layer is to prevent the rise of salts from the underlying tailings to the sealing layer above;

- A low permeability sealing layer (approximately 0.5 m deep) constructed above the capillary break layer to limit water infiltration. This material may need to be sourced from the NAF weathered waste rock dumps, weathered NAF in the ROM pad or general earthfill borrow pits located within the Project boundaries;

- A rainfall shedding waste rock cover layer will be constructed over the sealing layer. The rainfall shedding layer will consist of NAF waste rock and will allow for vegetation establishment. The layer will be approximately 1 m thick. A series of rock lined drains installed on the surface of the cover layer will direct rainfall runoff from the surface of the TSF to the low point in the Main Embankment wall, where runoff will be discharged through a spillway;

- Topsoil stripped from within the impoundment area at the time of construction will placed on top of the waste rock cover layer. Good quality topsoil available to be stripped from the TSF impoundment area is scarce and therefore is unlikely to be sufficient to cover the entire surface of the TSF. Therefore, topsoil will be spread thinly and in patches depending on the quantities available;

- The surface of the TSF will be ripped on the contour, fertilised and seeded with a mix of shallow rooting native species (shrubs and grasses) so as not comprise the integrity of the sealing layer;

- The downstream slope of the Main Embankment will be flattened to a slope suitable for perpetuity. The downstream slope will in effect be reconstructed as a broad, rock armored,

spillway chute, sized to pass the peak flood resulting from the Probable Maximum Precipitation (PMP); and

- The spillway at the Main Embankment will drain via a sediment pond to remove suspended material prior to discharge to the natural creek line downstream.

The general quantities of materials required to complete the rehabilitation of the TSF have been estimated in Table 3.45. Where possible these materials will be sourced from the NAF waste rock or civil cut materials stockpiled on the surface at the mining and processing area and hauled to the TSF. Where additional materials are required these will be sourced from borrow pits on the Project site or won from the surrounding hills.

Table 3.45 Estimated Quantities of Materials Required to Rehabilitate TSF

Description	Unit	Quantity
Embankment Slope Modification (4 horiz : 1 vert) - general rockfill	m^3	43,000
Capillary Break (0.3 m thickness) - select permeable rock fill	m^3	270,000
Sealing Layer (0.5 m thickness) - low permeability weathered waste rockfill or general earthfill	m^3	450,000
Waste Rock Cover (1.0 m thickness) - general waste rockfill	m^3	900,000
Topsoil Layer (0.1 m average thickness)	m^3	90,000
Total	**m^3**	**1,753,000**

3.7.3 NAF/PAF Waste Rock Dump

The NAF/PAF waste rock dump is the only waste rock dump that will remain on closure of the mine. The design of this waste rock dump is described in detail in Section 3.6.3.1

PAF material will not be stored in the base or slopes of the waste rock dump, only in the central core of the dump. The water rock dump will be constructed with at least 1 m of well compacted NAF waste rock at the base of the dump. The outer walls of the dump and areas under the outer slopes will be built exclusively from NAF material to produce an outer NAF encapsulation wall. The final slope of the outer waste dump walls will be approximately 15 degrees and will have a concave type profile, so as to resemble a natural hill. The outer walls of the dump will be built up progressively around the inner PAF core so that no rainfall runoff from the PAF material can exit the facility. PAF material in the centre of the dump will be built up in layer of 1 – 1.5 m thick to aid compaction of the material and minimise rainfall infiltration. The final height of the waste rock dump will be approximately 12.5 m.

On completion of the waste rock dump, the top of the dump will be sealed with a compacted low permeability layer of suitable NAF waste rock or other material (at least 0.5 m depth) and then covered with at least 1 m of NAF waste rock as a rainfall shedding cover. The top of the dump will slope gently to the north so that large rainfall events water will not pool on the top of the dump as this may increase the chances of infiltration through the compacted low permeability layer. Rainfall will be directed off the dump via a series of rock-lined drains to the existing stormwater dam. This stormwater dam will have been constructed as a high hazard dam during construction of the Project, and will have containment for a 1:100 Year ARI, 2 month wet season. After rehabilitation of the NAF/PAF waste rock dump, this stormwater dam will effectively act as a sediment pond.

Stormwater drainage off the NAF/PAF waste rock dump is expected to be non-contaminated due to the above encapsulation strategy, although may contain levels of suspended sediment. Therefore drainage off the dump will be via the existing stormwater dam to remove entrained sediment prior to

stormwater discharge, if necessary. Surface water management controls are discussed in detail in Section 3.5.4.

The final surface of the waste rock dump will be covered with a 100 - 200 millimetres (mm) layer of topsoil which will be deep ripped into the surface of the dump using a dozer. The dump will then seeded and fertilised as described in Section 3.7.14.

3.7.4 Underground Declines and Box Cut

On completion of mining, the underground declines and the box cut disturbance areas will be returned to safe and stable landforms, representative of the intended post mining land use. Decommissioning and rehabilitation methodology will include:

- Capping of the vertical declines with a 5 m long plug of concrete placed at the mine openings;
- Backfilling of the vent raises with NAF material;
- Backfilling of the box cut with NAF material; and
- Spreading of topsoil and revegetation of the final landform surface.

By sealing the underground declines with specifically designed concrete plugs the chances of subsidence into the underground workings is greatly reduced. This methodology ensures that the proposed subsequent land use is not compromised by surface instability or erosion.

3.7.5 Other Waste Rock Dump, ROM Pads and Mine Roads

At the end of mining, civil cut material and NAF waste rock will remain in the southern waste rock dump, the ROM pads, the Off ROM Stockpile and mine roads. This will amount to approximately 833,700 m^3 of material and waste rock. It is planned to utilise all this civil cut material and NAF waste rock in the rehabilitation of the TSF to form the different cover layers as required in Table 3.45.

The disturbance footprint under these areas that will remain once the material has been removed will be topsoiled and deep ripped to elevate compaction. The areas will then be fertilised and seeded as described in Section 3.7.14.

3.7.6 Stormwater Dams and Sediment Ponds

The stormwater dam downstream of the NAF/PAF waste rock dump will be retained on closure for removing sediment from stormwater runoff from this rehabilitated dump. A sediment pond will also remain downstream of the TSF for the same purpose.

Upon prior agreement by the landholder, other stormwater dams and sediment ponds may be left for landholder use if they are cleaned of all contaminated material. Contaminated materials will be removed for disposal to the TSF. Where stormwater dams or sediment ponds are not required for use by the landholder, surrounding clean fill material will be pushed into the dams and ponds, and they will be contoured to resemble the surrounding landscape. Dams that contain HDPE liners will have these liners ripped and folded into the centre of the dam prior to backfilling.

3.7.7 Processing Plant , Accommodation Camp and Offices

When planning for the rehabilitation of building and infrastructure sites the following process will be followed:

- Consultation with the owner regarding the structures to be left on-site which may be beneficial for the landholder;
- Auctioning of buildings and building materials not required to remain on the site;
- Recycling of recyclable materials that are not sold during auctions or are remaining on the site;
- Disposal of any remaining materials in an appropriate licensed landfill or the underground workings; and
- Areas from which buildings and infrastructure are removed will be ripped, re-contoured and revegetated.

Soil testing will be conducted to around the processing plant and mining areas to determine if any land contamination has occurred due to concentrate or mineralised ore handling. Contaminated materials will be excavated and disposed of to the NAF/PAF waste rock dump or the TSF, prior to their rehabilitation.

3.7.8 Workshops and Chemical/Fuel Storages

All workshops, chemical and fuel infrastructure will be removed from site on the completion of the mine life. Should any soil contamination remain at the locations then this will be removed and disposed of to an appropriately licensed facility or the TSF. Soil testing will be conducted to ensure that all contaminated materials have been removed.

3.7.9 Roads

Some roads may be left for the landholder where appropriate and under written agreement. Roads that are not required will be reshaped (if required), topsoiled (if available), deep ripped and revegetated.

3.7.10 Rubbish Disposal Site

All general waste remaining on site will be removed and recycled where possible or disposed of to the waste disposal site prior to rehabilitation. The waste disposal site will be backfilled, with clean fill and capped with a low permeability clay layer. The surface area will then be revegetated.

3.7.11 Borrow Pits

Borrow pits will be re-contoured, with batters pushed down to 15 degrees, and topsoil spread over the disturbed area. The area will then be ripped, seeded and fertilised.

3.7.12 Exploration Areas

Where exploration disturbances are to be temporarily rehabilitated, due to the potential for future disturbance, the following will occur:

- Capping the drill hole; and
- Removal of all sample bags and rubbish.

If permanent rehabilitation is required (no potential for future disturbance) exploration drill holes will be permanently plugged. This requires cutting the PVC collar off at ground level and plugging the hole with a concrete plug. Soil is then mounded over the concrete plug so that the plugged area sheds water. The following rehabilitation activities of the exploration drill pad will also occur:

- A drying out period to allow water to evaporate from the drilling mud in the sumps;
- Backfilling of drilling sumps;
- Scarifying the surface; and
- Should natural regeneration not be successful after the first year, seed from species native to the area will be sown before the following wet season to enhance revegetation.

These practices are the same as those applied to the current exploration activities on site.

3.7.13 Power Line and Water Pipeline

The powerline and water pipeline are significant and important infrastructure for the region which could be utilised by landholders and/or other mining operations on cessation of the Project. Therefore it is envisaged that this infrastructure will not require removal on closure of the Project but ownership may be transferred by agreement to another party.

3.7.14 Revegetation Methods

After appropriate surface preparation has occurred as outlined above, disturbed land will be revegetated as follows:

- Spread fertiliser at approximately 100 kg/ha or as determined by rehabilitation trials;
- Native species occurring naturally in the local area will be chosen for areas requiring the re-establishment of local native habitat;
- Where practicable, revegetation will occur through direct seeding of selected species. Where direct seeding is not possible (e.g. small areas with limited access), seeds will be manually broadcast; and
- A Weed Management Plan will be implemented to ensure revegetation initiatives are balanced with managing any existing weed species or those which are established due to land disturbance.

Table 3.46 lists species suggested for rehabilitation of disturbed land on the Project. The suggested rehabilitation species have been selected from the vegetation species list generated during the terrestrial flora and fauna surveys on the Project Site. Selection of rehabilitation species considers the key or dominant species in the area, those that are good colonisers, and those that are readily available from seed collectors. The proportion of each species used in the rehabilitation seed mix would be varied based on the post-mining land use to be established. For example, a higher proportion of grass species would be included in the seed mix for those rehabilitation areas to be returned to low intensity grazing, while native tree and shrub species may dominate the seed mix for those areas to be returned to a native habitat.

Table 3.46 Native Species to be used in Rehabilitation

Grass and groundcover	Shrubs	Trees
Aristida contorta	*Acacia chisholmii*	*Atalaya hemiglauca*
Aristida latifolia	*Acacia holosericea*	*Corymbia aparrerinjra*
Enneapogon oblongus	*Acacia lysiphloia*	*Corymbia terminalis*
Eriachne obtusa	*Acacia retivenea*	*Eucalyptus camaldulensis*
Solanum echinatum	*Acacia cambagei*	*Eucalyptus leucophloia*
Sida fibulifera	*Acacia bidwillii*	*Eucalyptus leucophylla*
Sporobolus australasicus	*Carissa lanceolata*	*Eucalyptus pruinosa*
Themeda triandra	*Crotalaria novae-hollandiae*	*Lysiphyllum cunninghamii*
Triodia pungens	*Senna artemisioides subsp. oligophylla*	*Lophostemon grandiflorus subsp. grandiflorus*
	Sesbania notabilis	*Hakea aborescens*
	Terminalia aridicola subsp. aridicola	*Grevillea striata*

3.7.15 Monitoring of Analogue and Rehabilitation Sites

Rehabilitation success criteria can be developed by comparing a number of variables between rehabilitation areas and existing ecosystems (analogue sites) over time.

A rehabilitation monitoring program will be established for the Project which will involve monitoring of suitable analogue sites to develop site specific rehabilitation success criteria, as well as incorporating rehabilitated areas into the program as they progressively become available.

Analogue sites, consisting of 50 m transect lines; will be established prior to any disturbance in areas adjacent to, or of similar character to, the land to be disturbed. At each analogue site the following parameters will monitored on an annual basis to provide baseline data:

- Tree Density (trees/ha);
- Shrub Density (shrubs/ha);
- Herb/Grass Density (grasses/ha);
- Groundcover (%);

- Species Composition;
- Chemical. and physical indicators of soil (Cation Exchange Capacity, Exchangeable Sodium Percentage, pH, Electrical Conductivity, organic carbon, nitrate, phosphate, sulphate, and metals);
- Erosion indicators (depth of rills or erosion lines, surface crusting, slopes); and
- Photographic records of the site.

The same methodology will be used for monitoring rehabilitation sites. For rehabilitation areas the following additional parameters will also be monitored:

- Surface water quality runoff;
- Groundwater quality surrounding rehabilitated areas such as waste rock dumps and the TSF;
- Topsoil depth; and
- Erosion monitoring as detailed in Section 3.7.15.1.

Annual monitoring of the analogue sites will determine the response of native grasses, herbs, shrubs and tree species to the natural fluctuations in the environment, and after a sufficient amount of data has been obtained, final rehabilitation success criteria will be determined for the rehabilitation sites.

3.7.15.1 Erosion Monitoring

Erosion monitoring on the Project will be conducted at a number of locations, focusing on constructed landforms with steep outer slopes which provide the greatest erosion risk. Permanent photographic points will be set up to monitor slope areas of the following landforms on an annual basis:

- Waste rock dumps;
- ROM Pads and ore stockpiles; and
- TSF embankment walls.

Photographs should be taken following each wet season in order to capture potential erosion caused by runoff. More than one photographic point will be required for some of these landforms to provide good photographic coverage of all slopes. The photographs will be compared to the previous years to determine any large areas of erosion that are increasing in size and therefore may require remedial works. The photographs will also provide a good record of remedial works conducted and the success of these works.

Physical examination of erosion will be conducted together with the photographic monitoring. Examination will be undertaken by traversing the landforms on foot at mid-slope and recording any erosion or rill lines deeper than 10 cm. The data to be collected at each erosion or rill line will include the following:

- GPS reading of location;

- General description of type of erosion (gully, rill line, circular failure, tunnelling etc) and possible causes;
- Depth of erosion;
- Width of erosion;
- Length of erosion;
- Where eroded material is being deposited;
- Whether the erosion line is being stabilised by vegetation; and
- Suggested remedial works if required.

Remedial works will generally be required for any erosion that is increasing in size from one year to another (i.e. has not stabilised on its own) or if the erosion is deeper than 1 m in depth or wider than 1 m in width. In some cases, if an erosion feature is larger than 1 m in depth or 1 m in width and vegetation is currently established and stabilising the erosion feature, it is better to wait and see until after the next wet season rather than conduct remedial works immediately and cause vegetation destruction which could be counterproductive.

3.7.16 Preliminary Rehabilitation Completion Criteria

The Project is in a semi-arid region where ecosystems are limited by water availability and can have extremely weathered soil profiles. There is limited nutrient cycling potential and limited natural topsoil. Rehabilitation of these areas, particularly after long periods of disturbance, can take an extended time frame and have limited initial success. The dynamics of the specific ecosystems and natural vegetation on site needs to be extensively studied over time, before any final rehabilitation success criteria can be determined. Therefore at this stage only preliminary rehabilitation success criteria have proposed for the Project.

The preliminary rehabilitation success criteria for the Project have been developed with reference to *Guideline 18: Rehabilitation Requirements for Mining Projects* (QEPA 2008). The preliminary rehabilitation completion criteria are as follows:

- Slopes of all constructed landforms will be less than 15 degrees;
- All constructed landforms will be safe and stable with no excessive erosion;
- Levels of metals in surface soils on rehabilitated landforms will be similar to that of relevant analogue sites;
- Land suitability consistent with that proposed for the disturbance type in the Environmental Authority;
- Surface water runoff quality of rehabilitated landforms will be consistent with water discharge criteria for Project as stated in the Environmental Authority or background/reference site levels;

- Groundwater quality surrounding rehabilitated landforms will be consistent with water discharge criteria for Project as stated in the Environmental Authority or background/reference site levels;

- Tree density (trees/ha), shrub density (shrubs/ha), herb/grass density (grasses/ha), groundcover (%) and species composition similar to relevant analogue sites; and

- Sulphate, pH and EC levels in soil similar to that of relevant analogue sites.

Department of Environment and Resource Management

Public Notice

Environmental Protection Act 1994 (EP Act) – Sections 51 and 52

Public notice of an Environmental Impact Statement (EIS)
Proposed Dugald River Project

An EIS has been prepared on behalf of the Mining and Metals Group (MMG) Pty Ltd for the proposed Dugald River Project to be located on mining development licence 79, exploration permit minerals 12163, mining leases 2467-71, 2477-82, 2496-99, 2500-02, 2556-59, 2596, 2599, 2601, 2638, 2684-85, 7496, 90047, 90049 and 90050-51, mining lease applications 90211, 90212 and 90213, and parcel prospecting permits 90520-23.

The proposed project is located approximately 65 kilometres north-west of Cloncurry, in north-western Queensland and involves a zinc, lead, silver and potentially copper underground mining operation. The expected mine life would be more than 23 years with a mining rate of 2 000 000 tonnes a year (t/y) of zinc, lead, silver ore and potentially 1 000 000 t/y of copper ore. The project is estimated to produce 408 000 t/y of zinc and silver concentrate, 40 000 t/y of lead and silver concentrate and potentially 75 000 t/y of copper concentrate.

The concentrates will be transported off site by covered quad road trains to the Yurbi Rail Loading Facilities, east of Cloncurry. From here, the concentrate will be transported by rail to the Port of Townsville where it will be unloaded for export. The project will include the development of a power transmission line from Chumvale and a water pipeline from the existing Lake Julius and Ernest Henry pipeline.

The EIS is currently available for review and anyone may make a submission to the Chief Executive about the submitted EIS. A copy of the EIS can be inspected at the locations listed below:

Brisbane Business Centre
Department of Environment and Resource Management
Level 3, 400 George Street
BRISBANE QLD 4000

Mount Isa Business Centre
Department of Environment and Resource Management
Corner Camooweal and Mary Streets
MT ISA QLD 4825

Cloncurry Municipal Library
Corner Scarr and King Streets
CLONCURRY QLD 4824

An electronic copy of the EIS can be obtained from the MMG website at www.mmg.com. A free CD copy can also be obtained by phoning Alejandro De Bary from MMG on 0422 238 267 or writing to PO Box 19421, Southbank, Victoria 3006.

Submissions may be made on the EIS from **Monday 24 January 2011 until the close of business on Monday 7 March 2011**. Submissions should be addressed to:

The Chief Executive
Attention: The EIS Coordinator, Dugald River Project
Environment and Natural Resource Regulation Division
Department of Environment and Resource Management
GPO Box 2454
BRISBANE QLD 4001

The Chief Executive will accept all properly made submissions and may accept written submissions even if they are not properly made. A properly made submission is one that:

- is written
- is signed by or for each person who made the submission
- states the name and address of each signatory
- is made to the chief executive
- is received on or before the last day of the submission period.

Please note that it is a statutory requirement that all submissions will be forwarded to the proponent so that they may consider them and provide a response to DERM.

For further information regarding the EIS process for this proposal, contact the EIS Coordinator on 13 QGOV (13 74 68).

BlazeQ005548

www.derm.qld.gov.au

Queensland Government

Q005548
18x4_148
North West News

Department of Environment and Resource Management

Public Notice

Environmental Protection Act 1994 (EP Act) – Sections 51 and 52

Public notice of an Environmental Impact Statement (EIS)
Proposed Dugald River Project

An EIS has been prepared on behalf of the Mining and Metals Group (MMG) Pty Ltd for the proposed Dugald River Project to be located on mining development licence 79, exploration permit minerals 12163, mining leases 2467-71, 2477-82, 2496-99, 2500-02, 2556-59, 2596, 2599, 2601, 2638, 2684-85, 7496, 90047, 90049 and 90050-51, mining lease applications 90211, 90212 and 90213, and parcel prospecting permits 90520-23.

The proposed project is located approximately 65 kilometres north-west of Cloncurry, in north-western Queensland and involves a zinc, lead, silver and potentially copper underground mining operation. The expected mine life would be more than 23 years with a mining rate of 2 000 000 tonnes a year (t/y) of zinc, lead, silver ore and potentially 1 000 000 t/y of copper ore. The project is estimated to produce 408 000 t/y of zinc and silver concentrate, 40 000 t/y of lead and silver concentrate and potentially 75 000 t/y of copper concentrate.

The concentrates will be transported off site by covered quad road trains to the Yurbi Rail Loading Facilities, east of Cloncurry. From here, the concentrate will be transported by rail to the Port of Townsville where it will be unloaded for export. The project will include the development of a power transmission line from Chumvale and a water pipeline from the existing Lake Julius and Ernest Henry pipeline.

The EIS is currently available for review and anyone may make a submission to the Chief Executive about the submitted EIS.
A copy of the EIS can be inspected at the locations listed below:

Brisbane Business Centre
Department of Environment and Resource Management
Level 3, 400 George Street
BRISBANE QLD 4000

Mount Isa Business Centre
Department of Environment and Resource Management
Corner Camooweal and Mary Streets
MT ISA QLD 4825

Cloncurry Municipal Library
Corner Scarr and King Streets
CLONCURRY QLD 4824

An electronic copy of the EIS can be obtained from the MMG website at www.mmg.com. A free CD copy can also be obtained by phoning Alejandro De Bary from MMG on 0422 238 267 or writing to PO Box 19421, Southbank, Victoria 3006.

Submissions may be made on the EIS from **Monday 24 January 2011 until the close of business on Monday 7 March 2011**. Submissions should be addressed to:

The Chief Executive
Attention: The EIS Coordinator, Dugald River Project
Environment and Natural Resource Regulation Division
Department of Environment and Resource Management
GPO Box 2454
BRISBANE QLD 4001

The Chief Executive will accept all properly made submissions and may accept written submissions even if they are not properly made.
A properly made submission is one that:
- is written
- is signed by or for each person who made the submission
- states the name and address of each signatory
- is made to the chief executive
- is received on or before the last day of the submission period.

Please note that it is a statutory requirement that all submissions will be forwarded to the proponent so that they may consider them and provide a response to DERM.

For further information regarding the EIS process for this proposal, contact the EIS Coordinator on 13 QGOV (13 74 68).

BlazeQ005548

www.derm.qld.gov.au

Queensland Government

Q005548
20x4_130
North West News

4.0 ENVIRONMENTAL VALUES AND MANAGEMENT OF IMPACTS

4.1 REGIONAL CLIMATE

Figure 4.1 below combines data from the Bureau of Meteorology's (BOM) Cloncurry AERO weather station (operated 1939 – 1975) and the Cloncurry Airport weather station (operated 1978 to present) to give monthly mean maximum and minimum temperatures and mean monthly rainfall for the Project region.

The mean annual maximum temperature is 32.7ºC with the hottest months being November through to January (over 37ºC). The mean annual minimum temperature is 18.6ºC with the coolest months being June through to August (below 12ºC). The mean daily maximum and minimum temperatures for each month are shown in Figure 4.1.

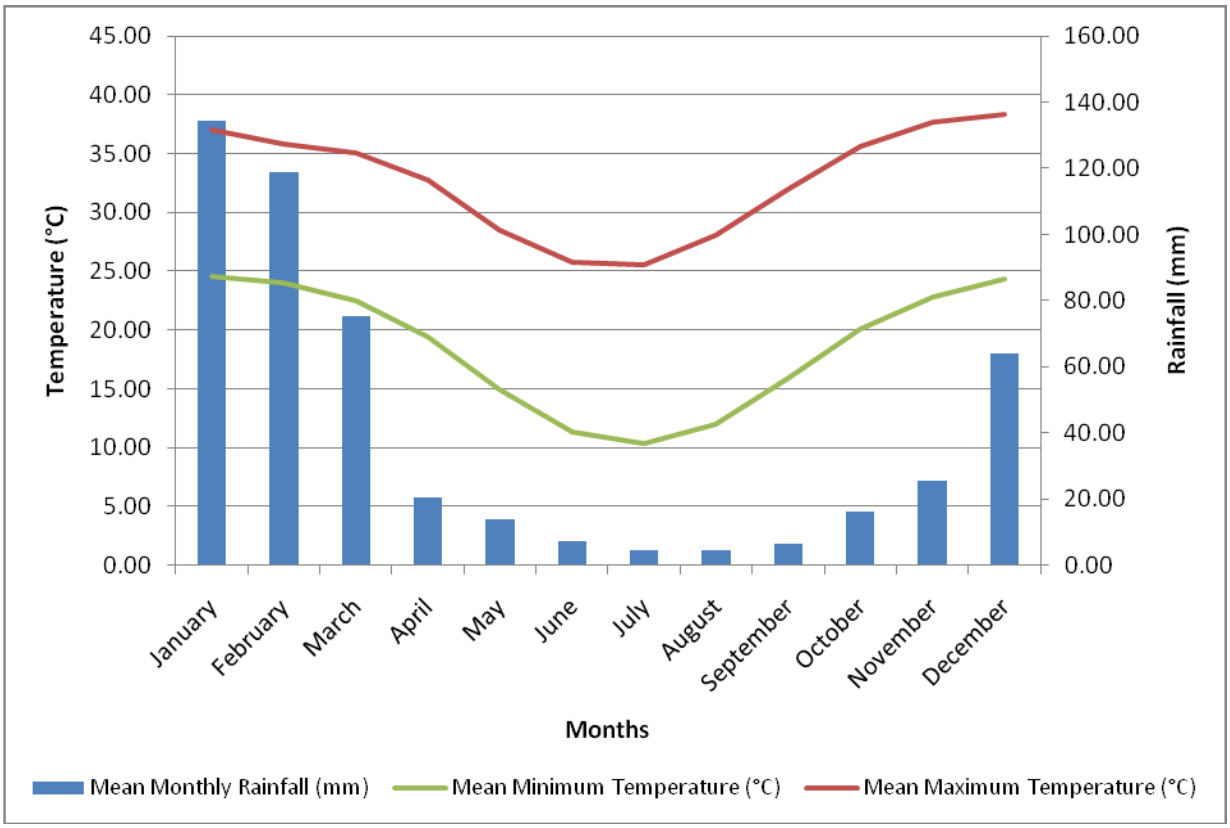


Figure 4.1 Mean Daily Maximum and Minimum Temperatures by Month and Mean Monthly Rainfall

Rainfall data from the weather stations at Cloncurry AERO and Cloncurry Airport show that January and February exhibit the highest mean monthly rainfall, averaging above 100 mm (January – 134.43 mm; February – 118.65 mm). These months also experience the most rainy days, with an average of more than 7 rain days per month. The driest months of the year are July and August with under 5 mm of rainfall (June – 4.44 mm; August – 4.49 mm), and with less than one day of rain per month. Figure 4.1 illustrates that the Cloncurry region experiences a distinctive wet season (between November and April), with very little rain falling in the remaining months of the year. The average annual rainfall for the region is 480 mm per year.

The average annual potential evaporation at the Project site is estimated at 3106 mm. Analysis indicates that the average annual potential evaporation at the Project site is about 6.5 times the average annual rainfall. As seen in Figure 4.2, the evaporation rate varies seasonally, with high evaporation rates occurring in the months between October and March. Further, the potential evaporation rates during the hotter months are about twice the evaporation rate during the cooler months.

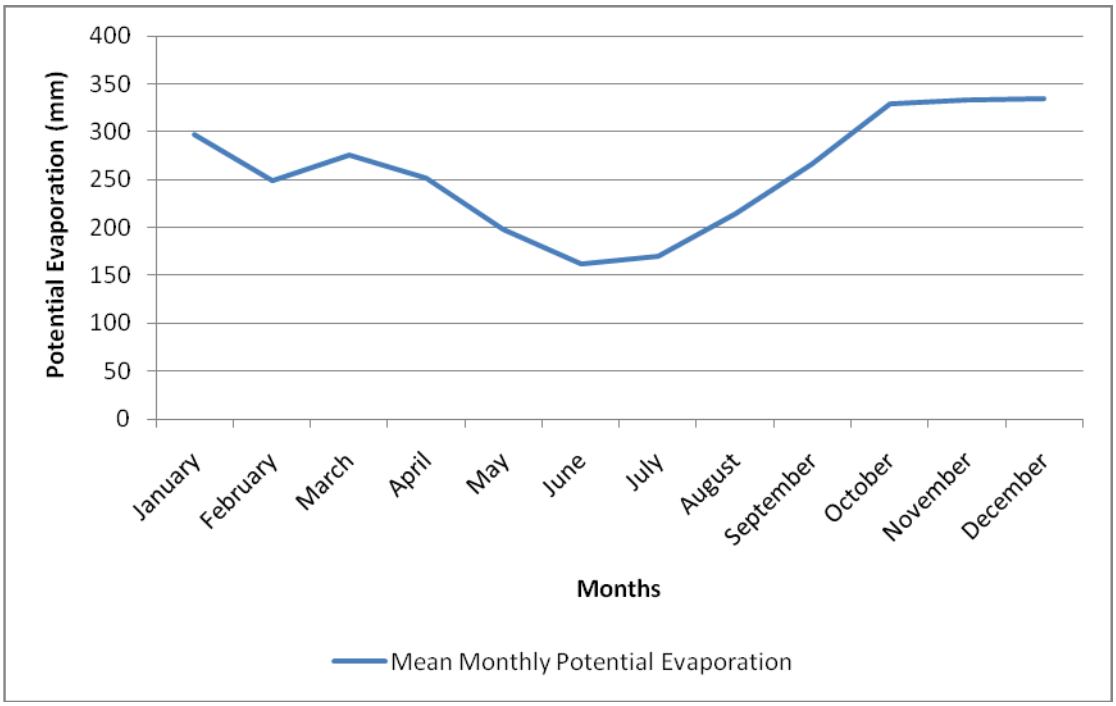
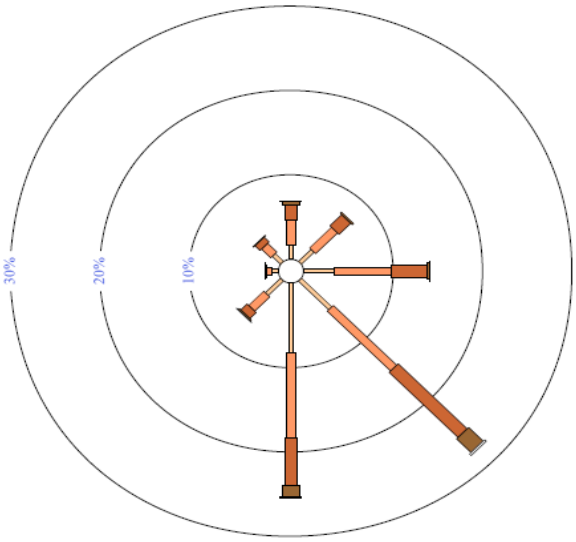


Figure 4.2 Mean Monthly Potential Evaporation

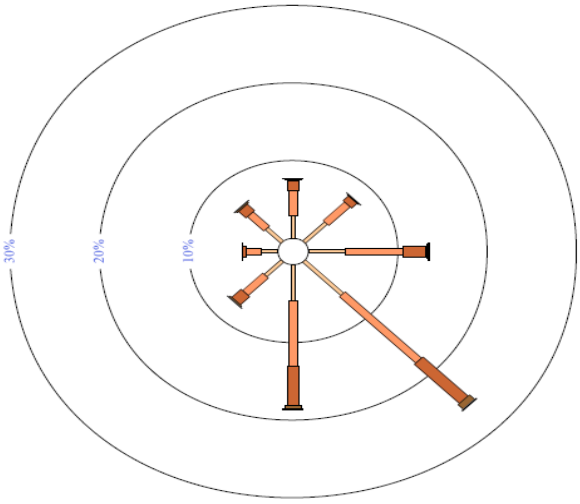
Mean wind speed measured at Cloncurry AERO and Airport weather stations at 9.00 a.m. show that the later months of the year exhibit the highest wind speeds, peaking in October at an average speed of 18.1 km/hr. Wind speeds are lowest from February to March, with an average of 12.5 - 13 km/hr at 9.00 a.m. Wind speed measured at 3.00 p.m. shows much less variation throughout the year, with all speeds within a range of 13.4 – 13.95 km/hr. Maximum wind gusts range from 65 km/hr in July, up to 145 km/hr in March.

The wind roses presented in Figure 4.3 show that the average annual wind direction in Cloncurry is predominantly from the south-east and south. For each season the dominant winds are moderate in strength from the southerly sector. During summer and spring there is a higher frequency of north to easterly winds. During autumn there is a higher frequency of east to south-easterly winds.

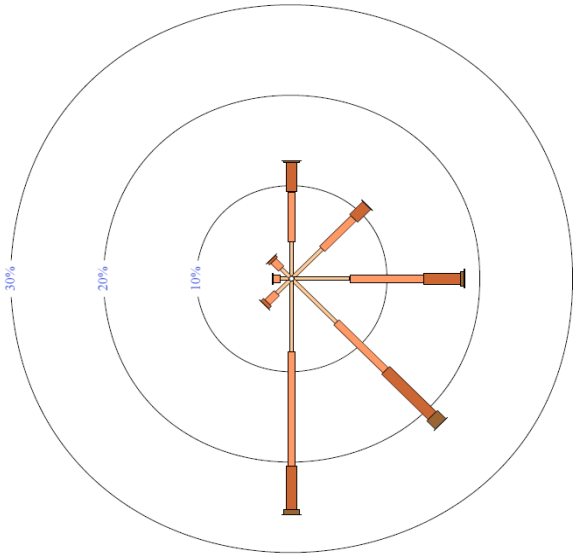
As the Cloncurry Bureau of Meteorology's sites are located approximately 65km from the Project site, specific meteorological data has been developed from detailed meteorological simulations covering the mine site and surrounding region for use in dispersion modelling. This data includes site specific wind speed, wind direction and atmospheric stability. This information is presented in Section 4.5.1.



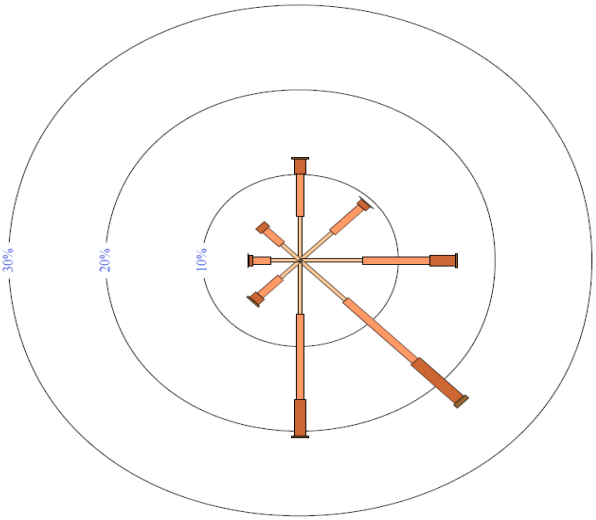
9.00 a.m. Cloncurry AERO – Calm 7%



3.00 p.m. Cloncurry AERO – Calm 8%



9.00 a.m. Cloncurry Airport – Calm 1%



3.00 p.m. Cloncurry Airport – Calm 1%

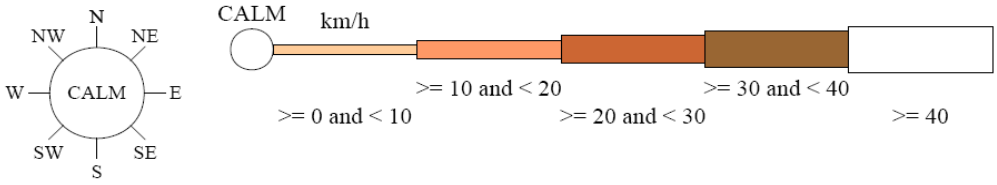


Figure 4.3 Average Wind Roses for Cloncurry AERO and Cloncurry Airport Weather Stations

4.1.1 Flooding

The semi-arid to arid Cloncurry area is described as having a tropical continental climate (BOM Australia - Köppen Australian climate classification scheme). There are large year-to-year variations in rainfall and a major rainfall event may occur only once every 3 to 20 years. Nevertheless, precipitation in the semi-arid to arid climate of Cloncurry is dominated by summer storms and floods.

The Australian BOM records show that a total of 13 Tropical Cyclones have passed within 200 km of Mount Isa during a 100 year period from 1906/07 to 2006/07. The majority of these did not have cross within the direct vicinity of the Project, but many have lead to increased rainfall at the Project site (see Figure 4.4).

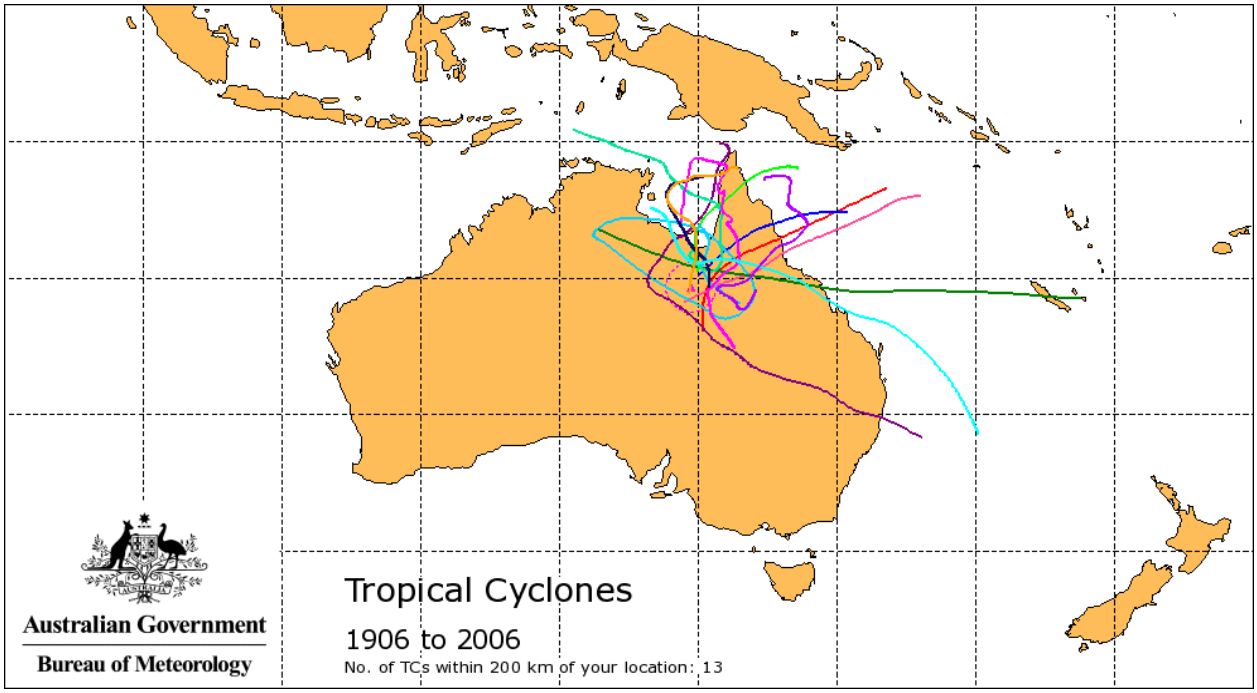


Figure 4.4 Tropical Cyclones Crossing Within 200 km of Mount Isa

There is no flood data for the local creeks through the Project Site, however parts of the Project Site, access roads and water pipeline route susceptible to flooding from tributaries of the Dugald River and Silvermine Creek. A detailed summary of the flood studies undertaken for the Project are discussed in Section 4.4.1.1.

The Project Site itself is not susceptible to flooding from the Dugald River however the main access road could be affected. During the period of 1969 - 2010 several significant floods have been recorded in the Dugald River at the Railway Crossing near where the Burke Developmental Road crosses this river. The most recent event was recorded in January 2009 with a peak discharge of 1319 m^3/s. Based on observations during the event and recorded water levels at the Silvermine Creek gauge site, no part of the Project site was inundated during the 2009 flood event however access from the Burke Developmental Road was cut intermittently for up to 2 months.

Other significant historical floods include the 1971 flood with a peak discharge of 1,330 m^3/s and the 1974 and 1997 flood events with peak discharges of 1,108 m^3/s and 1,148 m^3/s respectively. The next most significant flood event was recorded in 1995 with a peak discharge of 507 m^3/s. Based on a flood frequency analysis the ARI of the 2009 and 1971 events are between 50 and 100 years. The

ARI of the 1974 and 1997 events is between 20 and 50 years. The ARI of the 1995 event is approximately 5 years.

The total flood event may last from a few hours to several days depending on the rainfall pattern. If the rainfall lasts for an extended period the resultant flood would be multi-peaked. However, the duration of each flood peak would be quite short. Most of the flood waters would rise and fall within a period of approximately 12-18 hours.

WRM calculated the following ARIs for the Project site:

- 1 in 10 Year ARI, 24 hour event has a predicted rainfall depth of 160 mm;
- 1 in 100 Year ARI, 72 hour event has a predicted rainfall depth of 350 mm;
- 1 in 20 Year ARI, 2 month wet season has a predicted rainfall depth of 707 mm; and
- 1 in 100 Year ARI, 2 month wet season has a predicted rainfall depth of 1082 mm.

The management of flooding on the Project site in terms of proposed infrastructure is discussed in Section 4.4.1.1.

4.1.2 Droughts

Failure of the wet season to occur can cause severe strain on the pastures and available surface water supplies. The onset of drought is greatly enhanced by the high evaporation rates during the summer months. Evaporation losses during the dry season are less due to the lower temperatures.

The effect that drought may have on the Project has been taken into consideration by utilising an established and reliable source of water, the Lake Julius Dam as the Project's main water supply. This main water supply will be supplemented by recycling as much water as possible from the processing plant, the TSF and mine dewatering. The proposed TSF site itself provides for water harvesting off the dam from the valleys upstream. This is a valuable source of water for the Project and will reduce the amount of water the Project is required to source from Lake Julius via the proposed pipeline.

4.1.3 Bushfires

The peak fire season for the Project area is winter to spring (Figure 4.5) when the vegetation is at its driest and the probability of rainfall is low. Serious fires may follow long dry periods accompanied by El Nino - Southern Oscillation events.

The Project will put in place bushfire mitigation measures such as establishing fire breaks and prohibiting the lighting of open fires on the Project site.

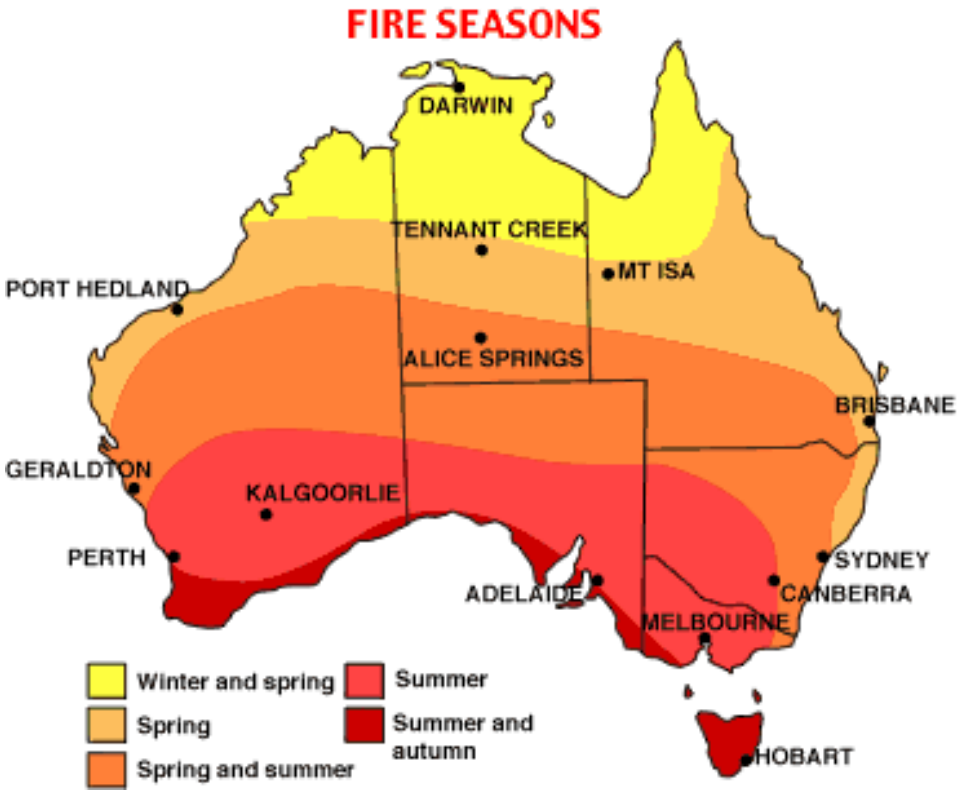


Figure 4.5 Typical Fire Seasons in Australia (BOM, 2008)