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PROGRESSIVE REHABILITATON AND CLOSURE PLAN

Version 8

Mining Leases

7459, 7460, 70049, 70326, 70365, 70366, 70367, 700061

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REHABILITATION PLANNING PART

This PRC Plan *Rehabilitation Planning* part includes information required by the EP Act and the guideline[1] under section 126C(1)(j) of the EP Act. It details how progressive rehabilitation and closure will be carried out over all the lands within relevant resource tenements at Ensham Mine.

Introduction

This is a transitional Progressive Rehabilitation and Closure (PRC) Plan for the Ensham coal mine, located near Comet, 35 kilometres (km) northeast of Emerald in central Queensland. Ensham uses conventional open-cut strip-mining and underground bord and pillar mining methods to extract coal from the late Permian aged Rangal Coal Measures. Opencut mining commenced in 1993 and has disturbed an area of approximately 4,847 hectares (ha) to date. Underground mining commenced in 2012 and causes no discernible surface disturbance. At the end of 2024, Ensham had completed 1,727.65 ha of land rehabilitation. Most of that rehabilitation has a target post-mining land use (PMLU) of cattle grazing.

Ensham is operated on behalf of joint venture partners by Ensham Resources Pty Limited. The joint ventures partners (Sungela Pty Ltd 85% and Bowen Investment (Australia) Pty Limited 15%) hold the relevant environmental authority (EA) and eight associated mining lease (ML) tenements covering 14,745Ha.

This PRC Plan has been developed in accordance with relevant sections 126C and 126D of the Queensland *Environmental Protection Act 1994* (EP Act) to satisfy requirements in the Queensland Government's *Guideline–Progressive rehabilitation and closure plans* (the Guideline) (DES 2019). The main purpose of the PRC Plan is to-

- Demonstrate planning for rehabilitation, including how and where environmentally relevant activities will be carried out in way that maximises the progressive rehabilitation of land to a stable condition.
- Provide for the condition to which land must be rehabilitated prior to surrender of the EA.

All areas disturbed within the relevant mining tenures will be rehabilitated to a PMLU or managed as a non-use management area (NUMA). Any undisturbed land within the relevant mining tenures is also identified as a PMLU.

Transitional arrangements.

Ensham is an existing, mine operating under an existing site-specific EA. Enshams's initial PRCP was a transitional PRC Plan submitted pursuant to the transition notice issued on 13 August 2020. The transitional provisions of the EP Act operate to preserve existing outcomes, which outcomes are reflected in this PRC Plan.[2]. Ensham has pre-approved non-use management areas (NUMAs) which were detailed in land outcome document EA *EPML00732813*. As pre-approved NUMAs were provided under the EA in effect at the time, the following requirements do not apply to this PRC Plan -

- Justification of the NUMA.
- Evidence to support justification of the NUMA.

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[1] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.0.*

[2] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00*, p47

- Public interest evaluation.
- Compliance with the prohibition of voids located within a flood plain having to be rehabilitated to a stable condition.

This PRC Plan outlines how Ensham will manage NUMAs to achieve best practice management and minimise risks to the environment.

Land outcome documents.

Land outcome documents are defined in section 750 of the EP Act. The following land outcome documents are relevant to this PRC Plan.

Legislative requirement	Land outcome documents
land outcome document, for land, means the following documents relating to the land—	
(a) an environmental authority for a resource activity on the land;	1. EA *EPML00732813,* dated 3/9/2020, and subsequent versions
(b) a document made under a condition of an environmental authority mentioned in paragraph (a), if— (i) the document relates to the management of a void within the meaning of section 126D on the land, or the rehabilitation of the land; and (ii) the document was received by the administering authority before the assent date; and (iii) the administering authority has not, within 20 business days after the assent date, given notice to the holder of the environmental authority that the document is insufficient in a material particular relevant to a matter mentioned in subparagraph (i); and (iv) before the assent date, the document had not been superseded;	
(c) a document made under a condition of an environmental authority mentioned in paragraph (a), if— (i) the document relates to the management of a void within the meaning of section 126D on the land, or the rehabilitation of the land; and (ii) the environmental authority requires the document to be given to the administering authority on a stated day that is on or after the assent date, or does not state a day when the document must be given; and (iii) the document is received by the administering authority within 3 years after the assent date; and (iv) the administering authority does not, within 20 business days after receiving the document, give the holder of the environmental authority notice that the document is insufficient in a material particular relevant to a matter mentioned in subparagraph (i);	None.
(d) a report evaluating an EIS under the *State Development and Public Works Organisation Act 1971*, section 34D;	None.
(e) an EIS assessment report;	None.
(f) a written agreement between the holder of an environmental authority mentioned in paragraph (a) and the State that is in force on the assent date.	None.

Ensham notes that the land outcome document list is hierarchical. Where there is an inconsistency between these documents, on either the final outcome or details of the outcome, then the document appearing first in the list will prevail to the extent of the inconsistency[3].

Accuracy.

Mining lease spatial inaccuracies.

Mining lease polygons used in this PRC Plan were downloaded from *QSpatial – Queensland Spatial Catalogue* (see http://qldspatial.information.qld.gov.au/catalogue/custom/index.page). We note this spatial data has inaccuracies in areas (size and extent) and boundaries (points and lines) (Figure P0-1). Inaccuracies mean the sum of each mining lease area is greater than the total area when mining leases are presented together. In this PRCP, all spatial data presented is accurate on a per mining lease basis only and cumulative totals are the sum of each tenement.

Cartesian area versus spherical area.

The QSpatial attribute area data is based on the registered survey plan. The area for survey plans is calculated as a cartesian area, which assumes a flat plane. In contrast, this PRC Plan presents all polygons as spherical area. Spherical area takes account of the curvature of the surface of the earth.

The sizes of planned versus actual rehabilitation areas will vary with level of accuracy.

There are many challenging aspects of mined land rehabilitation that will result in unavoidable mismatches between the size of predicted rehabilitation polygons or areas and the size of actual rehabilitation areas. These include design tolerances, and assumptions made on material volume losses and gains in earthworks, and the cascading effect that changes to one area have on those surrounding it. Whilst this PRC Plan reports future rehabilitation areas with a high degree of accuracy i.e., up to two decimal places, this level of accuracy is not realistic in rehabilitation earthworks. The identified rehabilitation areas are therefore subject to the following levels of accuracy:

- For discrete rehabilitation or improvement areas, the hectares presented herein are accurate to ±15 %.
- For total areas of PMLUs and NUMAs, the hectares presented herein are accurate to ±5 %.

[3] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00, p48.*

Figure P0-1 Example of spatial data inaccuracies in QSpatial

1 PROJECT PLANNING

In accordance with section 126C(1)(b) and (c)(ii) of the EP Act, the rehabilitation planning part of the PRC plan must include a description of:	
• **each resource tenure, including the area of each tenure**	Table 1-1
• **the relevant activities to which the application relates**	Table 1-3
• **the likely duration of the relevant activities**	Section 1.1
• **how and where the relevant activities are to be carried out, including maps.**	Section 1.1.1 & Figure 1-4 Environmentally relevant activities

1.1 Project description

Ensham is an operating opencut and underground coal mine located 35 kilometres (km) northeast of Emerald, near Comet, in central Queensland (Figure 1-1). The opencut uses a single dragline to expose coal which is removed with excavators and trucks. The underground uses five continuous miner production units to extract coal and a coal clearance system to convey coal to surface stockpiles. Ensham produces a high energy, low ash thermal coal for export via Gladstone Port and domestic electricity generation at Gladstone Power Station. The mine has operated since 1993 and supports a workforce of approximately 600 employees and contractors.

There are eight relevant resource tenements (Table 1-1, Table 1-3, and Figure 1-2). The mining operation commenced at Yongala on ML 70049 in 1993 with other mining leases added since, totalling a combined area greater than 14,000 ha. The duration of mining as a whole is planned to cease in 2037 with the completion of rehabilitation in 2043, subject to the approval of mining lease renewal where required. The term of the existing mining leases are currently authorised to continue until 2028 and a renewal of these leases to 2050 will be sought to accommodate mining the identified resource and mine rehabilitation. Primary mine features at Ensham include open-cut pits and overburden dumps, Underground infrastructure, rehabilitation, and Mine infrastructure (Figure 1-3). As this is a transitional PRC Plan, Ensham is not required to demonstrate how aspects of the mine site have been designed for closure for existing or approved disturbance.[4]

[4] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00, p19.*

Table 1-1 Ensham mining leases

70049	Sungela Pty Ltd Bowen Investment (Australia) Pty Ltd	28/01/1993	31/01/2028	1,648.0
7459	Sungela Pty Ltd Bowen Investment (Australia) Pty Ltd	21/04/1994	31/01/2028	6,154.0
70367	Sungela Pty Ltd Bowen Investment (Australia) Pty Ltd	21/04/1994	31/01/2028	1,004.0
7460	Sungela Pty Ltd Bowen Investment (Australia) Pty Ltd	21/04/1994	31/01/2028	774.3
70326	Sungela Pty Ltd Bowen Investment (Australia) Pty Ltd	15/09/2005	31/1/2028	25.7
70365	Sungela Pty Ltd Bowen Investment (Australia) Pty Ltd	04/11/2010	31/01/2028	2,766.0
70366	Sungela Pty Ltd Bowen Investment (Australia) Pty Ltd	04/11/2010	31/01/2028	254.3
700061	Sungela Pty Ltd Bowen Investment (Australia) Pty Ltd			2119

Table 1-2 Ensham affected lands and landholders

70049	Lot 3 CP911009 Lot 2 SP165518	Private landholder Private landholder
7459	Lot 31 CP864573 Lot 32 RP908643 Lot 30 CP864574 Lot 33 RP864576	Sungela Pty Ltd (85%) Bowen Investment (Australia) Pty Ltd (15%)
70367	Lot 31 CP864573 Lot 32 RP908643	Sungela Pty Ltd (85%) Bowen Investment (Australia) Pty Ltd (15%)
7460	Lot 31 CP864573 Lot 32 RP908643	Sungela Pty Ltd (85%) Bowen Investment (Australia) Pty Ltd (15%)
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70365	Lot 31 CP864573 Lot 32 RP908643	Sungela Pty Ltd (85%) Bowen Investment (Australia) Pty Ltd (15%)
70366	Lot 30 CP864574	Sungela Pty Ltd (85%) Bowen Investment (Australia) Pty Ltd (15%)
700061	Lot 8 TT345	Cowal Agriculture Holdings Pty Ltd
	Lot 6 TT309	Trustee – Central Highlands Regional Council (CHRC) Registered Lessee - Private landholder
	Lot 7 TT309	Trustee – CHRC Registered Lessee - Saratoga Holdings Pty Ltd
	Lot 2 CP911010	Private landholder
	Lot A AP7202	Trustee – CHRC Registered Permittee - Private landholder

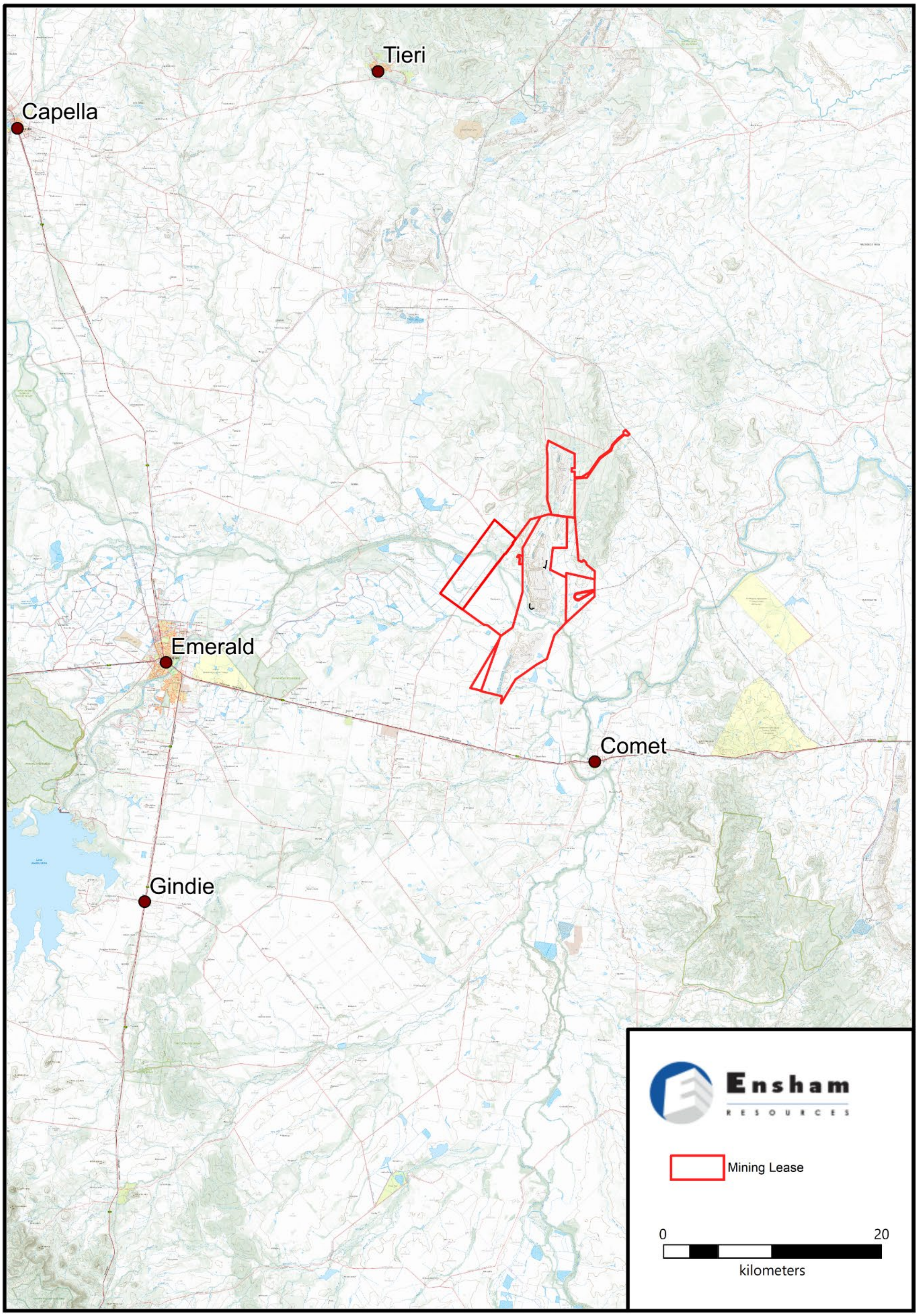


Figure 1-1 Ensham location in Central Queensland

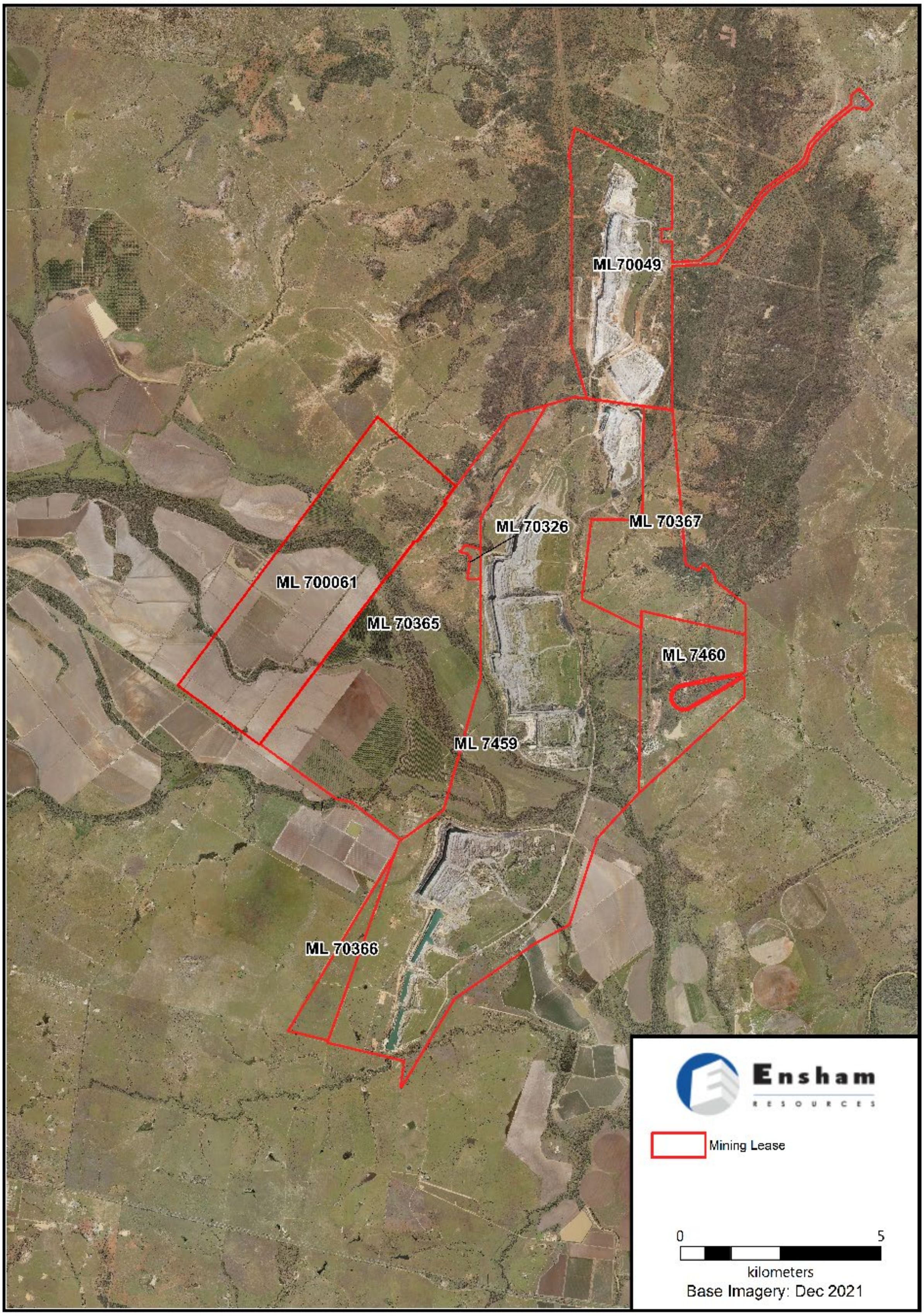


Figure 1-2 Ensham resource tenements (mining leases)

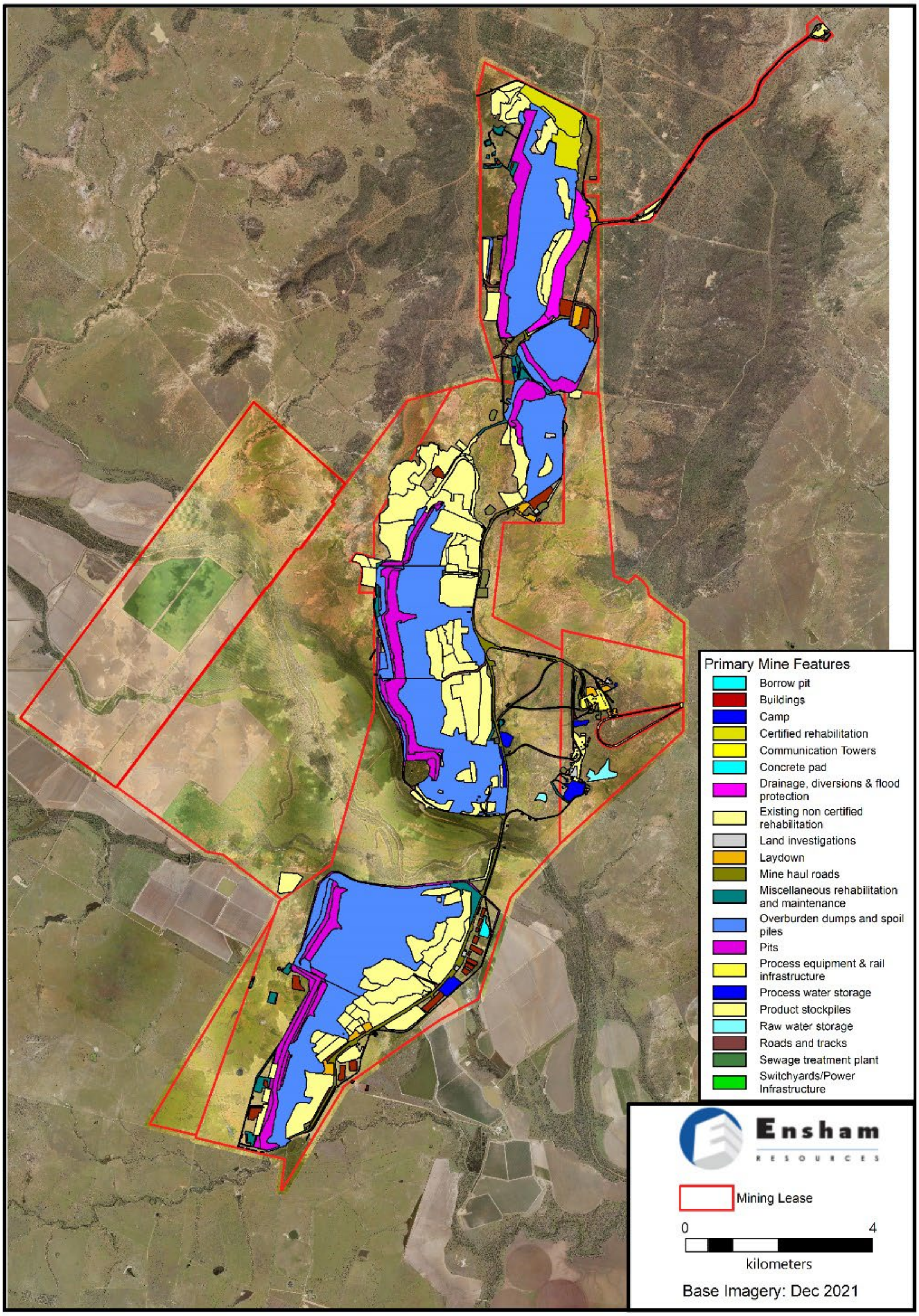


Figure 1-3 Ensham primary mine features

1.1.1 Environmentally Relevant Activities (ERA's)

Ensham's EA (EPML00732813) authorises the carrying out of the below listed ERA's. Not all ERA's currently occur in all mining leases despite that all ERA's are authorised for all mining leases. While open cut mining operations are downsizing, it is not possible to define the future commencement or locations of ERA's at Ensham specifically. A renewal is planned to be sought for all mining leases where required as notably, the mine plan and progression is everchanging with conditions and circumstances.

Table 1-3 Occurrence of Ensham's environmentally relevant activities

Mining lease (ML)	Relevant activities	Start	Finish
70049	Mining black coal	1993	2028
	Extraction & screening	1993	2028
	Waste disposal	1993	2028
7459	Mining black coal	1994	2043
	Chemical storage	1994	2043
	Extraction & screening	1994	2043
	Regulated waste storage	1994	2043
	Waste disposal	1994	2043
	Sewage treatment	1994	2043
70367	Mining black coal	1994	2043
7460	Mining black coal	1994	2043
	Sewage treatment	1994	2043
70326	Mining black coal	2005	2043
70365	Mining black coal	2010	2043
70366	Mining black coal	2010	2043
700061	Mining black coal		2043

*all of Ensham's ERA's are approved for all of Ensham's ML's and can occur in approved ML's different to the list above from time to time.

It is noted that the below figure does not display the extent of ERA 13 – mining black coal, as it extent is variable in both open cut and underground operations across the mining leases. It is considered that black coal mining occurs across the mining leases as a whole.

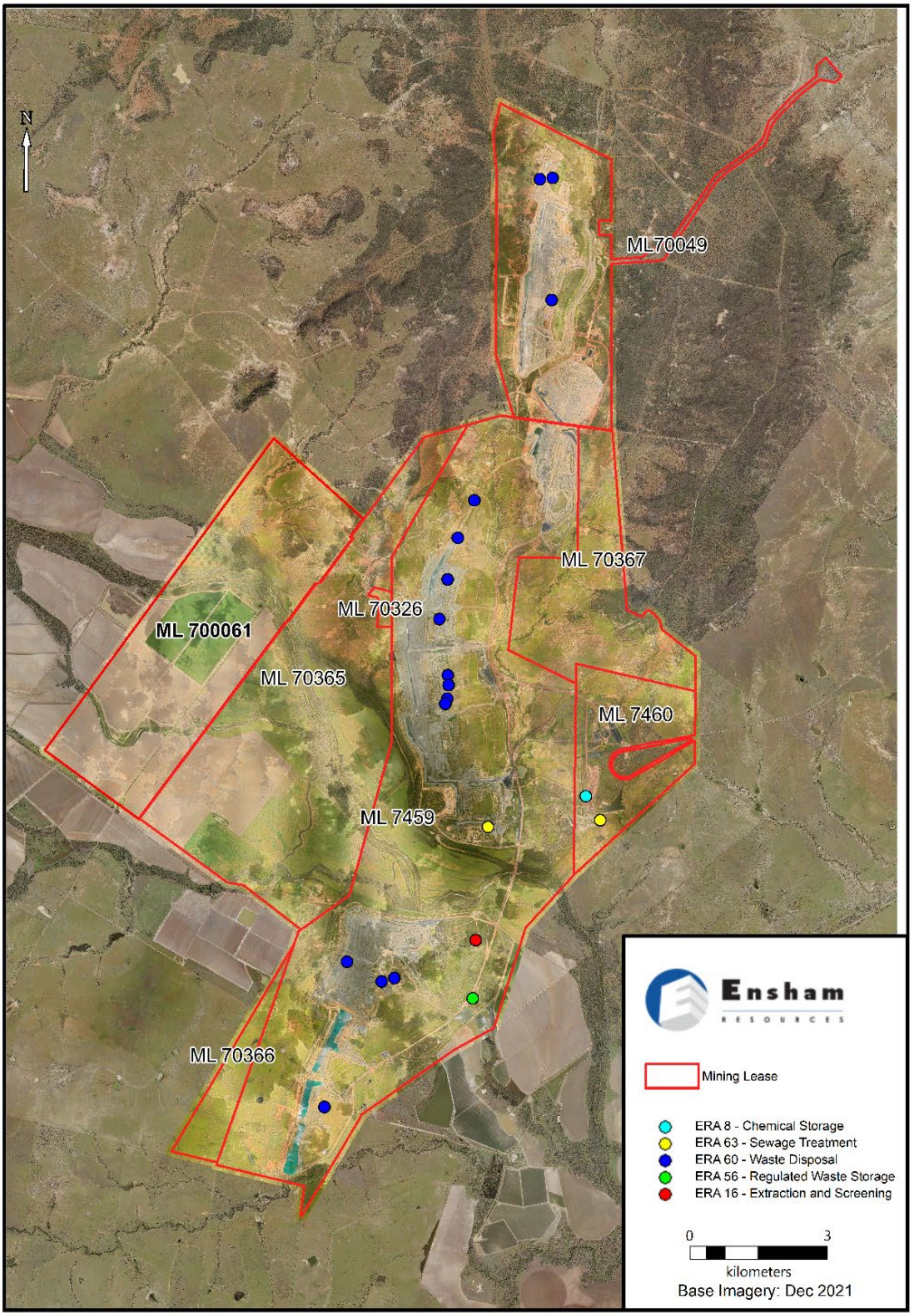


Figure 1-4 Environmentally relevant activities

1.2 Existing rehabilitation

Ensham has completed more than 1,600 ha of opencut mine rehabilitation since 2001 (Figure 1-5, Figure 1-6, Figure 1-7 and Figure 1-8). This equates to approximately one third of total mining disturbances. Most existing rehabilitation has a target PMLU of beef cattle grazing. Portions of existing rehabilitation have been approved as certified under the EP Act (Table 1-4) or not yet applied for.

Table 1-4 Ensham existing rehabilitation

Certified (2018)	97.2
Certified (2021)	565.63
Not yet applied for or certified	1064.82
TOTAL	**1727.65**

Figure 1-5 Existing rehabilitation at AB Pit (ML7459)

These areas are currently used for beef cattle grazing.

Figure 1-6 Existing rehabilitation at CDE Pit (ML7459)

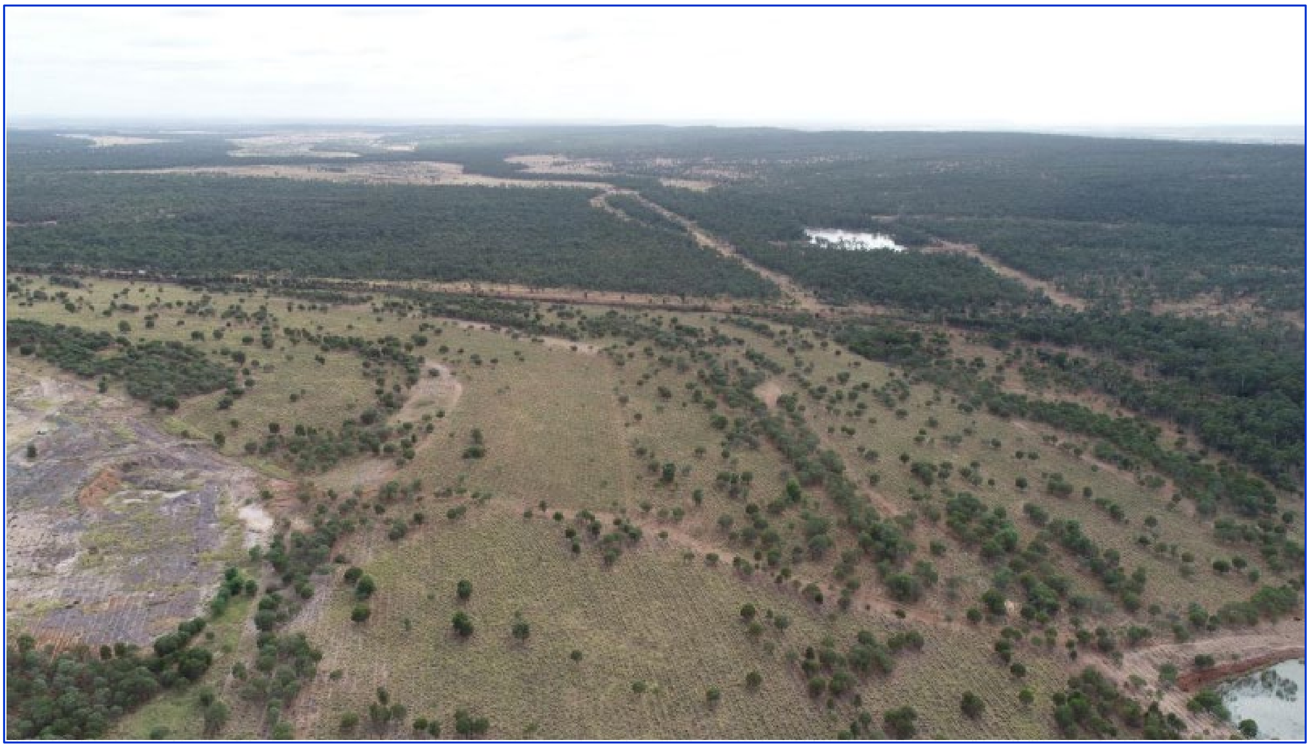


Figure 1-7 Existing rehabilitation at Y Pit (ML70049)

This area was certified in 2019 and is currently used for beef cattle grazing.

1.3 Progressive rehabilitation

Ensham have specified areas of progressive rehabilitation of the remainder life of the Ensham mine, as incorporated into the PRCP schedules. It is further noted that the spatial information provided to accompany this document meets the minimum 10-year period.

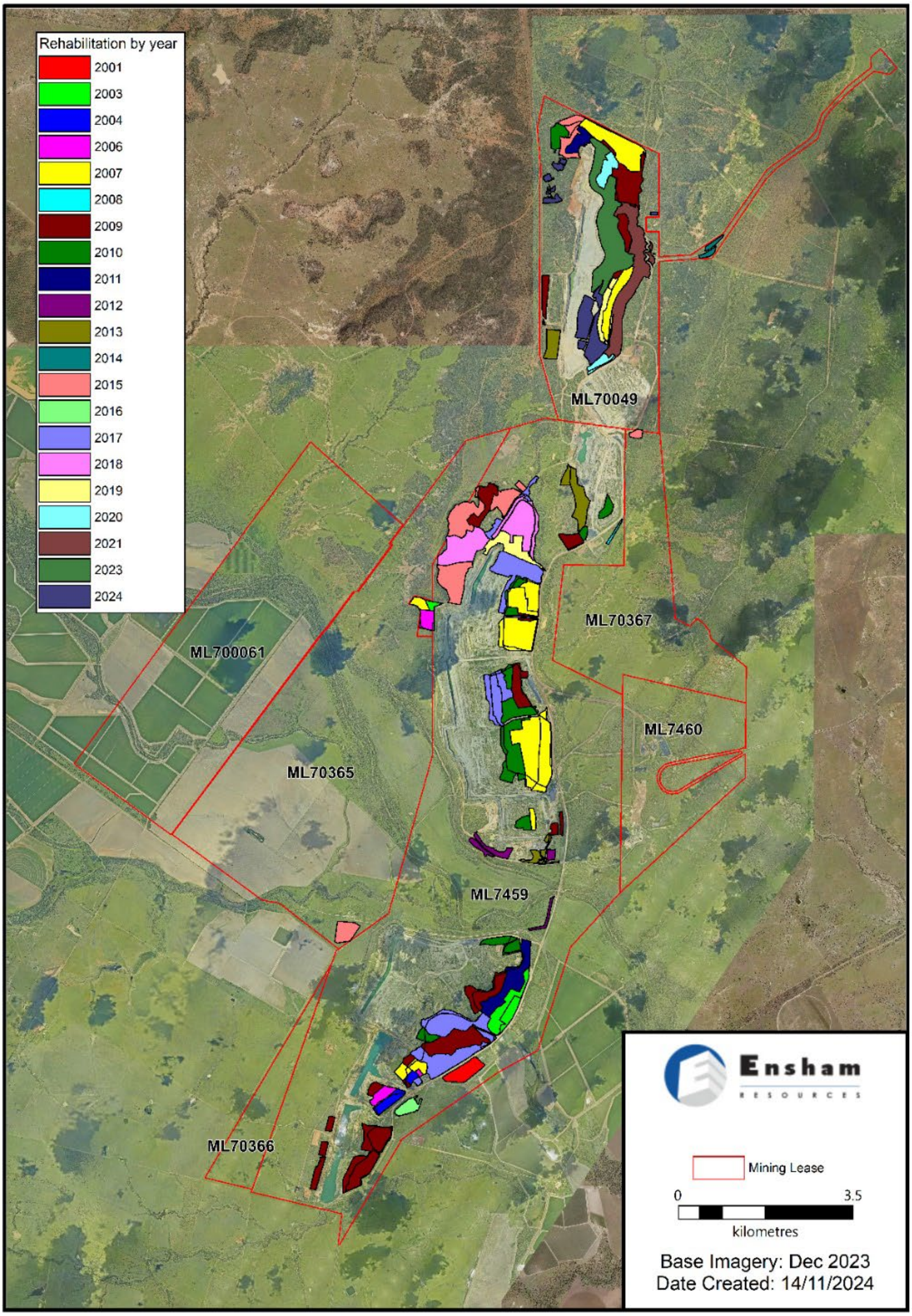


Figure 1-8 Ensham existing rehabilitation

1.4 Baseline Information

1.4.1 Site topography

The pre-mining topography at Ensham (Figure 1-9) is described as follows:

- Terrain in the northern half of the mine comprises mainly mildly dissected gently to moderately sloping and undulating lands, which form slopes and outwash plains flanking Boggy Creek. Erosion has occurred below the elevated plateau remnants that occur in the north. Plateau remnants feature steep escarpments, with sloes in the order of 33% to 66% gradient or more, with local relief up to 50 m between plateau crests and adjacent escarpment foot slopes.
- In the southern half, terrain is essentially gently sloping. This encompasses the extensive floodplain area of the Nogoa River and its major tributaries which flow through the area in a south-easterly direction within a broad alluvial tract approximately 4 km wide.

Key post-mining landform design parameters for rehabilitation are within the natural range of geometries of local landforms e.g., slope gradients and lengths.

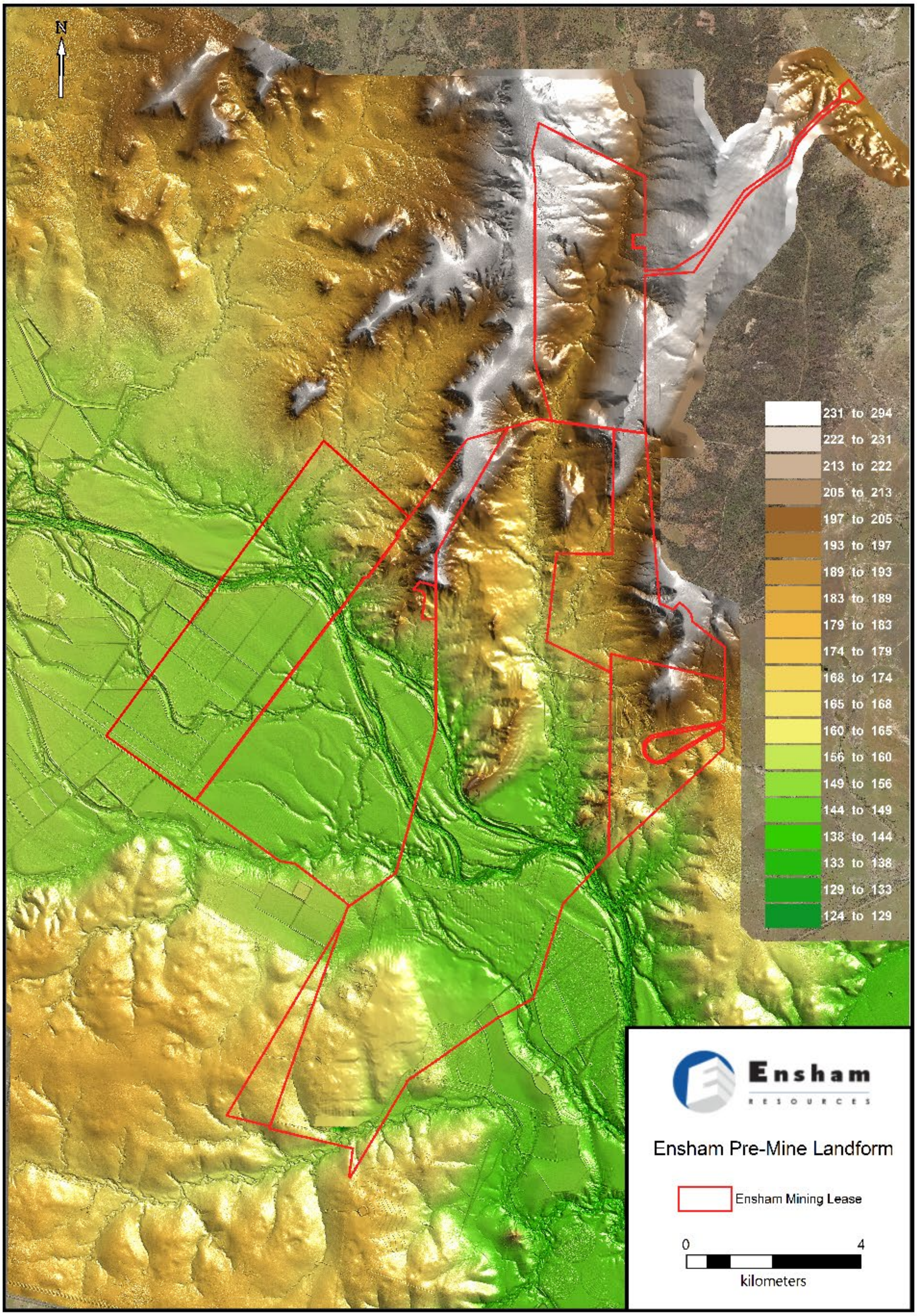


Figure 1-9 Ensham pre-mining topography

1.4.2 Climate

1.4.2.1 General

Ensham is in the Central Highlands Region which has a sub-tropical climate characterised by high variability in rainfall, temperature, and evaporation. Drought, flood, heatwaves, and frost are features of the climate. In general, winter days are warm and nights are cool, while summer days are hot and nights are warm. Rainfall summer dominant with almost half falling between December to February, often as high intensity thunderstorms.

According to CSIRO (2016), long term climatic modelling for Eastern Australia has predicted with very high confidence an increase in average minimum and maximum temperatures, the intensity of extreme rainfall events and the projection of droughts. A medium confidence prediction also indicates that there will be a decrease in average rainfall during winter and spring.

The closest Bureau of Meteorology (BoM) stations are Comet Post Office and Emerald Post Office.

1.4.2.2 Temperature, rainfall, and evaporation

December and January are the warmest months, reaching average high temperatures of 34.6 degrees Celsius (^{0}C) (Table 2-1). June and July are the coolest months. Humidity is fairly consistent throughout the year with morning ranging from 55 – 69 % and afternoons ranging from 33 – 47 %, with spring months drier than the rest of the year.

Average monthly rainfall approximately 17 mm in July to almost 90 mm in February. The average rainfall is received in about 60 rainy days. Almost half of annual rainfall occurs in summer, between December and February.

Table 1-5 Average temperatures rainfall and evaporation Emerald Airport from 1992 to 2020 (BoM 2020a)

Month	Temperature (°c)		Rainfall
	Min	Max	(mm)
January	22.3	34.6	84.2
February	22.1	33.8	87.6
March	20.5	32.8	59.7
April	17.0	30.0	28.9
May	13.1	26.4	18.0
June	10.3	23.4	30.4
July	9.1	23.4	17.2
August	10.0	25.5	20.3
September	13.6	29.2	25.6
October	17.1	31.8	44.2
November	19.5	33.5	50.4
December	21.4	34.5	81.5

Evaporation exceeds rainfall in all months (Table 1-6). Unremarkably, the highest deficits occur in the warmer months. The annual average moisture deficit is approximately 1,500 mm.

Table 1-6 Evaporation and moisture deficits (BoM 2020b)

Month	Rainfall (mm)	Evaporation (mm)	Moisture deficit (mm)
January	124.8	229.5	104.7
February	161.8	182	20.2
March	45.4	180.2	134.8
April	6.6	162.8	156.2
May	9.8	121	111.2
June	17.2	102.2	85
July	11.8	104.9	93.1
August	13.6	152.8	139.2
September	6.2	162.7	156.5
October	89	206.2	117.2
November	38.4	249.5	211.1
December	42.6	223.9	181.3
Total	**567.2**	**2077.7**	**1510.5**

1.4.3 Geological setting

Ensham mine is located within the western Bowen Basin. The stratigraphic sequence across the mining lease is comprised of unconsolidated Quaternary sediments overlying consolidated Permian and Triassic materials (Table 1-7). The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular (Ensham Resources 2018).

The coal deposits targeted for mining are located within the Rangal Coal Measures, the uppermost Permian unit (Figure 1-10). The Rangal Coal Measures are 100 m thick, and subcrop over a strike length of approximately 80 km around the northern and eastern limits of the mine. The coal seams which occur at Ensham include the following:

- The Aries seam (A1),
- The Aries 2-Castor seam (A2C), 4.3m thick,
- The Castor Seam Lower Split (C22), between 0.2 and 0.4 m thick,
- The Pollux Seam (P), present 6 to 12 m below the C22 Seam (Figure 1-11),
- The Orion Seam (Q)*, and
- The Virgo Seam (V)*.

*these seams are not mined at Ensham

Table 1-7 Ensham stratigraphic summary

Age	Unit	Description
Quaternary	-	Alluvium, comprising soil, silt, clay, sand, and gravel.
Tertiary	Emerald Formation	Mudstone, sandstone, conglomerate, siltstone sediments, weekly consolidated in parts. Tertiary volcanics (basalt) are also mapped as being present over 10 km to the west of the mine.
Triassic	Rewan Group	Mudstone with lithic sandstone interbeds.
Permian	Rangal Coal Measures	Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams. Coal seams include the Aries, Castor, Pollux and Orion

Age	Unit	Description
		seams. The main economic seams at Ensham are the Aries 2 and Castor seams.
	Burngrove Formation	Sandstones, siltstones and mudstones, and banded coal seams frequently interbedded with tuff and tuffaceous mudstones - coal seams include the Virgo and Leo seams.
	Fair Hill Formation	Lithic and feldspathic labile sandstone, siltstone, mudstone and conglomerate.
	Macmillian Formation	Lithic and feldspathic sublabile mudstone, siltstone and sandstone.

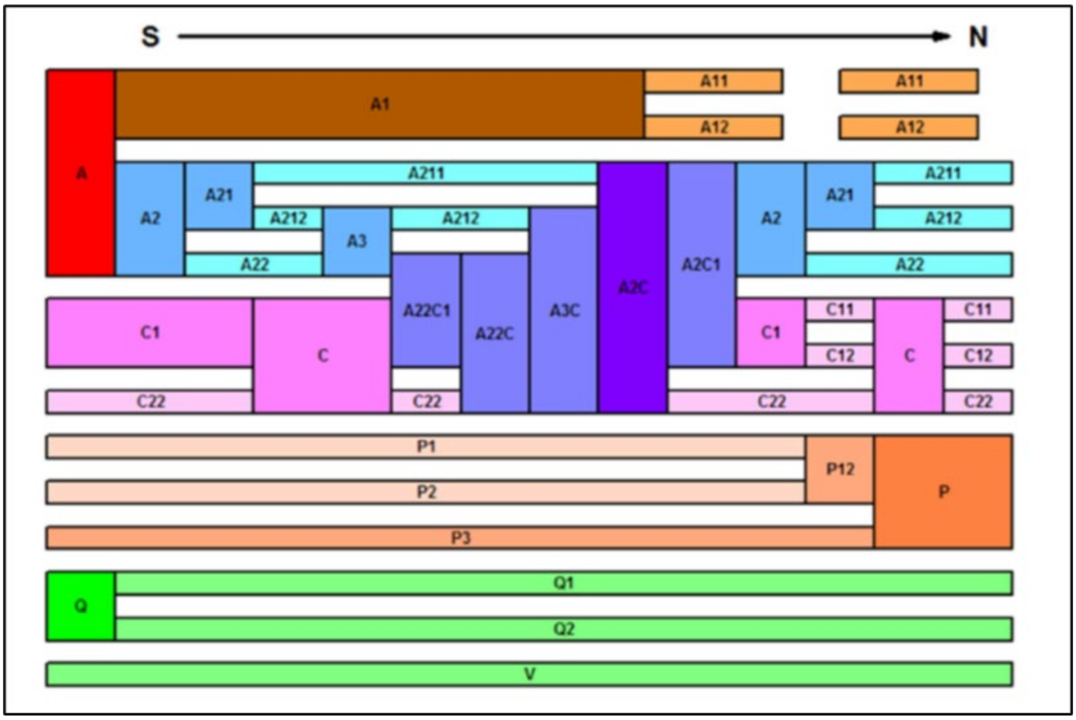


Figure 1-10 Rangal coal measures at Ensham

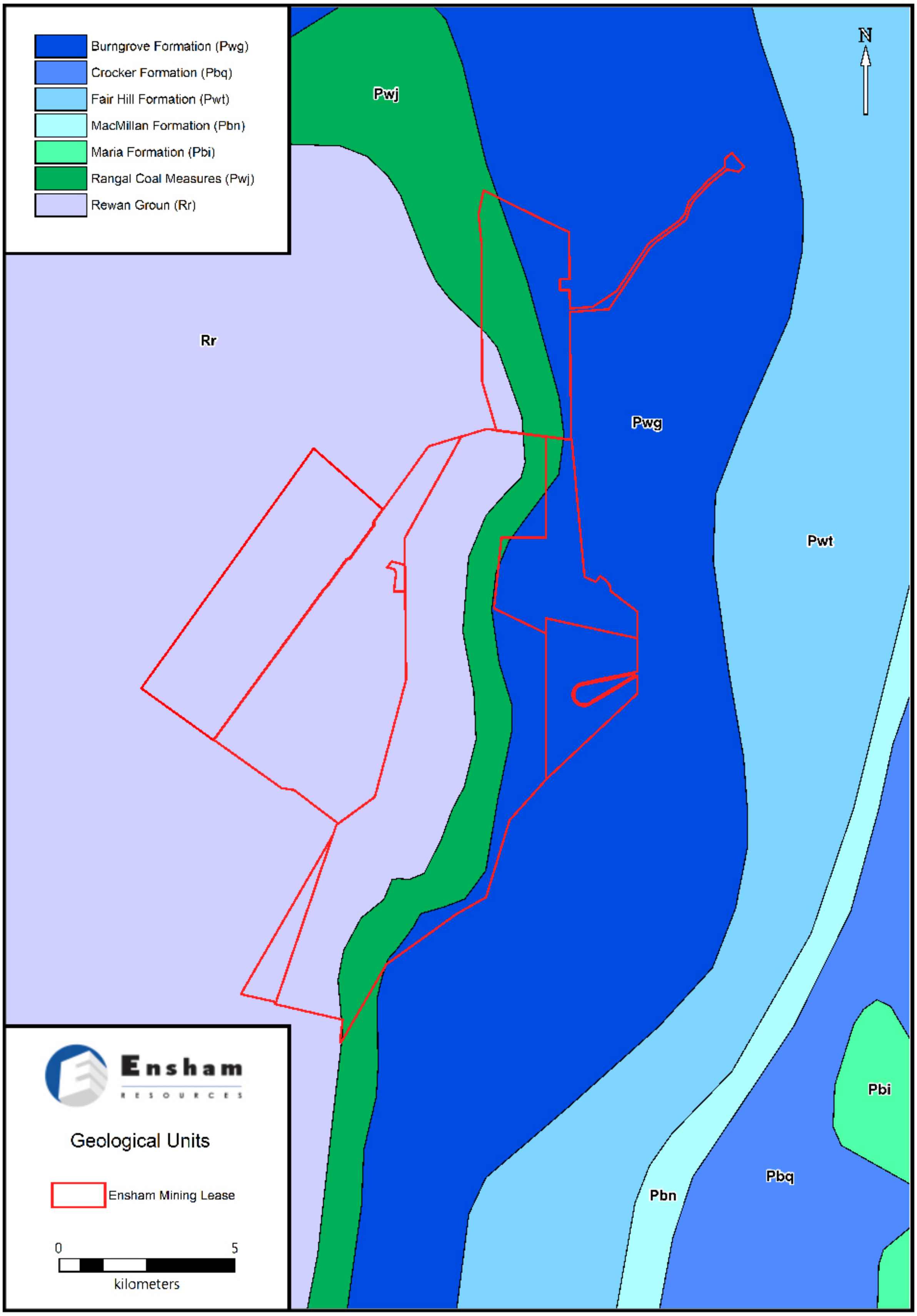


Figure 1-11 Geological units at Ensham

1.4.4 Site hydrology and fluvial units

Ensham is located approximately 10 km upstream of the confluence of the Nogoa and Comet Rivers and encompasses parts of the northern and southern floodplains of the Nogoa River. Boggy Creek is a smaller ephemeral tributary of the river which flows from the north, parallel to the exiting mine. Winton Creek is another ephemeral tributary which traverses the mine site on the south side of the river.

The Nogoa River forms part of the headwaters of the Fitzroy River Basin and includes the major tributary of Theresa Creek. The Nogoa and Comet Rivers combine to form the McKenzie River, which further downstream joins the Dawson River to become the Fitzroy River. The Fitzroy River flows to the Coral Sea at Rockhampton and is one of eastern Australia's largest river catchment systems.

Key features of fluvial networks at Ensham are as follows:

- The Nogoa River dissects the mine (Figure 1-12). The flood plain has been temporarily restricted to 1,600 m width by flood protection levees. PMLU – Flood Protection Landform will ultimately re-establish a minimum floodplain width of 2,000 m.
- Ephemeral tributaries of the Nogoa River that flow across the mining leases are Boggy and Winton Creeks.
- Corkscrew Creek, an ephemeral tributary of the Comet River, flows through the southern corner of ML 7459.
- A licenced diversion exists on Boggy Creek. Rehabilitation of this diversion to re-establish comparative up- and down-stream geomorphological characteristics commenced in 2020 and landform development was completed during 2021. This is PMLU – Boggy Creek Diversion.

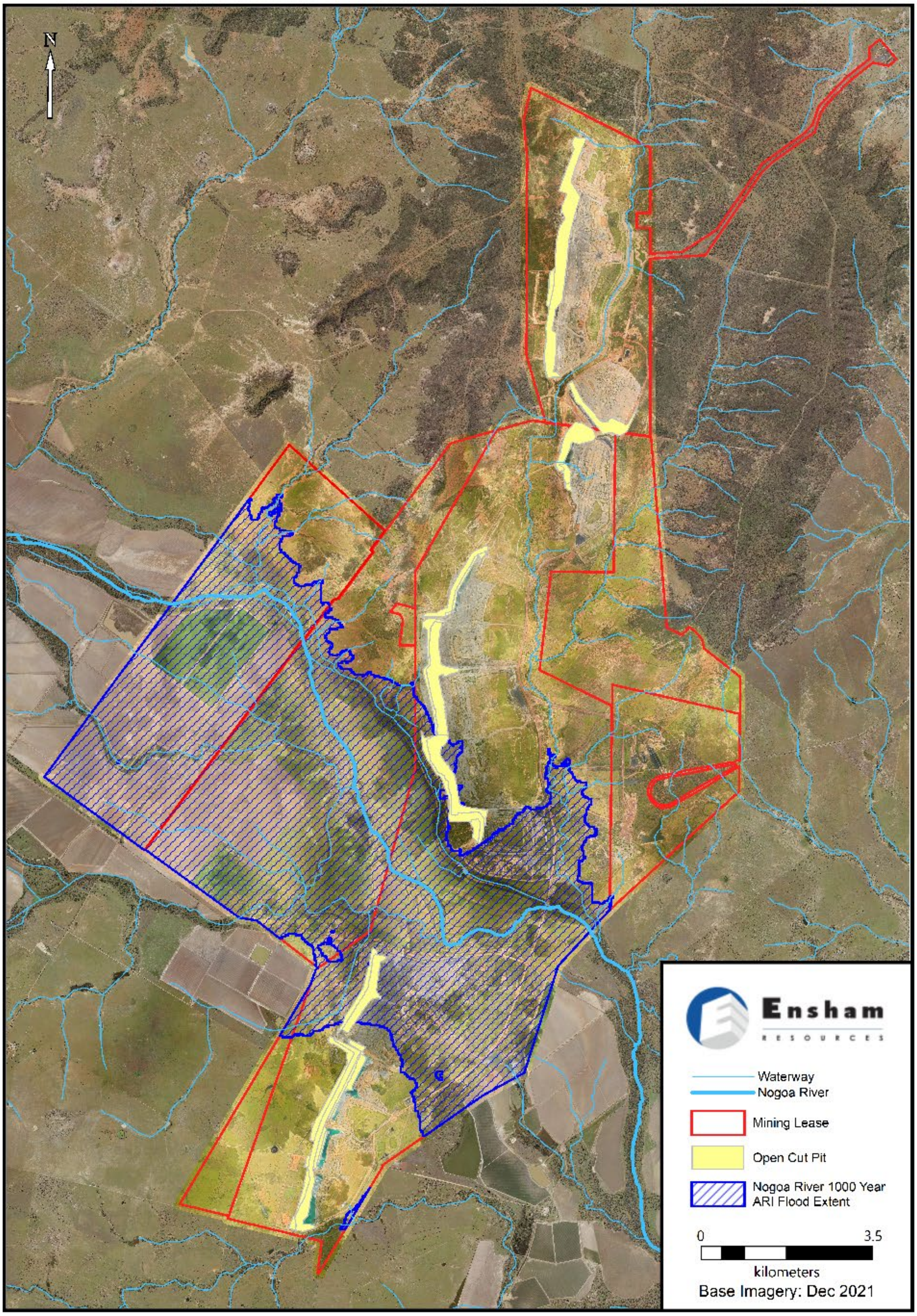


Figure 1-12 Nogoa River pre-mining floodplain extents

1.4.5 Groundwater

There are two main groundwater bearing units at Ensham, namely the shallow alluvium (Quaternary aged sediments) association with the Nogoa River floodplain and the much deeper Permian aged Rangal Coal Measures. These units are not hydraulically connected and are separated by a low permeability unit.

The alluvium is an unconfined system recharged by rainfall and irrigation practices. Its water is generally very saline and unsuitable for uses such as stock watering or irrigation. The alluvium is not well connected with the Nogoa River (Figure 1-13). Notwithstanding, groundwater monitoring by Ensham indicates standing water levels are influenced by rainfall and large flooding events (Figure 1-14). This creates large fluctuations in water level and quality.

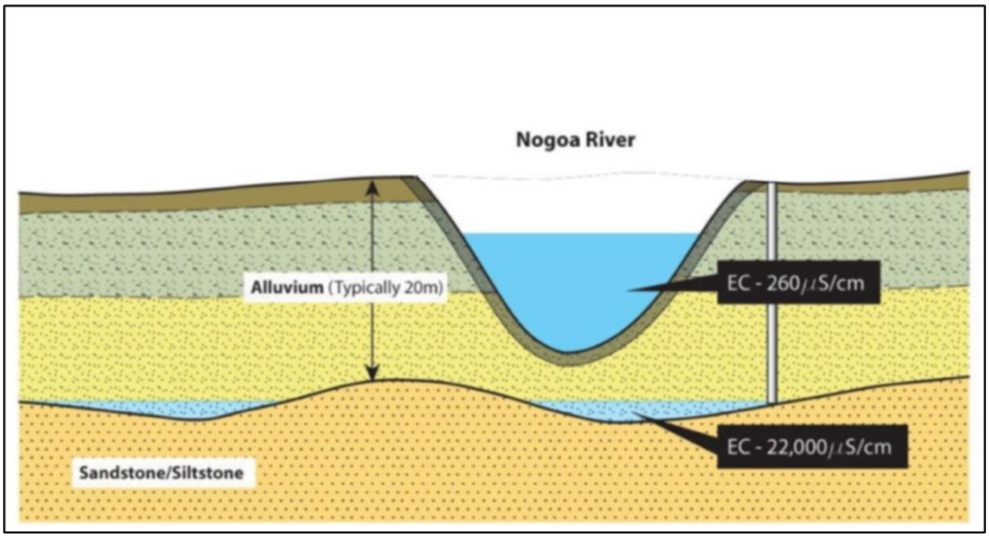


Figure 1-13 Conceptual cross-section of the Nogoa River floodplain and Quaternary alluvium aquifer (AGE 2006)

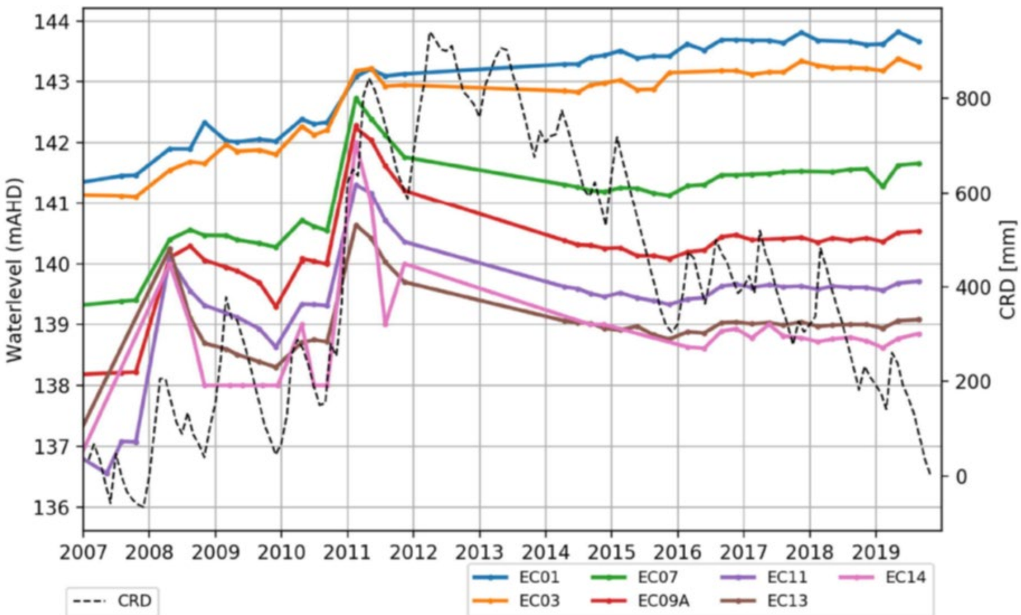


Figure 1-14 Standing water levels in Quaternary alluvium monitoring bores and cumulative rainfall departure (CRD)

Groundwater in the coal seams is also saline and not suitable for stock water supply or irrigation. These aquifers are confined by overlying and underlying shale and mudstones and exhibit relatively low transmissivity and recharge rates. Storage and movement of groundwater occurs within the coal seams, primarily along cleats and fissures and occasionally within minor fault zones. Groundwater quality is variable but typically very poor within this aquifer due to high salinity.

1.4.6 Soils

Story *et al.* (1967) describe several land systems and associated soil groups at Ensham (Table 1-8 and Figure 1-15 Land Systems at Ensham). There are six major soil groups present, each with one or more soil type variants (Table 1-9). Soils are generally highly weathered and chemically and physically poor, with salinity and sodicity limiting productivity at depth i.e., saline and sodic subsoils.

Table 1-8 Land systems at Ensham

Land system	Description	Approximate area within mining lease boundaries (ha)
Humboldt	Blackbutt and brigalow on weathered clay plains occurring in most parts of the area; texture contrast and cracking clay soils.	3314
Monteagle	Lowlands with box and texture-contrast soils on undissected Tertiary land surface throughout the area except in the extreme south and north-east.	1309
Blackwater	Characterized by brigalow plains and cracking clay soils on weathered tertiary clay and older rocks along the central axis of the area.	2438
Comet	Alluvial plains with brigalow and cracking clay soils, often flooded, along major streams.	5349
Durandella	Hills with lancewood and narrow-leaved ironbark on weathered Tertiary and Permian rocks in the north-west, center, and south-east; shallow rocky soils.	1923
Girrah	Lowlands with downs and brigalow and cracking clay soils on unweathered Permian shale and lithic sandstone in the north and center.	415

Table 1-9 Soil groups at Ensham (from Hansen 2006)

Major soil group	Soil type	Soil classification	Soil description
1 - Shallow Rocky Soils	1	Leptic Rudosols	Soil type 1 occurs on low rocky hills and steep escarpment slopes and eroded plateau remnants. These soils are shallow (<0.5m), exhibit very little profile development and contain gravel and rock cobbles from various geological formations.
2 – Moderately Shallow Gravelly Sands, Loams or Clay Soils	2.1	Colluvic Clastic Rudosols	This soil group occurs on eroded middle and lower slopes and broad low gravelly rises. These soils are shallow to medium depth and comprise uniform or weakly gradational sands, loamy sands or sandy loams, loams or clayey soils with varying amounts of ferrundinous and siliceous gravel or stone. These soils exhibit low soil fertility and water storage capacity.
	2.2	Regolithic Chemic Tenosols	
	2.3	Acidic Brown Clastic-Leptic Rudosols	
3 – Gradational Red and Yellow Earth Soils	3.1	Petroferric Red Kandosols-Tenosols	These soils area present on the elevated dissected and eroded Tertiary plateau remnants and undulating plains associated with the Tertiary Emerald Formation. These soils include sandy, sandy loam or loamy surface soils grading to red, reddish brown or yellowish-brown sandy loam to light to medium massive or structured clay subsoils often with appreciable amounts of ferruginous gravel.
	3.2	Acidic Mesotrophic Red Kandosols	
	3.3	Haplic Mesotrophic Red Ferrosols	
4 – Texture Contrast (Duplex) Soils	4.1	Subnatric Brown Sodosol	Group 4 soil types have formed on Permo- Triassic sedimentary rocks, on gently inclined slopes, dissection slope interfluves, broad low rises and plains and on alluvial terraces and drainage flats. These soils are sandy, silty or loamy on the surface with a clear to abrupt change to a clayey subsoil horizon.
	4.2	Eutrophic Mesonatric Brown Sodosols	
	4.3	Eutrophic Subnatric Yellow Sodosols	
5 – Uniform Fine-textured (Non-cracking) Clay Soils	5.1	Sodic Pedaric Brown Dermosols	These soil types are present on erosional plains, levees and high terraces along stream systems, undulating alluvial plains and associated with cracking clays of Soil Group 6. These soils exhibit uniform profiles or weakly gradational profiles where clay content may increase slightly with depth.
	5.2	Sodic Pedaric Brown Dermosols	
	5.3	Sodic Pedaric Brown Dermosols	
6 – Cracking Clay Soils	6.1	Epipedal Black, Grey or Black Vertosols	Group 6 soil types form the dominant soil type within the alluvial plains associated with the Nogoa River and its tributaries. These soils have uniform medium to high clay content, pronounced swelling and shrinkage properties and commonly feature gilgai.
	6.2	Endohypersodic, Epipedal Black, Grey or Brown Vertisols	

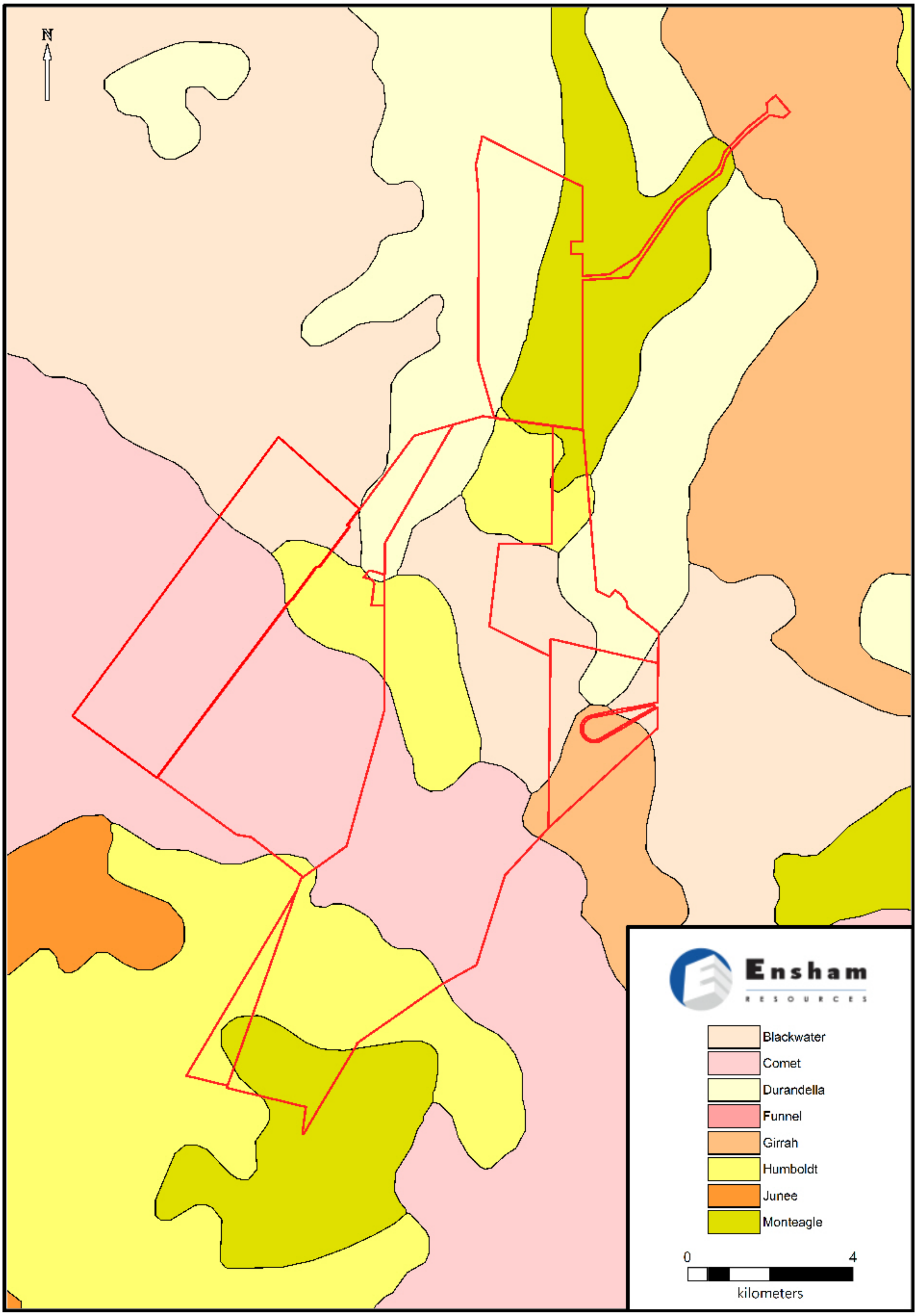


Figure 1-15 Land Systems at Ensham

1.4.7 Land stability

Many land systems and associated soils found in the northern part of Ensham have moderate to high erosion potential and are unsuitable for clearing and agricultural development. The initial EIS found soil stability was variable (Hollingswoth, Dames and Moore (1990) and noted the following:

> *"Overall, the Yongala property, which comprises the major part of the study area, is currently in a moderately to in places severely degraded condition…..those areas which are potential susceptible to degradation due to landform, soil type and drainage conditions, already reflect a substantial level of degradation.*
> *In places, very deep erosion gullies have developed in many of the depressional drainageways within the property…The size and severity of gullying is attributable to the generally dispersive nature of the soils and substrate materials within those land units and uncontrolled surface water runoff."*

A more recent assessment over the central parts of Ensham found soils were variably affected by an accumulation of salts which affected structural stability (Hansen 2006). For example, major soil groups 2, 4, 5 and 6 are moderately to highly saline (refer to Table 1-9). This study concluded that due to accumulated salts, soils will generally have low infiltration and hydraulic conductivity and be prone to dispersion and excessive erosion if exposed to runoff.

1.4.8 Vegetation

Much of the land at Ensham had been cleared of vegetation for agricultural development prior to mining. Vegetation mapping shows there are 13 regional ecosystems within the mining leases (Table 1-10 and Figure 1-16). There are four Threatened Ecological Communities identified as potentially occurring (Table 1-11).

Table 1-10 Regional ecosystems at Ensham

Regional ecosystem	Description	Biodiversity status	VM Act class[1]
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	Endangered
11.3.25e	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Of concern	Least concern
11.4.9a	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Endangered	Endangered
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of concern	Of concern
11.7.1	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrust	Of concern	Least concern
11.7.2	*Acacia spp*. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	No concern at present	Least concern
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	Endangered	Endangered

Regional ecosystem	Description	Biodiversity status	VM Act class[1]
11.7.4	*Eucalyptus decorticans* and/or *Eucalyptus spp*., *Corymbia* spp., *Acacia spp*., *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust	No concern at present	Least concern
11.5.9b	*Eucalyptus crebra* and other *Eucalyptus spp*. and *Corymbia spp*. woodland on Cainozoic sand plains and/or remnant surfaces	No concern at present	Least concern
11.7.1/11.7.2	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrust and *Acacia spp*. woodland on Cainozoic lateritic duricrust. Scarp retreat zone.	Of concern/least concern	Least concern
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland on fine-grained sedimentary rocks	No concern at present	Least concern
11.7.4/11.7.2	*Eucalyptus decorticans* and/or *Eucalyptus spp*., *Corymbia spp*., *Acacia spp*., *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust and *Acacia spp*. woodland on Cainozoic lateritic duricrust. Scarp retreat zone.	No Concern/no concern	Least concern
11.3.1/11.3.25	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains and *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines.	Endangered/of concern	Endangered
11.3.25e/11.3.3	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines and *Eucalyptus coolabah* woodland on alluvial plains.	Of concern/of concern	Least concern
11.3.1/11.3.3/ 11.3.37/11.3.2	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains, *Eucalyptus coolabah* woodland on alluvial plains, *Eucalyptus coolabah* fringing woodland on alluvial plains and *Eucalyptus populnea* woodland on alluvial plains.	Endangered/of concern/ no concern/of concern	Endangered
11.3.25/11.3.3/ 11.3.3c	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines and *Eucalyptus coolabah* woodland on alluvial plains	Of concern/of concern	Least concern
11.7.2/11.7.4	*Acacia spp*. woodland on Cainozoic lateritic duricrust. Scarp retreat zone and *Eucalyptus decorticans* and/or *Eucalyptus spp*., *Corymbia spp*., *Acacia spp*., *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust.	No concern/ no concern	Least concern
11.7.2/11.7.1	*Acacia spp*. woodland on Cainzoic lateriic duricrust. Scarp retreat zone and *Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slope on Cainozoic lateritic duricrust.	No concern / least concern	Least concern

Regional ecosystem	Description	Biodiversity status	VM Act class[1]
11.4.9/11.4.9b/ 11.4.8	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains and *Eucalyptus cambageana* woodland to open forest *with Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains.	Endangered/endangered	Endangered
11.9.2/11.9.1	*Eucalyptus melanophloia +/- E. orgadophila* woodland on fine-grained sedimentary rocks and *Acacia harpophylla-Eucalyptus cambageana* woodland to open forest on fine-grained sedimentary rocks	No concern/endangered	Least concern

Table 1-11 Threatened ecological communities potentially occurring at Ensham (DAWE 2021)

Name	Status	Type of presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural grasslands of the Queensland Central Highlands and norther Fitzroy Basin	Endangered	Community likely to occur within area
Poplar Box grassy woodland on Alluvial plains	Endangered	Community likely to occur within area
Weeping Myall woodlands	Endangered	Community likely to occur within area

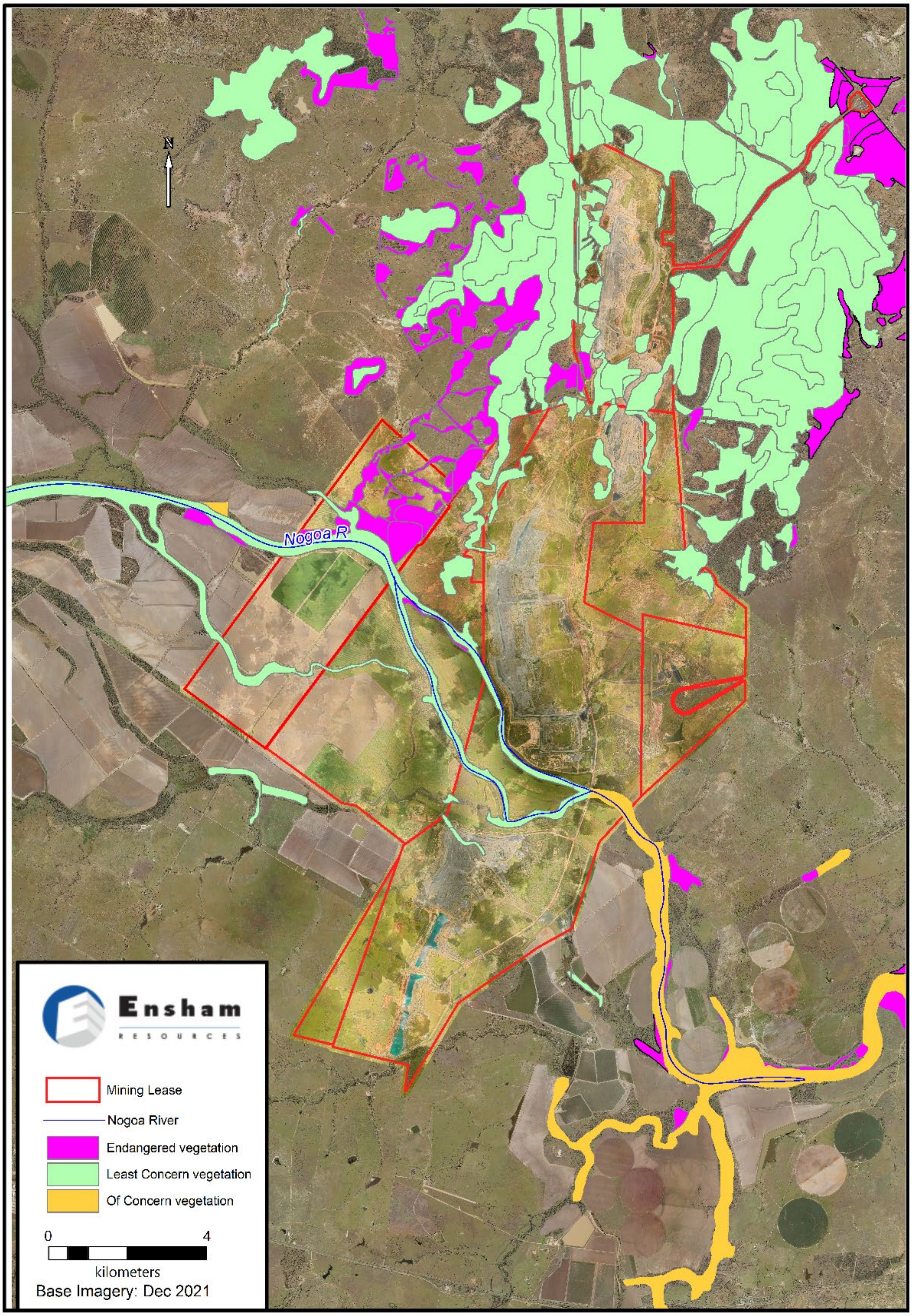


Figure 1-16 Regional ecosystems mapped at Ensham

1.4.9 Fauna

Desktop review indicates that 504 species have been recorded within a 50 km radius of Ensham (Queensland Government 2021). The species includes 22 amphibians, 103 reptiles, 27 ray-finned fish, 69 mammals, 14 insects and 269 birds. Of these, 23 species are identified as Matters of National Environmental Significance (MNES) as threatened species (Table 1-12). Field surveys conducted by Hansen Consulting (2006) recorded 193 terrestrial vertebrate species were recorded during two survey, including 22 mammals, 140 birds, 21 reptiles, and 10 amphibian species. None of the macroinvertebrates or fish species recorded are of conservation significance.

Table 1-12 Threatened species potentially occurring within 50 km of Ensham

Species name	EPBC Act 1999 listing status
Birds	
Calidris ferruginea Curlew sandpiper	Critically endangered
Erythrotriorchis radiatus red goshawk	Vulnerable
Falco hypoleucos Grey falcon	Vulnerable
Geophaps scripta Squatter pigeon (southern)	Vulnerable
Grantiella picta Painted honeyeater	Vulnerable
Neochmia ruficauda Star finch (eastern, Star finch (southern)	Endangered
Poephila cincta Southern black-throated finch	Endangered
Rostratula australis (Australian painted snipe)	Endangered
Mammals	
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat	Vulnerable
Dasyurus hallucatus Northern quoll	Endangered
Macroderma gigas Ghost bat	Vulnerable
Nyctophilus corbeni Corbens's long-eared bat	Vulnerable
Onychogalea fraenata Bridled nail-tail wallaby	Endangered
Petauroides volans Greater glider	Vulnerable
Phascolarctos cinereus Koala	Vulnerable
Pteropus poliocephalus Grey-headed flying fox	Vulnerable
Reptiles	
Delma torquata Adorned delma	Vulnerable
Denisonia maculata Ornamental snake	Vulnerable
Egernia rugosa Yakka skink	Vulnerable
Elseya albagula Southern snapping turtle	Critically endangered
Furina dunmalli Dunmall's snake	Vulnerable
Lerista allanae Allan's Lerista	Endangered
Rheodytes leukops Fitzroy River turtle	Vulnerable

1.4.10 Pre-mining land uses

Prior to mining, the land was used for agricultural purposes, predominantly cattle grazing, but also irrigated and non-irrigated farming. Cultivation was restricted to land within the floodplain of the Nogoa River, most of which has not been disturbed by opencut mining.

The 1992 Environmental Management Overview Strategy (EMOS) for the Yongala property, the first granted mining lease at Ensham Mine (ML70049), described the property by noting the following comments:

> *"The only current land use within the study area is beef cattle grazing on predominantly native pastures of low to moderate productivity with some areas of introduced pasture species, mainly Buffel grass. The Yongala property which comprises the major part of the area of interest for the mining project is currently in a moderately to severely degraded condition. The rating of "Erosion Status" in Table A3.1 in Appendix 3 largely reflects the current condition of the land in that those areas which are potentially susceptible to land degradation due to the existing soil types and drainage conditions, are already in a substantially degraded condition.*
>
> *In places deep erosion gullies have developed along many of the gently inclined natural drainage ways (see Figure 6) within the property. The size and severity of gullying is largely attributable to the occurrence and generally dispersive nature of the surficial soils and substrate materials in those areas, exacerbated by the effects of uncontrolled surface water runoff resulting from high intensity storms. Quite commonly, the initiation of these "badlands" type of erosion features can result from overgrazing by stock and other animals, or may be due to local soil/drainage effects. Whatever the cause, once developed to an advanced state, these types of erosion features are difficult and expensive to contain and rehabilitate successfully.*
>
> *Elsewhere on the property, mainly on the gently inclined mid-slopes below the red (lateritic) soil crestal plains, frequent small to locally quite extensive occurrences of surface scalding (bare areas) are evident. These areas may also reflect local soil/drainage effects, such as downslope subsurface drainage discharge zones with possible increased salinity or even higher nutrient levels which pre-dispose those areas to concentrated grazing by cattle. Irrespective of the origin of these features, once the areas become devoid of surface vegetative cover they are susceptible initially to sheet erosion and to the subsequent development of increasing levels of gully erosion."*

Whereas, the 1993 EMOS for the addition of ML7459, ML70367 and ML7460 notes:

> *"The area has been used for farming for many years and at least 90 percent of the lease area has been cleared including the land over the sites of the mine pits and the industrial area. The former owner of the Ensham property used it for beef cattle grazing, mainly on natural pastures but with some areas improved by deep ploughing and seeding with Buffel grass. The Duckponds property was mainly used for agricultural purposes, grain production, on the flood plain areas. The southern end of the lease was used primarily for improved pastures for beef cattle grazing."*

As per the above commentary, the pre-mining land condition varied across what is now Ensham Mine. Pre-mining imagery is displayed in Figure 1-17 below. The topography of this area (pre-mining) has been previously displayed in Section 1.4.1 (Figure 1-9).

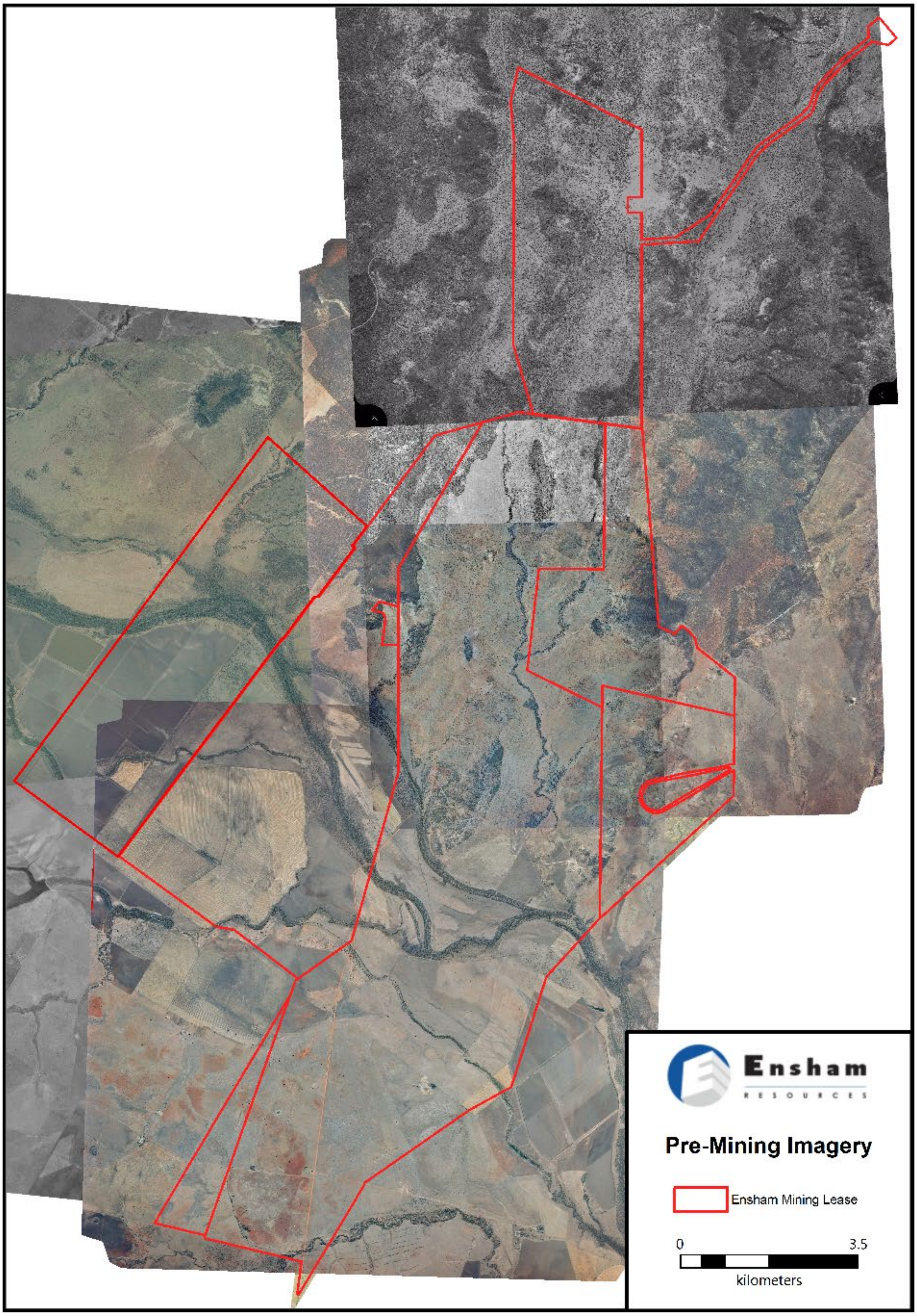


Figure 1-17 Ensham Pre-Mining Land Condition

1.4.11 Underlying landholders

Underlying landholders have been identified in Table 1-2 in Section 1.1 of this report.

2 COMMUNITY CONSULTATION

In accordance with section 126C(1)(c)(iii) and (iv) of the EP Act, the rehabilitation planning part of the PRC plan must include:	
• **details of the consultation undertaken by the applicant in developing the proposed PRC plan, and**	Section 2.2
• **details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan**	Section 2.3

2.1 Engaging the community

Ensham has a long history of meaningful engagement with the community on all matters, including progressive rehabilitation. The enduring objectives of community consultation are to:

1. Identify stakeholders and their issues regarding rehabilitation and closure of the mine,
2. Ensure that Ensham addresses and responds to stakeholder issues and keeps the community informed on progressive rehabilitation and steps towards mine closure.

Community consultation was undertaken for the land outcome in the RVP including a Social Impact Assessment (SIA) of the outcome for the voids. The SIA involved an assessment of the social impacts of the proposed landform designs including flood related and water quality impacts on the health and community wellbeing. As identified in the SIA, the retention of levees and the associated flood protection for downstream landholders was a significant issue in determining the final landform design. In addition to the consultation with the community and the administering authority, a further informal notification to members of the public in respect of the proposed landforms was undertaken pursuant to section 316Q of the Environmental Protection Act 1994. As a result of this process, the most suitable outcome for the residual voids was assessed consistently with the outcome of the consultation. In order to return the width of the flood plain more toward pre-mine levels, but still protecting downstream landholders, the widening of the existing flood plain will happen on the northern side as defined in Appendix 5 of the EA. This outcome was deemed acceptable in the EA amendment which outcome has been adopted in this PRCP.

Additionally:

- Ensham is a 30-year-old coal mine that has engaged with the community for 3 decades.
- Nominated PMLUs are transitioned from land outcome document EA *EPML00732813*.
- The largest PMLU in rehabilitation at Ensham is beef cattle grazing, which is:
  - Re-establishing the pre-mining land use; and
  - For the most part, consistent with surrounding land uses,
  - Being actively used as part of grazing operations.

- Ensham has received certification of 565.63 ha of rehabilitation with a beef cattle grazing PMLU during 2021 in addition to the existing 97.2 ha of cattle grazing PMLU certified in 2018 (pre-PRCP).

2.2 Stakeholder consultations – PMLU & NUMA

Ensham has conducted considerable stakeholder consultations about rehabilitation over the past 30 years. The matters collectively discussed with the community during these stakeholder consultations have informed and are the basis upon which the PRC plan has been developed. The outcomes in the PRC Plan are informed by these consultations. Over these years, formal stakeholder consultations have been undertaken inclusive of the following.

2.2.1 Environmental Impact Statements (EIS) (1990, 2009 & 2021)

Stakeholder consultation programs for EIS' have engaged with neighbouring landholders, local, state and federal governments, industry bodies, community groups and other interested parties. These programs identified a wide range of stakeholder issues, including mined land rehabilitation, that were subsequently addressed in EIS processes.

a) Ensham Coal Project, impact assessment study (Hollingsworth et al. 1990).

b) Revised Ensham Central Project, environmental impact statement including the outcomes of stakeholder engagements (Hansen Consulting 2006).

c) Ensham Life of Mine Extension Project, environmental and social impact assessments (2021).

2.2.2 Ensham Residual Void (RV) Project (2017-2020)

The focus of this project was to provide a platform to discuss rehabilitation options and rehabilitation success criteria for residual voids at the Ensham mine. The RV Project was primarily concerned with the location, extent, and potential environmental and social impacts of final voids, which are comprised in part of NUMAs, i.e., Groundwater daylighting water areas and Highwalls. As part of the RV project, the following engagement occurred:

2.2.2.1 Community Reference Group

In the early phases of the RV Project (November 2017), a Community Reference Group (CRG) was established to work with the company and its relevant consultants in relation to the Project. The CRG consists of 11 members, including an Independent Chair, that includes representation from nearby neighbours (3), mining area landholder (1), Central Highlands Council (2), CCHRUP (1), Fitzroy Partnership for River Health (1), Sunwater (1), Cotton Growers and Irrigators Association (1) and community (1).

The CRG has been established to:

- Establish good working relationships and promote information sharing between Ensham Mine, the local community and stakeholder groups on the Ensham RVP.
- Allow community members, and or their representatives, to seek information from Ensham Mine and provide feedback on the study to assist with the delivery of balanced social, environmental and economic outcomes for the community.
- Enable Ensham Mine representatives to keep the community informed about the project.
- Allow Ensham Mine to seek community views on the study and respond to matters raised by the community.

- Discuss the RV Project and raise any concerns associated with the Preferred Options and Final Option.
- Review the reports and studies undertaken for the RV Project.
- Provide comments on the reports and studies undertaken for the RV Project.
- Discuss community concerns with the RV Project, Preferred Options and Final Option.

CRG members were provided with all technical reports for review and comment and were briefed on the SIA approach and stakeholders to be engaged as part of the SIA program.

i. Social impact assessment (Umwelt 2019).
ii. Hydrology (Hydro Engineering and Consulting Pty Ltd 2019).
iii. Groundwater (Hydrosimulations 2019).
iv. Geochemistry (RGS 2019).
v. Water solute and balance (Hydro Engineering and Consulting Pty Ltd 2019b).
vi. Geotechnical stability (WSP 2019).
vii. Geomorphology (WRM 2019).
viii. Ecology (Umwelt 2019b).

2.2.2.2 Social impact report (Umwelt 2019).

This social impact assessment engaged with 48 stakeholders including neighbouring landholders, water catchment groups, local government, indigenous (Traditional Owners) groups and industry and business.

During the SIA engagement process, there were five key themes that were identified by stakeholders across the three options presented. These included: Flood, Water Quality, Option Management, Community Use and Landform Design.

This section provides further detail on the social impact themes identified drawing, where relevant, on engagement and social baseline data collected in the profiling and scoping phases of the SIA.

2.2.2.2.1 Flood

Flood was repeatedly identified by stakeholders as an impact across the options being assessed and is directly related to the Ensham Mine site being located on a flood plain of the Nogoa River. In 2008 and 2010, major flood events occurred in the region. The 2008 flood event saw the Ensham Mine inundated with water because of a levee failure and flood water flowing into the operational pits. The failure of the levee, and the perceived ramifications for nearby neighbours and community, resulted in reengineering and construction of levees to protect it from a flood, with an average recurrence interval of 1000 years in the Nogoa River (Queensland Floods Commission of Inquiry, 2012); subsequently approved by the Coordinator-General in 2009. These relatively recent flood events have raised concerns in the community regarding the management of existing voids, given imminent closure, and subsequent impacts on upstream and downstream landholders.

The Ensham Mine is surrounded by cotton farmers both upstream and downstream of the site and more broadly the Central Highlands region is heavily populated by farmers reliant on the availability of quality water to support their crops. As such, flood events have an intrinsic effect on the livelihoods of farmers; with some farmers reliant on smaller more regular flood events to maintain water security in the region. Conversely, large flood events pose the risk of negatively impacting farmers by damaging property, destroying crops and reducing yield. For example, in 2010-11, floods destroyed cotton crops in central Queensland with water logging reducing yield by approximately 10-15 per cent, resulting in significant financial implications for cotton growers (Australian Government, 2011). In 2013, Agforce estimated that about 30% of the Emerald cotton crop was inundated with a loss of 62,000 bales and a value in the order of $31m (Regional Australia Institute, 2013). These effects were reflected by landholders and other key stakeholders in the comments and concerns that arose during the engagement phases of the SIA. The ability to mitigate against major flood events has the potential to protect the economic and infrastructure strengths that exist in the CHRC area.

Major flood events have the added risk of affecting the health and wellbeing of residents, particularly psychosocial impacts such as stress. Adults of working age and residents of regional and remote areas in Queensland were more likely to report emotional impacts caused by the 2010 floods such as distress, feeling terrified, helplessness or hopelessness, and stresses associated with having reduced incomes. Mental health issues were the largest impact of the floods in 2010 with an estimated lifetime cost of approximately $5.9 billion (Australian Business Roundtable (ABR), 2016). Mental health-related behaviours such as substance use (alcohol and smoking) have been documented following natural disasters (ABR 2016), in Emerald there was anecdotal evidence of a significant increase in alcohol related problems and domestic violence post the 2010 flood event (QCOSS, 2011). It is reasonable to expect that the mental health of residents in Emerald and its surrounding regions was affected having experienced major flood events in both 2008 and 2010.

With Ensham Mine being located on a floodplain in proximity to the Nogoa River, Comet River and Winton Creek, there is a perception in the community that there is a high risk of contamination should seepage occur, with effects likely to be felt broadly across the Central Highlands region. Scientific studies show that seepage will not be an issue to either the river or groundwater, as further detailed in Appendix 9.4 – Hydrogeology summary report. The angst among stakeholders regarding the potential for seepage to the river system was evident during the SIA engagement process.

In 2013, farmers told the ABC that the Dee River was an unnatural shade of blue-green and that birds and fish were dying with contamination anecdotally reported to be occurring 55kms downstream from the Mount Morgan Mine. The high-profile nature of the problems at Mount Morgan, in relation to groundwater seepage and contamination of the waterways, contributes to the level of concern in the Emerald and Comet communities given their heavy reliance on water for a range of purposes. The sentiment was further exacerbated by the breeching of the levees that occurred in the 2008 flood event. It was iterated by downstream landholders during stakeholder meetings that removal of the current levee system would have detrimental impacts on their properties and infrastructure. The flood protection landform position on the southern side of the Nogoa River maintains the current protection for downstream landholders, while the floodplain widening on the northern side of the Nogoa River removes any upstream impacts.

2.2.2.2.2 Water Quality

Water security is critical to support industry and liveability of communities in the Fitzroy Basin. As with many parts of Australia, in the Fitzroy Basin there are multiple users of water, the coal industry and the agricultural industry are the two largest industries, raising concerns for: security of water supply; flood and drought impacts; the management of surface and underground water; and environmental flow and water quality (KPMG, 2018). The Central Highlands region has extensive water infrastructure, serviced by the Fairbairn Dam, a number of smaller weirs and a comprehensive irrigation network. Generally, water security is considered relatively strong; however, minimising water loss, unlocking future capacity and optimising water use and flexibility are ongoing challenges for the Central Highlands (KPMG, 2017).

Agriculture is the major industry across the Central Highlands region accounting for approximately 12 per cent of all employment in the region. Surrounding the Ensham Mine are primarily cropping farms (mostly cotton) and some cattle grazing, including Nogoa Pastoral that runs cattle within the boundaries of the land owned by the Ensham Joint Venture. The Nogoa Pastoral Company operates on land within all mining tenures except ML 70049. The underlying landowner undertakes grazing activities on rehabilitated land within ML 70049.

As at 31 July 2018, there were 1,971 head of cattle comprising 787 steers, 1,127 females and 37 bulls. The Nogoa River runs between Pit B and Pit C, connecting to the Fairbairn Dam and an intricate water system that provides water to the mines grazing operations, the mine itself and to the townships of Comet and Emerald and the region more broadly. As previously noted, water quality in the Central Highlands region is paramount to ensure it is usable for cropping and to support the current agricultural industry, as well as regional economic growth aspirations. Ensham also extract raw water for drinking supply from downstream of mining operations. Mining activities taking place on and around a floodplain, with the perception that there is potential for seepage to the river system, creates what is perceived to be a high-risk scenario for the Central Highlands Region. With Mount Morgan, also situated in the Fitzroy catchment, the fear of contamination from groundwater seepage is evident amongst stakeholders concerned for their livelihoods and the safety of their community. The largest social risk identified by participants related to water quality, as a result of the Ensham Mine, relates to salinity, or salt content and the effects that this would have on landholders and the agricultural industry. The stronger the conductivity levels of water, the higher the salt content. Table 7.2 shows the conductivity of water levels mapped to the salinity class for irrigation water.

2.2.2.2.3 Community Use

Increasing the availability of land for future grazing and or cropping would be deemed as high value in a region such as the Central Highlands. Comet, where the Ensham Mine site is located near, has agriculture as the largest employer making the potential for use of the land a valuable asset. The use of any rehabilitated land would not be able to occur until the rehabilitated areas are deemed safe, stable and non-polluting and able to sustain appropriate land use after rehabilitation (Queensland Government, 2014). Significant areas of rehabilitation are incorporated into the grazing operations of Nogoa Pastoral Company

2.2.2.2.4 Landform Design

Design refers to the impacts that directly relate to the landform design features of each of the options. A number of design changes have been made between round one and two SIA engagement phases. The most significant changes were made to Preferred Option 1 – Landform Levee, as a result of community feedback and preliminary findings from scientific studies. This resulted in a decision being made to: maintain landform to a 1:1000 level, negating the need to realign the anabranch; raise the floor of the pits to minimise groundwater interactions; and introduce a biodiversity corridor (treed corridor) along the highwalls of all pits.

Preferred Option 2 Flood Mitigation and Beneficial Use and Preferred Option 3 Backfill to PMF also saw changes to design with landform redesign to minimise geomorphological risks and the inclusion of the biodiversity corridor (treed corridor) along the western aspect of the rehabilitated landform between Corkscrew Creek and the Nogoa River. This would add to existing values in the natural landscape of the CHRC area that already contribute to a range of features and services that attract tourists to the region. The largest design related social risks for this project relate to the potential visual impacts of the voids for those living in the vicinity of the mine site.

Across all stakeholder groups consulted (key stakeholders, local and regional community residents and Ensham employees), Preferred Option 2 emerged as the key option preference (92), followed by Preferred Option 3 (29) and Preferred Option 1 (12). Key stakeholders consulted were more divided in their option preferences between Preferred Option 2 – Beneficial Use (16) and Preferred Option 3 – Backfill to PMF (19); whereas, both local and regional community residents (42) and Ensham employees (34) were more likely to demonstrate a clear preference for Preferred Option 2.

Option 2 was not supported by DAF, DNRME and DES. The outcome was a modified Option 1 with the retention of high walls to maximise the area of land suitable for grazing on the low walls. There is no potential for future beneficial use of the residual voids as water storages.

2.2.3 Background landholder/s

Ensham meets and communicates frequently with the background landholders to ML 70049 covering Lot 3 CP911009 and Lot 2 SP165518. These meetings have including detailed discussions about rehabilitation practices and outcomes at the Yongala and Boggy Creek properties.

2.2.4 DES Interactions

The following key communications were made with the administering authority during the community consultation process.

- Staged meetings with the Administering Authority, which included submission and discussion of the technical studies and the outcomes of stakeholder consultation.
- Application for amendment of EA EPML00732813 to include outcomes of the RV Project.

2.3 Community consultation plan

A community consultation plan has been developed to detail Ensham’s community engagement. This plan here on referenced as the Stakeholder Engagement Plan and is included as an attached reference document for the PRC plan.

2.4 Community consultation register

Ensham maintains a community consultation register that complies with section 126C(1)(c)(iii) of the EP Act. The details of all engagements with key stakeholders are recorded in the register. An extract of this register in included within a Figure in the Stakeholder Engagement Plan mentioned above.

3 POST MINING LAND USE

In accordance with section 126C(1)(d) of the EP Act, the rehabilitation planning part of the PRC plan must state the extent to which each post-mining land use for land identified in the PRCP schedule for the plan is consistent with:	
a) the outcome of consultation with the community in developing the plan, and	Section 2.2
b) any strategies or plans for the land of a local government, the State or the Commonwealth.	Section 3.2

3.1 Ensham PMLUs

Following are summary descriptions of rehabilitation PMLUs at Ensham. These PMLUs are translated into this transitional PRC Plan from, and are consistent with, land outcome document EA *EPML00732813*, meaning that determination and justifications of PMLU's are not required for this PRCP.

Each listed PMLU can be rehabilitated to a stable condition[5], whereby:

- 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 PMLU.

As this is a transitional PRC Plan, Ensham is not required to complete the information requirements under section 126C(1)(j) of the EP Act[6].

3.1.1 Cattle grazing on overburden / infrastructure areas

Beef cattle grazing is the largest land use in the Fitzroy Natural Resource Management (NRM) Region (ABARES 2015) occupying 12 million ha or 78 % of the total area. There are major beef cattle breeding, growing, and finishing operations and sale and processing facilities in the NRM region.

Rehabilitation that will be used for beef cattle grazing will have slope gradients not greater than 25 %, and will be sown to a mix of 3P (perennial, palatable and persistent) grasses and legumes. This rehabilitation will be land suitability class 1 (suitable) to class 4 (marginally suitable) according to the 2013 guidelines for agricultural land evaluation in Queensland (Queensland Government 2013b). Though not a criterion in land suitability assessment, cattle have grazed rehabilitated pastures at Ensham since 2012 and currently have access to about 600 ha of rehabilitated land.

[5] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00, p21.*

[6] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.0, p19.*

The Supplementary Landform Report (p 20):

> *The design of the grazing domain with deliver a significantly better post mining land suitability for grazing than pre-mining for this area. This is supported by land mapping completed prior to mining in 1992 and undertaken as part of the Ensham Mine Environmental Management Overview Strategy (EMOS). This mapping shows significant amounts of the northern mining areas as being Land Suitability Class 5. Land Suitability Class 5 describes land with extreme limitations that preclude any possibility of successful sustained use of the land in the proposed manner eg grazing (Guidelines for Agricultural Land Evaluation in Queensland 2013). The Completion Criteria contained in the submitted Rehabilitation Management Plan identifies that the areas that were Class 5 areas will now be equal to or greater than Class 4 (as defined in Appendix A: Land use limitation subclass threshold limits of the submitted Rehabilitation Management Plan)* .

The reinstatement of the grazing PMLU for the inward facing low wall slopes in the rehabilitated open cut mining areas is consistent with the pre mining land use (Hollingsworth, Dames and Moore ECP IAS 1990 p92) and aligned with Hierarchy no: 4 - reinstate previous land use (e.g. grazing or cropping). Additionally, the inclusion of the 675ha's into the grazing PMLU connects the grazing areas lower in the rehabilitated open cut mining areas with the grazing areas on the upper and outward facing slopes.

This complements the existing approved grazing domain area currently approved in the Ensham Mine Environmental Authority, delivering additional income producing land for the landowner which would assist with maintenance and upkeep of the rehabilitated land. Grazing has been, and continues to remain, a key industry for the Central Highlands (Central Highlands Economic Master Plan, 2017).

According to land outcome document EA *EPML00732813*, this PMLU will incorporate the following characteristics.

- All outward facing overburden slopes would achieve 0 to 10% slopes for tertiary materials, and 0 to 15% slopes for Permian materials.
- At least 90% of the inward facing slopes within this PMLU would achieve 0 to 10% slopes for tertiary materials, and 0 to 15% slopes for Permian materials.
- Up to 10% of inward facing slopes may exist between 15% to 25%, and would be fully contained within the areas of 0 to 15% slopes.
- Minimum factor of safety of 1.5.

These slopes would be topsoiled and seeded, hay mulched or other suitable treatment applied to further reduce erosion risk potential. Benches within the spoil rehabilitation are not topsoiled to allow germination of tree seed as part of cattle shelterbelts and visual amenity. It is noted that this practice occurs on areas of relatively flat ground (benches are typically constructed with very little slope) and has been demonstrated through progressive rehabilitation to be effective. Further detail is provided in Appendix 9.2 PMLU context report and Appendix 9.3 – Monitoring summary report.

Rehabilitated spoil with up to 10% of slopes at between 15% and 25% will be comparable with the slopes in some of the adjoining current grazing paddocks.

The below table and figure details the slope percentages of existing cattle grazing paddocks surrounding Ensham's mining and rehabilitation areas. Table 3-1 describes the percentage of area categorised within each slope percentage interval, eg. 63% of the area of No Man's Land Paddock has a slope of between 0-10%.

Table 3-1 Slope of existing grazing paddocks

Paddock	Area (ha)	0 – 10%	10 – 15%	15 – 20%	20 – 25%	25 – 100%	>100%
No Mans Land Paddock (part)	544	63%	17.6%	8.1%	4.1%	7.6%	0.1%
Boundary Paddock	207	51.4%	23.8%	12.4%	5.8%	6.4%	0.1%
Anabranch Paddock	895	57.9%	17.3%	8.7%	4.7%	11.2%	0.2%
Long Paddock	347	98.7%	0.9%	0.3%	0.1%	0.1%	0%
Boggy Creek Paddock	329	94.7%	2.4%	1.2%	0.7%	1.1%	0%
Adrians Paddock	356	84.9%	9.5%	2.7%	1.3%	1.6%	0%

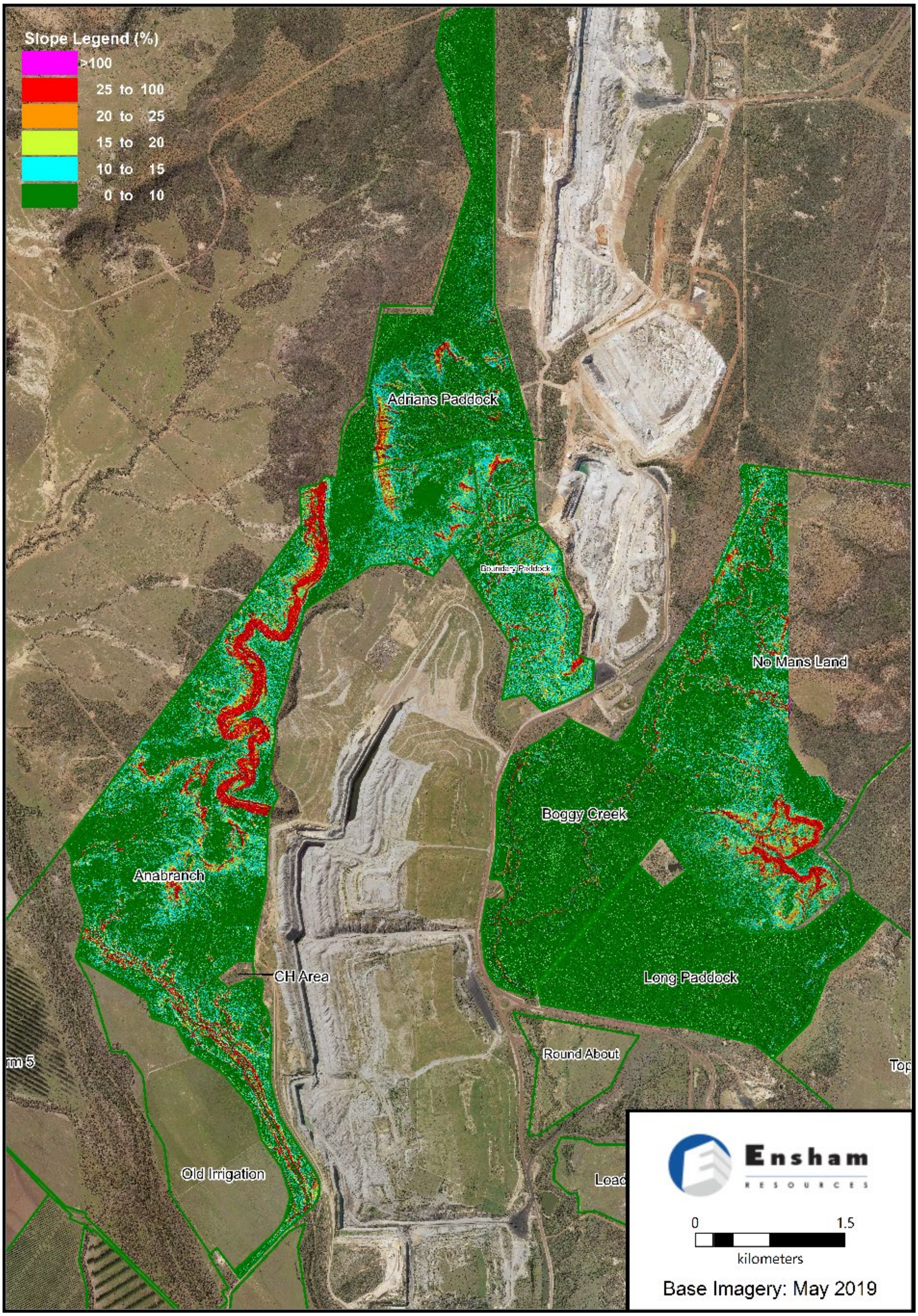


Figure 3-1 Slopes of existing grazing paddocks

3.1.2 Landholder retained infrastructure

As per the written agreements, some mining infrastructure will be retained by the background landholders. This includes roads, dams, pipelines, bridges and electrical reticulation to assist in meeting ongoing land management requirements. Though important to facilitating other PMLUs, landholder retained infrastructure will be a minor component of rehabilitation at Ensham of all PMLUs at the mine.

Landholder retained infrastructure will include the following.

- The main power supply line into the mine is also used for power supply to a rural switchyard which then provides power to the homestead and property infrastructure such as a river pump and a bore. The 66KV line to the rural switchyard and lines to property infrastructure are to be retained.
- Water is pumped from the river using a Water Licence allocation to 2 dams, Clear Water Dam and Sailors Dam. It is pumped firstly to Clear Water Dam and then pumped again to Sailors Dam. The water from both dams is used within the mining operation as raw water. Water from Sailors Dam is further pumped as part of the grazing property infrastructure to tanks and troughs. Currently Sailors Dam is the only permanent water supply to the eastern grazing paddocks. The dams and accompanying pipelines are to be retained as part of the grazing infrastructure.
- The access road commences from the gazetted road into Currimundi property. It is the main access used for transport of stock arriving or departing from the main cattle yards by road train. Access across to the northern side of the river is achieved via the main access road, which is capable of transporting heavy machinery such as dozers used for fire breaks and vegetation management. In the event of flooding a light vehicle bridge provides access to the northern portion of the property.
- The access road continues north of the river and provides access to the stock watering infrastructure at Sailors Dam. It is proposed to retain this infrastructure as part of the grazing operation.
- Boundary paddock has been used as part of the cattle grazing operation of Duckponds for at least the last 5 years. A sediment dam was installed when out of pit spoil was being rehabilitated within this paddock. The rehabilitation is certified but the sediment dam has been left as a valuable stock watering point. It is proposed to be retained in its current configuration as it provides permanent stock water.
- The section of Yongala Haul Road existing over the Simmon's property "Boggy Creek" has been requested to be retained as is.
- Access roads and the shed currently used for housing cultural heritage artifacts will be retained by agreement with the Yongala landholders.

3.1.3 Boggy Creek diversion

Excavation, reshaping, topsoiling and seeding of the Boggy Creek diversion has been completed in 2021. Adjoining areas and finalisation of drainage works are currently being undertaken. This rehabilitation will re-establish required geomorphological functionality to the watercourse, including suitable riparian vegetation. Like Native Bushland Corridor, this PMLU provides important habitat and ecosystem services, and links upstream and downstream remnant regional ecosystems, including those associated with the Nogoa River.

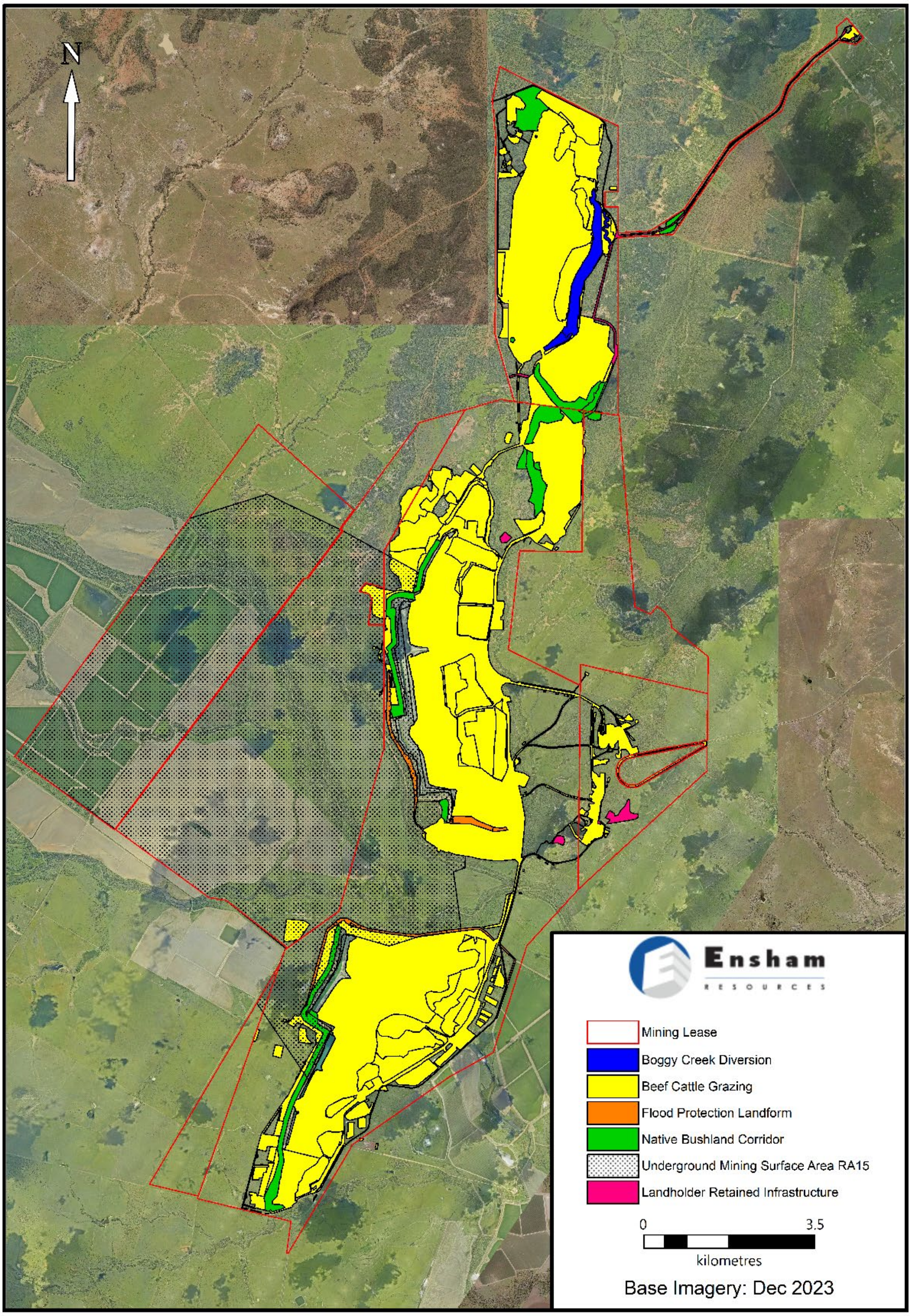


Figure 3-2 Locations and extents of PMLUs

3.1.4 Native bushland corridor

Regional ecosystems in the Brigalow Belt Bioregion have been extensively cleared for agriculture and within the Fitzroy NRM Region protected, conservation and minimum use areas occupy just 7.8 % of land (ABARES 2015). Native bushland corridor rehabilitation at Ensham will provide important habitat for a variety of native animals and plants, with linkages to existing remnant regional ecosystems associated with the Nogoa River.

Native Bushland Corridor PMLU is located on the western side of the rehabilitated open cut mining areas, connecting Corkscrew Creek with the Nogoa River floodplain and the escarpment country. The corridor also connects with Boggy Creek.

According to land outcome document EA *EPML00732813*, this PMLU will incorporate the following characteristics.

- ≥50% established and persistent vegetative groundcover for all slopes from 0-20%.
- ≥80% established and persistent cover (vegetative and/or rock mulch if required) for slopes from 20% to 25%.
- Species richness ≥ 2 tree species, ≥ 3 shrub species, ≥ 5 groundcover species.
- Maximum 25% slope
- Areas >15% to be certified by a suitably qualified person as being stable long term, with rock mulch applied as required.

This PMLU has three broad functions, viz.

- It will provide corridors which will increase the available vegetation cover and associated foraging opportunities in the locality and is anticipated to be beneficial for a variety of native fauna species as well as increasing fauna movement opportunities in this landscape.
- It will also prohibit vehicle access onto the rehabilitated highwall slopes. This sustainable control is seen as better practice than the conventional practice that includes constructing a berm and fencing of the highwall.
- It will also reduce any visual impacts that may be associated with the rehabilitated opencut mining areas. The rehabilitated open cut mining areas are designed to be consistent with, and blend with, the regional escarpment landscape. As such, the rehabilitated open cut mining areas are not expected to have any significant impact on the visual amenity of the area. The selection of the flora species will be determined closer to time of rehabilitation, utilizing tree shrub, and groundcover BioCondition benchmarks for relevant regional ecosystems.

3.1.5 Flood protection landform

The purpose of this rehabilitation is to prevent flood inundation of other rehabilitation areas. This PMLU replaces existing flood protection levees. Therefore, a key indicator is the design level of the landform crest, which must be at least 1 m above the estimated 1 in 1,000-year annual recurrence interval (ARI) flood event.

3.2 Relevant strategies and plans of the local, and State or Commonwealth governments

To the extent relevant, Ensham is on land affected by the following government plans.

1) Central Highlands Regional Council (CHRC)

   a) *Central Highlands Regional Council Planning Scheme 2016* (CHRC 2016).

2) Queensland Government

   a) *Central Queensland Regional Plan* (Queensland Government 2013).

3.2.1 CHRC planning scheme 2016

The *Central Highlands Regional Council Planning Scheme 2016*, adopted by Council on 24 February 2016, superseded the four Planning Schemes and associated planning scheme policies of the former Emerald, Duaringa, Bauhinia and Peak Downs Shires. Under the planning scheme, the Ensham mine is located in the rural zone. The following highlighted provisions are from *Part 3 Strategic Framework* and show the PMLUs at Ensham are strongly aligned with the planning scheme, as further described in Section 3.1.

> ***3.5 Natural resources and landscape theme***
>
> ***3.5.1 Strategic outcomes***
>
> *The strategic outcomes for the natural resources and landscape theme are the following:*
>
> *b. Natural and rural landscape features are appropriately managed, utilised and protected to ensure that the Central Highlands maintains its unique character and identity whilst also allowing its natural resources, such as mineral and agricultural assets, to be sustainably used and managed.*
>
> *c. Management and development practices reflect best practice methods for the sustainable use of the rich deposits of natural resources within the region, while encouraging new renewable and cleaner natural resources development.*
>
> *d. Key natural resources including biological, energy, extractive, land, air and water resources are protected and sustainably managed to allow communities to meet present needs while not compromising the ability of future generations to meet their needs.*
>
> *e. Use of land and its natural resources is undertaken in a way that does not cause an adverse impact on the environment.*
>
> *f. Natural ecosystems and water resources are protected and conserved as critical elements to the sustainability of all activities in the Central Highlands region.*
>
> *g. Development in and adjacent to natural resource areas within Central Highlands is managed to facilitate co-existence between traditional rural and agricultural pursuits and resource activities and avoid or otherwise mitigate negative impacts on the continued and future use of these resource areas.*
>
> ***3.5.3 Element 2 – Natural resource management***
>
> ***3.5.3.1 Specific outcomes***
>
> ***Mineral and extractive resources***

d. The economic benefits of extracting deposits of non-renewable resources and minerals from within the region are balanced against:

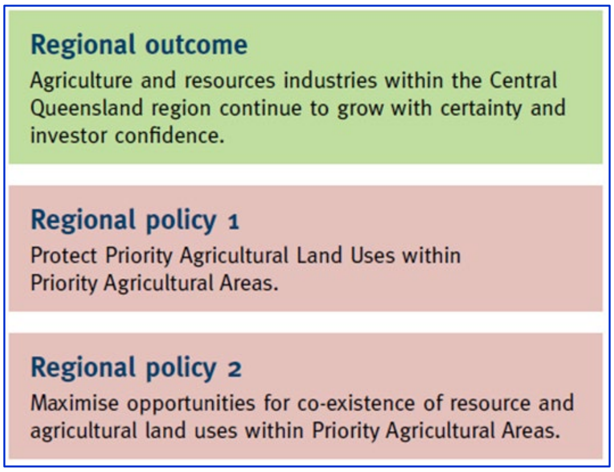
i. socio-economic and environmental impacts; and

ii. the long-term sustainable use of the land for non-extractive renewable activities and agricultural or pastoral uses.

e. Development within the Bowen Basin, as identified on [Strategic Framework Map SFM-003](), is appropriately designed and located to maximise opportunities for co-existence between mineral, petroleum and coal resource development and other land uses and sensitive environments.

3.2.2 Central Queensland Regional Plan 2013

The purpose of this plan is to identify the State's interests in land use planning in the central Queensland region. A large portion of Ensham Mine is located within a priority agricultural area, with current areas within the Ensham MLs (in proximity to the floodplain area, and overlying areas where underground mining is and has occurred) being utilised for cropping land now. Protecting priority agricultural land uses while supporting co-existence opportunities for the resource sector is a key regional policy (Figure B2-3). In addition, cattle current graze on rehabilitated land at Ensham and rehabilitation is primarily directed towards this beef cattle grazing as a PMLU, demonstrating rehabilitation is strongly aligned with the plan.



Regional outcome
Agriculture and resources industries within the Central Queensland region continue to grow with certainty and investor confidence.

Regional policy 1
Protect Priority Agricultural Land Uses within Priority Agricultural Areas.

Regional policy 2
Maximise opportunities for co-existence of resource and agricultural land uses within Priority Agricultural Areas.

Figure 3-4 Regional outcome for priority agricultural land (from Queensland Government 2013)

4 NON-USE MANAGEMENT AREAS

In accordance with sections 126C(1)(d), (g) and (h) of the EP Act, for each proposed non-use management area, the rehabilitation planning part of the PRC plan must:	
• **state the reasons the applicant considers the area cannot be rehabilitated to a stable condition**	s126C(1)(g) of the EP Act is not applicable to this transitional PRC Plan
• **include copies of reports or other evidence relied on by the applicant for each proposed non-use management area**	S126(1)(h) of the EP Act is not applicable to this transitional PRC Plan
• **state the extent to which the proposed non-use management area is consistent with the outcome of consultation with the community in developing the plan, and**	Section 2.2
• **state the extent to which the non-use management area is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.**	Section 4.2

4.1 Ensham NUMAs

Following are summary descriptions of rehabilitation NUMAs at Ensham. These pre-approved NUMAs are translated into this transitional PRC Plan from land outcome documents EA *EPML00732813*. On this basis, Ensham is not required to:

- Justify NUMAs.
- Provide evidence to support the justification of NUMAs.
- Go through the public interest evaluation process.
- Comply with the prohibition of voids located within a flood plain having to be rehabilitated to a stable condition.

The land outcome document (EA) sets out the criteria to be met for the high walls and groundwater daylighting water areas are to be safe, stable and non-polluting. They do not have a nominated land use.

It is noted that the EA outlines that the approximate area to be retained as Groundwater Daylighting Water Areas is a maximum of 192ha. However, it is noted, in Section 4.1.3, that the anticipated area is less than authorised in the EA.

4.1.1 Groundwater daylighting water areas

Regionally significant water storages, dams and reservoirs occupy less than 1.5 % of land within the NRM region (ABARES 2015). At a local level, minor water storages are important for stock and domestic supplies and assist native animals, particularly in times of drought. Groundwater daylighting water areas will be a minor component of rehabilitation at Ensham (Figure 4-1 and Table 4-1).

These areas will be fenced either prior to relinquishment, or, when water daylights (whichever is the sooner) to prevent cattle accessing these areas. It is anticipated that aquatic bird life will reside in these areas similar to current site water bodies which support large numbers of aquatic bird life that would not exist on site otherwise.

Table 4-1 Maximum final water levels, volumes and water areas (as authorised by EA EPML00732813)

<table>
<tr><th>Pit</th><th>Surface water level</th><th>Regional groundwater level</th><th>Water storage volume (GL)</th><th>Water area (ha)</th><th>Approximate time for groundwater to daylight</th><th>Approximate year of equilibrium</th></tr>
<tr><td>A south</td><td colspan="6">Groundwater does not daylight</td></tr>
<tr><td>A central</td><td>133</td><td>144</td><td>0.5</td><td>3</td><td rowspan="2">50 years</td><td rowspan="2">2140</td></tr>
<tr><td>A north</td><td>133</td><td>144</td><td>1.2</td><td>16</td></tr>
<tr><td>B</td><td>123</td><td>142</td><td>3.1</td><td>33</td><td rowspan="2">55 years</td><td rowspan="2">2200</td></tr>
<tr><td>C</td><td>125</td><td>142</td><td>22.1</td><td>65</td></tr>
<tr><td>D</td><td></td><td></td><td></td><td>75</td><td></td><td></td></tr>
<tr><td>E</td><td colspan="6" rowspan="3">Groundwater does not daylight</td></tr>
<tr><td>F</td></tr>
<tr><td>Y</td></tr>
<tr><td>Total</td><td></td><td></td><td>26.9</td><td>192</td><td></td><td></td></tr>
</table>

4.1.2 Highwalls

Highwalls is a relatively minor component of the rehabilitated landscape at Ensham as shown in Figure 4-1. Highwalls will have sufficient improvements to ensure safety, structural stability, and minimisation of environmental harm.

1) Improvements for safety.
   a) Safety bund constructed at ≥2 m high, base width of ≥5 m and crest width of ≤2 m.
   b) Safety bund positioned a distance not less than the total of the width of the *potentially unstable pit edge zone* plus an additional 10 m away from the existing pit edge. The width of the potentially unstable pit edge zone is defined by the distance between the existing pit edge and a point on the ground surface representing the intercept of a 45° plane projected from the slope toe.
   c) Fencing erected along extent of former highwalls.
   d) Fence position to be an additional 10 m away from the bund (in a direction away from the highwall edge).
   e) Warning signage posted every 500 m of the animal exclusion fence.
2) Improvements for structural stability.
   a) Slope gradients achieved as follows-
      i) Maximum of 275 % slopes for competent high walls.
      ii) Maximum of 50 % slopes for incompetent material

iii) A south pit, F Pits and Y Pits highwall must be reshaped to a maximum of 25 % slopes.

iv) Northern Endwall of B Pit maximum 15 % slope

b) Landforms are assessed as geotechnically stable with a factor of safety ≥1.5.

c) Water run-off from above the highwall is channelled to the groundwater daylighting water areas PMLU through design pathways.

3) Improvements to ensure minimisation of environmental harm.

a) Regional groundwater aquifers maintain their current water quality and groundwater monitoring bores do not exceed the water quality limits detailed in Table C11 – Groundwater quality limits in the relevant EA as a result of mining activities.

4.1.3 NUMA summaries

The total area and locations of each NUMA are provided for each mining tenement (Table 4-2).

Table 4-2 Planned location and extent of NUMAs at Ensham

NUMA	ML7459	ML7460	ML70365	ML70366	ML70367	ML70049	ML70326	ML700061
Highwalls	83.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater daylighting water areas	145.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

It is highlighted (as detailed in Table 4-1) that the maximum water area authorised for Ensham (as per Appendix 3 of EA EPML00732813 EPML) equates to a total of 192ha. However, as shown in Table 4-2 above, the actual area anticipated to be contained as 'Groundwater daylighting areas NUMA' is less than this, with a total of only 145.8ha. It is highlighted that Ensham are not planning for the full area authorised to be retained, as the landform design process has successfully sought to minimise the area to be retained as NUMA.

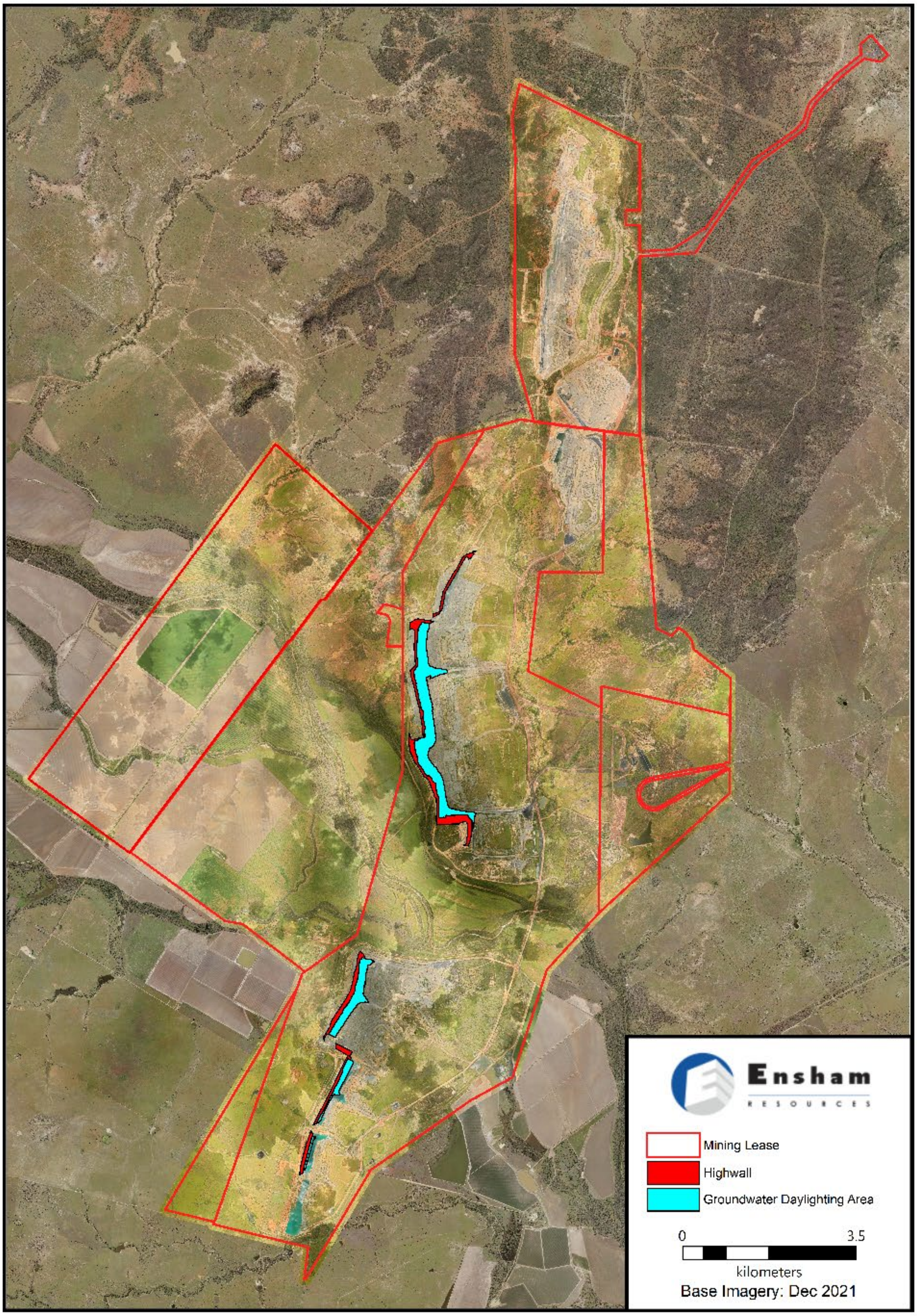


Figure 4-1 Location and extent of NUMAs

4.2 Relevant strategies and plans of the local, and State or Commonwealth governments

The existence of NUMAs in the post-mining landscape at Ensham is an inevitable consequence of the approved mining activities. Despite being pre-approved in land outcome documents, the area of NUMAs has been minimised and represents less than 5 % of all disturbed lands. The strategic outcome of protecting natural resources is supported by minimising the area of groundwater daylighting and the design which means that the residual areas are groundwater sinks not sources. Conversely, Ensham has sought to maximise the area of grazing PMLUs in the post-mining landscape. Therefore, to the extent possible, Ensham has complied with the local (CHRC 2016) and regional (Queensland Government 2013) planning instruments, particularly as these relate to resource and agricultural land use co-existence and sustainability.

4.3 Voids in floodplains

In accordance with section 126D(3) of the EP Act, if land the subject of the proposed PRCP schedule will contain a void situated wholly or partly in a flood plain, the schedule must provide for the rehabilitation of the land to a stable condition.

As NUMAs at Ensham have already been identified in a land outcome document, i.e., EA *EPML00732813*, this PRC Plan is not required to comply with sections 126C(1)(g) or (h) or 126(D)(2) or (3) of the EP Act.[7]

As the pre-approved NUMA locations have been specified in the EA and are shown in Figure 4-1, Ensham is not required to undertake floodplain modelling as part of this plan; however, references and information relating to flood modelling previously carried out have been included.

[7] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.0, p23.*

[8] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00, p26*

5 REHABILITATION MANAGEMENT METHODOLOGY

In accordance with section 126C(1)(e) and (i), the rehabilitation planning part of the PRC plan must:	
• **For each proposed post-mining land use for land, state the 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.**	Sections 5.2, 5.3, 5.5, 5.8, 5.9, 5.10, 5.12, 5.13 & 5.14
• **For each proposed non-use management area, state the proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRCP schedule for the area.**	Sections 5.1 and 5.11.

Following is a general description of the proven rehabilitation practices at Ensham and the significant drivers that have shaped development of those practices. General rehabilitation practices at Ensham are efficient and effective. To date, most rehabilitation has focussed on inter-ramp, outward facing slopes of 10 – 15 % gradient for cattle grazing PMLU.

Detailed information has been provided as to the proposed methods and techniques for rehabilitating the land to a stable condition for each proposed PMLU in Section 3.1 above, Section 5.14 as well as Appendices 9.3 and 9.6. This information has also informed rehabilitation milestones identified in Section 9.1.3.2 for the PRCP Schedule.

5.1 Hydrogeology

A detailed description of the hydrogeological systems of relevance to Ensham is provided in Appendix 9.4 – Hydrogeology summary report. The Appendix summarises relevant historical information and presents a summary of the hydrogeology of the site and all connected strata. Detail of a conceptual model has also been included to illustrate the mine site's groundwater systems.

The Bowen Basin is the largest productive coal basin in the country. The Bowen Basin stretches from Townsville to south of the Queensland-New South Wales border in a north to south direction. In the southern parts, the extent of the Bowen Basin and the hydrogeological Great Artesian Basin (GAB) overlap.

5.1.1 Groundwater overview

The Rewan Formation is recognised as the base aquitard of the GAB (Habermehl, 1980 and 1998).

At Ensham, the Rewan Group is present at subcrop. The Clematis Sandstone, an aquifer of the GAB is not present. The closest intake area (i.e. outcrop of the Clematis Sandstone) is located 50 km southeast of the mine area. The surface geology of the Project Area is dominated by the Nogoa River alluvium to the south and the Tertiary Sediment to the south and the north.

5.1.2 Occurrence and nature of groundwater at Ensham

The stratigraphic sequence comprises unconsolidated Quaternary aged sediments unconformably overlying consolidated Permian and Triassic aged sequences. The Triassic age Rewan Group overlies the Permian coal measures and occurs as in-fill material, thickening to the west with the dip of the coal measures and thin to the east. The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular.

The coal deposits mined at Ensham Mine are found within the Rangal Coal Measures, which is the uppermost Permian unit. The Rangal Coal Measures consist of interbedded sandstone, siltstone, mudstone, and coal with tuff (towards the base) and have a thickness of up to 100 m.

Further detail of the groundwater units and occurrence at Ensham is provided in Appendix 9.4.

Hydrogeological assessments (Cote, 2020; Hydrosimulations 2020) for Ensham describe that the main groundwater bearing units as the alluvium (quaternary sediments) and the Permian aged Rangal Coal Measures. The alluvium is an unconfined system recharged by rainfall and irrigation practices. These groundwater bearing units are referred to as the "regional groundwater system".

The data indicates that groundwater from the coal seams flows primarily towards underground workings. When underground workings are in close proximity to rehabilitated open cut mining areas, there can also be pathways with relatively high hydraulic conductivity that convey water from the rehabilitated open cut mining areas to the underground workings.

Figure 5-1 below shows a selected long-section of Ensham mine, and illustrates a conceptual understanding of the nature and occurrence of the groundwater systems as well as all surface to underground interactions. This long-section has been selected as an illustration of the patterns and processes at play, and further sections are available within Appendix 9.4 to show all parts of the Ensham site.

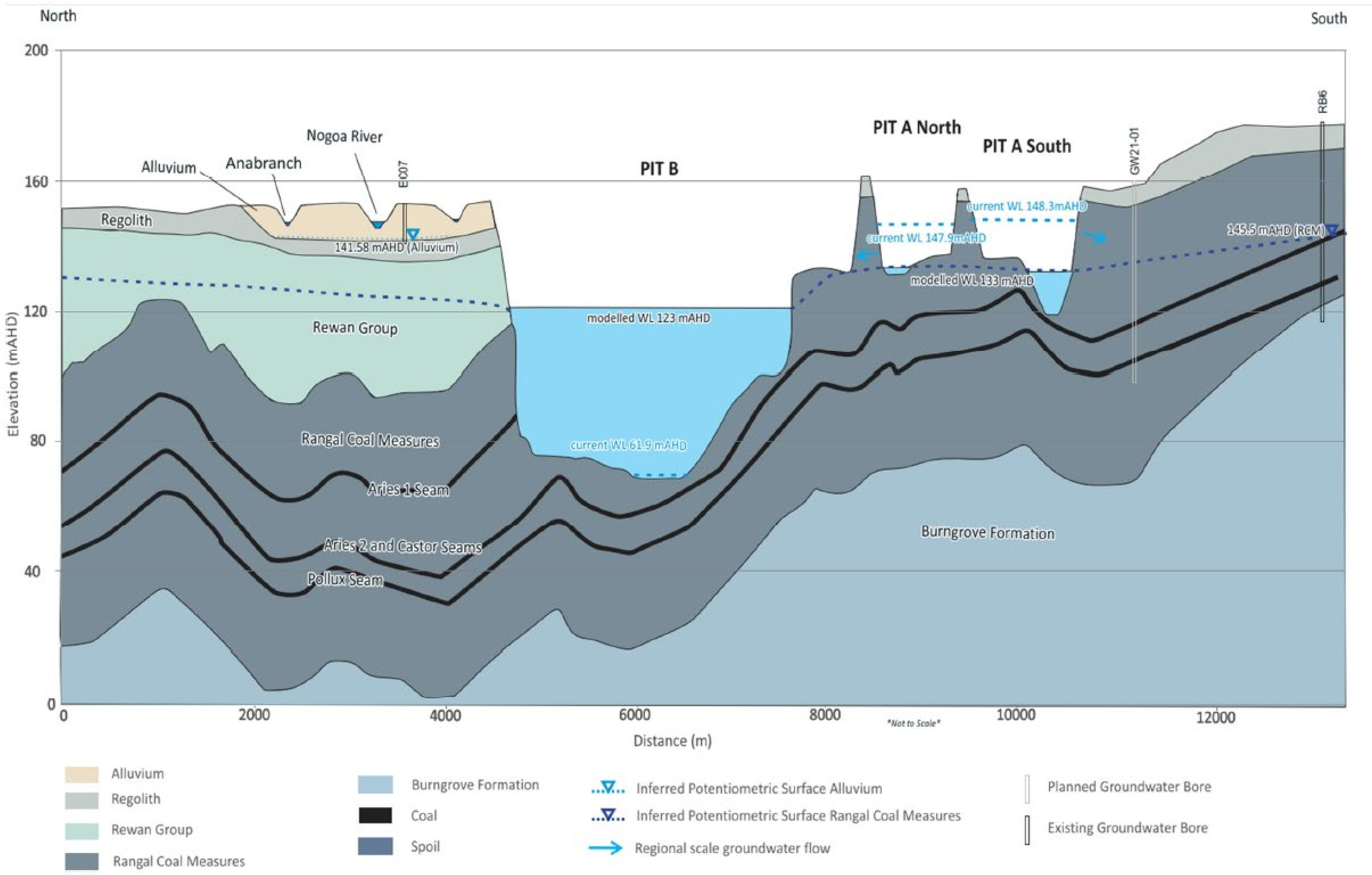


Figure 5-1 Cross section of Nogoa River and Pits A and B (north to south)

5.1.3 Water levels and flow characteristics

Groundwater level and flow in the alluvium is highly variable with thin saturated zones of poor-quality water in deeper sections of an otherwise largely unsaturated formation (SLR, 2020). Hydraulic testing also indicates the conductivities are variable. The primary driver of groundwater flow in the alluvium aquifer is the topographic gradient, and groundwater following the direction of the Nogoa River from north-west to south-east.

Groundwater in the Rangal Coal Measures flows primarily towards the Ensham underground mine area due to the dewatering and depressurisation associated with underground mine development. Recharge occurs primarily from rainfall infiltration on exposed outcrop. The coal measures also subcrop in localised zones beneath alluvium associated with the Nogoa River, where the unit may be recharged by downward seepage where there is an absence of clay and silt layers. Limited recharge may also occur via downward leakage from the Triassic age Rewan Group and Tertiary sediments, as well as from areas of site surface water storage (i.e. in-pit water storages from open-cut mining at the Ensham Mine). The coal seams are connected with the open-cut pits (which are the mined-out areas of the outcropping coal seams). If the pit voids fill up with water, this can create flow into the coal seams. Hydraulic conductivities within the Rangal Coal Measures interburden have also been measured to vary significantly (SLR, 2020).

Potentiometric mapping for both of the main aquifers has been provided within Appendix 9.4.

5.1.4 Water quality

There are two main groundwater units of relevance, the shallow Quaternary Alluvium as associated with the Nogoa River floodplain, and the much deeper Permian aged Rangal Coal Measures. These units are not hydraulically connected and are separated by a low permeability unit, and thus their chemistry is unique.

The alluvium is an unconfined system recharged by rainfall, flooding and irrigation practices. Water quality is highly variability but also exhibits high salinity and is therefore unsuitable for stock watering and irrigation. The majority of bores screened in the alluvium are of sodium-chloride (Na-Cl) water type dominance. Water pH is neutral with a median value of 7.1. Most of the alluvium is hydraulically isolated from the Nogoa River, resulting in brackish to highly saline conditions.

Groundwater in the Rangal Coal Measures is saline and not suitable for stock water supply or irrigation, with variable quality, but typically considered to be poor due to high salinity. Bores monitoring the Rangal Coal Measures are Na-Cl dominant. Water pH is neutral with a median value of 7.7.

Water infiltrating through the spoil material associated with the mine can mobilise solutes or metals that influence final void water quality. RGS (2019) suggest salts in overburden will be immediately soluble and mobilised by water flow, and will decline over time.

5.1.5 Drawdown, recharge and discharge

Groundwater models have been used at site to predict long-term drawdown, recharge and discharge. Model development and refinement has been an evolutionary process with a number of models completed and updated by various parties, most recently by SLR in 2020. Further detail is provided in Appendix 9.4.

The groundwater level recovery (or rebound) indicates some permanent reduction in water levels is predicted for the water levels in the target coal seams, with water levels in the Rangal Coal Measures predicted to recover slowly to around 10 m lower than in the surrounds. However, the water levels in the alluvium, the shallow groundwater system, are predicted to fully recover to pre-mining conditions.

The limited Rangal Coal Measures water level rebound is related to the influence of the Ensham Mine final voids, which will continue to act as a localised groundwater "sink". Considering the potential for groundwater interactions with the residual voids, the final landform for Ensham has a pre-approved NUMA to encompass these Groundwater daylighting water areas.

Cote (2020) noted that groundwater from the coal seams flows primarily towards underground workings. When underground workings are in close proximity to rehabilitated and/or open cut mining areas, there can also be pathways with relatively high hydraulic conductivity that convey water from the rehabilitated and/or open cut mining areas to the underground workings. This impacts on the water levels in the rehabilitated and/or open cut mining areas, which will likely only stabilise after closure. Initially the underground workings will fill with water after mining activities have ceased, and after this time, this groundwater will daylight to any residual voids in proximity. As a result, a pit lake will start to form in some voids, as described in Section 4.1.1. These areas as referred to as the Groundwater daylighting water areas NUMA.

As detailed in Table 4-1, it is anticipated for this to occur in Pits A (central and north), B, C and D. No daylighting of groundwater is expected for Pit A (south), nor with Pits E, F and Y (Yongala) due to backfilling above the modelled groundwater levels.

5.1.6 Uses of groundwater

Ensham is within by the Highlands Groundwater Management Area under the Fitzroy Water plan, and is located in the lower Nogoa Groundwaters of the Fitzroy Groundwater plan. Environmental values for the area that are pertinent to groundwater in the vicinity of Ensham include aquatic ecosystems, irrigation, farm supply/ use and stock water supply. Groundwater from the coal measures is not used for primary recreation or drinking water as the quality for Ensham is not suitable for drinking. Thus, it is mostly used for stock use. The alluvium aquifer is utilised in a similar manner.

5.1.7 Modelled results

Cote (2020) determined that some of the rehabilitated open cut mining areas will maintain a permanent water body with a water level that will fluctuate around a steady state 'equilibrium' level in response to climate variations. Equilibrium level is predicted to be reached after 50 years at A Pit, 100 years for the B Pit area, 150 years for the CD Pits rehabilitated open cut mining areas. These results are detailed in HEC (2020).

All predicted long-term average water levels are below the external "spill" level, the level at which water would overflow out of the rehabilitated open cut mining area. There will be no export of water from the rehabilitated open cut mining areas to surface water in the receiving environment. Further, all predicted water levels in the rehabilitated open cut mining areas are beneath the regional groundwater levels. Groundwater will flow from the regional system to the rehabilitated open cut mining areas. There will be no flow from the rehabilitated open cut mining areas to the regional groundwater system.

Regarding salt and long-term water quality, in the rehabilitated opencut mining area at A Pit, concentrations reach an equilibrium of approximately 12,500 µS/cm after about 20 years. This is because there is flow through the porous medium from A Pit to B Pit. There is a balance between the inputs and outputs of solutes so that concentrations remain around a stable value.

For rehabilitated open-cut mining areas at AB Pits, and CD Pits, concentrations are predicted to keep increasing. This is because the only outflow from these areas is via evaporation, which does not contain solutes. There is no output of solutes and concentrations increase with time. Given that the water held in the rehabilitated open cut mining areas does not reach levels that result in overflow to surface water or groundwater, this does not pose a threat to the receiving environment. In addition, it is not proposed to use the water for any PMLU. For these reasons, Cote (2020) concluded that all rehabilitated open cut mining areas are predicted to be non-polluting.

The modelling has informed which void areas will be partially backfilled above groundwater levels and which despite partial backfilling will eventually become groundwater daylighting areas, with a pit lake forming, as described in Section 4.1. These areas are referred to as Groundwater daylighting water areas and are consistent with the previously approved rehabilitation outcomes for the Ensham Coal Mine, as detailed in the EA (*EPML00732813).*

5.2 Flooding

Ensham is located within the Nogoa River catchment, and flooding interactions and impacts are an important consideration for the site. The susceptibility of the mine site to flooding, and potential influence of flood interactions in the long-term, has been extensively investigated. Reference is made to the Residual Void project completed by Ensham, which was required by the conditions of the previous EA.

This project saw the development of a wide-ranging body of work to understand potential long-term social and environmental interactions and aspects relevant to residual mining voids being retained for the site, as well as considering a number of long-term landform and void design concepts for the site. The project sought to initially establish a foundation of knowledge upon which landform and rehabilitation design concepts were explored, options assessed and consulted with stakeholders. The end result was to establish a landform design concept and a number of PMLUs and NUMAs for the site that are now reflected in the current EA for Ensham.

Based on the body of knowledge from these studies a high level of understanding exists to inform not only the flooding aspects of the site but also a wide range of environmental constraints. A summary is provided below.

5.2.1 Location of flood interaction areas

Ensham extends to the south and north of the Nogoa River floodplain. The following discussion about flooding summarises the analysis in WRM (2019) unless otherwise cited. This report has been provided by Ensham along with a number of other key studies, including but not limited to Umwelt (2019), Cote (2020), HEC (2020) and SLR (2021).

The Nogoa River consists of a well-defined 10 m deep channel that is carved through a relatively flat floodplain area. Flood slopes vary from 0.03 % to 0.05 %. The 0.1% AEP floodplain varies in width from about 4 km at the location of the mine (historically narrowed to 1.5 km by operational mine levees) to about 13 km near the Crinum Creek confluence. The historical floodplain was naturally restricted pre-mining to a distance of 2.6 km by Red Hill on the northern side of the anabranch and higher ground on the southern side of the Nogoa River where the present Duckponds homestead is located. The Duckponds homestead location has not been flooded by any of the floods during the time of Ensham Mine.

The floodplain consists of quaternary alluvium and lacustrine deposits of a mix of sand, silt, clay and gravel. Hansen Consulting (2006) characterised the alluvium as a strongly structured alkaline heavy (cracking) clay soil classified as a grey or brown Vertosol soil.

Flood interactions occur primarily for the southern and central Pits from A to E, and are particularly relevant to areas where voids will be retained, again as described in Section 4.1.1. Flood modelling has been conducted to ensure all voids located within flood plain areas will be rehabilitated to a stable condition, with the exception of any areas designated as NUMA. The extent of the floodplain is as shown on the Final site design map (as required by the PRCP guidelines), provided as Figure 9.1.

5.2.2 Alteration of catchment flows

Catchment flows have already altered for the existing operation and existing approvals are in place to licence all diversion structures as well as other features, which have resulted in alteration of flooding behaviour and catchment flows in particular.

Several anabranch flood channels cross the floodplain, with the most prominent located adjacent to C Pit. The anabranch receives flow every year on average and conveys 36% of the 10% AEP event. Other flood channels receive Nogoa River floodwater only for larger floods but convey a greater proportion of the flow during these large flood events. These channels may be parts of decaying or developing anabranch channels, varying through time. B Pit has been constructed across one of the flood channels called Old Winton Creek. Prior to mining, Old Winton Creek conveyed 6 % of the 10 % AEP flow and 34% of the 1% AEP flow.

Considering post-mining alteration of catchment flows, it is recognised that no licenced diversion or levee structures can remain once the Ensham site has been rehabilitated. As such, a permanent levee structure will be incorporated into a final landform, providing long-term stability. These have been described as a discrete PMLU within Section 3.1.5, as ‘Flood protection landform’. Design and construction of this landform will provide immunity to a 0.1% (1:1000) AEP year flood event.

The hydrology surrounding Ensham will be largely unchanged from the current active mining regime, if slightly improved as a result of an adequate floodplain width being maintained. Contributing catchments upstream of the mine are not expected to be affected during closure and the resulting response to rainfall events will remain similar. As part of the residual void project, commitments were made to:

- ensure a permanent flood protection structure is in place at closure; and
- reinstate a minimum of 2km floodplain width between the northern section of Pit B and the southern section of Pit C.

These requirements are incorporated into Appendix 5 (Floodplain Widening) of the Ensham EA, and have subsequently been transitioned across to milestone criteria for this PMLU (provided as RM11).

5.2.3 Modelled flood levels

Development of hydrologic modelling has occurred for all relevant catchments for all parts of the Ensham site, as well as hydraulic modelling to understand the nature of interactions with mining areas. Modelling has considered likely flood extents for a range of design storm events, up to and including probable maximum flood (PMF) levels. All modelled outputs have been made available to DES, and modelling work completed as part of the Residual Void project has also been subject to independent review and critique. It is considered fit for purpose and utilises contemporary flood modelling techniques.

Flood modelling of pre-mining conditions shows flood velocities are generally low with median channel velocities between 1.1 m/s and 1.3 m/s. Overbank velocities in the flood channels are much lower with median values between 0.2 m/s and 0.8 m/s. Observations of the Nogoa River channel and floodplain taken after the January 2008 and January 2011 floods, which were both very large events, found that the soils and vegetation characteristics at the time were capable of resisting channel bank and overbank sheet erosion, although minor localised erosion was encountered.

An indication of this is that the current anabranch of the Nogoa River through the mine was originally the main channel and the present main channel was the anabranch. Many government maps and databases reflect the original position and naming.

As an outcome of the Residual Void project, a landform design concept was adopted that prevents floodwater from inundating residual voids and grazing areas on the former floodplain, providing flood immunity up to the 0.1 % or 1 in 1,000 annual exceedance probability (AEP) flood event plus 0.5 m. It will permanently confine the floodplain to a minimum of 2 km width between the northern section of B Pit and the southern section of C Pit, as defined in land outcome document EA *EPML00732813*. The final landform design at Ensham includes a flood protection landform PMLU which relates to the permanent flood protection structure.

This will have an insignificant impact on flooding characteristics because flood modelling of the current levee alignment, which restricts the floodplain at Ensham to 1.5 km width, shows that compared to pre-mining conditions:

- There would be no change in peak velocities and shear stresses from pre-mine conditions for the 10% AEP flood;
- The differences between pre-mine and current flood velocities and shear stresses for the 1% AEP event are minor;
- Where increases from pre-mine conditions occur for the 1% AEP event, the predicted velocities and shear stresses are no greater than pre-mine velocities and shear stress along the upstream reach of the river for the same event; and
- the extreme event (adopted as 1.5 x the 0.1% AEP event) would increase velocities and shear stresses along the Nogoa River channel and the adjacent floodplain for about 7 km. Again, the increased velocities and shear stresses are no greater than pre-mine velocities and shear stress along the upstream reach of the river for the same event.

For each of these reasons, rehabilitation at Ensham is not expected to have a significant impact on the morphology of the Nogoa River in the long term.

5.2.4 Flooding risk profile

The final landform design at Ensham includes a flood protection landform PMLU to prevent floodwater from inundating residual voids on the former floodplain, providing flood immunity to Ensham up to the 0.1 % AEP flood event plus a minimum of 0.5 m. For each of these reasons, the flood risk at Ensham is considered to be low, through the application of landform design associated with pre-approved land outcomes.

5.3 Soil Assessment

Natural soils have horizons or layers, approximately parallel to the land surface, with morphological properties different from layers below and/or above it (National Committee on Soil and Terrain 2009). Horizon notation is deduced from profile descriptions, usually colour and texture, and sometimes laboratory data. Typical horizon notations are A horizons of darker, organic rich surface materials, B horizons of mineral soil layers with distinct colours, and C horizons of partly weathered parent materials beneath the solum (AB profile).

Most rehabilitation at Ensham requires creation of new soil profiles with A, B and C horizons. These new soil profiles are called Anthroposols (Isbell and National Committee on Soil and Terrain, 2016). To date, most rehabilitation at Ensham has been completed by placing a thin A horizon of topsoil over B and C horizons of overburden –

- A horizon (0 – 15 cm depth) of topsoil
- B horizon (15 – 90 cm depth) of overburden; and
- C horizon (>90 cm depth) of overburden.

The new solum i.e., A and B horizons, has an assumed depth of 90 cm as most plant roots, plant-available nutrients and accessible water, other plant-soil interactions and soil fauna, are contained within this depth.

5.3.1 Quality of available resources

Soils at Ensham have been characterised and summarised into six major soil groups. Most soils are highly weathered, chemically and physically 'poor', and can be saline and sodic at depth. Some of the mine spoils (overburden) can also be highly dispersive and /or saline in nature.

5.3.1.1 Topsoil/ Soil groups

Soils at Ensham have been comprehensively characterised, as described in Appendix 9.5 – Soil assessment report. Essentially, there are 6 major soil groups on site, which are:

- ***Soil Group (1) – Shallow Rocky Soils (Rudosols)*** that occur on low rocky hills and steep escarpment slopes and eroded plateau remnants. These soils are shallow (<0.5m), exhibit very little profile development and contain gravel and rock cobbles from various geological formations. Apart from the surface (A horizon) soil, this material is not considered suitable for use as topsoil due to the predominantly coarse texture, stoniness and lower water storage capacity.
- ***Soil Group (2) – Moderately Shallow Gravelly Sands, Loams and Clay Soils (Rudosols and Tenosols)*** that occur on eroded middle and lower slopes and broad low gravelly rises. These soils are shallow to medium depth and comprise uniform or weakly gradational sands, loamy sands or sandy loams, loams or clayey soils with varying amounts of ferruginous and siliceous gravel or stone. These soils exhibit low soil fertility and water storage capacity and are not considered suitable for use as topsoil (apart from A horizon materials).
- ***Soil Group (3) – Gradational Red and Yellow Earth Soils (Kandosols-Tenosols, Kandosols and Ferrosols)*** present on the elevated dissected and eroded Tertiary plateau remnants and undulating plains associated with the Tertiary Emerald Formation. These soils include sandy, sandy loam or loamy surface soils grading to red, reddish brown or yellowish-brown sandy loam to light to medium massive or structured clay subsoils often with appreciable amounts of ferruginous gravel. The low nutrient status of this soil requires addition of suitable fertiliser, and in places tends to be moderately strongly acidic.
- ***Soil Group (4) – Texture Contrast (Duplex) Soils (Sodosols)*** that have formed on Permo- Triassic sedimentary rocks, on gently inclined slopes, dissection slope interfluves, broad low rises and plains and on alluvial terraces and drainage flats. These soils are sandy, silty or loamy on the surface with a clear to abrupt change to a clayey subsoil horizon. In places, this soil type can be mildly dispersive, and sampling prior to use is recommended.
- ***Soil Group (5) – Uniform Fine-textured (non-cracking) Clay Soils (Dermosols)*** present on erosional plains, levees and high terraces along stream systems, undulating alluvial plains and associated with cracking clays of Soil Group 6. These soils exhibit uniform profiles or weakly

gradational profiles where clay content may increase slightly with depth, and are considered the most suitable in terms of soil physical and chemical properties.

- ***Soil Group (6) – Cracking Clay Soils (Vertosols)*** that form the dominant soil type within the alluvial plains associated with the Nogoa River and its tributaries. These soils have uniform medium to high clay content, pronounced swelling and shrinkage properties and commonly feature gilgai, and in places are unsuitable for use as topsoil due to increasing alkalinity, sodicity and adverse soil structure.

Most soils are highly weathered, chemically, and physically poor, and can be saline and sodic at depth.

5.3.1.2 Quality factors

5.3.1.2.1 Soil pH

Soil acidity/alkalinity affects the availability of various nutrients, toxic elements and chemical species present in soil solution and available to plant roots (Hazelton and Murphy 2007). Strong soil alkalinity reduces the plant-availability of both macro- and micro-nutrients in soils regardless of total concentration (Table 5-1). In very strongly alkaline conditions, where pH ≥ 9.0, the availability of 8 of the 13 essential plant nutrients is reduced.

Table 5-1 Influence of soil pH on nutrient availability (from Hazelton and Murphy 2007)

Nutrient		pH_{WATER} at which nutrient availability is reduced
Macro-	N	>9.0
	P	>8.5
Micro-	Ca	>9.0
	Mg	>9.0
	Mn	>8.0
	B	>7.5
	Cu	>8.0
	Zn	>8.0

The availability of soil nutrients is a major limitation to plant production in central Queensland (Shields and Williams 1991) and P deficiency is widespread. Unlike soil N, which can be 'fixed' from the atmosphere by rhizobium bacteria in symbiotic relationships with plant roots, all soil P is derived from soil parent materials and fertilisers, if applied. Plants require relatively large amounts of available P for normal, productive growth.

Given that soil available for use in rehabilitation in Central Queensland are typically strongly alkaline, a practical approach is proposed to decide soil suitability based on pH (Table 5-2). Marginally suitable soils, with pH 8.5 – 8.9, should be with the use of ameliorants.

Table 5-2 Soil suitability based on alkalinity as pH

Soil pH	Suitability
<8.5	Suitable
8.5 – 8.9	Marginally suitable but requires amelioration
≥9.0	Not suitable without amelioration

5.3.1.2.2 Salinity

For mined land rehabilitation in central Queensland, topsoil with an EC_{SAT} ≤4 dS/m is considered suitable. The growth of most plants is affected at higher salinities (Hazelton and Murphy 2007).

5.3.1.2.3 Sodicity

Topsoils with low sodicity are preferred for mined land rehabilitation in central Queensland. Generally, topsoils with an ESP <6 % are suitable, while topsoils with ESP >6 -14 % are marginally suitable and typically require amelioration with gypsum to ensure aggregate stability.

5.3.1.3 Suitability of materials

Suitable topsoils for rehabilitation will have the following characteristics:

- pH <8.5 preferably and 8.5 – 9.0 if no other soil resources are available.
- EC_{SAT} ≤4 dS/m; and
- ESP <6 preferably and ESP ≤14 % with amelioration if no other soil resources are available.

Several assessments have also considered the suitability of overburden material to support the rehabilitation, effectively being placed as an alternate growth media with a view that these materials will be remediated into a topsoil over time. Previous waste material characterisation assessments include CMLR (2005), Loch (2015), URS (2005), URS (2015), and RGS (2018). In summary, the assessments demonstrate that the spoils and soils are typically sodic and saline to varying extents, and non-acid forming (Ensham Resources 2021).

The Permian spoil materials are generally non-saline to saline and sodic, and thus has some potential for use as a growth media surrogate.

5.3.2 Quantity of available resources

Table 5-3 below shows the latest inventory of the topsoil stockpiles available in Ensham. The majority of the stockpiles are Class 1 and Class 2 in quality. No further surface disturbance is planned for Ensham mine and therefore the inventory represents the total volume of topsoil available for rehabilitation use.

Table 5-3 Inventory of topsoil materials available

Location	1 – Very Good	2 – Good	3 – Marginal	4 – Poor	Total (m^3)
Total	1,216,887	901666	602,469	21,129	2,742,151

From Table 5-3, a total of 2,118,553m^3 of good / very good topsoil is available, with a further 623,498m^3 considered to be of marginal, but usable, quality. Poor quality topsoil will require amelioration to be used. It is noted that Ensham frequently complete topsoil inventory updates, and this inventory reflect the latest understanding of topsoil resources available for the site (as at late 2024).

Table 5-4, below provides a summary of the disturbance to be rehabilitated for the Ensham site, and identifies the volume of topsoil resource required by area and type of disturbance footprint.

Table 5-4 Demand for topsoil materials, by area

Location	Topsoil volume available (m³)	Area (ha)	~Volume required @ 150mm re-spread (m³)
Yongala		384.3	576,450
Central		1,176.5	1,764,750
South		955.5	1.433.250
Total	**2,742,151**	**2,516.3**	**3,774,450**

*as at December 2024

From a comparison between Table 5-3 and Table 5-4, Ensham do not have sufficient suitable material to re-spread 150mm across all areas. There is a shortfall of approximately ~1,000,000m^3 of material., equivalent to approximately 688 ha. Notably, the above table includes the requirement for topsoil in some areas where topsoil is anticipated to be already available (non-stripped areas, natural ground and rehabilitation areas), meaning that less topsoil is likely required than described in the above table. The prevalence of topsoil within the landform will be managed on a case by case basis on the ground, only placing topsoil in areas of rehabilitation where it is required.

Given the magnitude of this shortfall, this is not considered to be of critical concern to the success of rehabilitation at Ensham, however the risk assessment (provided as Section 6 of this PRCP) considered the unmitigated risk associated to be high. Several actions and initiatives are proposed or underway to address this deficit and mitigate the risk. This includes the following:

- amelioration of poor topsoils and/or amelioration of spoil to create a suitable growth media, with early indications from the METS trials (detailed in Appendix 9.4) showing significant promise; and
- completion of a benchmarking exercise to understand the rehabilitation performance of other mine locations in central Queensland where 100mm of topsoil material has been applied. It is noted that, particularly for areas of 'virgin' ground such as infrastructure or disturbed areas that have been cleared and stripped, this is a common practice. It is also of note that if Ensham were to adopt an approach of applying 100mm to such areas, there would be sufficient material in inventory to meet demand.

5.3.3 Location and accessibility of resources

The haul distances described below and within the ERC are derived utilising the Spry Model, in conjunction to various site-based inputs. The Spry model simulates hauling topsoil from the stockpiles to the destination (rehabilitation) areas, recording information about the haulage including truck hours, total haul distance, etc. The Spry model uses a set of defined haul paths, and chooses the best route. By identifying the best route, this therefore identifies the haul distances for the topsoil.

Table 5-5 Topsoil haul distances derived by the Spry Model

Topsoil Location	Haul Distance
A Pit	>1000 m to <=1500 m
B Pit	>3000 m to <=4000 m
C Pit	>5000 m to <=6000 m
D Pit	> 6000 m
E Pit	>3000 m to <=4000 m
F Pit South	>1500 m to <=2000 m
F Pit North	>1000 m to <=1500 m
Y Pit	>1500 m to <=2000 m

5.3.4 Need for ameliorants and fertilisers

Most rehabilitation areas (where topsoil reapplication will occur) will require amelioration or fertiliser application at Ensham. This is due to the dispersive and/or saline nature of mine spoil, limited topsoil resources and the scale of rehabilitation works required, which requires some amelioration to support the creation of new soil profiles. Sampling of stockpiled material will occur prior to use to guide exact application rates, as well as selection and specifications of ameliorants and fertilisers.

Addressing soil limitations within Ensham soils has historically included the application of fertiliser, hay-mulch and, more recently, gypsum where needed. Past detailed amelioration and fertiliser assessment have informed the following sections. Application rates of each type of ameliorant and fertiliser are further discussed in Appendix 9.5 – Soil assessment report.

5.3.5 Suitability of soils to support PMLU outcomes

Given the limiting factors of topsoil quality and quantity at Ensham, the revegetation prescriptions are greatly influenced by land systems and soil types, ensuring the soil and spoil materials will suit the PMLU criteria and outcomes.

The extent and location of the PMLUs at Ensham which are relevant to the soil assessment, includes the following areas:

- Cattle grazing on overburden / infrastructure areas; and
- Native bushland corridor

It is notable that the majority of rehabilitation (90%) by area at Ensham has a target PMLU of beef cattle grazing. Rehabilitation suitability requires evaluation of soil and landform attributes based on the requirements for the specific PMLUs by using current technology and management.

Further, a long history of rehabilitation monitoring has demonstrated that the current rehabilitation methodology at Ensham, including treatment and use of soils, will result in successful achievement of milestone criteria for the relevant PMLUs.

Further discussion regarding to this can be found in the Appendix 9.5 – Soil assessment report, as well as Appendix 9.3 - Monitoring summary report and Appendix 9.2 – PMLU context document.

5.3.5.1.1 Use of spoil material for remediated soils

New B/C horizons provide anchorage for plants and contribute to soil nutrition; however, the principal role of subsoil is to store moisture for plant use. Understanding spoil characteristics and potential subsoil limitations that restrict root proliferation and access to stored water is essential in achieving satisfactory rehabilitation. Common limitations at Ensham that require amelioration are subsoil salinity and sodicity.

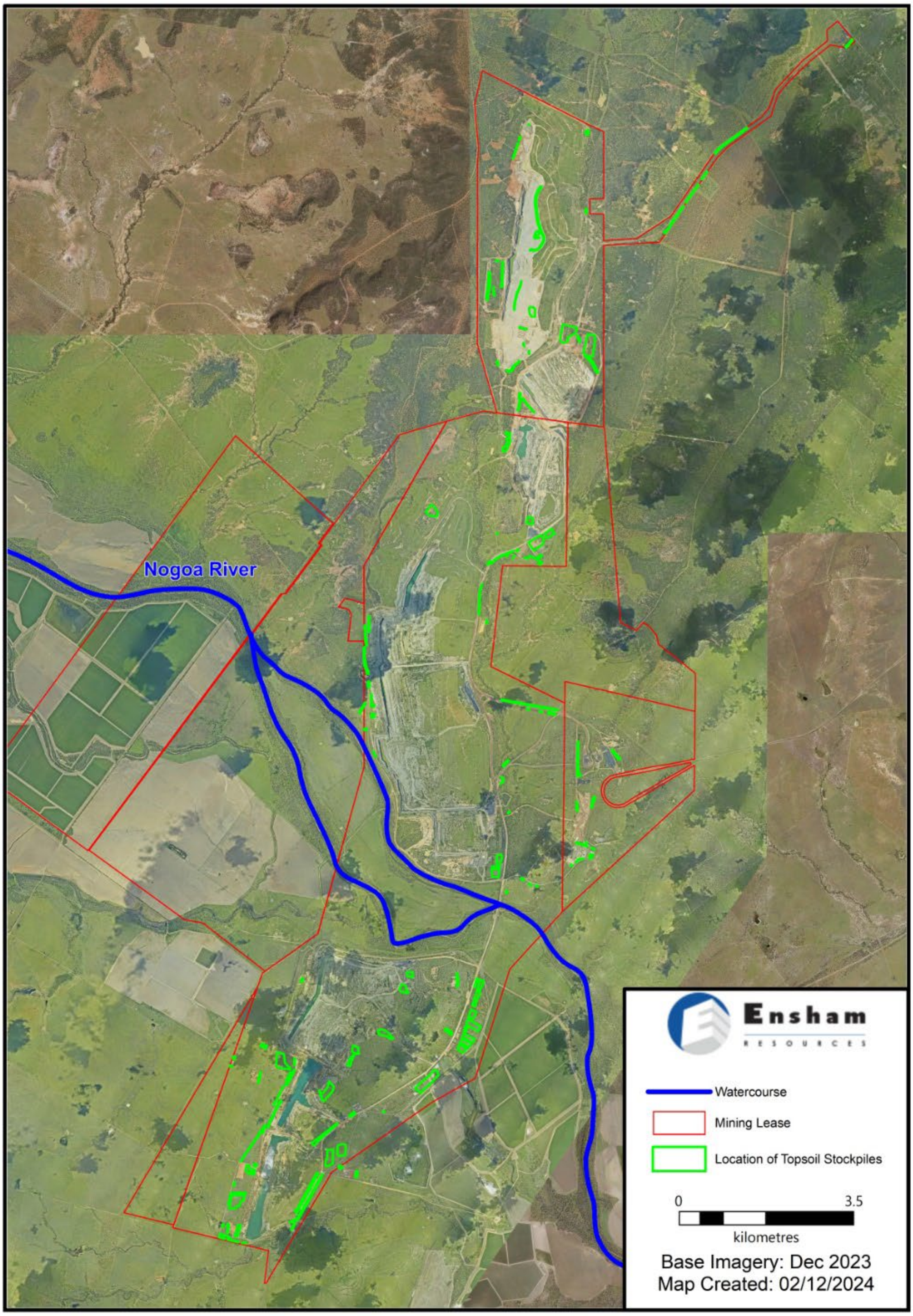


Figure 5-2 Locations of soil stockpiles at Ensham

5.4 Waste characterisation

An understanding of the geochemical characterisation of overburden materials has informed the selection of rehabilitation strategies, and appropriate PMLUs for Ensham. Geochemical hazards have been identified to investigate the character of waste rock and coal units, highlighting contaminants that pose a risk to the environment. This includes that associated with acid mine drainage (AMD), neutral mine drainage (NMD) and saline mine drainage. Adopted waste classification criteria are described as relevant and adopted by Ensham.

5.4.1 Review of sampling regime

Overburden materials at Ensham have been comprehensively characterised. To determine appropriate rehabilitated area design parameters for rehabilitation, it is crucial to understand material characteristics. Several reports have described materials at Ensham to varying extents, e.g., URS (2005), CMLR (2005), URS (2006), Loch (2015), URS (2015), and RGS (2019 and 2020) as well as RGS (2021), and each contain some useful information.

This knowledge base has covered the range of lithologies and waste materials commonly encountered at the mine. Reports demonstrate that spoils and soils are typically sodic and saline, and non-acid forming (RGS, 2018). The sampling regime meets leading practice standards in terms of sampling resolutions and coverage. It is also spatially representative of all material being mined as well as waste rock structures created, and is representative of all lithologies.

A range of analytical techniques have been applied to the sampling of waste materials, and is considered to meet and exceed the requirements of the PRCP guideline. In addition, reviews have also been conducted of downstream and surrounding surface and groundwater water quality for the site, with no evidence of AMD or NMD impacts (RGS 2019, 2020).

5.4.2 Summary of waste streams

Ensham removed Quaternary, Tertiary and Permian stratigraphic units and then mined the upper coal seam within the A, B, C, D, E, F and Y open pits. The geology of the area modelled comprises of Cenozoic sediments (alluvium, gravel, sand silt, and clay), and sedimentary rock units including sandstone, siltstone and claystone, and Triassic/Permian sedimentary units, including sandstone, siltstone, carbonaceous mudstone and siltstone and coal, as detailed in Table 5-6. The Cenozoic sediments and sedimentary units have been subdivided into Quaternary sediments and Tertiary sedimentary units when modelled. The major sedimentary rock units are primarily interbedded siltstone and sandstone with laterally continuous coal seams and some non-coal carbonaceous material, mostly mudstone.

Table 5-6 Percentage of lithological units present on pit high walls

Lithology	Pits A & B Volume (%)	Pits C, D & E Volume (%)	Pit F Volume (%)	Pit Y Volume (%)
Alluvium	1.27			
Carbonaceous Mudstone	0.37	0.38	1.01	2.63
Carbonaceous Siltstone		4.48		0.42
Clay	10.15	2.28	14.33	14.71
Claystone	5.88	0.49	6.67	0.56
Coal	0.59	5.12	7.02	7.88
Coaly Claystone			0.01	
Coaly Mudstone				0.02
Gravel	3.05			
Sand	6.96	0.67		1.38

Lithology	Pits A & B Volume (%)	Pits C, D & E Volume (%)	Pit F Volume (%)	Pit Y Volume (%)
Sandstone	28.32	54.4	33.66	42.53
Silcrete			3.21	0.07
Silt	0.27			
Siltstone	39.74	31.67	33.40	30.33
Soil	3.39	0.52	0.58	0.11
Sooty Coal			0.11	

The geological logs were used to derive inferred pre-mine volumes for the Quaternary Sediments, Tertiary Sediments and Permian Sediments. The pre-mine topography was calculated using a linear method from the crest of the highwall to the eastern edge of the deepest mined surface. The dip, and dip direction of Permian and Tertiary units was taken to be consistent and the Quaternary sediments were taken to be parallel to the predicted surface. These in-pit volumes can then be used to derive the relative proportion of these strata in the backfilled pits, as detailed in Table 5-7.

Table 5-7 Percentage of Quaternary, Tertiary and Permian by Pit(s)

Pit	Lithology Age	% of Pit	Overburden Movement (Mm^3)
Pit A and B	Permian	83.8	41.4
	Quaternary / Tertiary	16.2	
Pit C, D and E	Permian	97.8	41.0
	Quaternary / Tertiary	2.2	
Pit F	Permian	87.7	15.8
	Quaternary / Tertiary	12.3	
Pit Y	Permian	74.3	19.8
	Quaternary / Tertiary	25.7	

The result of the modelling of the type and nature of waste that comprises Ensham waste material, the following is highlighted:

- All pits are modelled as comprising a majority of Permian over/interburden, with the minor presence of Quaternary and Tertiary materials.
- Cenozoic sediments occur to varying depths from north to south.
- The geological model of all pits extends to the bottom of the relevant floor seam (namely Aries 1, Castor, and Pollux seams from north to south), between 90 – 125 m below ground level (bgl).
- The floor seams (Aries, Castor and Pollux) dips westward from approximately 2° – 6° and this dip and dip direction is roughly consistent through the model.

5.4.3 Contaminants of concern

URS (2015) found that materials represented by overburden and coal samples had low sulfur concentrations (< 0.05 %S) and contained up to two orders of magnitude more acid neutralising capacity compared to acid generating capacity. The overwhelming majority of samples were classified as non-acid forming (NAF) or Acid Consuming (AC) and the bulk mine waste materials had negligible risk of acid generation and a very high factor of safety in terms of their potential to generate acid.

Total metal/metalloid concentrations in the overburden and coal materials were low compared to un-mineralised soil materials. Leachate from these mining materials was generally pH neutral to slightly alkaline and had low levels of salinity. Dissolved metal/metalloid concentrations were below the majority of applied water quality guideline concentrations. There is the potential for saline drainage from spoil materials and dispersion due to elevated sodicity.

The depositional environment of the coal in the Ensham stratigraphic sequence was an alluvial environment with negligible marine influences at a regional level, therefore the magnitude of any potential for AMD generation is expected to be limited, compared to coal formed in marine influenced strata.

Surface water quality monitoring data collected over the past decade (2010 – 2021) is well aligned with the groundwater data and overall statistics show that at surface water quality is typically pH neutral with low concentrations of dissolved parameters such as metals/metalloids (RGS, 2021). Salinity in surface runoff collected from rehabilitated areas is also low and generally reflects predicted levels in pits and dams containing un-rehabilitated spoil runoff and water pumped from underground (RGS, 2021). Runoff quality, collected from rehabilitated landforms, comply with completion criteria for Electrical Conductivity, Sulphate and specified metals.

5.4.4 Classification of waste materials

CMLR (2005) provides a simple and practical classification of overburdens based on geology and measured physical and chemical parameters. Four distinct spoils were identified, described and mapped throughout the mine (Table 5-8). The geochemistry of these spoils is well understood and, as a result, there has been a focus on understanding and managing salinity and sodicity as the principal limitations to plant growth and stability in rehabilitation.

Soil salinity is the concentration of dissolved salts in soil solution. These are mainly Na+ but also K+, Ca^{2+} and Mg^{2+} which may be chlorides, sulphates, or carbonates. Excess salt in soil solution, i.e., high salinity, inhibits osmotic processes that enable plant roots to absorb soil moisture. Salinity is measured as electrical conductivity (EC) in a 1:5 soil/water suspension ($EC_{1:5}$ or EC_{WATER} dS/m). This is converted to saturated EC (EC_{SAT} dS/m) by accounting for the moisture holding capacity of the soil, i.e., clay content. EC_{SAT} is preferred as it better approximates the salinity of soil solutions experienced by plant roots.

Table 5-8 Spoil types and distributions at Ensham (adapted from CMLR 2005)

<table>
<tr><th rowspan="2">Era</th><th rowspan="2">Period</th><th rowspan="2">Group</th><th rowspan="2">Description</th><th colspan="7">Ensham pit</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>Y</th></tr>
<tr><td rowspan="3">Cainozoic</td><td>Quaternary</td><td>n/a</td><td>Alluvial sands, silt gravel</td><td colspan="3">Q</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Tertiary</td><td rowspan="2">n/a</td><td rowspan="2">Sandstone, siltstone, claystone</td><td></td><td colspan="2">T2</td><td></td><td></td><td colspan="2">T2</td></tr>
<tr><td colspan="7">T1</td></tr>
</table>

Era	Period	Group	Description	Ensham pit						
				A	B	C	D	E	F	Y
Palaeozoic	Upper Permian	Blackwater	Rangal coal measures	P COAL						

Sodicity occurs when the exchangeable Na^+ on the cation exchange complex leads to clay dispersion in soil. Sodic soils have the following issues.

- Surface crusting
- Low infiltration and hydraulic conductivity
- Hard, dense subsoils; and
- Tunnel and gully erosion.

The level of exchangeable Na^+ is determined by measuring the concentration of all the exchangeable cations in the soil and expressing the amount of exchangeable sodium as a proportion of the sum of all the exchangeable cations, known as the cation exchange capacity (CEC) (Hazelton and Murphy 2007). This proportion is called the exchangeable sodium percentage (ESP).

A description of each of the four spoils at Ensham follows.

5.4.4.1 Quaternary spoil (Q)

Pale brown to yellow alluvial sands and gravels (Figure 5-3). Low clay content means material has little water or nutrient holding capacity. Non-saline but sodic with low surface cohesion, this overburden is highly dispersive and prone to excessive erosive when exposed to rainfall.

Figure 5-3 Quaternary spoil in B Pit is screened for gravel and sand for use around site (left) and erosion in situ Quaternary spoil in B Pit endwall (right)

5.4.4.2 Tertiary spoil (T2)

This overburden is Tertiary age material that appears above T1 overburden in B, C, F and Y pits. It is distinguishable from T1 by its darker colour but is otherwise physically and chemically similar.

5.4.4.3 Tertiary spoil (T1)

Overlying the Permian overburden, this material is derived from Tertiary age alluvium or colluvium (Figure 5-4). It is consistently saline to extremely saline, with chloride levels toxic to plants at Y Pit, and consistently sodic to extremely sodic. This material is extremely dispersive.


Figure 5-4 Tertiary spoil overlying Permian spoil in Y Pit (left) and F Pit (right)

5.4.4.3.1 Permian spoil (P)

Easily distinguished by its bluish grey colour, consisting of rapidly weathering mudstones and siltstones, with orange/yellow resistant sandstone fragments (Figure 5-5). Derived from Permian sedimentary rocks of the Blackwater Group, it is generally non-saline to saline and sodic.


Figure 5-5 Permian spoil in D Pit emplacement (left) and E Pit highwall (right)

5.4.4.4 Waste management and placement strategies

At Ensham, conservative slope gradients have been adopted as a key management strategy to control erosion of Tertiary overburden materials. The common approach is to limit slope gradients, with the majority of slopes on site (and constructed using these materials) not more than 10%.

Key additional practices that are adopted include ensuring slope lengths do not exceed 200 m, not using contour banks or rock lined waterways, and applying surface treatment for erosion control at the time of seed sowing (hay mulch). Further information is provided as to landform design controls in Section 5.5.

Permian spoil materials are considered to be relatively benign, and it is about 50% less saline and sodic than the Tertiary overburden. Thus, it is favoured for use as a surrogate growth media material in rehabilitation because it is less hostile to plant establishment and growth, and more erosion resistant, due in part to its variable content of coarse sandstone fragments.

5.4.4.4.1 Effects of sodicity and salinity

Salinity and sodicity are opposing forces in soil / overburden aggregate stability: salinity is aggregating while sodicity is dispersing. Salinity and sodicity often occur together and salt affected materials have historically been grouped as saline, non-saline and sodic, or saline and sodic, depending on the relative composition of the salts present. Using available data, Ensham overburdens and soils can be grouped into these categories (Figure 5-6 and Figure 5-7). Here, a saturated electrical conductivity (ECe) >4 (dS/m) and an exchangeable sodium percentage (ESP) >6 are the generally accepted threshold limits for salinity impacts on plants and sodicity impacts on soil structure. For regional context, the 32 central Queensland soils and overburdens assessed by (So et al. 1998) in ACARP Project C4011 are included.

However, for a given sodicity value, as EC increases soil dispersion decreases. Conversely, very low EC values mean that a soil may become dispersive where the ESP is very low, e.g., ESP of 2. The relationship between salinity and sodicity is the electrochemical stability index (ESI). ESI is determined by calculating the ratio of EC to ESP, i.e., ESI = EC1:5/ESP. The adopted critical ESI value for Australian soils is 0.05 (McKenzie 1998). Materials with an ESI less than the critical value will be prone to dispersion. Most of the Ensham overburdens and soils are highly dispersive.

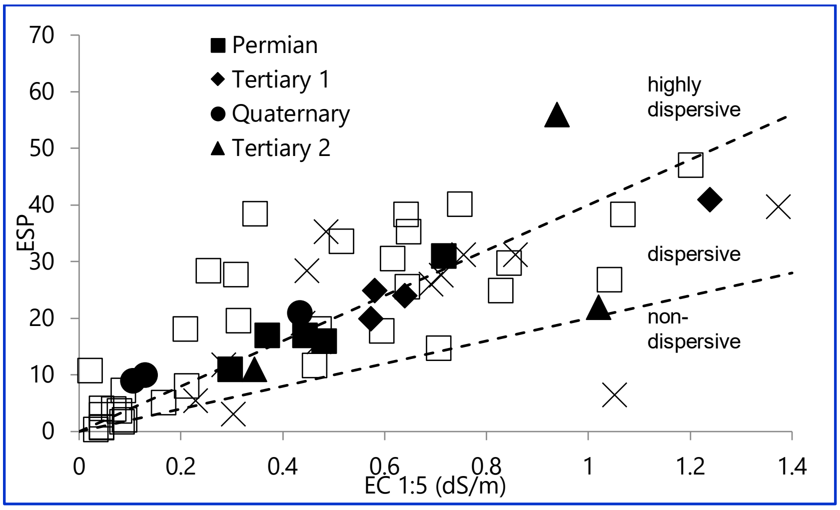


Figure 5-6 Classification of dispersive materials showing Ensham overburdens (after CMLR 2005), 16 central Queensland overburdens by ACARP C4011 (So *et al* 1998) and 40 central Queensland overburdens by ACARP C12031 (Henderson 2004)

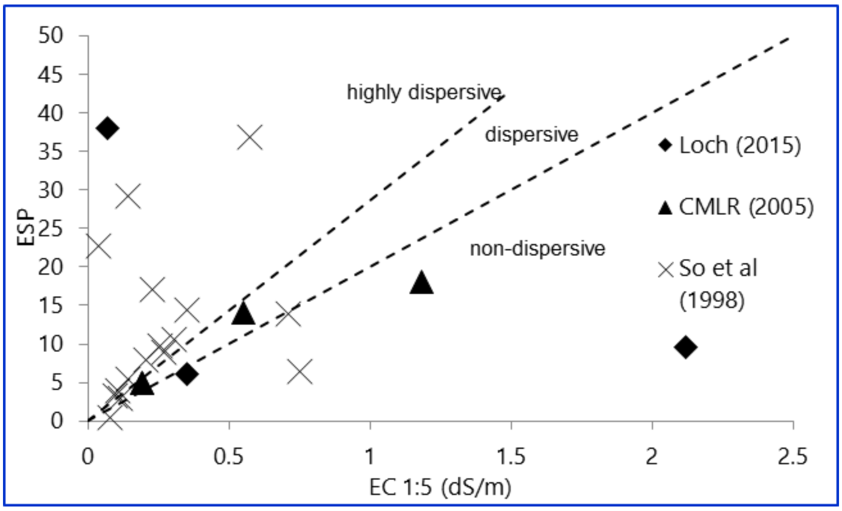


Figure 5-7 Classification of dispersive materials showing Ensham soils (after CMLR 2005 and Loch 2015) and 16 soils by ACARP C4011 (So *et al* 1998)

ESI explains the extremely dispersive nature of some overburdens, particularly Tertiary age materials. Although also highly saline, this salinity is insufficient to counter the effects of extreme sodicity, and the material disperses readily and is prone to excessive erosion. Ensham overburdens can be ranked in terms of salinity, sodicity and dispersivity (Figure 5-8).

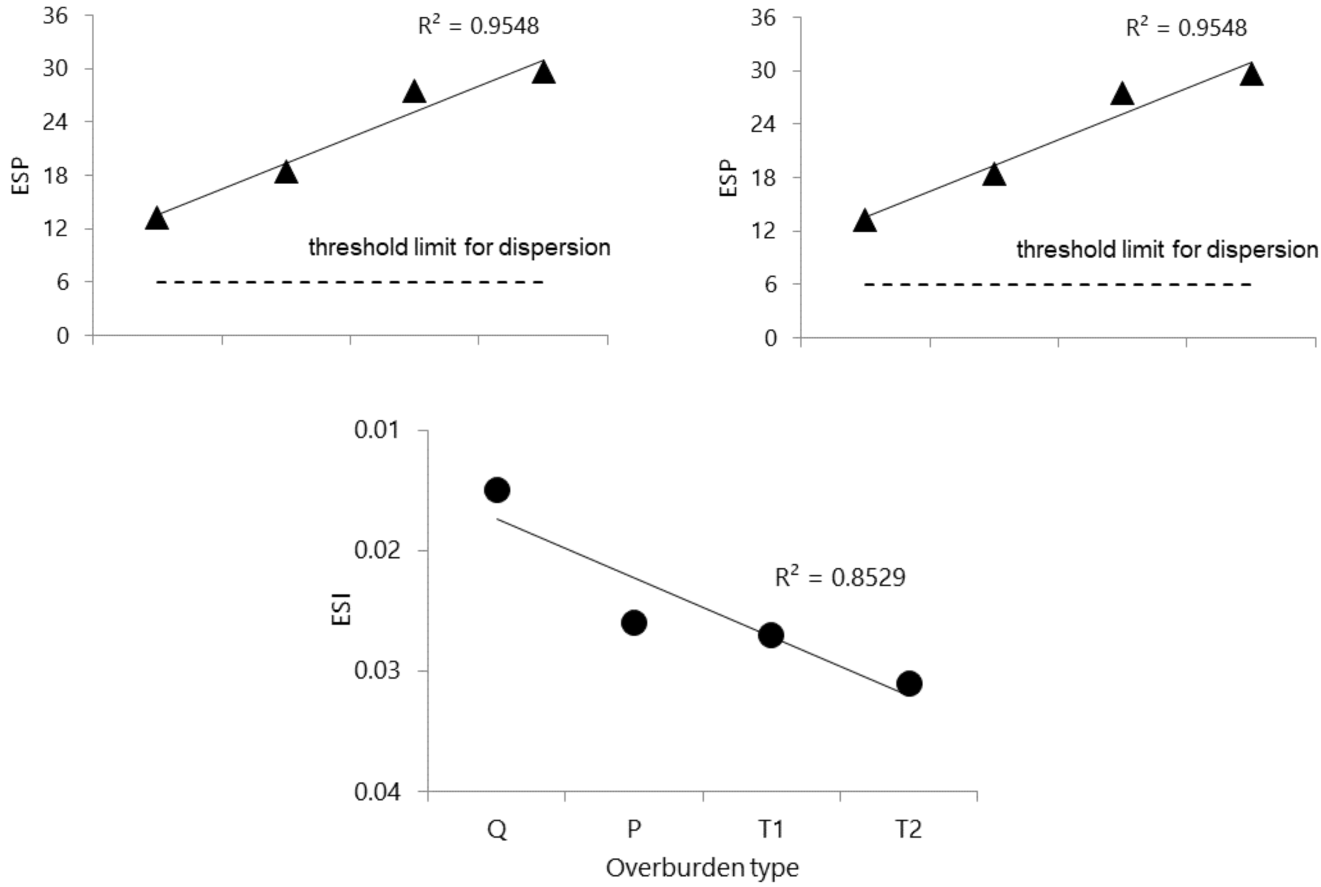


Figure 5-8 Relative salinity (a), sodicity (b) and dispersivity (c) of Ensham overburdens (after CMLR 2005)

This analysis shows that:

- Quaternary overburden is the most dispersive, but Tertiary overburdens are the most saline and most sodic;
- Tertiary overburdens are about twice as saline as Permian overburdens; and
- All overburdens are highly dispersive.

5.4.4.4.2 Quaternary spoil (Q)

Quaternary overburden is the most dispersive and least cohesive overburden at Ensham, making it prone to excessive tunnel and gully erosion. This material will be selectively placed and buried beneath other material to ensure it does not present at or near the surface of final landforms. It is not suitable for topsoil application and rehabilitation.

5.4.4.4.3 Tertiary spoils (T1 and T2)

Tertiary overburdens are the most saline and sodic, are prone to excessive dispersion and erosion, and occur in every pit at Ensham. Common throughout central Queensland mines, Tertiary overburdens have been extensively studied by ACARP and other industry-led research. For example, ACARP C12031 *Rehabilitation of Dispersive Tertiary Spoil in the Bowen Basin* by Henderson (2004) made the following recommendations in ascending order of risk of poor outcome, i.e., decreasing hazard control effectiveness.

- Bury under another spoil type.
- Cover with at least a metre of rocky spoil to create a 'store and release' cover system.
- Topsoil and grass cover at slope angles that avoid sliding failure along the soil/spoil interface when wet. Provide measures to assist erosion control until grass is established.

Practice at Ensham and other mines in central Queensland shows that conservative slope gradients are required to control erosion of Tertiary overburden. The common approach is to limit slope gradients to not more than 10%. Ensham can demonstrate appropriate hazard control effectiveness with respect to dispersion and erosion risks when:

- Slope gradients of Tertiary overburden do not exceed 10% maximum gradient
- Slope lengths do not exceed 200 m
- Contour banks and rock-lined waterways are not used; and
- Hay mulch is applied at the time of sowing.

5.4.4.4.4 Permian spoil (P)

Permian overburden is about 50% less saline and 50% less sodic than Tertiary overburdens. Though similarly dispersive, the material is favoured for rehabilitation because it is:

- Less hostile to the establishment and growth of plants; and
- More erosion resistant, due in part to its variable content of course sandstone fragments.

5.5 Landform design at Ensham

5.5.1 Development of design concept

Development of the landform design concept for Ensham commenced with collation of design criteria and literature review of regulatory publications, best practice guidelines, ACARP research reports, site documentation and historical information and previous landform studies completed. Relevant information on rehabilitation and landform designs from similar mine sites in Central Queensland was also utilised where available; and coupled with understanding and review of site conditions. This process developed a range of landform and residual void design options which were subsequently investigated.

A previous version of the EA required for a detailed residual void study to be completed to inform the strategy around retained voids, and by extension, surface landforms to be retained at the end of mine life for Ensham. The current EA (*EPML00732813*) is representative of the agreed outcomes from this Residual Void project.

Further discussion of the landform development process is provided in Appendix 9.6 – Landform design report.

5.5.2 Key factors of relevance to design concept

The Ensham EA requires all surface areas significantly disturbed by mining activities to be rehabilitated to a safe, stable and non-polluting landform, with self-sustaining vegetation cover. Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer other than the environmental harm constituted by the existence of the residual void itself. These requirements, have been incorporated into the landform design concept as appropriate.

Development of the landform design has further required the synthesis of a wide range of technical and environmental factors and constraints, into the design concept. This concept has addressed any underlying factors through design, but also responds to the specific requirements present for Ensham to ensure long-term environmental control and adequate performance.

The environmental factors have typically driven the design concept outcomes, as with the following considerations:

- spoil type
- appropriate slope criteria for each spoil type
- disturbed material and land
- the location and performance of adjacent watercourse
- floodplain interactions and protection
- rehabilitation drainage

The key environmental factor of relevance to Ensham relates to the erosive potential of materials, and by extension, the erosive stability of the landforms. This has formed a primary driver of the landform design concept as well as the overall rehabilitation approach for Ensham. A further secondary factor that has driven the landform design relates to the PMLU of cattle grazing, and ensuring the land suitability requirements are provided to support these land outcomes.

5.5.2.1 Achieving sustainable rates of soil loss (erosion)

Erosion is the greatest risk to any post-mining landscape in central Queensland. Though historical rates of soil loss up to 40 t/ha/y were considered acceptable, the contemporary view is that erosion rates from rehabilitated landforms should be analogous to surrounding unmined areas. Williams (2000) summarised various soil losses and found for mixed pasture and woodlands, rates have a maximum of around 4 t/ha/y. Coincidently, Grigg *et al.* (2001) conclude the rate of soil loss in mine rehabilitation should not exceed the rate of soil renewal, which is less than 4 t/ha/y.

It is well established that high vegetation percentages reduce erosion in rehabilitation, even on steep slopes (Carroll *et al.* 2000; Loch 2000). Under vegetation, infiltration capacities increase greatly, soil structure is improved, and erosion can be greatly reduced. So *et al.* (1998) suggest 30 to 40 % vegetation cover will be required to reduce erosion to acceptable levels. For sloping rehabilitation, rates higher than 50% were recommended by Grigg *et al.* (2001).

With consideration to material characteristics (as further detailed in Section 5.4) and more than 40 years of industry-led research and practice, Ensham has determined the following typical design objectives for slopes.

1. Tertiary overburden slopes, regardless of soil type, will typically have:
   - Gradients ≤10%, and
   - Lengths ≤200m, variable depending on the size of the contributing upper catchment.
2. Permian overburden slopes, regardless of soil type, will typically have:
   - Gradients ≤15%, and
   - Lengths ≤100m, variable depending on the size of the contributing upper catchment.

The above landform design criteria have been modelled to demonstrate they result in rehabilitation which is erosionally stable over the long term (as per Appendix 9.6 Landform design report), and is reinforced by practical examples of 20 year old rehabilitation demonstrating success. The gentle slope angles allow for longer slope lengths without resulting in unacceptable stability concerns.

5.5.2.2 Land suitability requirements for beef cattle grazing PMLU

More than 90 % of rehabilitation at Ensham has a target PMLU of beef cattle grazing. Determination of rehabilitation suitability requires evaluation of soil and landform attributes based on the requirements for beef cattle grazing land outcomes.

Five land suitability classes are defined for use in Queensland, with land suitability decreasing progressively from class 1 to class 5. Land is considered less suitable as the severity of limitations for a specified land use increase. The five land suitability classes are summarised below:

- Class 1 - Suitable land with negligible limitations.
- Class 2 - Suitable land with minor limitations.
- Class 3 - Suitable land with moderate limitations.
- Class 4 - Marginally suitable land with severe limitations.
- Class 5 - Unsuitable land with extreme limitations.

Suitability classification evaluates rehabilitation in terms of the potential to graze and finish cattle on improved pastures. The evaluation applies a strict set of rules to determine suitability and is based on frameworks developed and applied previously to unmined land in the region, e.g., Shields and Williams (1991), and is further described in Appendix 9.2- PMLU context report. Within this evaluation, there are certain landform aspects that have been considered and incorporated into the design concept.

5.5.3 Ensham final landform

Guided by the abovementioned principles and criteria, Ensham have designed a final landform in adherence to the objectives, PMLUs and the indicative plan in the land outcome document (EA). Development of the landform was undertaken through use of a modelling software that took into consideration limitations, criteria and rehabilitation strategies to enable the development of successful rehabilitation.

Key parameters were input into the modelling software, there are inclusive (but not limited to) the following:

- Identification of spoil type,
- Retaining maximum slope criteria for each spoil type dictated in the EA,
- Accounting for all disturbed material and land,
- Pertaining to the limitations dictated in the EA including, but not limited to:
  - Tertiary slopes 0-10%
  - Permian slopes 0-15% slopes
  - Maximum of 10% inward facing slopes in the Cattle grazing PMLU between 15-25% slopes (and encased by slopes 0-15%)
  - NBC maximum slope 25%
  - Maximum dimensions for groundwater daylighting areas
  - Competent highwalls maximum slope of 275%, incompetent maximum 50% slopes.
    - A South, F & Y pit ≤25%
    - B Pit Endwall ≤15%
  - Watercourse facing slopes ≤15%
  - Void facing slopes within the Highwalls NUMAs reduced to ≤25% under exempt conditions.
- Installation of benches into rehabilitation slopes
- Minimum of 2km width in the floodplain (between B & C pit)
- Retain permanent flood structure 0.1%AEP + minimum 0.5m freeboard
- Planned drainage, particularly from highwalls to groundwater daylighting areas
- Consideration that the final landform will be able meet success criteria (safe, stable, non-polluting, land use) and will not cause environmental harm.

The resulting final landform is displayed in the below 3D LiDAR figure (Figure 5-9). For reference, a pre-mining landform figure is located in Section 1.4.1.

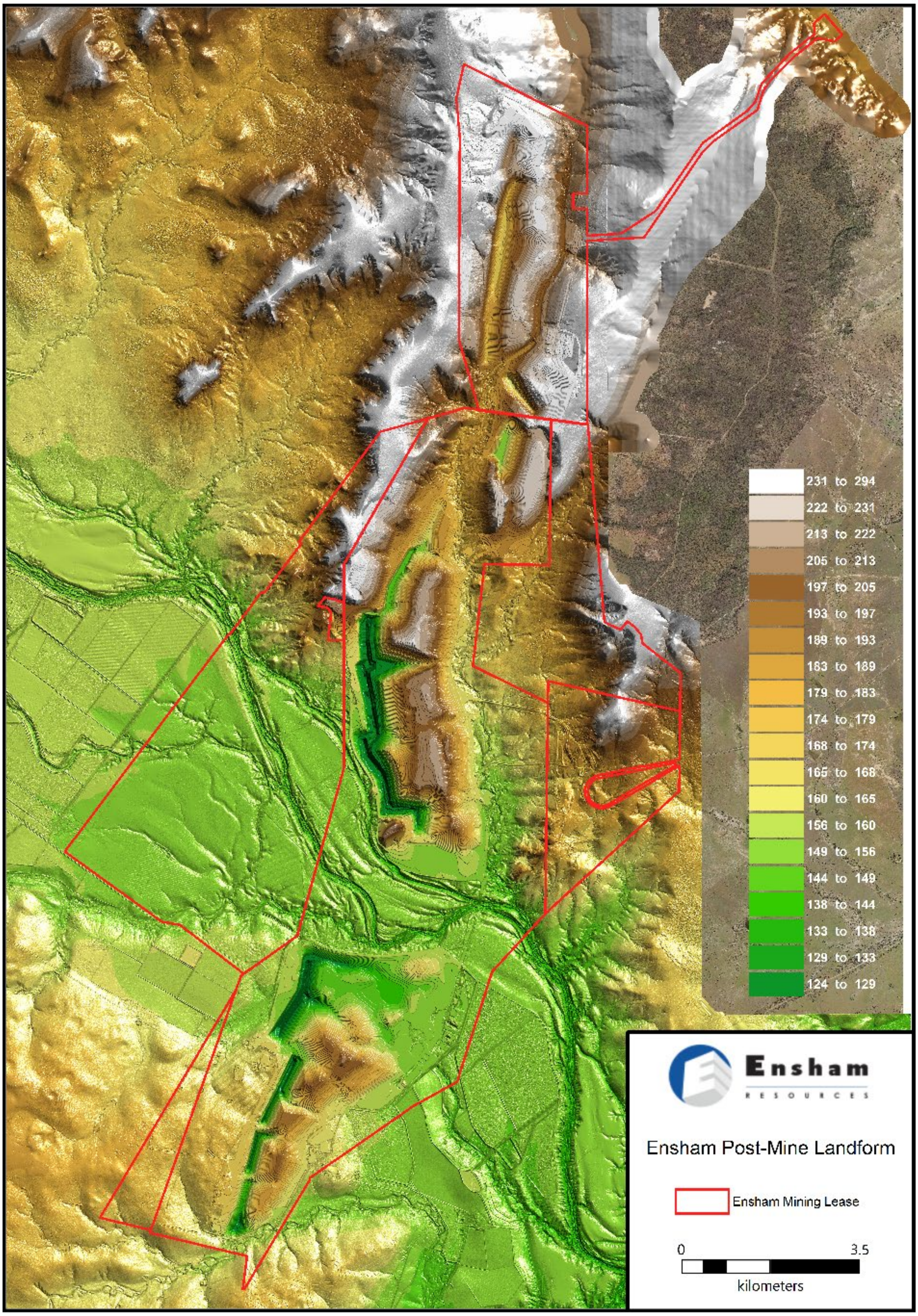


Figure 5-9 Ensham Final Landform

5.5.4 Assessment of long-term landform stability

A geotechnical investigation was undertaken as part of the Residual Void project to explore stability requirements for the final landform design in terms of void geometry. Geotechnical stability considers sudden and catastrophic surface failures such as gross rock failures, major landslips and highwall collapses. Key recommendations were made in relation to the maximum slope gradients that would be stable for the site over the long-term. This has subsequently informed the landform design concept.

In addition to geotechnical stability, the landform was also assessed against longer term, more gradual erosion, with landform evolution modelling completed. Slope angle, length of slope, and vegetation cover are important factors in the control of erosion, and can be incorporated in landform design to manage erosion characteristics of the final landform. Site practices for spoil rehabilitation have been developed over years considering the erosional stability of rehabilitated areas.

Modelling was completed for a 500-year period, and a benchmark range between 5 – 10 t/ha/yr is deemed to be appropriate, based on a literature review. Results showed that the erosion rates of the Ensham landform batter slopes are acceptable, and within this range. Further discussion of the assessment is presented in Appendix 9.6 – Landform design report.

Ensham has also had success rehabilitating Tertiary spoil dumps with 10% slope regrades, coupled with maximum slope lengths of 200m and 10m wide benches as slope breaks. Permian spoil has been found to be erosionally stable at regraded slopes of 15% with 100m slope lengths. Rehabilitation construction practices were consistent with current approaches, including topsoiling, deep ripping, grass seeding, and hay mulching. Benches are not topsoiled, but are populated with trees, as the absence of soil reduces competition between fast establishing grasses and the desired tree/shrub community.

5.5.5 Landform rehabilitation process

Ensham has a long history of completing successful rehabilitation and the following construction process has been developed from the proven methodologies. The key steps for the completion of rehabilitation for all PMLU areas, is as described within Section 5.14 of this PRCP.

The construction methodology has been prescribed based on the material availability and meeting PMLU land outcomes. A key requirements for achieving PMLU outcomes for areas of rehabilitation require the achievement of a stable landform, and therefore carefully adhering to the key landform construction process is of high importance to ensuring successful rehabilitation and land outcomes. Further discussion of the construction methodology is presented within Appendix 9.6 – Landform design report.

5.5.5.1 QA/QC processes

Ensham adopt a number of QA/QC processes to ensure rehabilitation outcomes are successfully me and rehabilitation meets quality requirements. This consists of 'conformance to design' processes, annual rehabilitation inspections and monitoring and rehabilitation performance reporting.

5.5.5.2 Trials

Ensham has a strong operational history of completing rehabilitation (with over 1,500 ha of progressive rehabilitation completed) and producing high quality rehabilitation areas. Trials and reviews have been conducted at Ensham, with review of tree and shrub species, a variety of soil arrangements, fire treatment assessment and investigation of grazing impacts within rehabilitation areas. Rehabilitation progress is reviewed annually and Ensham modifies the rehabilitation practices as needed to carefully improve rehabilitation outcomes.

5.5.5.3 Limitations and assumptions

Key assumptions and limitations of the Ensham landform design concept have been identified in Appendix 9.6 – Landform design report.

5.6 Cover design

A cover system is typically required for circumstances where the surface treatment of a mine landform or other waste material is needed to manage the exposure of waste materials that may be reactive (e.g. AMD, NMD or saline drainage). Where cover systems are required, it is in order to ensure that such contaminants are not released to the receiving environment, create legacy concerns or directly impact on the success of rehabilitation.

Most of the materials in Ensham are classified as NAF, with low potential for acid drainage. The materials also have a low potential to produce drainage with elevated metal or metalloid concentrations. Testing undertaken over the life of the mine to date have not identified any elevated levels of metals or metalloids. However, Ensham spoil material is of concern from the perspective of salinity and dispersivity.

For these materials, the preferential waste handling strategy employed for the site is that the more dispersive materials are placed under a cover of less dispersive material. Where this is not possible, the slope is reduced, as defined in Section 5.5.3

As such, no engineered covers will be installed, and therefore, the remaining requirements for cover design are not relevant.

5.7 Water management

Management of surface and groundwater is a key consideration in achieving long-term rehabilitation success, with surface water features being a primary consideration for rehabilitation at Ensham. Post-mining landforms at Ensham are designed to not concentrate overland flow and therefore, do not require contour banks or rock-lined waterways to transport overland flow downslope and off rehabilitation.

Rather, landform design is sympathetic to natural geo-fluvial processes. Slope lengths are broken by wide, flat benches to slow runoff velocities without concentrating flow and to encourage infiltration and soil profile wetting. This limits the volume and velocity of runoff and encourages revegetation. The existing water management plan will continue to be the basis of water management across site until end of mine life.

5.7.1 Contaminants of concern

Most of the contaminants of concern relevant to the completion of rehabilitation and closure relate to salinity and the transport of salts due to the water infiltration through the spoil materials. These issues have been considered with the design of the rehabilitation strategy for Ensham.

There may be other contaminants, such as metals or other chemicals utilised for mining activities. The risk posed by all contaminants is explored below, with the source, pathway and fate of contaminants detailed.

5.7.2 Source, pathway and fate of contaminants

A primary source of contaminants for Ensham is the spoil material that comprises the overburden dumps, and has been used to backfill in-pit voids. Both Quaternary and Tertiary materials can represent a source of salinity, as detailed in Section 5.4. It is noted that a wide range of management measures have been employed to address the risks posed by these materials, which primarily relate to potential for erosivity and saline drainage. Table 5-9 summarises the source, pathway and fate connections for contaminants relevant to Ensham.

Table 5-9 Contaminants of concern by source-pathway-receptor interactions

SPR	Potential contaminant and issue	Potential for environmental harm	Key interventions and management strategies
Source	Waste material encapsulated in WRD	Interaction of waste material with water resulting in mobilisation of salinity, sediment and other contaminants	• Placement strategy for waste materials • Adoption of appropriate landform design criteria to ensure erosionally stable land outcomes
	Point source contaminants from all areas	Mobilisation of sediment, salinity or other contaminants	• Records of contaminants placement on site • Adoption of an appropriate remediation process at closure
	Airborne dust and odour from WRD surface	Mobilisation of other contaminants and particulates	• Dust control during operations and rehabilitation activities • Rapid stabilisation of rehabilitation areas through revegetation
Pathway	Runoff into surface water drainage features	Mobilisation of sediment, salinity or other contaminants	• Direct WRD areas internally into voids • Adoption of appropriate landform design criteria to ensure erosionally stable land outcomes • Adoption of water features such as benches to prevent sediment laden runoff • Monitor WQ in receiving environment and manage if required
	Seepage passing from daylighting areas into groundwater systems	Interactions between daylighting locations and surrounding groundwater environment	• Modelling has indicates the groundwater will act as a permanent sink due to presence of void daylighting areas as per the EA, • Monitor for seepage locations and manage if required • Monitor WQ in groundwater systems
	Airborne particulates that are then deposited	Transport as airborne particulates	• Dust control during operations • Rehabilitate as soon as available to stabilise surface
Receptor	Groundwater daylighting water areas (NUMA)	N/A	N/A
	Receiving surface water environment	Impact to sensitive receptors – human or animal, or aquatic ecosystems Undesirable modification to WQ within downstream surface water catchments	• Monitor receiving environment and apply EA WQ criteria

SPR	Potential contaminant and issue	Potential for environmental harm	Key interventions and management strategies
	Surrounding groundwater system	Impacts to sensitive receptors – human or animal Undesirable modification to WQ within groundwater systems	• Monitor receiving groundwater systems and apply EA GW quality criteria
	Surrounding surface areas and dwellings	Impacts to sensitive receptors – human or animal Undesirable modification to surface systems, such as vegetation	• Monitor sensitive receptors and dust deposition levels

5.7.3 Infiltration and seepage intervention and collection

There are no areas or features where infiltration or seepage occur which would require intervention or collection. If any patterns of seepage change over time, further consideration may be required of the need for seepage intervention and collection systems. This is considered a low contamination risk, given the lack of current seepage, the landform design arrangement and the between source and potential receptors.

5.7.4 Current water management requirements

5.7.4.1 Management of Mine Affected Water (MAW)

MAW is pumped from mining areas and stored on site in mine water storages and in certain mining pits. The storage water levels are maintained with sufficient freeboard to prevent overtopping in design rainfall events, and in most cases are not affected by external catchments. The mine water system is able to discharge waters in a controlled manner from a number of storages to the Nogoa River, in accordance with EA release conditions (which include minimum flow requirements and maximum salinity levels). The EA conditions detail a variety of contaminants required to be sampled to identify the risk they post to the environmental values of the receiving environment.

5.7.4.2 Management of Surface Water Runoff

In order to collect the suspended sediments entrained in runoff from disturbed areas, catch drains direct the runoff to sediment mitigation areas such as sediment dams. Sediments are settled out or deposited before reaching receiving waters. Deposited sediments are excavated periodically to maintain the capacity of the dams. Alongside this, rainfall runoff samples are collected rehabilitated areas to demonstrate the compliance of the surface water runoff to EA quality characteristics as part of the certification process.

5.7.4.3 Management of Runoff from Infrastructure Areas

Industrial Area runoff is also collected in catch drains and directed to sediment dams. Areas which are known to produce oil or chemical-affected runoff are bunded to separate contaminants from cleaner flows, and directed to storage dams, with the water being recycled for use in the process.

5.7.4.4 Management of Sewage Effluent

Sewage effluent is produced at the sewage treatment plant and is stored in large secure tanks. The effluent is sampled regularly to demonstrate compliance, then enabling the effluent to be irrigated through a series of pipework into a low traffic area of irrigated trees.

5.7.5 Long term water management requirements

5.7.5.1 Drainage and Catchments

Ensham's Erosion and Sediment Control Plan details the specifics of Ensham's catchments and drainage strategies. As a summary, Ensham targets drainage to minimise the creation of MAW, whilst diverting the majority of runoff to sediment dams (or raw/stock water dams) where possible.

5.7.5.2 Surface Water Diversions

Ensham Mine has one surface water diversion existing within the mining tenures. The Boggy Creek Diversion (BCD) was established in 1993 to reroute water away from the planned mining areas. Following extensive planning and the appropriate regulatory approvals, the BCD commenced rehabilitation in 2019 and is scheduled to be completed in 2021. This diversion is a permanent diversion and will require minimal maintenance through its life.

5.7.5.3 Dewatering Requirements

In order to fulfil rehabilitation requirements at Ensham Mine, mine pits will require dewatering. This shall be done by:

- Use of the water for dust suppression
- Release into the Nogoa River
- Translocation to water storages underground
- Evaporation

Avenues for treatment and or sale of water can be explored should it be deemed necessary by the mine.

5.7.5.4 Water Monitoring

Regular water monitoring is undertaken at Ensham Mine to track the quality (and levels for groundwater) of MAW, runoff, groundwater and raw water, inclusive of upstream and downstream reaches of the Nogoa River.

Monitoring of the condition of water management structures, such as dams, sediment dams and levees is also incorporated into Ensham's scheduled monitoring. These inspections assess not only the condition, but also identify any repairs required, and provide recommendations for improvement.

5.8 Revegetation

5.8.1 Revegetation objectives

Revegetation has two primary aims. Initial rapid vegetation establishment is required to achieve a transitional groundcover greater than 50% to control soil loss by water erosion to sustainable levels. This may be achieved in some instances using a non-persistence cover crop such as annual millet, in addition to longer-lived grasses and forbs. In the longer term, establishment and persistence of specific species is needed to achieve specific completion criteria for each PMLUs.

Ensham has developed revegetation objectives for each PMLU (Table 5-10). Some of these are common, like rapid establishment for erosion hazard control effectiveness, while others are specific to PMLUs, e.g., 3P species for beef cattle grazing PMLU.

Table 5-10 Revegetation objectives for each PMLU at Ensham

PMLU	Revegetation objectives
Beef cattle grazing	1. Rapid groundcover establishment to provide long-term erosion hazard control effectiveness. 2. ≥50% established and persistent vegetative groundcover for all slopes from 0-15%. 3. ≥80% established and persistent vegetative cover for slopes from 15% to 25%. 4. A persistent sward of at least 4 3P pasture species including legumes (perennial, palatable and persistent).
Landholder retained infrastructure	There are no revegetation objectives for this PMLU.
Native bushland corridor	1. Rapid groundcover establishment to provide long-term erosion hazard control effectiveness. 2. ≥50% established and persistent ground cover (vegetative and/or rock mulch) for all slopes from 0-20%. 3. ≥80% established and persistent ground cover (vegetative and/or rock mulch) for slopes from 20% to 25%. 4. Species richness ≥ 2 tree species, ≥ 3 shrub species, ≥ 5 groundcover species. 5. Species from one of a combination of the following regional ecosystems: 11.7.1, 11.7.2, 11.7.4, 11.5.9, 11.10.12 & 11.10.1
Boggy Creek diversion	1. Rapid groundcover establishment to provide long-term erosion hazard control effectiveness. 2. ≥50% established and persistent ground cover (vegetative and/or rock mulch) for all vegetated slopes. 3. Terrestrial vegetation communities should aim to resemble RE11.7.2/11.7.4 and RE11.7.1 4. Riparian vegetation communities should resemble RE11.3.25. 5. The revegetation outcome must achieve a long-term self-sustaining vegetation community.
Flood protection landform	1. Rapid groundcover establishment to provide long-term erosion hazard control effectiveness. 2. ≥50% established and persistent ground cover (vegetative and/or rock mulch) for all slopes.

5.8.2 Key flora species selection

The selection of flora species to be used in revegetation considers the PMLUs outcomes to be achieved. The selection has considered the surrounding and post-mining land use concept, and the capacity of the available topsoil resources at the time of revegetation to support seed.

5.8.2.1 Seed mixes

Key species representative of each PMLU for beef cattle grazing and flood protection landform are provided (Table 5-11). For revegetation of Boggy Creek diversion, Alluvium (2018) recommends more than 60 suitable species. The species mix for Native Bushland Corridor will vary across the site and is to be comprised of species from one or a combination of the following regional ecosystems:

- 11.7.1
- 11.7.2
- 11.7.4
- 11.5.9
- 11.10.12
- 11.10.1

Where possible, seed mixes will be locally sourced, or at minimum, will aim to be sourced from suppliers that harvest from areas demonstrating similar environmental characteristics to that of Ensham Mine. In many cases, supply availability and historical seed success performance/quality will be the key factors driving seed sourcing.

Table 5-11 Key species for Beef cattle grazing and Flood protection landform

Scientific name	Common name	Sowing rate (kg/ha)
Chloris gayana	Reclaimer Rhodes	2.5
Chloris gayana	Katambora Rhodes	2.5
Chloris gayana	Callide Rhodes	2.5
Macroptilum bracteatum	Burgundy Bean	2.5
Stylosanthes spp.	Stylo Mix	2.5
Urochloa mosambicensis cv. Saraji	Sabi grass	5
Cynodon dactylon	Couch	2.5
	TOTAL	**20**

5.8.2.2 Species of conservation significance

As detailed in Sections 1.4.8 and 1.4.9 of this PRCP, there are a range of vegetation communities and fauna species of conservation significance with potential to occur at Ensham. Recent studies (AARC, 2019) also indicate there are three flora species of conservation significance which may occur in in Ensham.

The areas covered by Native Bushland Corridor will be investigated to the view of incorporating species of conservation or cultural significance.

5.8.3 Fauna habitat and use requirements

The predominant PMLU for Ensham will be cattle grazing. The Native bushland corridor PMLU provides opportunities from native fauna species movement in the landscape (Ensham Resources, 2021). Revegetation with native tree species will aim to connect surrounding areas of natural habitat. Where available, logs and other woody debris will be distributed in revegetated areas to provide fauna habitat opportunities as available such has been incorporated into adjoining areas of the Boggy Creek Diversion.

5.8.4 Analogue sites for monitoring

Rehabilitation efforts at Ensham have been guided by the long history of progressive rehabilitation completed for the site, and an evidence based understanding of what practices result in successful outcomes, as further described in both Appendix 9.2 PMLU context report and Appendix 9.3 Monitoring summary report. Further, monitoring of rehabilitation has also been informed by an understanding of conditions similar to that anticipated for the rehabilitation areas after closure. These areas are termed analogue or reference sites.

Rehabilitation monitoring has included assessment and comparison of rehabilitation outcomes to the analogue sites. The analogue sites selected are comparative of:

- Soil, land area, and land suitability
- Vegetation form
- Species assemblage; and
- Land use.

As most rehabilitation areas are aimed towards a cattle grazing PMLU, analogue sites established for Ensham are based on unmined areas of grazing land use. Appendix 9.3 Monitoring summary report provides detail of reference sites for rehabilitation.

5.8.5 Process of establishing vegetation

Vegetation establishment in rehabilitation at Ensham is aided by attention to the following basic principles.

5.8.5.1 Growth medium

As described in Section 5.3, Ensham have ~2.7 million cubic metres (Mm^3) of topsoil available on site for rehabilitation. A soil assessment is to be completed by an AQP to confirm quantity, quality, compatibility with rehabilitation methodology and PMLU, and guide amelioration of material. Topsoil will be spread at a depth of 150mm across the majority of site. The outcomes of rehabilitation trials will determine strategies to address the current topsoil deficit (eg. amelioration of spoil).

5.8.5.2 Seedbed preparation

Ensham sows into well prepared seedbeds that are loose and friable, with many micro-niches to enable good contact between soil and seeds. This is essential for good germination. At Ensham, deep ripping is usually enough to create a good seedbed as this activity causes significant surface soil disturbance and enables rainfall infiltration.

5.8.5.3 Sowing good quality seed

Ensham sows good quality seed. Whilst there are no established thresholds, the results of independent seed tests are used to compare quality and price of available seed. This includes purity (%), germination (%) and percentage of pure live seeds (purity % x germination %).

5.8.5.4 Sowing at the right time

Sowing at the right time and avoiding a false start is critical to revegetation. Ensham aims to sow in the warmer months of the year from September to March, and ideally November to January when the probability of rainfall is highest. Where possible, use of irrigation may be used to establish germination and pasture in rehabilitation areas, removing the need to sow at the "right time" suited to climatic conditions and rainfall.

5.8.5.5 Correcting soil limitations

Understanding and correcting soil limitations ensures revegetation success. Testing of rehabilitation materials ensures the correct fertilisers and ameliorants are applied to promote revegetation success. Ensham will sample and test all materials used in future rehabilitation. Addressing soil limitations within Ensham soils has historically included the application of fertiliser, hay-mulch and, more recently, gypsum, where needed.

5.8.5.6 Controlling weeds

Weed prevention is far better than weed control. Weed prevention in rehabilitation is achieved by not over-fertilising, controlling weeds around site generally, ensuring hay mulch is weed free, inspecting machinery before it enters site, sowing soon after seedbed preparation so that weeds do not get a head start. Ensham's weed management will operate in accordance to the Weed and Feral Animal Management Plan.

5.8.5.7 Managing grazing livestock

Livestock are excluded from established rehabilitation until monitoring demonstrates revegetation has been successful, including demonstrating a sustainable groundcover for erosion control. Once cattle are moved onto rehabilitation, best practice grazing management ensures rehabilitation is not overgrazed and the overall land condition is maintained or improved over time. This is done so in accordance to the Grazing Management Plan.

5.9 Erosion control

It is well established that high cover percentages, above 50 % groundcover, reduce erosion in rehabilitation, even on steep slopes, e.g., see Loch (2000) and Carroll (2000). However, the period when the soil is bare and vulnerable to erosion by surface runoff presents a significant window of erosion risk (Loch 2000; Carroll and Tucker 2000; Carroll *et al*. 2001). For typical rehabilitation with slope gradients ≤15 %, this window of erosion risk exists from the time of sowing until >50 % groundcover is established. It is during this period, which may be weeks or months depending on rainfall and other factors that affect plant establishment and growth, that active control erosion is required to prevent unacceptable soil loss and potentially severe gully erosion and landscape failure.

Ensham applies hay mulch immediately after sowing to provide instant groundcover and close the window of erosion risk (Figure 5-10). This is particularly important for any slopes greater than 20%. Hay mulch applied at a minimum rate of 20 round bales or 12 large square bales / ha (approximately 5 t/ha) is a quick and effective erosion hazard control. It also promotes germination and establishment of sown species by assisting to retain soil moisture through reducing evapotranspiration and lowering soil temperatures in the hotter months.

Figure 5-10 Spreading hay mulch for erosion control in rehabilitation at Ensham

These erosion and sediment control measures are applied for all PMLUs, including those cattle grazing and native bushland corridors areas where slope requires it. Review of the performance of progressive rehabilitation (as contained in Appendix 9.3) as well as long-term modelling of the erosive potential of the landform (as detailed in Appendix 9.6) demonstrate that these erosion control measures are effective for ensuring the landform remains stable.

5.10 Tailings Storage Facilities

Ensham does not operate a traditional coal handling and preparation plant (CHPP) to wash coal and therefore, does not generate fine tailings waste or reject material. There are no tailings storage facilities (TSFs) at the mine.

5.11 Voids

Ensham's final landform has a pre-approved NUMA for Groundwater daylighting water areas. Pits A South, E, F & Y will be partially backfilled to support a final land use of grazing, therefore not considered a void. Pits A, Central, A North, B, C & D will also be partially backfilled but are predicted to have groundwater daylighting areas within them, resulting in a NUMA.

5.11.1 Final void configuration and options

All remaining Ensham voids are considered as NUMA, with the final configuration as detailed in Section 4 of this PRCP. Given that these voids are pre-approved, the justification and options requirement (as per section 126C(1)(g) and 126C(1)(j) of the EP Act) do not apply.

However, it is highlighted that Ensham has undertaken a significant process of considering a range of void configuration options, with extensive investigations and consultation occurring to inform options assessment. This occurred as part of the Residual Void project, which culminated in the selection of a preferred option in relation to the final voids that are to be retained, as presented in this PRCP.

For completeness, the three key conceptual options subject to intense investigation are as summarised below:

- **RV Option 1: Retention of a permanent Landform Levee to provide flood immunity** – this assumed partial backfilling of the residual voids to create a rehabilitated landform protected by permanent landforms along the existing levee alignment.

- **RV Option 2: Flood Mitigation and Beneficial Use** – this option involves two phases, with the first phase involves rehabilitation of the post-mining voids on the floodplain to develop permanent landforms suitable for water storages. The second phase involves the reuse of the void depending on the commercial arrangement for the funding and operation of the water storage area.
- **RV Option 3: Backfill to Probable Maximum Flood (PMF) level** – this comprises significant backfilling of the residual mining voids, up to the elevation of the original floodplain within the lateral extent of the pre-mining PMF level.

The negotiated final void option was modified to retain highwalls and maximise the area of land suitable for grazing. The revision was based on feedback from stakeholders (including DAP, DNRME and DES).

5.11.2 Void design details

The design detailed of the remaining Ensham voids are as detailed in Section 4 of this PRCP.

5.11.3 Void stability considerations

5.11.3.1 Highwall stability

Regarding long-term stability of highwalls, a recent geotechnical assessment by (WSP 2018), including slope stability analysis to assess overall factor of safety, determined the following:

- Tertiary-aged materials should be regraded to a slope gradient ≤1(V):3(H), which is numerically equivalent to grade of 33.3 % or angle of 18.4 degrees, to improve stability to an acceptable standard.
- Weathered Permian-aged materials should be regraded to a slope gradient of 1(V):2(H), equivalent to a grade of 50 % or angle of 26.6 degrees.
- Fresh Permian-aged materials should be regraded to a slope gradient of 1(V):1(H), equivalent to a grade of 100 % or angle of 45 degrees.
- If recommended slope geometries cannot be achieved, partially backfilling of voids to buttress walls with spoil could be considered.

Risk assessment of the void design was conducted (Rowan and Associates, 2020) to identify risks relating to residual void design. It was observed that weathering, block and slip failures are one of the few risks that were identified in relation to highwall stability. Management actions to mitigate highwall regression include annual inspections and monitoring of highwall stability during post construction phase and prior to relinquishment and modifications of surface drainage. The risk assessment is set out in Section 6.0 to this PRC Plan.

5.11.4 Void hydrology

The void hydrology has been modelled to develop water balance models for the residual voids in Ensham. The model is based on the updated Digital Elevation Model (DEM) of the landforms for the void configuration, climate data, surface runoff and catchment hydrology.

5.11.5 Void hydrogeology

Void hydrogeology, addressing the long-term water balance and water levels within voids and potential to overtop, has been detailed previously in this PRC Plan (see Section 5.1).

5.11.6 Void water quality and balance

A hydrological and limnology assessment conducted on the water quality data of the final void, which includes the pH, EC, temperature and oxygen data showed that there are no chemoclines or thermoclines present in the water bodies (RGS, 2018). This was hypothesised due to overturning of the pit water in February 2018 after heavy rainfall. It was reviewed that the chemoclines and the thermoclines in the residual void could have potential effects on the water quality. However, there will be no flow from the rehabilitated open cut mining areas to the regional groundwater system.

5.11.7 Void rehabilitation strategies

All residual voids will be retained as NUMA, with no expectation to achieve a PMLU outcome.

5.12 Underground mining

Underground mining at Ensham has negligible surface impacts because, unlike longwall mining, bord and pillar mining does not cause discernible surface subsidence. The underground workings are accessed from a section of C Pit highwall (Figure 5-11).

Figure 5-11 Entrances to the existing Ensham underground mine.

The areas above underground mining panels will be subject to short term surface disturbance. The requirement to drill bore holes for geotechnical, coal quality, gas extraction, mine inertisation, groundwater monitoring and service holes will continue for the life of the mine. Once the drill hole is finished with, the bore and the areas disturbed by these activities are rehabilitated and returned to previous land use of cattle grazing consistent with the rehabilitation milestones under the PRCP schedule for the relevant rehabilitation areas.

Exploration and underground service holes are not included in future disturbance or rehabilitation planning. These holes are temporary in nature and rehabilitated upon closure of the hole. Planned disturbance for the drilling of these holes is unable to be identified as the drill locations are fluid based on a series of environmental and operational factors.

5.12.1 Geotechnical stability and surface subsidence

Bord and pillar mining at Ensham forms a regular array of stable coal pillars and roadways in each panel i.e., mining area, and does not cause large scale overburden fracturing or surface subsidence (Gordon 2020). In a recent geotechnical assessment, Gordon (2020) confirmed:

- The long-term stability of the mine layout with a minimum factor of safety of 1.6.
- Predicted surface subsidence of less than 40 mm vertical movement, because of elastic compression of the strata i.e., compression due to the additional load on the pillars after the coal is extracted.
- No surface cracking due to subsidence and associated strains and tilts.
- No surface topographical depressions that would cause ponding of incident rainfall and runoff water.

As underground mining does not cause any discernible surface impacts, no rehabilitation activities are necessary. The potential for measurable subsidence in the long-term is very low due to the stability of the overburden (Gordon 2020). The size and location of coal pillars is designed to ensure a very conservative long-term factor of safety is maintained i.e., a very low probability of coal pillars crushing out that would cause overburden instability and surface subsidence.

As well as the factor of safety approach, the long-term life expectancy of pillars can be estimated using empirical studies from South Africa. Using this methodology, the 24 m x 28 m (centres) pillars, at 4.5 m high and 130 m depth of cover, are calculated to be stable in excess of 26,000 years. Furthermore, in regards to long-term stability, after mining is completed and the workings flood with groundwater, the buoyancy effect of the groundwater will reduce the vertical load on the pillars by up to 40%. For a pillar below the Nogoa River anabranch, designed with a FoS of 2.11, at 140 m depth of cover, reducing the vertical load on the pillar by a conservative 25%, to account for any potential strength loss in the coal and surrounding strata, increases the FoS to 2.82. This FoS has a probability of failure well in excess of 1 in 10,000,000.

A range of subsidence monitoring is completed for Ensham, including both annual LIDAR surveys and real-time monitoring of ground movement (using RTK technology). This is further detailed in Appendix 9.3 Monitoring Summary Report.

5.12.2 Underground hydrogeology

The hydrogeological setting comprises two groundwater bearing units, viz. the Quaternary aged alluvium and the Permian aged Rangal Coal Measures. The two are separated by a low permeability unit and neither aquifer is suitable for stock or domestic use due to salinity (SLR 2020). Underground mining causes aquifer drawdown of the Permian coal-aquifer during mining operations and recovers post-mining (SLR 2020). This will have no impact on rehabilitation at Ensham.

5.12.3 Sealing requirements

On completion of all underground operations, it is planned to seal all portals and shafts to the underground environment. This sealing process will be risk assessed as and when the portals become available for rehabilitation, so that an approved Mine Sealing Management Plan can be created.

As a minimum, all life of mine seals will be a Type D rated to 345 Kpa (50 psi), however this would be confirmed through the risk assessment outcomes. It would also be assessed to determine if the seals would also need to hold a water head rating. All seals used would be required to have a certified RPEQ qualified engineer rating certificate.

The Sealing Management Plan is to be developed using the guidance of the updated version of the following documents as a minimum:

- Queensland Coal Mining Safety and Health Regulation 2017
- Coal Mining Safety and Health Act 1999
- DNRM Inspectorate Compliance Checklist
- Recognised Standard 9 - The Monitoring of Sealed Areas; and
- MDG 6001 Guideline for the Permanent Filling and Capping of Surface Entries to Coal Mines

5.13 Built infrastructure

All specific mining related buildings, plant and equipment and infrastructure[8] will either be decommissioned, demolished, salvaged and/or disposed, utilising methods as described below. Alternatively, infrastructure such as roads, powerlines and other structures may be formally retained by an appropriate stakeholder, where it is consistent with the PMLU land outcome.

Demolition planning and execution will be undertaken in accordance with relevant standards, policies and legislation requirements, and will include both an investigation of the site and surrounding aspects, and an investigation for the structures to be removed.

All infrastructure to be retained by a landholder is as detailed in Section 3.1.2, this is a complete inventory, and has been grouped into a distinct PMLU. If further opportunities arise to retain additional infrastructure in the future, a similar process of confirming the infrastructure transfer will occur with formal agreements developed. Given the continued operational life for Ensham mine, landowner agreements for infrastructure will be developed at closure.

An inventory of all infrastructure is provided below as Table 5-12, with the intended fate and status identified.

[8] all specific mining activity related buildings, plant and equipment and infrastructure does not include homesteads, sheds, cattle yards, tractors and all other agricultural buildings, plant, equipment and infrastructure that may be present.

Table 5-12 Register of infrastructure for Ensham

Infrastructure type	Description	Objective	Status
Buildings	Workshops	Decommissioned	-
	Administration	Decommissioned	-
	Warehouse	Decommissioned	-
	Village	Decommissioned	Yongala camp has already been decommissioned
Laydowns	Concrete footings and pads	Decommissioned	-
	Hardstand areas	Decommissioned	-
	Stockpile areas	Decommissioned	-
	Carparks	Decommissioned	-
Utilities and Services	Electrical reticulation	Decommissioned	-
	Powerlines	Main power supply line to be retained for Duckponds homestead and essential property infrastructure	Consultation has confirmed expectations around retention
	Substations	Decommissioned	-
	Communications	Decommissioned	-
	Underground services	Decommissioned	-
	Water and sewage treatment	Decommissioned	-
Water Management	Sumps	Decommissioned	-
	Tanks	Decommissioned	-
	Boreholes	Decommissioned	-
	Washdown facilities	Decommissioned	-
	Sediment Dams	Sediment dam at Boundary Paddock to be retained	Consultation has confirmed expectations around retention
	Dams/Reservoirs Water licences (allocation)	Water allocation, structures for Clear Water Dam and Sailors Dam line to be retained	Consultation has confirmed expectations around retention
Land Management	Fencelines	Decommissioned if not forming part of grazing property management	-
	Roads and tracks	Gazetted access road into Currimundi property to be retained	Consultation has confirmed expectations around retention
Operational	Mining machinery	Decommissioned	-

Infrastructure type	Description	Objective	Status
	ROM, crusher, conveyors	Decommissioned	-
	Coal stacking and reclaiming	Decommissioned	-
	Transfer stations	Decommissioned	-
	Gantries	Decommissioned	-
	Train load out	Decommissioned	-
	Fuel farm	Decommissioned	-
	Haul roads	Yongala Haul Road and Yongala access to be retained	Consultation has confirmed expectations around retention
	Boreholes	Decommissioned	-
	Rail loop	Decommissioned	-

No equipment, hazardous materials or contamination will remain in the post-mining landscape at Ensham.

5.13.1 Methods for infrastructure decommissioning

Ensham has commenced decommissioning and removal of built infrastructure. In 2019 – 2020, the former Yongala Camp facilities and workshop were decommissioned and removed to allow for Boggy Creek diversion rehabilitation. Remaining infrastructure to be progressively decommissioned and removed from site includes the following.

- Draglines, continuous miners and ancillary opencut and u/g mining equipment.
  All equipment will be de-oiled, isolated, and depressurised prior to sale for overhaul and reuse, or salvage and scrap value. All mobile equipment will be removed from site.
- Opencut and u/g administration, office, workshop and stores buildings, and camp facilities.
  All buildings will have services terminated prior to removal from site for sale or salvage and scrap value. Concrete foundations, driveways, pathways, and similar non-hazardous wastes will be disposed of in-pit and buried.
- ROM, crusher, coal stacking and reclaiming, and train loading infrastructure.
  All coal preparation infrastructure will be pull-down and removed from site for sale or salvage and scrap value. Concrete foundations, driveways, pathways, and similar non-hazardous wastes will be disposed of in-pit and buried. Coal will be disposed of in-pit and buried.
- Vehicle refuelling facilities.
  All fuel, oil and lubricants will be extracted for recycling or disposal. All infrastructures will be removed from site for sale or salvage and scrap value. Concrete foundations, driveways, pathways, and similar non-hazardous wastes will be disposed of in-pit and buried.
- Vehicle washdown facilities.
  All chemical agents will be extracted for recycling or disposal. All infrastructures will be removed from site for sale or salvage and scrap value. Concrete foundations, driveways, pathways, and similar non-hazardous wastes will be disposed of in-pit and buried.

Following the safe decommissioning and removal of infrastructure from site, a contaminated land investigation will be conducted. The investigation will be guided by the location of any environmentally relevant activities conducted on site.

5.13.2 Infrastructure to be retained post-mining

Built infrastructure that is proposed to be retained in the post-mining landscape is limited to items considered advantageous to on-going land management activities associated with the PMLUs. These items have been listed, and represent a complete inventory (see Section 3.1.2).

5.14 Methods to achieve a stable condition

Further detail of the rehabilitation construction methods and techniques are as described below, with further information as to the landform construction process also provided as Appendix 9.6 Landform design report. Following is a summary of the proven rehabilitation methods used to deliver rehabilitated land in a stable condition at Ensham (Table 5-13). A stable condition is defined in section 111A of the EP Act as follows.

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 PMLU.*

Table 5-13 Rehabilitation methods for each rehabilitation PMLU at Ensham

PMLU	Rehabilitation methods
Beef cattle grazing.	1. Remove infrastructure. 2. Spoil and soil laboratory testing. 3. Undertake a contaminated land assessment where required. 4. Reshape overburden as required to achieve landform design parameters paired to land suitability requirements and spoil types. 5. Apply gypsum if needed. 6. Respread topsoil to minimum 150 mm depth, or where topsoil deficit exists, additional treatments have been applied as appropriate to generate a plant growth medium.[7. Deep rip profile to minimum 600 mm depth. 8. Apply seed and fertiliser. 9. Apply hay mulch at minimum rate of 20 round bales or 12 square bales /ha. 10. Monitor and manage rehabilitation to achieve completion criteria, demonstrating the land is in a stable condition. 11. Certification of progressive rehabilitation.

PMLU	Rehabilitation methods
	12. Monitor, manage, and maintain the rehabilitated land in a stable condition until mine closure.
Landholder retained infrastructure.	1. Identify infrastructure to be retained by land holder/s. 2. Obtain a formal written agreement or consent from the administering authority where the landholder or landowner is the EA holder. 3. Monitor and manage until landholder takes control.
Watercourse, bed and banks of the Boggy Creek diversion.	1. Remove infrastructure. 2. Spoil and soil laboratory testing. 3. Undertake a contaminated land assessment where required. 4. Reshape land as required to achieve landform design parameters per DRNM approved design. 5. Revegetate as per requirements of the Water Licence Revegetation Management Plan. 6. Monitor and manage rehabilitation to achieve completion criteria, demonstrating the land is in a stable condition. 7. Surrender Water Licence 8. Certification of progressive rehabilitation. 9. Monitor, manage, and maintain the rehabilitated land in a stable condition until mine closure.
Native bushland corridor	1. Remove infrastructure. 2. Spoil and soil laboratory testing. 3. Undertake a contaminated land assessment where required. 4. Apply ameliorants as required. 5. Apply seed and fertiliser. 6. Apply hay mulch at minimum rate of 20 round bales or 12 square bales /ha where required. 7. Monitor and manage rehabilitation to achieve completion criteria, demonstrating the land is in a stable condition. 8. Certification of progressive rehabilitation. 9. Monitor, manage, and maintain the rehabilitated land in a stable condition until mine closure.
Flood protection landform	1. Spoil and soil laboratory testing. 2. Reshape overburden as required to achieve landform design parameters. 3. Apply gypsum if needed.

PMLU	Rehabilitation methods
	4. Respread topsoil to minimum 150 mm depth, or where topsoil deficit exists, additional treatments have been applied as appropriate to generate a plant growth medium. 5. Apply rock for erosion / scour protection as needed. 6. Deep rip profile to minimum 600 mm depth (where no rock is applied). 7. Apply seed and fertiliser. 8. Apply hay mulch at minimum rate of 20 round bales or 12 square bales /ha. 9. Monitor and manage rehabilitation to achieve completion criteria, demonstrating the land is in a stable condition. 10. Certification of progressive rehabilitation. 11. Monitor, manage, and maintain the rehabilitated land in a stable condition until mine closure.

6 RISK ASSESSMENT

In accordance with section 126C(1)(f) of the EP Act, the rehabilitation planning part of the PRC plan must identify the risks 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.

In accordance with section 126C(1)(f) of the EP Act, this section identifies the risks of a stable condition for land described as a PMLU not being achieved, and how Ensham intends to manage or minimise those risks. It also identifies the risks of the NUMA causing environmental harm and not being safe and structurally stable and details how Ensham intends to manage and minimise the identified risks.

6.1 Risk assessment methodology

The risk assessment is built using the Workplace Risk Assessment and Control (WRAC) methodology as described in MDG 1010 Minerals Industry and Safety and Health Risk Management Guideline and the National Minerals Industry Safety and Health Risk Assessment Guideline. The risk assessment methodology applied and the aforementioned guidelines used are in accordance with the ISO31000:2018 Risk Management – Guidelines and ISO 31010:2019 Risk Management – Risk Assessment Techniques.

The procedure describes risk assessment as the overall process of risk identification, risk analysis, risk evaluation and risk treatment, and the framework for each of these aspects is as described further below.

6.1.1 Risk Identification

As a first step, the assessment involves identification of the risks/unwanted event, cause(s) of the event, potential maximum consequences, current controls in place, and current risk control effectiveness.

6.1.2 Risk Analysis and Evaluation

The risk analysis step involves exploring an understanding of risks identified, determining risk causes and sources. The assessment considers potential consequences and the likelihood that those consequences can occur. Consequence and likelihood of the unwanted event occurring are rated using a standard 9x9 risk matrix. This table contains five rating levels for consequence and likelihood each.

After completion of the previous steps, options for addressing the risks are selected for implementation. The most appropriate risk treatment options are selected after consideration of multiple factors including cost benefit, regulatory obligations, social responsibility and protection of the surrounding environment.

The risk treatment step details a justification for selecting the option, details proposed activities, identifies parties responsible for implementation as well as resources required. Performance measures and constraints are highlighted, reporting and monitoring requirements outlined and detail provided on timing and scheduling of each risk treatment option.

6.2 Risk assessment of PMLUs and NUMAs and relevant milestones

A risk assessment workshop was convened on 14 December 2020 at Ensham mine and the risk assessment report has subsequently been revised. A detailed report is provided below (as Table 6-1). All risks associated with the achievement of rehabilitation milestones for PMLUs and management milestones for NUMAs were identified and evaluated using the Ensham risk matrix and risk acceptance threshold model.

This tool includes likelihood and consequence tables, and a quantitative risk matrix. It recognises AS ISO 31000:2018 Risk Management – Guidelines (Standards Australia, 2018), Queensland coal mining safety and health legislation, and other standards.

Where additional risk treatments are proposed to ensure risks are as low as reasonably possible, then the risk treatment step in the risk assessment also highlights-

- The reasons for selecting the treatment option.
- Those responsible for the approval and implementation of the plan
- Proposed actions.
- Resource requirements.
- Performance measures and constraints.
- Reporting and monitoring requirements.
- Timing and scheduling.

There are no significant risks that will prevent Ensham from achieving this PRCP, including rehabilitation milestones and management milestones as stated in the schedule.

Table 6-1 Ensham PRCP risk assessment

PRIMARY EVENTS IDENTIFIED AND EXISTING ACTIONS/ACTIVITIES TO ADDRESS RISKS | **IF REQUIRED - SECONDARY ACTIONS/ACTVITIES REQUIRED TO ADDRESS IDENTIFIED RISKS**

Process Step Rehabilitation Milestones	Hazard Type	Description of Unwanted Event	Consequence Type	Current Controls in Place	Control Type	Control Quality	Maximum Reasonable Consequence	Likelihood	Risk Score	Additional treatment options	Reason for selecting the treatment option	Responsibility for approval and implementation	Proposed actions	Resource requirements	Performance measures and standards	Reporting and monitoring requirements	Timing and scheduling	Maximum Reasonable Consequence	Likelihood	Risk Score
							The likelihood of the MRC of the unwanted event													
RM1 Infrastructure decommissioning and removal	Other	Infrastructure decommissioning and removal takes longer than planned.	Legal & Regulatory	Asset register. As built drawings. Infrastructure maintenance. Experience in decommissioning of infrastructure on site.	Administrative	60-90%	Minor	Possible	Medium	Infrastructure decommissioning and removal plan to be developed and implemented.	A management plan is required to ensure that infrastructure decommissioning and removal is completed on time and budget.	GM Operations	Plan to include register of infrastructure, schedule, budget and responsible roles.	Time Budget Personnel	None	Internal reporting Monitor project milestones.	Annual reviews	Minor	Rare	Low
	Chemical	Discovery of unknown hazardous materials e.g. asbestos	Safety	Asbestos register - 3rd party audited and verified.	Administrative	>90%	Insignificant	Rare	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Land	Spill of hazardous substance causes potential environmental harm.	Environment	Personnel spill training. Secondary containment. Spill clean up equipment. Removal of hazardous substances prior to decommissioning.	Elimination	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Other	Decommissioning: - Not all services disconnected - Not all buildings and infrastructure removed from EA - Not all plant and equipment removed from EA No formal agreement reached on retainment with landholder	Legal & Regulatory	Review services documentation, visual inspection assisted by checklist	Administrative	>90%	Insignificant	Rare	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
RM2 Identification and remediation of contaminated land	Chemical	Previously unknown contamination discovered	Environment	Site based history of contamination and sites that contain a risk.	Administrative	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Chemical	Previously unknown contamination discovered	Financial	Site based history of contamination and sites that contain a risk.	Administrative	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Other	Contaminated land assessment not completed by SQP, as evidenced by PSI and DSI sealed.	Legal & Regulatory	Review water and soil quality assessments and monitoring to identify contamination, review PSI, DSI reports	Administrative	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Land	Identified contaminated land not remediated or managed	Legal & Regulatory	Review DSI report, Site Validation Report. Auditor sign off required as per EP Act requirements. Arrange remediation or continued remediation if required	Administrative	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Other	Land not removed from Contaminated Land Register, prior to relinquishment	Legal & Regulatory	Review Contaminated Land Register. Arrange deregistration.	Administrative	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Other	Land not removed from Environmental Management Register prior to relinquishment	Legal & Regulatory	Review Environmental Management Land Register. Arrange deregistration.	Administrative	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
RM3 Final landform development	Other	Final landform development takes longer than planned.	Legal & Regulatory	Mine planning, scheduling and budgeting. Some flexibility for completion built into schedule	Administrative	>90%	Minor	Possible	Medium	Progress of landform construction to occur as part of operational processes.	Have relevant site technical personnel sign off critical stages of the rehabilitation procedure to ensure specifications are followed as per required timeframes.	Manager HSET Systems	Develop a sign off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time	None	Internal reporting	Develop by 31/12/2022	Minor	Rare	Low
	Other	Unsuitable material for landform development.	Legal & Regulatory	Spoil cross sections detailing composition, allowing spoil type identification. Landform design suited to material type. RMP.	Administrative	>90%	Minor	Possible	Medium	Final landform design to be reviewed by on site Technical Services Team.	Site technical services team have a wealth of local knowledge about past mining activities, including how dumps and landforms were constructed.	GM Operations	Develop a sign off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time	None	Internal reporting	Develop by 31/12/2022	Minor	Rare	Low
	Other	Incorrect or inappropriate slope gradients or lengths for rehabilitation in accordance to criteria.	Legal & Regulatory	Landform design suited to material type. Survey control and progression validation.	Engineering	60-90%	Moderate	Unlikely	Medium	Formalise rehabilitation progression signoff process to ensure conformance to design. Landform stability investigated for erosional and geotechnical stability and deemed adequate	Have relevant site technical personnel sign off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Develop a sign off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time	None	Internal reporting	Develop by 31/12/2022	Minor	Unlikely	Low
	Land	Landform instability, soil movement, slumping or sliding	Environment	Material type selected and used for the landform design, with differential landform design criteria developed for each waste material based on erodibility risk. In particular, considering risk posed by of dispersive materials.	Engineering	60-90%	Minor	Possible	Medium	Reducing slopes or loading the toe of cuttings (buttressing) - and backfilling of northern pit areas to support stability outcomes (as well as void). Landform stability investigated for erosional and geotechnical stability and deemed adequate. Formalise rehabilitation progression signoff process to ensure conformance to design.	Have relevant site technical personnel sign off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Develop a sign off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time	None	Slope gradient is to be measured yearly during operations by remote sensing or ground survey, with results verified by a Registered Surveyor QLD	Develop by 31/12/2022	Minor	Unlikely	Low
	Land	Erosional instability	Environment	Landform design criteria - slope angle, length of slope, and vegetation cover	Engineering	60-90%	Minor	Possible	Medium	Managed by final landform design and learnings from existing rehabilitation. Final landform design concept has now been investigated for erosional stability (with LEM modelling) and deemed adequate.	Site practices for spoil rehabilitation have been developed over years considering the erosional stability of rehabilitated areas. LEM modelling supports design concept	Manager HSET Systems	Develop a sign off procedure to ensure relevant site personnel are involved at critical stages.	Personnel Time	None	Slope gradient is to be measured yearly during operations by remote sensing or ground survey, with results verified by a Registered Surveyor QLD	Develop by 31/12/2022	Insignificant	Rare	Low
RM4 Seedbed preparation	Land	Unsuitable topsoil quality and condition in accordance to specifications.	Environment	Topsoil mapping register and procedure, placement and treatment as per plan. Trials and rehabilitation performance utilised to demonstrate current topsoiling practices (as aligned to historical practices) will support rehabilitation success for each PMLU.	Administrative	>90%	Moderate	Possible	High	Soils assessment (Appendix 9.5 of the PRCP) indicates that suitable growth media resources are available, and outlines amelioration and handling requirements. Adoption of the requirement as specified will mitigate against unsuitable topsoil quality and condition. Noted that topsoil treatment varies according to PMLU requirements, with from 150mm to 'topsoil free'. A strong site history can demonstrate that planned topsoil practices will support PMLU outcomes.	Ensuring requirements outlined in the Soils Assessment (App 9.5) are adopted.	Environmental Superintendent.	Ensure rehabilitation sign off procedure considers soil requirements.	Personnel Time Budget	None	Internal reporting	Develop by 31/12/2022	Minor	Unlikely	Low
	Land	Topsoil depth not applied to an adequate minimum depth to support PMLU outcomes.	Environment	Survey, spot checks. Trials and rehabilitation performance utilised to demonstrate current topsoiling practices (as aligned to historical practices) will support rehabilitation success for each PMLU.	Administrative	>90%	Minor	Possible	Medium	Formalise topsoil application checks to be completed prior to ripping. Soils assessment (Appendix 9.5 of the PRCP) indicates that suitable growth media resources are available, and outlines amelioration and handling requirements for each PMLU.	Ensuring topsoil is applied to the appropriate depths for each PMLU so there is sufficient topsoil to support vegetation. Ensuring requirements outlined in the Soils Assessment (App 9.5) are adopted.	Environmental Superintendent.	Ensure rehabilitation sign off procedure considers soil requirements.	Personnel Time Budget	None	Internal reporting	Develop by 31/12/2022	Minor	Rare	Low
	Land	Insufficient topsoil material available to meet minimum depth requirements	Environment	Topsoil inventory, and procedure, placement and treatment as per plan. Management of stockpiled resources. Investigation of alternate topsoiling practices in region.	Administrative	>90%	Moderate	Likely	High	Finalisation of spoil amelioration trials to demonstrate that a surrogate growth media can be developed (note current MITS trial underway). Develop area based inventory and complete regional benchmarking review to understand rehabilitation success for certain landform types with reduced topsoil depths.	Ensure sufficient topsoil material is available to complete rehabilitation methodology.	Environmental Superintendent.	Conclude MITS trial. Conduct benchmarking study	Personnel Time Budget	None	Internal reporting	Develop by 31/12/202[illegible]	Moderate	Unlikely	Medium
	Land	Unconventional topsoil depth does not support vegetation growth.	Environment	Topsoil mapping register and procedure, placement and treatment as per plan. Land suitability criteria demonstrated with past trials and existing rehabilitation performance of over 20 years can be used to demonstrate current topsoiling practices (as aligned to historical practices) will support rehabilitation success for each PMLU.	Engineering	60-90%	Major	Rare	High	Soils assessment (Appendix 9.5 of the PRCP) indicates that suitable growth media resources are available, and outlines amelioration and handling requirements for each PMLU. Site historical monitoring information indicates that a range of topsoil depths (down to topsoil free) can support successful rehabilitation outcomes. Ongoing monitoring to be continued to understand the ongoing trajectory of existing and future rehabilitation, with annual reviews of any areas not on track. For those areas, consider corrective actions as part of a formal management of change review to identify the consequences of modified outcomes or actions.	Continue annual rehabilitation monitoring. Apply existing site change management processes if needed to ensure rehabilitation achieves required land suitability class in scenarios where less topsoil is used and areas are not on track to achieve milestone criteria.	Manager HSET Systems	Implement site standard for management of change. Continue annual rehabilitation monitoring processes.	Personnel Time Budget	None	Internal reporting	Annual reviews	Moderate	Rare	Medium

PRIMARY EVENTS IDENTIFIED AND EXISTING ACTIONS/ACTIVITIES TO ADDRESS RISKS | **IF REQUIRED - SECONDARY ACTIONS/ACTVITIES REQUIRED TO ADDRESS IDENTIFIED RISKS**

Process Step Rehabilitation Milestones	Hazard Type	Description of Unwanted Event	Consequence Type	Current Controls in Place	Control Type	Control Quality	Maximum Reasonable Consequence	Likelihood	Risk Score	Additional treatment options	Reason for selecting the treatment option	Responsibility for approval and implementation	Proposed actions	Resource requirements	Performance measures and milestones	Reporting and monitoring requirements	Timing and scheduling	Maximum Reasonable Consequence	Likelihood	Risk Score
							The likelihood of the MRC of the unwanted event													
	Land	Incorrect ameliorant application applied.	Environment	Topsoil quality & ameliorant specifications	Administrative	>90%	Minor	Possible	Medium	Include step in rehab sign off process for ameliorant application.	Have relevant site personnel sign off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Ensure rehabilitation sign off procedure considers soil requirements.	Personnel Time	None	Internal reporting	Develop by 31/12/2022	Minor	Rare	Low
	Land	Unsuitable and limited fertiliser applied.	Environment	Topsoil quality & fertiliser specifications reviewed against soil laboratory documentation	Administrative	>90%	Minor	Unlikely	Low	Review soil limitations in line with selected vegetation	Have relevant site personnel sign off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Ensure rehabilitation sign off procedure considers soil requirements.	Personnel Time	None	Internal reporting	Develop by 31/12/2022	Minor	Rare	Low
	Land	Deep Ripping depth and spacing not to specifications.	Environment	Site based procedure to achieve specifications.	Administrative	>90%	Minor	Unlikely	Low	Confirm deep ripping process is documented. Include in site rehabilitation process signoff	Have relevant site personnel sign off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Develop a sign off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to EHP WorkPack system.	Personnel Time	None	None	Develop by 31/12/2022	Minor	Rare	Low
	Land	Unable to supply volume of rock to meet specifications.	Environment	Noted that rock mulch is only potentially required within Native Bushland Corridor PMLU, which represent only 4.9% of the site footprint. Rock mulch requirements to be initially sourced from harvesting of available rock on site. Utilising/recycling suitable materials from decommissioning work where possible.	Substitution	60-90%	Moderate	Possible	High	Noted that the quantum of potential rock material required is not considered to warrant a major risk consequence, and the ranking has been adjusted. Ensham will further investigate the quality and quantity of rock resources available on site, to develop an inventory for these materials according to likely supply requirements. This inventory investigation will consider and determine suitable sources of rock from offsite suppliers/locations if required to address any shortfall. Given the landform design concept has been deemed to be adequate from a stability perspective, alternative landform options are not considered to be warranted at this time. However, if the rock inventory investigation reveals that there are no suitable sources of the rock, further investigations (into alternal design arrangements) will be made for those landform areas that may require rock for stability.	Identification of suitable rock sources and design outcomes to ensure the requirement for rock can be met.	Environmental Superintendent	Complete a rock inventory investigation, considering rock requirements, and supply sources. If needed, also consider alternative landforms to reduce the need for rock mulching.	Personnel Time Budget	None	None	Develop by 31/12/2023	Moderate	Rare	Medium
RA5 Seeding	Land	Seed mix not to quality or specification.	Environment	Reputable supplier. Seed mix designed to meet specification.	Administrative	60-90%	Minor	Possible	Medium	Introduce seed quality verification process.	A seed quality verification process will reduce the use poor quality seed mixes, therefore increasing likelihood of plant establishment.	Environmental Superintendent	Develop a seed quality verification process.	Personnel Time Budget	None	None	Develop by 31/12/2023	Minor	Rare	Low
	Land	Unable to source specific species of seed.	Environment	No current controls in place.	Administrative	<30%	Minor	Possible	Medium	Identify primary and secondary species lists for substitution purposes. Address seeding program in advance to engage with supplier to ensure supply. Investigate seed harvesting options.	Developing site specific primary and secondary species lists for PMLUs to provide to supplier to ensure supply when required.	Environmental Superintendent	Develop primary and secondary species lists for relevant PMLUs.	Personnel Time Budget	None	None	Develop by 31/12/2023	Minor	Rare	Low
	Land	Unable to source supply of hay sufficient to rehabilitation requirements.	Environment	External source of hay mulch.	Administrative	60-90%	Minor	Possible	Medium	Consider options to grow product on site on Ensham owned farming land.	Growing a suitable crop to use as hay mulching on site will reduce costs and ensure supply.	Environmental Superintendent	Investigate feasibility of growing mulch hay on site.	Personnel Time Budget	None	None	Develop by 31/12/2023	Minor	Unlikely	Low
	Land	Hay mulch not applied to specification.	Environment	Rate of application defined.	Administrative	>90%	Minor	Unlikely	Low	Rehabilitation sign off process - include specification for hay mulch coverage rates and appropriate application methodology.	Have relevant site personnel sign off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Develop a sign off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to EHP WorkPack system.	Personnel Time	None	None	Develop by 31/12/2022	Minor	Rare	Low
RA6 Vegetation established	Land	Vegetation does not satisfy completion criteria.	Environment	RMP developed based on historical rehabilitation practices which have demonstrated adequate achievement of completion criteria, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%	Moderate	Rare	Medium	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Ensure vegetation established as per agreed rehabilitation guidelines and completion criteria	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time	None	Visual inspection or remote sensing. Monitor vegetation groundcover in cattle grazing area	Yearly as end of growing season (April to June)	Minor	Unlikely	Low
	Land	Groundcover does not satisfy completion criteria.	Environment	RMP developed based on historical rehabilitation practices which have demonstrated adequate achievement of completion criteria, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%	Moderate	Rare	Medium	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Ensure vegetation established as per agreed rehabilitation guidelines and completion criteria	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time	None	Visual inspection or remote sensing. Monitor vegetation groundcover	Yearly as end of growing season (April to June)	Minor	Unlikely	Low
	Land	Weeds species in groundcover is <10%.	Environment	RMP developed based on historical rehabilitation practices which have demonstrated adequate achievement of completion criteria, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%	Moderate	Rare	Medium	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Ensure vegetation established as per agreed rehabilitation guidelines and completion criteria	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time	None	Visual inspection or remote sensing. Monitor vegetation groundcover	Yearly as end of growing season (April to June)	Minor	Unlikely	Low
	Land	No beef cattle grazing PMLU: ≥50% established and persistent vegetative groundcover for all slopes from 0-15%.	Environment	RMP developed based on historical rehabilitation practices which have demonstrated adequate achievement of completion criteria, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%	Moderate	Unlikely	Medium	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Ensure vegetation established as per agreed rehabilitation guidelines and completion criteria	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time	None	Visual inspection or remote sensing. Monitor vegetation groundcover in cattle grazing area	Yearly as end of growing season (April to June)	Minor	Unlikely	Low
	Land	No beef cattle grazing PMLU: ≥60% established and persistent vegetative cover for slopes from 15% to 25%.	Environment	RMP developed based on historical rehabilitation practices which have demonstrated adequate achievement of completion criteria, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%	Moderate	Unlikely	Medium	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Ensure vegetation established as per agreed rehabilitation guidelines and completion criteria	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time	None	Visual inspection or remote sensing. Monitor vegetation groundcover in cattle grazing area	Yearly as end of growing season (April to June)	Minor	Unlikely	Low
	Land	No native bushland corridor PMLU: ≥50% established and persistent vegetative groundcover for all slopes from 0-20%.	Environment	RMP developed based on historical rehabilitation practices which have demonstrated adequate achievement of completion criteria, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%	Moderate	Unlikely	Medium	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Ensure vegetation established as per agreed rehabilitation guidelines and completion criteria	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time	None	Visual inspection or remote sensing. Monitor vegetation groundcover	Yearly as end of growing season (April to June)	Minor	Unlikely	Low
	Land	No native bushland corridor PMLU: ≥60% established and persistent cover (vegetative and/or rock mulch) for slopes from 20% to 25%.	Environment	RMP developed based on historical rehabilitation practices which have demonstrated adequate achievement of completion criteria, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%	Moderate	Unlikely	Medium	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Ensure vegetation established as per agreed rehabilitation guidelines and completion criteria	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time	None	Visual inspection or remote sensing. Monitor vegetation groundcover	Yearly as end of growing season (April to June)	Minor	Unlikely	Low
	Land	No native bushland corridor PMLU: Species richness ≥ 2 tree species, ≥ 3 shrub species, ≥ 5 groundcover species.	Environment	RMP developed based on historical rehabilitation practices which have demonstrated adequate achievement of completion criteria, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%	Moderate	Unlikely	Medium	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Ensure vegetation established as per agreed rehabilitation guidelines and completion criteria	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time	None	Visual inspection or remote sensing. Monitor vegetation groundcover	Yearly as end of growing season (April to June)	Minor	Unlikely	Low
RA7 Achievement of a stable condition (beef cattle grazing PMLU)	Land	Rehabilitation areas contains significantly more hazards than the surrounding unmined landscape.	Safety	Rehabilitation design & signoff processes, which have considered inherent hazards that may be present and developed an appropriate design response.	Administrative	>90%	Minor	Rare	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Water	Rehabilitation area surface water runoff does not comply with completion criteria and causes environmental harm.	Legal & Regulatory	Mine Waste Management Plan, Water Management Plan (includes monitoring). RMP and past review of completed rehabilitation (including for certification) to demonstrate that rehabilitation areas do indeed comply with water completion criteria.	Administrative	>90%	Moderate	Rare	Medium	Commence an annual review of water quality as part of the rehabilitation monitoring process, to allow for early response to non compliance with water completion criteria.	Incorporate a review of water quality into annual rehabilitation review processes.	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time Budget	None	Internal Reporting	Annual reviews	Minor	Unlikely	Low
	Land	Rehabilitation areas do not achieve a land suitability class between 2 and 4.	Legal & Regulatory	Material characterisation, selective placement (design plan), topsoil management strategies, rule set for land suitability. Review of historic rehabilitation to indicate that the currently adopted practices can achieve PMLU outcomes.	Administrative	>90%	Moderate	Possible	High	Material testing prior to use, re fertilise, treat top soil, change species mix, re sow, as appropriate	Testing materials prior to use to ensure suitable materials are used in rehabilitation.	Environmental Superintendent	Develop a material testing procedure to ensure suitable materials are used in rehabilitation.	Personnel Time Budget	Site assessment by AQP	Internal - Review Rehabilitation Management Plan	Develop by 31/12/2024	Minor	Rare	Low
RA8 Achievement of a stable condition (landholder retained infrastructure)	Land	Rehabilitation areas contains significantly more hazards than the surrounding unmined landscape.	Safety	Rehabilitation design & signoff processes, which have considered inherent hazards that may be present and developed an appropriate design response.	Administrative	>90%	Moderate	Unlikely	Medium	At closure, complete a closure risk assessment with strong focus on addressing contamination requirements and risks associated with infrastructure areas. If required as an outcome of this risk assessment, process additional controls related to remediating infrastructure and contamination.	A detailed closure risk assessment is an in depth process intended to uncover hazards in detail and resolve	GM Operations	Complete closure risk assessment to consider hazards associated with PMLU	Personnel Time Budget	Site assessment by AQP	As per EP Act requirements.	At closure	Moderate	Rare	Medium
	Other	The landholder does not accept the condition and structural integrity of the infrastructure.	Legal & Regulatory	Where Ensham is not the background landholder or an agreement is not in place, complete removal of the infrastructure has been costed in the ERC.	Elimination	>90%	Insignificant	Rare	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Water	Rehabilitation area surface water runoff does not comply with completion criteria and causes environmental harm.	Legal & Regulatory	Mine Waste Management Plan, Water Management Plan (includes monitoring). Contaminated land review and investigation process will be applied as per the requirements of the EP Act.	Administrative	>90%	Moderate	Unlikely	Medium	At closure, complete a closure risk assessment with strong focus on addressing contamination requirements and risks associated with infrastructure areas. If required as an outcome of this risk assessment, process additional controls related to remediating infrastructure and contamination.	A detailed closure risk assessment is an in depth process intended to uncover hazards in detail and resolve	GM Operations	Complete closure risk assessment to consider hazards associated with PMLU	Personnel Time Budget	Site assessment by AQP	As per EP Act requirements.	At closure	Moderate	Rare	Medium
	Other	The land holder does not formally accept the infrastructure.	Legal & Regulatory	Where Ensham is not the background landholder or an agreement is not in place, complete removal of the infrastructure has been costed in the ERC.	Elimination	>90%	Insignificant	Rare	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			

PRIMARY EVENTS IDENTIFIED AND EXISTING ACTIONS/ACTIVITIES TO ADDRESS RISKS | **IF REQUIRED - SECONDARY ACTIONS/ACTVITIES REQUIRED TO ADDRESS IDENTIFIED RISKS**

Process Step Rehabilitation Milestones	Hazard Type	Description of Unwanted Event	Consequence Type	Current Controls in Place	Control Type	Control Quality	Maximum Reasonable Consequence	Likelihood	Risk Score	Additional treatment options	Reason for selecting the treatment option	Responsibility for approval and implementation	Proposed actions	Resource requirements	Performance measures and timetables	Reporting and monitoring requirements	Timing and scheduling	Maximum Reasonable Consequence	Likelihood	Risk Score
							The likelihood of the MRC of the unwanted event													
RM9 Achievement of a stable condition (Boggy Creek diversion)	Land	Rehabilitation areas contains significantly more hazards than the surrounding unmined landscape.	Safety	Rehabilitation design /landform processes, which have considered inherent hazards that may be present and developed an appropriate design response.	Administrative	>90%	Minor	Rare	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Land	The Rehabilitation Area has an Index of Diversion Condition <10.	Legal & Regulatory	Rehabilitation design /landform design plan approved by DNRM.	Administrative	>90%	Moderate	Unlikely	Medium	Annual rehabilitation monitoring processes to incorporate this PMLU area until completion criteria are met. Normal corrective, maintenance and remediate processes to apply as per the RMP if this rehabilitation is not on track to achieve completion criteria. Re-work of revegetation may be required.	Ensure vegetation established as per agreed rehabilitation guidelines and completion criteria	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time	None	Visual inspection in line with ACARP requirements to develop ESC ranking	Yearly as end of growing season (April to June)	Minor	Unlikely	Low
	Water	Rehabilitation area surface water runoff does not comply with completion criteria and causes environmental harm.	Environment	Mine Waste Management Plan, Water Management Plan (includes monitoring). RMP and reviews of completed rehabilitation to demonstrate that rehabilitation areas comply with water completion criteria.	Administrative	>90%	Moderate	Unlikely	Medium	Commence an annual review of water quality as part of the rehabilitation monitoring process, to allow for early response to non compliance with water completion criteria. If required by review, investigate further remedial and corrective actions as required.	Incorporate a review of water quality into annual rehabilitation review processes	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time Budget	None	Internal Reporting	Annual reviews	Minor	Unlikely	Low
	Land	Rehabilitation area has unsuitable riparian vegetation that is inconsistent with PMLU outcomes.	Environment	Mine Waste Management Plan, Water Management Plan (includes monitoring). RMP and reviews of completed rehabilitation to demonstrate that rehabilitation areas comply with vegetation completion criteria. Ensure stock exclusion.	Administrative	>90%	Moderate	Unlikely	Medium	Ongoing monitoring and inspection	Learnings to be utilised and deployed in future rehabilitation areas	Environmental Superintendent	Monitoring plan developed and executed	Personnel Time Budget	None	Review Rehabilitation Management Plan	To be determined	Minor	Rare	Low
RM10 Achievement of a stable condition (Native bushland corridor PMLU)	Land	Rehabilitation areas contains significantly more hazards than the surrounding unmined landscape.	Safety	Rehabilitation design /landform processes, which have considered inherent hazards that may be present and developed an appropriate design response.	Administrative	>90%	Minor	Rare	Low	None required.	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Land	Rehabilitation area surface water runoff does not comply with completion criteria and causes environmental harm.	Legal & Regulatory	Mine Waste Management Plan, Water Management Plan (includes monitoring). RMP and past review of completed rehabilitation (including the certification) to demonstrate that rehabilitation areas do indeed comply with water completion criteria.	Administrative	>90%	Moderate	Rare	Medium	Commence an annual review of water quality as part of the rehabilitation monitoring process, to allow for early response to non compliance with water completion criteria.	Incorporate a review of water quality into annual rehabilitation review processes	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time Budget	None	Internal Reporting	Annual reviews	Minor	Unlikely	Low
RM11 Achievement of a stable condition (Flood protection landform)	Land	Rehabilitation areas contains significantly more hazards than the surrounding unmined landscape.	Safety	Rehabilitation design /landform processes, which have considered inherent hazards that may be present and developed an appropriate design response.	Administrative	>90%	Minor	Rare	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Water	Rehabilitation area surface water runoff does not comply with completion criteria and causes environmental harm.	Environment	Mine Waste Management Plan, Water Management Plan (includes monitoring). RMP and reviews of completed rehabilitation to demonstrate that rehabilitation areas comply with water completion criteria.	Administrative	>90%	Moderate	Rare	Medium	Commence an annual review of water quality as part of the rehabilitation monitoring process, to allow for early response to non compliance with water completion criteria. If required by review, investigate further remedial and corrective actions as required.	Incorporate a review of water quality into annual rehabilitation review processes	Environmental Superintendent	Annual rehabilitation monitoring	Personnel Time Budget	None	Internal Reporting	Annual reviews	Minor	Rare	Low
	Other	Rehabilitation area is not constructed following certified designs.	Legal & Regulatory	Reputable contractors, supervision, as built drawings signed off by RPEQ, inspections.	Administrative	>90%	Moderate	Possible	High	Apply existing site contractor and project control standards to ensure adequate supervision and control over landform construction and to ensure the project meets design standards.	Apply existing contract management systems to construction of levee landform structures	GM Operations	Complete a review of compliance to contract management system at the completion of construction of the landform levee, including conformance to design assessment	Personnel Time Budget	None	Internal Report	At completion of construction of landform levee structures	Moderate	Rare	Medium
RM12 Infrastructure retention for handover	Other	The landholder does not accept the condition and structural integrity of the infrastructure.	Legal & Regulatory	Where Ensham is not the background landholder or an agreement is not in place, complete removal of the infrastructure has been costed in the ERC.	Elimination	>90%	Insignificant	Rare	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Other	The land holder does not formally accept the infrastructure.	Legal & Regulatory	Where Ensham is not the background landholder or an agreement is not in place, complete removal of the infrastructure has been costed in the ERC.	Elimination	>90%	Insignificant	Rare	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
MM1 Sufficient improvements to ensure structural stability	Other	Incorrect slope gradients for NUMAs in accordance to completion criteria.	Legal & Regulatory	Final landform design and geotechnical assessment have assessed that slope gradients for NUMAs are acceptable.	Administrative	>90%	Moderate	Unlikely	Medium	Site assessment to be completed of slopes (likely using survey information and/or LIDAR, by ACP	Incorporate a review of wall stability at closure, or into existing rehabilitation review processes as available	GM Operations	Annual rehabilitation monitoring	Personnel Time Budget	None	Internal Reporting	Annual reviews	Moderate	Rare	Medium
	Other	Landforms are not geotechnically stable (FoS <1.5).	Legal & Regulatory	Final landform design and geotechnical assessment have assessed that slope gradients for NUMAs are acceptable.	Administrative	>90%	Minor	Possible	Medium	Site assessment to be completed of slopes (likely using survey information and/or LIDAR, by ACP	Incorporate a review of wall stability at closure, or into existing rehabilitation review processes as available	GM Operations	Annual rehabilitation monitoring	Personnel Time Budget	None	Internal Reporting	Annual reviews	Minor	Unlikely	Low
MM2 Sufficient improvements to ensure safety and avoidance of serious environmental harm	Other	A safety bund is not constructed to the correct dimensions.	Safety	Construction plan, reputable contractors, supervision, inspections.	Administrative	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Other	Safety bund is constructed in a potentially unstable area.	Safety	Geotechnical assessment to identify unstable areas.	Administrative	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Other	Animal exclusion fencing fails to meet specifications.	Safety	Construction plan, reputable contractors, supervision, inspections.	Administrative	>90%	Insignificant	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			
	Land	Regional groundwater aquifers exceed water quality limits outlined in Table C11 – Groundwater quality limits in the relevant EA.	Environment	Mine Waste Management Plan, Water Management Plan (includes monitoring).	Administrative	>90%	Minor	Unlikely	Low	None Required	None Required	N/A	N/A	N/A	None	None Required	None Required			

6.3 Rehabilitation trials

Rehabilitation for grazing is well understood at Ensham, given a history of over 20 years and >1500ha of successful progressive rehabilitation has been completed. As such, no rehabilitation trials are proposed as a method to manage or minimise a risk of a stable condition not being achieved on grazing areas. Notwithstanding, rehabilitation trials may be conducted as a component for implementing NBC ecosystems and amelioration of spoil to produce growth media. Rehabilitation trials have been and will continue to be conducted at Ensham from time to time as a component of continuous improvement.

6.3.1 Grazing trials

6.3.1.1 Yongala grazing trial

In Dec 2015 to Apr 2016, a grazing trial was conducted at Ensham. This trial was undertaken at Yongala and aimed to provide evidence that demonstrates the ability of rehabilitated mine spoil to meet an end land use of a grazing rangeland system. The priorities of the grazing trial were to;

- demonstrate the rehabilitated areas can support a carrying capacity of similar land types and conditions of grazing areas in the surrounding district; and
- that rehabilitation remains a safe and stable landform prior to and following the grazing trial; and
- to ensure established rehabilitation pasture species remain viable following the grazing trail.

Whilst not directly analysed in the assessment, condition and performance of the cattle was considered following removal from the rehabilitation area.

Pre and post grazing assessments were completed in the trial areas, collating data on the following parameters:

- Ground cover (%)
- Soil condition rating (1-5)
- Pasture condition rating (1-4)
- Dry matter (DM) yield (kg/ha)
- Yield unpalatable (%)

Assessment of these, alongside consideration of the condition and performance of the cattle within the area enabled the following conclusions to be drawn.

- Dry matter yield decreased with grazing
- % of unpalatable forage decreased significantly (attributed to cattle compacting and mulching rank unpalatable material, whilst promoting new growth through disturbance and rainfall) – this increased the pasture condition rating.
- Slight decrease in groundcover post grazing.
- Soil condition unchanged with the presence of grazing

The native woodland reference site experienced similar conditions, but however did not see as significant of a fluctuation in dry matter yield post grazing.

Overall, the results from the grazing trial indicate that grazing on rehabilitation at Ensham is sustainable to stocking rates comparable to the surrounding district without risk of deterioration in landform stability and viability of pasture species, therefore aiding in developing rehabilitation strategies moving forward.

6.3.1.2 Ramps 10, 22 and 82 grazing trial

A recent grazing assessment was conducted at Ramp 10, Ramp 22 and Ramp 82 (Greenfields, 2017; 2018) to demonstrate the ability of rehabilitated mine spoil to meet an end land use of a grazing rangeland system. The priorities of this grazing trial was to demonstrate the rehabilitation could support a carrying capacity of similar land types and conditions of grazing areas in the Fitzroy Basin; and ensure rehabilitation remains a safe and stable landform (with minimum 50% ground cover) conserved both prior to and following the introduction of cattle; and established pasture species remaining viable following grazing.

Soil and pasture condition ratings primarily remained unchanged from pre to post assessment. No visual signs of crusting, compaction, soil movement and or erosion occurred in rehabilitation areas. The grazing assessment on Ramp 22 produced a total average live weight gain of 0.98 kg/per day, well above expectations for Live Weight Gain in the Fitzroy Basin.

6.3.2 Bushland trials

6.3.2.1 Trees on benches

Rehabilitation to promote the establishment of tree and shrub species, as opposed to a grassland or grazing land use, has occurred on benches, which are areas of relatively flat ground. This has been demonstrated as highly effective with progressive rehabilitation, with plant health recorded for Ensham consistently maintained at a high level.

6.3.2.2 NEDO Trial

The earlier of Ensham's trials, the NEDO trial, was aimed to establish a high capacity carbon sink in a short period time by trialling methods of afforestation. This trial expanded from 2001 to 2005 and studied various treatments and conditions (inclusive of soil additives/fertilisers, fungi presence, watering regimes, and groundcover variability) for 2 tree species. The findings from the trial provided a foundation of data to understand the growth of trees in rehabilitation, particularly with respect to measurable carbon fixation.

6.3.2.3 BCS Growth Trials

BCS Consortium (Cammel Consulting, Innovate Enviro and SoilCyclers Pty Ltd) have undertaken growth trials at Ensham using ameliorated and remediated overburden as a growth media as part of a project jointly funded by METS Ignited and Idemitsu. The aim of the trial was to be able to identify strategies to improve spoil and topsoil for use in rehabilitation. Laboratory results of the ameliorated material have shown results to be equal to or better than a typical site topsoil.

SoilCyclers sampled overburden from across the site and they have developed an amelioration strategy to turn overburden into a growth media to address the topsoil shortfall. Two samples of typical Tertiary and Permian spoil material were chosen for onsite amelioration trials which commenced in December 2020. BCS Consortium and Ensham have shown that ameliorating overburden to a growth media is a proven solution to meet rehabilitation needs as required, but further refinement is required.

7 MONITORING AND MAINTENANCE

Monitoring at Ensham is undertaken for a range of environmental aspects, with some monitoring conducted separately under the EA and other regulatory requirements. This section highlights the monitoring methods utilised at Ensham which demonstrate how milestones and milestone criteria will be achieved. Further details of the methods used can be found within Appendix 9.3 – Monitoring summary report.

7.1 Overview of milestone monitoring

A monitoring program has been developed and is aligned to the eleven Rehabilitation Milestones described in Section 9.1.3.2. This is as summarised below, and has also informed the schedule presented as Table 7-1.

7.1.1 Monitoring of RM1 – Infrastructure decommissioning and removal

Where relevant, this RM is the initial step in the rehabilitation process. Achievement of this milestone will be determined by completion of a checklist and formal signoff by relevant Ensham personnel. This may include formal confirmation of the following:

- Have all services been disconnected?
- Have all road materials been removed?
- Have all pipelines been removed?
- Have all buildings and foundations been removed?
- Has all machinery and equipment been removed?
- Has all scrap been removed?
- Has all general and regulated waste been removed?

A report will be compiled of the infrastructure removed and disposal process.

7.1.2 Monitoring of RM2 – Identification and remediation of contaminated land

This RM is relevant to rehabilitation areas that were previously used for an *environmentally relevant activity* e.g., fuel storage, sewage treatment. Where such activities were conducted, the following process will apply:

- Engage a suitably qualified person.
- Site investigation report, to determine if contamination exists.
- Validation report, describing works conducted to remediate any contaminated land.
- Remediation of contaminated land as per works described in the validation report, as required.
- Site suitability statement, indicating the land is not contaminated.

The above listed documentation will demonstrate achievement of this RM.

7.1.3 Monitoring of RM3 – final landform development

Achievement of this RM will be determined by ground and aerial survey, and generation of 'as constructed' digital terrain models and/or plans. These will be signed off by relevant Ensham personnel, including technical and operation functions at the mine, confirming design specifications have been achieved within acceptable engineering tolerances.

7.1.4 Monitoring of RM4 – Seedbed preparation

Seedbed preparation will generally require the spreading of topsoil and tillage to create loose, friable surface with plenty of micro-niches for seed/soil contact. Achievement of this RM will be demonstrated as follows:

- Laboratory soil testing to determine material suitability for use as a growth media.
- Amelioration and fertilisation to overcome plant growth limitations identified by soil laboratory testing.
- Survey control and mapping of the extent and depth of topsoil replacement, where topsoil is used.
- The date of topsoil replacement and subsequent treatments e.g., deep ripping, sowing.

7.1.5 Monitoring of RM5 - Sowing

Achievement of this RM will be documented, including the following information:

- The extent (boundaries) of each area sown, in the site GIS.
- The seed mix sown.
- Date of sowing.
- Sowing methods.
- Seed quality records.

7.1.6 Monitoring of RM6 – Vegetation establishment

Vegetation establishment will be monitored as:

- Percentage groundcover, using ground methods which may be supplemented with remote sensing methods.
- Species richness and composition, where applicable.

Field assessments are conducted by competent technical personnel, and data review and reporting by an appropriately qualified person.

7.1.6.1 Groundcover monitoring

Specifically, groundcover monitoring consists of visual observations using a transect or quadrat to delineate a representative groundcover measurement for the rehabilitation area. This is then verified over larger areas by remote sensing methods. Observations on the type of cover are made for the assessment area alongside biomass, diversity/species presence and weed infestations.

Groundcover assessments are subsequently also paired with erosion monitoring of the associated rehabilitation areas.

7.1.6.2 Erosion Monitoring

In-field visual observations shall constitute erosion monitoring in rehabilitation areas. This assessment will note the presence of any erosion within the rehabilitation, its severity and any recommended actions, where deemed necessary. This monitoring can also be paired with drainage and runoff assessments with the aim to identify and rectify converging flow paths.

7.1.7 Monitoring of RM7 – Achievement of a stable condition (beef cattle grazing PMLU)

7.1.7.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO31000:2018) to demonstrate each rehabilitation is safe, relative to unmined lands used for the same purpose e.g., cattle grazing.

7.1.7.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in rehabilitation areas is polluting receiving waters. This will include monitoring for the following parameters:

- pH
- Salinity, as electrical conductivity (EC)
- Total suspended solids
- Arsenic
- Molybdenum
- Selenium
- Sulphate.

Rainfall runoff will be sampled to ensure rehabilitation areas are in compliance with the criterion outlined in the PRCP schedule. Any instances of seepage from rehabilitation areas will be sampled.

7.1.7.3 PMLU

Agricultural land resource evaluation and land suitability assessment will be used to determine if rehabilitation areas can sustain a PMLU of cattle grazing. Details of this land evaluation methodology have been provided (refer to Section 5.5.2.2). Alongside this, pasture productivity assessment will be conducted to identity its suitability for cattle grazing (eg. 3P grasses).

7.1.8 Monitoring of RM8 - Achievement of a stable condition (landholder retained infrastructure PMLU)

7.1.8.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO31000:2018) to demonstrate each rehabilitation area is safe, relative to unmined lands used for the same purpose.

7.1.8.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in areas is polluting receiving waters. This may include monitoring for the following parameters:

- pH
- Salinity, as EC
- Total suspended solids

- Arsenic
- Molybdenum
- Selenium
- Sulphate.

7.1.8.3 PMLU

This PMLU will be demonstrated by formal written agreement between the underlying landholders and Ensham or consent from the administering authority where the landholder or landowner is the EA holder.

7.1.9 Monitoring of RM9 - Achievement of a stable condition (Boggy Creek diversion PMLU)

7.1.9.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO13000:2009) to demonstrate each rehabilitation is safe, relative to unmined lands used for the same purpose.

7.1.9.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in rehabilitation areas is polluting receiving waters. This will include monitoring for the following parameters:

- pH
- Salinity, as EC
- Total suspended solids
- Arsenic
- Molybdenum
- Selenium
- Sulphate.

Rainfall runoff will be sampled to ensure rehabilitation areas are in compliance with the criterion outlined in the PRCP schedule. Any instances of seepage from rehabilitation areas will be sampled.

7.1.9.3 PMLU

This PMLU will be demonstrated by application of diversion monitoring methods outlined in Criteria for functioning river landscape units in mining and post-mining landscapes (ACARP Project C20017). Specifically, this will require assessment of riparian vegetation to determine an index of diversion condition (IDC) score. IDC is designed specifically for Bowen Basin diversions and provides rapid assessment of channel condition and flags potential management issues.

7.1.10 Monitoring of RM10 - Achievement of a stable condition (native bushland corridor PMLU)

7.1.10.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO13000:2009) to demonstrate each rehabilitation is safe, relative to unmined lands used for the same purpose.

7.1.10.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in rehabilitation areas is polluting receiving waters. This will include monitoring for the following parameters:

- pH
- Salinity, as EC
- Total suspended solids
- Arsenic
- Molybdenum
- Selenium
- Sulphate.

Rainfall runoff will be sampled to ensure rehabilitation areas are in compliance with the criterion outlined in the PRCP schedule. Any instances of seepage from rehabilitation areas will be sampled.

7.1.10.3 PMLU

To monitor native bushland rehabilitation areas, Ensham will establish permanent transects and adapt the BioCondition methodology by Eyre et al. (2015). This may include:

- Transects.
- Canopy cover.
- Stem counts, grouped into type (tree, shrub) and genus (Eucalypt, Acacia).
- Groundcover.
- Species richness.

7.1.11 Monitoring of RM11 - Achievement of a stable condition (flood protection landform PMLU)

7.1.11.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO13000:2009) to demonstrate each rehabilitation is safe, relative to unmined lands used for the same purpose.

7.1.11.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in rehabilitation areas is polluting receiving waters. This will include monitoring for the following parameters:

- pH
- Salinity, as EC
- Total suspended solids
- Arsenic
- Molybdenum
- Selenium

- Sulphate.

Rainfall runoff will be sampled to ensure rehabilitation areas are in compliance with the criterion outlined in the PRCP schedule. Any instances of seepage from rehabilitation areas will be sampled.

7.1.11.3 PMLU

Survey monitoring and generation of 'as constructed' digital terrain models and/or plans. These will be signed off by relevant personnel, including technical and operation functions at the mine, confirming design specifications have been achieved within acceptable engineering tolerances.

7.1.12 Monitoring of RM12 - Achievement of a stable condition (Underground Mining Surface Areas – not applicable to underground workings)

7.1.12.1 The surface area above underground areas is stable.

Mine plans are created which comply with a minimum factor of safety of 1.6 under the Nogoa River floodplain, with the exception of a factor of safety of 2.11 under the Nogoa River and anabranch. An AQP is responsible for ensuring plans comply with the FOS and survey post mining still comply.

7.1.13 Improvement areas

A monitoring program has also been developed for the Improvement Areas (IAs) and it is aligned with the Management Milestones (MM) set in Section 9.1.4. Monitoring methodologies to ensure both MMs are achieved are through site assessment of the slopes (LiDAR and/or survey information) to ensure long-term stability on the slopes. Groundwater monitoring is also conducted to meet the MMs, ensuring that the groundwater quality does not exceed water quality limits and does not cause environmental harm.

7.2 Schedule of monitoring and maintenance

The schedule provided as Table 7-1, over the page, forms the basis of a monitoring and maintenance program that identifies and describes the monitoring to be carried out in order to demonstrate that milestone and management criteria have been achieved. This provides site-specific detail as to the proposed timing and methodology, attributes to be monitored, who may conduct monitoring and what he outputs should be.

This has been developed in a manner that would allow for a repeatable program of monitoring to be carried out.

Table 7-1 Monitoring and maintenance schedule for Ensham

Criteria	Monitoring Methods	Frequency	Contingency/ Maintenance	Reporting	Review
RM 1 Infrastructure decommissioning and removal					
Redundant services to be disconnected by end of closure phase, as evidenced by formal notice.	Review services documentation, visual inspection assisted by checklist	Once off	Arrange disconnection	Internally	Annually
Redundant buildings and infrastructure to be removed from RA by end of closure, as evidenced by site inspection	Review hazardous materials documentation, visual inspection assisted by checklist	Once off	Arrange removal	Internally	Annually
Redundant plant and equipment to be removed from RA by end of closure, as evidenced by site inspection	Review hazardous materials documentation, visual inspection assisted by checklist	Once off	Arrange removal	Internally	Annually
RM2 Identification and remediation of contaminated land					
Contaminated land assessment to be completed by AQP, as evidenced by Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI) if needed.	Review water and soil quality assessments and monitoring to identify contamination, review PSI, DSI reports	Once off, upon receipt of PSI, DSI reports	Arrange PSI, DSI	Internally	Annually
Identified contaminated land to be remediated or managed, as evidenced by auditor sign-off as per EP Act requirements	Review DSI report, Site Validation Report	Upon receipt of DSI Report, Site Validation Report	Arrange remediation or continued remediation if required	Internally	Annually
Removal of land from Contaminated Land Register, prior to relinquishment	Review Contaminated Land Register	Upon receipt of Site Validation Report showing full remediation	Arrange deregistration	Internally	Annually
Removal of land from Environmental Management Register if feasible, prior to relinquishment	Review Environmental Management Land Register	Upon receipt of Site Validation Report showing full remediation	Arrange deregistration	Internally	Annually
RM3 Final landform development					
Beef cattle grazing					
• All outward facing overburden slopes to achieve 0-10% slopes for Tertiary materials and 0-15% slopes for Permian materials.	Site assessment of slopes and or Lidar by AQP review AQP report, review Annual Rehabilitation Monitoring Reports	Upon receipt of AQP report, and annually for ongoing monitoring	Re-shape landform to design specifications prior to topsoiling	Internally	Upon completion of re-shaping
• 90% of the inward facing slopes achieving 0-10% slopes for Tertiary materials and 0-15% slopes for Permian materials.	Site assessment of slopes and or Lidar by AQP review AQP report, review Annual Rehabilitation Monitoring Reports	Upon receipt of AQP report, and annually for ongoing monitoring	Re-shape landform to design specifications prior to topsoiling	Internally	Upon completion of re-shaping
• Up to 10% of the inward facing slopes may include slopes between 15% to 25%, subject to these areas being fully contained within areas of 0-15% slopes.	Site assessment of slopes and or Lidar by AQP review AQP report, review Annual Rehabilitation Monitoring Reports	Upon receipt of AQP report, and annually for ongoing monitoring	Re-shape landform to design specifications prior to topsoiling	Internally	Upon completion of re-shaping
• Landforms are assessed as being geotechnically stable with a factor of safety ≥1.5.	Assessment by AQP of compliance with slope and material type	Upon receipt of AQP assessment	Arrange remediation	Internally	Upon completion of remediation

Criteria	Monitoring Methods	Frequency	Contingency/ Maintenance	Reporting	Review
Native bushland corridor PMLU					
• Maximum 25% slope	Site assessment of slopes and or Lidar by AQP, review AQP report, review Annual Rehabilitation Monitoring Reports	Upon receipt of AQP report, and annually for ongoing monitoring	Re-shape landform to design specifications prior to topsoiling or rock mulching	Internally	Upon completion of re-shaping
• Areas >15% to be certified by a suitably qualified person as being stable long term, with rock mulch applied as required.	Site assessment of by AQP, review AQP report, review Annual Rehabilitation Monitoring Reports	Upon receipt of AQP report, and annually for ongoing monitoring	Re-shape landform to design specifications prior rock mulching	Internally	Upon completion of re-shaping
Flood protection landform PMLU					
• Watercourse facing slopes ≤15%.	Site assessment of slopes and/or Lidar by AQP, review AQP report, review Annual Rehabilitation Monitoring Reports	Upon receipt of AQP report, and annually for ongoing monitoring	Re-shape landform to design specifications prior to topsoiling	Internally	Upon completion of re-shaping
• Void facing slopes ≤15%, except where constrained by proximity to void regrade, batters can be reduced to ≤25%.	Site assessment of slopes and/or Lidar by AQP, review AQP report, review Annual Rehabilitation Monitoring Reports	Upon receipt of AQP report, and annually for ongoing monitoring	Re-shape landform to design specifications prior to topsoiling	Internally	Upon completion of re-shaping
• Bench of 10m to separate inward toe embankment from adjacent edge of void stabilisation regrade.	Site assessment and/or Lidar by AQP, review AQP report	Upon receipt of AQP report	Re-shape landform to design specifications	Internally	Upon completion of re-shaping
• Landform – 0.1%AEP +0.5m freeboard.	Site assessment and/or Lidar by AQP, review AQP report	Upon receipt of AQP report	Re-shape landform to design specifications	Internally	Upon completion of re-shaping
• Line the river facing embankments at sharp changes in alignment where turbulence could occur with hard, durable rock rip rap.	Site assessment by AQP, review AQP report	Upon receipt of AQP report	Re-line embankment with rip-rap to design specifications	Internally	Upon completion of re-lining
• Must be fenced to exclude stock and permanent fencing in place post construction and maintained.	Visual inspection	Monthly	Re-install fencing	Internally	Annually, and upon re-installation
Boggy Creek Diversion PMLU					
• Geotechnically stable with a factor of safety ≥1.5	Assessment of RPEQ and review of RPEQ assessment	Upon receipt of RPEQ assessment	Arrange remediation	Internally	Upon completion of remediation
• As constructed drawings submitted to Department of Regional Development, Manufacturing and Water	Review submission evidence (email, submission slip, receipt)	Upon completion of construction	Arrange submission	Department of Regional Development, Manufacturing and Water	During annual reporting
RM4 Seedbed preparation					
Topsoil is replaced to 150mm depth on all areas to be revegetated.	Visual inspection	Upon completion of placement	Re-place or place topsoil to specifications	Internally	Upon re-placement
Soil ameliorants and fertilisers are applied as needed to address soil limitations.	Review soil laboratory documentation, rehabilitation records	Upon completion of amelioration, annually for ongoing monitoring	Re-ameliorate or ameliorate	Internally	Upon completion of re-amelioration

Criteria	Monitoring Methods	Frequency	Contingency/ Maintenance	Reporting	Review
RM5 Sowing					
Beef cattle grazing PMLU: 3P pasture species mix sown at appropriate rate	Review seed mix specification, rehabilitation records, annual rehabilitation monitoring	Upon completion of seeding, and annually for ongoing monitoring	Re-seed or seed according to specifications	Internally	Upon completion of re-seeding
Native bushland corridor PMLU: Native trees and shrub species mix sown at appropriate rate	Review seed mix specification, rehabilitation records, annual rehabilitation monitoring	Upon completion of seeding, and annually for ongoing monitoring	Re-seed or seed according to specifications	Internally	Upon completion of re-seeding
Flood protection landform PMLU: Native trees and shrub species mix sown, grass species sown at appropriate rate	Review seed mix specification, rehabilitation records, annual rehabilitation monitoring	Upon completion of seeding, and annually for ongoing monitoring	Re-seed or seed according to specifications	Internally	Upon completion of re-seeding
Hay mulch applied as required	Review mulching specification, rehabilitation records, annual rehabilitation monitoring	Upon completion of mulching, and annually for ongoing monitoring	Re-mulch according to specifications	Internally	Upon completion of re-mulching
RM6 Vegetation establishment					
Beef cattle grazing PMLU: ≥50% established and persistent vegetative groundcover for all slopes from 0-15%.	Annual rehabilitation monitoring	Annually	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Internally	Upon completion of annual rehabilitation monitoring reports
Beef cattle grazing PMLU: ≥80% established and persistent vegetative cover for slopes from 15% to 25%.	Annual rehabilitation monitoring	Annually	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Internally	Upon completion of annual rehabilitation monitoring reports
Native bushland corridor PMLU: ≥50% established and persistent vegetative groundcover for all slopes from 0-20%.	Annual rehabilitation monitoring	Annually	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Internally	Upon completion of annual rehabilitation monitoring reports
Native bushland corridor PMLU: ≥80% established and persistent cover (vegetative and/or rock mulch) for slopes from 20% to 25%.	Annual rehabilitation monitoring	Annually	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Internally	Upon completion of annual rehabilitation monitoring reports
Native bushland corridor PMLU: Species richness ≥ 2 tree species, ≥ 3 shrub species, ≥ 5 groundcover species.	Annual rehabilitation monitoring	Annually	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, change species mix, re-sow or re-plant, as appropriate	Internally	Upon completion of annual rehabilitation monitoring reports

Criteria	Monitoring Methods	Frequency	Contingency/ Maintenance	Reporting	Review
RM7 Achievement of PMLU to a safe, stable, and non-polluting condition					
Certification from an AQP that the area is geotechnically safe and stable at end of closure phase (including through subsidence)	Review AQP certification	Upon receipt of certification	Arrange corrective actions, as required	Internally	Upon completion of corrective actions
Certification from an AQP that surface water quality will not cause environmental harm to the surrounding environment, using release contaminant trigger investigation levels outlined in the EA at end of closure phase	Review AQP certification	Upon receipt of certification	Arrange corrective actions, as required	Internally, Administering Authority	Upon completion of corrective actions
0 (zero) significant difference as defined in AS/NZS ISO 31000:2018 Risk Management (from DES comments)	Hazard assessment by AQP, review of AQP report	Upon receipt of AQP report	Arrange corrective actions, as required	Internally	Upon completion of corrective actions
RM8 Achievement of a self-sustaining condition with respect to beef cattle grazing PMLU					
Certification from an AQP that rehabilitation is suitable for sustainable cattle grazing and is land suitability class 2 to 4 as defined in the Guidelines for Agricultural Land Evaluation in Queensland (State Department of Queensland 2013).	Site assessment by AQP, review AQP report	Upon receipt of AQP report	Investigate cause of failure to achieve suitability class 2 to 4, re-fertilise, treat top soil, change species mix, re-sow, as appropriate	Internally	Upon completion of remediation
RM9 Achievement of a stable condition (Boggy Ck diversion)					
Certification from an AQP that riparian vegetation is suitable for conservation of rehabilitated creek diversion areas and has an IDC score >10 as defined in Criteria for functioning river landscape units in mining and post-mining landscapes (ACARP Project number C20017).	Site assessment by AQP, review AQP report	Upon receipt of AQP report	Investigate cause of failure to score >10, and remediate as appropriate	Internally	Upon completion of remediation
RM10 Achievement of a stable condition (native bushland corridor)					
Certification from an AQP that rehabilitation has native species and bushland characteristics, including: • ≥2 tree species • ≥3 shrub species • ≥5 groundcover species	Annual rehabilitation monitoring	Annually	If revegetation fails or trends indicate that criterion will not be achieved, investigate cause, and re-fertilise, treat top soil, re-sow or re-plant, as appropriate	Internally	Upon completion of annual rehabilitation monitoring reports
RM11 Achievement of a stable condition (flood protection landform)					
Certification from an AQP that construction is per certified designs provided under condition H11 of the EA.	Site inspection, review of AQP report	Upon receipt of AQP report	Arrange corrective actions, as required	Internally	Upon completion of remediation
Permanent flood structure in place at end of closure phase	Site inspection by AQP, review of AQP report	Upon receipt of AQP report	Arrange corrective actions, as required	Internally	Upon completion of remediation
Floodplain width re-instated. Minimum 2km width between the northern section of B Pit and the southern section of C Pit as located generally in accordance with Appendix 5 (of the EA).	Site and/or remote sensing imagery inspection by AQP, review of AQP report	Upon receipt of AQP report	Arrange corrective actions, as required	Internally	Upon completion of remediation
RM12 Achievement of a stable condition (Underground Mining Surface Areas – not applicable to underground workings)					
Assessment by an AQP that the mined land is comparable to the unmined land.	Review of survey records and check of FOS	Minimum annually	Arrange corrective actions, as required	Internally	Annually

Criteria	Monitoring Methods	Frequency	Contingency/ Maintenance	Reporting	Review
MM1 Sufficient improvements to ensure structural stability					
Slope gradients (for highwalls) achieved as follows for NUMAs- • Maximum of 275% slopes for competent high walls. • Maximum of 50% slopes for incompetent material • A south pit, F Pits and Y Pits highwall must be reshaped to a maximum of 25% slopes. • Northern Endwall of B Pit maximum 15% slope	Site assessment of slopes and or Lidar by AQP, review AQP report	Upon receipt of AQP report	Re-shape landform to design specifications	Internally	Upon completion of re-shaping
RPEQ geotechnical assessment to certify that landforms are geotechnically and erosionally stable with a factor of safety ≥1.5	Review of RPEQ assessment	Upon receipt of assessment	Arrange remediation	Internally	Upon completion of remediation
Water run-off from above the highwall is channelled to the groundwater daylighting water areas PMLU through design pathways.	Site inspection by AQP, review AQP report	Upon receipt of AQP report	Re-shape landform to ensure water drains into channels as envisaged	Internally	Upon completion of re-shaping
MM2 Sufficient improvements to ensure safety and avoidance of serious environmental harm					
Improvement areas to be bunded, fenced and signed to exclude humans and stock	Site inspection	Monthly	Re-install bunds, fences, and signage if required	Internally	Upon completion of re-instalment
Assessment by an AQP that groundwater daylighting areas act as groundwater sinks and regional groundwater aquifers maintain their current water quality and groundwater monitoring bores do not exceed the water quality limits detailed in Table C11 – Groundwater quality limits in the relevant EA as a result of mining activities.	Bore inspection, quarterly monitoring, review monitoring report, AQP review	Upon receipt of quarterly monitoring report Upon receipt of AQP report	Review water management arrangements and initiate remedial actions	Internally, Administering Authority (2 yearly Groundwater Management and Monitoring Program Report)	Upon completion of remedial actions
Groundwater daylighting water areas maximum dimensions:					
• A Central – Surface Water Level -133mAHD, Water storage Volume -0.5GL, and Water Area – 3ha	Site and/or LiDAR inspection by AQP, review AQP report	1 July and 1 November annually, upon receipt of AQP report	Review water management arrangements and initiate remedial actions	Internally, Administering Authority	Upon completion of remedial actions
• A North – Surface Water Level – 133mAHD, Water storage volume – 1.2GL, and Water Area – 16ha	Site and/or LiDAR inspection by AQP, review AQP report	1 July and 1 November annually, upon receipt of AQP report	Review water management arrangements and initiate remedial actions	Internally, Administering Authority	Upon completion of remedial actions
• B – Surface Water Level – 123mAHD, Water Storage Volume – 3.1GL and Water Area – 33ha	Site and/or LiDAR inspection by AQP, review AQP report	1 July and 1 November annually, upon receipt of AQP report	Review water management arrangements and initiate remedial actions	Internally, Administering Authority	Upon completion of remedial actions
• C and D – Surface Water Level – 125mAHD, Water Storage Volume – 22.1GL and Water Areas – 65ha for C and 75ha for D	Site and/or LiDAR inspection by AQP, review AQP report	1 July and 1 November annually, upon receipt of AQP report	Review water management arrangements and initiate remedial actions	Internally, Administering Authority	Upon completion of remedial actions

7.3 QA/QC processes

QA/QC processes are to be undertaken by an appropriately qualified personnel (AQP). Monitoring data collected will be reviewed by an AQP and evaluated for the initial purpose of analysis and manipulation of data by preparing tables and graphs. The QA/QC process will aim to identify the inherent quality of data collected, as well as provide assurance that relevant internal checks and balances are in place to consider and review summary statistics that indicate the suitability of sampling resolution and number, spread of data, repeatability over time/space as well as use for predicting the future trajectory of rehabilitation performance.

7.3.1 Corrective actions

As required by EA conditions H7 and H8, an annual rehabilitation monitoring report is prepared to incorporate all monitoring completed for the annual campaign. The purpose of the annual report is to present an annual update of the rehabilitation progress towards the achievement of rehabilitation requirements specified by the EA, which are analogous to the PMLU criteria.

The results of each additional year of monitoring will be compared to previous years to show the trending of areas towards the achievement of the safe, stable, non-polluting and self-sustaining PMLU criteria, with recommendations provided to improve and further support the continued progression of the rehabilitation.

The report may also describe corrective actions/contingency strategies, should these require implementation. Examples of some of the corrective actions that will be taken are set out in Appendix 9.3. The report is to be reviewed by Ensham for implementation of contingency strategies as appropriate.

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9 APPENDICES & ATTACHMENTS

9.1 PRCP schedule & supporting information

In accordance with section 126D(1) of the EP Act, the PRCP schedule in the PRC plan must:	
a) describe the area of each resource tenure either a post-mining land use or non-use management area, and	Section 3 & Section 4
b) for each post-mining land use state: **i. each rehabilitation milestone required to achieve a stable condition, and** **ii. when each rehabilitation milestone is to be achieved, and**	Section 9.1.3 & Refer to P-PRCP-100751503 Schedule.
c) for each non-use management area state: **i. each management milestone, and** **ii. when each management milestone is to be achieved, and**	Section 9.1.4 & Refer to P-PRCP-100751503 Schedule.
d) include maps showing the land mentioned in (a), (b) and (c).	Refer to P-PRCP-100751503 Schedule.

9.1.1 Final site design

PMLUs and NUMAs at Ensham are as listed in the land outcome document EA *EPML00732813*, with a description of each PMLU and NUMA provided in the planning part of this PRCP.

The location of all PMLUs and NUMAs within all Ensham MLs is as shown in Figure 9.1, as the Final Site Design map. Both disturbed and undisturbed areas are shown in the same way to emphasise the continuity of the mine disturbance land uses with land use in surrounding undisturbed areas, as well as showing the maximum disturbance footprint and resource tenure (ML) boundaries. The floodplain extent (aligned to the 0.01% AEP flood event) is also shown.

Figure 9-2 to Figure 9-8 (inclusive) shows the key PMLUs and NUMAs for each of the mining leases and includes both disturbed and undisturbed lands. Subsequently, the issued PRCP schedule, Section C and D, are further focused on the disturbance footprint at Ensham, which related to both rehabilitation and/or improvement areas.

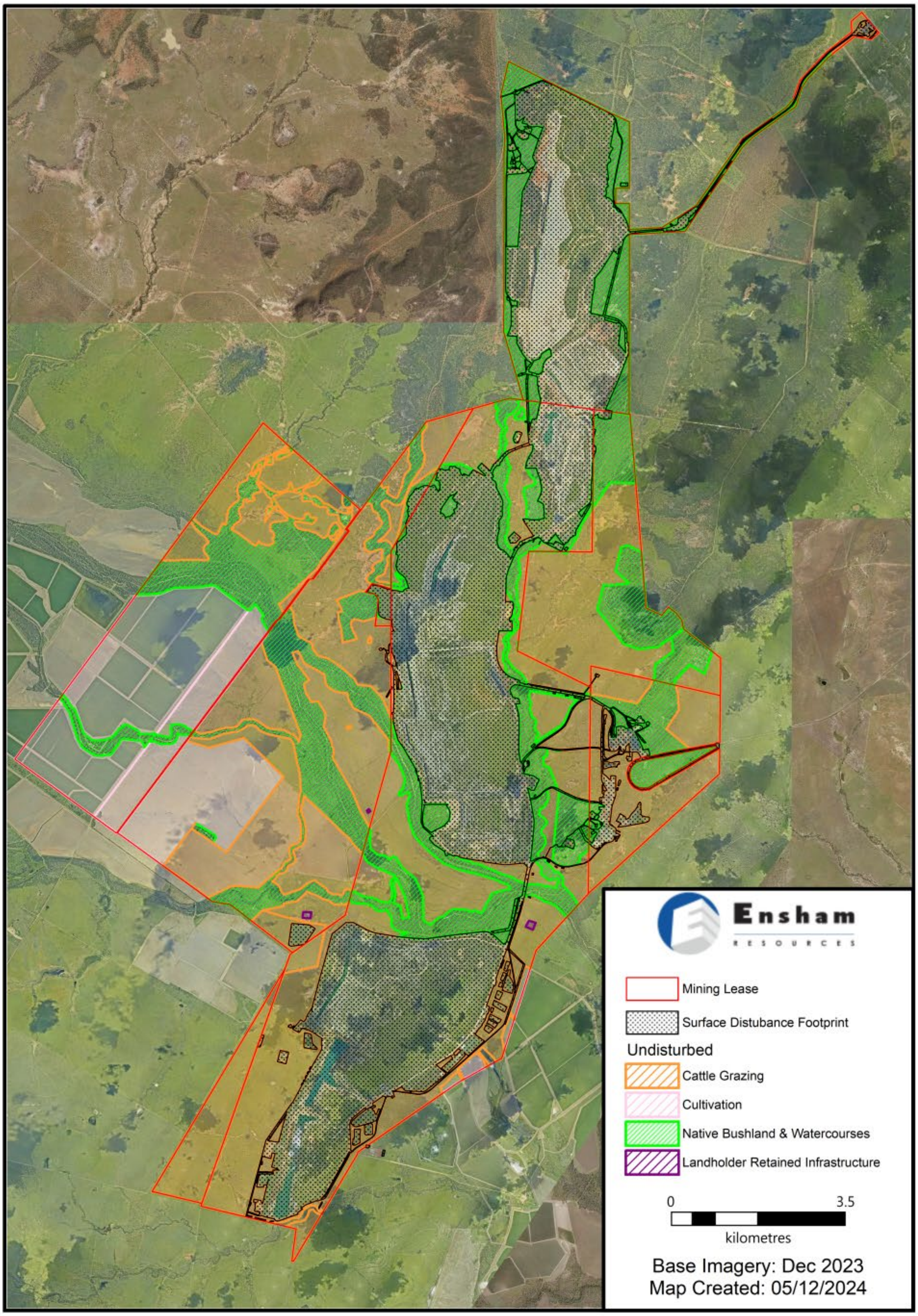

Figure 9-1 Final site design map

9.1.2 Land use categorisation

All lands within the relevant mining lease tenements, including undisturbed lands, have been provided with either a PMLU or a NUMA (as per Table 9-1, and as shown from Figure 9-2 to Figure 9-8). There are eight mining lease tenements, which combined cover approximately 14,775 ha of land.

Table 9-1 All tenements land use categories

Undisturbed	PMLU	Cattle grazing	5,233.5
		Cultivation for cropping	1,704.9
		Native bushland and watercourses	2,981.1
		Major landholder infrastructure	4.3
		Subtotal	**9,923.8**
Disturbed by mining activities	PMLU	Cattle grazing	4,318.8
		Landholder retained infrastructure	69.8
		Native bushland corridor	290.0
		Boggy Creek diversion	75.0
		Flood protection landform	65.3
		Subtotal	**4,818.9**
	NUMA	Groundwater daylighting water areas	145.7
		Highwalls	83.1
		Subtotal	**228.8**
		TOTAL	**14971.5**
		Registered survey (QSpatial)	14,745.3

- For discrete rehabilitation or improvement areas, the hectares presented herein are accurate to ±15 %.
- For total areas of PMLUs and NUMAs, the hectares presented herein are accurate to ±5 %.

It is also noted that there is some minor overlapping of the areas disturbed, as a result of maintenance and rework required for existing rehabilitation areas. As such, the above table (Table 9-1) should not be used for verification of areas subject to this PRCP, and the areas contained within the PRC Schedules should be taken as the formal estimate of areas subject to progressive rehabilitation, and requiring progression of rehabilitation and closure activities in accordance with the established milestones.

9.1.3 Post-mining land uses

PMLUs at Ensham are listed in the land outcome document EA *EPML00732813* and reproduced here as follows.

- Cattle grazing on overburden and infrastructure areas.
- Landholder retained infrastructure.
- Boggy Creek diversion.
- Native bushland corridor.
- Flood protection landform.

A description of each PMLU is provided in the planning part of this PRCP (see Section 2.4). These PMLUs account for approximately 95 % of mining disturbance in the post-mining landscape at Ensham.

9.1.3.1 Rehabilitation areas

A total of 15 rehabilitation areas (RAs) have been identified at Ensham. This includes 4 areas of existing rehabilitation, RA1 to RA4, and 11 areas of future rehabilitation, RA5 to RA15.

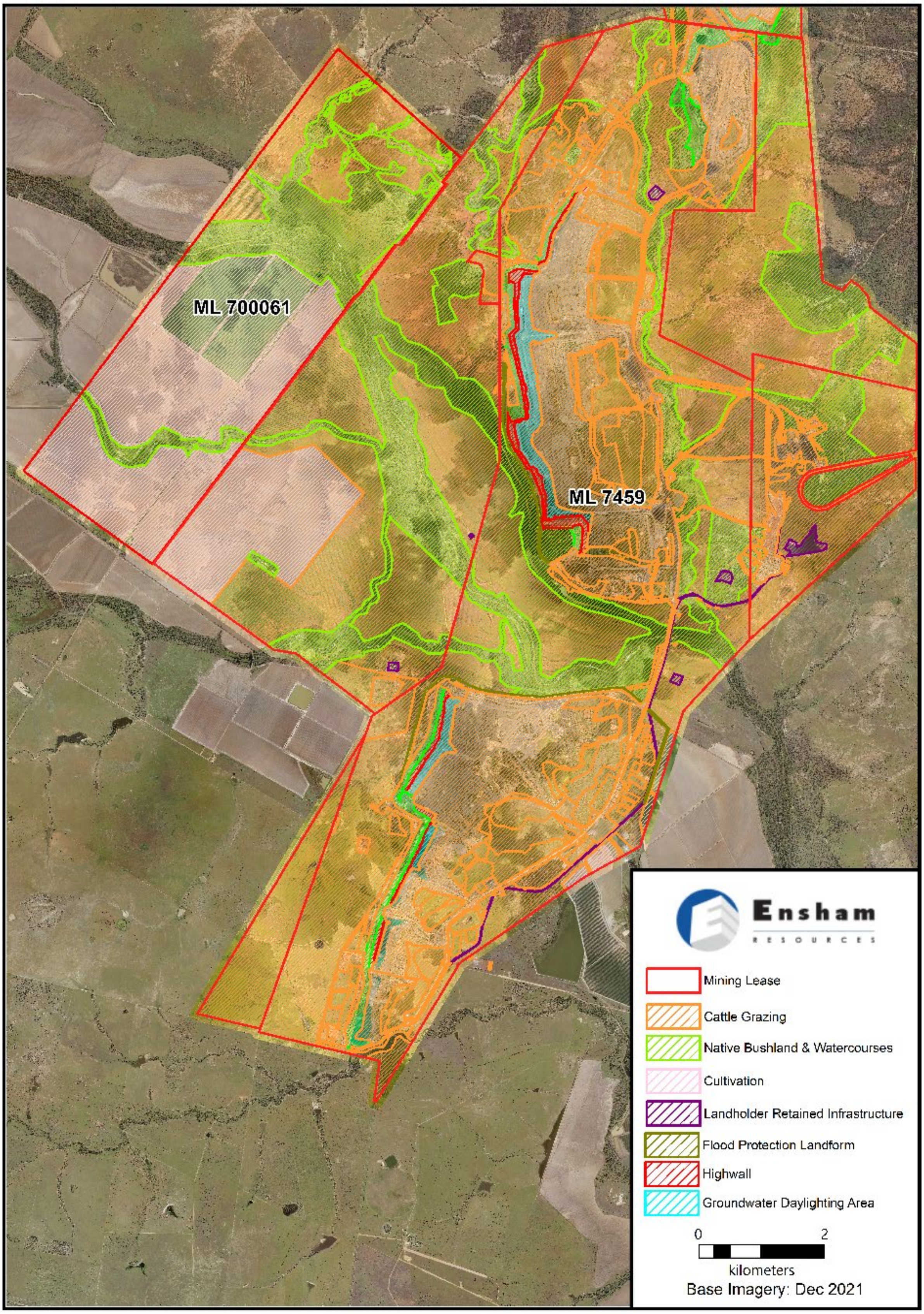

Figure 9-2 ML7459 land use categories

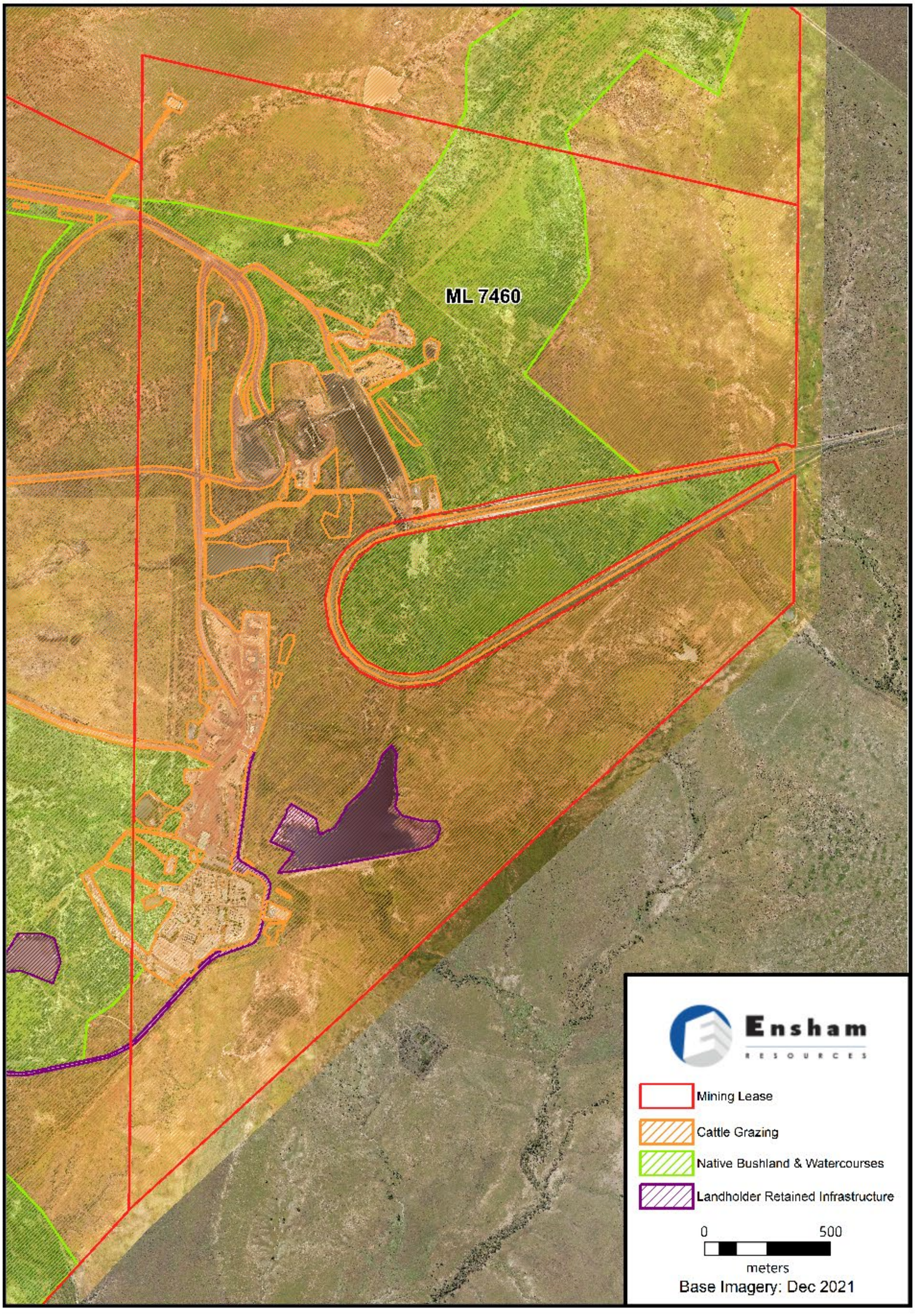

Figure 9-3 ML7460 land use categories

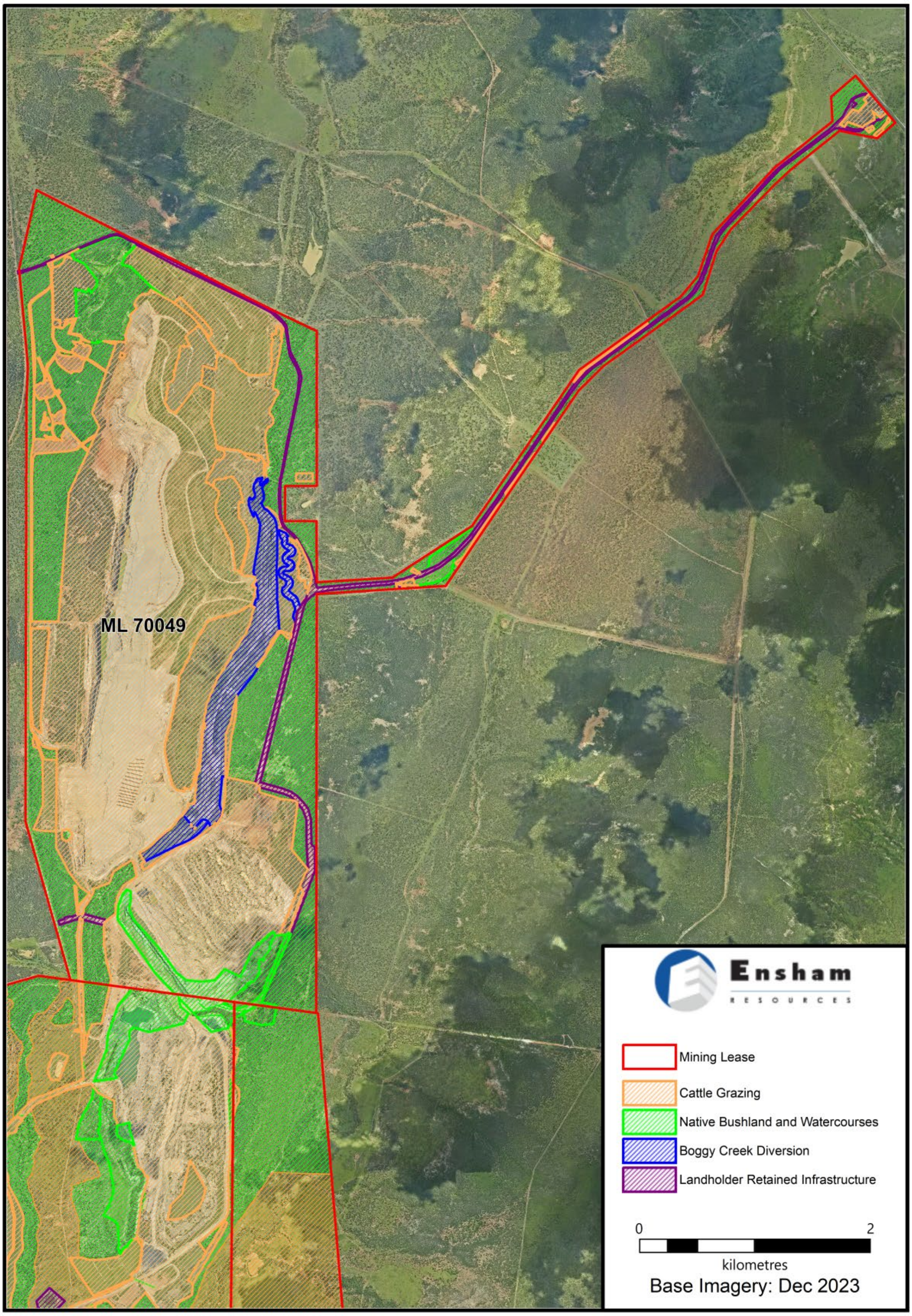

Figure 9-4 ML70049 land use categories

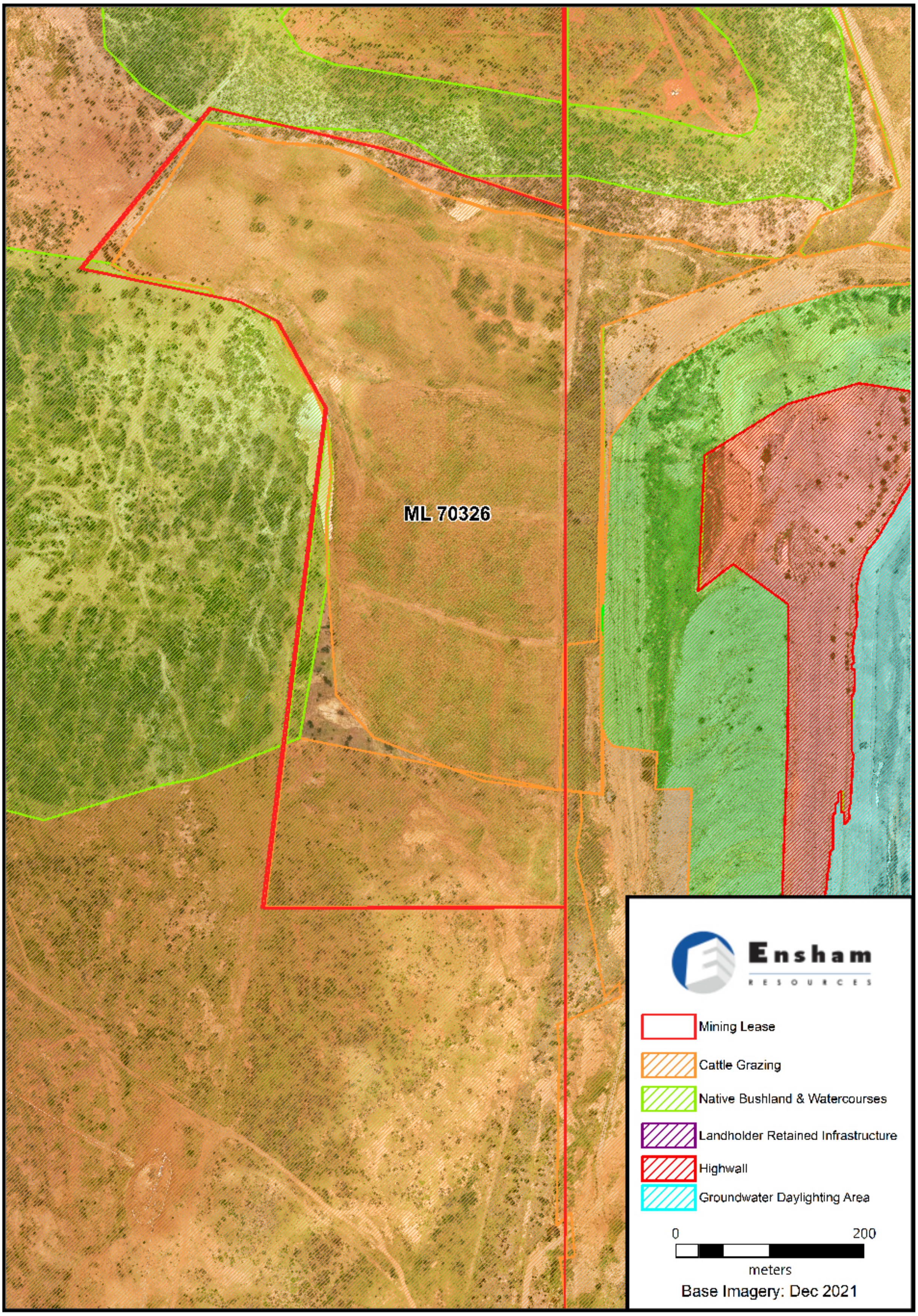

Figure 9-5 ML70326 land use categories

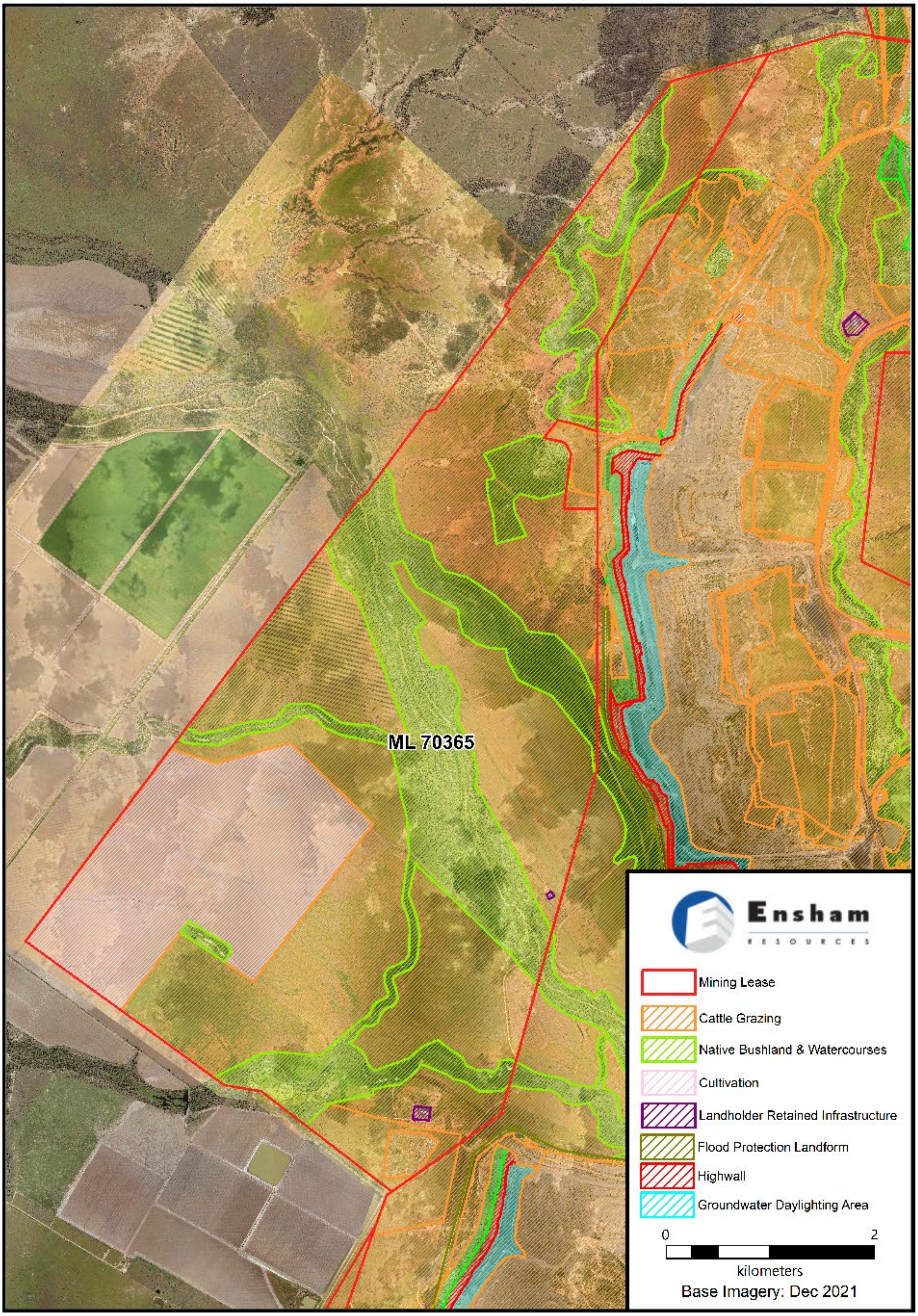

Figure 9-6 ML70365 land use categories

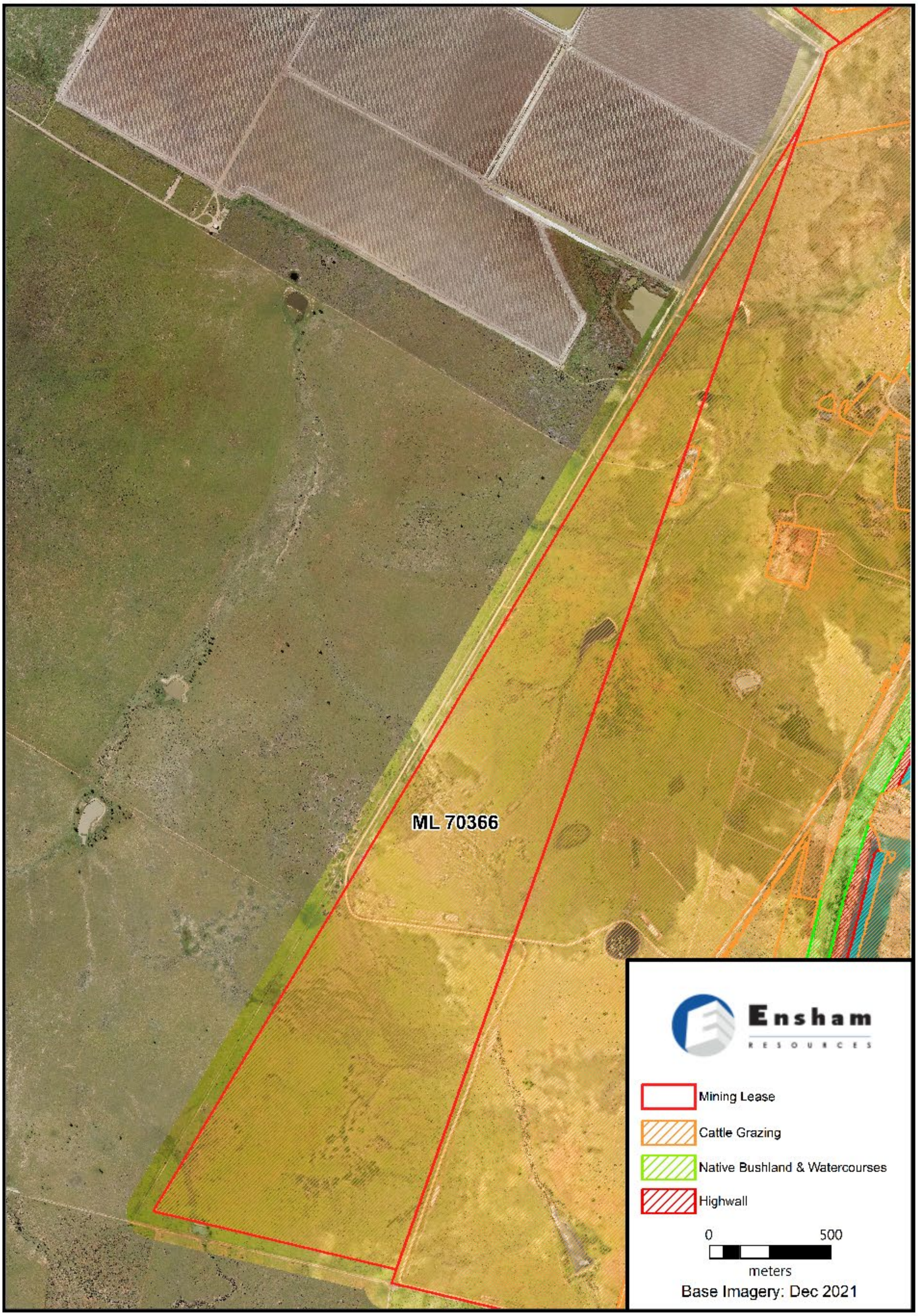

Figure 9-7 ML70366 land use categories

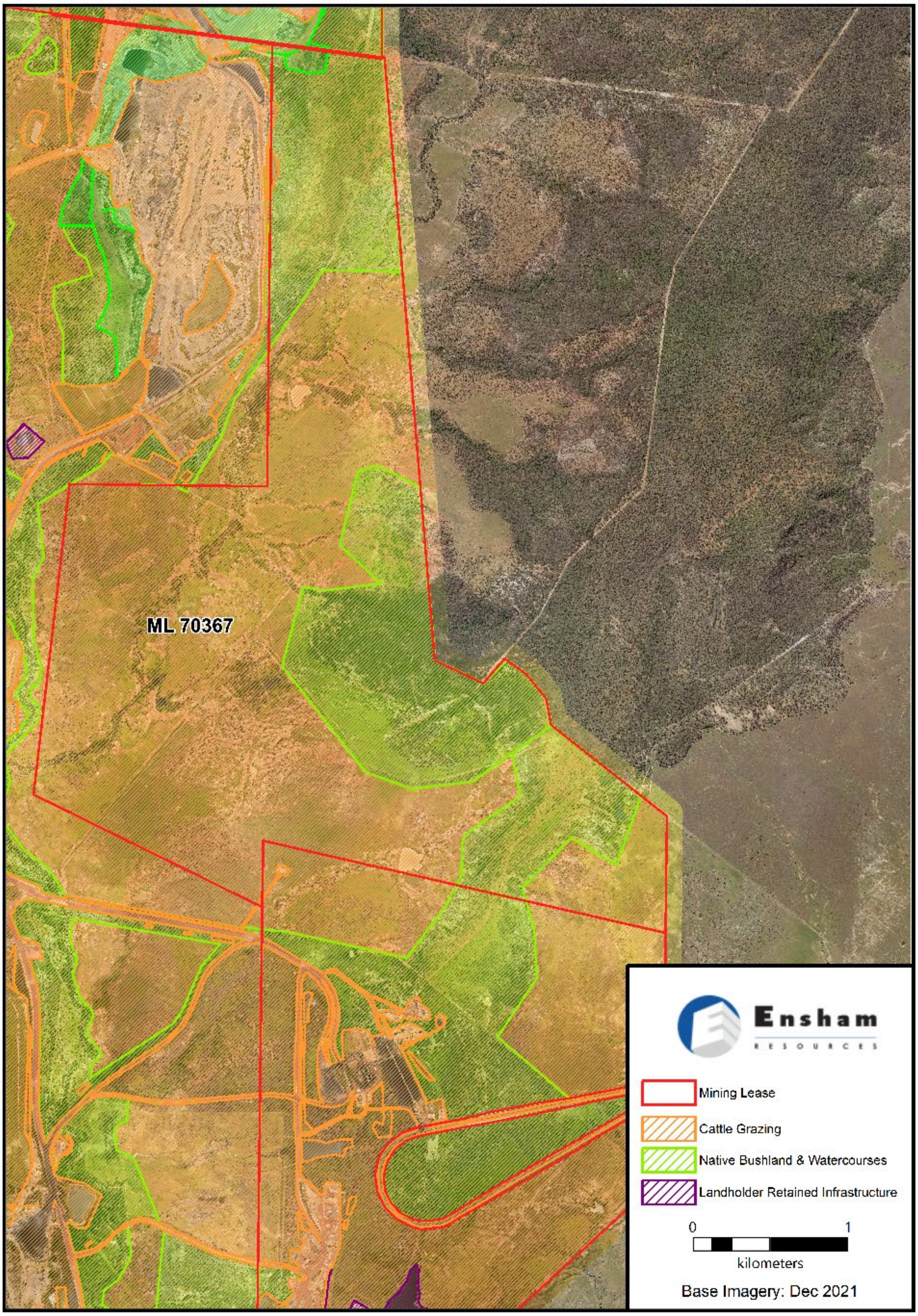

Figure 9-8 ML70367 land use categories

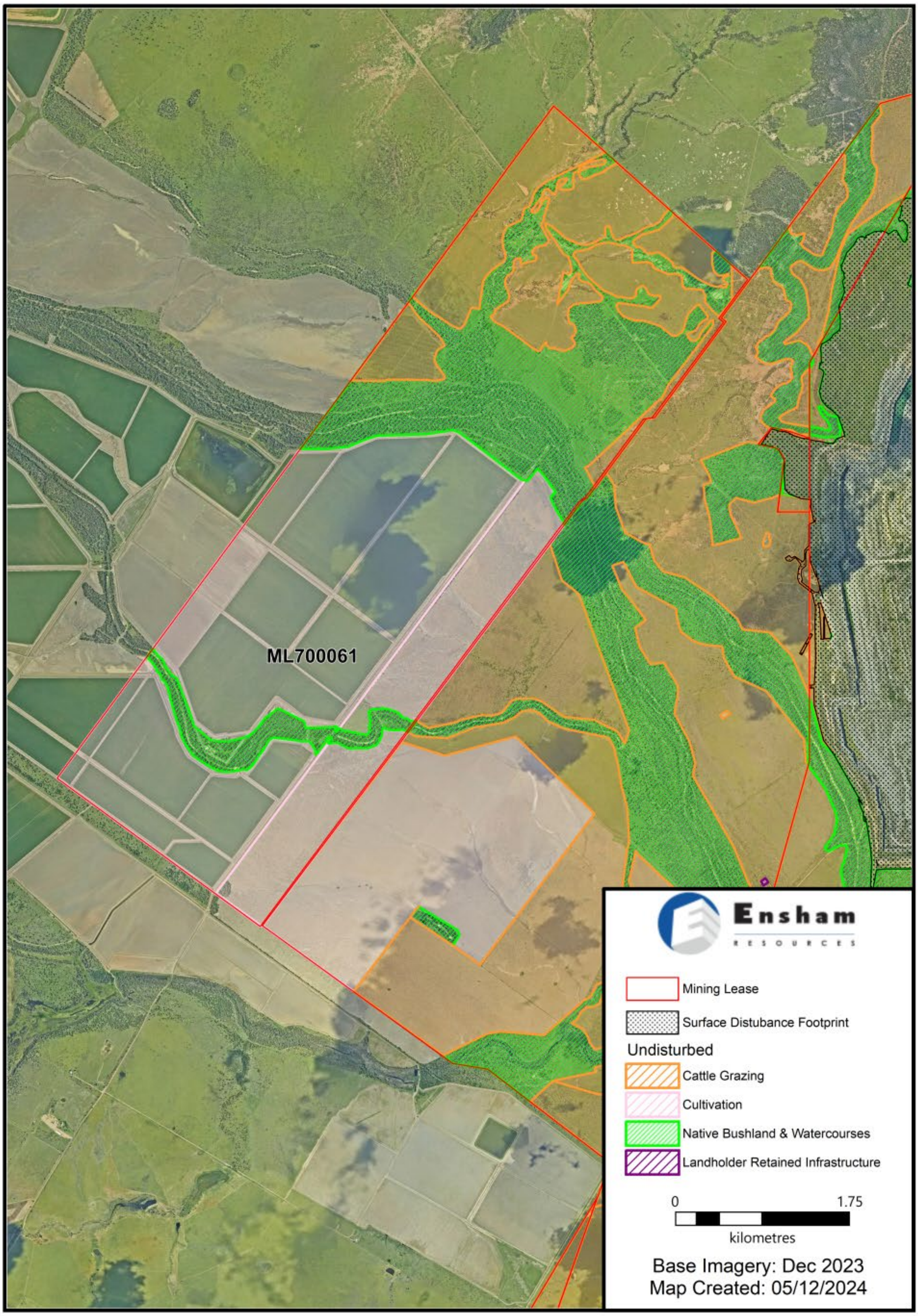

Figure 9-9 ML700061 Land use categories

Table 9-2 Rehabilitation Areas and descriptions

RA #	PMLU	Area (ha)	Comment
1	Cattle grazing	662.8	Existing rehabilitation, certified in 2019 and 2021
2	Cattle grazing	817.4	Existing rehabilitation, not certified
3	Native bushland corridor	83.9	Existing rehabilitation, not certified
4	Boggy Creek diversion	70.3	Existing rehabilitation, not certified
5	Cattle grazing	197.05	Completed to RM5, not certified
7	Boggy Creek Diversion	4.7	Completed to RM5, not certified
	Subtotal	**1634.4**	**Existing rehabilitation at Ensham**
5	Cattle grazing	575.24	Scheduled rehabilitation, Yongala
6	Native bushland corridor	37.8	Scheduled rehabilitation, Yongala
8	Cattle grazing	1140.8	Scheduled rehabilitation, Ensham Central
9	Native bushland corridor	92.1	Scheduled rehabilitation, Ensham Central
10	Flood landform levee	35.7	Scheduled rehabilitation, Ensham Central Levee
11	Cattle grazing	925.9	Scheduled rehabilitation, Ensham South
12	Native bushland corridor	76.2	Scheduled rehabilitation, Ensham South
13	Flood landform levee	29.6	Scheduled rehabilitation, Ensham South Levee
14	Landowner retained infrastructure	69.8	Landowner retained infrastructure*
15	Existing surface use, PLMU or NUMA, where applicable	5619.3	Surface area of the underground mining area*
	Subtotal	**2913.34**	**Approximate Scheduled rehabilitation at Ensham**

** It is noted that this RA area has not been included in the subtotal, as the infrastructure will be retained or due to the presence of overlaps between undisturbed areas, disturbed areas and RA's.*

Note: There are areas of existing established rehabilitation (within RA2, RA3 etc) which will be disturbed and rehabilitated again in order to construct the agreed final landform. This means that some areas of land are overlapped by two RAs. Overlaps are also seen with RA15 and various other RA's or disturbed and rehabilitated land. As such, the rehabilitation areas cannot be reconciled, compared or tallied.

The areas contained within the PRC Schedules should be taken as the formal estimate of areas subject to progressive rehabilitation and ongoing management, and requiring progression of activities in accordance with the established milestones. Updates will continually be required to adjust boundaries to identify actual completion and modification of landform designs.

9.1.3.2 Rehabilitation milestones and criteria

Rehabilitation milestones and criteria have been developed for all rehabilitation areas that have a PMLU (Refer P-PRCP-100751503 Schedule - Rehabilitation Area Milestones). These milestones are SMART, meaning they are:

Specific – is it clear what must be done.

Measurable - it is possible to know when it is achieved.

Achievable - it is capable of being achieved.

Reasonable – there is a clear connection between the milestone and the desired rehabilitation outcome.

Timely – it is clear when the milestone will be completed.

Rehabilitation milestones include:

- Infrastructure decommissioning and removal
- Identification and remediation of contaminated land
- Final landform development
- Seedbed preparation
- Sowing
- Vegetation establishment
- Achievement of a stable condition
- Remediation of unpredicted surface cracking

9.1.4 Non-use management areas

There are two pre-approved NUMAs at Ensham. These are shown in land outcome document EA *EPML00732813* and reproduced here as follows.

- Groundwater daylighting water areas.
- Highwalls.

9.1.4.1 Improvement areas

A total of 2 improvement areas have been identified at Ensham (Refer Figure 4-1). A schedule of improvement area availability for management is provided (Table 9-3).

This schedule is cognisant of mining activities and infrastructure requirements, particularly as these relate to underground mining operations, and the feasibility of completing rehabilitation. Feasibility includes considerations of timing and management complexity, and safety, cost, and engineering requirements.

Table 9-3 Schedule of NUMA land availability for improvement

IA	2021 (ha)	2022 (ha)	2023 (ha)	2024 (ha)	2025 (ha)	2026 (ha)	2027 (ha)	2028 (ha)	2029 (ha)	2030 (ha)	2031 (ha)	2032 (ha)	2033 (ha)	2034 (ha)	2035 (ha)	2036 (ha)	2037 (ha)	2038 (ha)	2039 (ha)	2040 (ha)	2041 (ha)	2042 (ha)
1												3.0				18.9	7.7	11.9		8.6	12.9	20.1
2																30.7		35.0		32.4	14.3	33.4
Total by year (ha)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**3.0**	**0.0**	**0.0**	**0.0**	**49.6**	**7.7**	**46.9**	**0.0**	**41.0**	**27.2**	**53.5**

9.1.4.2 Improvement area milestones

Improvement area milestones and criteria have been developed for all improvement areas that have a NUMA (Refer P-PRCP-100751503 Schedule - Improvement Area Milestones). These milestones are SMART, meaning they are:

Specific – is it clear what must be done.

Measurable - it is possible to know when it is achieved.

Achievable - it is capable of being achieved.

Reasonable – there is a clear connection between the milestone and the desired rehabilitation outcome.

Timely – it is clear when the milestone will be completed.

Management milestones include:

- Sufficient improvements to ensure structural stability
- Sufficient improvements to ensure safety and minimisation of environmental harm

The milestones will be achieved by:

- Inspection and assessment by suitably qualified person for each highwall to determine the boundaries of competent and incompetent materials.
- Design of construction process for slope of incompetent material.
- Backfill northern endwall of B pit to < 15% using suitably sourced material.
- Monitor the groundwater aquifers and investigate any emerging trends.