PROGRESSIVE REHABILITATION AND CLOSURE PLAN

Curragh Complex
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BASIS OF REPORT

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1 Introduction

In accordance with the *Environmental Protection Act 1994* (EP Act), all mining activities approved through a site-specific environmental authority application must develop and submit a Progressive Rehabilitation and Closure Plan (PRCP) to the Department of Environment and Science for assessment. The main purpose of the PRCP is for the holder of an EA to plan for how and where activities will be carried out on land in a way that maximises the progressive rehabilitation of the land to a stable condition, and, to provide for the condition to which the holder must rehabilitate the land before the EA is surrendered.

This PRCP has been developed in accordance with the transition notice issued under section 754 of the EP Act to Coronado Curragh Pty Ltd (CCPL). This PRCP meets the legislative requirements in section 126C and 126D of the EP Act and the statutory guideline: Progressive Rehabilitation and Closure Plans (ESR/2019/4964).

1.1 Relevant Legislation and Policies

1.1.1 Mined Land Rehabilitation Policy

The Mined Land Rehabilitation Policy is a joint departmental policy between the Department of Environment and Science, the Department of Natural Resources and Mines and Queensland Treasury. The Policy presents Queensland Government's position on mine rehabilitation and is the basis of the changes made through the MERFP Act.

The Policy states that, "land disturbed by mining is considered to be rehabilitated when it can be demonstrated it is safe, stable, does not cause environmental harm, and is able to sustain the post-mining land use approved in the PRCP (referred to as 'stable condition'). An area of land that does not sustain a post-mining land use (referred to as a 'non-use management area') may be approved if best practice management can be demonstrated, and:

- Rehabilitating the area would cause greater environmental risk than not rehabilitating, or
- The environmental risks from the area are localised, and the cost of rehabilitation would be so excessive as to not be in the public interest."

The Policy also introduces the prohibition of final voids situated wholly or partly in a floodplain.

1.1.2 Environmental Protection Act 1994

The amendments to the EP Act requiring mines with site-specific EAs to have a PRCP, came into effect on 1 November 2019. The EP Act states the legislative information requirements for the rehabilitation planning part (section 126C) and PRCP schedule (section 126D). The EP Act also details the assessment process for the approval of a proposed PRCP.

The EP Act contains transitional provisions relating to existing site-specific mines. During the three-year transition period, DES will issue notices to existing mines requiring them to develop and submit a proposed PRCP by a specific date (no less than six months from issuing the notice). The transitional provisions also state that existing approvals may be translated into the proposed PRCP without additional assessment or public notification. Final voids approved in a land outcome document are exempt from the prohibition of a final void in a floodplain and the requirement for a public interest evaluation for a non-use management area.

1.1.3 Environmental Protection Regulation 2019

The Environmental Protection Regulation 2019 (EP Regulation) includes PRCP objectives and performance outcomes (schedule 8A) the administering authority must consider when approving a PRCP. The EP Regulation also contains additional requirements for deciding the extent of a floodplain (0.1% Annual Exceedance Probability (AEP)) for the purposes of prohibiting a final void within a floodplain.

1.1.4 PRCP Guideline

The PRCP Guideline is a statutory guideline made under section 550 of the EP Act and includes additional information requirements the administering authority deems necessary or desirable within a PRCP.

The PRCP Guideline provides information about the assessment process for a PRCP, information requirements for the PRCP, relevant post-approval processes and transitional provisions. The PRCP Guideline stipulates the detailed technical information that is expected to be included in a proposed PRCP.

2 Project Planning

2.1 Project Description

The Curragh Complex is located within the Central Highlands Regional Council, approximately 6 km north of the town of Blackwater and approximately 200 km west of Rockhampton (**Figure 2-1**). The total mining lease area is about 19,650 ha.

The Curragh Complex consists of (**Figure 2-2** and **Figure 2-3**):

- Curragh Central (Pit X-west);
- Curragh Central Extended (Pit X-east & Pit D);
- Curragh Extended (Pit J);
- Curragh South (Pit Z);
- Curragh West (Pit Y);
- Curragh East (Pit A-C, Pit E—I, Pit K-L); and
- Curragh North (Pit s, Pit T and Pit U).

The Curragh Complex is an open cut operation producing a variety of coking, PCI and steaming coal products for both the export and domestic markets. The operation is a mix of dragline and truck and shovel fleets. The mine is predominantly divided into mining areas 'Curragh Main' and the more recent 'Curragh North'. Curragh Main consists of Curagh East, West and Extended, with mining commencing in this area in approximately 1983. Curragh North is a satellite mining operation which commenced operations in 2005 and is connected to Curragh Main by a haul road for supply and servicing, and a conveyor for coal transport to the Curragh Main Coal Handling and Preparation Plant (CHPP).

The approved annual run of mine (ROM) production is 18 million tonnes per annum (Mtpa). Coal extraction has been ongoing since 1983, through surface mining methods. Coal is transported from the mine to Gladstone via the Central Rail Line also known as the Blackwater Line. The current project Life of Mine is 2044.

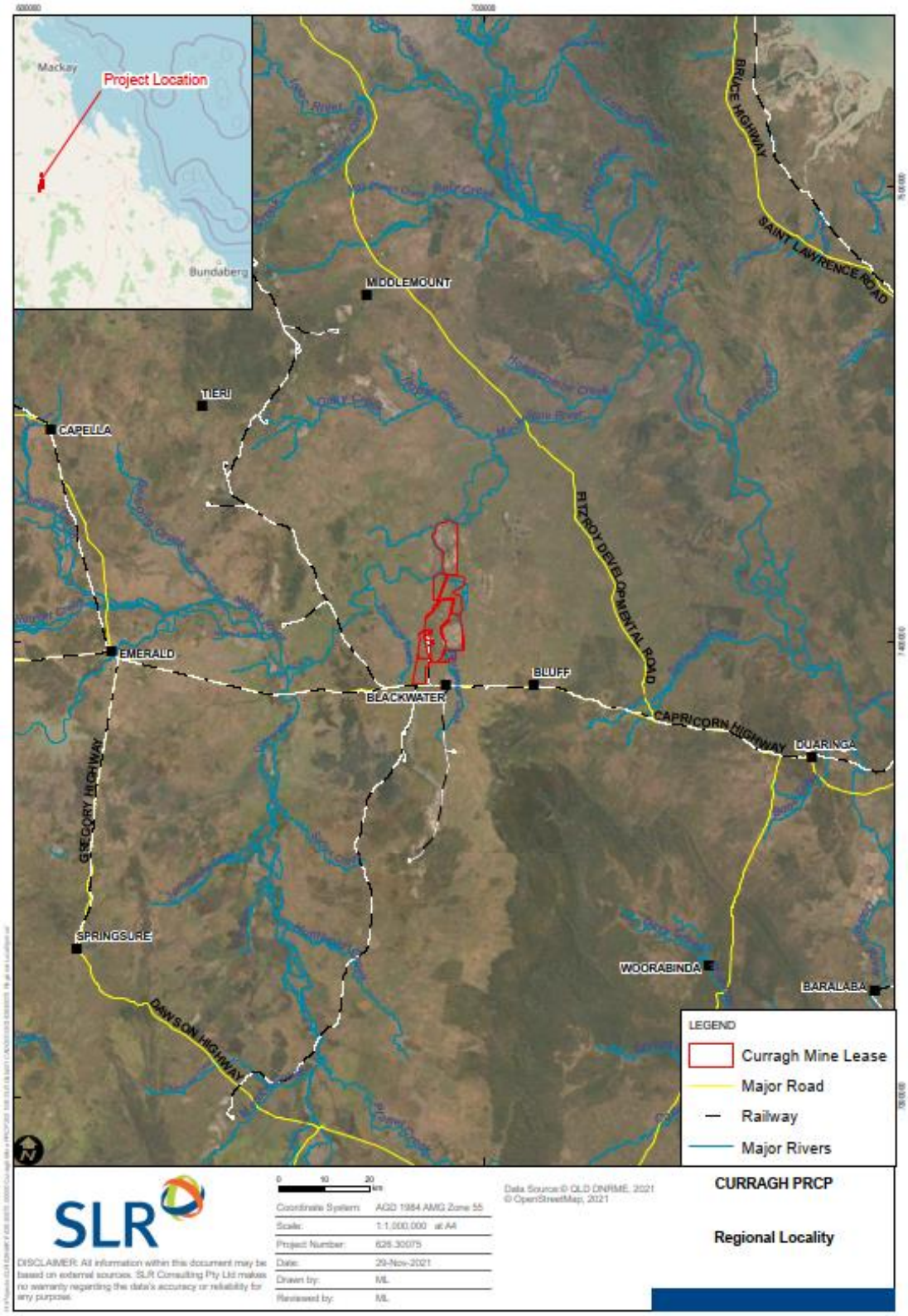


Figure 2-1 Regional Locality

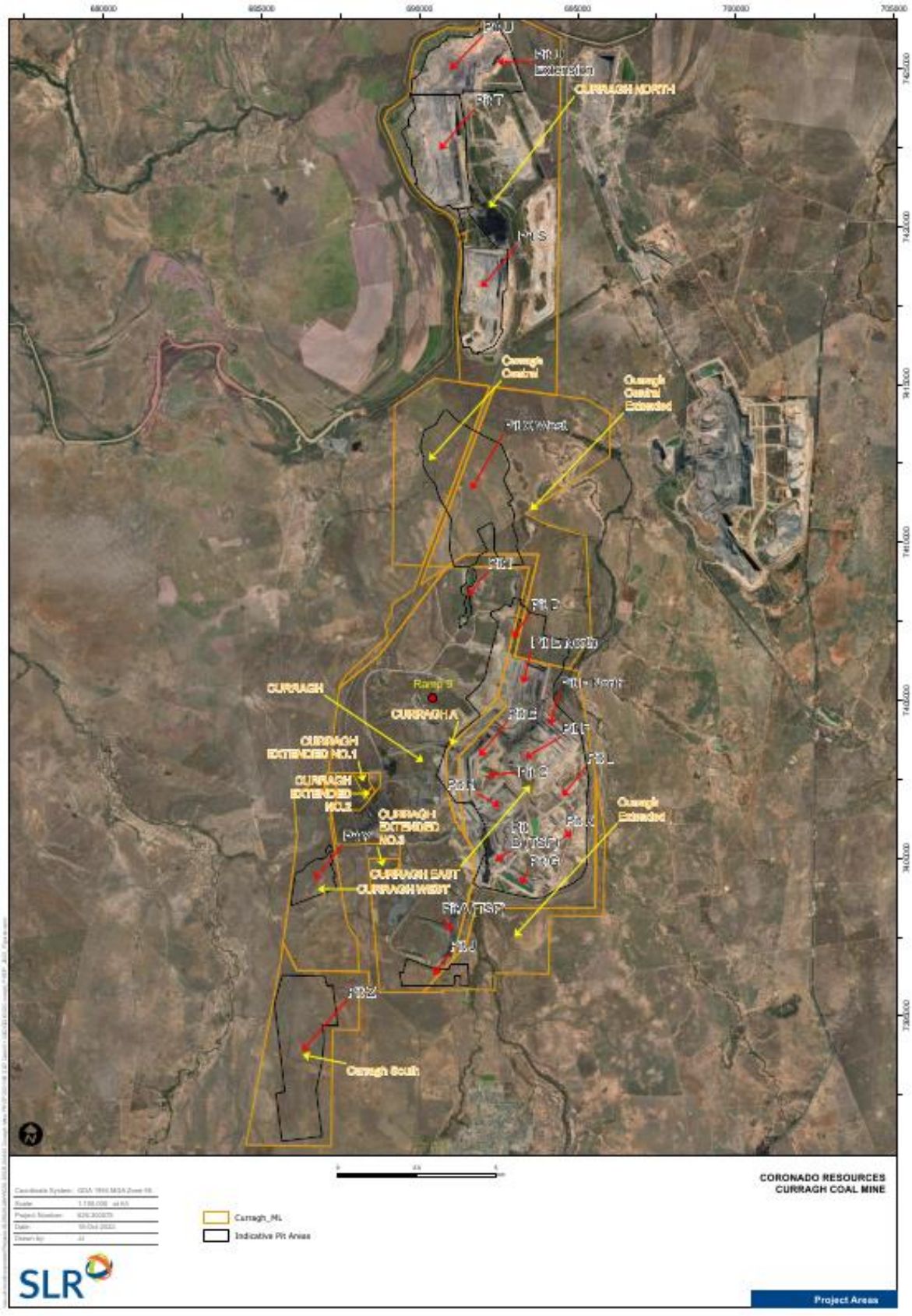


Figure 2-2 Curragh Complex Areas

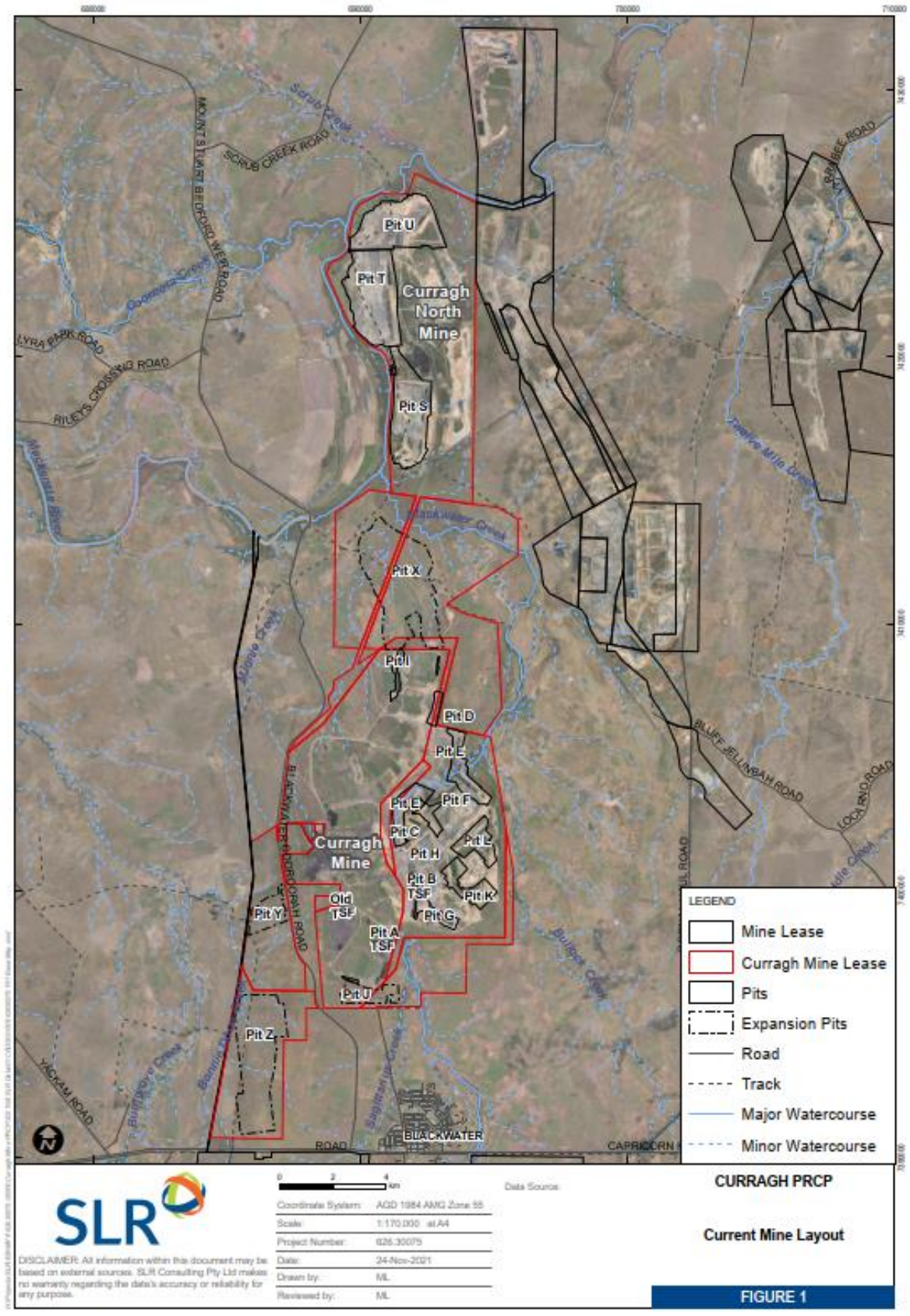


Figure 2-3 Curragh Existing and Proposed Pits

The mine infrastructure and activities on site include, but are not limited to:

- Exploration drilling;
- Clearing vegetation;
- Stripping and stockpiling of topsoil material;
- Explosives;
- Mining;
- Coal processing and stockpiling;
- Tailings and coarse reject disposal;
- Coal stockpiling, train loading and transport via conveyor and rail;
- Rehabilitation of disturbed land;
- Water management;
- Levees and regulated dam management;
- Blackwater Creek Diversion;
- Facilities and Infrastructure;
- Waste management;
- Sewage treatment;
- Mechanical workshops;
- Storage of fuels, oils and chemicals; and
- Village accommodation.

The activities are all undertaken within the relevant mining leases (MLs). The Curragh Complex includes 14 MLs the details of which are provided in **Table 2-1**.

Table 2-1 Mining Leases

Tenure	Project Area	Tenure Expiry	Tenure Area (ha)
ML1878	Curragh Main	31/05/2024	4,455
ML1990	Curragh Main	31/05/2023 (under renewal)	172.3
ML80010	Curragh Main – Extended No.1	31/05/2023 (under renewal)	24.18
ML80011	Curragh Main – Extended No. 2	31/05/2023 (under renewal)	6.14
ML80012	Curragh Main – Extended No. 3	31/05/2023 (under renewal)	42.57
ML80086	Curragh East	31/10/2025	3,026.19
ML80110	Curragh North	31/07/2044	4859.11
ML80112	Curragh Main – TL218070	30/09/2025	110.33
ML80123	Curragh North	31/07/2044	4.91
ML80171	Curragh West	31/07/2040	952.60
ML700006	Curragh South	30/06/2041	1431.98

Tenure	Project Area	Tenure Expiry	Tenure Area (ha)
ML700007	Curragh Central	30/06/2041	1123
ML700008	Curragh Central Extended	30/11/2040	2643
ML700009	Curragh Extended	30/11/2040	797.31

2.2 Baseline Information

2.2.1 Climate

The climate of the region is subtropical with the highest rainfall and evaporation occurring from October through till March (BoM, 2021). Historical climate data was obtained for the period January 1900 to September 2021 from the Scientific Information for Landowners (SILO) database (Queensland Government, 2021) for the location of the mine area (latitude -23.5, longitude 148.9). **Table 2-2** outlines the total monthly average rainfall (565 mm) and evaporation. The data shows that the total potential average annual evaporation (2,054 mm/yr.) is almost four times annual rainfall (565 mm/yr.). The high annual evaporation rates are strongly related to seasonal temperatures (

Figure 2-4).

Table 2-2 Total Monthly Rainfall and Evaporation (January 1900 to August 2021)

Average Total Monthly (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall	93	88	58	30	29	29	24	16	21	42	56	80	565
Evaporation	229	184	190	151	118	94	103	132	173	214	226	240	2,054

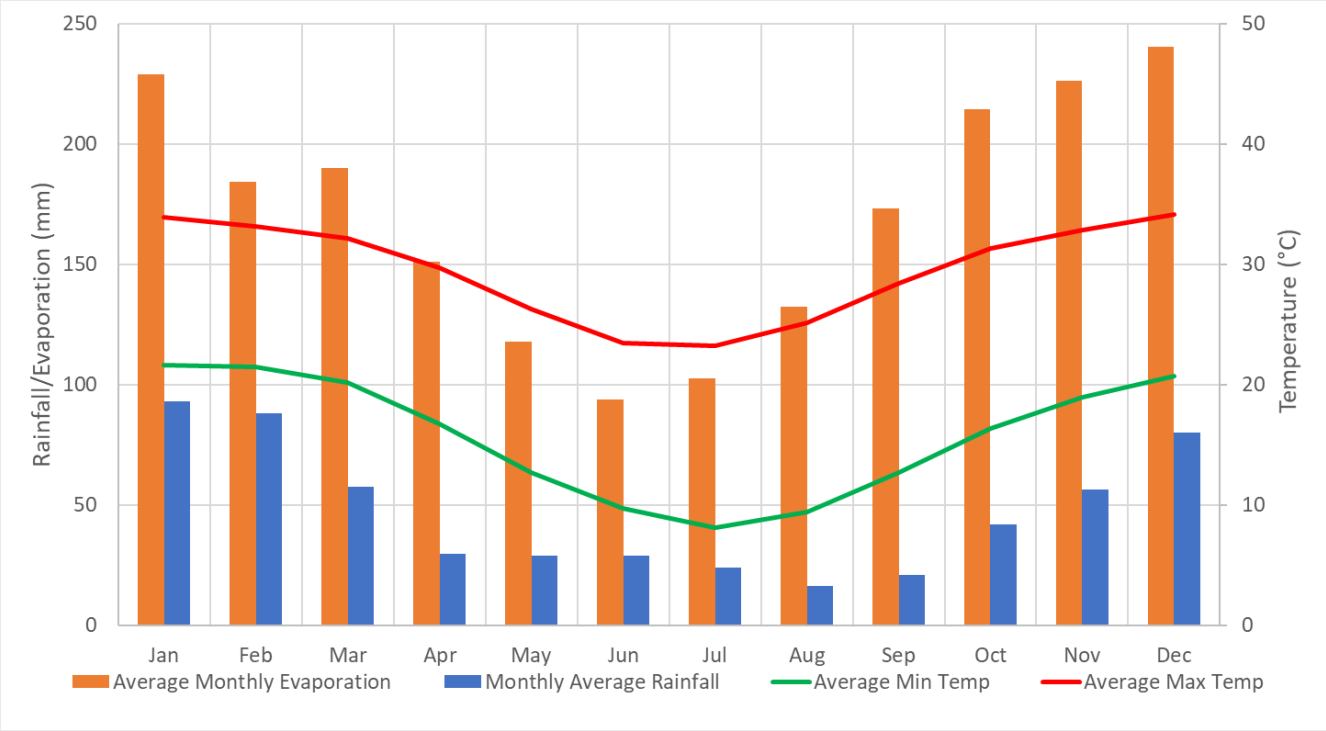


Figure 2-4 Average Monthly Evaporation, Rainfall and Temperature (January 1900 to August 2021)

In order to assess recent rainfall distribution in a historical context for water modelling purposes, the cumulative rainfall departure (CRD) was calculated for the data period 1900 to 2021 (**Figure 2-5**). The CRD is a summation of the difference between the actual monthly rainfall and the average monthly for the same period. A rising slope in the CRD indicates periods of rainfall above the long term average (e.g., 2010 to 2012), and a falling slope indicates periods when rainfall is below the long term average (e.g., 1999 to 2007). Rainfall volumes over more recent years of the record (2017 to 2021) have been lower than average, as is indicated by the falling slope in the CRD. Since the start of mining in 1983 the area has generally seen lower than average rainfall, except for the remainder of the 1980s and significant wet seasons in late 1998 and 2010/11.

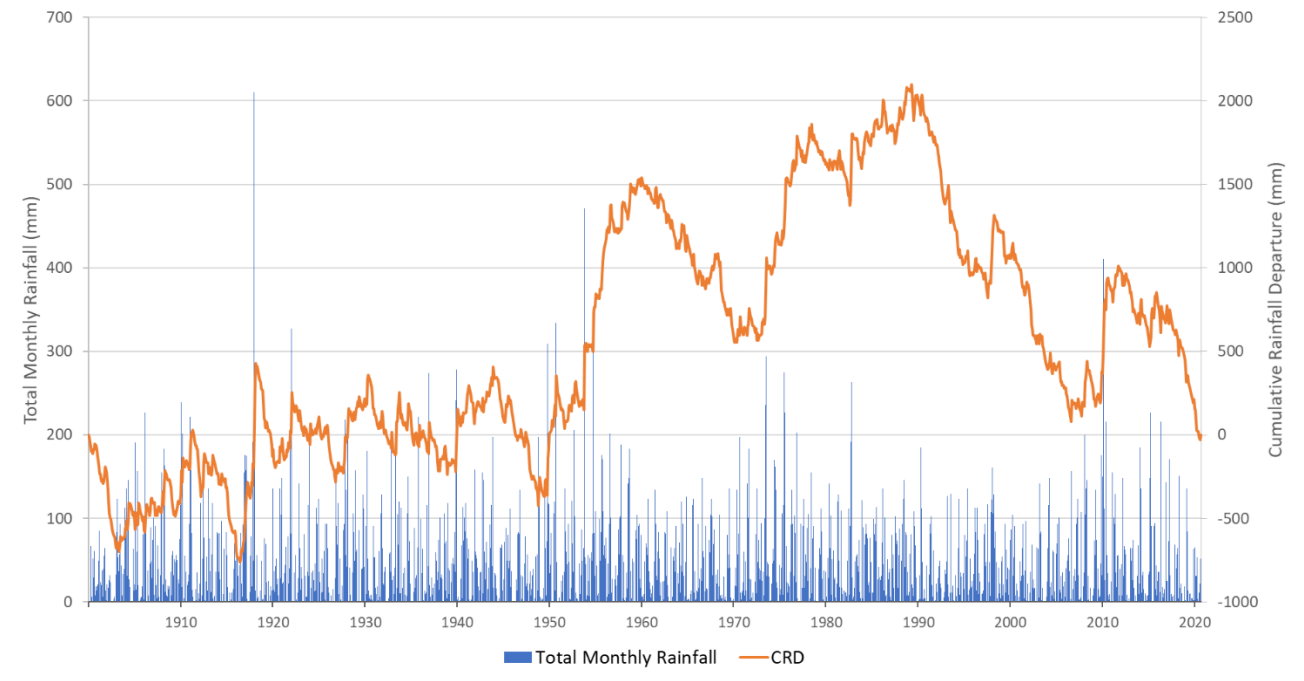


Figure 2-5 Cumulative Rainfall Departure and Total Monthly Rainfall (1900-2021)

2.2.2 Geography and Topography

The land surrounding the mine is typically gently undulating and comprises the floodplain of Mackenzie River. The topography of the area is dominated by the major drainage features (Mackenzie River and tributaries), creek lines, the open cut pits and spoil dumps of Curragh Mine and neighbouring mines.

Aside from the Township of Blackwater and the surrounding mines, the predominant land use is rural with large areas turned over to livestock grazing. Some areas of dryland cropping and minor irrigated cropping adjacent to Mackenzie River are also present.

2.2.3 Geology

The surface geology across the study area (based on the 1:100,000 mapping), is presented in **Figure 2-6** and the regional (solid) geology is presented in **Figure 2-7.**

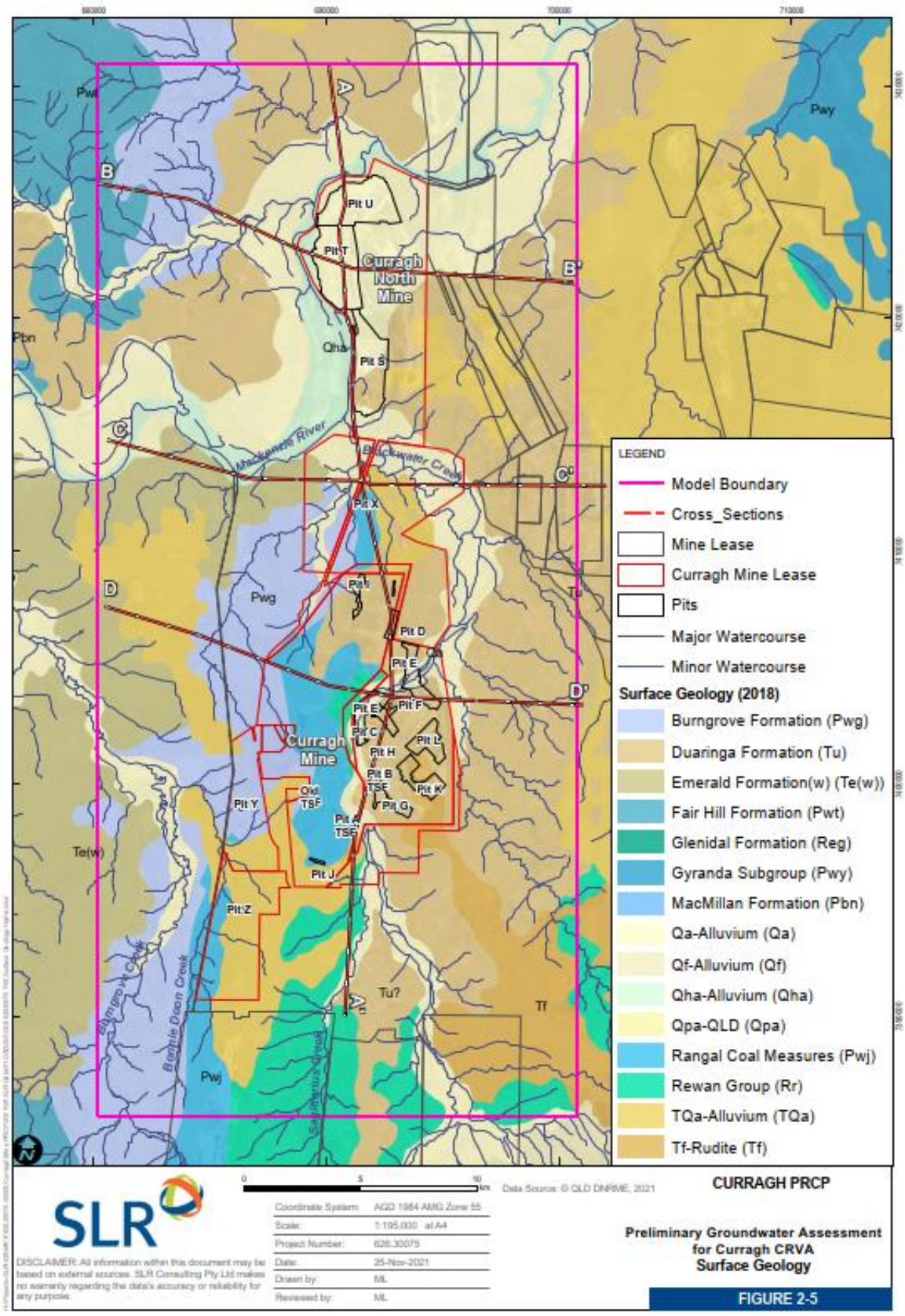


Figure 2-6 Surface Geology

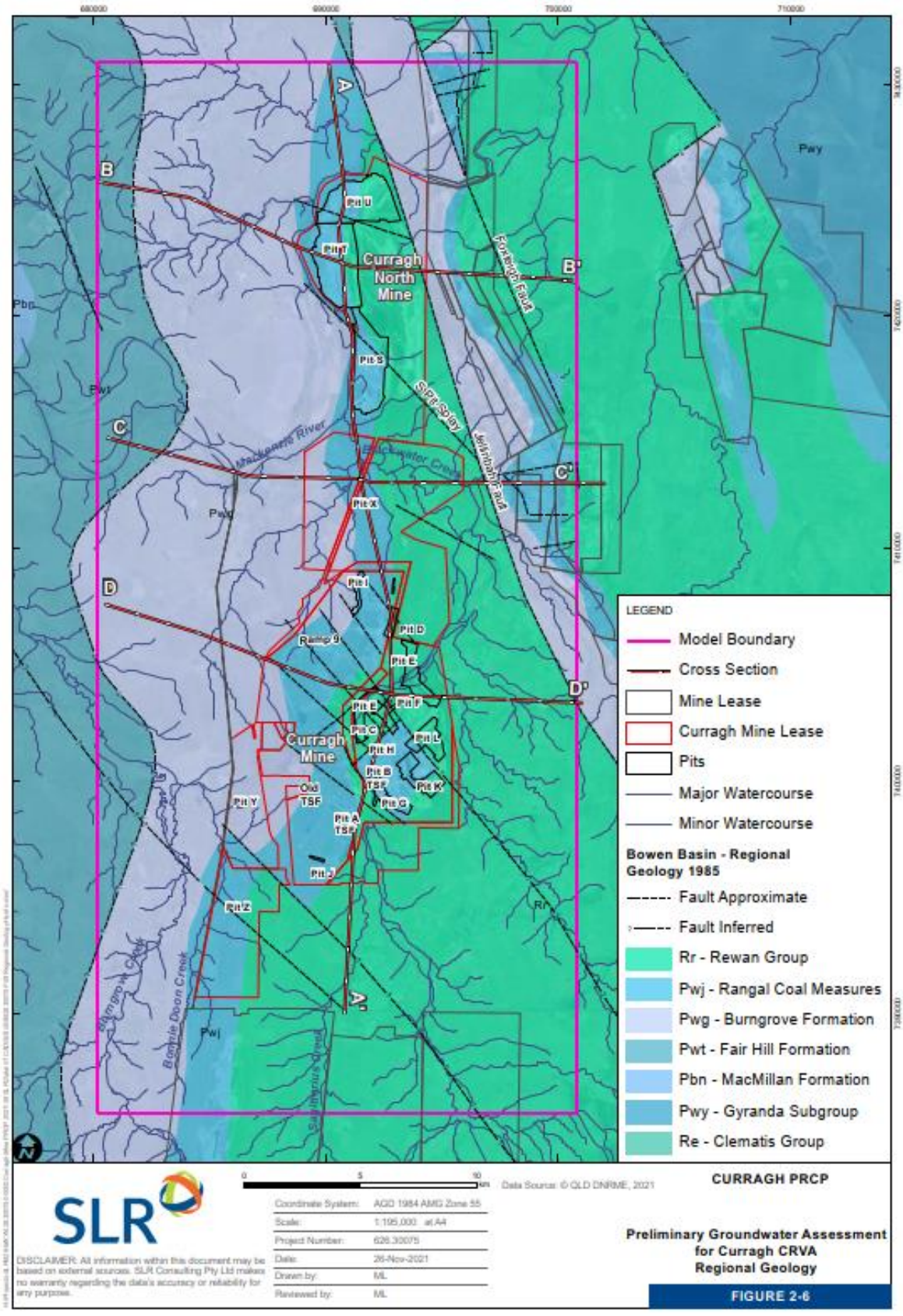


Figure 2-7 Regional Geology

The mine area is underlain by Permian to Quaternary sediments located within a gently folded and faulted sequence of the Bowen Basin. The Permo-Triassic sediments dip eastward and include the Triassic Rewan Formation and the underlying Permian Blackwater Group, which includes the Rangal Coal Measures, Burngrove Formation and Fair Hill Formation. The Permian strata are overlain by unconsolidated Quaternary alluvium associated with creeks, rivers and floodplains, and the poorly consolidated Tertiary sediments of the Duaringa and Emerald formations. The Back Creek Group underlies the Blackwater Group and forms the basement of the area.

The stratigraphic sequence underlying the study area is presented in **Table 2-3** and summarised below.

Table 2-3 Regional Stratigraphy

Age	Group	Stratigraphic Unit	Description
Quaternary		Alluvium	Soils, unconsolidated silts, sands, gravels, and clays,
Cenozoic (Tertiary)		Duaringa Formation/ Emerald Formation	Claystone, siltstone, sandstone, conglomerate (often poorly consolidated), lignite, basalt
Triassic	Mimosa	Rewan Formation	Mudstone, interbeds of lithic sandstone.
Upper Permian	Blackwater Group	Rangal Coal Measures	Coal seams calcareous sandstone, calcareous shale, mudstone, calcareous tuff in places. Main coal seams include Aries, Castor, Pollux, Orion, Pisces.
		Burngrove Formation	Siltstone, carbonaceous shales and mudstone, fine lithic sandstone, calcareous lithic and feldspathic sandstone, tuffaceous shales, and thin coal seams.
		Fair Hill Formation	Lithic and feldspathic labile sandstone, quartzose sublabile sandstone, siltstone, mudstone, calcareous and tuffaceous sandstone, volcanic conglomerate, carbonaceous mudstone, coal
Permian	Back Creek Group	Macmillan Formation	Interbedded mudstone and sandstone, prominent dark grey basal unit.

Quaternary and Tertiary alluvium

Alluvium associated with the main watercourses of the Mackenzie River and Blackwater Creek (and their tributaries) is present across much of the extension areas and Curragh North.

In the proposed Pit X area, exploration drilling indicates the alluvium is typically less than 12m thick and predominantly comprised of clay with occasional channel sand and gravel lenses at depth. Alluvium in the vicinity of proposed Pit J and Pit Z is generally thin (typically 2m but up to 4m) and comprised of clay and silt. Alluvium occurs in the southeast corner of proposed Pit D extension and is typically less than 2m (and up to 10m) and comprised of clay and sand (WSP 2016).

Floodplain alluvium associated with the Mackenzie River occurs extensively at Curragh North and exhibits an overall fining upwards sequence and significant lateral variability with an average thickness of 18 - 20m. Drilling data indicates the alluvium may be up to 35 m thick and the base of the alluvium is deepest close to the Mackenzie River (WSP 2016).

Cenozoic sediments

The Duaringa Formation is present in the proposed Pit X and Pit D extension areas and outcrop extensively in the north, east and south of the study area. In the north of the study area the Cenozoic sediments have been eroded by the Mackenzie River. The Emerald Formation is present in the western section of the proposed Pit X area and outcrop in the west of the study area (WSP 2016).

The Cenozoic sediments consists of interbedded stiff to hard clayey sands, gravels and thick beds of ferruginous clays of medium to high plasticity. They are fluvial and colluvial in origin and partially consolidated. The sequence unconformably overlies Permian coal measures with an indistinct boundary due to the clay rich and ferruginous composition of both horizons caused by in-situ weathering (WSP 2016).

Triassic sediments

The Rewan Formation overlies the Rangal Coal Measures and outcrops / subcrops directly east of the mined areas. It typically comprises thinly interbedded mudstones, lithic sandstones and siltstones. Drilling in the Minyango mine area recorded Rewan Formation up to 350m thick with a depth of weathering between 30 and 70 m (WSP 2016).

Permian sediments

The Permian Rangal Coal Measure (RCM) is the uppermost sequence in the Blackwater Group and comprises predominantly fine grained to occasionally medium grained lithic sandstone, siltstone, mudstone, carbonaceous mudstone and coal.

The RCM contains seams of high quality PCI coal, high quality medium-to-low ash coals suitable for prime coking coal, anthracite and semi-anthracite, and high energy thermal coals. The Cancer, Aries, Castor, Pollux, Orion and Pisces seams within the RCM are mined at Curragh. The strata generally dip to the east at less than 3°, with dips increasing locally in fault zones. The Rangal Coal Measures outcrop / subcrop in Curragh North and Curragh Main areas. The Rangal Coal Measures also subcrop east (the upthrow side) of the Jellinbah Fault where they are extracted at Jellinbah Mine (WSP 2016).

The boundary between the Burngrove Formation and the overlying RCM is the Yarrabee Tuff Bed, a distinctive marker horizon. The tuff lies between the target Pisces seam in the RCM and the Pisces Lower seam. The upper part of the Burngrove Formation (below the Yarrabee Tuff Bed and Pisces Lower seam), comprise dark grey to grey mudstones grading to siltstones. The Burngrove Formation outcrops/subcrops in the proposed Pit X, Y and Z locations and to the west of Curragh Mine (WSP 2016).

The Fair Hill Formation underlies the Burngrove Formation and outcrops/subcrops to the west of the mine. The formation comprises lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff and tuffaceous mudstone and includes the Fort Cooper Coal Measures.

The upper Permian sediments are weathered. The depth of weathering in the study area is approximately 14 metres below ground level (mbgl), except where Quaternary erosion and deposition has resulted in the replacement of Permian sediments by Quaternary alluvium. Where this occurs deeper weathering up to 35 mbgl is observed (WSP 2016).

2.2.4 Soils

A soil study by Land Reclamation Services (1990) identified seven soil mapping units in the Curragh mine area. **Table 2-4** gives a brief description of the soil units described by Land Reclamation Services and outlines the soils suitability for rehabilitation. Care should be taken when using the table as 'there is considerable variation within these mapping units'.

Table 2-4 Soil Mapping Units at Curragh Complex

Soil Unit	Brief Description of Suitability for Rehabilitation
Red brown melonhole clays	Top 10 cm chemically suitable for rehabilitation Lower horizons are dispersive and have high chloride concentration Melonhole relief makes striping top layer without contamination from lower horizons impossible Therefore this soil is not suitable for rehabilitation
Red brown non- cracking clays	Top 20cm are suitable for rehabilitation Lower horizons are dispersive and have moderate chloride concentrations Topsoil should be carefully stripped to 20 cm
Grey-brown cracking clays	High chloride concentrations throughout the profile All horizons are potentially dispersive Recommended that this soil is not used in rehabilitation
Grey-brown cracking clays over calcareous material	Well-structured cracking clay with low chlorides and dispersity to at least 60 cm Soil should be stripped to 60 cm depth 0–30 cm should be stockpiled separately to 30-60 cm
Red brown cracking clays – acid sub soil	Only the top 20 cm is chemically suitable for rehabilitation
Mixed clays and texture contrast soils	Only the top 15 cm is suitable for rehabilitation Lower horizons consist of impervious clays which are dispersive
Red texture contrast soils	Only the A horizon should be used for rehabilitation as the lower clays are impervious and dispersive Therefore only the top 15 cm should be stripped and stockpiled for rehabilitation

Curragh East

Additional mapping of the Curragh East Project Area was completed by Environment Health and Safety Systems (1998). Soil samples were taken from 17 sites and soils were described in sufficient detail to classify into mapping units (**Table 2-5** and **Figure 2-8**). In general, the report shows that:

- Soil sample analyses show that the soils of the mine area are poorly to moderately fertile;
- Soils are potassium and nitrogen deficient;
- Soils are calcium and magnesium moderately deficient; and
- Sodicity of soils is low although deeper layers may prove more problematic.

Table 2-5 Curragh Main Soils

Soil Type	Description of Soils
Variable Texture Contrast Soils	• Occur on the eastern and north-eastern part of the Curragh East area and are characterised by coarse textured sandy clay loams to sandy clay over-lying coarsely structured alkaline clay subsoil. • The soils are associated with the ridge running north/south over the Curragh East area and support a range of vegetation from tall Poplar Box forest to short mixed forest.
Cracking Clays over Alluvial Parent Material	• This mapping unit is associated with the undisturbed section of the Blackwater Creek streambed. This cracking heavy clay forms a deep layer over an alluvial parent material, the dark brown to grey soil has a coarse blocky structure and ranges from acid to neutral in the upper 0.5 metres to strongly alkaline below this depth.

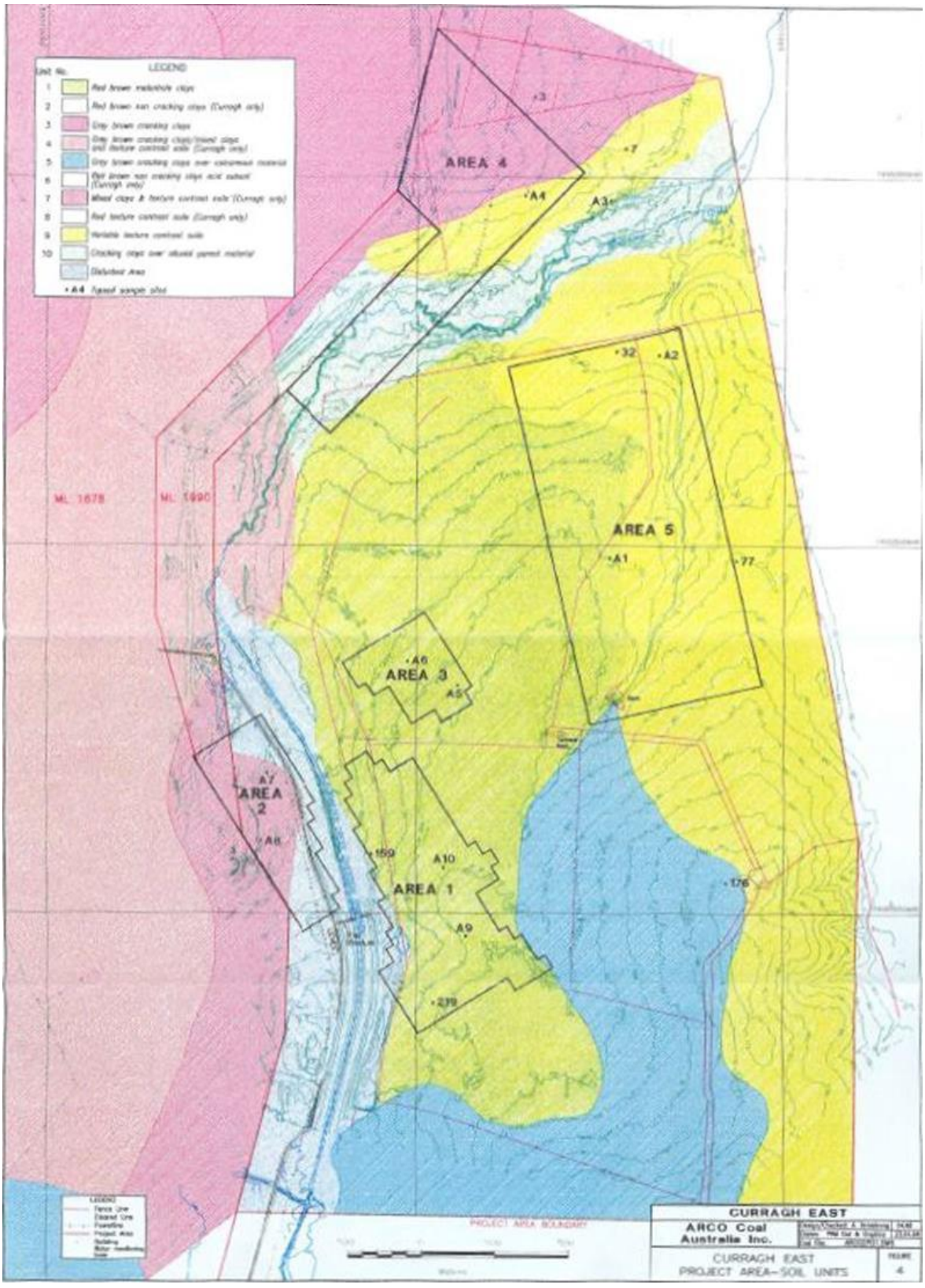


Figure 2-8 Curragh East Soil Types

Three primary soil types were identified using the diagnostic criteria of the *Australian Soil Classification* (Isbell, 1996). The three soil types were allocated into a corresponding Agricultural Management Units (AMU) relevant to the Dawson/Callide District within the Land Management Manual. General trends included:

- Increased clay content in the northern section of the mine Area and progressively decreased in the south;
- Increased CEC within the north section of the mine Area which decreases as the clay content decreases;
- Increased sodicity within the southern section of the mine Area; and
- Decreased effective depth towards the southern section of the mine Area.

Soil Classification

Australian Classification	Agricultural Management Unit	Physical Property Summary	Chemical Property Summary
Black Vertosol	Dee	Black to brownish black self mulching heavy clay. Structure changing with depth from gradual to medium blocky. Effective depth typically beyond 1m.	Alkaline (pH min 6.5, max 8.6, avg 7.8), non-sodic (ESP % min 1.0, max 9.7, avg 3.9) non-saline (EC µS/cm min 34, max 261, avg 130). High CEC (meq/100g min 14.8, max 71.3, avg 38.9).
Black or Brown Chromosol	Callide	Light clay to clay loam A horizon graduating to medium to heavy clay subsoil. Effective depth typically beyond 1m.	Neutral to slightly alkaline (pH min 6.3, max 8.9, avg 7.4), non-sodic (ESP % min 0.4, max 9.75, avg 3.9), non-saline (EC µS/cm min 33, max 353, avg 98) Moderate to high CEC (meq/100g Min 11.3, Max 91, Avg 27.1).
Sodosol	Oombabeer	Sandy clay to clay loam A horizon graduating to medium clay subsoil. Duplex soils. Alluvial influence apparent. Effective depth typically 0.6m to 1.0m.	Neutral to slightly alkaline (pH3 min 6.4, max 8.4, avg 7.2), sodic (ESP % min 2.9, max 18.5, avg 10.3), non-saline (EC µS/cm min 11, max 81, avg 43.5) very low to low CEC (meq/100g min 3, max 12.6, avg 6.9).

Figure 2-9 Soil Classifications at Curragh Mine following the Australian Soil Classification and Agricultural Management Units relevant to Dawson/Callide District Land Management Manual

Curragh North

In 2003, a soil survey of the Curragh North Project (ML80110 and ML 80123) site was conducted by Australasian Resource Consultants Pty Ltd as part of a study of the existing environment for the Curragh North project. The results of this survey included the results of soil sampling undertaken in 1996, 1998 and 2003. In total, 61 samples were collected in these previous sampling episodes. Based on field and laboratory assessment, the soil

types identified at Curragh North have been mapped into 4 different mapping units (**Table 2-6** and **Figure 2-10**).

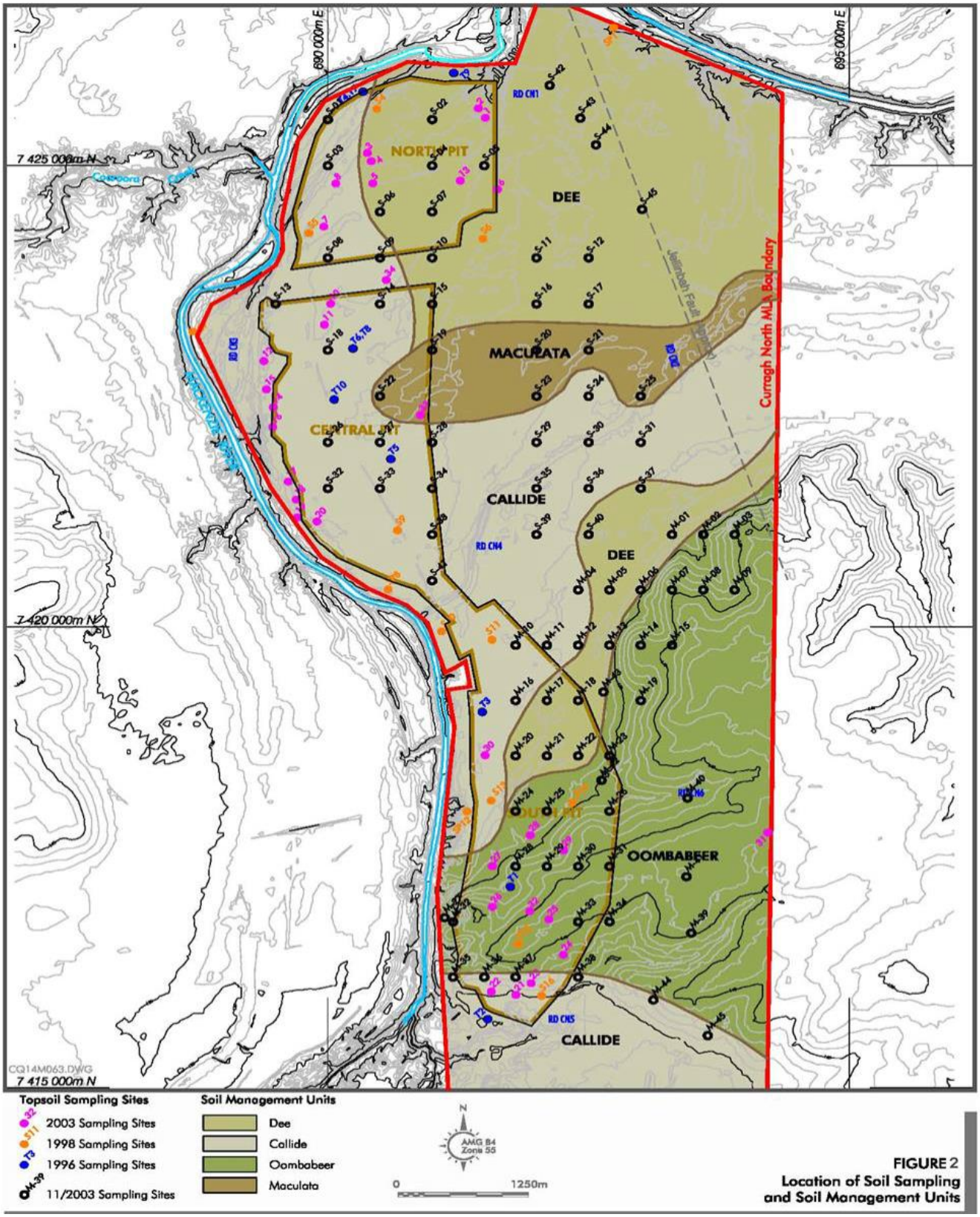


FIGURE 2
Location of Soil Sampling and Soil Management Units

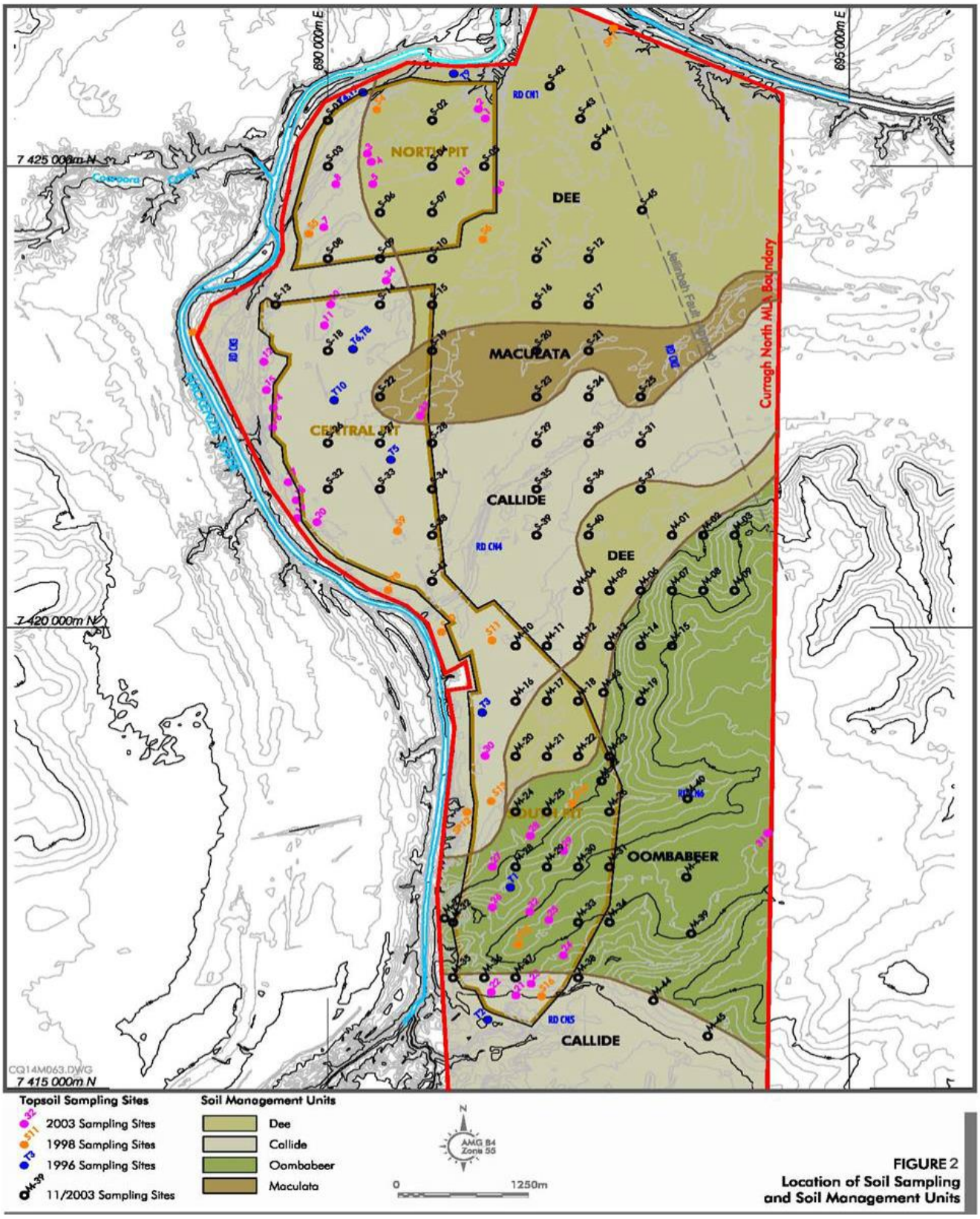


Figure 2-10 Curragh North Soil Management Units

Table 2-6 Curragh North Soil Types

Soil Type	Soil Description
Soil Type 1	• Grey to reddish brown self-mulching clays with a moderate to strong pedal structure with some calcareous inclusions. • The majority of this area has been cleared for low intensity grazing on improved pastures. The topography is of low relief with slopes tending to be less than 2%. This soil type constitutes the Dee soil management unit. • Structure changes with depth to become massive typically at a depth of approximately 30cm. The soil is alkaline to strongly alkaline, non-saline, of low sodicity and a high cation exchange capacity. Calcareous inclusions occur at depths below approximately 30cm.
Soil Type 2	• Light clay to clay loam A horizon (grey to dark reddish brown) graduating to medium to heavy clay subsoil. Moderately pedal structure is typical throughout the profile. • The area has previously been cleared for low intensity grazing. The topography is generally of low relief with slopes tending to be less than 2%. • The area is characterised by grey to dark clay loam to light clay with occasional cracking. The surface is firm and is typically moderately pedal. Peds are less than 20 mm in size. The A horizon is approximately 30 cm in depth, below which a sharp texture and colour change of the lower horizon can be found. Colour becomes darker and texture increases to medium to heavy clays. • The soil is typically slightly acid to neutral with pH increasing with depth. The soils are non-sodic and are of moderate to high cation exchange capacity. This soil constitutes the Callide soil management unit.
Soil Type 3	• Loamy sand to clay loam A horizon (dark reddish grey to black) underlain by sandy loam to silty clay loam horizons. Structure is typically moderate to strongly pedal and polyhedral in nature. • Native vegetation has been cleared from this soil type for low intensity cattle grazing. The topography is of low relief with slopes of less than 2% common. • This soil is typified by loamy sand to clay loam a horizon of approximately 20 cm in depth. The A horizon is dark reddish grey to black in colour. Underlying the A horizon is a sandy loam to silty clay loam horizon which is darker in colour than the A horizon. The boundary between horizons is clear in nature. A polyhedral structure of moderate to strong pedality occurs throughout the profile. • pH of the A horizon is neutral to slightly alkaline, with the pH becoming more alkaline with depth. These soils are non-saline in nature and are of moderate fertility (CEC). This soil constitutes the Maculata soil management unit.
Soil Type 4	• Light yellowish brown to reddish black loamy sand to sandy loam A horizon of weak to moderate pedality overlying loamy sand to silty loam horizons. • Soil type 4 has been cleared of native vegetation for low intensity cattle grazing. Occurring on the upper ridges and steeper slopes of the proposed mining lease area, this soil type is found on gently to moderately inclined relief. • A loamy sand to sandy loam A horizon typifies this soil type. This horizon is generally light yellowish brown to reddish black in colour. The A horizon is of weak to moderate pedality. Underlying the A horizon is a horizon of slightly higher clay content (loamy sand to silty loam). The underlying horizon is also darker in colour and is only weakly pedal or a pedal (granular) in structure. The boundary between these horizons is abrupt. • These soils are slightly acid to slightly alkaline in the A horizon, with alkalinity increasing with depth. These soils are slightly to moderately sodic in the surface horizon with exchangeable sodium percent generally increasing with depth. Excessive salinity does not occur in these soils. This soil is one of the three soil types which constitute the Oombabeer soil management unit.
Soil Type 5	• Brown/dark brown A horizon of light clay with strong polyhedral pedality overlying a pale yellow massive B horizon.

Soil Type	Soil Description
	• This soil type occurs in a portion of the mining lease adjacent to the Mackenzie River on which native woodland is established. Cattle frequently graze this area. This soil type occurs on slopes with a slope of less than 2%. • The A horizon of this soil consists of a brown/dark brown light clay with strong polyhedral (< 20mm) pedality. A pale yellow massive B horizon underlies the A horizon. The boundary between horizons is gradual. • These soils are moderately alkaline in the A horizon, with alkalinity increasing with depth. This soil type is also non-sodic in nature and is of moderate fertility. Salinity is not a limitation to plant growth on this soil. This soil is one of the three soil types which constitutes the Oombabeer soil management unit.
Soil Type 6	• Weak red to dark reddish grey A horizon of loamy sand to clayey sand texture overlying a weak red to pinkish grey B horizon with a single grain apedal structure. Each of these soil types is described below. • This soil type has been cleared for low intensity cattle grazing. Improved pastures are found on this soil type. This soil type occurs on low relief with slopes tending to less than2%. • A weak red to dark reddish grey loamy sand to clayey sand constitutes the A horizon of this soil. This horizon is characterised by a weak pedal structure with peds less than 10 mm. The underlying horizon is a weak red to pinkish grey loamy sand with granular apedal structure. A gradual boundary separates the horizons. • This soil is neutral to moderately alkaline with pH increasing with depth. The soil is also non-sodic, non-saline and of low cation exchange capacity (fertility). This soil is one of the three soil types which constitute the Oombabeer soil management unit.

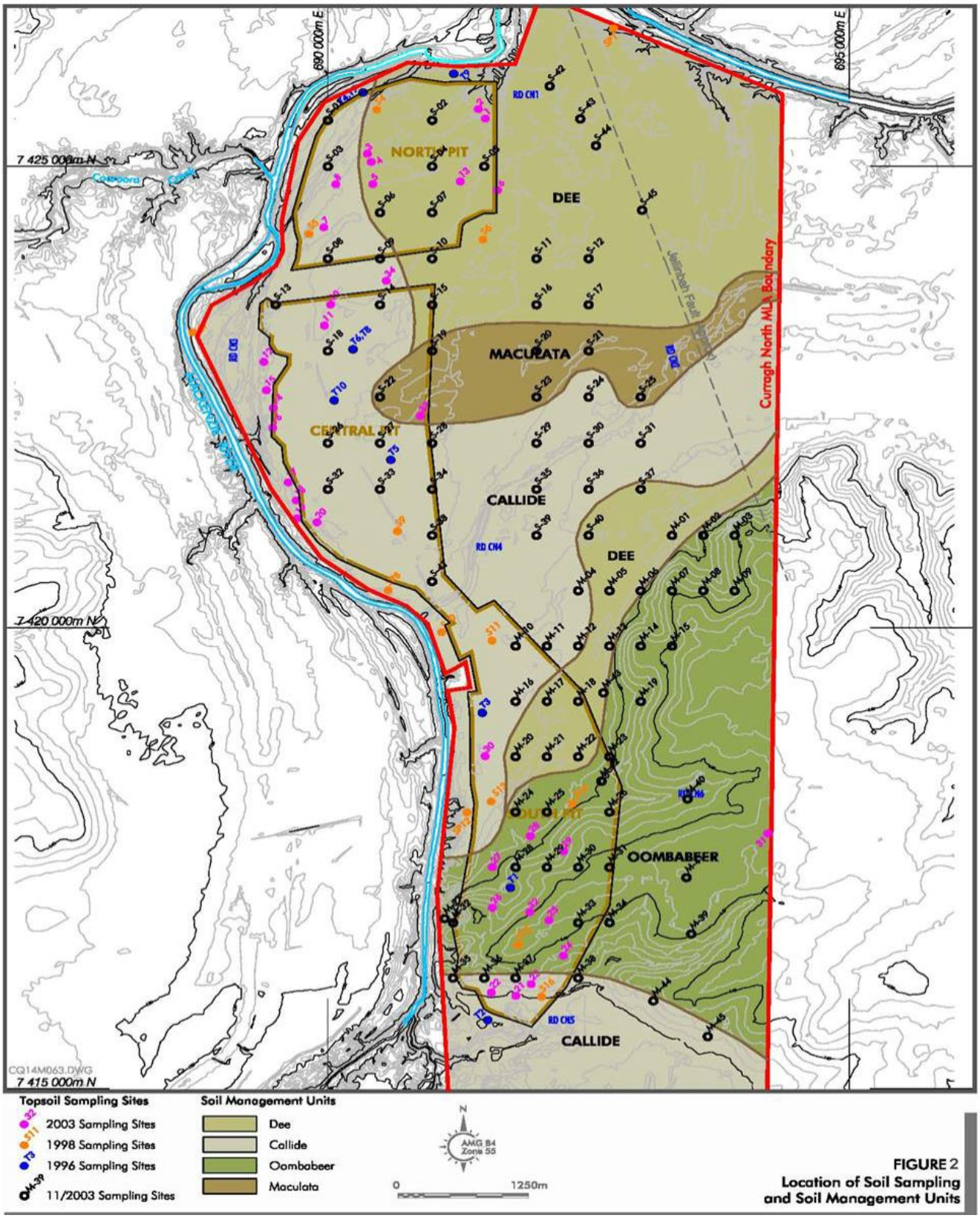


Figure 2-11 Curragh North Soil Types

Curragh West

Existing soils data for Curragh West (ML 80171) is limited to broad-scale mapping based on aerial photo interpretation and limited regional scale fieldwork. A soil investigation was conducted to determine soil types and a summary included in the 2011 Environmental Management Plan prepared by Parsons Brinckerhoff. Selected soil samples were tested to assess their acidity, salinity, dispersion potential, and nutrient content. The results were used to aid classification of individual soil types and to assess reuse potential of soils for future rehabilitation purposes.

Based on the investigation, three soil units were identified within Curragh West. The distribution of soil units is closely related to the topography and geomorphology of Curragh West. Abrupt boundaries between soil types generally do not occur. The three soil types are Grey duplex soils, Grey-brown uniform clays, and Red-brown uniform clays.

Alkaline and sodic soils are generally dispersive and have high erosion potential if exposed. Sodic, alkaline soils are also poor plant growth mediums due to low nutrient availability and should not be used as such in rehabilitation of disturbed areas. The topsoil portion of all encountered soils are considered suitable for use in rehabilitation however, all soils have some limitations. Subsoils of the Grey-brown duplex and Red-brown uniform clays are considered to be highly sodic and moderately to strongly alkaline. Subsoils of these soil units should not be used as topsoil for any rehabilitated areas. All soils (and overburden) that is alkaline or sodic should be buried below non-dispersive and non-hostile material.

All soils are subject to erosion if vegetation is removed, and rehabilitation is not undertaken within an appropriate timeframe. Soils most susceptible to wind erosion are the Grey-brown duplex soils which have loamy topsoils.

The main erosion potential for the mine relates to water-induced erosion, in the form of sheet flow and channelised flow. All disturbed sites will be susceptible to water erosion, regardless of slope gradient and whether the mines comprise natural or created terrain. Soils most susceptible to erosion by flowing water are the Grey-brown duplex soils and the Red-brown uniform clays, which have dispersive (sodic) topsoil or upper subsoil.

Curragh Extension Project

Soil data for the Curragh Extension Project (ML700006, ML700007, ML700008 and ML700009) was commissioned by WSP in 2015 by SLR Consulting Australia. Within the Study Area, one soil mapping unit (Soil Map Unit 1) was identified that contained three soil types (**Figure 2-12**):

- Self-mulching Brown Vertosol (dominant);
- Self-mulching Black Vertosol (sub-dominant) and
- Eutrophic Brown Dermosol (sub-dominant).

The Self-mulching Brown Vertosol is characterised by silty clay grading to heavy clay or uniform clay throughout the profile. This soil type is generally alkaline throughout the profile and exhibits increasing concentrations of chloride with depth, reaching extreme soil salinity levels. The profiles are generally non-sodic in the topsoil and marginally strongly sodic in the subsoil.

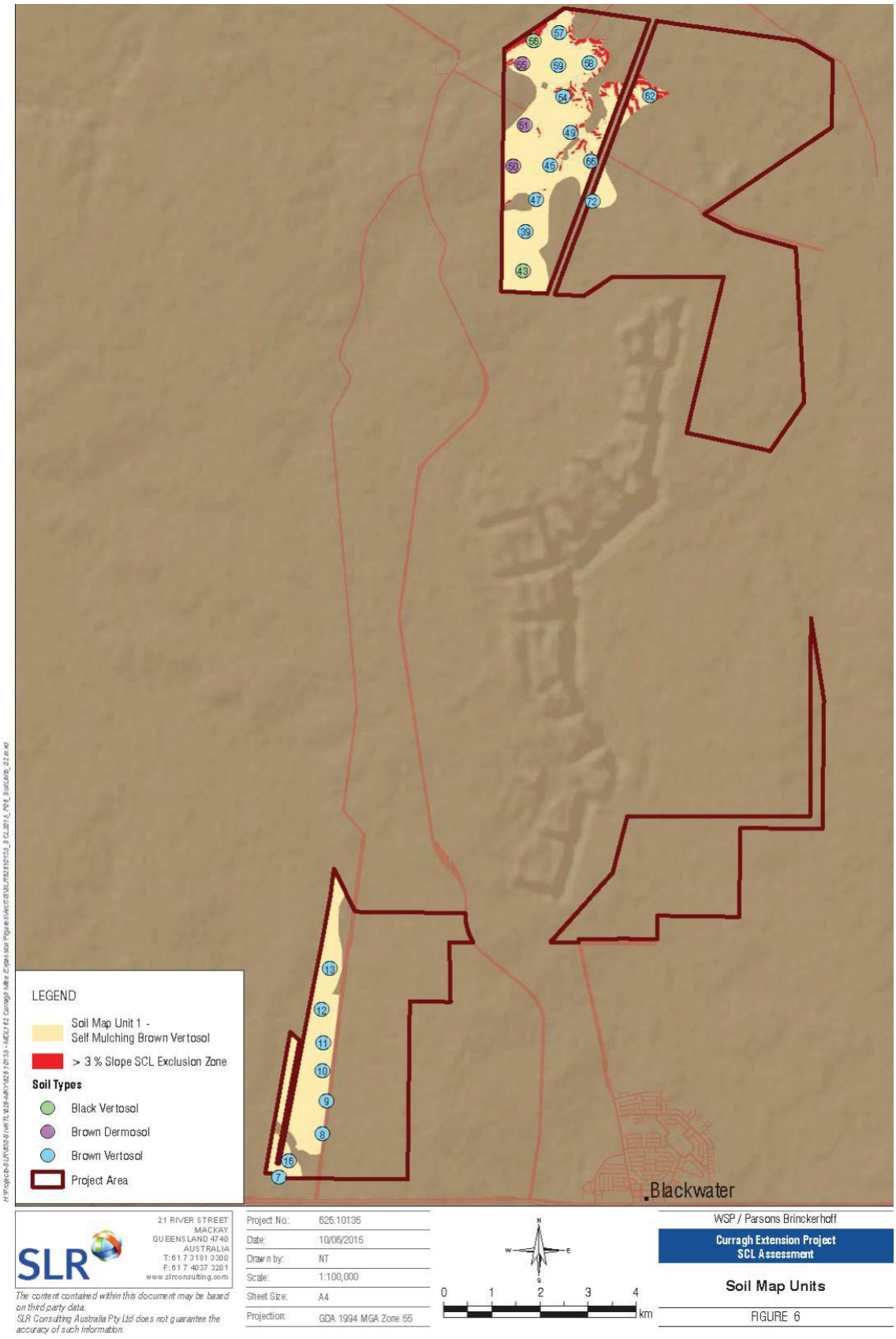


Figure 2-12 Curragh Extension Soil Management Units

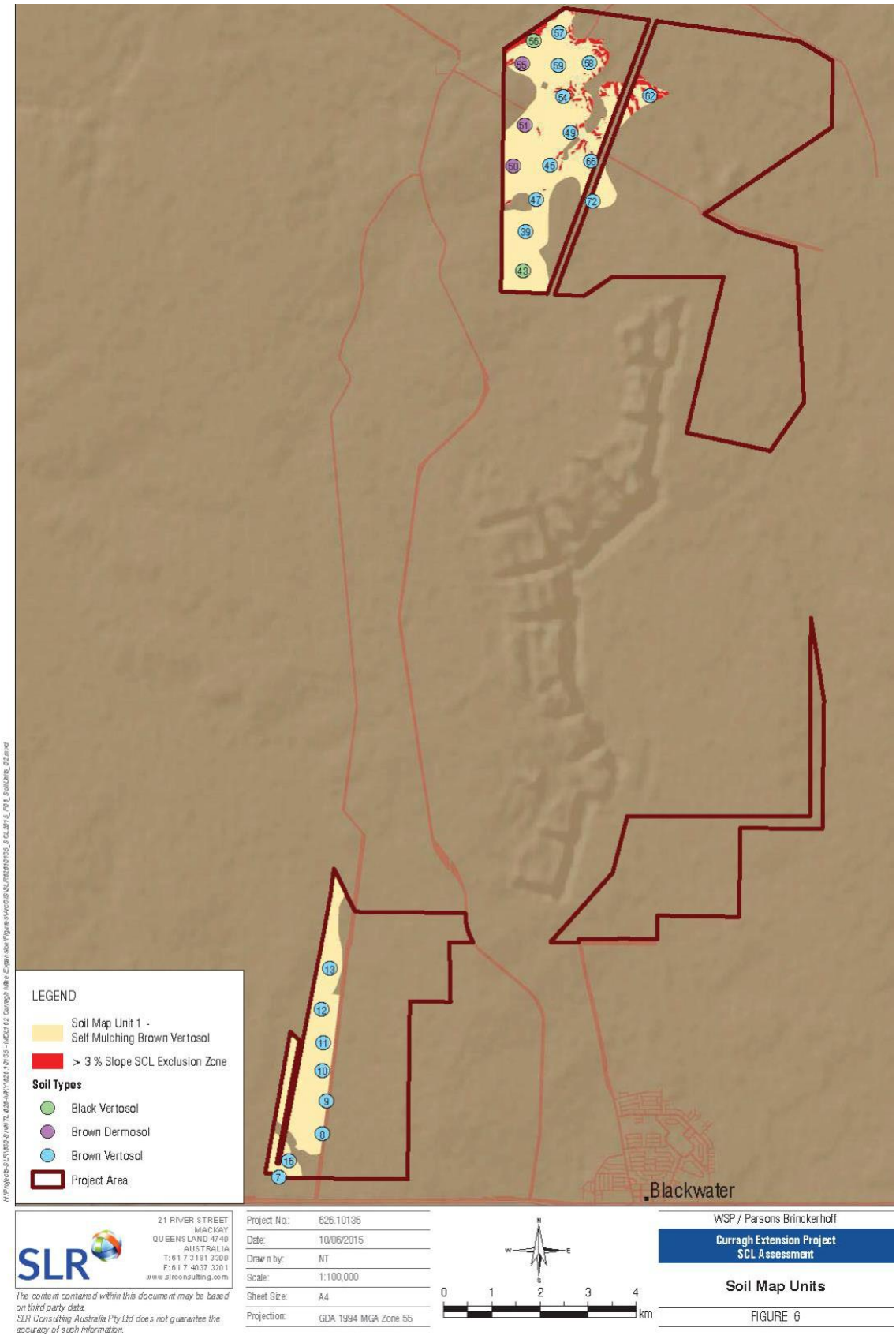


Figure 2-13 Curragh Extension Soil Types

2.2.5 Land Suitability and Capability

A land suitability assessment was undertaken within the Curragh North EIS. The assessment included considerations of land use characteristics, land quality attributes and how these match conditions necessary for successful and sustained land utilisation types.

A summary of the land suitability classes for the mine area is presented below (Curragh North EIS, 2003).

Table 2-7 Land Suitability Classes present at Curragh North Mine

Suitability for Cropping	Suitability for Grazing	Percentage of Project Area
2	1	3.0
3	2	68.6
4	3	28.4

The post mining land capability classes were assessed as the below:

Table 2-8 Post Mining Land Capability Classes at Curragh Mine (Coronado Curragh, 2021)

Class	Description	Hectares
IV	Land primarily used for pastoral uses but can be carefully cropped occasionally	89
VII	Land not suitable for cultivation and only careful pastoral use possible	1,823
VIII	Land not suitable for agricultural or grazing uses	10,789

2.2.6 Ecology

2.2.6.1 Terrestrial Flora

The Vegetation Management Supporting Map (DRNME, 2019) indicates that the study area contains five (5) remnant vegetation communities, outlined below in **Table 2-9**. These communities are mapped to occur as isolated mixed vegetation community polygons, characterised as Regional Ecosystems (RE), with the surrounding area dominated by non-remnant vegetation. Field Studies in 2003 identified two (2) further RE communities listed under the Queensland *Vegetation Management Act 1999*. Therefore, there are seven (7) RE's present within the Curragh Complex Area.

Table 2-9 Regional Ecosystem Classes present at Curragh Mine

RE Code	VM Act Status	Biodiversity status	REDD Short Description
RE 11.3.1	Endangered	Endangered	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains
RE 11.4.8	Endangered	Endangered	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains
RE 11.4.9	Endangered	Endangered	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains
RE 11.4.7 (field mapped)	Endangered	Endangered	*Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on Cainozoic clay plains

RE Code	VM Act Status	Biodiversity status	REDD Short Description
RE 11.3.3	Of Concern	Of Concern	*Eucalyptus coolabah* woodland on alluvial plains
RE 11.3.25	Least Concern	Of Concern	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines
RE 11.7.1 (field mapped)	Least Concern	Of Concern	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrust

Curragh has five environmental management areas that are requirements of conditions of approval under the two separate referrals under the Commonwealth *EPBC Act 1999* (**Figure 2-14**). These environmental management areas and the relevant referrals involve:

- Curragh North Coal Mine (EPBC 2003/1096);
    - Brigalow Management Area (55ha) – Condition 2,
    - Brigalow Rehabilitation Area (37ha) – Condition 2, and
    - Transport Corridor Management Area (17ha) – Condition 1.
- Blackwater Creek Diversion and Coal Mine (EPBC2007/3925);
    - Northern Brigalow Area (44.9ha) – Condition 1, and
    - Northern Brigalow Revegetation Area (21.4ha) – Condition 1.



Figure 2-14 Environmental Management Areas at Curragh Mine

2.2.6.2 Flora and Fauna

The riparian vegetation is generally dominated by native species; however, conditions are poor to moderate due to high disturbance and clearing, combined with low-instream diversity, moderate to extensive bank erosion and fine-sediment dominated substrates (Curragh North EIS, 2003).

Studies of terrestrial vegetation were taken in 1998, 2001 and 2003 by AustralAsian Resource Consultants Pty Ltd (AARC) and within these studies, six vegetation communities were identified on the mine site (**Figure 2-15**):

- Community 1: Fringing River Red Gum (*Eucalyptus camaldulensis*) tall woodland on alluvial plains;
- Community 2: Open Coolabah (*Eucalyptus coolabah*) woodland with a predominantly grassy understorey;
- Community 3: Brigalow (*Acacia harpophylla*) woodland with Yellowwood (*Terminalia oblongata*);
- Community 4: Poplar Box (*Eucalyptus populnea*) and Dallachy's Gum (*Corymbia dallachiana*) open woodland;
- Community 5: Lemon-scented Gum (*Corymbia citriodora*) woodland with Rosewood (*Acacia rhodoxylon*); and
- Community 6: Open Grassland with Scattered Trees.

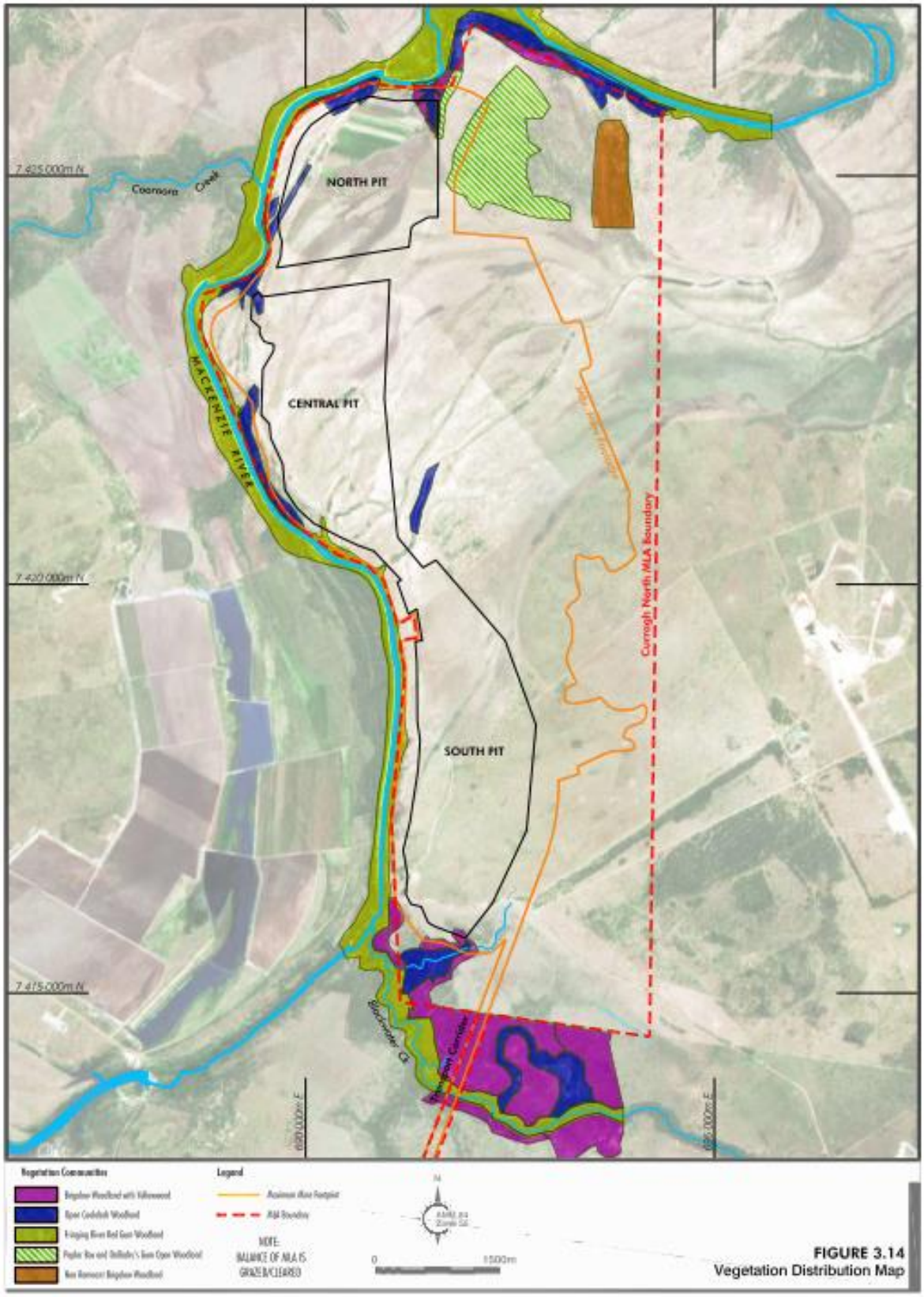


Figure 2-15 Vegetation Communities mapped for Curragh North

During the 1998, 2001 and 2003 AARC surveys a total of 198 fauna species were observed or recorded including 14 butterflies, 15 amphibians, 22 reptiles, 120 birds and 27 mammals were identified.

The following species of conservation significance were recorded at the Curragh Complex:

- Brigalow Scaly-Foot (*Paradelma orientalis*) (no longer listed);
- Ornamental Snake (*Denisonia maculata*);
- Squatter Pigeon (*Geophaps scripta scripta*) – Vulnerable under EPBC Act; and
- Little Pied Bat (*Chalinolobus picatus*). (no longer listed).

Six species of 'declared plants' under the Queensland *Land Protection (Pest and Stock-route Management) Act 2002* during the field surveys for the Curragh Complex, which are included below (**Table 2-10**).

Table 2-10 Declared Plants under the Queensland Land Protection (pest and Stock-route Management) Act 2002 at Curragh Mine

COMMON NAME	BOTANICAL NAME	DECLARED STATUS*
Parthenium weed	*Parthenium hysterophorus*	Class 2
Parkinsonia	*Parkinsonia aculata*	Class 2
Prickly Pear	*Opuntia* sp	Class 2
Mother of Millions	*Bryophyllum tubiflorum*	Class 2
Harrisia Cactus	*Eriocerus* sp	Class 2
Rubber Vine	*Cryptostegia grandiflora*	Class 2

2.2.7 Surface Water

Mackenzie River

The mine is located within the Mackenzie River catchment (**Figure 2-16**), which forms at the confluence of the Nogoa and Comet Rivers, is a major tributary of the Fitzroy River which flows through Rockhampton into the Coral Sea (Parsons Brinckerhoff, 2015). The mine area is surrounded by ephemeral waterways including Blackwater Creek and Sagittarius Creek which drain north and north-west to the Mackenzie River (Coronado Curragh, 2021).

The catchments are bordered by the Expedition Range to the east, the Great Dividing Range to the south, the Drummond Range to the west and the Peak Range to the north. The total catchment area of the Mackenzie River to the Bingegang Weir (downstream of project boundary) is approximately 50,960km^2. The catchment areas of the tributaries at the upstream end of the Mackenzie River are approximately 28,550km2 for Nogoa River and 16,510 km^2 for Comet River (SLR, 2021a).

During the dry season, flows are controlled by the upstream structures, including Fairbairn Dam and the Bedford Weir and are usually within the river channel typically a flow width of 30-40 m. During the wet season, flow widths can reach 200-300m during frequent rainfall (Parsons Brinckerhoff, 2004).

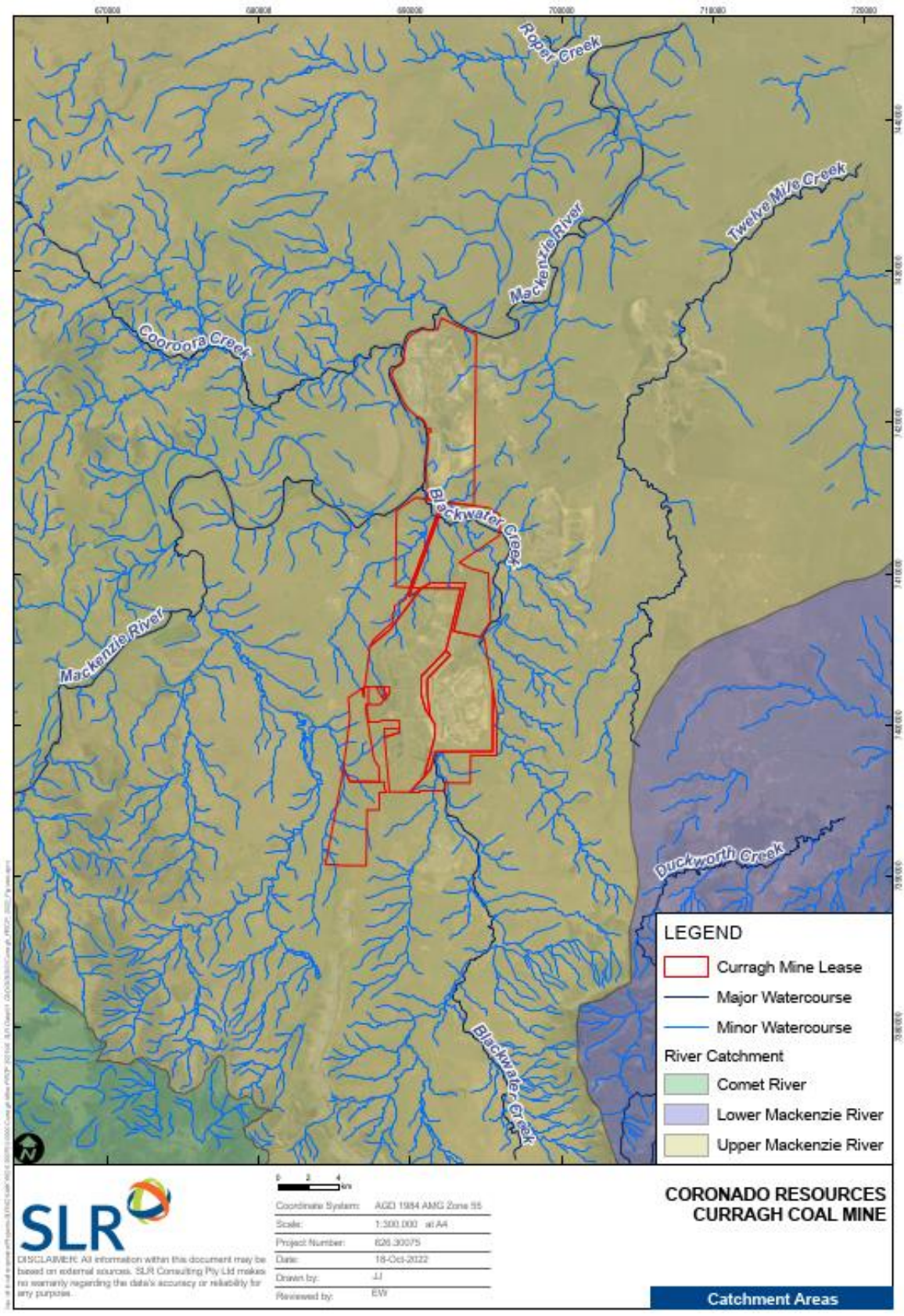


Figure 2-16 Curragh Catchment

Water quality in the Mackenzie River sub-catchment (including Project Area) has previously been categorized as poor to moderate due to (Parsons Brinckerhoff, 2015):

- Turbidity higher than the relevant water quality guidelines;
- Electrical conductivity higher than the relevant water quality guideline;
- Dissolved oxygen that typically lower, but sometimes higher than the water quality guidelines;
- Concentrations of metals (including dissolved aluminium, copper, chromium, iron, lead, silver, zinc and uranium) higher than the relevant water quality guidelines; and
- Concentrations of nutrients (nitrogen and phosphorus) higher than the relevant water quality guidelines.

Blackwater Creek

Blackwater Creek is the main local tributary draining into Mackenzie River about 3.3 km downstream of the Bedford Wier (1 km upstream of project boundary), which flows in a northerly direction through the mine site (SLR, 2021a).

Blackwater Creek has undergone a number of diversions, the last of which was completed in December 2009 to allow for access to additional coal reserves while maintaining the watercourse corridor through the area (Lanyonscapes, 2019). Blackwater Creek has Curragh Coal Mine and numerous other mines (Jellinbah, Curragh, BMA Coal & Cook Mine) dissecting its flow. During the wet season, Blackwater Creek only exhibits intermittent short duration flows.

Just downstream of the diversion around Curragh Main and to the east of the proposed Pit X, Blackwater Creek becomes an ephemeral braided channel system.

Tributaries of Blackwater Creek include Taurus Creek, Sagittarius Creek, Minnie Creek and Bullock Creek, all of which are ephemeral. Minnie Creek flows through the proposed Pit X area and will be subject to a 5.3 km diversion near its confluence with Blackwater Creek plus a 2.9 km diversion of one of its unnamed tributaries around the western side of the pit prior to the commencement of mining in this area (PB 2016).

Minor Tributaries

There are several minor tributary systems of Blackwater Creek that traverse the mining area, and the total catchment area from these tributaries at the confluence of Blackwater Creek and Mackenzie Creek is some 1,082km^2 (SLR, 2021a). These tributaries include:

- Taurus Creek;
- Sagittarius Creek;
- Bullock Creek;
- Minnie Creek;
- Bonnie Doon Creek; and
- Burngrove Creek.

2.2.8 Groundwater

The main hydrostratigraphic units in the vicinity of the mine are described below, from the shallowest to the deepest/oldest:

- **Alluvium** – up to 30m thick in the north associated with the floodplain / channel deposits of the Mackenzie River. Thinner (up to 12 m), near extension Pit X and comprises clay, sand and gravel units. At Curragh Main and southern extension Pits up to 10 m thick but generally much thinner and predominantly clay and silt. The alluvium is dry in many areas. Unconfined water bearing sand and gravel may occur at the base of the alluvial sequence around Curragh North near proposed Pit X, but it is considered unlikely to be significantly water bearing where it occurs in the south of the mine.
- **Regolith** - unconsolidated surface layer of weathered rock which may provide a preferential flow pathway for groundwater. Occurs across the mine area at thicknesses between 5 and 15 m. Includes weathered residual rocks of the Duaringa and Emerald formations, Rewan Formation, Rangal Coal Measures and Burngrove Formation in areas of outcrop and sub-cropping alluvium. Variable permeability.
- **Cenozoic** (Tertiary Duaringa and Emerald formations) - Occurs around Curragh Main extension Pits X and D. Comprises cemented sands and gravels and sandstones, siltstones and mudstones. Water bearing zones may occur in more permeable layers, unconfined to semi-confined.
- **Rewan Group** - is a regional aquitard comprising mudstones interbedded with siltstone and fine to medium grained labile sandstone.
- **Rangal Coal Measures** - Occurs along the strike of the mine and is overlain to the east by the Rewan. Groundwater flow is primarily within the coal seams (via interconnected cleats and fractures), which are confined by low permeability overburden and interburden. The coal measures are highly faulted resulting in "compartmentalisation" with coal seams juxtaposed against lower permeability interburden limiting the lateral continuity of flow. Faults themselves may form barriers to flow or provide conduits.
- **Burngrove Formation** – outcrops/subcrops to the west of the mine dipping east below the Rangal Coal Measures. Groundwater flow occurs primarily via the coal seams and fractured sandstone units with low permeability siltstone and claystone forming aquitards. As with the RCM sequence, it is considered to be highly faulted with coal seams juxtaposed against lower permeability interburden limiting the lateral continuity of groundwater flow. This Formation is considered the basement for the purposes of this assessment.

Groundwater quality data is generally available from late 2015 onward with limited data provided from before this time. Historically, groundwater quality monitoring was undertaken infrequently from 1997 to 2012 with the frequency increasing thereafter. Samples were analysed for electrical conductivity (EC), pH, major ions, nutrients, dissolved metals and hydrocarbons and water quality statistics for selected analytes are shown in **Table 2-11**.

Table 2-11 Currently available groundwater quality data

Screened Formation	Bore ID	Data availability	
		From	To
Alluvium	1309MB	28-10-2015	01-04-2020
Alluvium	1312MB	03-10-2019	03-10-2019
Alluvium	1426MB	30-10-2015	10-11-2020
Alluvium	1531MB	28-10-2015	13-05-2020
Alluvium	1410MB	03-03-2016	29-06-2018
Alluvium	1411MB	28-04-2016	11-06-2019
Tertiary (weathered)	1301aMB	30-01-2020	06-01-2021
Tertiary (weathered)	1302MB	03-10-2019	07-01-2021
Tertiary (weathered)	1303MB	03-10-2019	07-01-2021

Screened Formation	Bore ID	Data availability	
		From	To
Tertiary (weathered)	1304aMB	18-09-2013	13-06-2016
Tertiary (weathered Duaringa Fm.)	1419MB	06-08-2015	28-06-2018
Tertiary (weathered Duaringa Fm.)	1420MB	30-12-2016	20-06-2017
RCM	BH1	26-06-2000	09-11-2020
RCM	BH2	09-02-2000	16-11-2020
RCM	BH3	09-02-2000	11-11-2020
RCM (weathered)	1301bMB	03-10-2019	06-01-2021
RCM (weathered)	1304bMB	04-09-2013	06-01-2021
RCM	1529MB	06-08-2015	10-11-2020
RCM	1534MB	06-08-2015	09-12-2020
RCM	1536MB	16-04-2018	14-05-2020
RCM	1538MB	19-08-2015	11-11-2020
RCM	1539MB	29-10-2015	20-08-2018
Burngrove Fm.	BH4	09-02-2000	09-12-2020
Burngrove Fm. (weathered)	1323MB	07-01-2014	09-11-2020
Burngrove Fm. (weathered)	1417MB	05-08-2015	09-11-2020
Burngrove Fm. (weathered)	1418MB	22-06-2015	11-11-2020
Burngrove Fm. (coal seam)	1537MB	30-10-2015	10-11-2020

2.2.8.1 Groundwater Dependent Ecosystems

A Groundwater Dependent Ecosystem (GDE) is one in which the plant and/ or animal community is dependent on the availability of groundwater to maintain its structure and function. The BoM Groundwater Atlas (BoM, 2021) indicates areas of primarily low potential terrestrial GDEs / IDEs (inflow dependent ecosystems) associated with the riparian corridor of the Mackenzie River and, to a lesser extent, Blackwater Creek (**Figure 2-17**). These terrestrial GDEs are vegetation ecosystems that rely on the subsurface presence of groundwater.

The 2016 Parsons Brinckhoff assessment (due to its objective of assessing impacts associated with expansion), considered the potential for impacts on GDEs in considerable detail. The area of potential subsurface GDEs was assumed to be restricted to areas of saturated alluvium based on the results from the numerical groundwater modelling. It was also assumed that within the areas of saturated alluvium that groundwater dependence was related to the depth to the water table and vegetation rooting depth. The following criteria were used to refine the areas of likely and potential subsurface GDEs in the vicinity of the mine:

- Where field verified and Queensland Herbarium mapped regional ecosystems associated with likely and potential GDEs intersected with modelled areas of saturated alluvium
- depth to groundwater within the area of saturated alluvium:
    - High – depth to groundwater within saturated alluvium <10 m
    - Possible – depth to groundwater within saturated alluvium between 10 and 20 m
    - Unlikely – depth to groundwater within saturated alluvium >20 m.

The assessment (PB, 2016) identified that much of the reach of the Mackenzie River and Cooroora Creek (tributary of the Mackenzie), within the model domain, and the northern reaches of Blackwater Creek, had a high potential to host terrestrial GDEs along the riparian corridor with a likely depth to groundwater of < 10m.

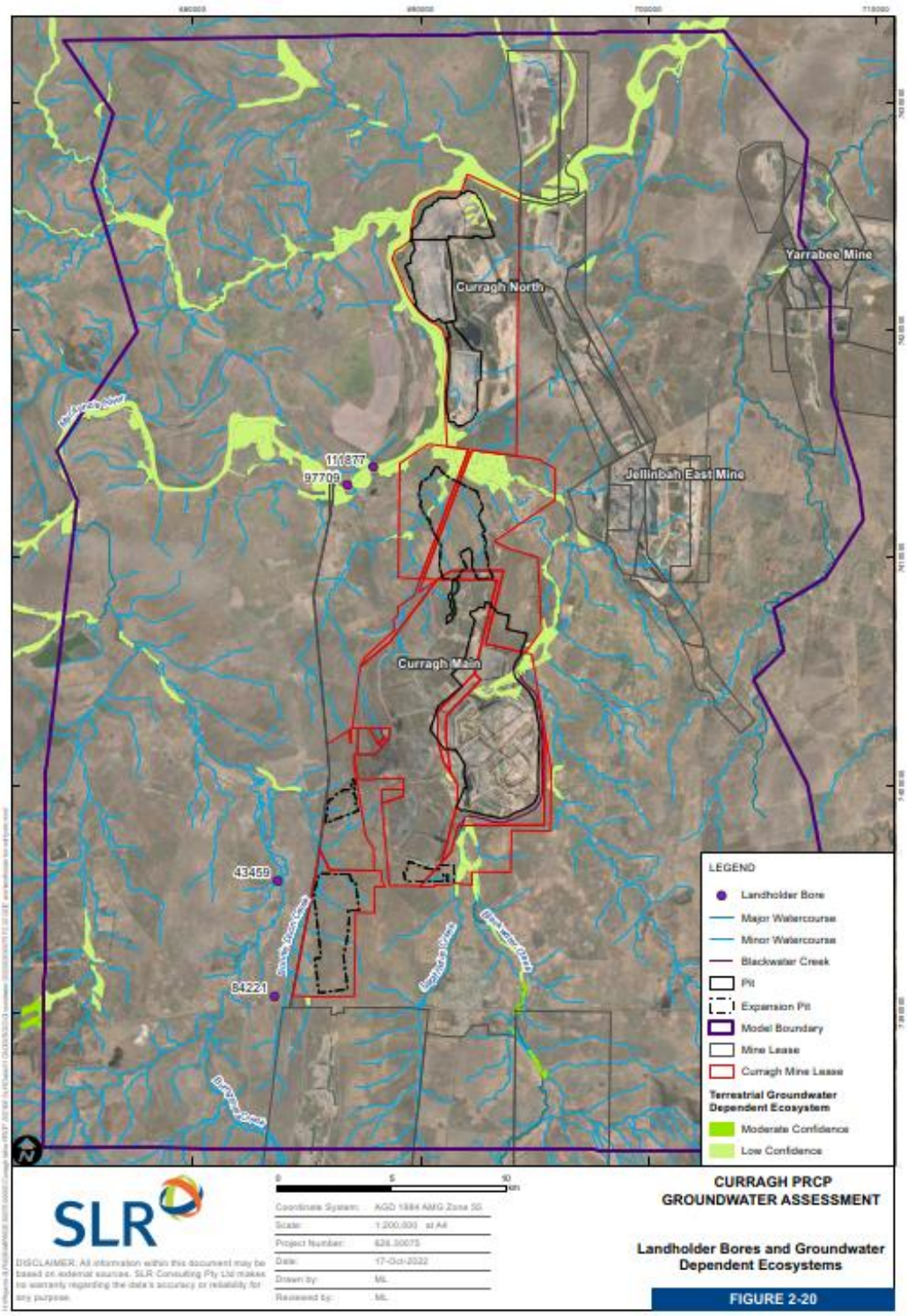


Figure 2-17 Groundwater monitoring network and GDEs

There are four registered bores within 3 km of Curragh mining operations (existing or proposed); details are presented in Table 2-12.

Table 2-12 Registered bores within 3km of Curragh mining operations

RN	Aquifer	Depth (m)	SWL (mbgl)	Water quality	Yield (L/s)	Installed
43459	-	-	-	-	-	-
84221	Burngrove Formation	31	30	salty	0.12	1988
97709	-	57	13	Fresh	3.2	1998
111877	Mackenzie River Alluvium	23	15			2002

RN111877 is owned by Central Highlands Regional Council and located at the campground approximately 150 m south of Bedford Weir on the Mackenzie River. The Council have indicated the bore is used to irrigate grass near and in the toilet block at the campground and that the groundwater is relatively saline. The bore is used to fill a 45,000 L tank 2 to 3 times each week (PB, 2016).

2.2.9 Pre-Mining Land Use

The Curragh Complex is located in the Central Highlands Region Local Government Area (LGA) about 30 km north of Blackwater in Central Queensland. The mine is surrounded by land uses including low-intensity cattle grazing, irrigated cultivation and a variety of domestic, industrial and pastoral situations (Coronado Global Resources, 2019). Coal mines in the area include the Curragh Mine, Yarabee, Blackwater and Jellinbah East. Existing land use in the mine area is predominantly cattle grazing with a small area at the north-east end historically used for irrigated cultivation. Overall pre-mining land use consisted of beef cattle grazing (85%), conservation (11%) and disturbed areas (4%) (Coronado Curragh, 2019).

Clearing for cattle grazing in the area has been extensive with remnant vegetation remaining on higher ridgelines, major creek lines and highly fragmented on open plains.

2.2.10 Underlying Landholders

The underlying landholders over Curragh mining leases is shown in **Figure 2-18**. Majority of the land within the mining leases is owned by CCPL, with some land in Curragh North owned by a private landholder, Peter Dunn, and some land in Curragh East owned by the State of Queensland.

Overlapping Tenure

Overlapping petroleum tenure exists over the southern extents of the CCPL tenements. Under MERCPA 2014 legislation this entails annual information exchange and the provision and maintenance of Joint Information Management Plans with the overlapping tenement holder.

Sensitive Receptors

There are 13 sensitive receptors surrounding the Curragh Complex, these are shown in **Figure 2-19**.

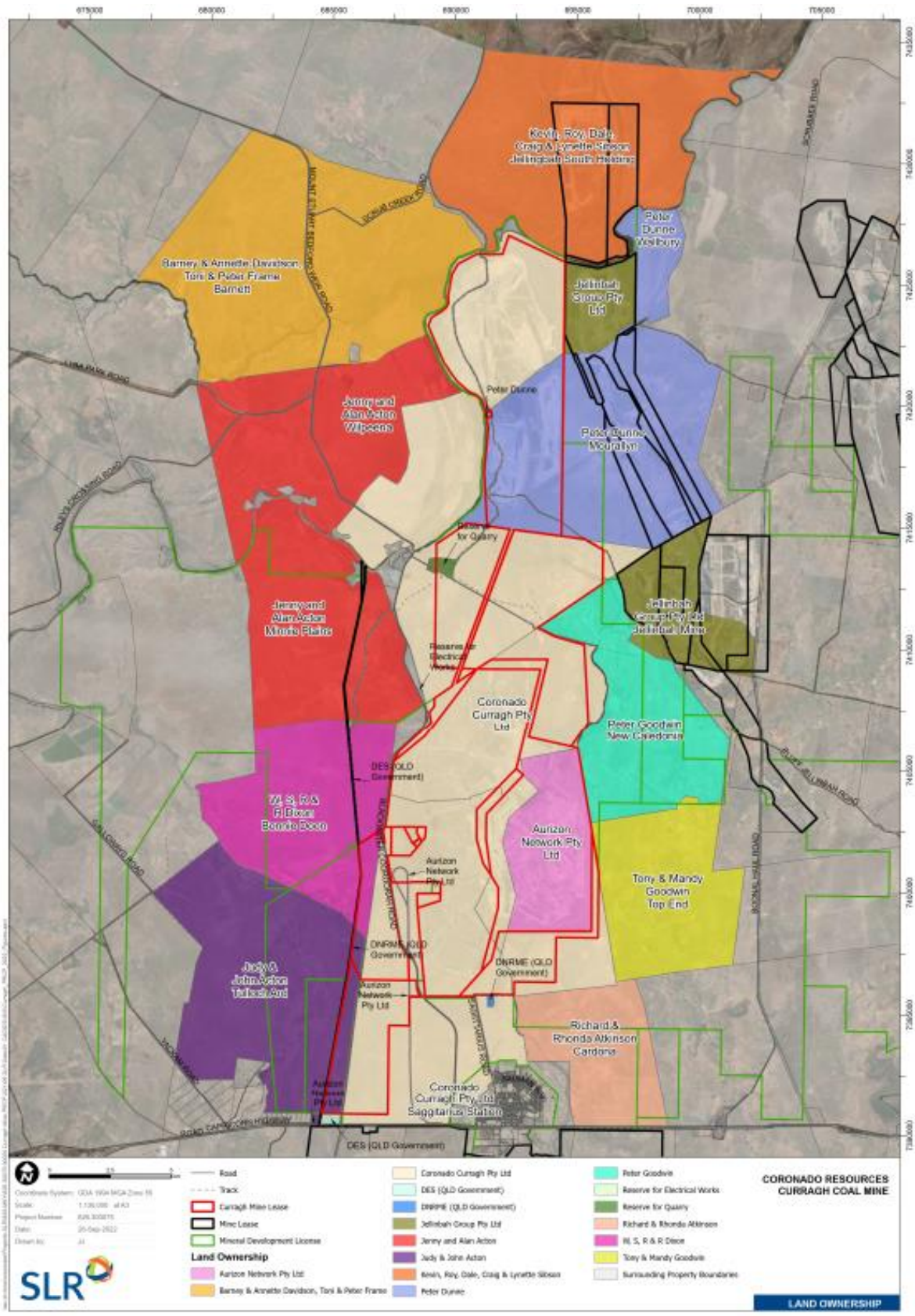


Figure 2-18 Underlying land holders

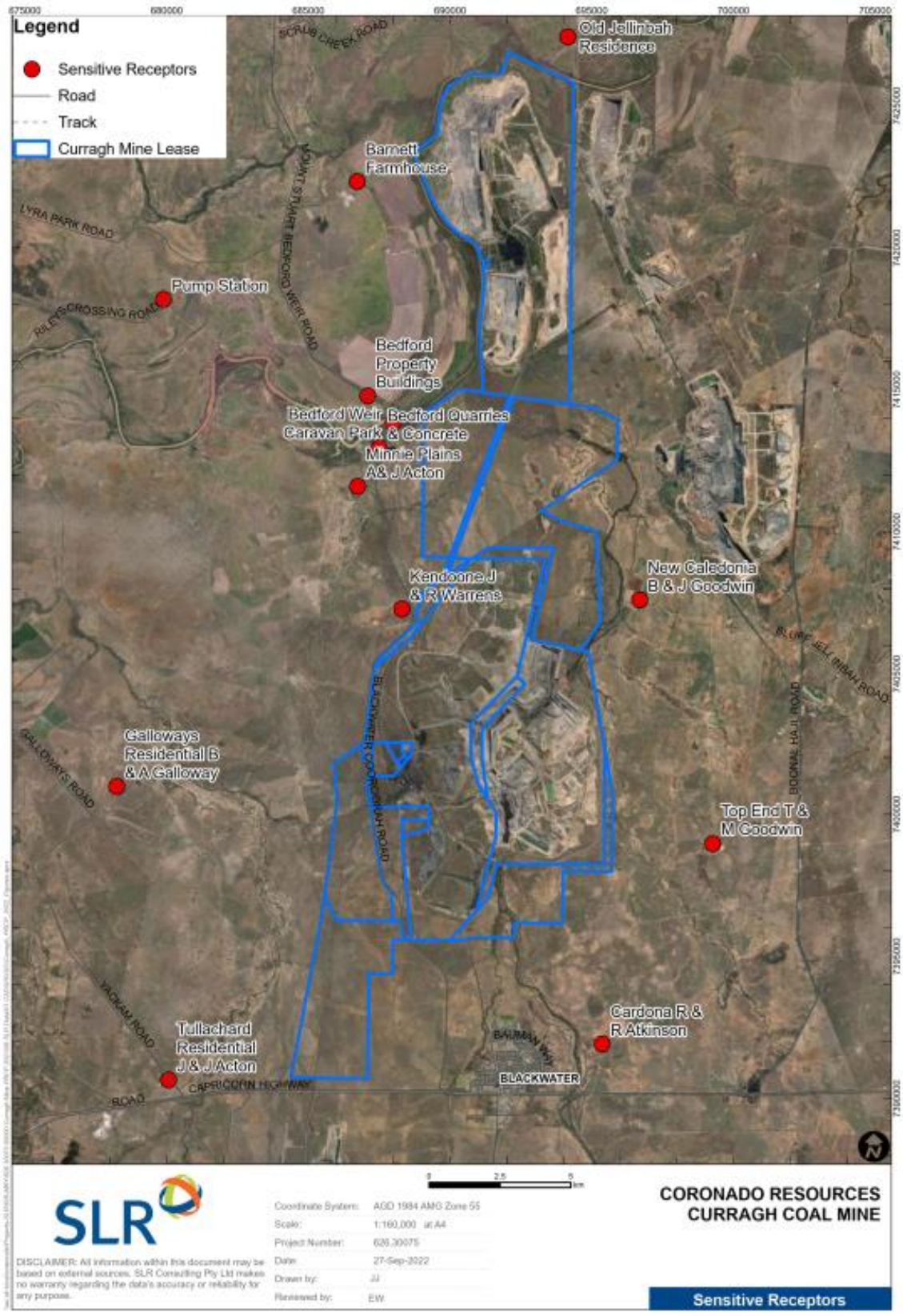


Figure 2-19 Sensitive Receptors

2.3 Design for Closure

Not applicable to existing operations.

2.4 Rehabilitation Planning

The current anticipated life of mine is to 2044. Progressive rehabilitation has already occurred on site and will continue to over the life of the mine. **Table 2-13** shows the key domains on site and the predicted duration of activities.

Table 2-13 Predicted Duration of Activities

Activities	Area (ha)	Predicted Duration of Mining Land Use	Progressive Rehabilitation
Existing Rehabilitation	1,653	1985-2044	Progressive rehabilitation that has occurred throughout the mine life.
Overburden, in pit tailings, ramps	9,565	1985 - 2044	Progressive rehabilitation will occur throughout the mine life.
Voids/Pits	1,499	1985 - 2044	Reshaping of the void area will occur in conjunction with the surrounding overburden as mining in the pits is completed.
Infrastructure areas and miscellaneous activities (buildings, laydown yards, cleared areas, topsoil stockpiles, roads, access tracks, etc.)	592	1983 - 2048	Progressive rehabilitation of infrastructure and miscellaneous activities will be limited as most infrastructure will be required past the end of mining to support rehabilitation activities. Some areas such as topsoil stockpiles will be used throughout the mine life but it's hard to determine when these areas will become available.
Stable Embankments	367	1985 - 2044	Progressive rehabilitation will occur throughout the mine life as embankments are constructed
Blackwater Creek Watercourse Diversion	156	Permanent structure constructed in 2010	The diversion was constructed in 2010 and will be maintained and monitored over the life of mine and be retained post closure.
Bonie Doon and Minne Creek Watercourse Diversions	61	Permanent structures to be constructed	Approved in EA but not yet constructed

Activities	Area (ha)	Predicted Duration of Mining Land Use	Progressive Rehabilitation
Water Infrastructure	65	1983 - 2049	Water infrastructure will be required for the whole life of mine with little opportunity for progressive rehabilitation. The infrastructure may also be required for some time after mining has ceased to support rehabilitation activities.
Out-of-pit Tailings Storage Facility (Old TSF)	185	1987 - 2015	There is the potential for tailings to be reprocessed and therefore the TSF is not considered to be available for rehabilitation yet.

CCPL has developed a rehabilitation schedule for the overburden and voids area based on the mine plan and availability of fleet resources. This schedule has been used to inform the development of the PRCP schedule.

2.5 Existing Rehabilitation

Progressive rehabilitation has been ongoing at Curragh since 1988 (CCPL, 2016). The University of Queensland Centre for Mined Land Rehabilitation (CMLR) undertook rehabilitation monitoring from 2002 to 2016. Since 2019, WSP has been conducting rehabilitation monitoring. Curragh Complex currently has 1653 ha of existing rehabilitation, predominantly in ramps and on placed overburden (**Figure 2-20**).

There is currently no certified rehabilitation at Curragh; however, in 2019 WSP undertook an assessment of existing rehabilitation with the purpose of identifying areas of rehabilitation that are performing at a level suitable for progressive certification application. The report focussed specifically on six areas identified by CCPL:

- Ramp 4 North 2005;
- Ramp 2 North 2002;
- Ramp 2 North SW2000;
- Ramp 7 North 1992;
- Ramp 9 North 1999; and
- Ramp 13 West 2008.

The assessment involved analysing remote sensing and GIS data, as well as field based monitoring of existing transects. Based on the monitoring results WSP recommended a combined area of 75.4 ha from RAN2005, SW2000 and R2N2002 could be put forward for progressive certification.

Rehabilitation monitoring continued to be undertaken by WSP in 2020 and 2021. Both of these reports found that the rehabilitation was not yet conforming with completion criteria but was on a trajectory towards achieving this. A number of recommendations were made for ongoing monitoring and future rehabilitation, including but not limited to:

- The topsoil/spoil strip method is continued in a modified form (short strips/patches of strips) as it has proven to achieve stability and promote tree and shrub growth in the spoil strips due to the exclusion of topsoil, which supports rehabilitation progression towards a mixed open woodland/light grazing use.
- Establish additional reference sites that reflect a light grazing and open woodland use, ideally on a neighbouring grazed cattle property.
- Areas with a predominant grazing/open grassland outcome should be proposed in 100% topsoil areas.
- Any recalcitrant bare areas >0.1 ha, particularly where groundcover is underperforming, should be tested for soil quality and remediation plans be developed to enable these areas progress towards future certification.
- Buffel grass should be excluded from rehabilitation seed mix due to its impact on native tree and shrub recruitment.

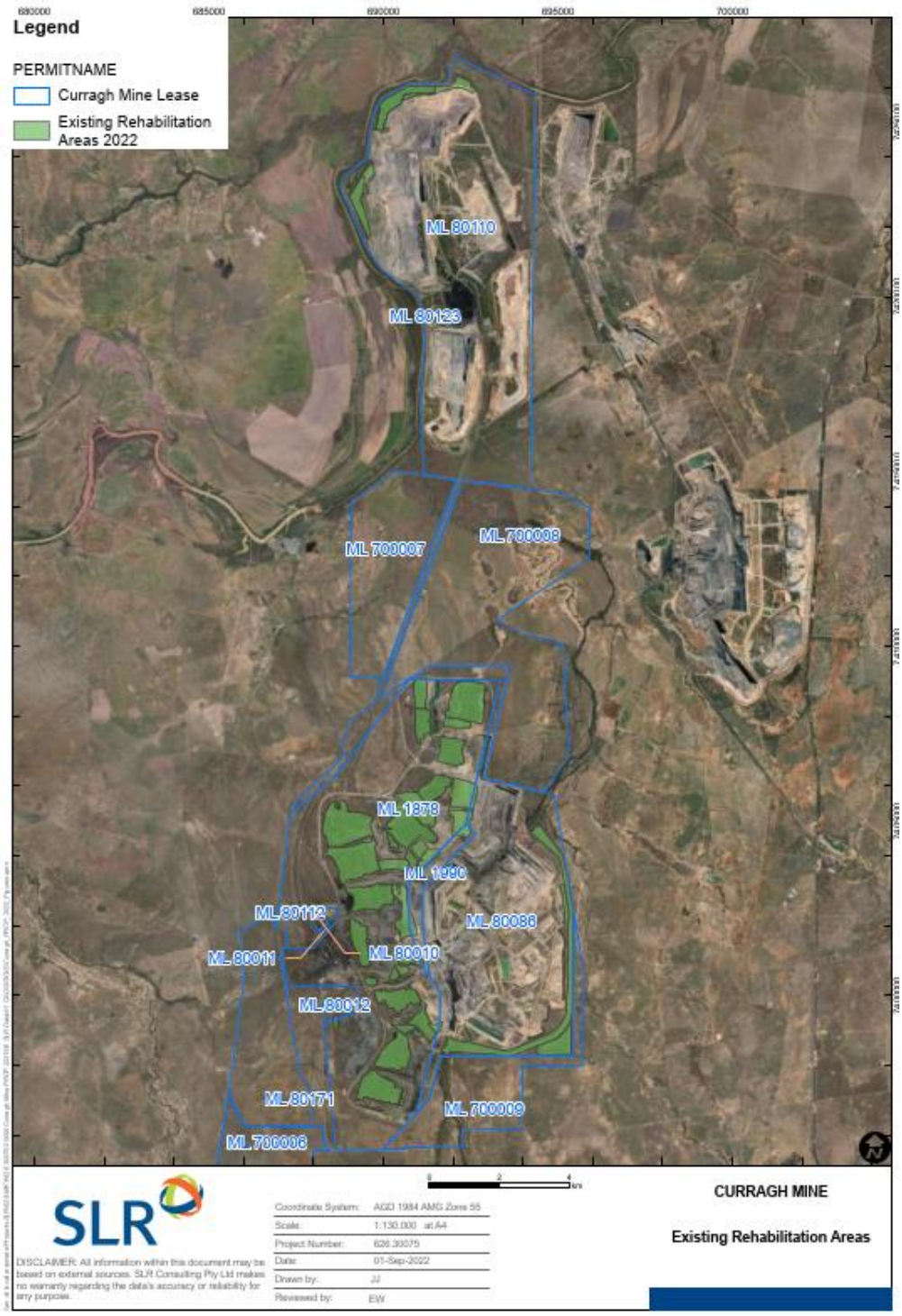


Figure 2-20 Existing Rehabilitation at Curragh Complex

3 Community Consultation

SLR has prepared a Community Consultation Plan (**Appendix A**) which includes the required information in the EP Act and PRCP Guideline, including, but not limited to:

- Objectives for community consultation;
- How the community will be engaged;
- Proposed consultation frequency;
- What information will be released for community consultation;
- How feedback/comments will be considered; and
- Community Consultation Register.

The Community Consultation Register (contained within the Community Consultation Plan) only captures engagement activities undertaken by CCPL where closure of the Curragh complex was discussed.

3.1 Initial PRCP Consultation

As part of the PRCP process CCPL has engaged three key stakeholders – DES, Traditional Owners Group and Peter Dunn (underlying landholder).

3.1.1 DES Meeting

CCPL and SLR had a PRCP pre-lodgement meeting with the Department of Environment and Science (DES) on 1 June 2021. The primary purpose of the meeting was to confirm what land outcomes are approved in Land Outcome Documents and to agree to a PRCP submission date. The outcomes of the meeting include:

- The Curragh Complex has pre-approved residual voids as Non-Use Management Areas;
- CCPL will update the Residual Void study to provide clarification on previously identified voids and to include any voids within the new MLs; and
- A proposed combined PMLU of grazing and native habitat was agreed upon.

The other key outcome of the meeting was that the PRCP for Curragh would be due to DES on 21st October 2022.

3.1.2 Traditional Owners

CCPL has a quarterly meeting with the local indigenous group, Gaangalu Nation People, to discuss a number of matters as they arise. At the meeting in May 2022, SLR provided a presentation on the PRCP process and how this relates to the Curragh Complex. The key discussion items included:

- Explanation of the PRCP process and purpose and presentation of a PowerPoint which includes a description of the consultation process;
- Where the rehabilitation seeds come from and potential for supply by local Indigenous supplier;
- An overview of the nature of PRCP being progressive and reiterative as the mine life continues;
- Possibility of Curragh looking to complete fauna surveys as evidence of return of totemic species and to further support the suitability of rehabilitation;

- Curragh requested a list of target species that can be targeted in fauna surveys; and
- Potential for returning artefacts to the land, however, will need to be a conversation with the native title applicants and consider what the post mining use will be.

In September 2023, SLR and Curragh met with the Traditional Owners, the Gaangalu Nation People, to discuss the PRCP process, the current status of the PRCP and Rehabilitation at Curragh. The following key items were discussed:

- An overview of the PRCP
- Curragh Mine Rehabilitation
- Totem Species and seed mixes
- Post Mining Land Uses
- Returning of Artefacts to rehabilitated/relinquished land

3.1.3 Underlying Landholder

On 9th August 2022, CCPL and SLR had a one-on-one meeting with an underlying landholder (property manager of Mourallyn) at Curragh North. The purpose of the meeting was to discuss the PRCP framework and how it relates to Curragh Complex. SLR provided a presentation on the PRCP process, the proposed post-mining land uses at Curragh and the community consultation process. Key discussion points from the meeting included:

- Conversation with the landholder about how a 'grazing' land use is assessed. The landholder's advice is that this should focus on management requirements and not specific parameters such as stocking rates given that these change with changing conditions (e.g. weather, condition of pasture, etc.);
- Some of the key queries regarding the closure of Curragh for the landholder included:
    - Responsibility of final voids;
    - How the land will be managed for grazing;
    - Importance of an ongoing relationship between the landholder and CCPL;
    - Erosion of the land;
    - Potential for the retainment of infrastructure including areas of bare land;
- Peter was happy for consultation to occur as required and was interested in attending larger community events and site visits; and
- It was reiterated that the land should be rehabilitated with the final land user in mind and that there should be no surprises at the time of surrender.

Peter offered to provide some guidance on grazing management strategies that he would recommend for incorporation into the rehabilitation strategy.

4 Post-Mining Land Uses

A post-mining land use (PMLU) is defined under section 112 of the EP Act as the purpose for which the land will be used after all relevant activities for the PRC plan carried out on the land have ended. A PMLU must meet the definition of stable condition. Land is in a stable condition if:

a) The land is safe and structurally stable; and

b) There is no environmental harm being caused by anything on or in the land; and

c) The land can sustain a PMLU.

The proposed land outcomes for Curragh Complex are shown in **Figure 4-1**. As shown, CCPL is proposing four PMLUs composed of:

- Light Grazing,
- Open Woodland,
- Watercourse and
- Fauna Habitat and Ecosystem Services.

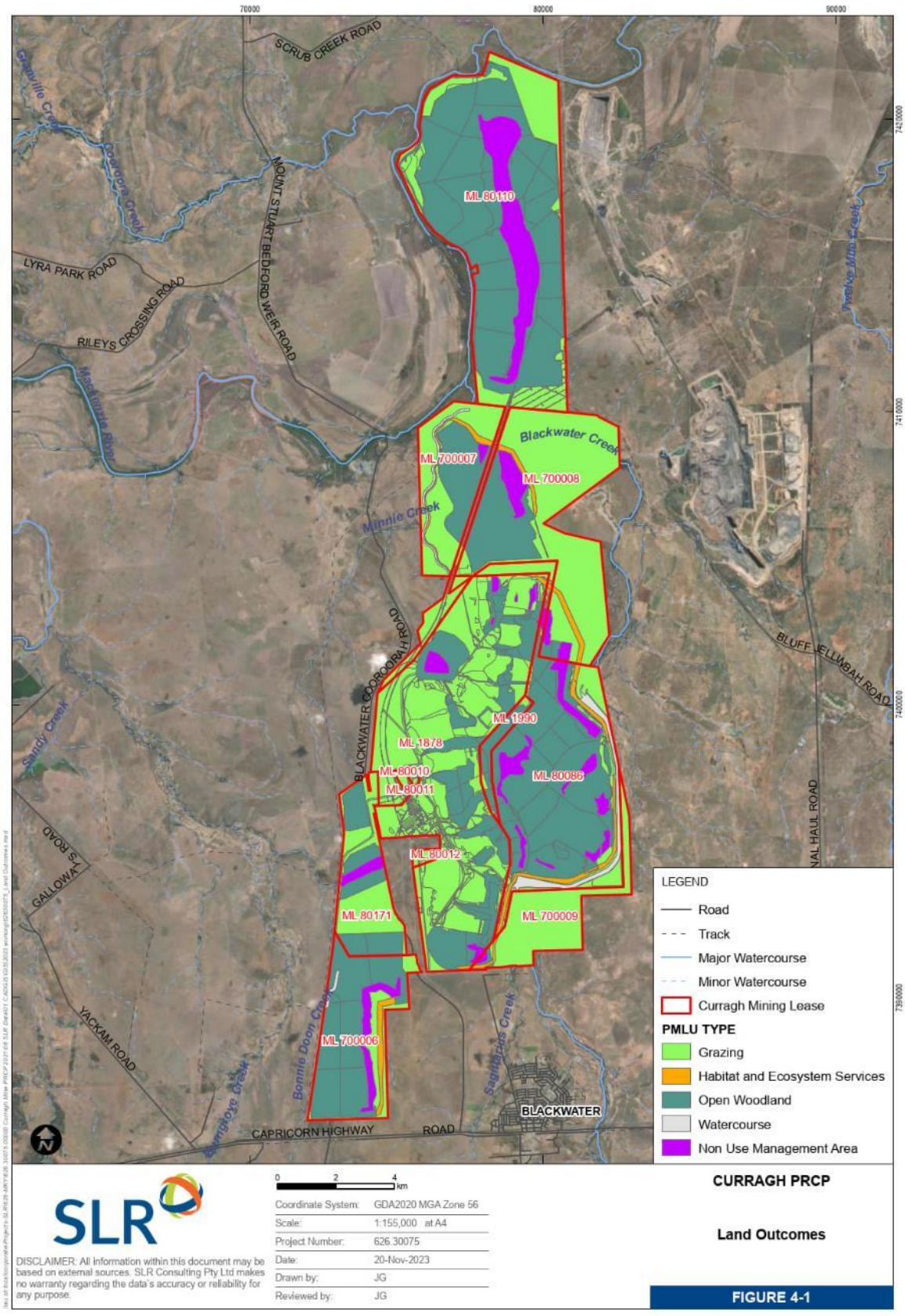


Figure 4-1 Proposed Land Outcomes

4.1 Pre-approved PMLUs

Under the transitional provisions of the EP Act, existing approved PMLUs are able to be transitioned into the PRCP without further assessment or public notification. Existing approvals must be included in a land outcome document. Land outcome documents are listed in section 750 of the EP Act and include:

a. An EA;

b. A document made under a condition of an EA that:

   i. Relates to the management or rehabilitation of land (e.g., rehabilitation and closure plan or residual void management plan);

   ii. Was provided to the administering authority, and had not been superseded, before 30 November 2018; and

   iii. Before 15 January 2019, the administering authority had not notified the EA holder that the document was insufficient.

c. A document made under a condition of an EA that:

   i. Relates to the management or rehabilitation of land (e.g., rehabilitation and closure plan or residual void management plan);

   ii. Was provided to the administering authority between 20 November 2019 and 30 November 2021; and

   iii. Within 20 business days after receiving the document, the administering authority had not notified the EA holder that the document was insufficient.

d. A report evaluating an EIS under section 34D of the *State Development and Public Works Organisation Act 1971* (SDPWO Act);

e. An EIS assessment report; and

f. A written agreement between the EA holder and the State that is in force on 30 November 2018.

The Land Outcome Documents associated with Curragh Complex, in order of hierarchy, include:

- Environmental Authority EPML00643713 (**Appendix B**);
- Concept Residual Voids Assessment made under Condition G14 of the EA and submitted to the administering authority prior to November 2018 (AECOM, 2012);
- Rehabilitation Management and Monitoring Plan created under Condition G18 of the EA and submitted prior to November 2018 (Coronado Curragh, 2018);
- Blackwater Creek Diversion Monitoring and Maintenance Plan referred to in Condition G17 of the EA (Coronado Curragh, 2019a) (**Appendix C**);
- Concept Residual Voids Assessment updated under Condition G14 of the EA (SLR, 2021) (**Appendix D**);
- Rehabilitation Management and Monitoring Plan updated under Condition G18 of the EA (Coronado Curragh, 2021) (**Appendix E**); and
- Curragh North EIS Report (2003).

Please note that the Concept Residual Voids Assessment and Rehabilitation Monitoring and Maintenance Plan were updated in late 2021 to provide further clarity of the rehabilitation outcomes and to include additional planned disturbance since the 2012 versions. Although the earlier versions of these documents are considered higher in the LOD hierarchy, the updated versions will be used for transitioning land outcomes as they are substantially the same and provide additional information / disturbance areas.

The EA doesn't include specific land outcomes but does include a number of relevant conditions including:

G10 All areas significantly disturbed by mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover.

G13 Residual voids must comply with the following rehabilitation outcomes:

a) 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 and subject to any other condition within this environmental authority.

In a pre-lodgement meeting with DES in June 2021, DES officers stated that the EA conditions provide for the option of having residual voids and that Condition G10 was not intended to apply to pit lake areas.

The Conceptual Residual Voids Assessment focuses on voids that are proposed as NUMAs and discussed further in **Section 5** of this report.

The Rehabilitation Management and Monitoring Plan (2021) focuses on all areas with the exception of voids proposed as NUMAs. The post mining land use for all areas in the RMMP is identified as having a mixed use of Light Grazing and Open Woodland.

4.2 Proposed PMLUs

Proposed PMLUs must meet the PRCP objectives and performance outcomes outlined in Schedule 8A of the EP Regulation-

Each post-mining land use-

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

b) Satisfies at least 1 of the following-

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

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

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

iv. The use will deliver, or is aimed at delivering, a beneficial environmental outcome.

CCPL originally proposed to transition a single post-mining land use from the RMMP, Light Grazing and Open Woodland, into the PRCP Schedule. However, upon consultation with DES, it was emphasised that a site is only able to have one primary PMLU and the proposed land use constitutes two PMLUs. It was therefore determined that the primary PMLU for the Curragh Complex is light grazing. Open woodland is also to be transitioned from the RMMP as a secondary PMLU.

The PMLUs of Light Grazing and Open Woodland are viable with consideration of the surrounding land uses. One of the underlying land holders is a grazier who intends to graze the land once it is rehabilitated. Areas that have already been rehabilitated demonstrate that the land use Open Woodland is achievable. The land before mining was grazing land with sparse to moderate tree coverage, therefore the proposed PMLUs are consistent with the land use prior to mining.

Conversations with the underlying landholder and local grazier has helped provide further clarification on how grazing of the land would occur. It is seen that the rehabilitated land would not be used to fatten cattle or as a long term are of use. It would be more appropriate for pulse grazing and using grazing as a land management practice.

The stable embankments will require rock mulch for the slope facing the watercourse in order to ensure erosional stability (further information in **section 6.1.1**). The stable embankment as a whole will provide a PMLU of Fauna habitat and ecosystem services with the slope that is rock mulched providing an additional secondary use of fauna habitat. There are a number of reptiles recorded to occur on site as per the Wild Net Species List for ML1878 (Queensland Government, 2022):

- Spotted Python;
- Brown Tree Snake;
- Orange-naped Snake;
- Eastern Brown Snake;
- Burton's Legless Lizard;
- Eastern Blue-tongued Lizard.

There are a number of studies (Michael et al., 2008; Michael et al., 2012; Wolfe et al., 2018) that identify rocky habitat as an important landscape for reptiles especially where grazing has caused mass clearing of areas. Therefore, the rock mulched slope will be able to support a use in addition to the general landscape use of Light Grazing and Open Woodland.

At the moment, there are no landholder agreements for the retainment of infrastructure, however in stakeholder consultation a desire to retain certain infrastructure and laydown areas was expressed. This will continue to be pursued by CCPL over the life of mine.

CCPL are the underlying landholders of majority of the mine. Advice from the underlying landholder and grazier is that the land needs three key things to be used for grazing – water, fencing and feed. To support the PMLU of light grazing one of the requirements is to have available water sources; therefore, CCPL are proposing to retain all raw water dams. The raw water dams to be retained will have the sediment removed then be allowed to naturally fill again. The water is expected to be of a stock watering quality in accordance with ANZECC Guidelines.

4.2.1 Community Consultation

CCPL has actively engaged with Traditional Owners and an underlying landholder about the proposed PMLUs. Neither party raised any issues with the proposed PMLU and were generally supportive. The underlying landholder was very interested in having the land returned to a landform suitable for light grazing and has provided advice on how to achieve this. Relevant stakeholders will continue to be consulted over the life of the mine to ensure communication of the PMLU and expectations are managed appropriately.

4.2.2 Plans and Strategies

Section 126C of the EP Act requires the PRCP to state the extent to which the PMLU is consistent with any strategies or plans for the land of a local government, the State, or the Commonwealth. Relevant plans and strategies have been identified below.

Water Resources (Fitzroy Basin) Plan 2011

The Water Plan (Fitzroy Basin) 2011 (current as of 2 September 2017) provides a framework for sustainably managing water and taking water from overland flows and Groundwater while considering existing water users including the environment. Mine closure planning including final landforms and drainage (e.g., water diversions) has considered the protection of flows (e.g., prevention of impounding waters, connection of base flows, etc.), water quality and groundwater recovery for surrounding ecosystems and users in accordance with this plan.

The Queensland Plan

The Queensland Plan is an aspirational 30-year community vision with nine foundation areas which include the following relevant areas to mine closure planning for this project: Regions – building thriving communities, Environment – achieving balance, and Infrastructure – being connected. Mine closure planning is required to consider goals of capitalising on unique regional opportunities and assets, environmental protection, effective natural resource management, and connectivity and accessibility across the state.

Central Highlands Regional Council Planning Scheme 2016

The Central Highlands Regional Council (CHRC) Planning Scheme 2016, which is currently operating under amendment no.6 (May 2022), was developed as a planning instrument under the Planning Act 2016 (Queensland Government). The CHRC Planning Scheme aims to manage growth of the region through the regulation of existing land use and new development to reflect community aspirations. The land on which Curragh Complex is situated is zoned for Rural land use which supports the propose PMLU of Light Grazing and Open Woodland.

4.2.3 Final Milestone Criteria

Completion criteria for the different domains within the proposed PMLU is identified in the RMMP. This criterion has been further built upon with the outcomes of the PRCP technical studies and is shown in section 9.3 of this report.

5 Non-Use Management Areas

A Non-use Management Area (NUMA) is defined in section 112 of the EP Act as an area of land the subject of a PRCP that cannot be rehabilitated to a stable condition after all relevant activities for the PRCP carried out on the land have ended. A NUMA can only be proposed due to one of the following reasons:

a) carrying out rehabilitation of the land would cause greater risk of environmental harm than not carrying out the rehabilitation; or

b) both of the following apply:

   a. The risk of environmental harm as a result of not carrying out rehabilitation of the land is confined to the area of the relevant resource tenure.

   b. The applicant considers, having regard to each public interest consideration, that it is in the public interest for the land not to be rehabilitated to a stable condition.

5.1 Pre-approved NUMAs

As mentioned above in section 4.2, land outcomes are able to be transitioned from Land Outcome Documents in accordance with the transitional provisions in the EP Act. The Conceptual Residual Void Assessment (CRVA) is the LOD which identifies voids as NUMAs.

The CRVA (AECOM, 2012) is higher on the LOD hierarchy and identifies a total of 1,742 ha as pit area. The updated CRVA (SLR, 2021) refined this for the purpose of maximising areas which can support a PMLU while also adding in extra mining areas and identified a total area proposed as a NUMA of 1,499 ha. The NUMAs identified in the CRVA (SLR, 2021) is shown in **Figure 5-1**.

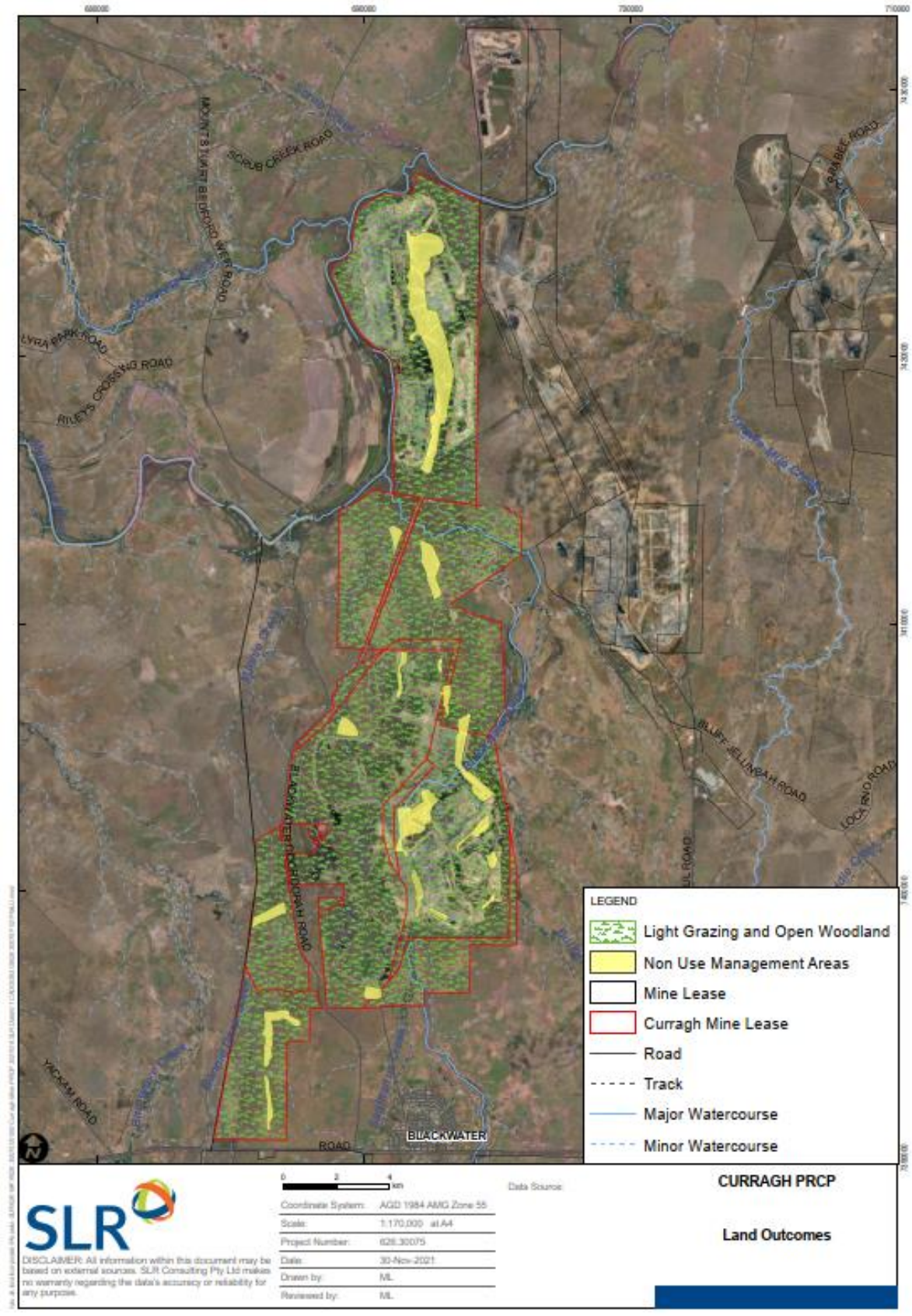


Figure 5-1 Land Outcomes from CRVA (SLR, 2021)

5.2 Proposed NUMAs

CCPL are proposing the transition the pre-approved NUMAs from the updated CRVA (SLR, 2021) into the PRCP Schedule with some minor changes. Following the update to the CRVA, updates were made to mine planning and therefore the proposed final landform was amended. The void water balance modelling was also updated to identify any changes to the pit lakes. Two additional pit lakes were identified (referred to as Main Other and Pit X West 2). The Main Other pit lake is located within an area of existing rehabilitation, and it was originally thought that this water would be suitable to support a PMLU; however, water modelling has shown that over time the water will become highly saline.

In order to maintain the same NUMA area approved in the CRVA (2021), CCPL has amended the NUMA locations to ensure no additional areas have been included. Pit I has been reassessed to remove some of the area originally identified as NUMA. **Figure 4-1** shows the proposed locations of NUMAs for this PRCP.

Table 5-1 shows a comparison of the 2012 proposed residual voids, the 2021 preliminary NUMA areas and the final proposed NUMA areas. This shows that the area which could be interpreted as a NUMA in the PRCP has been reduced in this version of the CRVA and proposed PRCP schedule. This was achieved by reviewing the parameters of what is considered a 'NUMA' and optimising the PMLU for the low wall and Tertiary highwall.

Table 5-1 Residual Voids / NUMA Areas 2012 vs 2021 vs Proposed

Domain	2012 CRVA Residual Void Area (ha)	2021 CRVA NUMA Area (ha)	Final proposed NUMA Area (ha)
Curragh Main	1,096	561	546
Curragh North	646	637	637
Pit X	-	125	141
Pit Y	-	48	48
Pit Z	-	128	128
Total	**1,742**	**1,499**	**1,500**

This change in location of the NUMAs is insignificant. The change has occurred to align with the objectives for characterising a residual void as a NUMA; that being that the highwall slope is over 16% and there is permanent hypersaline water present.

The flood model, residual void water modelling and numerical groundwater model have all be revisited to identify any potential environmental harm which may result from the residual voids being left in their proposed location. There was no difference in potential harm identified in these studies. Therefore, CCPL would consider the proposed NUMAs to still be 'substantially similar' to those proposed in the CRVA (2021) in accordance with section 754(3) of the EP Act.

5.2.1 Plans and Strategies

The Central Highlands Regional Council Planning Scheme identified the Curragh Complex lease area as 'rural.' It is acknowledged that mining and exploration activities occur within this planning zone. Therefore, the final land use of final void/water containment is consistent with the current planning scheme for the area.

5.2.2 Community Consultation

CCPL has actively engaged with Traditional Owners and an underlying landholder about the proposed NUMAs. Neither stakeholder had any strong objections to the proposed NUMAs. The underlying land holder had questions about the quality of the void water and responsibility of the voids post-surrender.

5.2.3 Final Milestone Criteria

SLR have developed completion criteria for the proposed NUMAs (**Table 5-2**) using the technical studies undertaken and detailed above. It should be noted that this criterion is only applicable to the Permian Highwall and maximum void water level.

Table 5-2 NUMA Criteria

Objective	Criteria	Justification
Safe for humans, livestock and native fauna	Static Factor of Safety >1.5 Dynamic Factor of Safety >1.1	Factor of safety design criteria is recommended in the Geotechnical Report.
	Certification from an appropriately qualified person that the residual void is safe to humans and livestock	Example from PRCP Guideline.
	Installation of bunding or fencing and signage where required.	The installation of bunding or fencing and signage would be confirmed in the PRCP once the final landform has been finalised.
Geotechnically and erosionally stable	The final landform does not form rill erosion of >30 cm.	This is a standard criterion for demonstrating erosional stability.
	Permian highwalls battered to a geotechnically stable slope.	As recommended in Geotechnical Report. Where fault related rock mass shearing and/or adversely orientated structures are interpreted or inferred final walls may have to be constructed as softwalls at 22 degrees.
	Certification from an appropriately qualified person that the residual void is geotechnically and erosionally stable.	Example from PRCP Guideline.
Does not cause 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	Construction of a stable, long-term embankment which prevents the ingress of flood water into the residual voids.	The embankment will protect the voids from interacting with the floodplain. The Flood Model Report provides the minimum height for the embankment based on very conservative flood modelling. This height may be reviewed based on more detailed flood modelling recommended as part of the PRCP.
	Saline void water will not spill or seep into the surrounding environment at a concentration that will cause environmental harm.	The void water balance modelling shows that the voids are highly unlikely to spill. Groundwater modelling demonstrates that the voids are likely to act as sinks and not contaminate the surrounding environment.

Objective	Criteria	Justification
	Certification from an appropriately qualified person that the residual void does not cause 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.	Similar example from PRCP Guideline.

6 Rehabilitation/Management Methodologies

6.1 Rehabilitation/Management Studies

6.1.1 Landform

Overburden

The overburden dumps have been designed to have a maximum slope of 16%, although the majority of the slopes are lower than this. There are three different types of spoil material at the Curragh Complex, Permian, Quaternary and Tertiary. The dumping method will aim to have Permian or Quaternary material on the surface with any Tertiary spoil buried due to its high dispersivity.

Highwalls

The void highwalls have been designed in the Conceptual Final Landform to the lowest angles proposed in the Geotechnical Assessment (Raine Associates, 2021). While CCPL will endeavour to keep the void highwalls as steep as possible while achieving long term stability, the final landform has incorporated the lowest slopes proposed for the highwall as a worst case scenario for the total area of the NUMAs. A steeper slope would result in a reduced NUMA footprint. Further information on the highwall angles is provided in **section 6.1.9**.

Stable Embankment

As the Curragh Complex is located on a floodplain, an indicative cross section of the long-term stable embankment has been designed to prevent flood ingress into the residual voids. The embankment design has been based on the B Pit embankment section, developed from the B Pit Tailings Storage Facility Design Plan (Golders, 2017). A conceptual embankment design is shown in **Figure 6-1** with parameters outlined in **Table 6-1**. Stable embankments are based on this concept and are constructed to heights that provide freeboard to protect residual voids against the 0.1% AEP flood event are being incorporated into the final landform design for the mine.

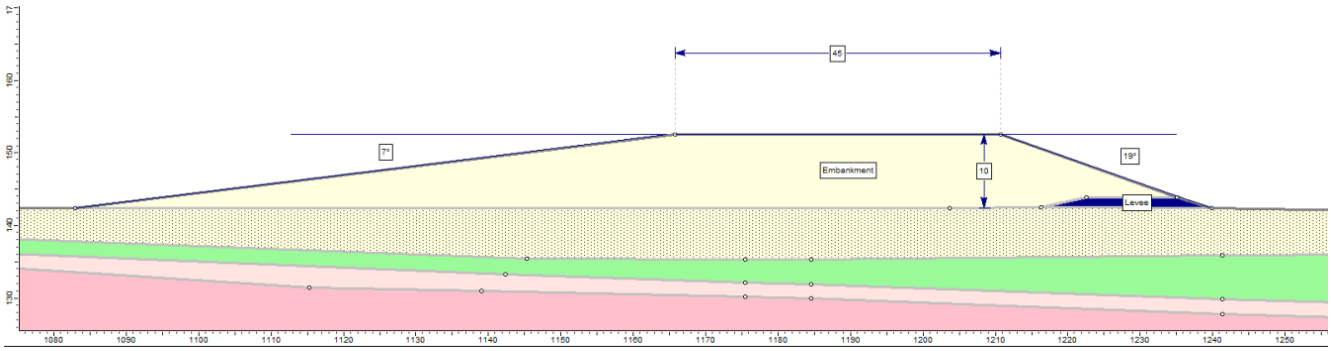


Figure 6-1 Stable Embankment Conceptual Design (Raine Associates, 2021)

Table 6-1 Indicative Stable Embankment Standard Parameters

Parameter	Value
Height	10 m (actual will be 0.1% AEP plus 1 m freeboard)
Top width	45 m (actual to be determined during design)

Parameter	Value
Water facing slope	<19° (actual to be long term stable to erosion and flood scour)
Residual void facing slope	7° (actual to be long term stable to erosion)

The outcomes of the flood model have been incorporated into the conceptual landform design for the PRCP to ensure flood water does not enter residual voids.

Conceptual Final Landform

The conceptual final landform and proposed slope gradients are shown in **Figure 6-2**, **Figure 6-3** and **Figure 6-4**.

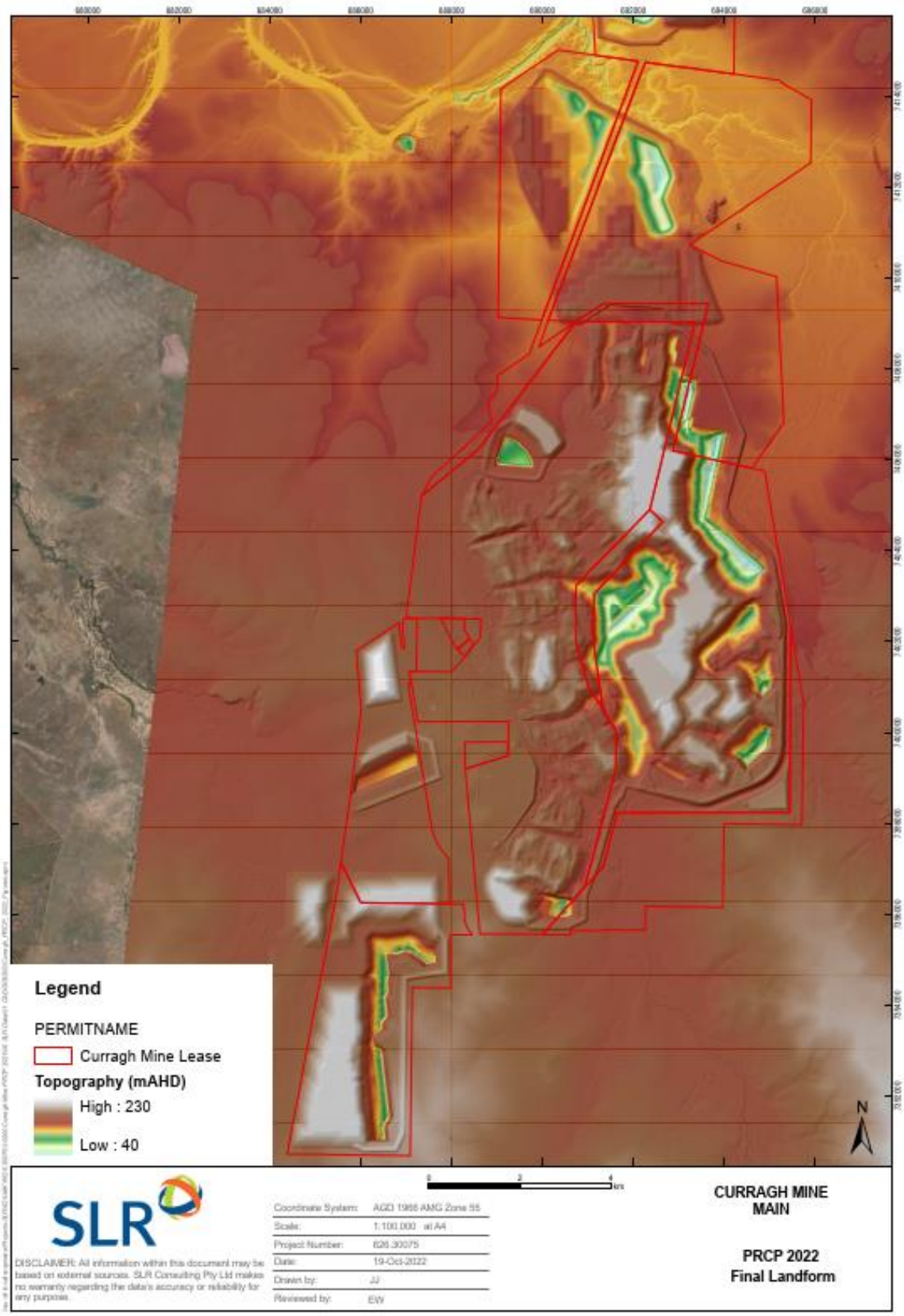


Figure 6-2 Conceptual Final Landform

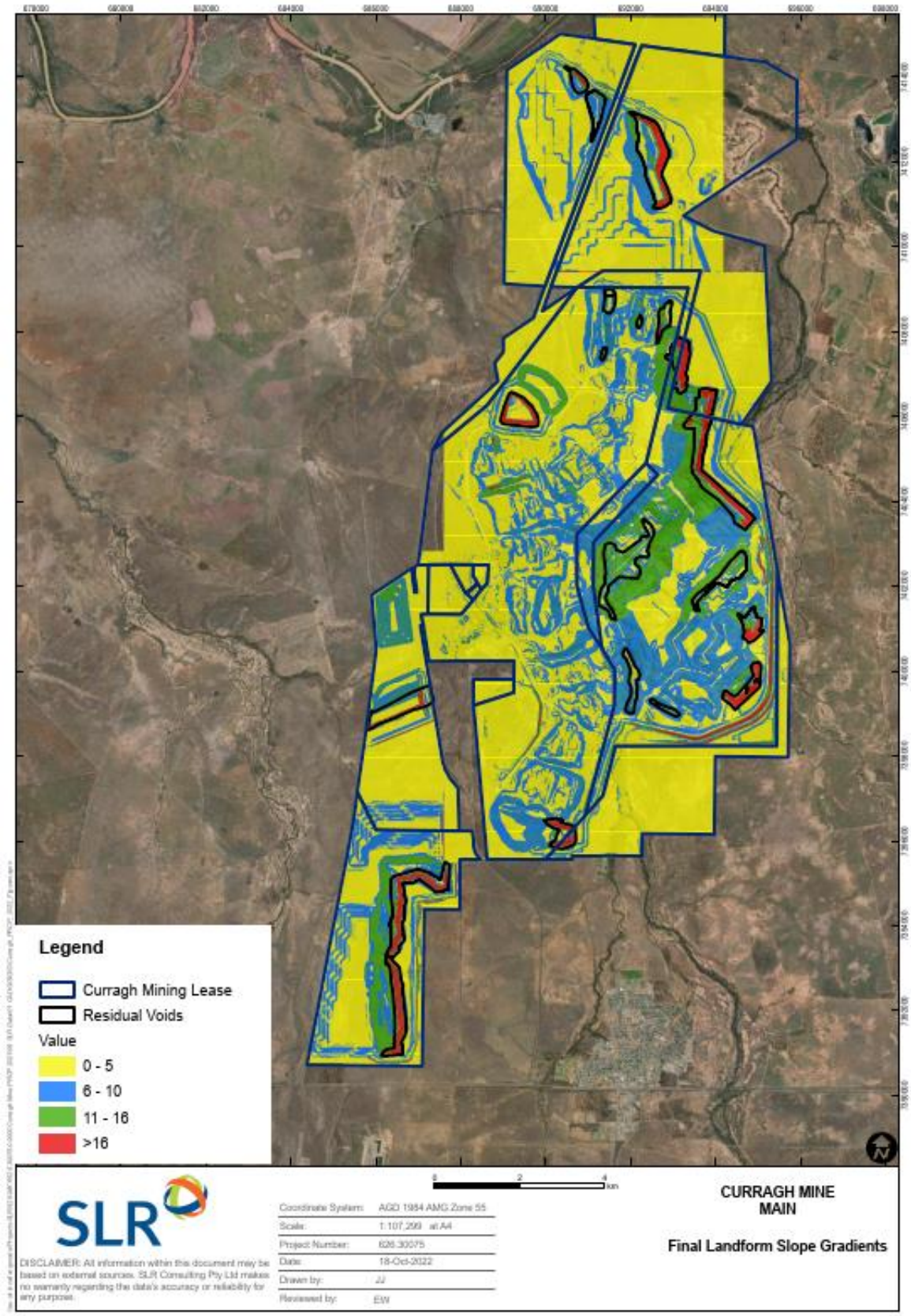


Figure 6-3 Curragh Main Final Landform Slope Gradients (%)

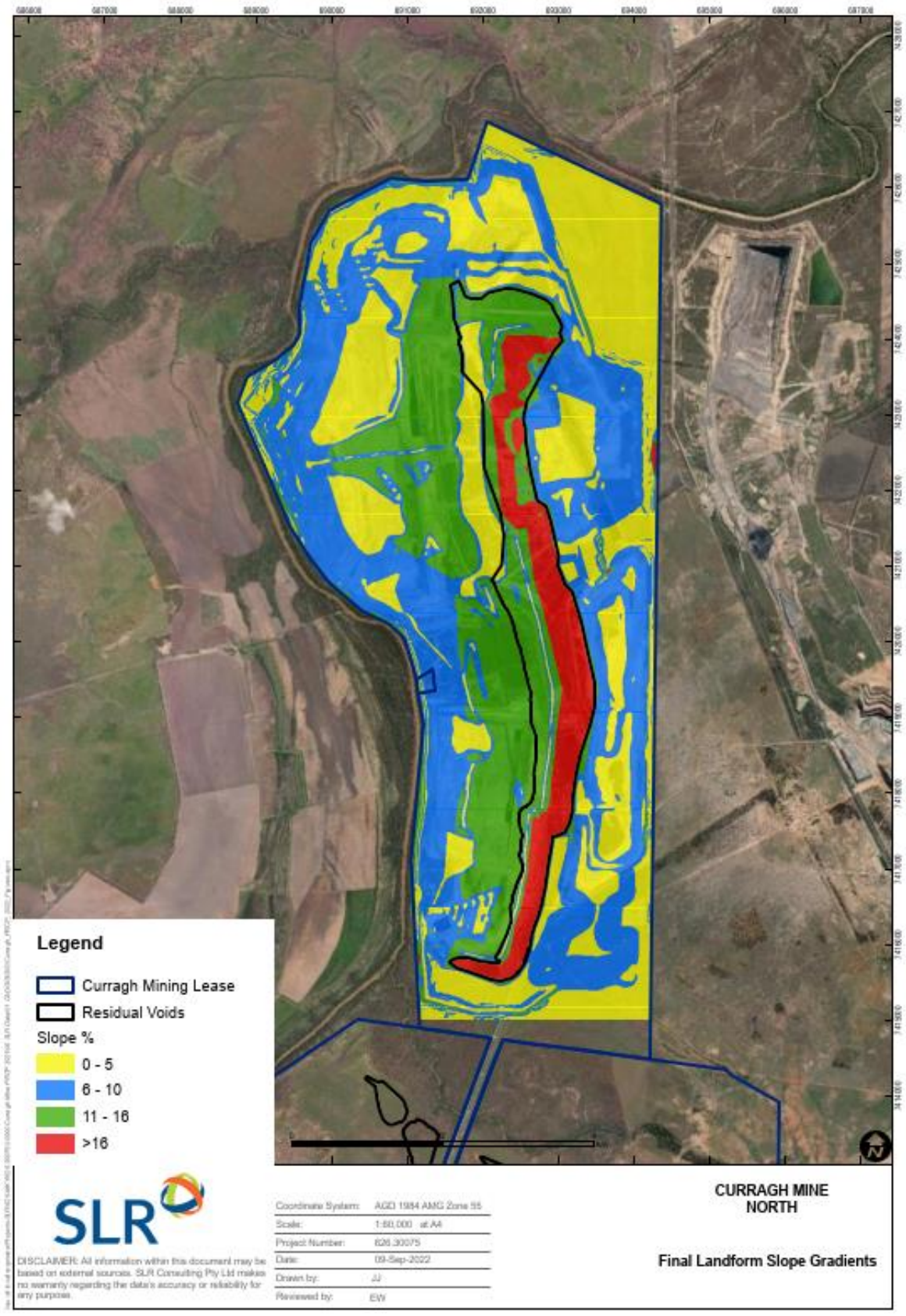


Figure 6-4 Curragh North Final Landform Slope Gradients (%)

6.1.1.1 Erosion Assessment

An erosion assessment of the conceptual final landform was undertaken by SLR (2022) (**Appendix F**). The erosion assessment utilised the revised universal soil loss equation (RUSLE) to calculate the potential soil loss from the conceptual landform. This method was used as an early indicator into whether the proposed slopes would be erosionally stable.

Topsoil and spoil samples were taken from across the mine and analysed in a laboratory in order to provide input for the RUSLE calculations. A number of cover methods were assessed including different levels of grass cover, the application of hydromulch, a cover crop with straw mulch and a cover crop with stone.

There is currently no broad agreement on what constitutes an 'acceptable rate of erosion' on a rehabilitated landform. Spatial data available from CSIRO (2020) provides estimates of broad scale and in situ soil erosion in Australia. The soil erosion estimates provided for the Curragh site range from 0.026 to 31.4 t/ha/y. SLR have used the Food and Agricultural Organisation (FAO) soil loss classes for assessing an acceptable soil loss criterion at Curragh Complex, as shown in **Table 6-2**.

Table 6-2 FAO soil loss classes after Bergma et al (1991)

Soil loss (ton/ha/yr.)	Class
< 5	very low
5 – 12	low
12 – 25	moderate
25 – 60	high
60 – 150	very high
> 150	extremely high

The results of the RUSLE calculations are provided in **Table 6-3** for Permian, Quaternary and Tertiary spoil and **Table 6-4** for topsoil from Curragh North and Curragh Main. The results indicate the following:

- Stable 16% slope gradients can be achieved on all spoil types by applying hydromulch;
- Permian and Quaternary spoil with 16% slope gradients will be stable once 50% cover is established;
- Tertiary spoil will only be stable when at least 80% cover is established;
- Spoil stability is increased as a result of stone fragments which provide additional cover;
- Stone cover offer the best protection against erosion with soil losses classified as very low to low where this is applied;
- Topsoil from Curragh North is less erodible and will reach a low annual soil loss once 60% cover is established; and
- Topsoil from Curragh Main is more erodible and gentler slopes should be considered.

Table 6-3 Soil loss (t/ha/yr.) for Spoil at Curragh Complex

Lithology		Slope angle (%)	35%	25%	18%	16%	14%	12%	10%	8%	6%
		Slope length (m)	31m	45m	45m	55m	70m	80m	90m	105m	115m
	Cover management				Calculated annual soil loss (t/ha/yr.)						
Permian	Newly established grass cover no canopy	0	219.0	204.9	116.9	110.4	106.1	88.0	69.6	52.3	38.2
		20	98.6	92.2	52.6	49.7	47.7	39.6	31.3	23.5	17.2
		40	43.8	41.0	23.4	22.1	21.2	17.6	13.9	10.5	7.6
		50	32.9	30.7	17.5	16.6	15.9	13.2	10.4	7.8	5.7
		60	21.9	20.5	11.7	11.0	10.6	8.8	7.0	5.2	3.8
		80	6.6	6.1	3.5	3.3	3.2	2.6	2.1	1.6	1.1
	Hydromulch		15.3	14.3	8.2	7.7	7.4	6.2	4.9	3.7	2.7
	Cover crop with 2.5 t/ha straw mulch		43.8	41.0	23.4	22.1	21.2	17.6	13.9	10.5	7.6
	Cover crop with 3.8 t/ha straw mulch		26.3	24.6	14.0	13.2	12.7	10.6	8.4	6.3	4.6
	Cover crop with 330 t/ha stone		11.0	10.2	5.8	5.5	5.3	4.4	3.5	2.6	1.9
	Cover crop with 600 t/ha stone		4.4	4.1	2.3	2.2	2.1	1.8	1.4	1.0	0.8
Quaternary	Newly established grass cover no canopy	0	148.9	139.4	79.5	75.1	72.1	59.9	47.4	35.6	26.0
		20	67.0	62.7	35.8	33.8	32.5	26.9	21.3	16.0	11.7
		40	29.8	27.9	15.9	15.0	14.4	12.0	9.5	7.1	5.2
		50	22.3	20.9	11.9	11.3	10.8	9.0	7.1	5.3	3.9
		60	14.9	13.9	7.9	7.5	7.2	6.0	4.7	3.6	2.6
		80	4.5	4.2	2.4	2.3	2.2	1.8	1.4	1.1	0.8
	Hydromulch		10.4	9.8	5.6	5.3	5.0	4.2	3.3	2.5	1.8
	Cover crop with 2.5 t/ha straw mulch		29.8	27.9	15.9	15.0	14.4	12.0	9.5	7.1	5.2
	Cover crop with 3.8 t/ha straw mulch		17.9	16.7	9.5	9.0	8.7	7.2	5.7	4.3	3.1
	Cover crop with 330 t/ha stone		7.4	7.0	4.0	3.8	3.6	3.0	2.4	1.8	1.3
	Cover crop with 600 t/ha stone		3.0	2.8	1.6	1.5	1.4	1.2	0.9	0.7	0.5
Tertiary	Newly established grass cover no canopy	0	236.5	221.3	126.3	119.2	114.6	95.1	75.2	56.5	41.3
		20	106.4	99.6	56.8	53.7	51.6	42.8	33.8	25.4	18.6
		40	47.3	44.3	25.3	23.8	22.9	19.0	15.0	11.3	8.3
		50	35.5	33.2	18.9	17.9	17.2	14.3	11.3	8.5	6.2
		60	23.7	22.1	12.6	11.9	11.5	9.5	7.5	5.7	4.1
		80	7.1	6.6	3.8	3.6	3.4	2.9	2.3	1.7	1.2
	Hydromulch		16.6	15.5	8.8	8.3	8.0	6.7	5.3	4.0	2.9

Lithology	Slope angle (%)	35%	25%	18%	16%	14%	12%	10%	8%	6%
	Slope length (m)	31m	45m	45m	55m	70m	80m	90m	105m	115m
	Cover management	Calculated annual soil loss (t/ha/yr.)								
	Cover crop with 2.5 t/ha straw mulch	47.3	44.3	25.3	23.8	22.9	19.0	15.0	11.3	8.3
	Cover crop with 3.8 t/ha straw mulch	28.4	26.6	15.2	14.3	13.7	11.4	9.0	6.8	5.0
	Cover crop with 330 t/ha stone	11.8	11.1	6.3	6.0	5.7	4.8	3.8	2.8	2.1
	Cover crop with 600 t/ha stone	4.7	4.4	2.5	2.4	2.3	1.9	1.5	1.1	0.8

Table 6-4 Soil loss (t/ha/yr.) for Topsoil at Curragh Complex

Lithology	Slope angle (%)		35%	25%	18%	16%	14%	12%	10%	8%	6%
	Slope length (m)		31	45m	45m	55m	70m	80m	90m	105m	115m
	Cover management		Calculated annual soil loss (t/ha/yr.)								
Curragh North	Percentage newly established grass cover no canopy	0	184.0	172.1	98.2	92.7	89.1	73.9	58.5	43.9	32.1
		0.2	82.8	77.5	44.2	41.7	40.1	33.3	26.3	19.8	14.5
		0.4	36.8	34.4	19.6	18.5	17.8	14.8	11.7	8.8	6.4
		0.5	27.6	25.8	14.7	13.9	13.4	11.1	8.8	6.6	4.8
		0.6	18.4	17.2	9.8	9.3	8.9	7.4	5.8	4.4	3.2
		0.8	5.5	5.2	2.9	2.8	2.7	2.2	1.8	1.3	1.0
	Hydromulch		12.9	12.1	6.9	6.5	6.2	5.2	4.1	3.1	2.2
	Cover crop with 2.5 t/ha straw mulch		36.8	34.4	19.6	18.5	17.8	14.8	11.7	8.8	6.4
	Cover crop with 3.8 t/ha straw mulch		22.1	20.7	11.8	11.1	10.7	8.9	7.0	5.3	3.9
	Cover crop with 330 t/ha stone		9.2	8.6	4.9	4.6	4.5	3.7	2.9	2.2	1.6
	Cover crop with 600 t/ha stone		3.7	3.4	2.0	1.9	1.8	1.5	1.2	0.9	0.6
Curragh Main	Percentage newly established grass cover no canopy	0	245.3	229.5	130.9	123.7	118.8	98.6	78.0	58.6	42.8
		0.2	110.4	103.3	58.9	55.6	53.5	44.4	35.1	26.4	19.3
		0.4	49.1	45.9	26.2	24.7	23.8	19.7	15.6	11.7	8.6
		0.5	36.8	34.4	19.6	18.5	17.8	14.8	11.7	8.8	6.4
		0.6	24.5	23.0	13.1	12.4	11.9	9.9	7.8	5.9	4.3
		0.8	7.4	6.9	3.9	3.7	3.6	3.0	2.3	1.8	1.3
	Hydromulch		17.2	16.1	9.2	8.7	8.3	6.9	5.5	4.1	3.0
	Cover crop with 2.5 t/ha straw mulch		49.1	45.9	26.2	24.7	23.8	19.7	15.6	11.7	8.6
	Cover crop with 3.8 t/ha straw mulch		29.4	27.5	15.7	14.8	14.3	11.8	9.4	7.0	5.1
	Cover crop with 330 t/ha stone		12.3	11.5	6.5	6.2	5.9	4.9	3.9	2.9	2.1
	Cover crop with 600 t/ha stone		4.9	4.6	2.6	2.5	2.4	2.0	1.6	1.2	0.9

6.1.2 Hydrogeology

SLR have reviewed the existing groundwater, climate, geology, surface water and topography data available for Curragh Complex and developed a Groundwater Technical Report (**Appendix G**) to support this PRCP. The objectives of the hydrogeological assessment are to understand the post-closure groundwater regime around the mine and specifically to:

1. Present an understanding of the hydrogeological setting of the mine including potential groundwater receptors;

2. Simulate the post mining groundwater level recovery using the final landform (mine void backfill levels) developed by CCPL to understand whether the final voids act as groundwater sinks or sources; and

3. Understand the long-term effect of the proposed post mining landform on local groundwater levels i.e. the residual drawdown, and post-mining groundwater flux.

Section 2 of the Groundwater Technical Report presents information on the hydrogeological setting of the Curragh mine and the Conceptional Hydrogeological Model (CHM) including:

- Topography, climate and hydrology;
- Geology and Hydrostratigraphy;
- Groundwater monitoring data (quality, levels, local Water Quality Objectives); and
- Groundwater values (Groundwater Dependant Ecosystems and local groundwater use).

The surface geology across the study area (based on 1:100,000 published mapping), is presented in **Figure 2-6** and the regional (solid) geology is presented in **Figure 2-7.** Cross-sections showing the geology of the study area have been developed using the geological model for the mine together with LiDAR (current and pre mining), and the final landform. The locations of all cross-sections presented in the groundwater technical appendix (**Appendix X**) are shown on **Figure 2-7**, and selected cross sections are reproduced here including the north-south long section (A-A' **Figure 6-5**), and east-west sections (C-C' **Figure 6-6**, E-E' **Figure 6-7**, and G-G' **Figure 6-8**).

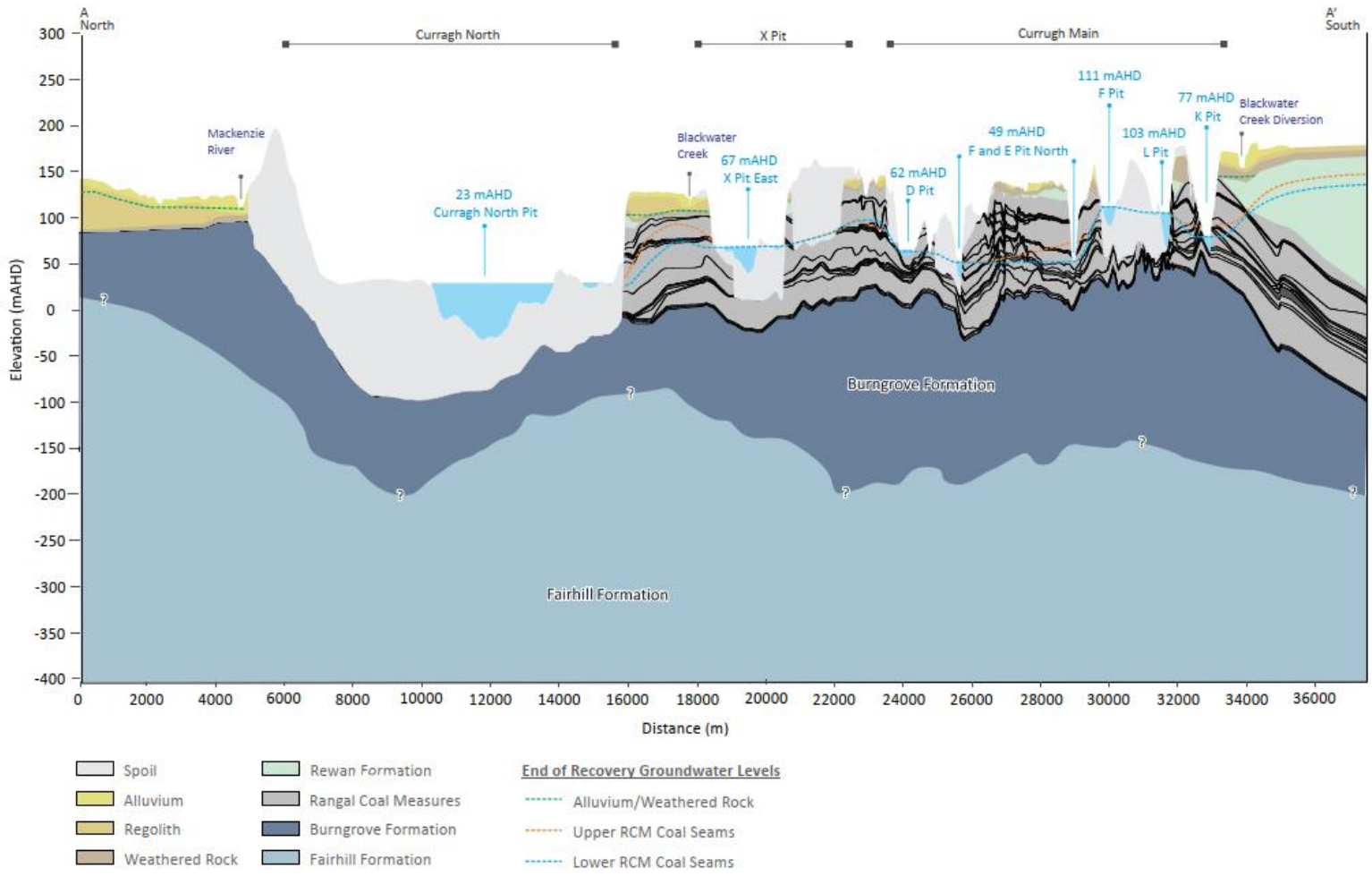


Figure 6-5 Conceptual geological cross-section A-A' (PB, 2016)

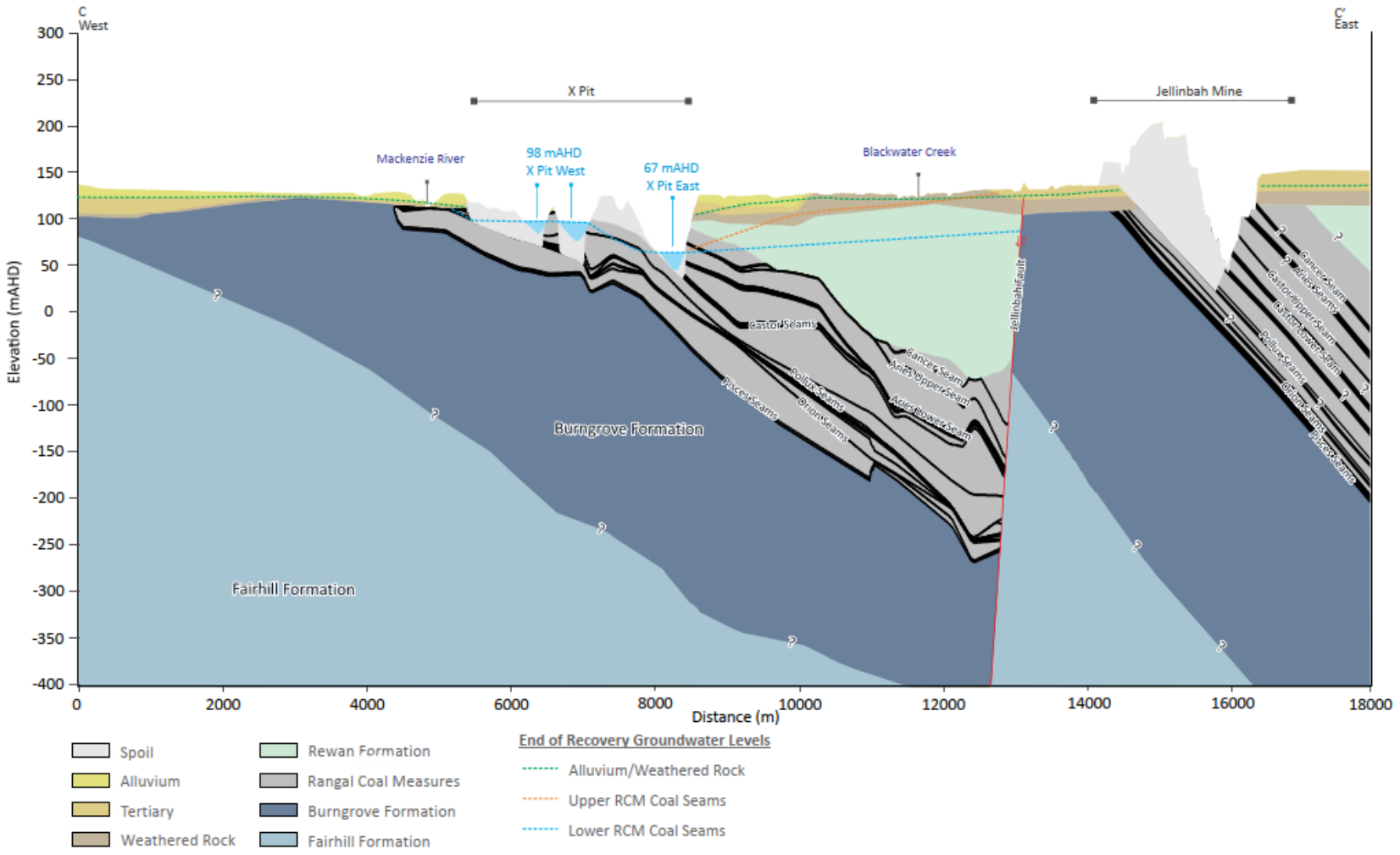


Figure 6-6 Geological cross-section C-C' of Curragh Complex showing final landforms/voids and groundwater levels

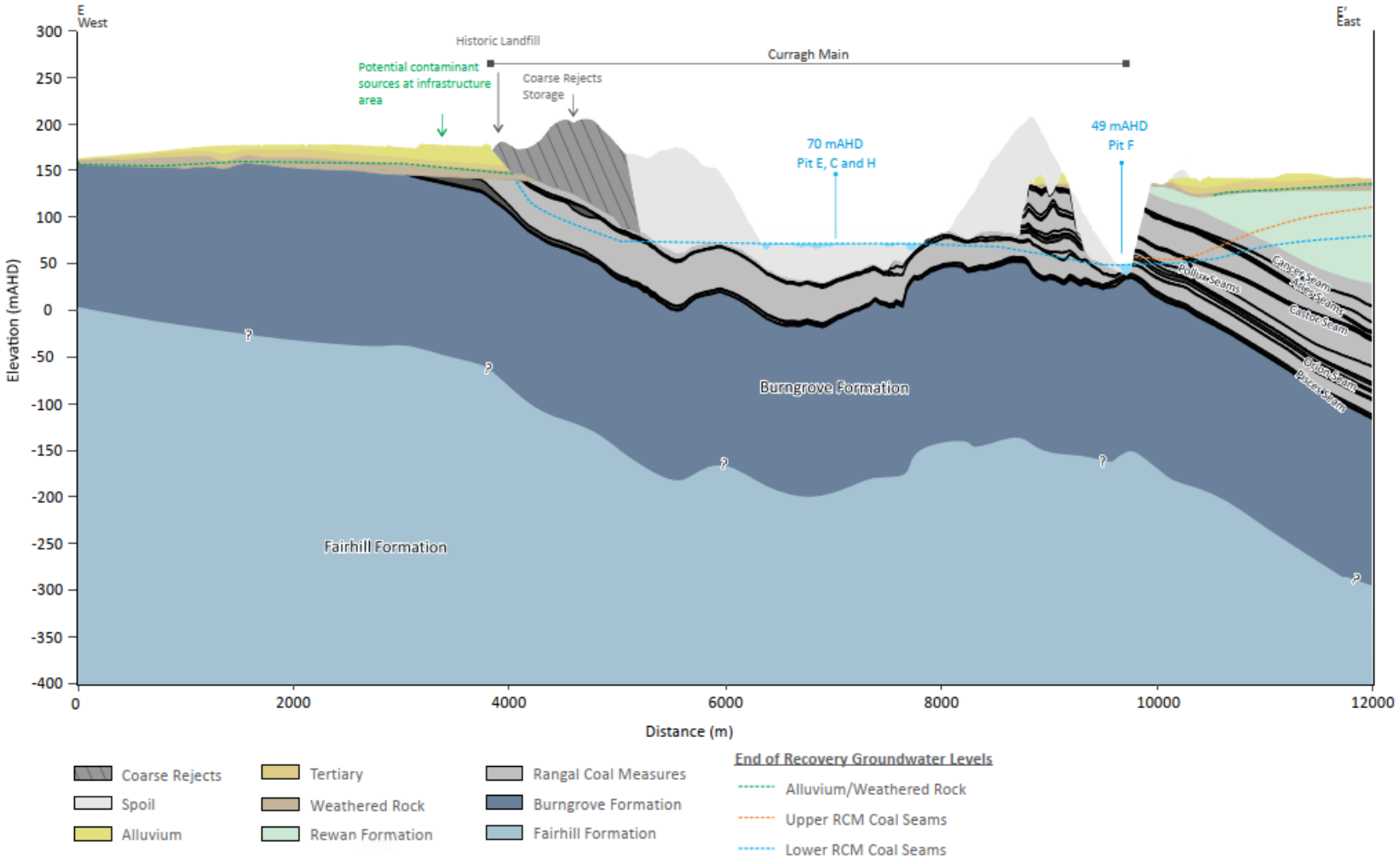


Figure 6-7 Geological cross-section E-E' of Curragh Complex showing final landforms/voids and groundwater levels

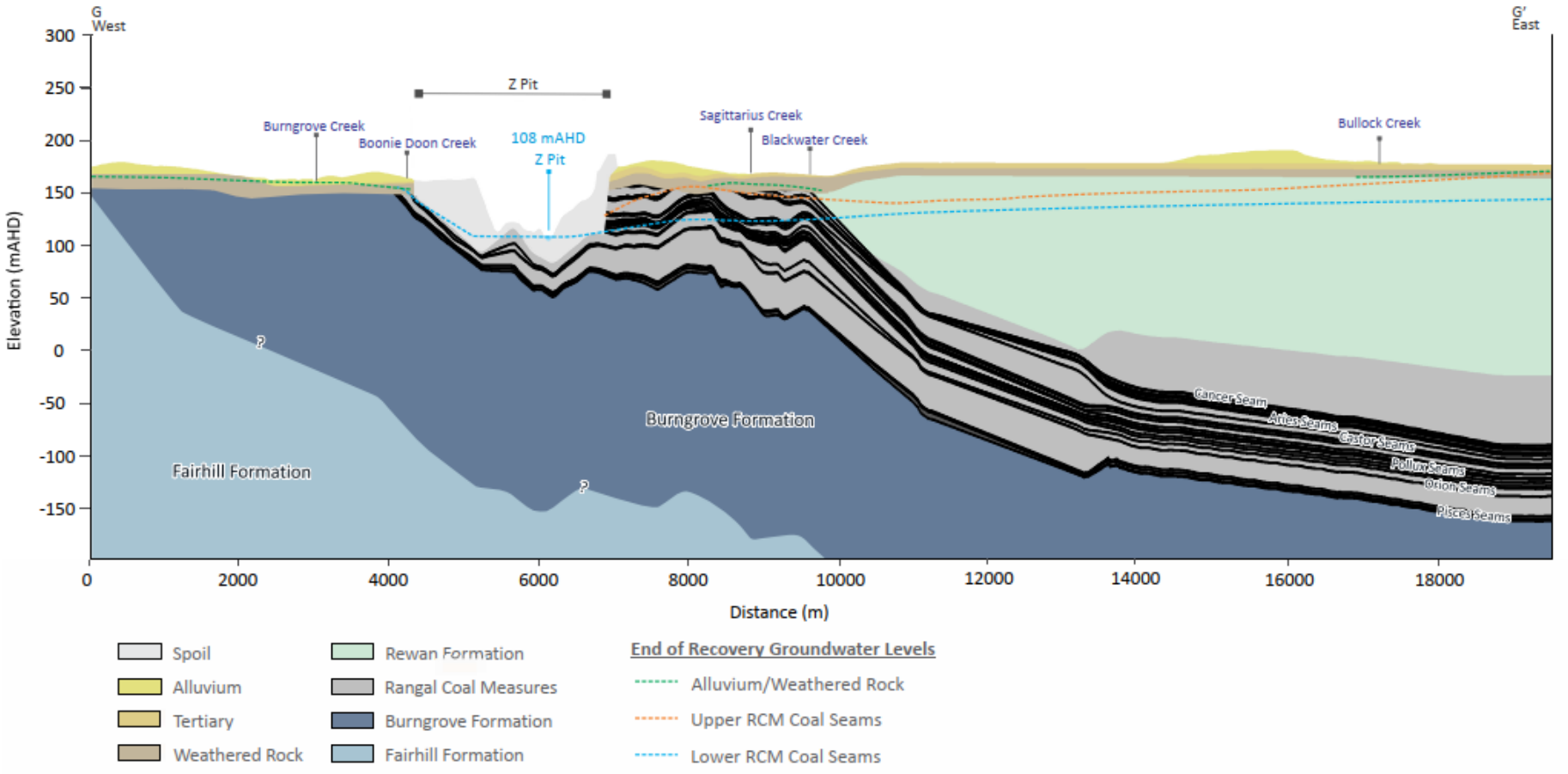


Figure 6-8 Geological cross-section G-G' of Curragh Complex showing final landforms/voids and groundwater levels

An updated model has been constructed by SLR to assess the recovery of the groundwater system after mine closure. The key changes to the model design from that reported for the 2021 CRVA model (SLR, 2021) include:

- Model extent and grid – extended model domain, unstructured Voronoi grid with refinement in key areas;
- Model layers – constructed layers to capture significant displacement faults within Curragh Mine area and incorporate the most recent geological model for the Curragh Mine Complex;
- Boundary conditions – set model boundary conditions with revised grid and regional flows;
- Stresses – model inputs updated with recent and site-specific data;
- Calibration – the new model has been calibrated with an updated calibration data set.

The key modelling objectives were to:

- Develop a calibrated model with mine progression, final voids, tailings storages in line with the current closure landform design developed by Coronado;
- Simulate the post-mining groundwater level recovery to assess whether the final voids will generally act as groundwater sinks or sources; and;
- Understand the long-term effect of the proposed post-mining landform on local groundwater levels by comparing the long-term post closure case to a null case (no mining scenario).

Further information on the numerical model is provided in **Appendix G**.

Post mining impacts were investigated with a recovery model, commencing at the end of active mining. A preliminary transient recovery model was developed initially to assess the relationship between the final voids' lake elevations and groundwater inflow. The relationship between groundwater inflows to the voids and void lake level was extracted from the preliminary recovery model and incorporated into the mine water balance model (WBM). The WBM predicts the equilibrium lake levels for each void and these levels were then used in the final groundwater recovery model.

The final recovery model uses the MODFLOW river package (RIV) to simulate increasing void lake elevations in the final voids over the recovery period, with stage elevations vs time applied according to the WBM predictions for each void, up to the predicted equilibrium lake levels. The WBM predicted water levels in the final voids to reach equilibrium conditions after approximately 50 to 80 years, dependent on void structure and interaction with the regional groundwater system

The simulated average groundwater takes at the end of recovery (December 2132) for each site area is presented in **Table 6-5.** The net groundwater flux has been calculated as a cumulative void flux for each area at the Curragh Complex (Curragh North, X Pit, Curragh Main, Ramp 9, Y Pit and Z Pit) (**Figure 6-9**) to account for interaction between the adjacent voids within each area. The groundwater fluxes to the final voids are total fluxes, including throughflow from spoil (higher recharge over the spoil and drainage into the final void), and groundwater inflow from the Rangal Coal Measures (RCM).

An equilibrium groundwater flux of 6.14 ML/day was predicted at Curragh North, where the minimum elevation of the final landform is significantly lower than the other voids. The relative depth of the residual void at Curragh North is likely accountable for the higher predicted groundwater flux to the void in this area. Equilibrium total groundwater flux to the voids in X Pit, Curragh Main, Ramp 9, Y Pit and Z Pit are predicted to be 0.57, 1.44, 0.02, 0.08 and 0.64 ML/day respectively, indicating all simulated voids are predicted to be groundwater sinks with net groundwater flow into the voids.

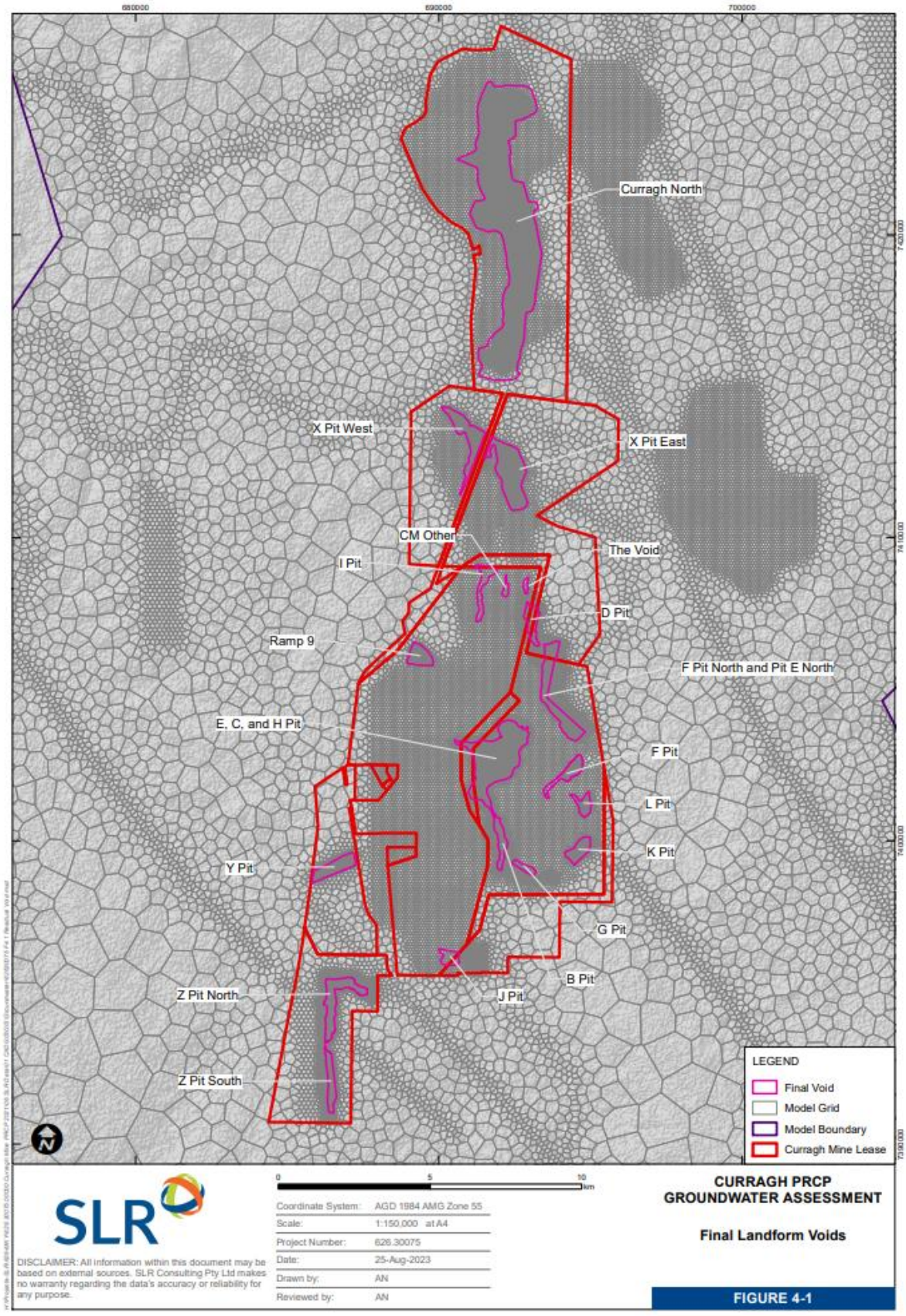


Figure 6-9 Hydrogeologic Residual Void Groups

Table 6-5 Post-mining equilibrium residual void summary

Curragh Area:		Curragh N	X Pit		Curragh Main												Ramp 9	Y Pit	Z Pit	
Residual Void[1]:		**UTS**	**X West**	**X East**	**I Pit**	**Main Other**	**The Void**	**D Pit**	**F Pit**	**F Pit North & E Pit**	**E,C,H Pits**	**B Pit**	**K Pit**	**L Pit**	**G Pit**	**J Pit**			**Z Pit North**	**Z Pit South**
Final landform minimum elevation (mAHD)		-48	78.4	33.5	133.1	120	93	29.1	91.6	26.6	40.6	108	63.1	64.6	130.1	92.6	77.1	116	78.1	87.1
Post-mining equilibrium void lake level (mAHD)*		23	98	67	135	135	100	62	111	49	70	112	77	103	137	111	132	123	108	105
Final landform crest elevation (mAHD)		132.5	123.5	123.5	146	147	135	103.5	149	103.5	129	129	163	149	150	153	156	162	136	136
Approximate base of weathering (mAHD)**		45	105	99	130	126	126	120	120	117	130	136	137	133	137	131	123	148	153	160
Void lake salinity (uS/cm), predicted by the water balance model.[2]	~10 years	13,900	19,200	15,600	>50,000	11,700	10,200	16,500	18,200	27,500	15,700	>50,000	28,400	13,800	40,700	23,300	17,300	40,600	19,800	23,400
	~30 years	20,100	39,600	27,500	>50,000	25,700	15,600	28,800	38,600	>50,000	33,700	>50,000	>50,000	24,200	>50,000	49,300	25,600	>50,000	37,600	48,500
	~200 years	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000	>50,000
Net groundwater flux to void at equilibrium (ML/day)***		6.14	0.57		1.44												0.02	0.08	0.64	

Notes:
1 The residual voids have been grouped where a void may act as a source of water to an adjacent void, but where collectively they act as a groundwater sink.
2 532,836 µS/cm is the maximum salinity limit set in the surface water balance model (SLR 2022)
* Final lake levels were derived from the surface water model.
** Approximate elevation of base of weathering estimated from available data.
*** Total flux including inflow draining from the spoil and groundwater inflow from the RCM

The predicted post-mining water table at equilibrium (end of recovery) is shown in **Figure 6-10**. Hydraulic gradients at equilibrium indicate an overall flow direction toward residual voids at Curragh Main and Curragh North. All residual voids show hydraulic heads decreasing with proximity to the void, indicating all voids are predicted to act as local groundwater sinks.

Predicted drawdown figures (**Figure 6-11** and **Figure 6-12**) show where residual drawdown impacts are predicted to exceed 1 m. **Figure 6-11** presents the residual drawdown within the alluvium only, at post-mining equilibrium. Predicted recovered heads in the alluvium west of Curragh North show residual drawdowns of 1 to 2 m extending up to 4 km from mined pits at Curragh North although drawdowns at the very edge of the voids are higher (10-20 m). **Figure 6-12** presents the residual drawdown of the water table at post-mining equilibrium.

To investigate groundwater movement within and around the mine from the end of mining through to post-mining equilibrium particle tracking has been used. Mod-PATH3DU code (S.S. Papadopulos & Associates, Inc., 2021) was used to track the flow paths and destination of groundwater during and after recovery. Particle starting locations were selected within and around the mining areas and particles are released in the uppermost saturated layer at the start of the post-mining simulation (end of mining). The particle starting locations and their movement through the groundwater recovery simulation and in the post mining equilibrium setting are shown in **Figure 6-13** and **Figure 6-14**. Particle pathways are colour coded by the geological formation through which they are traveling. Particle tracking runs for 500 years from the end of mining.

The particle flow paths indicate that in all cases groundwater flow is ultimately toward the residual voids i.e., none of the voids act as seepage sources to the wider groundwater system (although some voids may act as sources to adjacent voids with lower final landform elevations or predicted equilibrium water levels). Particle tracking also indicates that indicates that there is no off-site migration of groundwater and that groundwater in the vicinity of the TSFs and sources of potential groundwater contamination (infrastructure area, landfills) will migrate towards the final voids rather than migrate off site.

In some cases it can be seen that particle traces initially show movement of particles is away from the voids. This occurs during the initial recovery phase where higher recharge over the spoil may result in more rapid recovery within the pit shells than the surrounding geology and some initial outward movement of groundwater from the mined areas. As recovery progresses groundwater levels in the in the surrounding geological formations exceed the recovery levels within the pit shells and final voids and any initial outward hydraulic gradients reverse and groundwater movement is towards the final voids.

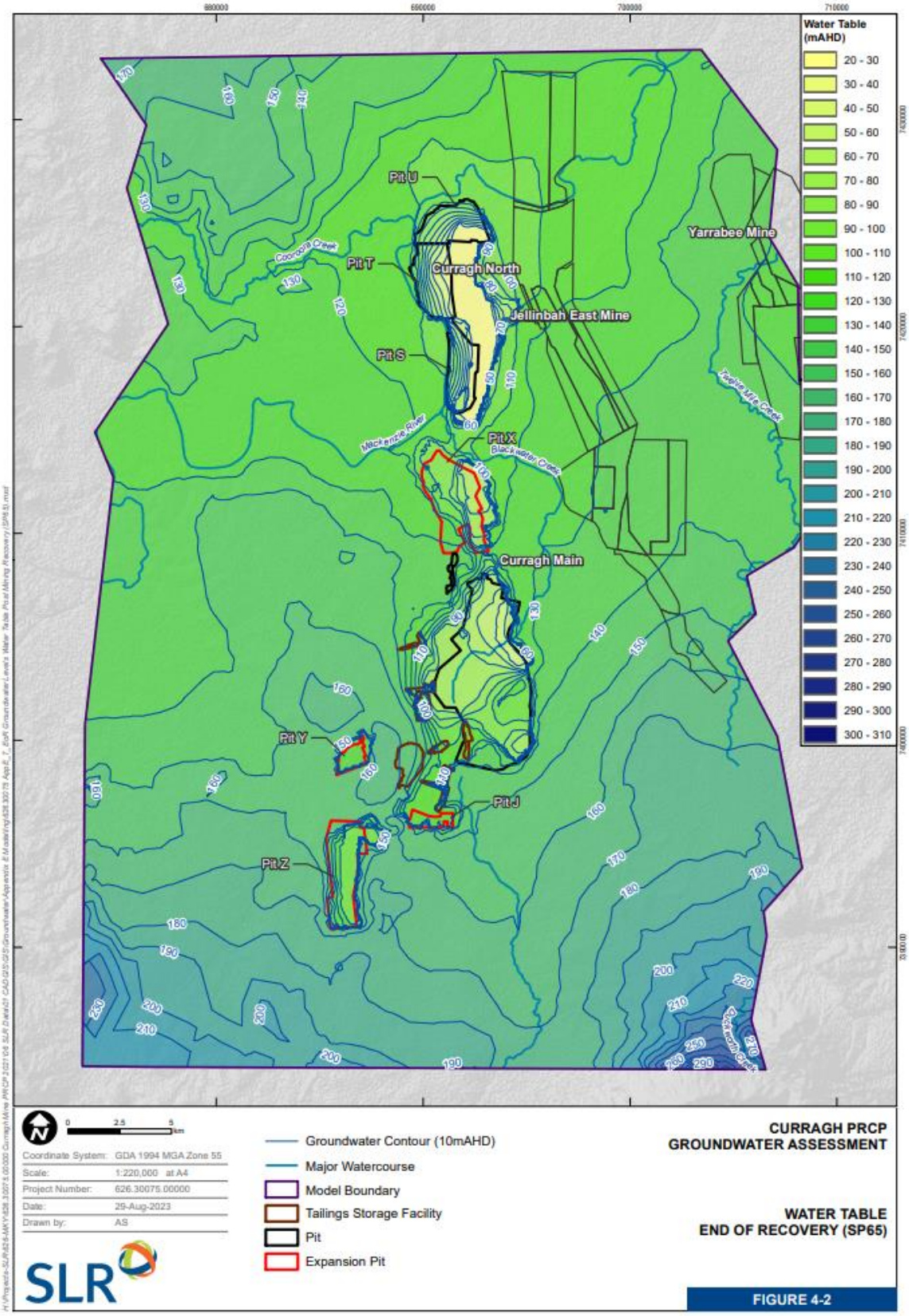


Figure 6-10 Predicted Water Table at End of Recovery

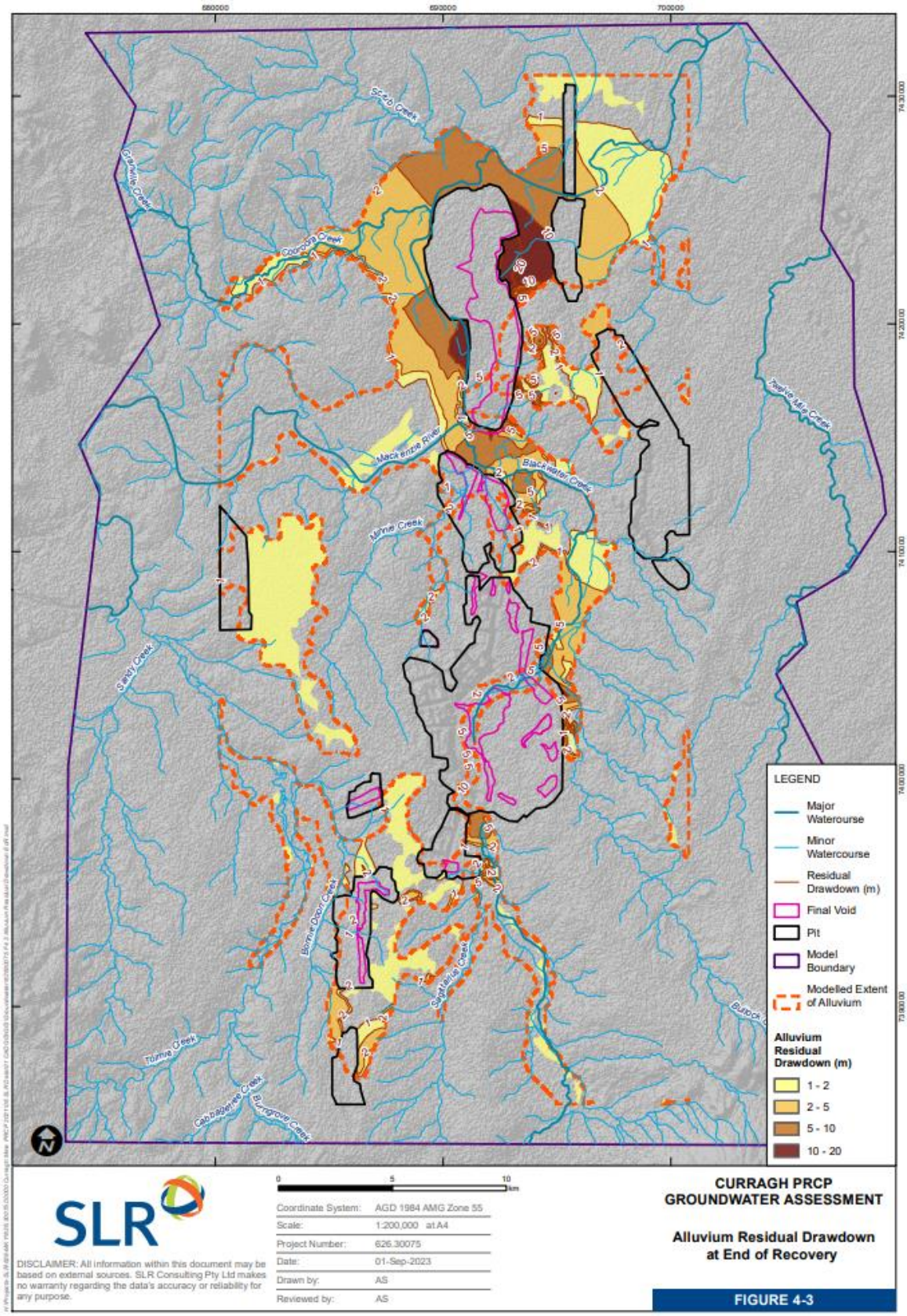


Figure 6-11 Predicted Residual Drawdown in Alluvium at End of Recovery

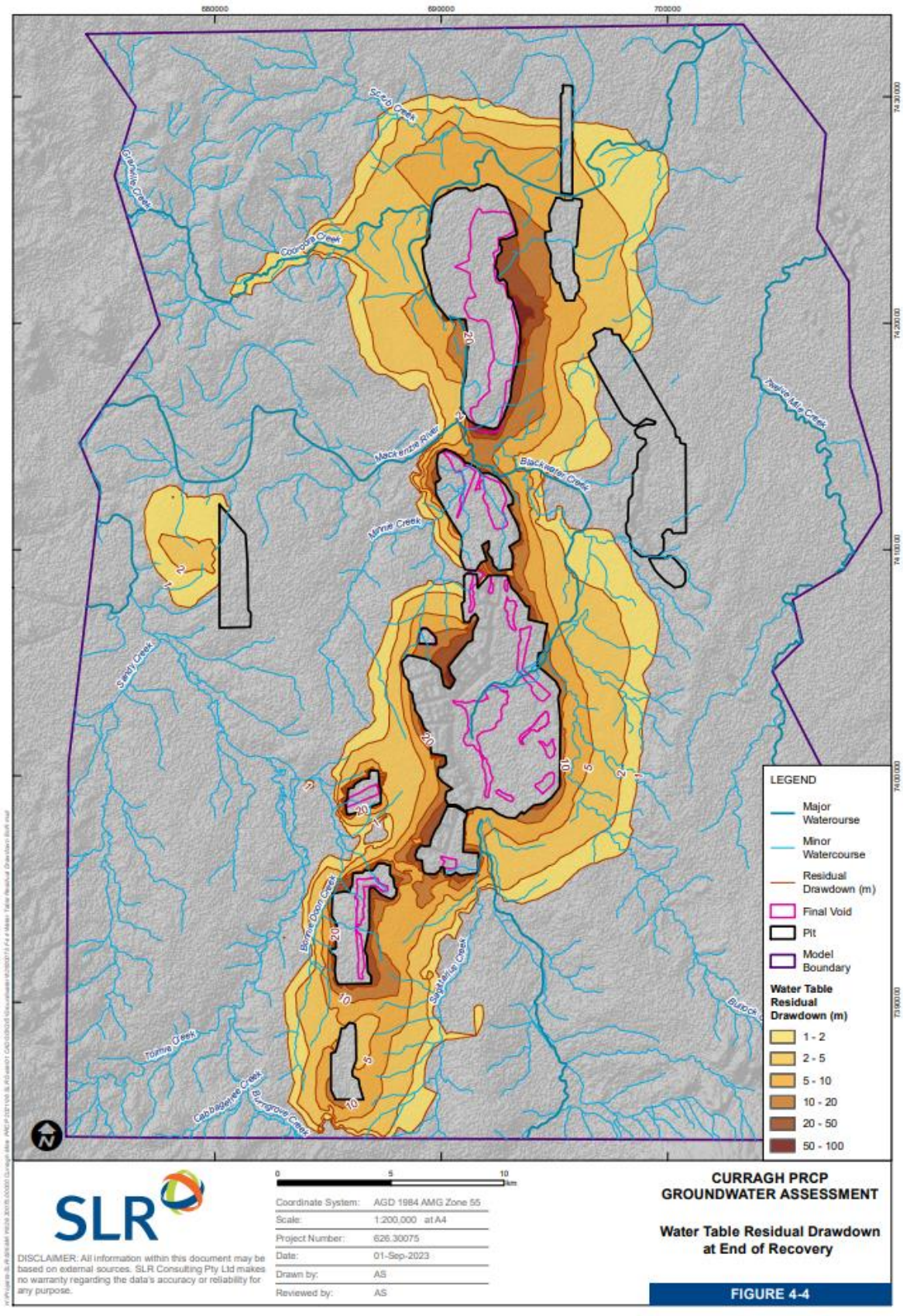


Figure 6-12 Predicted Residual Water Table Drawdown at End of Recovery

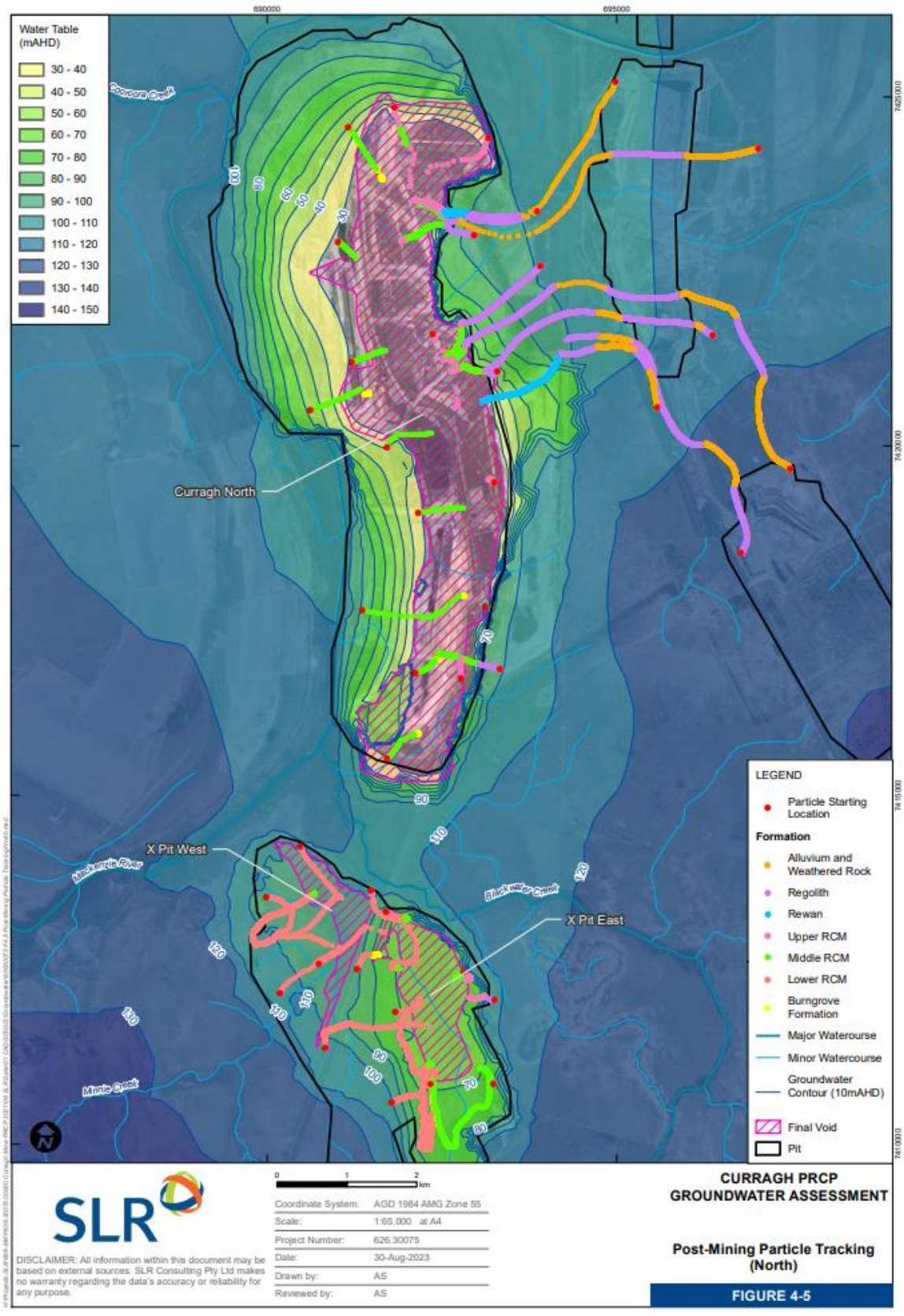


Figure 6-13 Particle Tracking – Groundwater recovery and Post-Mining Equilibrium (North)

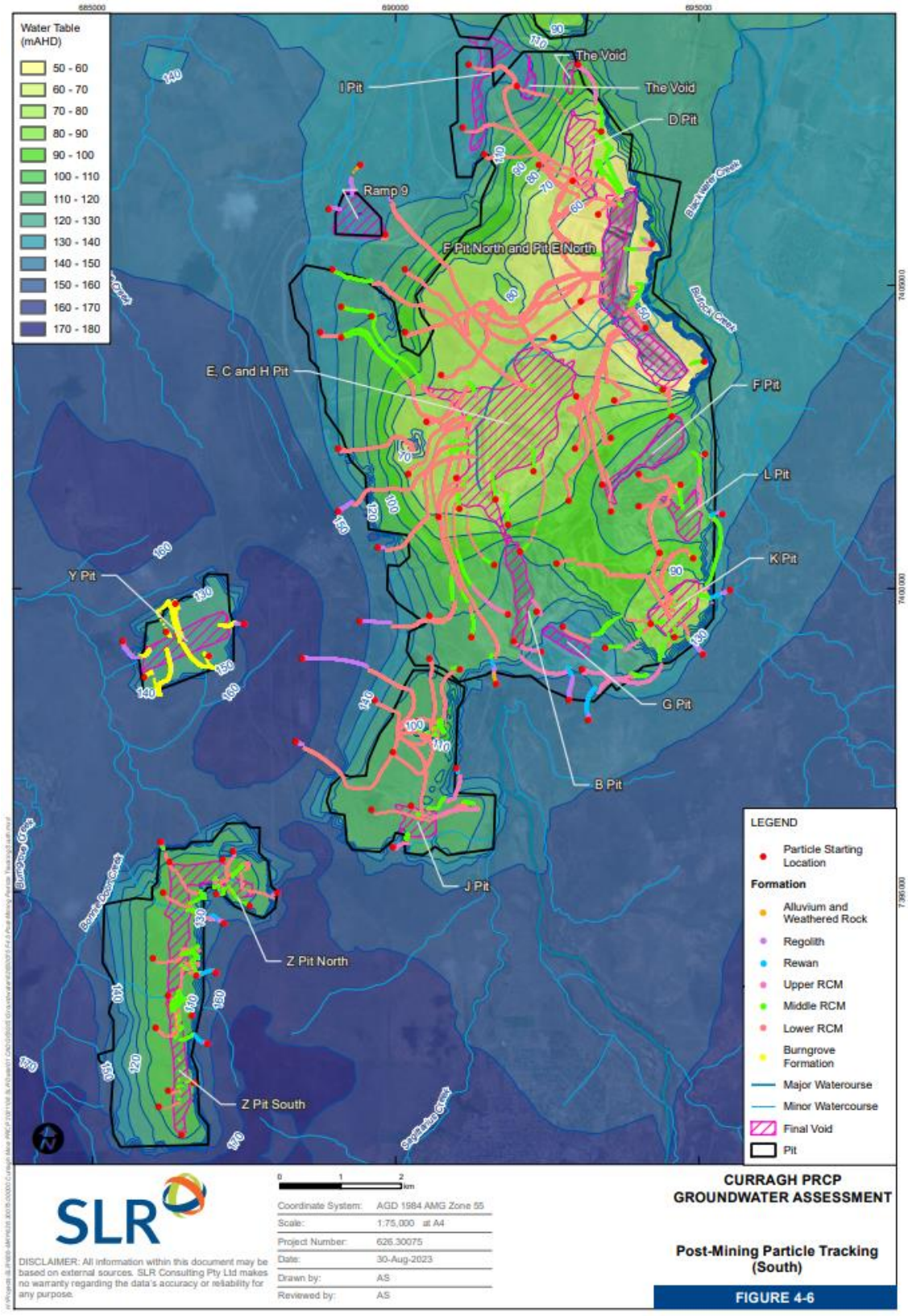


Figure 6-14 Particle Tracking – Groundwater recovery and Post-Mining Equilibrium (South)

The following key conclusions are drawn from the numerical modelling assessment of the post-mining groundwater environment at the Curragh Mine Complex:

- The modelling indicates that lakes will form within the final voids of the proposed post-mining landform. These lakes will act as groundwater 'sinks' with groundwater within mining disturbed areas (including the TSFs, CRS and shallow groundwater at the location of potential sources of contamination) migrating towards these sinks. This is clearly demonstrated by the particle tracking (**Figure 6-13** and **Figure 6-14**), post mining (end of recovery) groundwater contours for key formations and the geological cross sections showing post-mining (end of recovery) groundwater levels.
- Post-mining residual drawdown in the Mackenzie River Alluvium to the west of Curragh North will generally be in the order of 1-2m (but up to 20m near the mine voids), noting that the Mackenzie River is regarded as a "losing" watercourse with pre-mining groundwater levels in the alluvium 3-5m below the river stage in the vicinity of the mine. This is consistent with conclusions drawn from the preliminary numerical modelling (SLR, 2021).
- Based on the geological data reviewed for this assessment, it appears that equilibrium void lake levels are generally below the base of the alluvium and the base of weathering (potential preferential pathways for outward seepage of water from the void lakes). Where the minimum base of weathering elevation is potentially exceeded by the predicted equilibrium void lake levels at Ramp 9 and Pit G, particle tracking shows that any seepage from these voids will migrate to adjacent voids with lower void lake levels.
- Post-mining, the total estimated "groundwater" inflow to all voids is approximately 8.89 ML/d although the majority of this is water derived from infiltration to the spoil and drainage into the void lake rather than inflow from the Rangal Coal Measures or Alluvium.

6.1.3 Material Assessment

Topsoil Management

Topsoil is managed in accordance with the mine Topsoil Management Procedure which outlines stripping methods, topsoil storage and topsoil placement.

Topsoil depth as determined from the soil mapping will provide a guide as to the depth of topsoil to be removed. All preferable topsoil shall be removed to the correct depth prior to mining. EMS PROC 1.3 Topsoil Management Procedure together with the EMS PROC 1.2 Permit to Disturb Procedure governs the removal of topsoil along with conditions and controls required for vegetation management.

Curragh's topsoil management program targets a stockpile surplus that is capable of ensuring that:

- Topsoil strips unable to sustain vegetation cover (e.g. through drought conditions) can be re-topsoiled if necessary;
- Bare spoil strips unable to sustain vegetation cover can be topsoiled where appropriate;
- If topsoil quality deteriorates in some areas of stockpile, there is sufficient volume of suitable quality to ensure that topsoiling needs are met; and
- Topsoil inventory reconciliations are undertaken regularly by the Curragh Survey team based on surveyed volumes.

Where suitably prepared areas are not yet ready for topsoil placement, topsoil shall be stockpiled to a maximum height of two lifts with rear dump trucks or scrapers to a height of about four metres to limit soil degradation. Procedures for the management of Topsoil are found in EMS PROC 1.3 Topsoil Management Procedure.

Topsoil replacement at Curragh Complex is carried out in accordance with the following procedures EMS PROC 1.3 Topsoil Management Procedure and EM PLAN 1.3 Rehabilitation Management and Monitoring Plan.

Topsoil Inventory

CCPL (2020) has undertaken a topsoil quality assessment which includes information on the volumes and quality of topsoil stockpiles within the Curragh Complex. Topsoil is currently stripped in advance of mining activities and stockpiled for utilisation in planned rehabilitation activities. As each new topsoil stockpile is created it is included into the topsoil inventory in its specific zone and allocated the next numerical number available. Therefore, the lower the stockpile ID number the older the topsoil stockpile is. However, as mining progresses some of the old topsoil stockpiles are required to be relocated. As this occurs comments are made in the topsoil inventory to indicate that a topsoil stockpile has been relocated to a new location, and whether it has kept its original number or had a new number allocated.

Topsoil stockpile zones are allocated as a new active mining pit or overburden dump location are created. Topsoil stockpiles are surveyed by the Curragh Survey Team for topsoil volume as they are generated, or at the end of each month with the aerial LIDAR process. Topsoil stockpile volume and location reconciliations are conducted by the Curragh Survey and Environmental Teams regularly and are saved in both a mapping layer for visual representation and an inventory list for volumetric analysis.

Topsoil stockpile locations and topsoil zones for Curragh Main and Curragh North are shown in **Figure 6-15** and **Figure 6-16** respectively, with current stockpiled topsoil volumes, by topsoil zone, provided in **Table 6-6**.

Table 6-6 Topsoil Inventory June 2022

Location Description		Volume m^3	Total m^3
Curragh Main	Zone 1	893,942	5,620,304
	Zone 2	70,284	
	Zone 3	533,081	
	Zone 4	255,829	
	Zone 5	626,809	
	Zone 5	433,939	
	Zone 7	955,893	
	Zone 8	785,359	
	Zone 9	1,065,168	
Curragh North	Zone 10	56,461	7,294,292
	Zone 11	119,893	
	Zone 12	134,156	
	Zone 13	856,792	
	Zone 14	849,045	
	Zone 15	4,180,573	
	Zone 16	1,097,372	
Total			**12,914,596**

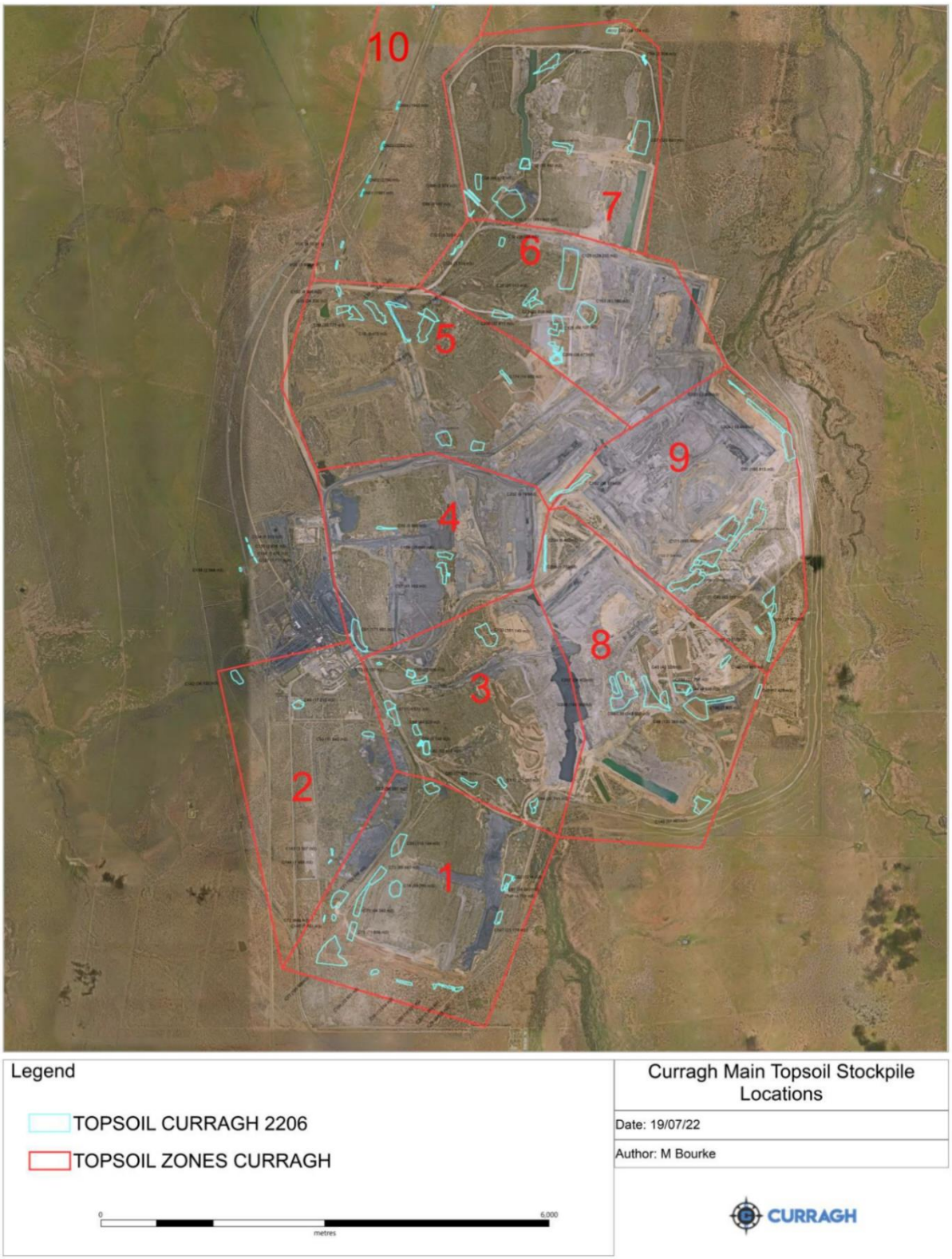


Figure 6-15 Curragh Main Topsoil Stockpile Locations by Zone

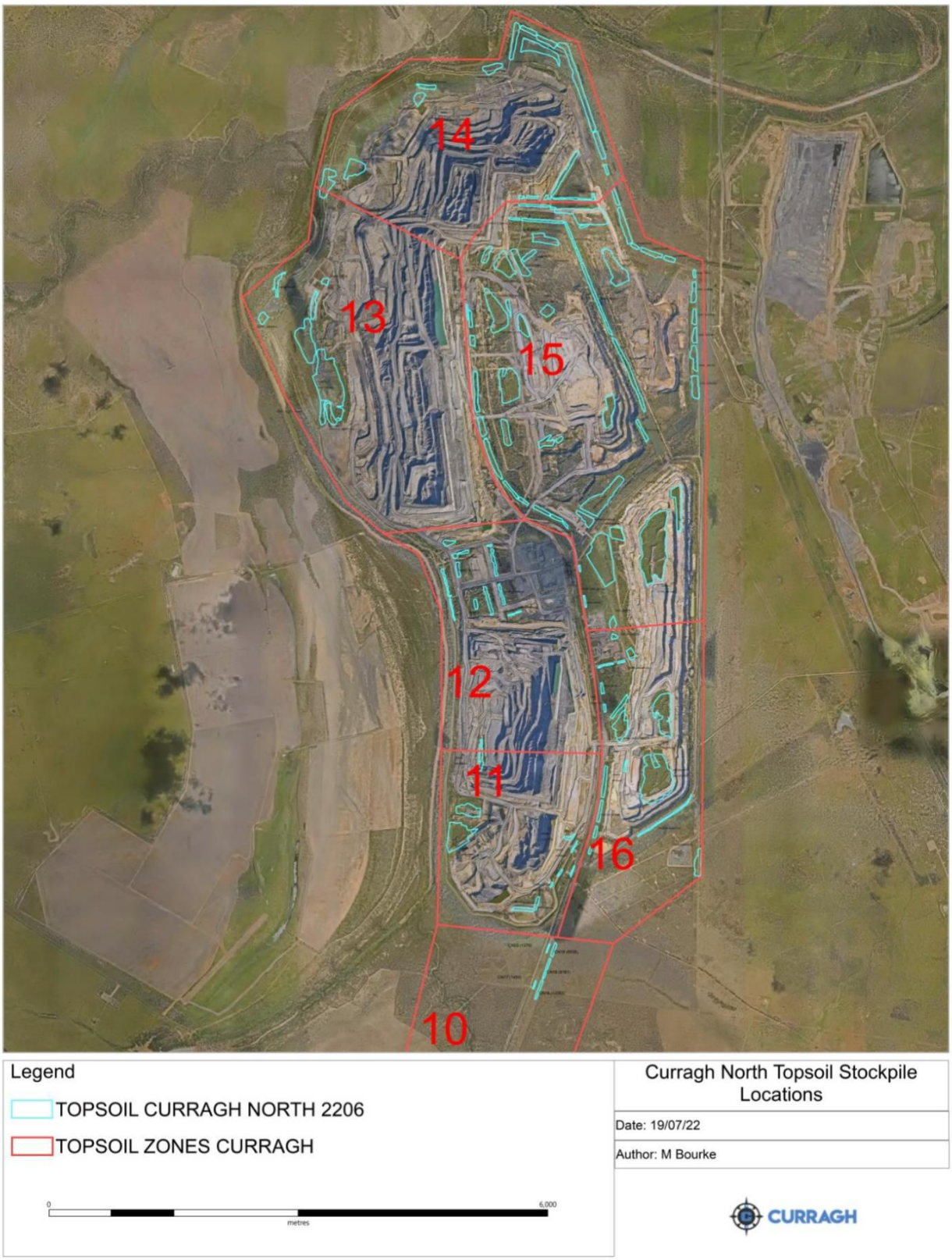


Figure 6-16 Curragh North Topsoil Stockpile Locations by Zone

Topsoil Quality

In 2020, CCPL conducted topsoil sampling program which included at least one stockpile from each zone (**Appendix H**). Zones with a collective volume of greater than 650,000m^3 of topsoil, were required to have two stockpiles from each zone sampled. Zones with a collective volume of less than 650,000m^3 were required to have only one stockpile from each zone sampled. Stockpile locations within each zone were chosen after a spatial assessment of all stockpile locations, taking into consideration adjacent zones.

Two composite samples, consisting of four grab samples each, were taken within every assessed stockpile. Each composite sample was collected in a north / south or east / west cross section dependent on the form and location of the stockpile.

The sampling strategy resulted in 23 stockpiles being sampled and a total of 45 individual samples being collected. The samples were taken by the Curragh environment personnel and sent to an Australian Laboratory Services (ALS) Laboratory for analysis of physical and chemical properties.

Both field and laboratory analysis were undertaken. The field observations recorded included, but was not limited to:

- Vegetation cover;
- Soil surface;
- Erosion impacts present;
- Soil colour; and
- Inclusion of waste or foreign objects.

All of the samples were sent to an ALS laboratory for analysis of the below parameters:

- ADMC at 40°C;
- pH plus EC 1:5;
- Total N, Nitrate, Nitrite, Ammonia;
- Bicarbonate Ext P (Oslen - Alkaline Soils);
- Organic Matter Content;
- Exchangeable Cations (Ca, Mg, K, Na), CEC, Ca/Mg ratio, ESP;
- Metals (Mn, Cu, Fe, Zn, B, Al);
- Sulphur (Total as S); and
- Chloride.

The following tables (**Table 6-7**, **Table 6-8** and **Table 6-9**) were used as the basis for the infield assessment of all soil samples.

The results of the infield assessments are presented in **Table 6-10** and indicate that of the 45 samples taken across 23 stockpiles on site, 32 samples or 71% place within the suitable range for field dispersion, 32 or 71% place within the suitable range for slaking behaviour and 45 or 100% of the samples place within the suitable range for dispersive behaviour.

Table 6-7 Field Dispersion Analysis

Score	Field Analysis
0	Very stable soil
1	Stable soil, will resist dispersion after tillage
2/3	Soil is prone to compaction and hard setting
4/5	Soil will disperse if cultivated wet
6	Soil disperses strongly if cultivated wet
7	May benefit from stubble retention If complete dispersion is observed within both initial wetting and remoulded aggregate tests, it is likely that dispersive attributes of the soil may require soil amelioration and provide a poor environment for plant growth. Laboratory analysis will assist with further analysis

Table 6-8 Field Slaking Scores

Score	Slaking Behaviour	Field Analysis
0	If the aggregate remains intact	This soil is stable to wetting. This is typical pasture soils. No action is needed.
1	If the aggregate collapses around the edges but remains mainly intact	
2	If the aggregate collapses into angular pieces	This is typical of self-mulching clays. If the soil does not disperse no action is necessary.
3	If the aggregate collapses into small (less than 2 mm diameter) rounded pieces, forming a cone	Surface may form a crust. However, this is only a problem in non-swelling.
4	If the aggregate collapses into single grains	This soil is very likely to crust and hard-set (sands and loams). Reduced cultivation, stubble retention and more frequent irrigations may be necessary on these soils.

Table 6-9 Dispersive Behaviour

Score	Dispersive Behaviour
0	Nil dispersion
1	Slight dispersion, recognised by slight milkiness of water adjacent to the aggregate
2	Moderate dispersion with obvious milkiness
3	Strong dispersion with considerable milkiness and about half of the original volume of the aggregate dispersed outwards
4	Complete dispersion, leaving only sand grains in a cloud of clay

Table 6-10 Curragh North Field Dispersion and Slaking Behaviour

Topsoil Stockpile #	Zone #	Volume (m^3)	Dominant Texture	Field Dispersion Score	Field Slaking Score	Dispersive Behaviour
CN364_1	11	305,894	Clay, loam sandy	2 - 3	3	0
CN364_2	11	305,894	Clayey sand	2 - 3	1	0
CN385_1	11	26,135	Clayey sand	4 - 5	1	1
CN385_2	11	26,135	Clayey sand	4 - 5	3	2
CN387_1	11	51,624	Clayey sand	4 - 5	3	2
CN387_2	11	51,624	Sandy loam	4 - 5	3	0
CN212_1	12	22,240	Clay loam	1	2	0
CN212_2	12	22,240	Clay loam	1	2	0
CN413_1	13	420,158	Sandy clay loam	1	1	1
CN413_2	13	420,158	Sandy clay loam	4 - 5	3	0
CN55_1	13	38,570	Clay loam	1	1	1
CN55_2	13	38,570	Clay loam	1	1	2
CN326_1	14	46,764	Light medium clay	1	1	1
CN326_2	14	46,764	Light clay	2 - 3	1	0
CN400_1	14	66,387	Clay loam	1	4	0
CN400_2	14	66,387	Clay loam	1	4	0
CN93_1	15	328,172		2 - 3	1	0
CN93_2	15	328,172	Medium Clay	2 - 3	1	2
CN225_1	16	17,600	Medium heavy clay	4 - 5	3	0
CN225_2	16	17,600	Medium clay	4 - 5	1	0
CN414_1	16	28,087	Sand	4 - 5	0	1
CN414_2	16	28,087	Sand	4 - 5	4	1

General topsoil stockpile categorisation values can be assigned to each stockpile based on the overall presence of vegetation and percentage of uncontaminated material observed as per the categories defined in **Table 6-11**.

Table 6-11 Stockpile Quality Category

Topsoil Stockpile Category	Value Description
A	High value. Low levels of contaminated material. Uncontained soil content at least 70% of the stockpile. Quality Topsoil.
B	Moderate value. Soil purity 50-70%. Higher levels of contamination and variable quality. Useable topsoil value but preferable in lower sloping areas or as subsoil material or capping
C	Marginal. Significant levels of contamination present (>50%). Quality better than spoil present but only useful a capping/subsoil material in rehabilitation

D	Unsuitable. No Better than spoil material present

In total 23 Stockpiles were sampled during the study and the categories assigned to the stockpiles show a 50:50 split of Category A and Category B stockpiles, with 48% and 52% respectively. At Curragh Main the results split was 58%:42% for Category A and Category B stockpile qualities. With Curragh North stockpiles had 41% assigned a stockpile quality Category A and 59% assigned a Category B.

The laboratory results were also assessed using categories for primary parameters tested. Soil pH is important as it affects the ability of nutrients in soil. Ensuring the pH of the soil is as close as possible to the neutral range as indicated below in **Table 6-12** will ensure satisfactory results when the topsoil is used for planned rehabilitation activities.

Table 6-12 pH Rating

Rating	pH
Acidic	5.6 – 6.5
Neutral	6.6 – 7.5
Mild Alkalinity	7.6 – 8.5
Alkaline	>8.5

The laboratory results of all pH (1:5 soil/water) samples show soil pH within the 7.3 – 9.2 range. Topsoil at Curragh Main ranges from 7.6 – 8.4 with the average value of 8.13. Topsoil at Curragh North ranges from 8.4 – 9.2 with the average of 8.71. A graph of all samples analysed is shown in

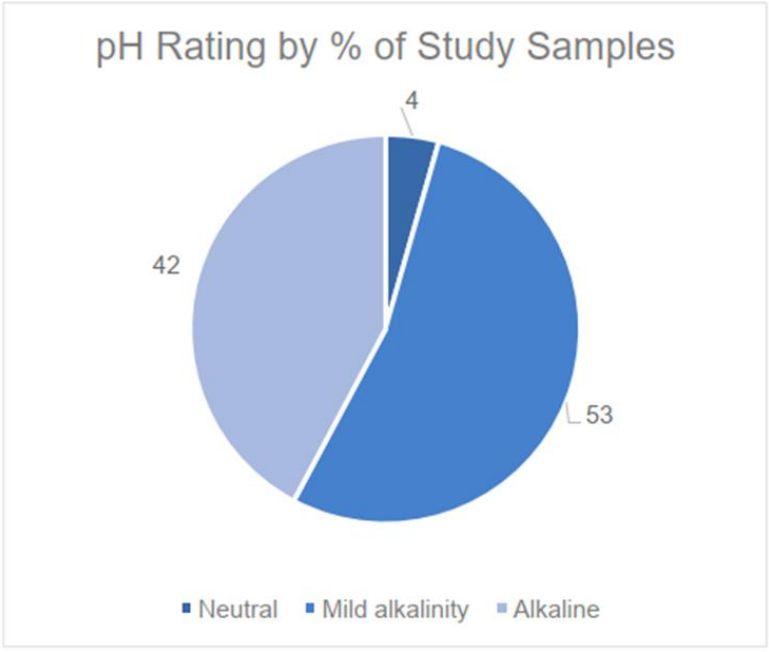


Figure 6-17**.**

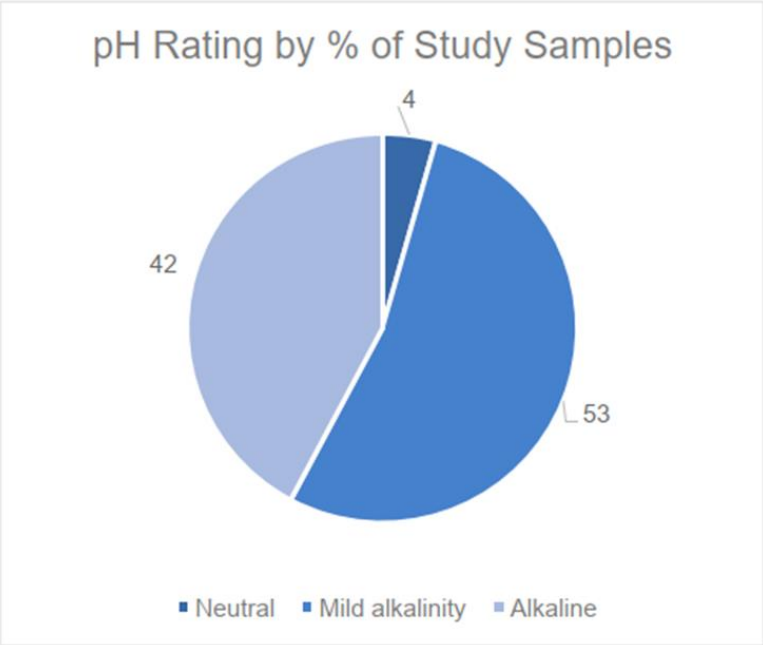


Figure 6-17 pH Rating by % of Study Samples

Cation Exchange Capacity (CEC) is the measurement used to assess the overall nutrient holding capability of soil. The stockpiled topsoil has been surface soil stripped and placed into stockpiles predominantly using scrapers. The samples sent for laboratory analysis were all taken from within a depth of 300mm of the stockpile surfaces and results interpreted in accordance with **Table 6-13**.

Table 6-13 Cation Exchange Capacity Rating and Results

Rating	CEC/ECEC (meq/100g of soil)	Number of Samples	Percentage of Study Area
Very Low	<5	3	7
Low	5 – 15	11	24
Moderate	15 – 25	25	56
High	25 – 40	6	13
Very High	>40	0	0

The results of all CEC samples indicate a range of results regarding cation exchange (nutrient holding) capacity. The results indicated 13% of samples were in the moderate CEC range and 31% in the low to very low range with the higher results coming from the Curragh Main area and the lower results from the Curragh North area. The average CEC for Curragh Main is 20.26meg/100g soil and Curragh North is 13.96meg/100g soil.

Exchangeable sodium percentage (ESP) is used to assess the relative abundance of exchangeable sodium. Where high levels of exchangeable sodium are present relative to other cations the soil material physical property is deemed to be of a sodic nature. **Table 6-14** provides the rating table used for analysis of the sample results. Soils with a high exchangeable sodium percentage disperse readily.

Table 6-14 Exchangeable Sodium Percentage Rating

Rating	Exchangeable Sodium Percentage (%)
Non-sodic (low)	<6

Sodic (moderate)	6 – 15
Strong Sodic (high)	15 – 20
Extremely Sodic (very high)	>20

Calcium Magnesium ratio provides a guide to the relative abundance of the two major cations (Calcium and Magnesium) and is useful when used in conjunction with Exchangeable Sodium Percentage to predict soil physical behaviour. Soils with a high Calcium dominance, as described by the rating in **Table 6-15**, will counteract the dispersive nature of the ESP.

Table 6-15 Calcium Magnesium Ratio Rating

Rating	Ca/Mg Ratio	Comments
Very Low	<0.10	Mg is > 10 times more dominant than Ca
Low	0.10 – 0.50	Mg is 5 – 10 times more dominant than Ca
Moderate	0.51 – 1.0	Ca and Mg becoming co-dominant
High	1.1 – 2	Ca more dominant than Mg
Very High	>2	Ca >2 times dominant than Mg

The laboratory results of both the ESP and calcium/magnesium ratio indicate majority of soils across site (80%) rated as non-sodic with 18% being sodic and 2% (one sampled stockpile) with a strongly sodic rating. The strongly sodic stockpile is located at Curragh North. Correspondingly, of the soils sampled across site, 88% and 12% identify as having a very high and high dominance of calcium resulting in majority (80-100%) of soils across site physical property being non dispersive.

Bicarbonate Extractable Phosphorus is the current measurement for the assessment of relative differences in soil fertility. Using the rating table adapted from Ahern provided in McCann, R (2019) (**Table 6-16**), 46.7% of the samples taken during the assessment returned a moderate or higher soil fertility rating. 37.8% returned a low fertility rating and 15.6% returned a very low soil fertility rating. On average Curragh North samples indicated almost two times greater soil fertility than Curragh Main with the reading being 15.8ppm and 8.31ppm respectively. Curragh North samples ranged from 1ppm to 48.2ppm, whilst Curragh Main samples ranged for 1ppm to 26.7ppm.

Table 6-16 Bicarbonate Extractable Phosphorus Rating

Rating	Bicarb. Extr. P (ppm)
Very Low	<5
Low	6 – 9
Moderate	10 – 15
High	16 – 40
Very High	>40

Total Organic Carbon is generally used to assess surface soil fertility. All topsoil stockpiles on the mine site are surface topsoil stripped and placed in stockpiles. Therefore, the assessment of total organic carbon is relevant to each stockpile in its entirety.

Using the rating table from Bruce and Rayment (1982) (**Table 6-17**) the Laboratory results for Total Organic Carbon indicate that 44% of the samples taken during the assessment returned a moderate or higher soil fertility. 53% returned a low fertility rating and 2% a very low rating. Curragh Main samples were on average higher than Curragh North samples, with average values of 1.9% and 1.1% respectively. Curragh Main results ranged from 1% to 4.2%, whilst Curragh North results ranged from 0.5% to 2.4%.

Table 6-17 Organic Carbon Rating

Rating	Organic Carbon (%)
Very Low	<0.5
Low	0.5 – 1.5
Moderate	1.6 – 2.5
High	2.6 – 5.0
Very High	>5

This topsoil quality assessment study conducted in 2020 has shown most of the stockpiled topsoil at both Curragh Main and Curragh North is of acceptable physical and chemical quality and will not require amelioration during planned rehabilitation activities. With selective placement of topsoil depending on its quality and proposed location, any potential negative effects from poorer soil quality can be further mitigated.

The overall stockpiled topsoil quality is rated as an A or B, based of field observations, indicating high purity and relatively uncontaminated high value topsoil. The results from the topsoil quality assessment indicate a similar quality to that which has historically been found within Brigalow and Eucalypt Scrub plains at Curragh and Curragh Main (McCann, R, 2019).

Amelioration could be considered if rehabilitation of an area is required to be established prior to an upcoming unfavourable weather event such as drought or a severe wet season. Inclusion of amelioration would improve the speed in which the vegetative cover establishes and provide protection from environmental impacts. Similarly, the use of a hydromulch or other materials could be considered in such circumstances.

Material Balance

A topsoil materials balance has been developed outlining the material available and material requirements for rehabilitation as of June 2022 (**Table 6-18**Error! Reference source not found.). This material balance will be updated throughout the life of mine as mining and rehabilitation progress.

The Topsoil inventory at Curragh fluctuates each year due to the nature of managing topsoil. Topsoil utilisation during rehabilitation reduces the topsoil balance, whilst topsoil stripping in new mining areas significantly increases the topsoil inventory. As of June 2022 Curragh has a topsoil balance surplus of 3,971,478m^3. At the end of mine life, the Surplus will not be as significant as at present as the topsoil will be utilised for rehabilitation.

Table 6-18 Topsoil Balance as of June 2022

Inventory	Topsoil Amount (m^3)
Topsoil Available	12,914,596
Topsoil Required for Rehabilitation	8,943,118
Topsoil Balance	**Surplus 3,971,478**

Topsoil Rehabilitation Strategy

The majority of the mine has a post-mining land use of Light Grazing and Open Woodland. Topsoil placement will be prioritised where a more concentrated grazing outcome is desired as topsoil promotes grass growth. Topsoil is proposed to be placed at a depth of 0.2 m to the following areas:

- Infrastructure areas;
- Miscellaneous activities (rehabilitated roads and tracks, ROM Pad, etc.);
- 65% of overburden dumps; and
- Tailings Storage facility.

A topsoil inventory of the areas requiring topsoil as of June 2022 is provided in **Table 6-19**.

Table 6-19 Topsoil Required for Rehabilitation as of June 2022

Domain	Topsoil Required (m^3)
Infrastructure Areas	1,109,204
Miscellaneous activities	183,086
65% Overburden Dumps	7,010,498
Tailings Storage Facility	640,330
Total	**8,943,118**

Only 65% of the overburden dumps are proposed to be topsoiled using a spoil strip and topsoil rehabilitation strip method. This method involves planting native tree and shrub species directly into the overburden. The topsoil areas provide immediate grass coverage and act as a source of grass seeds to occupy the overburden areas once the native trees have established. Therefore, overcoming the issue of the introduced grass species outcompeting the native trees and shrubs (Australian Government, 2016). This method allows both grass and tree and shrub species to establish and therefore provide for the land uses of Light Grazing and Open Woodland.

WSP (2019) completed a Progressive Rehabilitation Certification Report with the purpose of identifying potential areas suitable for progressive certification under the EP Act. One of the recommendations of this report was to continue using the spoil/topsoil strip method as it has proven to promote tree and shrub growth and support the post-mining land use towards certification readiness.

6.1.4 Waste Characterisation

A review of existing documentation has been undertaken to assess the types of mine waste present at Curragh, the percentages of material present and to propose a suitable rehabilitation treatment for spoil. This review includes Curagh Main, Curragh East and Curragh North. Given that Curragh West and the Curragh Extension Project have not yet commenced there is no existing waste characterisation to assess; however, a preliminary indicative waste characterisation program has been outlined for collecting future data in these areas.

The key outcomes identified in the review include:

- Overburden is characterised by a low propensity for acid generation and acid and metalliferous drainage (AMD) is unlikely to develop to be a management issue;
- Sodicity levels for the overburden material are sufficiently high to warrant placement of overburden below the root zone; and
- Salinity levels are not sufficiently high to adversely affect plant growth.

Although the AMD risk is very low, it has been adjusted to account for a small number of samples at Curragh North that have some acid generating potential, thus between 90-95% NAF waste across Curragh Mine, 5% PAF waste at Curragh North and an overall 5% uncertainty to account for areas that may not have been fully represented in the sampling programmes.

Curragh Mining Complex

Stuart Miller & Associates (1984, 1980) and Emmerton (1993) carried out spoil characterisation studies to provide physical and chemical data for dragline spoil throughout the mine. Emmerton encountered some acidity and potential acidity in the Ramp 11 to Ramp 12 area, but quantities of these materials were not large.

Stuart Miller and Associates (1984) completed field and laboratory investigation to characterise overburden and identify management techniques that may be required to maximise rehabilitation success and preserve water quality. This report focuses on overburden samples taken from Pits C and E (formerly known as Pit E East) as well parts of Pits B and D.

The results show that:

- The total sulphur content of samples ranged from 0.03 to 2.8%;
- The ANC is high in all samples – hence sufficient to neutralise acid produced by oxidation of sulphur;
- The thin (<0.5m) interburden layer between the Aries/Castor and Pollux seams is acid forming in places but shouldn't prove problematic in rehabilitation, provided that this strata is mixed with other layers;
- Spoils were moderately to highly saline and were highly sodic; and
- Coal seams are potentially acid forming and hence rejects generated from this area may be acidic in nature.

Land Reclamation Service completed a survey of dragline dumped spoil in 1993, 81 grab samples were analysed for pH and EC, with results from these samples used to select 41 samples for further analysis. The in-situ and laboratory results have shown that:

- The majority of spoil is saline and sodic:
- Of the 81 grab samples only 6 returned an acidic pH;
    - One sample came from coal reject material;
    - Four samples contained oxidised coal material;
    - One clay and grey shale material with slight acidity was found between ramps 7 and 8.

In addition to the dragline spoil sampling, Land Reclamation Services also completed analysis of overburden chips from 5 drill holes within the mining lease. The samples were analysed for pH and EC (1:5) and results show that:

- In general, weathered materials (ranging from 333 to 2270 µS/cm) appear to have higher salinities than unweathered materials (EC between 293 and 945 µS/cm); and
- The majority of the chip samples were strongly alkaline with the exception being some near surface clay samples from the northern area of the mining lease.

HLA-Envirosciences completed pH and NAG analysis on 20 samples from 5 bore holes in March 1998. Of the twenty samples only two had an acidic pH and a NAG of >0.1. The details of these two samples are shown below:

- Sample 98137-13100 was taken from between the base of weathering and the Aries roof, a pH of 3.4 and NAG of 12.9 kg/t was recorded; and
- Sample 98143-13118 was taken between Aries floor and Caster roof, a pH of 2.9 and NAG of 4.5kg.

The above was summarised in the 2002 EMOS as follows: “NAG testing was also undertaken during 1998 in conjunction with the highwall drilling program, i.e. west of Blackwater Creek to identify any adverse material that would need to be ameliorated. A total of 20 soil sampled were analysed by an independent NATA registered laboratory. The results indicated that the spoil being removed was non-acid forming.

Curragh East Mining Complex

As part of the Curragh East Project, Environmental Geochemistry International (EGI) was commissioned to investigate the Acid Forming Potential (AFP) and environmental geochemistry of the overburden in the Curragh East project area. Curragh Mine personnel supplied the EGI laboratory with 119 samples from varying depths within 16 drill holes. All samples were analysed for total sulphur content and ANC with subsequent calculations to determine NAPP being made. Selected samples then underwent Net Acid Generation (NAG) testing and a multi element analysis. From the analysis the following conclusions were drawn:

- All samples had low sulphur contents (<0.01 to 0.36%), the samples with the greater than 0.15% Sulphur were almost exclusively from the roof or floor of the Aries and Castor seams;
- ANC were typically moderate to high, and generally increased with sample depth;
- In most cases the ANC is at least 20-times the acid production potential;
- NAPP results were all negative and therefore all samples are classified as non-acid forming;
- Overburden is slightly to moderately enriched with Silver, Arsenic and Selenium; however concentrations are below levels which would limit rehabilitation of the overburden after mining;
- Spoil was found to be generally sodic in nature; and
- The potential for generation of acidic leachates in all types of spoil from the Curragh East area is extremely low.

The above was summarised in the 2002 EMOS as follows: “East of Blackwater Creek, 119 samples of overburden and interburden were tested for acid formation potential (EGI, 1993). Eleven of these were selected for Net Acid Generation (NAG) testing. All 119 samples had low sulphur contents and highly negative Net Acid Producing Potential (NAPP) and NAG testing confirmed an excess of acid neutralising capacity (ANC), hence little likelihood of acid generation by spoil during or after mining.”

Curragh North Mining Complex

Spoil characterisation studies were carried out during the feasibility analysis for Curragh North (Wesfarmers Curragh Pty Ltd, 2003). All overburden samples analysed were non-saline, while the pH and Net Acid Producing Potential results have indicated that the overburden characterised demonstrates a low propensity for acid generation.

More specific information on the types of overburden, with regards to PAF is provided in Austral Asian Resource Consultants (1999) in MinServe Pisces Coal Project - Environmental Management Overview Strategy (Draft) indicating the following:

- Median ANC values for alluvium and Permian overburden were 10 and 12 kg/t respectively;

- Median acid producing potential (APP) for alluvium and Permian material were 0.5 kg/t and 1 kg/t respectively. Six of the 36 samples displayed a positive NAPP. All of these were Permian, fine grained mudstone and siltstones. Acid leachate will not be a concern in the context of future spoil heaps; and
- All samples tested were alkaline however, alluvium has slightly lower pH results.

Geochemical analysis of spoil material at Curragh North (undertaken during 2002 and 2004 for the Curragh North EIS and updated in 2009) indicates that most of the overburden demonstrates a low propensity for acid generation, and all the overburden materials contain sufficient acid neutralising capacity (ANC) to neutralise any acid that may be generated. Additionally, there are no known incidents of acid mine drainage from the mine.

The geochemical properties of the overburden to be placed on the raised dumps will be the same as currently stockpiled. As such, increasing the height of the spoil dumps is not expected to increase the risk of environmental harm. This is based on the:

- Known characteristics of the overburden (little likelihood of acid generation by spoil during or post mining); and
- On-site mine water management system (which collects and retains mine affected water on-site).

Overburden characterisation was undertaken by AustralAsian Resource Consultants Pty Ltd (AARC) for the Curragh North EIS. This characterisation used analytical results from 33 overburden samples to identify and evaluate potential management issues associated with the handling of overburden material.

The samples were analysed for:

- Acid leach potential pH, Net Acid Producing Potential (NAPP);
- Salinity (electrical conductivity - EC);
- Sodicity/dispersity – exchangeable sodium percentage (ESP);
- Activity – cation exchange capacity (CEC), major cations;
- Soil aluminium toxicity; and
- Heavy metals – arsenic, selenium.

The outcomes from this work are summarised in **Table 6-20**.

Table 6-20 Summary of Results from Geochemical Analysis of Overburden

Analysis	Summary of Results
Acid producing potential	pH: • all samples tested were neutral to strongly alkaline (pH ranging from 7.3 to 10.1) • Permian material tended to be more strongly alkaline • elevated pH results indicate that aluminium toxicity is unlikely to be of management concern NAPP: • ranged from -295.6 kg/t to 5 kg/t • only 6 of the 33 samples displayed a positive NAPP, all of which were Permian, fine-grained mudstone and siltstones • the overburden demonstrated a moderate neutralising capacity (average acid neutralising capacity (ANC) 35 kg/t)

Analysis	Summary of Results
Sodicity	• pH for the overburden is moderately to highly sodic (ESP 5 – 35) indicating an increased potential for dispersion and erosion, surface crusting, impermeability and poor aeration • the magnesium/calcium ratio suggests that isolated Tertiary alluvium samples display a greater susceptibility to dispersion than Quaternary or Permian material • Tertiary material and much of the fine-grained Permian material will not be desirable as subsoil and should where practical be placed below the root zone.
Salinity	• all overburden samples analysed were non-saline with EC values ranging between 80 µS/cm and 1180 µS/cm, with an average EC of 352 µS/cm • the highest EC result was present in Permian sandstone material and fall well below that likely to affect plant growth.

Based on these characterisation results it was concluded that:

- pH and NAPP results - indicate that the overburden is characterised by a low propensity for acid generation and acid and metalliferous drainage (AMD) is unlikely to develop to be a management issue;
- Sodicity levels for the overburden material are sufficiently high to warrant placement of overburden below the root zone; and
- Salinity levels are not sufficiently high to adversely affect plant growth.

Curragh, Curragh East and Curragh North

Further sampling of mine spoil from Curragh, Curragh East and Curragh North was undertaken during 2009 by Curragh Mine site personnel. As outlined in the Curragh Complex Rehabilitation Management and Monitoring Plan (EM PLAN 1.3), sampling used an experimental process which involved measuring field pH (pHF) and field pH peroxide (pHFOX) on sub-samples of mine spoil. The Guidelines for Sampling an Analysis of Lowland Acid Sulfate Soils in Queensland (Ahern et al. 1998) were also used to interpret the experimental results. Based on the Ahern (1998) guideline, a combination of three factors was applied to describe a positive field sulfide identification:

- A reaction with hydrogen peroxide;
- A much lower pH_{FOX} than field pH_F (ΔpH); and
- Actual value of pH_{FOX}.

In addition to field investigations, 11 samples were sent to a NATA accredited laboratory for further analysis.

The results from the field and laboratory analysis are summarised in **Table 6-21**.

Table 6-21 Results of Overburden Sampling (On-site 2009)

Parameter	Field assessment	Laboratory Analysis (11 samples)
pH	pH_F: 7.4 to 9.4 Note: one sample from Permian material on the Curragh North Eastern spoil dump returned a pH_F of 6.3.	pH: 7.8 to 9.4

Parameter	Field assessment	Laboratory Analysis (11 samples)
pH_{FOX} / △pH	Only two samples returned an acidic pH_{FOX} (Tertiary and Permian materials from the Curragh North Eastern spoil dump). Permian material on the Curragh North Eastern spoil dump has the highest acid sulfate soil (PASS) potential, with pH_{FOX} of 2.7 and ΔpH of 3.6. Three samples had a ΔpH > 1 they were from mine spoils located on the Curragh North Eastern spoil dump (both Tertiary and Permian material) and the Curragh North levee access road.	As per the field assessment two samples returned an acidic pH_{OX} these samples were the two samples from the Curragh North Eastern spoil dump.
Net acid generation (NAG)	N/a	<0.5 kg (H_2SO_4)/tonne for all except one sample, Curragh North Eastern spoil dump 2 (Permian material) had a NAG of 3.5 kg (H_2SO_4)/tonne
ANC	N/a	6.1 to 67 kg (H_2SO_4)/tonne for all 11 samples.
NAPP	N/a	Negative for all samples, suggesting that the samples have enough ANC to prevent acid generation.

The results suggested that if isolated areas of PASS are discovered, future spoil sampling may be required to facilitate successful spoil placement (WSP, 2019).

Summary

Using the available information on overburden characterisation, from studies between 1980 to 2019 the overall indication is that overburden at the Curragh Mine is predominantly alkaline, with a low sulphur content and has no or very little acid producing potential. Due to the extremely low potential for PAF at Curragh East and Curragh Mine, material was considered to be 0% PAF, 95% NAF with 5% uncertainty to allow for areas that may not have been represented in the sampling programme. At Curragh North a very small number of samples tested positive for NAPP, but NAG testing confirmed an excess of ANC, hence acid mine drainage potential is very low. However, this isolated and small potential has been taken into account and for Curragh North material were considered to be 5% PAF, 90% NAF with 5% uncertainty, the latter to account for areas that may not have been represented in the sampling programme.

Table 6-22 Summary of Waste Characterisation at Curragh Complex

Waste material	PAF %	NAF %	Uncertain%
Curragh	0	95	5
Curragh East	0	95	5
Curragh North	5	90	5

2022 Sampling

A total of 20 waste rock samples were collected from the Curragh WRD. These samples were sent to a certified laboratory for geochemical analysis. SLR has summarised the results in a technical memorandum (**Appendix I**).

The characterisation of 20 waste rock samples from the Curragh WRD (**Figure 6-18** and **Table 6-23**) suggests that 17 of 20 samples are non-acid forming (NAF). Two sample are classified as uncertain, and one sample was classified as potentially acid generating (PAF). The net acid producing potential (NAPP) of all 20 samples ranges from positive 6.7 to negative 88.8 kg/H_2SO_4/tonne. Combined with the mostly alkaline NAG pH (16 of 20 samples) the overwhelming negative NAPP indicates a strong and available alkaline buffering capacity. Given this strong and available buffering capacity, the bulk waste rock is very unlikely to develop acid generating characteristics.

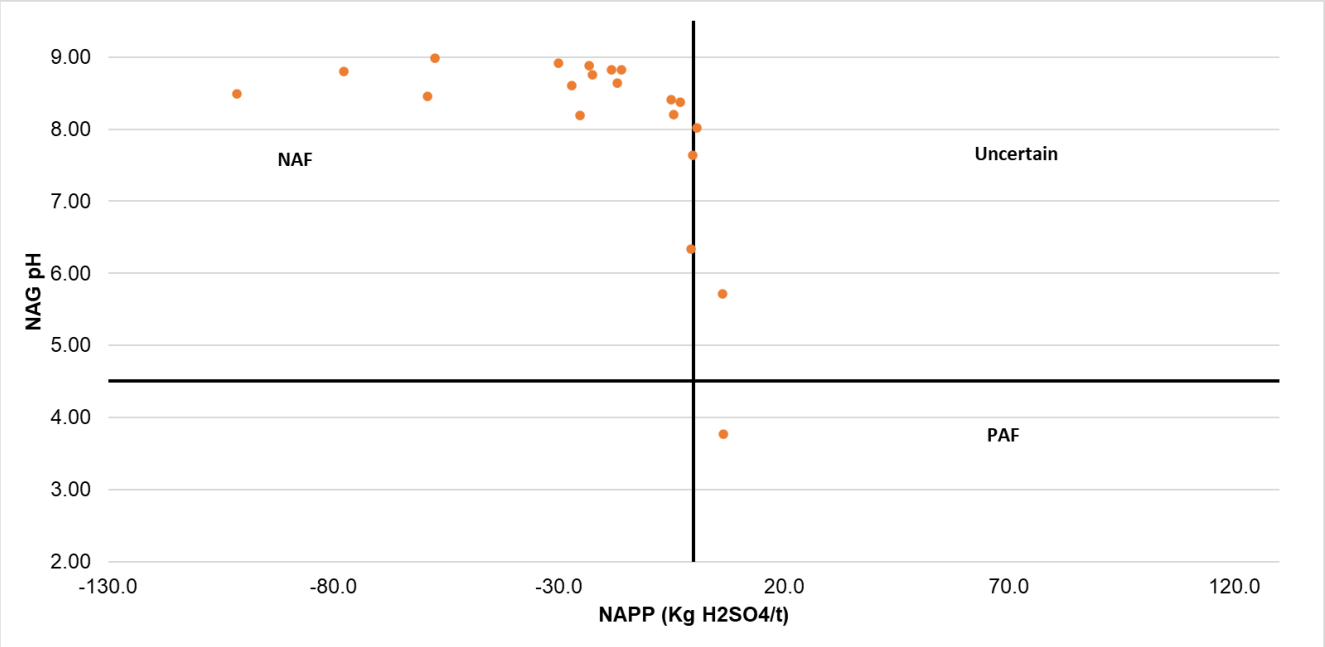


Figure 6-18 AMD Characteristics of total 20 samples collected

Table 6-23 Summary of test results for 20 Curragh waste rock samples collected

Sample	NAG pH	MPA kg H_2SO_4/t based on total S	ANC kg H_2SO_4/t	NAPP kg H_2SO_4/t based on total S
SP-CN-C418	8.64	1.348	18.3	-23.8
SP-CN-C16	7.64	0.980	1.1	-0.1
SP-CM-C07	8.91	0.980	31.0	-30.1
SP-CM-C10	8.49	0.858	102.4	-88.8
SP-CM-C126	8.02	3.461	2.9	-6.5
SP-CM-C042	8.98	1.041	58.4	-61.1
SP-CM-C152	8.82	1.776	17.9	-30.7
SP-CM-C100	8.41	1.807	6.8	-10.7
SP-CM-C38/38	8.75	2.266	24.7	-54.8
SP-CM-C077	8.82	1.960	20.3	-38.6
SP-CN-C369/370	5.72	7.656	1.2	-1.8
SP-CN-CN93	8.20	1.378	5.9	-6.9

Sample	NAG pH	MPA kg H_2SO_4/t based on total S	ANC kg H_2SO_4/t	NAPP kg H_2SO_4/t based on total S
SP-CN-CN320	6.34	1.011	1.7	-0.7
SP-CN-CN342	3.77	6.584	0.0	6.7
SP-CN-CN413	8.19	1.439	26.7	-37.7
SP-CN-CN334	8.37	5.114	8.0	-36.8
SP-CN-CN364	8.88	1.807	25.0	-44.4
SP-CM-C051	8.60	1.348	28.5	-37.9
SP-CN-CN223	8.46	1.256	60.4	-76.3
SP-CM-C142	8.80	0.858	78.5	-67.9

The geochemical assessment of 20 additional waste rock samples from Curragh confirmed the results of previous waste rock assessments by URS in 2005 and 2015. The waste rock collected is in its entirety non-acid generating and has significant buffering capacity. Metal concentrations of the waste rock, represented through the GAI, are very low. Showing that the sedimentary sequences forming the waste rock are depleted with regards to most metals. As a result of the high buffering capacity and relatively low metal concentrations of the solid waste rock future metal leaching from the waste rock will be low. Compared to available guideline values for freshwater, several ASLP metal concentrations, particularly aluminium and vanadium, are in exceedance. Such exceedances are unlikely at the reported leachate pH and are thought to be the result of colloid transport through the 0.45µm filter membrane.

Future Waste Characterisation Sampling Program

CCPL proposes that a waste characterisation sampling program be conducted in active pits as the opportunity arises in existing planned holes, and preferably some at least within the next 12 months. Data collection would be ongoing as mining progresses in future mining areas.

Figure 6-19 and **Table 6-24** summarises the proposed program, samples numbers and approximate timing of sampling.

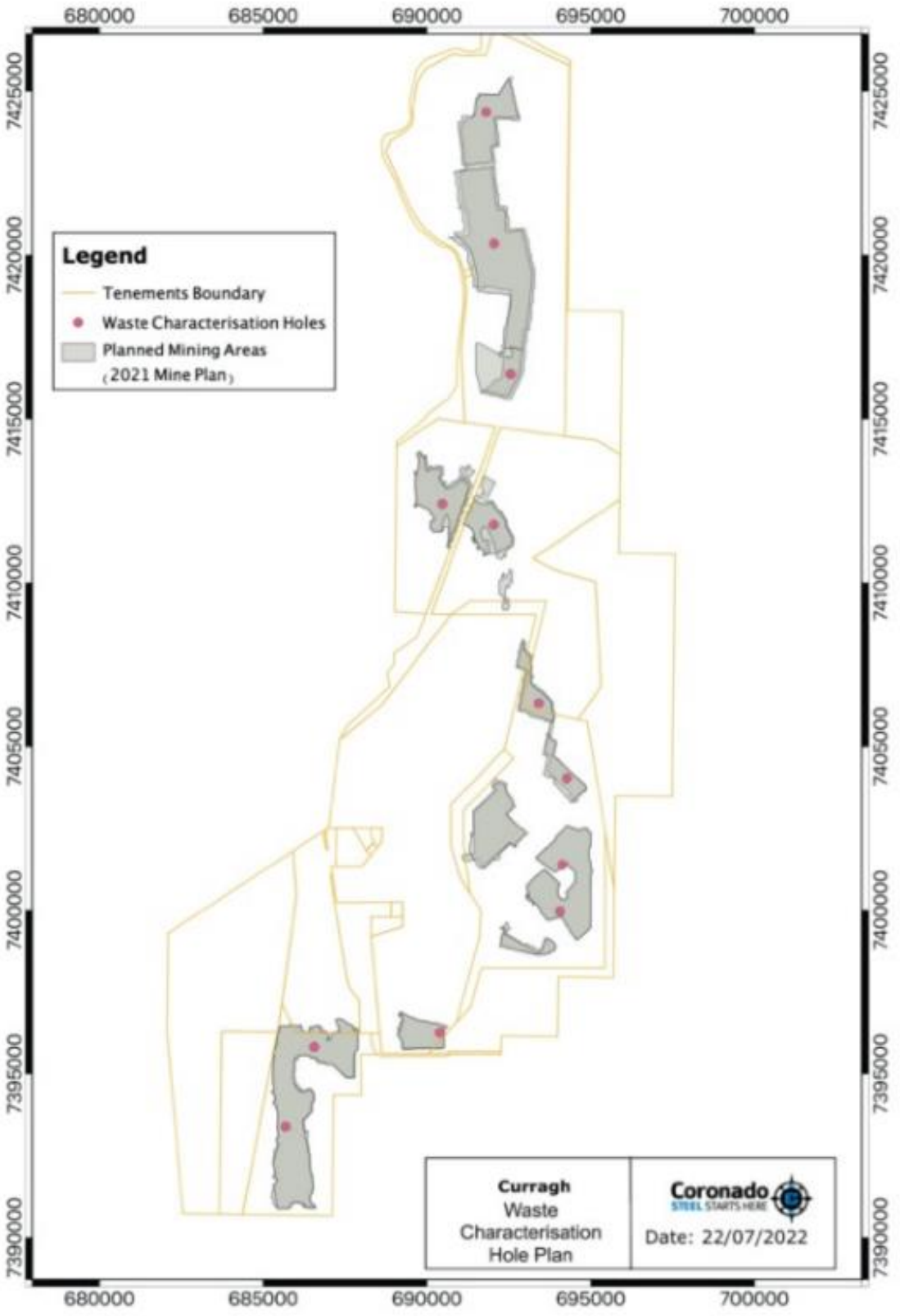


Figure 6-19 Proposed Waste Characterisation Holes

Table 6-24 Planned Waste Characterisation Holes

Site_ID	Easting	Northing	Year	Samples
L11_GC_GC259	694135	7401386	FY23	30
K18_GC_GC190	694062	7399964	FY23	30
UEX35_GC_GC11	691804	7424367	FY23	30
J4_GTGC133	690388	7396256	FY25	30
PITT_WC1	692053	7420345	FY24	30
PITSSTH_WC1	692553	7416370	FY24	30
PITX_WC2	690464	7412406	FY30	30
PITX_WC1	692044	7411763	FY30	30
PITE_WC	693422	7406318	FY23	30
PITZ_WC1	686558	7395823	FY24	30
PITZ_WC2	685677	7393388	FY24	30
FNTH_WC	694273	7404027	FY24	30
TOTAL				380

Proposed analytes in the sampling program are:

- pH;
- Conductivity (EC);
- NAPP Suite (aged pH 1:2, Aged EC 1:2, Sulfate SHCl, Total Sulphur, TOS Tot S – SO_4, ANC, Acid Base Accounting;
- NAG;
- Total Metals (As, Al, B, Be, Cd, Co, Cr, Cu, Fe, Mo, Mn, Ni, Pb, Sn, V, Zn); and
- Dissolved Metals (As, Al, B, Be, Cd, Co, Cr, Cu, Fe, Mo, Mn, Ni, Pb, Sn, V, Zn).

6.1.5 Flooding

SLR has undertaken flood modelling of the floodplain surrounding the Curragh Complex to assist in design levels for the concept flood barriers for proposed residual voids. The Flood Model Assessment Report has been provided in **Appendix J**.

The modelling was undertaken to estimate a 0.1% Annual Exceedance Probability (AEP) flood event for the relevant watercourses that impact the Curragh Complex. The intent of the assessment is to understand the locations and dimensions of the flood barrier (long-term stable embankment) required to protect the nominated residual voids from flood influx. For planning purposes, the model has adopted a high level of conservatism by using the most conservative (i.e. largest) flow estimate derived from the flood frequency analysis (FFA).

Modelling highlighted that all residual voids within the Curragh Complex are not subject to flood inundation (0.1% AEP event) due to the diversion of Blackwater Creek and the stable embankments defined as part of the proposed final landform (**Figure 6-20**). The modelled results show that a residual void landform can effectively use spoil dumps and long-term stable embankments to protect the residual voids from flood ingress. SLR adjusted the provided residual void landform along the existing Blackwater Creek diversion and between X Pit and Curragh North to provide additional protection. Modelled results for the 0.1% AEP flood event show that no voids are inundated, however inundation of Curragh North, X Pit West, X Pit East, E Pit, C Pit, B Pit, H Pit, and J Pit occurs in the PMF event.

Based on the results of the flood modelling undertaken, the main outcomes are:

- All pits are not inundated in events up to and including the 0.1% AEP, as required by PRCP guidelines;
- Scour and erosion potential of landforms is unlikely for the 1% AEP, as high shear stresses and velocities occur in localised areas within the existing watercourses;
- Inundation of Curragh North, X Pit West, X Pit East, E Pit, C Pit, B Pit, H Pit, and J Pit occurs in the PMF event (Note there are no requirements that pits be flood free in a PMF event);
- High velocities and bed shear stress are predicted within the Blackwater Creek diversion, which may require ongoing monitoring in accordance with legislative requirements; and
- High velocities and bed shear stress are predicted in the 0.1% AEP and PMF events north of Curragh North.

It should be noted that the flood assessment undertaken was unable to include adjacent mining disturbance by other companies due to limited public information. It is recommended that flood modelling be reassessed over the life of the mine as changes to the catchment occur around Curragh Complex.

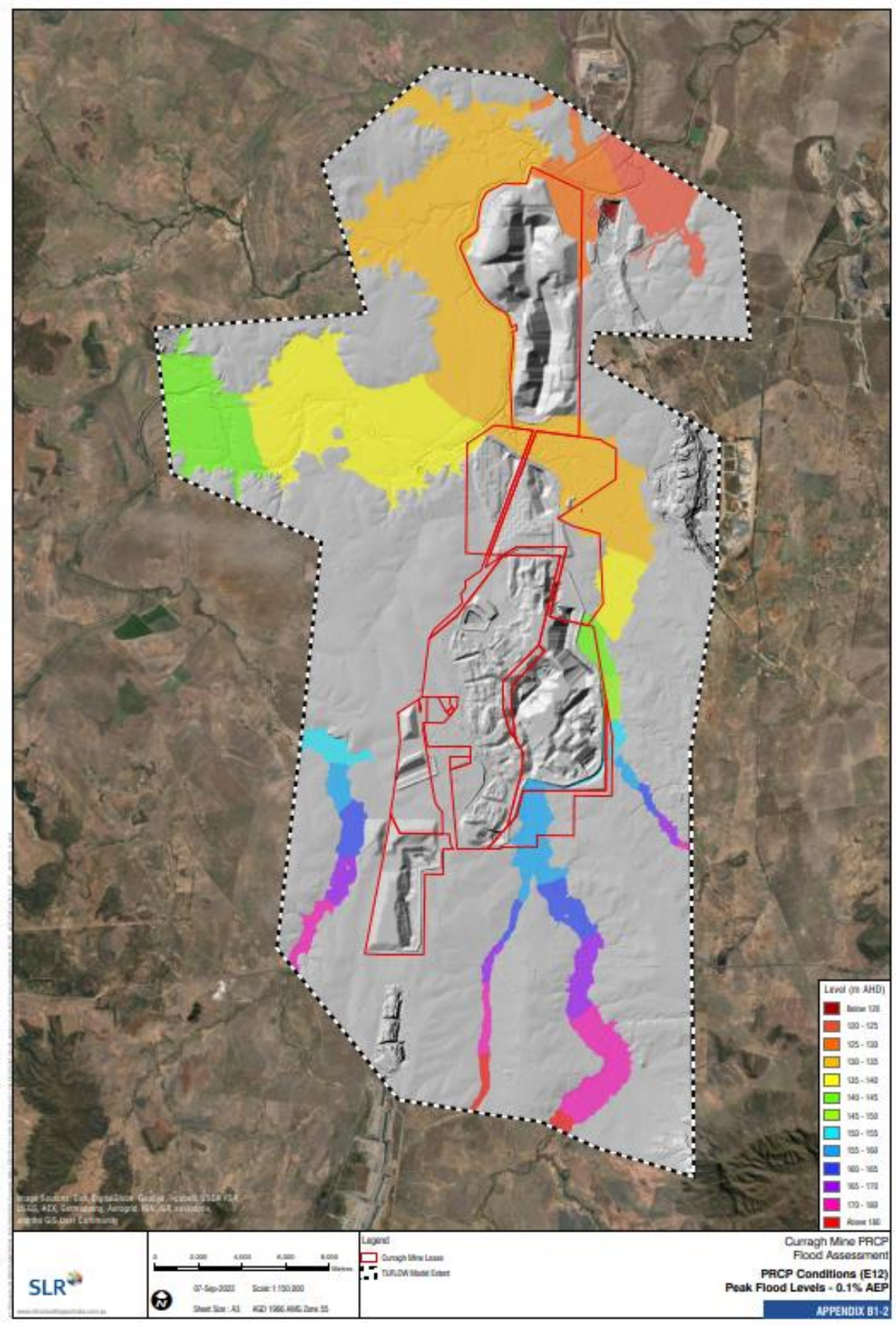


Figure 6-20 Flood extent for 0.1% AEP Event

6.1.6 Final Voids

SLR developed a void water balance model to assess the predicted void water levels and salinity concentration (**Appendix K**). Following closure of the mine, 19 residual void areas are expected to remain. The arrangement of these voids for the purpose of the Water Balance Model (WBM) to determine void water volume, quality and spill frequency is listed below with multiple pits grouped where hydrologically linked:

- Curragh North;
- Curragh Main: Pit I; Curragh Main Other; The Void; D Pit; F Pit North and Pit E North; E, C, B and H Pits; E, C, B and H Tailings; F Pit; L Pit; K Pit; G Pit; Ramp 9; J Pit; and
- Expansion Areas: X Pit (East and West), Y Pit, J Pit, Z Pit (North and South).

A WBM was developed using the Goldsim software package to assess the long-term water level and water quality was of the residual voids following closure of the Curragh Complex.

The model simulates daily changes in the volumes of stored water in response to inflows (rainfall, groundwater) and outflows (evaporation and controlled releases/overflows). The WBM was run for daily time step over 200-year simulation period, represented by 500 climate sequences, allowing the model to assess long term water levels, quality and risk of overflow for each void.

The water balance model was developed to include a high-level salt balance to track both the quantity and quality of water on-site. The salt balance tracks the water quality in all of the inflows into the voids and subsequent effects from evaporation and releases on the storage water quality. The water quality values are presented in **Table 6-25**. These adopted values are consistent with those adopted for other Queensland mine sites.

Based on groundwater monitoring data at the mine, an EC of 12,500 µS/cm was adopted as the average salinity concentration of groundwater inflows. Salinity parameters for surface runoff were determined based on prior experience in the area.

Table 6-25 Adopted Salinity Generation Parameters

Inflow	Salinity (EC) (µS/cm)
Void	3000
Rehabilitation	250
Groundwater Inflow	12,500

The above salinity values are converted to a concentration in milligrams per litre using an average multiplication factor of 0.67 (Measuring Salinity DERM, June 2007) to quantify the mass of salt transferred in the model.

The WBM was predicted to stabilise after approximately 100 years to the approximate levels for the median condition shown in **Table 6-26**. It is noted that some individual voids within the WBM reached equilibrium level in less than 20 years.

Table 6-26 Residual Void Water Level Summary

Void	Residual Void Level (50%ile) (mAHD)	Depth (m)	Surface Area (ha)
Curragh North	23	71	197
I Pit	135	1	5
Curragh Main Other	135	15	2
The Void	100	7	1
D Pit	62	33	12
F Pit North and Pit E North	49	23	24
E, C, B and H Pits	70	30	45
Pit B	112	4	13
F Pit	111	19	12
L Pit	103	38	6
K Pit	77	14	8
G Pit	137	7	6
Ramp 9	132	54	39
J Pit	111	18	8
X Pit East	67	33	39
X Pit West	98	20	19
Y Pit	123	8	8
Z Pit North	108	30	27
Z Pit South	105	17	13

The relative size of external catchment to the void footprint results in water levels that stabilise well below the indicative spill level with evaporative losses balancing inflows into the voids. A similar trend in water level is seen across all the residual voids. Water depths range from 1 m to 71 m within the voids for median conditions (50th percentile). During dry climatic conditions (5th percentile) water levels are approximately 0.1 m to 6 m lower. During very wet (99th percentile) climatic conditions the water level increases by 0.4 m to 9 m depending on the void and generally causes greater fluctuation in the equilibrium water level. Median final water levels range from 11 m to 109 m below the indicative spill levels and are not expected to overtop.

Water within the residual voids becomes highly saline throughout the simulation. This was not unexpected due to the high salinity of groundwater in the region and the assumption that the only loss from the system is evaporation (through which no salt is lost). Within the WBM, salinity is capped at a maximum EC of 532,836 µS/cm, which is equivalent to the point where the concentration of salt becomes high enough that the solution is saturated, and any additional salt will precipitate out of solution. All voids are expected to exceed hypersaline EC levels (>50,000 µS/cm) within approximately 120 years of closure, with some exceeding this value within 30 years.

The average salinity of the voids throughout the simulation period are provided in **Table 6-27**.

Table 6-27 Average Stage Salinity (EC µS/cm)

Void	Year 10	Year 30	Year 200
Curragh North	13,900	20,100	>50,000
I Pit	>50,000	>50,000	>50,000
Curragh Main Other	11,700	25,700	>50,000
The Void	10,200	15,600	>50,000
D Pit	16,500	28,800	>50,000
F Pit North and Pit E North	27,500	>50,000	>50,000
E, C, B and H Pits	15,700	33,700	>50,000
B Pit	>50,000	>50,000	>50,000
F Pit	18,200	38,600	>50,000
L Pit	13,800	24,200	>50,000
K Pit	28,400	>50,000	>50,000
G Pit	40,700	>50,000	>50,000
Ramp 9	17,300	25,600	>50,000
J Pit	23,300	49,300	>50,000
X Pit East	15,600	27,500	>50,000
X Pit West	19,200	39,600	>50,000
Y Pit	40,600	>50,000	>50,000
Z Pit North	19,800	37,600	>50,000
Z Pit South	23,400	48,500	>50,000

At Curragh Complex the median residual void water levels are expected to range from 23 mAHD to 137 mAHD with water depths of 1 m to 71 m . The results indicate that the mine is not a net accumulator of water after approximately 100 years when the equilibrium water levels are reached. The final water levels remain below the spill level and the voids are unlikely to overtop in the 99th percentile climate scenario.

A significantly high concentration of salt is expected to accumulate within the residual voids. The elevated salinity of the groundwater inflows input a high level of salt into the voids which is not lost from the system via evaporation. The salinity of the voids is expected to exceed that of the groundwater and form highly concentrated solution. Although poor quality, water within the voids is not expected to interact with surrounding surface water given the final water levels.

6.1.7 Tailings/Rejects

There are currently five tailings/rejects disposal facilities on site: Out-of-pit Tailings Storage Facility, Pit A, Pit B, Ramp 8 and Ramp 3 (**Figure 6-21**). Only Pit B is in use with all other storages at capacity or no longer planned to receive additional material. Pit B is anticipated to provide tailings storage for the rest of the current mine life.

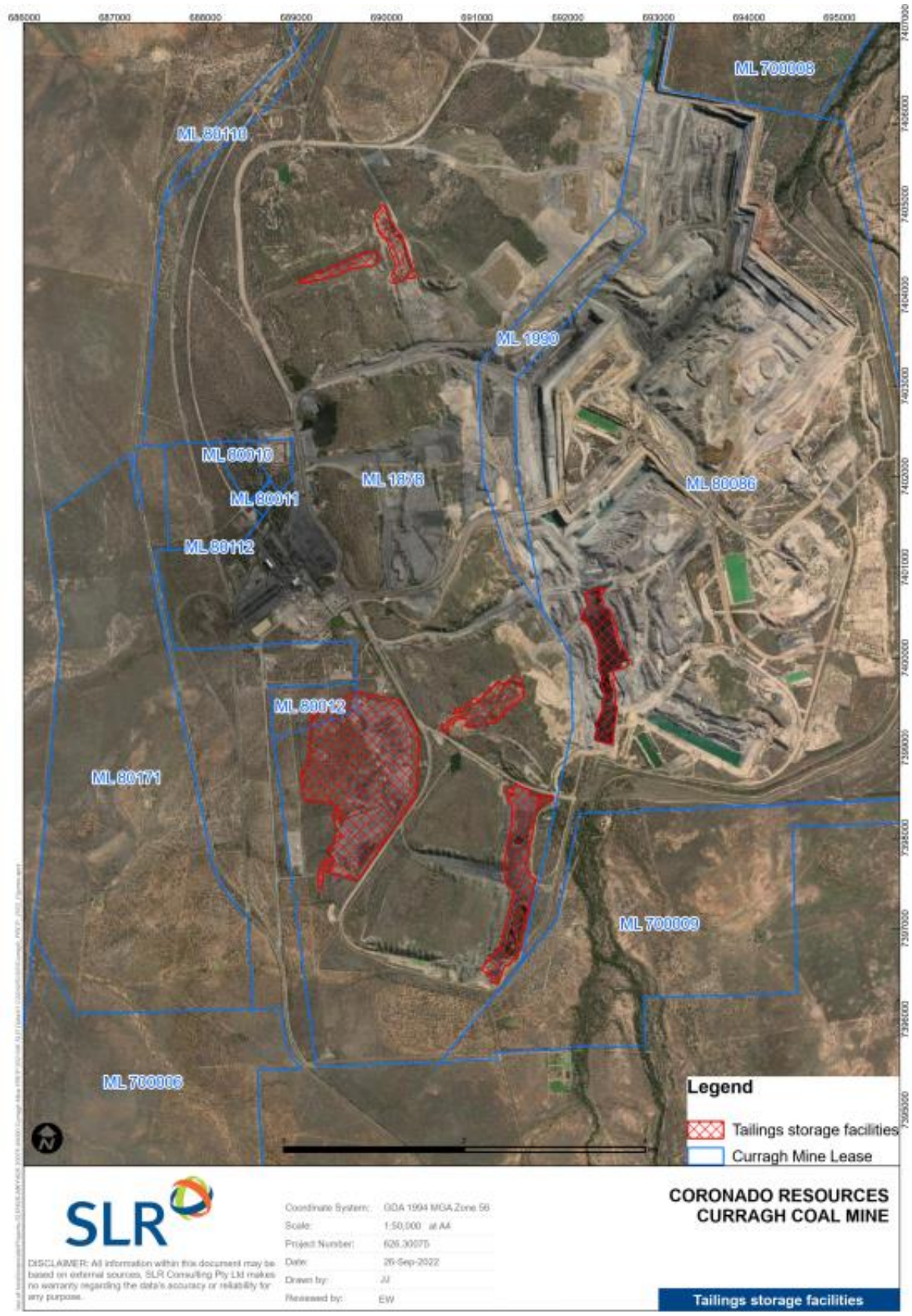


Figure 6-21 Curragh Complex Tailings Storage Facilities

Tailings/Rejects Characterisation

Tailings samples were collected from Pit A in July 2022, including 6 samples taken from 10 cm depth and 7 samples from 40 cm depth. All samples were analysed by ALS Laboratory for a plant growth suite including pH, Electrical Conductivity (EC), and Sulfur content (both as soluble major anions and total Sulfur content). Samples collected from a 40 cm depth were also analysed for sample Particle sizing, and soil classification (based on particle size).

Key findings from the analysis of the 40 cm depth samples include:

- Majority of the samples were predominantly sand (>63 µm particle size);
- pH ranged from 7.6 to 8.7, with sample one an outlier at 3.5 pH;
- EC ranged from 1,100 to 3,020 µS/cm; with Sample 7 recording 8,590 µS/cm;
- Moisture content ranged from 5.2 – 15.4% with an average of 8.9%; and
- Total Sulfur for Samples 2-7 ranged from 810 – 6,470 mg/kg with an outlier of 23,000 mg/kg recorded in Sample 1.

Key findings from the analysis of the 10 cm depth samples include:

- pH ranged from 5.5 – 8.6 pH for Samples 2-6 with Sample 1 recording 2.4 pH;
- EC ranged from 2,080 to 7,080 µS/cm;
- Moisture content ranged from 6.6 to 15.1% with an average of 11.33%; and
- Total Sulfur for Samples 2-6 ranged from 5,500 – 11,300 mg/kg with an outlier recorded in Sample 1 at 38,900 mg/kg.

The results suggest that the majority of material has a low EC and Sulfur content with a few samples identified as outliers. The moisture content from both sampling depths is relatively low and therefore indicates that the surface is well crusted and dry. However, further sampling would be required to determine trafficability.

Golders (2017) summarised Curragh's geotechnical tailings physical and geochemical characteristics in **Table 6-28** and **Table 6-29**, respectively.

Table 6-28 Tailings Physical Characteristics

Parameter	Value	Unit	Source
Annual production rate	1,040,000	tpa	Curragh
Particle size	≤0.5	mm	Sedgman
Particle density	1.65	t/m^3	Curragh
Solids concentration – m/m	37.4	%	Curragh
Solids concentration – v/v	26.5	%	Curragh
Slurry density	1.17	t/m^3	Curragh
Tailings initial settled dry density	0.8	t/m^3	Golder
Tailings beaching angle			
Above water	0.5	%	Golder
Below water	3.0	%	Golder

Table 6-29 Tailings Geochemical Properties (CHPP Data for Tailings Liquor 2013)

Date	pH		EC (µS/cm)	
	CHPP1	CHPP2	CHPP1	CHPP2
24/09/2013	8.22	8.25	4,630	756
27/09/2013	7.38	7.89	1,656	650
30/09/2013	8.49	8.08	3,950	2,050
14/10/2013	7.66	8.21	4,750	4,000

A summary of other tailings/rejects characterisation available is provided in **Table 6-30**.

Table 6-30 Tailings Characterisation Summary

Tailings Facility	Source	Tailings Characteristics
Old Tailings Dam	Parsons Brinkerhoff (2016)	Laboratory results indicate that the tailings is of medium to high plasticity and is predominantly silt sized. Moisture contents generally increase with depth
Old Tailings Dam – Core Samples	Mitra PTS (2019)	• 100% passing 1mm • Ash 30-48% • Relative density 1.63 - 1.78 t/m^3 • Exposed tailings dry on surface 0-3m (13-20% free moisture) • Damp 1-9m (24-26% free moisture) • Wet below 9 (26-30% free moisture)
Old Tailings Dam	FDP Mining (2020)	Particle Size Distribution analysis indicated an average of approximately 60% at < 38µ
Pit A tailings	ALS (2022) EB2220646	• Predominately neutral to alkaline, EC (1:5) 1100 to 8590, Soluble Sulfur as S (mg/kg) 770 to 6970

Tailings Facility	Source	Tailings Characteristics
Pit A Tailings	ALS (2022) EB22003071	• Organic Sulphur <0.02 – 1.00% • Inorganic Sulphur 0.39 – 3.86% • % less than 1mm 98.7 – 99.9% • Dominant fractions 0.25 – 0.5mm and <0.038mm)
Tailings (General)	Curragh (2015)(Appendix I)	• pH (average) = 8.02 • EC (average) = 3,000 µS/cm

6.1.8 Cover Design

6.1.8.1 Old Tailings Dam Capping Strategy

Parsons Brinckerhoff completed a Geotechnical Investigation and Assessment for Capping for the Out of Pit Tailings area in 2016 (**Appendix L**).

Capping material and layer thickness

Capping material is to comprise coarse reject material or inert well-graded granular mine spoil with boulders greater than 500 mm removed to reduce the likelihood of a punching failure. The capping material will need to have a low moisture content (i.e. not saturated) prior to placement and will need to be placed in accordance with approval requirements regarding minimum cover. Capping material should be dumped short of the leading edge of the advancing cap and pushed into position by a dozer. Dumping of the capping material directly onto the tailings surface should be avoided until additional geotechnical testing is carried out across the tailings surface.

Rate of construction

The geotechnical analysis indicates that the tailings profile tested was of sufficient shear strength to support a capping thickness of up to 1.0 m. Some additional strength gain might also be expected with time following capping placement. Block tipping may be possible over the capping layer as it progresses but will require a minimum offset to be maintained from the leading edge. Larger vehicles and increased block tipping limits may be possible after some measured strength gain within the tailings.

Water management

The existing tailings surface should be kept free of water until such time as the entire tailings surface is capped. The placed capping layer should generally be graded in a south direction towards the spillway.

Testing

As construction of the capping layer progresses, testing of the tailings should be carried out in front of the advancing layer. Geotechnical investigation including test pitting by mini excavator and shear vane testing at to assess the tailings profile within capped areas to verify the shear strength for access by larger dump trucks.

Capping construction

Given the size of Old Tailings Dam works area may be defined for placement of capping material in a single shift which will allow working on multiple fronts. Placement of capping in these areas would then be on a round-robin basis. Equipment sizes should be kept to a minimum. In the above analysis, a ground pressure applied by the equipment has been limited to 100 kPa. Where dump trucks are used for the placement of material over tailings consideration should be given to offset distances (e.g. 50/30 m rules). These should be maintained while working on the capping to limit the interaction of dynamic loads. Further investigation of the underlying tailings shear strength is required following the placement of the initial cap prior to placement of subsequent layers or accessing by larger construction vehicles than analysed.

Final landform earthworks

As part of mine rehabilitation, additional earthworks are required to tie the capping layers in to the surrounding landform. Future capping layers should be placed from the north of the storage towards the south to promote the drainage of surface water runoff and prevent areas of ponding. The final capped surface should tie in with the surrounding landform in accordance with mine approvals. Further geotechnical advice is required prior to the placement of subsequent capping layers to confirm the strength of the underlying tailings to support the additional capping material and advise on allowable construction load limits for future rehabilitation

6.1.8.2 B Pit TSF Closure Strategy

Golders Associates completed a Design Plan for the B Pit Tailings Storage facility in 2017 (**Appendix M**). A conceptual cover design is included in the Design Plan.

The final surface cover of the TSF will be subject to investigation works and detailed assessment in the years prior to closure and would typically include an assessment of the geochemistry and leaching of the tailings material which would be used in conjunction with detailed cover analysis in determination of the preferred capping philosophy, whilst achieving the overall objectives as outlined below. Typical cover design options to be considered may include a barrier/low hydraulic conductivity cover or a store-and-release cover. Notwithstanding the above, the following provides a conceptual strategy for the closure of the B Pit TSF, with the final cover system including all or a subset of the cover components as described below.

The typical objectives to be adopted for rehabilitation of the TSF would be to create a landform that is:

- Stable and sustainable;
- Compatible with the surrounding landform; and
- Of minimum long term environmental impact (i.e. non-polluting).

Based on these objectives, a concept for the TSF is as follows:

Landform development

It is envisaged that the final TSF landform would reach a level below any Quaternary surface water tables to enable the tailings to be confined within the tight Permian highwall strata. The final landform will be free draining. This may therefore necessitate a final campaign of tailings deposition at the southern end of the TSF to infill any significant depression. The TSF will be capped, and final drainage installed.

Tailings surface capping

A tailings surface cap would serve the following purposes:

- Facilitate ongoing free drainage and prevent ponding;
- Stabilise the surface to mitigate against potential ongoing erosion;
- Produce a substrate capable of plant growth and a grazing land use; and
- Reduce potential rainfall infiltration into the tailings as recharge to seepage.

The cap would comprise the following components as described below to meet these performance standards. This configuration assumes that the tailings would remain geochemically benign.

Tailings surface stabilisation layer

To provide a geotechnical competent surface over the surface of the tailings, a stabilization layer may be necessary to provide a competent subgrade or bridging layer for capping. The area most likely to require stabilisation would be the decant pond surface, due to the likely extent of saturated slimes materials and this being the natural accumulation point for surface water. The stabilisation layer would typically comprise a rock mattress (the rock comprising competent and durable material) or subject to the bearing capacity and shear strength of the tailings, may comprise a geotextile layer.

Sealing layer

Given the benign nature (to plant growth as evidenced by results and in-situ tailings vegetation) and low hydraulic conductivity of the tailings, low rainfall and the construction of a capping layer, a specific sealing layer for the tailings is unlikely to be required.

Surface protection layer

To protect the tailings surface from erosion and exposure deterioration (through wetting and drying), a surface protection/capping layer would be required. This cap could also be utilized as a rooting zone for vegetation depending on the proposed end land use. This layer would be formed typically using select mine overburden. The thickness of this layer would be selected to not only maintain drainage, but also to compensate for settlement within the underlying tailings. A more detailed assessment of a suitable capping configuration would need to be completed, subject to more data being available with respect to the physical and geochemical characteristics of the tailings. In particular, geochemical compatibility between the tailings and capping materials must be confirmed to ensure the integrity of the capping horizon is not compromised.

6.1.8.3 Proposed Cover Design for all In-Pit TSFs

Given that only conceptual work has been undertaken on Pit B TSF, CCPL is proposing to use the low risk TSF cover design from the ERC Calculator. As demonstrated in **section 6.1.7**, the tailings deposited in these facilities has low to moderate salinity and is of moderate strength and therefore a low risk cover design was proposed and accepted in the latest Estimated Rehabilitation Cost application. The low risk cover design includes:

- 1 m of rock/overburden cover; and
- 0.15 m of growth media cover.

6.1.9 Geotechnical

Raine Associates (2021) undertook a geotechnical stability assessment of the residual voids (**Appendix N**). Final landform designs were geotechnically assessed using deterministic slope stability analysis, using two-dimensional limit equilibrium methods and Rocscience's proprietary software SLIDE 2.0 (SLIDE). Nine (9) selected cross-section locations through the supplied final landform designs were analysed.

The following assumptions, comments and qualifications are made in relation to the analyses completed:

- Static and dynamic scenarios have been considered. To consider the potential impacts of earthquakes (i.e. dynamic scenarios) a peak ground acceleration (g) of 0.02 has been applied, equivalent to an event with an exceedance probability of 2% in 50 years (refer to Section 2.3).
- For design acceptance criteria, a minimum factor of safety (FoS) of 1.5 for static conditions and 1.1 for dynamic conditions have been adopted for these analyses;
- The Spencer method has been adopted for these analyses;
- The Path Search method has been adopted for these analyses;
- The slope stability analysis considers Global Stability of the slope;
- For the purpose of these analyses a slope angle of 7-degrees in the soil materials has been assumed. It is understood that this is to help prevent and minimise surface erosion, rather than to maintain long term stability of the relevant final landform slopes;
- A Disturbance (D) Factor of 0.7 has been applied when determining Hoek-Brown material parameters for a blast affect Permian rock mass;
- A Disturbance (D) Factor has been applied to a width equal to approximately half the bench height, where the final landform comprises final excavated pitwall geometries in the Permian rock;
- The analysis of final excavated pitwall geometries in the Permian rock only considers potential failures through the rock mass and does not consider the potential impact(s) of individual fault planes, fault orientation(s) and fault interaction(s); and
- Groundwater and surface water can have a significant and adverse impact on the stability of pitwalls and must therefore be appropriately understood and considered. Limited groundwater and/or hydrogeological information is available.
    - The Steady State FEA tool provided in SLIDE has been utilised to model groundwater movement and hydrostatic pressures through the materials based on the adopted ground models, for the assumed water levels and adopted material hydraulic conductivities (Table 5-7).
    - Flood levels have been adopted as per Section 6.1.5. A 1m freeboard was added to the provided flood levels for the presented analysis. Values were converted to the CCPL mine grid coordinate system prior to use.
    - The final voids have been assumed to be dry for the presented analyses.
    - Perched water tables have not been considered

Slope Stability Analysis Results The analysis results for the critical failure surfaces analysed are provided in **Table 6-31**.

Table 6-31 Critical Failure Surfaces of Final Landform Options

Pit	Scenario	Estimated Static Factor of Safety	Estimated Dynamic Factor of Safety
U Pit	Planned Final Landform Option - Highwall Side	1.8	1.7
S Pit South	Planned Final Landform Option - Highwall Side	1.8	1.7
	Planned Final Landform Option - Lowwall Side	1.7	1.6
X Pit	Planned Final Landform Option - Highwall Side	1.8	1.7
D Pit	Planned Final Landform Option - Highwall Side	2.4	2.3
	Alternative Final Landform Option - Highwall Side	3.2	2.7
	Alternative Final Highwall Re-Shaped Final Slope Option - Highwall Side	1.6	1.5
F Pit South	Planned Final Landform Option - Highwall Side	1.9	1.8
	Alternative Final Highwall Re-Shaped Final Slope Option - Highwall Side	1.8	1.7
	Planned Final Landform Out Board Slope	1.7	1.6
	Planned Final Landform Option - Lowwall Side	2.9	2.6
K Pit	Planned Final Landform Option - Highwall Side	2.5	2.4
	Alternative Final Landform Option - Highwall Side	3.2	3.1
	Alternative Final Highwall Re-Shaped Final Slope Option - Highwall Side	1.7	1.6
J Pit	Planned Final Landform Option - Highwall Side	1.7	1.6
	Planned Final Highwall Re-Shaped Final Slope - Highwall Sid	1.6	1.5
Y Pit	Planned Final Landform Option - Highwall Side 2.7 2.5	2.7	2.5
	Planned Final Highwall Re-Shaped Final Slope - Highwall Side	2.0	1.9
Z Pit	Planned Final Landform Option - Highwall Side	1.8	1.7
	Planned Final Highwall Re-Shaped Final Slope - Highwall Sid	1.6	1.5

Deterministic analysis results for the final landform designs, based on the adopted ground models and analysis methodology and assumptions, indicate that the final landform designs meet the adopted design acceptance criteria (a minimum factor of safety (FoS) of 1.5 for static conditions and 1.1 for dynamic conditions).

Past pitwall performance at Curragh indicates that geological structures are a key factor requiring consideration as part of the design process and CPS. The analysis of sections that include remnant pitwalls in the Permian rock only considers potential failures through the rock mass and does not consider the potential impact(s) of individual fault planes, fault orientation(s) and fault interaction(s). Where adverse fault orientations and interactions, relative to pitwall geometries and locations are present, the planned final pitwall geometries (as provided) may not be appropriate for CCPLs long-term final landform stability requirements. In such cases alternative design options such as the construction of softwalls in blasted Permian rock may be required. Due to potential surface erosion mitigation requirements and in order to meet the adopted design acceptance criteria for long-term slope stability, it may be necessary to re-shape softwalls to reduce slope angles. A re-shaped slope angle of approximately 22-degrees has been considered in the analysis undertaken for ground models that consider re-shaping of softwalls constructed in blasted Permian rock. The associated cut-fill balance of these options is to be further investigated as detailed design works are completed.

The ability to identify geological fault locations and geometries accurately for the final pitwall is limited by existing data coverage and density. Fault interpretations and geotechnical ground models for final pitwalls are to be developed as mining progresses and/or additional geology and geotechnical data is collected and obtained.

To consider the provided flood levels for X-Pit the proposed final landform has been raised by approximately 10 m for the purpose of these analyses.

6.1.10 Revegetation

The objective of revegetation is threefold:

- To stabilise the re-contoured ground, and/or;
- To fit in and complement the surrounding flora and habitat, and/or;
- To enhance or increase diversity.

Revegetation is predominantly carried out by seeding a combination of pasture grasses and native tree seed. Previous applications using tube stock planting has resulted in a high mortality rate, and direct seeding appears to yield more robust outcomes. However, should favourable conditions present themselves Curragh may engage in tube stock planting for target areas or stock.

Through previous experience on site and at other mines deep ripping of the spoil/topsoil is undertaken after shaping has been completed to improve rainfall infiltration and decrease erosion. Deep ripping is undertaken by a specifically designed winged tyne (**Figure 6-22**) to loosen the subsoil profile immediately prior to seeding.

Deep ripping is carried out to a depth of 60–75 cm with the rip-lines oriented across the slope at a gradient of 0.5% (1h: 200v) off the contour. The machine operator uses the graded banks, which are also at 0.5% gradient, for alignment guidance. Deep ripping is carried out in conjunction with the seeding operation.

The seed mix employed at Curragh Complex will vary from year to year depending on environmental and operational factors. Rehabilitation monitoring records show that 13 to 23 native tree and shrub species are seeded on the bare spoil strips and between 6 to 9 grass and legume species are seeded in the topsoil strips. A typical seed mix is provided in **Table 6-32**, however it is subject to availability and may change.

Figure 6-22 Winged tyne used at Curragh



Table 6-32 Typical Seed Mix

	Scientific Name	Common Name
Acacias	Acacia bancroftiorum	Bancrofts wattle
	Acacia complanata	Long-Pod Wattle
	Acacia stenophylla	Shoestring Acacia
	Acacia cretata	
	Acacia macradenia	Zig-zag Wattle
	Acacia holosericea	Soap Bush
	Acacia salicina	Sally Wattle
	Acacia harpophylla	Brigalow
	Acacia saligna	Golden Wreath Wattle
Eucalyptus	Eucalyptus camaldulensis	River Red Gum
	Eucalyprus cambageana	Blackbutt/Dawson gum
	Eucalyptus tereticornis	Blue Gum
	Eucalyptus populnea	Poplar Box
	Eucalyptus citriodora	Lemon-scented gum
	Eucalyptus crebra	Narrow-Leaved Ironbark
	Eucalyptus longirostrata	Grey Gum
	Eucalyptus punctata	Grey Gum

	Eucalyptus thozetiana	Napunyah
Native Grasses	Digitaria didactyla	Blue Couch
	Cynodon dactylon	Bermuda Grass
	Heteropogon contortus	Black Speargrass
	dichanthium sericeum	Queensland Blue Grass
	Astrebla lappacea	Mitchell Grass
	Themeda triandra	Kangaroo Grass
	Paspalidium caespitosum	Brigalow Grass
Legumes	Clitoria ternatea	Butterfly Pea
	Chamaecrista rotundifolia	Round-leaf Cassia
	Stylosanthes scabra	Shrubby Stylo
	Stylosanthes hamata	Caribbean Stylo
Introduced/Exotic Grasses	Chloris Gayana	Rhodes Grass
	Urochloa mosambicensis	Bushveld signal grass
	Panicum coloratum	Blue Panic
	Panicum maximum	Guinea Grass
Other Trees/Shrubs	Atalaya hemiglauca	Whitewood
	Brachychiton rupestris	Narrow-leaved Bottle Tree
	Senna artemisioides	Silver Cassia
	Casuarina cristata	Belah
	Lysiphyllum carronii	Northern Bean Tree
	Senna notabilis	Cockroach Bush

Normally, 50% of the Acacia seed (except *A. harpophylla*) is scarified and 50% is left un-scarified. Scarification enhances early establishment of Acacias following the first rain after seeding. The remaining un-scarified seed will germinate at a longer period. This arrangement provides a backup in the event of the initial seeds perishing due to minimal follow up rain.

6.1.10.1 Amelioration

The Curragh topsoil management plan (Curragh, 2020) provides information on soil baseline studies undertaken from 1990 to 2015. The study with the MLs associated with the respective studies are outlined in **Table 6-33** and shown in **Figure 6-23.**

Table 6-33 Land resource assessments conducted at Curragh Complex

Year	Author	Curragh sites	MLs associated with study
1990	Land Reclamation Services	Curragh Main	ML1878, ML 1990, ML80010, ML80011, ML80012
1998	Environment Health and Safety Systems	Curragh Main	ML80086
2003	Australasian Resource Consultants Pty Ltd	Curragh North	ML80110, ML80123
2011	Parsons Brickenhoff	Curragh Main, Section of area associated with Pit Y	ML80171
2015	SLR	Curragh Main, Sections of areas associated with Pit X and Pit Z	ML700006, ML700007, ML700008, ML700009

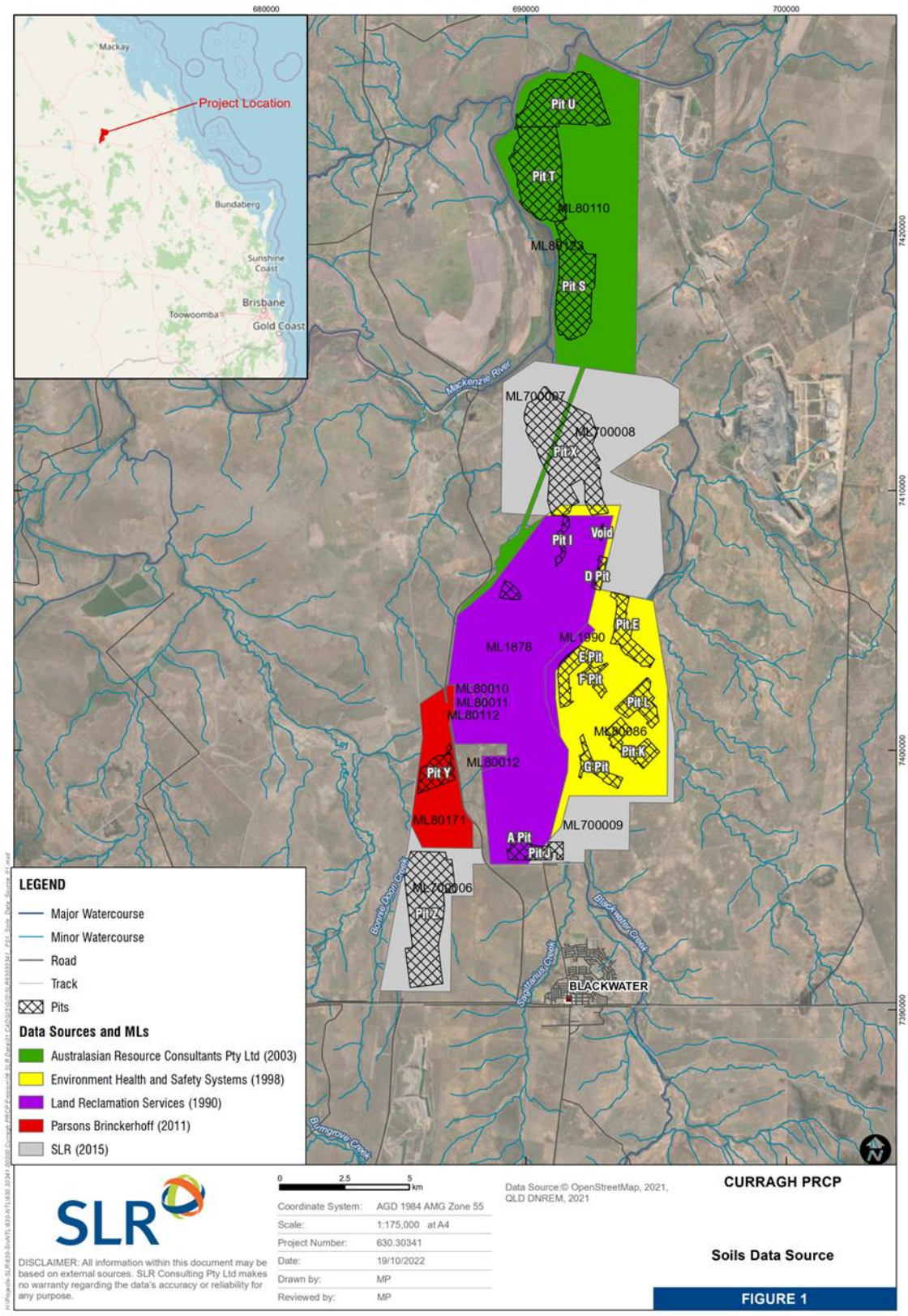


Figure 6-23 Curragh Soil baseline Data Available

Site Investigation

Based on observations on site and the desktop review, SLR provided Curragh personnel with guidance to complete a sampling program (SLR, 2022). Curragh collected topsoil and spoil samples under advice from SLR. The samples were collected during late July to August 2022. The mine number names, material type and sample dates are listed in **Table 6-34.** Site numbers provide the following information:

- Material type: SP (spoil) or TS (topsoil)
- Location: CN (Curragh North) or CM (Curragh Main)
- Stockpile or location name is provided as the third code in the sample number (e.g., C042 in site number SP-CM-C042).

Sample logs and photographs for the mines are provided in **Appendix F.**

Samples were submitted to NATA accredited laboratory, Environmental Analytical Laboratory (EAL) at the Southern Cross University in Lismore. Certificates of analysis are provided in **Appendix F**. Samples were submitted for the following analytical suites:

- **Growth medium:** Typical soil analysis associated with plant growth including pH, electrical conductivity, nitrate nitrogen, plant extractable phosphorus and particle size analysis to inform proposed ameliorant or treatment requirements to assist with vegetation establishment and long-term growth on steeper slopes
- **Propensity for dispersion:** Analysis of the propensity for dispersion by Emerson aggregate test and analysis of exchangeable sodium percentage

Table 6-34 Curragh North & Curragh Main topsoil & spoil samples collected for cover material investigation

Curragh Main			Curragh North		
Material type	Site No.	Date	Material type	Site No.	Date
Spoil	SP-CM-C042	01-08-2022	Spoil	SP-CN-C16	02-08-2022
Spoil	SP-CM-C051	02-08-2022	Spoil	SP-CN-C369/370	02-08-2022
Spoil	SP-CM-C07	02-08-2022	Spoil	SP-CN-C418	02-08-2022
Spoil	SP-CM-C077	01-08-2022	Spoil	SP-CN-CN223	02-08-2022
Spoil	SP-CM-C10	01-08-2022	Spoil	SP-CN-CN320	04-08-2022
Spoil	SP-CM-C100	01-08-2022	Spoil	SP-CN-CN334	03-08-2022
Spoil	SP-CM-C126	01-08-2022	Spoil	SP-CN-CN342	04-08-2022
Spoil	SP-CM-C142	05-08-2022	Spoil	SP-CN-CN364	02-08-2022
Spoil	SP-CM-C152	01-08-2022	Spoil	SP-CN-CN413	04-08-2022
Spoil	SP-CM-C38/38	01-08-2022	Spoil	SP-CN-CN93	04-08-2022
Topsoil	TS-CM-C042	01-08-2022	Topsoil	TS-CN-C16	02-08-2022
Topsoil	TS-CM-C051	02-08-2022	Topsoil	TS-CN-CN223	02-08-2022
Topsoil	TS-CM-C07	02-08-2022	Topsoil	TS-CN-CN320	04-08-2022
Topsoil	TS-CM-C077	01-08-2022	Topsoil	TS-CN-CN334	03-08-2022
Topsoil	TS-CM-C10	01-08-2022	Topsoil	TS-CN-CN342	04-08-2022
Topsoil	TS-CM-C100	01-08-2022	Topsoil	TS-CN-CN364	02-08-2022
Topsoil	TS-CM-C126	01-08-2022	Topsoil	TS-CN-CN369/370	02-08-2022
Topsoil	TS-CM-C142	05-08-2022	Topsoil	TS-CN-CN413	04-08-2022

Curragh Main			Curragh North		
Material type	Site No.	Date	Material type	Site No.	Date
Topsoil	TS-CM-C152	01-08-2022	Topsoil	TS-CN-CN93	04-08-2022

SLR also included amelioration rates for topsoil stockpiles sampled by Curragh in 2020 under guidance from the *Topsoil Training, Assessment and Sampling* guideline developed by GT Environmental in 2019.

Twenty-three topsoil stockpiles were sampled and a total of 45 samples were submitted for analysis to ALS laboratory. The samples were analysed at ALS for similar parameters to the samples collected during the current investigation with the exclusion of Emerson aggregate tests (EAT) and particle size analysis (PSA). Soil texture was determined by Curragh personnel in the field and not included in the analytical suite. Results of the analysis was reported in the 2020 and 2022 reports titled *Topsoil Quality Assessment Report* (Curragh, 2020) and (Curragh, 2022)).

Results

The laboratory results for the mines are summarised in **Table 6-36** with analyte thresholds outlined in **Table 6-35.**

Certificates of analysis are provided in **Appendix F**. Samples were collected and bulked at each stockpile site. The results indicate the following:

Organic matter (OM) is marginal to across most of the spoil sites and at good levels for the majority of the topsoil sites. Amelioration with composted organic matter at all sites where OM is marginal will improve plant establishment.

Nitrate nitrogen levels are typically deficient across most sites and will require amelioration to improve nitrogen levels. Nitrogen is to be applied as DAP or Urea,

- Colwell extractable phosphorous is typically deficient across most sites and will require amelioration. Phosphorus to be applied as MAP or DAP.
- pH is generally strongly alkaline to very strongly alkaline at the spoil sites. Site SP-CN-C369/370 is moderately acidic while SP-CN-CN342 is very strongly acidic, and both will require amelioration towards neutral with lime. Very high pH can be overcome during plant establishment by utilising zinc coated MAP or DAP.
- Salinity (ECe) ranges from non-saline to extremely saline at spoil sites, with levels are generally low at topsoil sites, ranging from non-saline to slightly saline. Sites with ECe above 2 dS/m will require amelioration with composted organic matter.
- Sodicity (ESP) varies between sites, with the majority of topsoil stockpiles being non-sodic. Most of the spoil samples are marginally sodic to strongly sodic and will require amelioration with gypsum.
- Emerson aggregate test (EAT) values of 3 or 4 were reported at the majority of topsoil sites, indicating minimal dispersion potential. Most spoil sites mostly had values of 2 indicating potential dispersion, which can be ameliorated with gypsum.
- Calcium to magnesium ratio (Ca:Mg) is typically low (less than 3) across most sites and will require amelioration. Gypsum or lime will provide adequate calcium to increase the Ca:Mg.
- Zinc (Zn) levels are typically low, due to the elevated pH across most sites and can be ameliorated with zinc coated MAP or DAP.

Table 6-35 Analyte Thresholds

OM	Nitrate N	P (Colwell)	Zn	Mn	Fe	Cu	B	ESP	EAT	Ca:Mg	pH	ECe
%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	Score	Ratio	H20	Value
>2.0	>10.0	≥35	>0.7	4.0 – 50.0	4.0 – 50.0	>0.4	≥0.8	<5	4, 6, 7	>3.0	≥6.0	<2.0
≤2	7-10	<35	≤0.7	<4.0 or >50	<4.0 or >50	≤0.4	>0.8	≥5	2, 3	2-3	≤6.0	2-8
<1	<7.0	<20	<0.5	N/A	N/A	N/A	>1.5	>15	1, 5	<2	≤5.5	>8.0

Analytes thresholds are derived from the following sources:

- The Grazier's Guide to Pastures (DPI, 2003)
- Soil Sense: Soil Management for North Coast Farmers (Lines-Kelly, 1995)
- Soil Analysis: An Interpretation Manual (Peverill, Sparrow, & Reuter, 1999)

Table 6-36 Soil sample analysis & threshold ratings 2022 sites

Site	Material	OM	Nitrate N	P (Colwell)	Zn	Mn	Fe	Cu	B	ESP	EAT	Ca:Mg
SP-CN-C418	Spoil	1.0	0.8	10.5	0.9	3.3	17.6	3.0	0.2	6.9	2	1.2
SP-CN-C16	Spoil	0.4	0.8	4.9	<0.5	0.5	2.3	0.2	1.2	20.4	2	0.8
SP-CM-C07	Spoil	0.6	9.6	5.6	<0.5	4.1	2.7	0.4	1.9	30.2	2	2.1
SP-CM-C10	Spoil	3.6	6.6	8.2	<0.5	1.5	3.3	0.4	1.0	19.2	2	1.8
SP-CM-C126	Spoil	3.7	9.6	8.2	19.3	2.6	8.4	8.7	0.8	45.5	2	0.7
SP-CM-C042	Spoil	2.2	0.8	5.9	<0.5	0.2	0.6	0.1	0.4	8.2	2	1.0
SP-CM-C152	Spoil	0.8	7.1	6.2	<0.5	0.3	<0.5	<0.1	1.2	45.5	2	1.1
SP-CM-C100	Spoil	0.4	0.8	10.5	<0.5	1.3	1.9	0.2	0.5	17.4	2	1.4
SP-CM-C38/38	Spoil	2.4	1.4	5.6	0.8	1.6	4.1	0.2	0.3	19.0	2	1.6

Site	Material	OM	Nitrate N	P (Colwell)	Zn	Mn	Fe	Cu	B	ESP	EAT	Ca:Mg
SP-CM-C077	Spoil	1.7	24.5	9.2	<0.5	1.6	2.4	0.5	0.8	18.0	2	2.6
SP-CN-C369/370	Spoil	29.6	0.8	38.4	0.6	18.0	19.8	0.9	0.3	1.8	4	0.9
SP-CN-CN93	Spoil	0.4	0.7	20.0	<0.5	2.5	3.4	0.4	0.7	11.0	2	1.8
SP-CN-CN320	Spoil	0.3	<0.1	6.9	<0.5	0.9	1.8	0.2	<0.1	9.0	2	0.9
SP-CN-CN342	Spoil	0.5	<0.1	12.5	1.0	7.8	16.1	0.1	0.3	2.0	4	1.6
SP-CN-CN413	Spoil	2.0	0.7	6.9	2.7	2.3	8.7	2.5	0.2	3.3	2	1.6
SP-CN-CN334	Spoil	27.7	0.8	20.0	5.8	12.4	30.4	3.2	0.2	17.4	2	1.4
SP-CN-CN364	Spoil	1.8	6.3	13.4	3.5	7.5	15.7	2.1	0.3	18.1	2	1.7
SP-CM-C051	Spoil	4.5	9.1	20.7	<0.5	0.1	<0.5	<0.1	0.9	16.0	2	1.7
SP-CN-CN223	Spoil	1.5	4.7	15.4	0.7	0.8	2.3	0.2	0.4	9.6	2	1.3
SP-CM-C142	Spoil	1.5	1.3	6.9	<0.5	3.6	4.6	0.2	0.2	1.8	4	5.7
TS-CM-C077	Topsoil	2.3	9.6	11.8	<0.5	6.2	8.5	1.6	0.6	4.2	3	3.9
TS-CM-C142	Topsoil	10.5	1.8	7.2	<0.5	4.3	3.3	0.7	0.4	1.4	4	3.9
TS-CM-C100	Topsoil	1.8	25.6	17.1	<0.5	4.8	9.0	1.3	1.0	9.4	2	3.1
TS-CM-C051	Topsoil	4.8	95.7	13.1	<0.5	3.5	6.8	0.7	0.3	1.2	4	14.3
TS-CM-C042	Topsoil	2.9	11.0	8.5	<0.5	3.0	6.7	1.2	0.5	1.5	4	4.4
TS-CM-C07	Topsoil	2.6	4.2	8.2	<0.5	5.3	10.7	1.3	0.7	5.3	3	3.3
TS-CM-C10	Topsoil	2.6	3.8	6.9	<0.5	5.8	7.0	2.0	0.6	1.4	4	2.9
TS-CM-C38/38	Topsoil	2.2	4.2	10.5	<0.5	4.9	6.6	1.1	0.9	4.3	3	5.1
TS-CM-C152	Topsoil	2.0	3.1	7.9	<0.5	8.0	4.6	1.0	0.5	0.8	4	4.4
TS-CN-C16	Topsoil	2.8	2.7	26.9	<0.5	3.7	7.0	1.1	1.0	3.2	4	3.3
TS-CN-CN364	Topsoil	0.8	1.3	8.2	<0.5	2.7	11.9	0.4	0.3	1.5	3	7.0
TS-CN-CN223	Topsoil	1.5	81.4	38.0	<0.5	6.0	11.6	0.5	0.4	3.7	4	3.1
TS-CN-CN342	Topsoil	2.1	10.0	58.4	<0.5	6.0	9.4	0.8	0.4	1.9	3	2.4

Site	Material	OM	Nitrate N	P (Colwell)	Zn	Mn	Fe	Cu	B	ESP	EAT	Ca:Mg
TS-CN-CN413	Topsoil	1.3	3.5	40.7	<0.5	3.7	4.4	0.5	0.3	1.2	3	4.6
TS-CN-CN334	Topsoil	2.2	5.7	48.9	<0.5	5.5	10.5	0.9	1.0	3.9	3	2.3
TS-CN-CN93	Topsoil	3.3	0.7	25.6	0.6	2.4	6.1	1.1	0.8	4.7	3	1.9
TS-CN-CN320	Topsoil	2.1	0.9	58.1	<0.5	5.1	11.0	0.9	0.7	2.6	3	2.3
TS-CN-CN369/370	Topsoil	0.7	1.2	16.1	<0.5	4.6	7.6	0.4	0.3	2.5	3	2.3
TS-CM-C26	Topsoil	1.9	4.4	19.7	<0.5	4.8	8.8	1.2	1.4	9.6	2	2.8

Table 6-37 Soil Sample Analysis & Threshold Ratings for pH and EC 2022 sites

Site	Material	pH	Rating	Texture*	ECe**	Rating
SP-CN-C418	Spoil	9.5	Very Strongly Alkaline	Silty Loam	1.4	Non-Saline
SP-CN-C16	Spoil	8.9	Strongly Alkaline	Medium Clay	1.3	Non-Saline
SP-CM-C07	Spoil	8.7	Strongly Alkaline	Medium Clay	14.8	Highly Saline
SP-CM-C10	Spoil	9.5	Very Strongly Alkaline	Light-Medium Clay	4.3	Moderately Saline
SP-CM-C126	Spoil	8.3	Moderately Alkaline	Silty Clay Loam	23.0	Extremely Saline
SP-CM-C042	Spoil	9.8	Very Strongly Alkaline	Clay Loam	1.9	Non-Saline
SP-CM-C152	Spoil	8.8	Strongly Alkaline	Clay Loam	27.7	Extremely Saline
SP-CM-C100	Spoil	9.4	Very Strongly Alkaline	Clay Loam	1.0	Non-Saline
SP-CM-C38/38	Spoil	10.0	Very Strongly Alkaline	Loam	4.0	Slightly Saline
SP-CM-C077	Spoil	9.2	Very Strongly Alkaline	Silty Clay Loam	6.3	Moderately Saline
SP-CN-C369/370	Spoil	5.7	Moderately Acidic	Silty Clay	1.0	Non-Saline
SP-CN-CN93	Spoil	9.2	Very Strongly Alkaline	Clay Loam	1.5	Non-Saline
SP-CN-CN320	Spoil	9.2	Very Strongly Alkaline	Sandy Loam	0.5	Non-Saline
SP-CN-CN342	Spoil	3.4	Very Strongly Acidic	Sandy Clay Loam	12.7	Highly Saline
SP-CN-CN413	Spoil	9.3	Very Strongly Alkaline	Loam	1.2	Non-Saline

Site	Material	pH	Rating	Texture*	ECe**	Rating
SP-CN-CN334	Spoil	9.5	Very Strongly Alkaline	Silty Clay Loam	2.3	Slightly Saline
SP-CN-CN364	Spoil	9.7	Very Strongly Alkaline	Clay Loam	3.7	Slightly Saline
SP-CM-C051	Spoil	9.1	Very Strongly Alkaline	Silty Clay Loam	6.0	Moderately Saline
SP-CN-CN223	Spoil	9.5	Very Strongly Alkaline	Clay Loam	1.7	Non-Saline
SP-CM-C142	Spoil	9.1	Very Strongly Alkaline	Clay Loam	0.9	Non-Saline
TS-CM-C077	Topsoil	8.9	Strongly Alkaline	Heavy Clay	1.0	Non-Saline
TS-CM-C142	Topsoil	8.5	Strongly Alkaline	Medium Clay	0.6	Non-Saline
TS-CM-C100	Topsoil	8.9	Strongly Alkaline	Heavy Clay	2.2	Slightly Saline
TS-CM-C051	Topsoil	8.4	Moderately Alkaline	Light-Medium Clay	2.6	Slightly Saline
TS-CM-C042	Topsoil	8.8	Strongly Alkaline	Heavy Clay	0.8	Non-Saline
TS-CM-C07	Topsoil	8.9	Strongly Alkaline	Light-Medium Clay	1.1	Non-Saline
TS-CM-C10	Topsoil	8.8	Strongly Alkaline	Heavy Clay	0.8	Non-Saline
TS-CM-C38/38	Topsoil	9.1	Very Strongly Alkaline	Light Clay	1.3	Non-Saline
TS-CM-C152	Topsoil	8.8	Strongly Alkaline	Light Clay	0.9	Non-Saline
TS-CN-C16	Topsoil	8.9	Strongly Alkaline	Heavy Clay	0.9	Non-Saline
TS-CN-CN364	Topsoil	8.8	Strongly Alkaline	Sandy Loam	0.9	Non-Saline
TS-CN-CN223	Topsoil	7.5	Mildly Alkaline	Sandy Clay Loam	2.5	Slightly Saline
TS-CN-CN342	Topsoil	7.6	Mildly Alkaline	Clay Loam	0.7	Non-Saline
TS-CN-CN413	Topsoil	8.4	Strongly Alkaline	Sandy Clay Loam	0.7	Non-Saline
TS-CN-CN334	Topsoil	8.3	Moderately Alkaline	Heavy Clay	0.5	Non-Saline
TS-CN-CN93	Topsoil	8.9	Strongly Alkaline	Silty Clay	1.1	Non-Saline
TS-CN-CN320	Topsoil	8.1	Moderately Alkaline	Heavy Clay	0.5	Non-Saline
TS-CN-CN369/370	Topsoil	7.7	Mildly Alkaline	Sandy Loam	0.5	Non-Saline
TS-CM-C26	Topsoil	9.0	Very Strongly Alkaline	Heavy Clay	1.5	Non-Saline

Table 6-38 Soil sample analysis and threshold ratings 2020 sites

Site	TOC	Nitrate N	P (Olsen)	ESP	Ca:Mg	pH	Rating	Texture*	ECe**	Rating
C07_1	1.7	8.8	1.7	1.0	3.0	8.4	Moderately Alkaline	Medium Clay	0.8	Non-Saline
C07_2	1.9	12.0	2.6	1.5	2.7	8.4	Moderately Alkaline	Medium Clay	0.8	Non-Saline
C122_1	0.9	19.4	10.7	12.0	2.2	8.4	Moderately Alkaline	Light clay	8.5	Highly Saline
C122_2	1.0	45.1	16.4	5.3	3.3	8.2	Moderately Alkaline	Silty Clay Loam	2.5	Slightly Saline
C125_1	1.4	23.9	1.5	11.7	3.0	8.9	Strongly Alkaline	Silty loam	3.2	Slightly Saline
C125_2	1.2	17.8	1.7	9.8	3.1	8.9	Strongly Alkaline	Silty loam	2.1	Slightly Saline
C142_1	1.0	5.7	2.4	<0.2	5.1	8.5	Strongly Alkaline	Loamy Sand	1.8	Non-Saline
C142_2	2.0	3.3	<1.0	0.9	3.9	8.4	Moderately Alkaline	Loamy Sand	1.6	Non-Saline
C149_1	1.3	16.8	14.8	1.3	2.6	8.5	Strongly Alkaline	Silty Clay Loam	1.3	Non-Saline
C149_2	1.4	42.4	11.8	0.1	2.4	8.4	Moderately Alkaline	Light Clay	1.5	Non-Saline
C17_1	2.8	10.9	5.8	0.1	3.0	8.5	Strongly Alkaline	Medium Clay	0.9	Non-Saline
C17_2	2.4	7.1	1.3	0.1	3.8	8.5	Strongly Alkaline	Medium Clay	0.8	Non-Saline
C31_1	1.5	23.7	8.8	0.1	2.2	7.4	Mildly Alkaline	Loamy Sand	3.2	Slightly Saline
C46_1	1.5	34.7	11.4	3.8	2.5	8.2	Moderately Alkaline	Sand	4.3	Moderately Saline
C46_2	1.2	11.7	21.9	0.1	3.5	7.6	Mildly Alkaline	Sand	1.7	Non-Saline
C51_1	1.9	21.4	4	1.1	3.0	8.5	Strongly Alkaline	Light Clay	1.2	Non-Saline
C51_2	4.2	78.6	4.2	0.1	4.0	8.0	Moderately Alkaline	Light Clay	2.1	Slightly Saline
C60_1	2.1	29.7	26.7	0.1	3.3	8.2	Moderately Alkaline	Light Clay	1.2	Non-Saline
C60_2	1.9	33.1	12.7	0.1	2.3	8.5	Strongly Alkaline	Light Clay	1.4	Non-Saline
C71_1	2.1	11.9	3.3	0.1	3.6	8.3	Moderately Alkaline	Silty Clay Loam	1.2	Non-Saline
C71_2	2.8	22.5	4	0.1	2.9	8.2	Moderately Alkaline	Medium Clay	1.2	Non-Saline
C81_2	3.1	56.5	14.1	0.1	2.4	8.3	Moderately Alkaline	Light Clay	1.5	Non-Saline

Site	TOC	Nitrate N	P (Olsen)	ESP	Ca:Mg	pH	Rating	Texture*	ECe**	Rating
CN212_1	1.7	5.4	26.1	0.1	2.3	7.9	Moderately Alkaline	Light Clay	1.5	Non-Saline
CN212_2	1.7	14.8	35.8	0.1	3.4	8.5	Strongly Alkaline	Clay Loam	1.0	Non-Saline
CN225_1	1.0	48.8	4.4	12.8	2.5	7.8	Mildly Alkaline	Clay Loam	0.6	Non-Saline
CN225_2	1.1	43.3	4.6	15.4	2.1	8.6	Strongly Alkaline	Medium Clay	6.8	Moderately Saline
CN326_1	1.0	1.9	15.5	3.6	1.6	8.8	Strongly Alkaline	Medium Clay	5.0	Moderately Saline
CN326_2	0.9	1.4	10	4.8	1.7	8.6	Strongly Alkaline	Light clay	0.7	Non-Saline
CN364_1	0.8	4.7	4.6	8.5	1.9	9.0	Strongly Alkaline	Light clay	0.8	Non-Saline
CN364_2	0.7	9.5	6.5	0.1	2.4	9.1	Very Strongly Alkaline	Sandy Loam	1.7	Non-Saline
CN385_1	0.6	2.1	<1.0	0.1	2.4	8.8	Strongly Alkaline	Sand	2.0	Slightly Saline
CN385_2	0.6	5.4	2.9	0.1	1.9	8.7	Strongly Alkaline	Sand	1.7	Non-Saline
CN387_1	<0.5	6.5	1.8	11.4	2.6	8.2	Moderately Alkaline	Sand	1.1	Non-Saline
CN387_2	0.8	6.6	6.4	0.1	4.7	9.2	Very Strongly Alkaline	Sand	2.9	Slightly Saline
CN400_1	1.1	36.7	18	4.6	2.3	8.4	Moderately Alkaline	Sandy loam	0.7	Non-Saline
CN400_2	1.2	9.7	30.2	3.5	2.5	8.0	Moderately Alkaline	Clay Loam	1.8	Non-Saline
CN413_1	1.6	41.5	17.7	7.0	2.7	8.0	Moderately Alkaline	Clay Loam	0.8	Non-Saline
CN413_2	0.9	26.6	16.2	11.2	1.9	8.7	Strongly Alkaline	Sandy Clay Loam	3.0	Slightly Saline
CN414_1	0.8	21.4	6.4	0.1	1.9	9.0	Strongly Alkaline	Sandy Clay Loam	2.8	Slightly Saline
CN414_2	0.8	3.6	5.4	0.1	1.8	7.8	Mildly Alkaline	Sand	1.4	Non-Saline
CN55_1	2.4	11.6	48.2	0.4	2.9	8.3	Moderately Alkaline	Sand	0.8	Non-Saline
CN55_2	1.8	19.4	38.7	1.6	3.3	7.3	Neutral	Clay Loam	0.5	Non-Saline
CN93_1	2.2	24.7	24	0.1	2.5	8.3	Moderately Alkaline	Clay Loam	0.8	Non-Saline
CN93_2	1.9	13.9	23.2	0.1	2.3	8.0	Moderately Alkaline	Medium Clay	1.0	Non-Saline

Table 6-39 Soil sample analysis and threshold ratings 2020 sites

Site	TOC	Nitrate N	P (Olsen)	ESP	Ca:Mg
C07_1	1.7	8.8	1.7	1.0	3.0
C07_2	1.9	12.0	2.6	1.5	2.7
C122_1	0.9	19.4	10.7	12.0	2.2
C122_2	1.0	45.1	16.4	5.3	3.3
C125_1	1.4	23.9	1.5	11.7	3.0
C125_2	1.2	17.8	1.7	9.8	3.1
C142_1	1.0	5.7	2.4	<0.2	5.1
C142_2	2.0	3.3	<1.0	0.9	3.9
C149_1	1.3	16.8	14.8	1.3	2.6
C149_2	1.4	42.4	11.8	0.1	2.4
C17_1	2.8	10.9	5.8	0.1	3.0
C17_2	2.4	7.1	1.3	0.1	3.8
C31_1	1.5	23.7	8.8	0.1	2.2
C46_1	1.5	34.7	11.4	3.8	2.5
C46_2	1.2	11.7	21.9	0.1	3.5
C51_1	1.9	21.4	4	1.1	3.0
C51_2	4.2	78.6	4.2	0.1	4.0
C60_1	2.1	29.7	26.7	0.1	3.3
C60_2	1.9	33.1	12.7	0.1	2.3
C71_1	2.1	11.9	3.3	0.1	3.6
C71_2	2.8	22.5	4	0.1	2.9
C81_2	3.1	56.5	14.1	0.1	2.4
CN212_1	1.7	5.4	26.1	0.1	2.3
CN212_2	1.7	14.8	35.8	0.1	3.4
CN225_1	1.0	48.8	4.4	12.8	2.5
CN225_2	1.1	43.3	4.6	15.4	2.1
CN326_1	1.0	1.9	15.5	3.6	1.6
CN326_2	0.9	1.4	10	4.8	1.7
CN364_1	0.8	4.7	4.6	8.5	1.9
CN364_2	0.7	9.5	6.5	0.1	2.4
CN385_1	0.6	2.1	<1.0	0.1	2.4
CN385_2	0.6	5.4	2.9	0.1	1.9
CN387_1	<0.5	6.5	1.8	11.4	2.6
CN387_2	0.8	6.6	6.4	0.1	4.7
CN400_1	1.1	36.7	18	4.6	2.3
CN400_2	1.2	9.7	30.2	3.5	2.5
CN413_1	1.6	41.5	17.7	7.0	2.7

Site	TOC	Nitrate N	P (Olsen)	ESP	Ca:Mg
CN413_2	0.9	26.6	16.2	11.2	1.9
CN414_1	0.8	21.4	6.4	0.1	1.9
CN414_2	0.8	3.6	5.4	0.1	1.8
CN55_1	2.4	11.6	48.2	0.4	2.9
CN55_2	1.8	19.4	38.7	1.6	3.3
CN93_1	2.2	24.7	24	0.1	2.5
CN93_2	1.9	13.9	23.2	0.1	2.3

Dispersive soils

Soils with EAT indices of 1-3 will disperse if water is allowed to pond on them. Thus, the soils tested are prone to dispersion, hardsetting or the development of a surface crust when dry. This is also indicated by the exchangeable sodium percentage measured at the mines.

It is critical that on-site management includes measures that provide for protection and treatment of sodic and dispersive soils so as to limit the potential for erosion and generation of turbid water. Turbid water from construction areas also needs to be treated on site, as once clays are in suspension and turbid water runs off into waterways, it is very difficult to remove from the water.

Vegetated swales and wetlands along waterways will assist with stormwater treatment and entrapment of silt and sand fractions but are unlikely to be effective in removing dispersed clay from suspension. Treatment of water collected in sedimentation basins may be required to remove suspended clays from water, prior to discharge of water into waterways. Water collected in sedimentation basins may be treated with a flocculant and involve the use of cyclones to improve water quality, prior to entering waterways.

The management of water flows over and through dispersive soils is a key tool in control of detrimental effects. Approaches may include:

- Diversion of water flows away from these materials. This is not always possible due to the extensive distribution of these dispersive soils
- Minimising potential convergence and/or ponding of surface flows, particularly on disturbed soils
- Development of appropriate cover/protection of dispersive soils (i.e. creation of stable linings that a resistant to rainfall erosion and runoff)
- Soil chemical ameliorants are recommended for short-term stabilisation of dispersive soils on construction sites. Three primary soil ameliorants and their uses for stabilising dispersive soils on construction sites are:
  - Natural or recycled gypsum ($CaSO_4$) primarily for stabilising dispersive topsoil or subsoil
  - Hydrated lime ($Ca(OH)_2$) stabilises soil cations by supply of calcium and increasing soil strength
  - Agricultural lime ($CaCO_3$) will provide minor soil stability.

Salinity

Most topsoil sites have a low or very low salinity risk and meet the rehabilitation criterion milestone ‘a leaching profile has developed, or is likely to, and EC values are sufficiently low to allow survival and growth of the plant species present’. Four spoil samples are considered to have extreme salinity (EC) risk and may not meet this criterion milestone. Amelioration for salinity with compost is recommended at sites as outlined in **Table 6-40**.

pH levels

pH levels at sites that were acidic and where material with pH ≤6 was present may not currently meet the criterion milestone 'levels of pH are within the range required to allow plant growth' and will require amelioration towards neutral pH levels at the rehabilitation sites. Amelioration recommendations with lime are outlined in **Table 6-40**. Where pH is very strongly alkaline (>9) zinc coated MAP or DAP should be considered to ensure zinc levels are adequate for pasture establishment.

Nutrients

The calcium magnesium ratio (Ca:Mg) is typically low across all sites and may not meet the criterion milestone 'levels of soil macro and micro nutrients are likely to be sufficient to ensure that trees do not experience nutrient deficiencies'. It is recommended that gypsum or lime application is undertaken across all sites which are marginal or deficient. Use of gypsum or lime will be determined according to pH and/or ESP status (**Table 6-40**). Gypsum and lime will increase the Ca:Mg towards more desirable levels for increase soil stability and pasture growth, with gypsum having the added benefit of supplying a source of sulfur. If "recycled" gypsum is to be sourced, then these rates should be increased by 20%. The gypsum can be broadcast directly over the top of the pasture and incorporated by rainfall.

At sites where organic matter (OM) levels were deficient to marginal, compost can be applied to ameliorate organic carbon content as outlined in **Table 6-40**.

Nitrate N levels are typically marginal to deficient across most sites and requires amelioration to improve plant available nitrogen with DAP as outlined in **Table 6-40**. Mono-ammonium phosphate (MAP) and di-ammonium phosphate (DAP) will also address phosphorous deficiencies across identified sites.

Recommendations

Recommendations for ameliorants are summarised in **Table 6-40** and **Table 6-41.** Ameliorant recommendations listed in **Table 6-40** are for samples collection in July/August 2022 by Curragh and analysed as outlined in the *Curragh Topsoil and Spoil Sampling Program* proposed by SLR in 2022. Ameliorant recommendations listed in **Table 6-41** are for samples collection in 2020 by Curragh and analysed as outlined in the *Topsoil Training, Assessment and Sampling* guideline by GT Environmental (2019).

Table 6-40 Ameliorant Recommendations for sample collection in July/August 2022

Site	Potential Stockpile Use	Gypsum	Lime	Compost	MAP + Zn	DAP +Zn	Urea
		t/ha	t/ha	m³/ha	kg/ha	kg/ha	kg/ha
SP-CN-C418	Native Topsoil	5	Nil	2	Nil	200	Nil
SP-CN-C16	Native Topsoil	10	Nil	2	Nil	200	Nil
SP-CM-C07	Subsoil	10	Nil	15	Nil	200	Nil
SP-CM-C10	Native Topsoil	10	Nil	5	Nil	200	Nil
SP-CM-C126	Subsoil	10	Nil	20	Nil	200	Nil
SP-CM-C042	Native Topsoil	10	Nil	Nil	Nil	200	Nil
SP-CM-C152	Subsoil	10	Nil	20	Nil	200	Nil
SP-CM-C100	Native Topsoil	10	Nil	2	Nil	200	Nil
SP-CM-C38/38	Native Topsoil	10	Nil	5	Nil	200	Nil
SP-CM-C077	Native Topsoil	10	Nil	5	Nil	200	Nil
SP-CN-C369/370	Subsoil	10	5	10	50	Nil	100

Site	Potential Stockpile Use	Gypsum	Lime	Compost	MAP + Zn	DAP +Zn	Urea
		t/ha	t/ha	m³/ha	kg/ha	kg/ha	kg/ha
SP-CN-CN93	Native Topsoil	5	Nil	2	Nil	150	Nil
SP-CN-CN320	Native Topsoil	5	Nil	2	Nil	200	Nil
SP-CN-CN342	Native Topsoil	2	10	15	Nil	200	Nil
SP-CN-CN413	Native Topsoil	2	Nil	Nil	Nil	200	Nil
SP-CN-CN334	Native Topsoil	10	Nil	10	Nil	150	Nil
SP-CN-CN364	Native Topsoil	10	Nil	5	Nil	200	Nil
SP-CM-C051	Native Topsoil	10	Nil	5	Nil	150	Nil
SP-CN-CN223	Native Topsoil	5	Nil	2	Nil	200	Nil
SP-CM-C142	Native Topsoil	Nil	Nil	2	Nil	200	Nil
TS-CM-C077	Pasture Topsoil	Nil	Nil	Nil	Nil	200	Nil
TS-CM-C142	Pasture Topsoil	Nil	Nil	Nil	Nil	200	Nil
TS-CM-C100	Pasture Topsoil	5	Nil	5	150	Nil	Nil
TS-CM-C051	Pasture Topsoil	Nil	Nil	10	200	Nil	Nil
TS-CM-C042	Pasture Topsoil	Nil	Nil	Nil	200	Nil	Nil
TS-CM-C07	Pasture Topsoil	5	Nil	Nil	Nil	200	Nil
TS-CM-C10	Pasture Topsoil	Nil	Nil	Nil	Nil	200	Nil
TS-CM-C38/38	Pasture Topsoil	Nil	Nil	Nil	Nil	200	Nil
TS-CM-C152	Pasture Topsoil	Nil	Nil	Nil	Nil	200	Nil
TS-CN-C16	Pasture Topsoil	Nil	Nil	Nil	Nil	150	Nil
TS-CN-CN364	Pasture Topsoil	Nil	Nil	2	Nil	200	Nil
TS-CN-CN223	Pasture Topsoil	2	Nil	5	50	Nil	Nil
TS-CN-CN342	Pasture Topsoil	2	Nil	Nil	50	Nil	100
TS-CN-CN413	Pasture Topsoil	Nil	Nil	2	50	Nil	100
TS-CN-CN334	Pasture Topsoil	2	Nil	Nil	50	Nil	100
TS-CN-CN93	Pasture Topsoil	2	Nil	Nil	Nil	150	Nil
TS-CN-CN320	Pasture Topsoil	2	Nil	Nil	50	Nil	100
TS-CN-CN369/370	Pasture Topsoil	2	Nil	2	Nil	200	Nil
TS-CM-C26	Pasture Topsoil	5	Nil	2	Nil	200	Nil

Table 6-41 Ameliorant Recommendations for sample collection in 2020

Site	Potential Stockpile Use	Gypsum	Lime	Compost	MAP + Zn	DAP +Zn	Urea
		t/ha	t/ha	m³/ha	kg/ha	kg/ha	kg/ha
C07	Pasture Topsoil	Nil	Nil	2	Nil	200	Nil
C122	Pasture Topsoil	5	Nil	10	200	Nil	Nil
C125	Pasture Topsoil	5	Nil	5	200	Nil	Nil
C142	Pasture Topsoil	Nil	Nil	2	Nil	200	Nil
C149	Pasture Topsoil	2	Nil	2	200	Nil	Nil
C17	Pasture Topsoil	Nil	Nil	Nil	Nil	200	Nil
C31	Pasture Topsoil	2	Nil	5	200	Nil	Nil
C46	Pasture Topsoil	2	Nil	5	200	Nil	Nil
C51	Pasture Topsoil	Nil	Nil	5	200	Nil	Nil
C60	Pasture Topsoil	2	Nil	2	200	Nil	Nil

Site	Potential Stockpile Use	Gypsum	Lime	Compost	MAP + Zn	DAP +Zn	Urea
		t/ha	t/ha	m³/ha	kg/ha	kg/ha	kg/ha
C71	Pasture Topsoil	2	Nil	Nil	200	Nil	Nil
C81	Pasture Topsoil	2	Nil	Nil	200	Nil	Nil
CN212	Pasture Topsoil	Nil	Nil	2	Nil	150	Nil
CN225	Pasture Topsoil	5	Nil	5	200	Nil	Nil
CN326	Pasture Topsoil	2	Nil	5	Nil	200	Nil
CN364	Pasture Topsoil	5	Nil	5	Nil	200	Nil
CN385	Pasture Topsoil	2	Nil	5	Nil	200	Nil
CN387	Pasture Topsoil	5	Nil	5	Nil	200	Nil
CN400	Pasture Topsoil	2	Nil	2	Nil	200	Nil
CN413	Pasture Topsoil	5	Nil	5	200	Nil	Nil
CN414	Pasture Topsoil	2	Nil	5	Nil	200	Nil
CN55	Pasture Topsoil	2	Nil	Nil	150	Nil	Nil
CN93	Pasture Topsoil	2	Nil	Nil	150	Nil	Nil

Notes:

- Where multiple samples were taken at the same site, amelioration recommendations were made on the "worst" results to achieve the best outcome
- Trace elements were analysed using a methodology which determines concentration of total elements and not DTPA extractable concentration
- ECe and amelioration rates are based on field texture as lab determined particle size analysis was not undertaken

The majority of spoil stockpiles are recommended for use as topsoil for establishment of native woodland. The four spoil stockpiles recommended for use as subsoil is due to high salinity and/or sodicity. If these four stockpiles are utilised as subsoil no amelioration is recommended. Similarly, if any other stockpiles are utilised as subsoil, amelioration is not required. All topsoil stockpiles are recommended for use as topsoil for establishment of grass pasture or grassy woodland.

Soil improvers selected for use in the amelioration program are as follows:

- Gypsum provides calcium, sulfur and reduces dispersion – if recycled gypsum is used the application rate needs to be increased by 20%.
- Agricultural lime provides calcium and increases pH towards neutral.
- Compost provides organic carbon, increases water holding capacity, permeability and decreases salinity.
- MAP + Zinc provides phosphorus and some nitrogen (22P, 10N) and trace element zinc.
- DAP + Zinc provides phosphorus and nitrogen (20P, 18N) and trace element zinc.
- Urea provides nitrogen only (46N).

Soil re-spreading and seedbed preparation

Where topsoil resources allow, topsoil should be spread to a nominal depth of 0.15 m on all re-graded land. Topsoil should be spread, treated with gypsum and seeded in one consecutive operation to reduce potential for topsoil loss to wind and water erosion. Soil respreading on steep slopes at depths exceeding 0.15 m can be deleterious because of the sponge effect which can cause slippage of the topsoil from the slope. Flat areas should be topsoiled at a nominal depth of 0.2 m.

Thorough seedbed preparation should be undertaken to ensure optimum establishment and growth of vegetation. All topsoiled areas should be lightly contour ripped (after topsoil spreading) to create a "key" between the soil and underlying material. Best results will be obtained by ripping when soil is moist and when undertaken immediately prior to sowing. The respread topsoil surface should be scarified prior to or during seeding to reduce runoff and increase infiltration.

6.1.11 Water Management

Water Infrastructure Post Closure

CCPL is proposing to leave all raw water dams in order to support the PMLU of light grazing and open woodland. In order to successfully graze the land stock water sources are required. CCPL will remove sediment from any dams to be retained then allow them to naturally fill again. The water in these dams will be required to meet stock watering requirements as outlined in ANZEEC Guidelines.

Processing dams will be decommissioned and rehabilitated to the proposed PMLU. A land contamination study will be undertaken for all processing dams then the dam will be rehabilitated by battering in the dam walls, topsoiling, ripping and seeding to establish the land to the surrounding land use.

Erosion and Sediment Control

CCPL will continue to produce a landform design that, where possible, will emulate the natural drainage and slopes in the mining area. Landform design will incorporate natural and engineered structures to minimise erosion.

Where required, erosion and sediment control structures will be implemented where required in accordance with the EM Plan 2.1 Erosion and Sediment Control Management Plan.

Contour banks may be constructed in areas of steep slopes or long slope lengths to manage runoff during rehabilitation and closure. Contour banks are earthen structures constructed at intervals down the slope to intercept run off and safely channel it into stable waterways.

Contour bank design parameters include:

- Low gradient design of 0.5% along the flow alignment;
- Flow velocities below 1.0 m/sec (for nil vegetation case);
- Spoil construction, covered by 200 mm of topsoil;
- Bank invert left bare, no topsoil; and
- Up slope bank face at 1:2, down slope face at 1:3.

Contour banks less than 400 m long are built to a standard dimension of 1 m high of spoil, plus a 200 mm topsoil cover. Contour banks effectively minimise erosion on slopes but tend to produce concentrated high velocity flows at their discharge end. Contour banks are therefore arranged to discharge into a strategically placed energy dissipation basin or waterway.

Some waterways may require rock armouring due to the high flow velocities encountered. At the Curragh Complex, the Ishbash equation has been used to determine optimum rock size and all rehabilitation waterways are designed to a 50-year ARI.

Several rock lined waterways have been constructed in the rehabilitation areas and are working efficiently. The rock size grading is specified according to the steepness of the channel and the subsequent velocities experienced.

Hydraulic jump basins will be used at the bottom of the slope to dissipate energy and therefore limit the length of the waterway.

If contour banks are left to remain in the longer term, after the establishment of a vegetative cover, they may increasingly be at risk of overtopping. This failure could cause a concentration of flow to occur and commencement of gully erosion. Consequently, after establishment of adequate vegetative cover, the potential will be assessed as to whether the contour banks will be removed to avoid that possibility.

Removal could be carried out by a variety of methods depending on the height of the bank and its manner of construction. These methods may include:

- Grading out the bank material up and down slope;
- Complete removal by scraper;
- The area of the removed bank will be re-seeded and where necessary, re-topsoiled.

Blackwater Creek Diversion

In 2008 Wesfarmers Curragh Pty Ltd received approval to divert a 9.4 km section of Blackwater Creek to allow the extension of mine operations to the east. The Blackwater Creek Diversion (BWCD) has a constructed length of 10.2 kms and consists of a meandering low flow channel, high flow channel, batter banks and terraces that all required rehabilitation and revegetation.

The intent of the rehabilitation is to provide a comprehensive strategy that facilitates the re-establishment of in-stream and ex-stream ecological processes within the channel. The aim of the rehabilitation is to create as much as possible, a self-sustaining system that requires minimal management in the short to medium term and no future management beyond the cessation of the mining operations. The BWCD will result in a permanent, stable and sustainable creek alignment that will provide an important ecological corridor over the entire length of the diversion.

The diversion channel has been designed to imitate the bed grade, channel plan form, cross-section form, and other geomorphic and habitat features of the reaches of the natural channel that the diversion will replace. Essentially the functional design aims to recreate a “natural” reach of channel that will be self-sustaining over the long term, well beyond the cessation of mining operations.

To achieve this the design aims to recreate a system as close as possible to, within the limits posed by the engineering design requirements of the diversion, the naturally occurring in stream and riparian zones in undisturbed parts of Blackwater Creek. This will aid in the establishment of natural in stream habitat, riparian and near riparian zones (riverine zones) featuring as far as practicable, locally occurring native plant species that include groundcovers, shrubs and trees.

Restoration of a diverse physical structure within the stream, and a diverse floristic structure, will see a corresponding increase in habitat diversity and an increase in faunal activity, diversity and dispersal.

A geometrically engineered diversion channel was designed by Parsons Brinckerhoff which included both low flow and high flow components divided into zones that reflect the profile attributes of the diversion.

The mandatory elements that were incorporated into the design were:

- Variations in the longitudinal and latitudinal section of the floor of stream form; and
- Strategic location of vegetation to increase habitat values and maximise bank stability.

Some amendments were made to the original rehabilitation design that was assessed as ongoing improvements and adaptations to achieve the desired outcomes.

The rehabilitation zones are referred to as:

- Channel: low flow channel;
- Zone A: low flow channel batter (1V:3H);
- Zone B1: high flow terrace extending up to Zone B2;
- Zone B2: high flow terrace extending up to Zone C; and
- Zone C: high flow batters (batters of 1V:3H), levees and drains extending to natural ground.

Rehabilitation success criteria for diverting Blackwater Creek were that the diversion must achieve a minimum of 75% groundcover and have weediness not greater than 5%.

The establishment of adequate vegetative groundcover was deemed necessary to achieve acceptable scour resistance within the range of velocity, shear and stream power characteristics predicted. The criteria and staged response are outlined in **Table 6-42**. These assigned parameters aligned with the time intervals proposed for the formal assessment monitoring.

Due to the acceleration of the mine, cover and weediness were still the target values which had to be achieved at the opening stage. These are considered to be the Primary Success Criteria.

Table 6-42 Rehabilitation Success Criteria for Practical Completion

Parameter	3 Months	6 Months	12 Months	18 Months	24 Months
Cover/m^2 – Groundcover – Hydromulch Zones A, B2 & C	30%	50%	75%	75%	75%
Weediness	15%	10%	5%	5%	5%

Biodiversity Success Criteria were not necessary for Practical Completion but are considered necessary for proving reinstatement of biodiversity performance. **Table 6-43** details the long-term biodiversity outcomes.

Table 6-43 Long Term Biodiversity Outcomes

Parameter	3 months	6 months	12 months	18 months	24 months
Cover/m^2 – Groundcover – Hydromulch Zones A, B2 & C	30%	50%	75%	75%	75%
Diversity – Groundcover – Hydromulch Zones A, B2 & C	≥3 Species	≥3 Species	≥4 Species	≥5 Species	≥6 Species
Height (Median) – Direct Planting cells and continuous planting in Zone B1	20cm	40cm	75cm	100cm	125cm
Diversity – Direct Planting cells and continuous planting in Zone B1	≥5 Species	≥5 Species	≥7 Species	≥10 Species	≥10 Species

It is the intention that the diversion will be maintained post-opening to ensure that it complies with the long-term diversity criteria.

Other Watercourse Diversions

There are two other permanent watercourse diversions proposed to occur as part of the Curragh Extension project; Minnie Creek Diversion and Bonnie Doon Creek Diversion (**Figure 6-24**).

The western portion of Curragh Central intersects with Minnie Creek. An approximately 6.9 km long diversion of Minnie Creek is proposed around the western perimeter of Curragh Central and discharging into the Blackwater Creek.

A portion of the mine vehicle haul road along the western perimeter of Curragh South crosses and traverses Bonnie Doon Creek. An approximately 1.1 km long diversion of Bonnie Doon Creek is proposed on the western side of the mine vehicle haul road.

These diversions have not yet been designed or constructed. Prior to construction a certified design plan in accordance with the EA conditions must be submitted to the administering authority. 'As Constructed' drawings and specifications must also be submitted at least 60 days after the construction of a diversion.

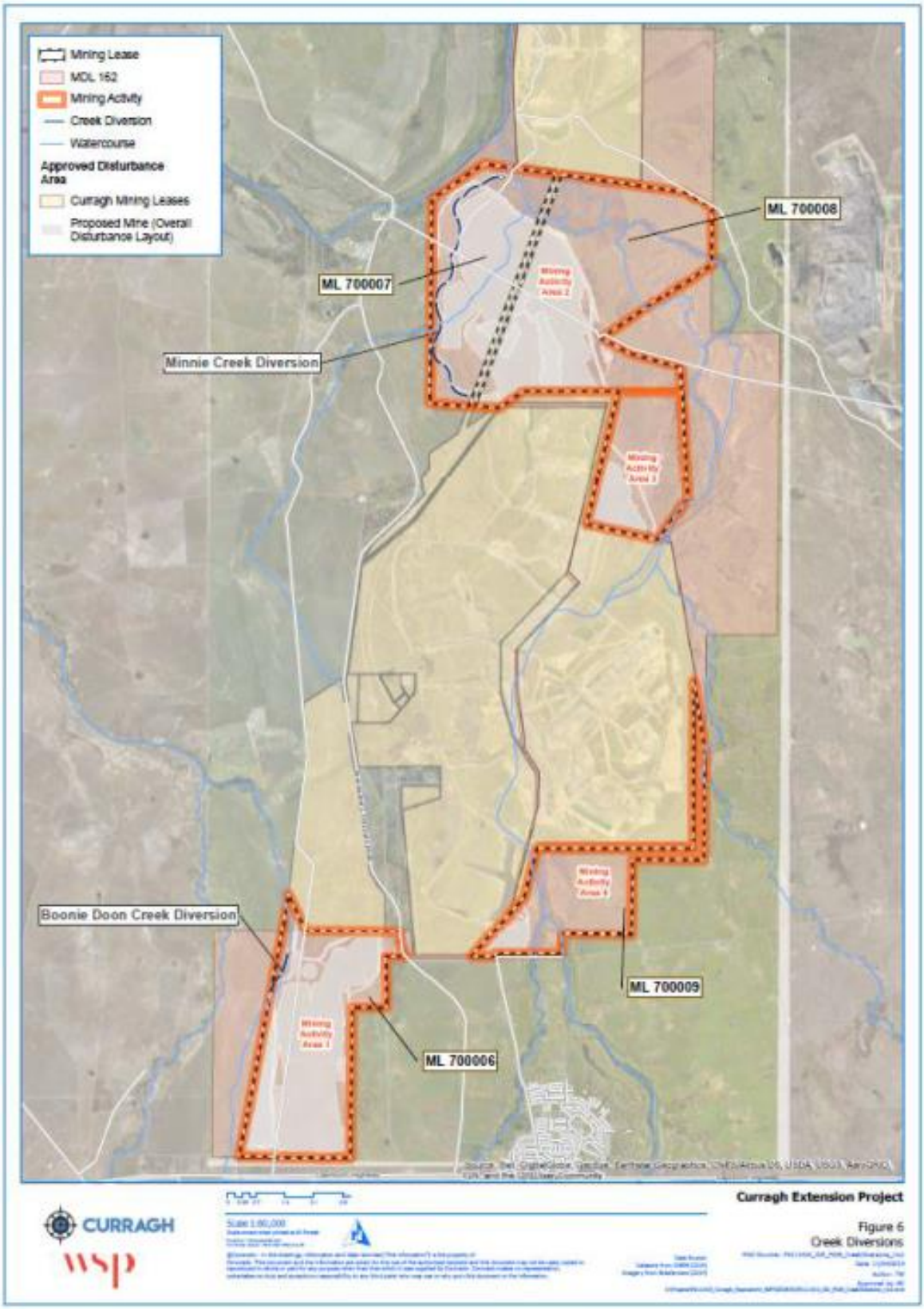


Figure 6-24 Proposed Watercourse Diversions

6.2 Rehabilitation/Management Strategy

The rehabilitation objectives for the Curragh Complex are:

i. To achieve a self-sustaining open pasture and woodland, capable of supporting both native fauna and pasture for light intensity grazing that requires minimal on-going maintenance;

ii. To ensure the land disturbed by mining activities will be made stable; and

iii. Maintain downstream water quality at an acceptable standard consistent with ambient water quality conditions.

To avoid land degradation, grazing should be of a light intensity only. Light grazing is a condition with less than 30% grass utilization to produce slaughter steers. A 30% pasture utilization is considered the maximum to maintain land condition without degradation (Bowen and Chudleigh, 2017).

The basic elements essential to the attainment of these objectives are landform stability, topsoil management, revegetation, and the control of run-off water.

The rehabilitation strategy is built around five benchmarks as follows:

- Areas re-contoured (reshaped to final grade);
- Areas topsoiled;
- Areas seeded (ripped and seeded, irrespective of germination success);
- Areas established (vegetation has established, although minor reseeding/ erosion repairs may be necessary); and
- Areas successfully rehabilitated and certified (compliance with rehabilitation success criteria).

6.2.1 Infrastructure

Discussions between CCPL and the underlying landholder for the retention of some infrastructure are ongoing. Currently, there are no formal agreements between CCPL and the underlying landholder for the retention of built infrastructure in the post-mine landscape. Decommissioning and final rehabilitation of built infrastructure will therefore occur on a staged basis over several years. The rehabilitation process will include:

- The removal of buildings and structures;
- The breaking up and covering of concrete slabs and or/coal stockpile areas with a suitable depth of inert material; and
- The removal of redundant roads by removal of contaminated material before ripping and seeding.

Haul roads and hardstand areas will be rehabilitated by removal of contaminated material and ripping of compacted areas, topsoiling and seeding.

6.2.2 Water Management Infrastructure

CCPL is proposing to leave all raw water dams in order to support the PMLU of light grazing. In order to successfully graze the land stock water sources are required. CCPL will remove sediment from any dams to be retained then allow them to naturally fill again. The water in these dams will be required to meet stock watering requirements as outlined in ANZEEC Guidelines.

Processing dams will be decommissioned and rehabilitated to the proposed PMLU. A land contamination study will be undertaken for all processing dams then the dam will be rehabilitated by battering in the dam walls, topsoiling, ripping and seeding to establish the land to the surrounding land use.

6.2.3 Overburden Dumps

The overburden dumps will be reshaped in accordance with the proposed final landform. Landform morphology will be developed and implemented to ensure an integrated final landform. Water and erosion will be managed though use of the appropriate water management structures e.g. contour banks, rock lining on waterways.

Topsoil will be applied in strips to approximately 65% of the area in order to allow tree and shrub growth without the competition of grasses which prefer topsoiled areas.

Deep ripping of spoil/topsoil in conjunction with seeding will be utilised to minimise erosion. Revegetation will be surveyed on a regular basis and maintenance will be carried out to meet rehabilitation success criteria. Revegetation will be carried out predominantly using a seeder to broadcast seed.

6.2.4 Tailings

The Out-of-pit tailings storage facility will be rehabilitated in accordance with the Parson Brinckerhoff (2016) Design report. Once the cover design is installed and signed off by a RPEQ qualified person, the area will be topsoiled and seeded with predominantly grass species.

The in pit tailings disposal areas will be covered in at least 1 m of inert rock as part of the reshaping of the overburden dumps and low walls. The area will then be topsoiled within at least 0.2 m of growth media, ripped then seeded.

6.2.5 Final Voids

The final voids will be reprofiled in accordance with the geotechnical report based on the rock material assessed prior to rehabilitation occurring. The geotechnical report summarised in **section 6.1.9** outlines the different scenarios shown for each pit. Once the pit wall is reprofiled a bund will be constructed to limit access to the highwall. Fencing and signage have not been proposed as safety bunds will be constructed to minimise access to the final voids. The voids will be allowed to fill with water which has been modelled to show that it will not interact with the surrounding environment.

6.2.6 Stable Embankments

The stable embankments will be formed when the voids are mined to their final location and the area is rehabilitated. The embankments will be constructed using Permian or Quaternary spoil. Rock mulch will be applied to the watercourse side slope (19°) to provide erosional stability. The full extent of the stable embankment will support a use of ecosystem services and fauna habitat.

7 Risk Assessment

7.1 Principles and Methodology

The key steps to the risk assessment process were:

- **Establish the Context:** Consideration should be given to both the internal and external environment, the limits within the risk assessment are valid, the activity being assessed and the cross section of people contributing to the risk management process;
- **Identification of Hazards:** Risk identification refers to the process of identifying risks against a pre-defined set of business objectives, taking into account the context, the previous risk assessments, incidents and the findings of audits performed onsite;
- **Risk Analysis:** each potential consequence should be analysed separately, and existing or current controls should be identified, and their effectiveness and efficiency taken into account.
- **Risk Evaluation:** to assist in making decisions, and to define which risks need treatment and the priority for treatment implementation; and
- **Risk Treatment:** selecting control options for modifying risks and implementing those controls to reduce residual risk factors to a level as low as is reasonably achievable (ALARA). Costs and efforts of the controls versus the benefits derived should be reviewed. Reduction of the risks should be according to the hierarchy of controls:
    - Elimination;
    - Substitution;
    - Engineering controls;
    - Administrative controls; and
    - Personal protective equipment.

A PRCP Closure Risk Workshops were facilitated by SLR over two days 6th and 7th June 2022. Attendees were as per **Table 7-1**.

Table 7-1 Risk Assessment Attendees

Name	Employer	Department	Date of Attendance
Mark Stokes	Coronado Curragh	Development	06/06/2022 07/06/2022
Margaret Stewart	Coronado Curragh	Development	06/06/2022 07/06/2022
Brad Radloff	SLR Consulting	Environmental Approvals and Management	06/06/2022 07/06/2022
Emma Williams	SLR Consulting	Environmental Approvals and Management	06/06/2022 07/06/2022
Kim Tuart	Coronado Curragh	Technical Services	06-06-2022
Madeline Bourke	Coronado Curragh	Technical Services	06-06-2022
Kelly Smith	Coronado Curragh	Technical Services	06-06-2022

Name	Employer	Department	Date of Attendance
Amanda Dawson-Evenhuis	Coronado Curragh	Technical Services	06-06-2022
Connor Jacklin	Coronado Curragh	Technical Services	06-06-2022
Liz Blythe	Coronado Curragh	HR and Social	07-06-2022
Anne Palmer	Coronado Curragh	HR and Social	07-06-2022
Tania Fitzgerald	Coronado Curragh	HR and Social	07-06-2022
Danny Millers	Coronado Curragh	Mine Planning	07-06-2022
Brett Mason	MineOp Consulting	Mine Planning	07-06-2022
Eugene Cooper	Coronado Curragh	Mine Planning	07-06-2022
Anthony De Domenico	Coronado Curragh	Management	06/06/2022 07/06/2022
Scott Weatherall	Coronado Curragh	Mine Planning	07-06-2022
Eaton Sheridan	Coronado Curragh	Mine Planning	07-06-2022

7.2 Risk Matrix

A risk matrix was used to assess the level of risk with certain events. The risk matrix considers the consequence and likelihood of each event. The consequence and likelihood categories have been developed based on the criteria from the Integrated Mine Closure Good Practice Guide, 2nd Edition (ICMM, 2019). The risk matrix is shown in **Table 7-2**.

Table 7-2 Risk Matrix

Likelihood		Consequence				
		1 - Insignificant	2 - Minor	3 - Moderate	4 - Significant	5 - Major
		No lasting rehabilitation impact, no remediation required, no rehabilitation delivery impacts	Minor rehabilitation impact requiring minor remediation or repair, delivery impact of <6 months	Moderate rehabilitation impact requiring moderate remediation or repairs, delivery impact of <2 years	Significant rehabilitation impact requiring significant remediation or repairs, delivery impact of <10 years	Major rehabilitation impact requiring major remediation or repairs, delivery impact of >10 years
5 - Almost Certain	Greater than 90% likelihood of occurring Has happened, will probably happen during the mine life/closure and there is no reason to suspect it won't happen	**11 - Medium**	**16 - Significant**	**20 - Significant**	**23 - High**	**25 - High**
4 - Likely	Likelihood of occurring is equal to or more than 30% and less than 90% This consequence is not uncommon in the mining and metals industry/area	**7 - Medium**	**12 - Medium**	**17 - Significant**	**21 - High**	**24 - High**
3 - Possible	Likelihood of occurring is equal to or more than 10% and less than 30% There is a possibility of this risk occurring as it has occurred before (albeit infrequently) in the mining and metals industry/area	**4 - Low**	**8 - Medium**	**13 - Significant**	**18 - Significant**	**22 - High**
2 - Unlikely	Likelihood of occurring is more than or equal to 3% and less than 10% There are no specific circumstances to suggest this could happen	**2 - Low**	**5 - Low**	**9 - Medium**	**14 - Significant**	**19 - Significant**
1 - Rarely	Likelihood of occurring is less than 3% it would require a substantial change in circumstances to create an environment for this to occur, and even then, this is a rare occurrence	**1 - Low**	**3 - Low**	**6 - Medium**	**10 - Medium**	**15 - Significant**

7.3 Summary of Key Closure Risks

The risk assessment outcomes are outlined in **Appendix O**. A total of 30 risks were identified and assessed. No high risks, 11 significant risks, 13 medium risks and 6 low risks were classified in accordance with the risk matrix.

The 11 significant risks identified include:

- Changes to mine planning resulting in non-compliance with PRCP schedule.
- Change in mining methods.
- Changes in infrastructure requirements over mine life (e.g. tailings/rejects storage).
- Incorrect placement of materials resulting in erosion and/or geotechnical instability.
- Waste characterisation inadequate.
- Grass competition results in insufficient woodland development.
- Inadequate monitoring data to support relinquishment.
- Drought impacting rehabilitation success.
- Uncontrolled bushfire damaging rehabilitation.
- Stakeholder support of post-mining land uses change.
- Potential changes to regulator rehabilitation expectations / interpretation impacting PRCP schedule amendments.

7.4 Risk Treatment Plan

A Risk Treatment Plan (**Appendix O**) has been developed for the risks identified in the risk assessment. The Risk Treatment Plan includes the following:

- Proposed treatments for each risk;
- Reason for the proposed treatment;
- Performance measures and constraints;
- Reporting and monitoring requirements;
- Potential corrective actions;
- Resources requirements;
- Timing; and
- Responsibility.

The outcomes of the risk treatment plan assessment are linked with the monitoring and maintenance programs to ensure that all actions necessary are undertaken to ensure risks are mitigated and minimised.

7.5 Rehabilitation Trials

7.5.1 Heightened Spoil Dumps at Curragh North

Issues and risks that may affect the success and performance of revegetation on increased slope angles include:

- Soil erosion and landform stability;
- Adequacy of current species mixes for final landform and land use; and
- Vegetation establishment on steeper slopes >16%.

Consequently, the following measures will be trialled for rehabilitation of the steeper slopes associated with the heighted Curragh North spoil dumps.

Contour banks / slope breaks

On the steeper slopes associated with the heighted spoil dumps at Curragh North, the regularity of contour banks and/or slope breaks will be increased (to approximately 55m apart for vegetated slopes up to 20%). The adequacy of these additional contour banks and slope breaks for maintaining erosion and landform stability, will be assessed through erosion and landform stability monitoring as outlined below.

Erosion analysis

For the heighted spoil dumps at Curragh North, field-based erosion monitoring will be undertaken at the same time as rehabilitation monitoring. Evidence of erosion will be assessed in accordance with the Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain 2009) and includes:

a. type of erosion (wind, water, scald, sheet, rill, gully, tunnel and mass movement)
b. state of erosion (active, partially stabilised or stabilised)
c. severity of erosion (dependent upon type of erosion present – present/absent and if present either minor, moderate, severe or very severe)
d. for gullies - the depth and width of erosion
e. opportunistic identification of all areas of significant erosion encountered outside of the assessment areas.

Landform stability

Landform stability of the rehabilitation on the heightened spoil dumps will be assessed using current Light Detection and Ranging (LiDAR) data and remote sensing software to generate 1 m digital elevation models (DEMs) of the landform. DEMs from previous years will be compared to assess stability as it relates to identifying areas of settlement, deposition, subsidence and erosion.

The DEM slope analysis will also be used to assess the as built landform against the landform design criteria with a maximum slope of 16% for the out of pit (OoP) dump slope tying into the final landform and with in-pit dump slopes of up to 27% for the internal rehabilitation batters.

Annual erosion and landform stability monitoring will enable early detection of instability of rehabilitated slopes >16%, particularly areas that may be developing deep rills or gullies and/or areas that are either subsiding or were run off is settling. Early detection will enable targeted rework as required to maintain overall landform stability.

Species mix

The following measures will be implemented to improve rehabilitation success on steeper slopes associated with the heightened spoil dumps at Curragh North:

- Establishment of additional vegetation reference sites in surrounding vegetation communities on steep slopes (i.e. > 16%) to improve species data and vegetation data to inform rehabilitation on the steeper slopes;
- Tree, shrub and grass species representative of the surrounding vegetation will be included in the species mix for steeper slopes; and
- To establish short-term groundcover, a cover crop such as millet or oats will be included with the revised native tree, shrub and grass seed mix.

Vegetation establishment on steeper slopes

The current rehabilitation method includes deep ripping, with the use of a winged tyne and direct seeding. For steeper slopes, (>16%) there is an increased risk of erosion. To reduce this risk, rehabilitation is focused on establishing a high ground cover to reduce rainfall impact on soils and on establishing deeper roots to stabilise slopes. To improve native tree and shrub establishment on steeper slopes all areas of rehabilitation that have been adequately topsoiled are seeded with the revised native species mix (outlined above).

In areas of rehabilitation lacking suitable topsoil, consideration will be given to hydro mulching slopes >16% to improve vegetation establishment to achieve >50% cover with revised species mix in less than one year to reduce the risk of erosion.

When preparing the soils for direct seeding, consideration will be given to the constraints associated with the material below the depth of ripping (i.e. poor structure from sodicity or subsoil salinity). The addition of soil ameliorants such as lime or gypsum or alternatively a calcium based soil conditioner in combination with recalcitrant carbon-based soil conditioner, a biologically active fertiliser blend including soil bacteria and mycorrhizal fungi developed for rehabilitation, and a soil binder product may be required to stabilise the soil prior to direct seeding and ripping.

8 Monitoring and Maintenance

8.1 Monitoring Program

The overall aim of the rehabilitation monitoring program is to provide Curragh Complex with accurate information about the performance and development of its rehabilitation over time. Within this broad aim there are number of specific objectives:

- To measure the density, richness and condition of canopy, shrub (overstorey) and shrub (understory) woody species established on rehabilitated land using plot-based methods, and to benchmark the results against completion criteria;
- To measure species richness in the rehabilitation and compare against completion criteria.
- To accurately assess vegetation success against completion criteria;
- Assessment of slope stability, erosion 'hotspots' or slumping across the mine using LiDAR (or similar); and
- To determine if any relationships exist between biophysical parameters, such as substrate quality, soil moisture and rainfall patterns at the time of sowing, and rehabilitation success.

Table 8-1 Rehabilitation Monitoring Program

Monitoring Activity	Year 1-3	Year 5	Year 7	>Year 10	Milestone Criteria
Inspections of Highwalls	Annual	Once	Once	Every five years until certification	• Static Factor of Safety >1.5 and Dynamic Factor of Safety >1.1. • Installation of signage as required. • Highwall slopes maximum of 65°. • Bund highwall area.
Event Inspection	Wet season	As required	As required	As required	• No maintenance actions required.
Erosion monitoring	Annual	Once	Once	Every five years until certification	• Absence of rill/gully erosion >0.3 m.
Surface water quality monitoring	Annual	Once	Once	Every five years until certification	• Surface water quality meets the water quality characteristics outlined in the EA.
Groundwater monitoring	Annual	Once	Once	Every five years until certification	• Groundwater quality meets the limits outlined in the EA.
Soil quality monitoring	Annual	Once	Once	Every five years until certification	• Soil salinity content is <800 dS/m, pH is between 5.5-9 and exchangeable sodium percentage is <15%.
Topsoil depth	After topsoil spreading				• Topsoil spread to >200 mm. • Topsoil strips spread to >200 mm over approximately 65% of overburden dump area.
Ecological monitoring /LFA	Annual	Once	Once	Every five years until certification	• Presence of at least 1 Eucalyptus species and at least 2 Acacia species. • Mean vegetative groundcover is >50%.

Monitoring Activity	Year 1-3	Year 5	Year 7	>Year 10	Milestone Criteria
					• 5 Year average pasture yield of 1,500kg DM/ha • Presence of 3P (pastural, perennial and productive) grass species • Evidence of second-generation recruitment of native tree/shrub species • Evidence of native fauna utilising area
Diversion monitoring	After 2018, every two years until relinquishment.				• Blackwater Creek Diversion criteria for Blackwater Creek Diversion • Groundcover diversity an average of >6 species

8.1.1 Inspection and certification of highwalls

To ensure the structural stability and integrity of the void highwalls sign off from an appropriately qualified person should be undertaken post any reshaping. Annual inspections should then occur to report on evidence of:

- Cracking or slumping;
- Erosion;
- Water runoff; and
- Void creep.

8.1.2 Surface Water Monitoring

Surface water monitoring will take place in accordance with methodology to be outlined in the Receiving Environment Monitoring Program (REMP). The REMP will outline the surface water quality monitoring to be undertaken at locations across the Curragh site. To ensure that milestone criteria are met, surface water monitoring will take place throughout the wet season, annually. However, the climate of the region is generally dry, resulting in periods when surface water is not present, and monitoring is not possible.

8.1.3 Groundwater Monitoring

Groundwater quality and water levels will be monitored in accordance with the locations and frequencies outlined in the EA. Table C12 of Schedule C outlines the groundwater monitoring locations and frequencies and appendix 5 outlines the groundwater monitoring locations for quality characteristics identified in **Table C13 – groundwater contaminant trigger levels**. The EA states the groundwater quality limits and that groundwater is to be measured at least every 6 months.

8.1.4 Revegetation Monitoring

A modified transect-based approach is used at Curragh to provide continuity with previous monitoring of rehabilitation on site and to inform remotely sensed imagery interpretation. The assessment focuses on collecting data suitable for comparison against the rehabilitation success criteria.

Sites less than one year old

For sites less than one year old the following are recorded:

- plant species richness – native, pasture species and weeds;
- percentage cover; and
- rill and gully erosion.

A walk through of the mine is undertaken to record all native and weed species observed across representative area of the mine, ensuring variation across the mine is assessed, e.g. areas of woodland species, pasture grasses, weedy areas and any area where there are obvious differences in vegetation cover. Following this, a representative location towards the centre of the mine is chosen and a 1m x 1m quadrat is randomly placed in the four compass directions (north, east, south and west).

The species assemblage (including declared weeds) and the following groundcover percentages within the quadrats are recorded. Rill and gully formation are also noted and where significant gullies are forming a GPS waypoint is recorded so that gully stability can be assessed over time.

This assessment is undertaken for each site with a minimum of four quadrat samples per 10 hectares provided the mine is relatively homogeneous. If there is substantial variation in vegetation cover across a site, the mine will be stratified so that an additional four quadrats will be sampled for each strata, e.g. high cover areas, low cover areas, weed dominated areas.

For each quadrat the following are recorded:

- Native grasses;
- Non-native grasses;
- Native forbs and others;
- Woody species (saplings);
- Non-native forbs and others; and
- Bare ground/rock.

Sites greater than one year old

At each new site, three transects of 50m x 14m running downslope will be established and permanently marked for future re-assessment. At each (new and established) transect assessments are undertaken in 50m x 14m, 50m x 8m, 50m x 4m and in 1m x 1m quadrats (listed in Table 9), with the following parameters assessed:

- Species richness – total number of different species in each life form layer as described in the BioCondition Methodology (Eyre et al., 2015);
- Coarse woody debris – total length in metres of all woody debris over 0.5m length and 0.1m diameter; and
- Tree species recruitment – regeneration of canopy and sub-canopy species.

Table 8-2 Data Attributes Collected in Different Quadrants

50m x 4m quadrats	1m x 1m quadrats
Canopy cover, sub-canopy cover and shrub layer cover using the line intercept method along the transect centre line. Cover is recoded for each layer where it intercepts the tape measure laid out along the centre line	Native perennial grass cover, native other grass, native forbs and other species (non-grass), native shrubs
stem counts identified into groupings – Eucalypt/Corymbia, Acacia, Other (tree), Shrub based on final life form, i.e. a young Eucalypt in the shrub layer is still recorded as a tree	
estimate of the mean height of the sub-canopy and shrub layer based on field measurements	
number of large trees. A large tree will be determined based on comparison with the relevant reference sites and measured against a DBH threshold	

8.1.5 Soil Sampling

Soil sampling (0-10 cm) at both ends of the transect on newly revegetated sites (or problem sites) across topsoil/spoil media for analysis of EC, pH and nutrient characteristics.

8.1.6 Erosion Monitoring

Erosion data will be collected from a 50 m cross-section along the centre of each LFA transect. Data collected will include:

- Type of erosion;
- Length and width of each site of erosion;
- Erosion depth and
- Stability of erosion.

This information will be used to estimate the scale and current activity of erosion at each monitoring site. The information will be reported in the Rehabilitation Monitoring Report with the LFA status of each monitoring site. Where erosion gullies are greater than 400 mm deep and active rill erosion less than 300 mm deep, action to mitigate erosion including:

- The repair of any contour drains;
- The addition of minor contour drains to disburse and distribute water;
- The installation of sediment fencing and
- The re-establishment of vegetation where required.

8.1.7 Blackwater Creek Diversion

The Blackwater Creek Diversion will be monitored and maintained in accordance with the EMS Plan 1.4 Blackwater Creek Diversion Monitoring and Maintenance Plan (**Appendix C**).

8.2 Maintenance Plan

A range of maintenance and management activities may be required in rehabilitated areas to facilitate achievement of defined success criteria. Rehabilitation areas should be monitored at an early stage and results compared to success criteria. Areas that do not meet the defined success criteria should have maintenance or management activities completed to facilitate achievement of the success criteria. These activities are outlined below (**Table 8-3**).

Table 8-3 Maintenance and Management Program

Aspect	Management Action	Maintenance Action
Vegetation	• Identify vegetation cover and compare with success criteria or natural bare areas. • Fence off areas to control grazing. • Utilise (grazing) areas to prevent overgrazing, i.e., correct stocking ration / rotational system depending on maturity of system.	• Apply follow-up fertiliser where specified or based on soil analysis. • Re-seed areas by hand if soil quality is addressed. • Re-seed with selected species if diversity is not acceptable. • Stimulate growth with controlled grazing.

Aspect	Management Action	Maintenance Action
	• Check for dormancy. • Vegetation assessment to determine if success criteria (cover, diversity, vitality, etc.) are met.	• Increase roughness of surface or mulch layer to trap seeds. • All vegetation established including tree species was effective with seeding and re-planting of trees are not needed.
Erosion	• Monitor extent and severity of erosion and determine causes – do not repair erosion if activity will cause excessive additional disturbance – allow another season to monitor the progression or stabilisation of small-scale erosion. • Identify footpath creation during utilisation of area. • Identify unwanted concentration of runoff over large areas.	• Small rill erosion – selected branch or rock packing. • Gullies – backfill where needed by borrowing from surrounds or use small earthworks equipment (e.g., TLB); use coarse material for backfilling. • Large gullies – import material to backfill from stockpiles or borrow pits or construct structures (e.g., silt fences, etc.). • Reinstate / upgrade water control structures. • Spread runoff where concentration occurs. • Improve vegetation cover.
Sediment Control	• Monitor and inspect sediment control structures that were constructed. • Evaluate the need for de-silting in view of stabilisation of rehabilitated areas and buffer capacity of sediment control structures. • Inspect sediment control structures especially after intense rain events and increased erosion.	• De-silt sediment control structures where capacity has been compromised – place silt on areas that is not subject to erosion, ameliorate and vegetate. • Construct new sediment control structures where needed. • Re-route runoff based on evaluation of drainage pattern after rehabilitation. • Repair upstream erosion. • Improve vegetation cover.
Water Control Structures (e.g., berms, graded banks)	• Identify reduced capacity due to sedimentation. • Check for vertical alignment, i.e., uneven settlement or consolidation causing low areas. • Check for long-term stability, e.g., scouring. • Check condition of low-lying areas that were constructed on the top of dumps and other flat areas.	• Remove sediment from sediment traps. • Repair damages to berms or channels. • Revisit Surface Water Management Plan after evaluation of drainage pattern after rehabilitation and construct additional structures where needed or remove is no longer required/functional.
Weed Management	• Continue with weed control programme.	• Annual weed inspections and mapping. • Weed control with selected herbicides appropriate to area concerned (e.g., rehabilitated areas vs. firebreaks). • Bush encroachment control follow up on previously cleared areas. • Thin out undesirable species where it may impact/affect grass cover. • Mowing/slashing periodically as removing biomass repeatedly causes reduced vigour in many weed species. Use in combination with herbicides.

Aspect	Management Action	Maintenance Action
		• Weed removal using a weed wrench or root talon.
Feral Animal Management	• Identify feral animals that can affect rehabilitated areas.	• Implement feral animal control plan. • Liaise with neighbouring stakeholders, where needed, to address the cause of the problem.
Fire Management	• Maintain firebreaks.	• Maintaining firebreaks on boundaries. • Vegetation control along firebreaks. • Clear firebreaks mechanically where needed.
Land Stability	• Monitor land stability.	• Erosion and sediment control structures are appropriately maintained.

9 PRCP Schedule

The PRCP Schedule has been provided as a pdf and excel format as per the DES template (**Appendix P**).

9.1 Final Landform Design

The final site design is shown in **Figure 9-1** and delineates the following:

- The maximum disturbance footprint;
- Mining lease boundaries;
- The PMLUs and NUMAs for the area; and
- 0.1% AEP flood extent.

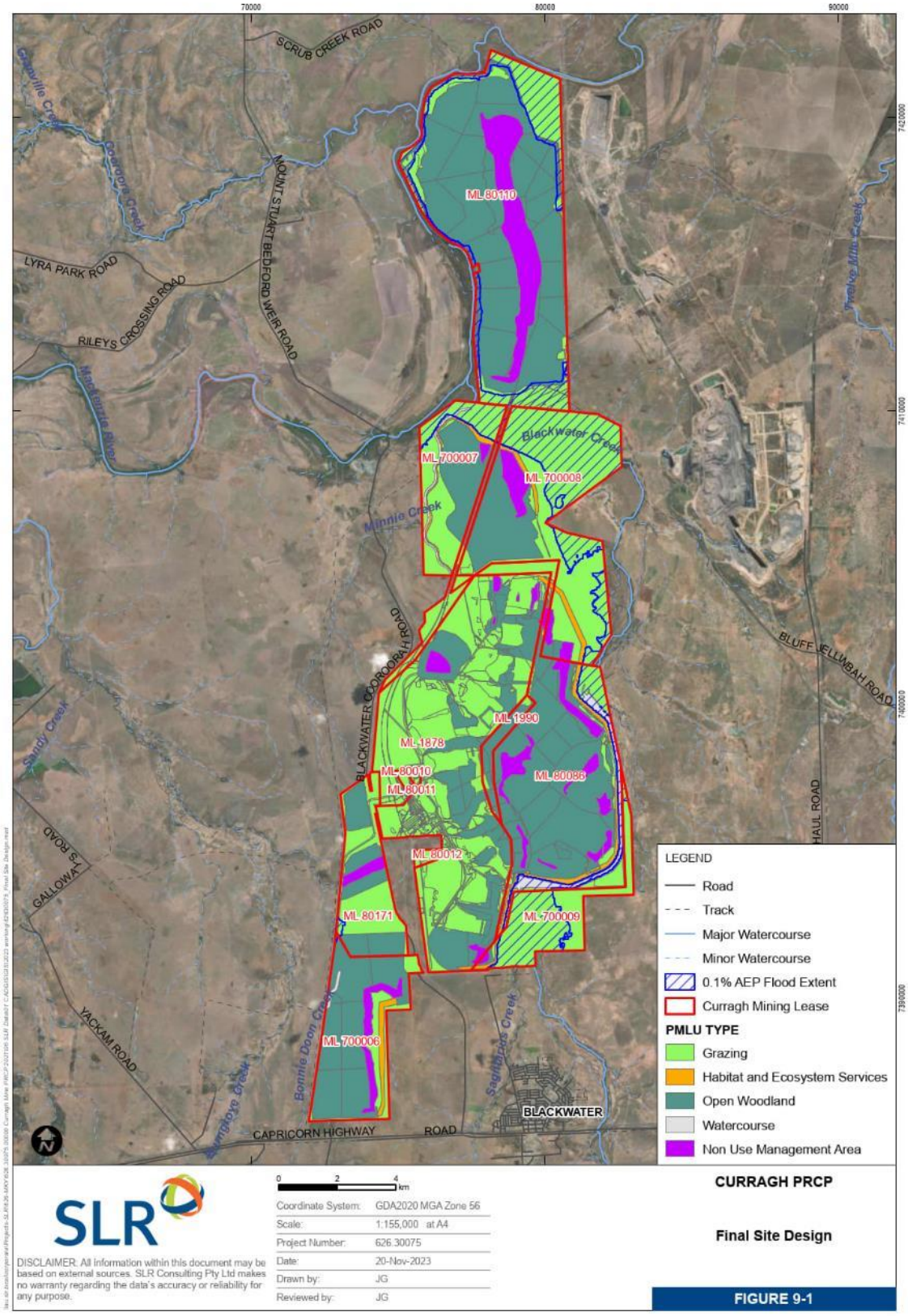


Figure 9-1 Curragh Complex - Final Site Design

9.2 Rehabilitation/Improvement Areas

A Rehabilitation Area (RA) is defined in the EP Regulation as an area of land in the post-mining land use to which a rehabilitation milestone for the post-mining land use relates. The Curragh Complex has four PMLUs of Light Grazing, Open Woodland Fauna habitat and ecosystem services and watercourse. The residual voids are proposed as NUMAs. The applicable rehabilitation methodology/milestones have been used to identify different rehabilitation areas.

The proposed rehabilitation areas are detailed in **Table 9-1** and shown in **Figure 9-2, Figure 9-3, Figure 9-4** and **Figure 9-5**.

Table 9-1 Proposed Rehabilitation and Improvement Areas

Rehabilitation Area / Improvement Area	Description	Total Size (ha)	Post-mining Land Use
RA1	Overburden Dumps and Ramps	9,497	Open Woodland
RA2	Infrastructure activities requiring a land contamination study	128	Light Grazing
RA3	Miscellaneous Activities – topsoil stockpiles, roads, laydown yards, cleared areas	464	Light Grazing
RA4	Blackwater Creek Watercourse Diversion	156	Watercourse
RA5	Water Infrastructure	65	Light Grazing
RA6	Out-of-pit Tailings Storage Facility	185	Light Grazing
RA7	Stable Embankments	367	Fauna Habitat and Ecosystem Services
RA8	In-Pit Tailings	68	Open Woodland
RA9	Existing Overburden Rehabilitation	1,653	Light Grazing
RA10	Minnie Creek and Bonnie Doon Creek Watercourse Diversion	61	Watercourse
IA1	Voids	1,499	Residual Void

The approximate total rehabilitation area for Curragh Complex is 14,143 ha.

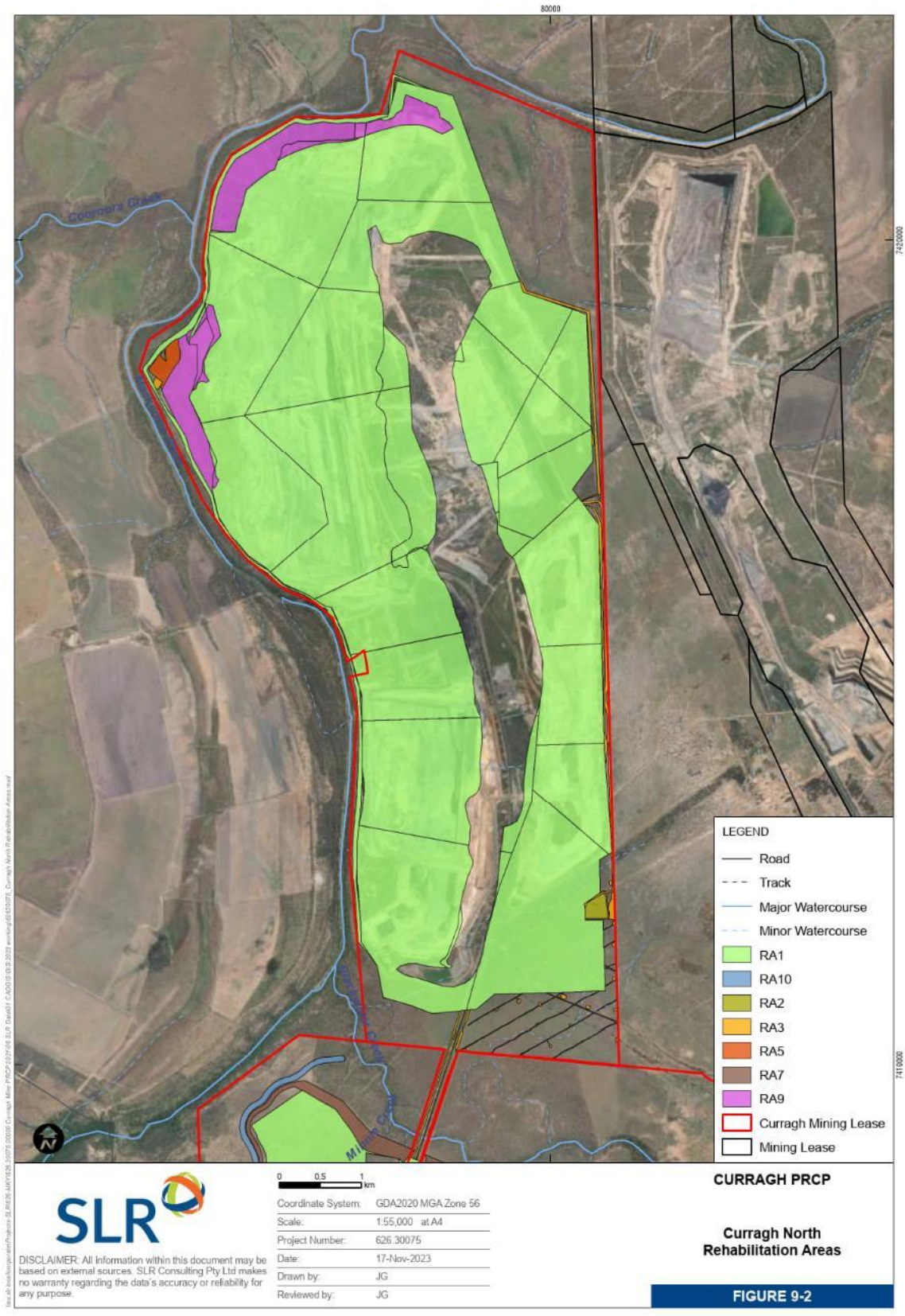


Figure 9-2 Curragh North Rehabilitation Areas

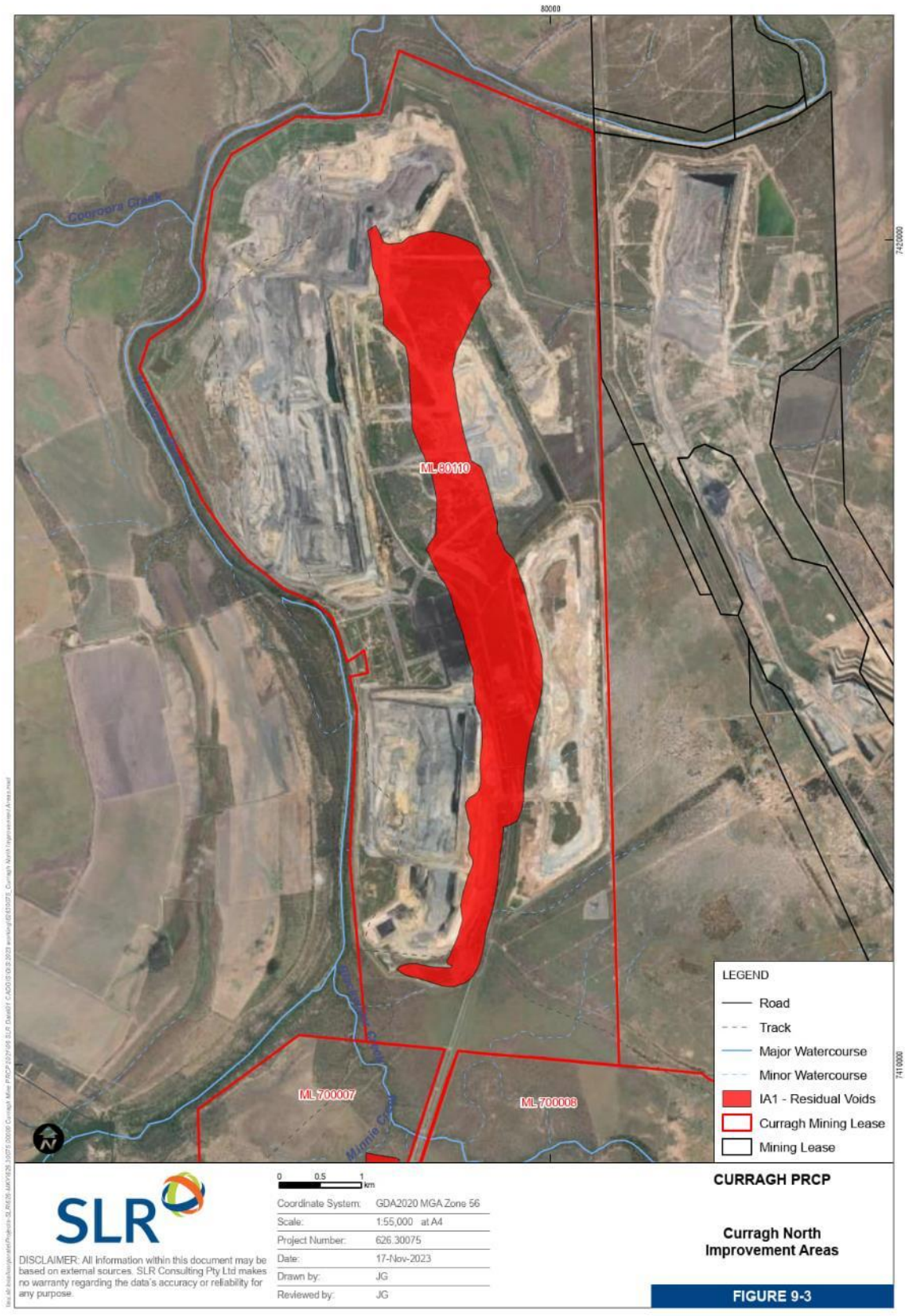


Figure 9-3 Curragh North Improvement Areas

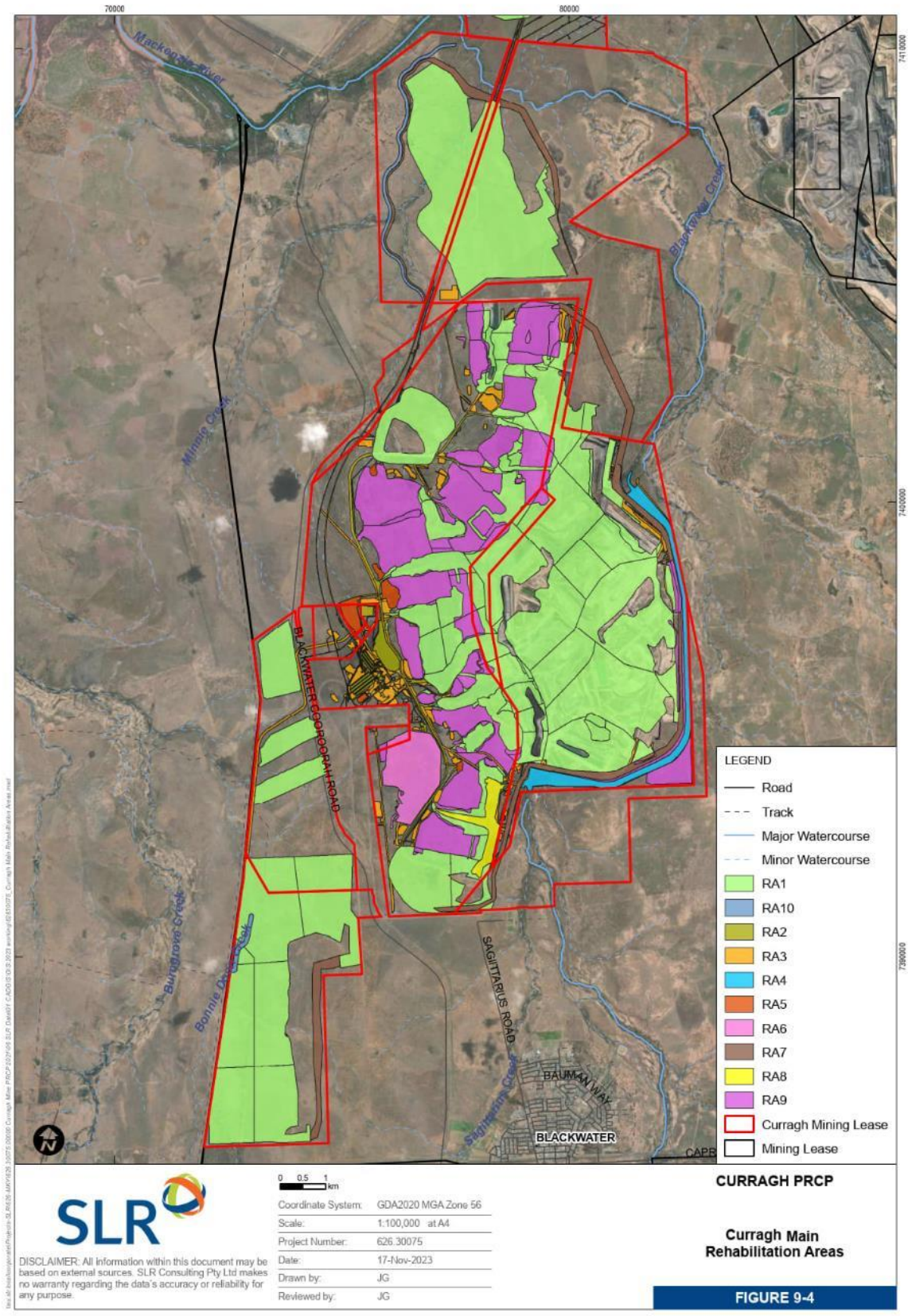


Figure 9-4 Curragh Main Rehabilitation Areas

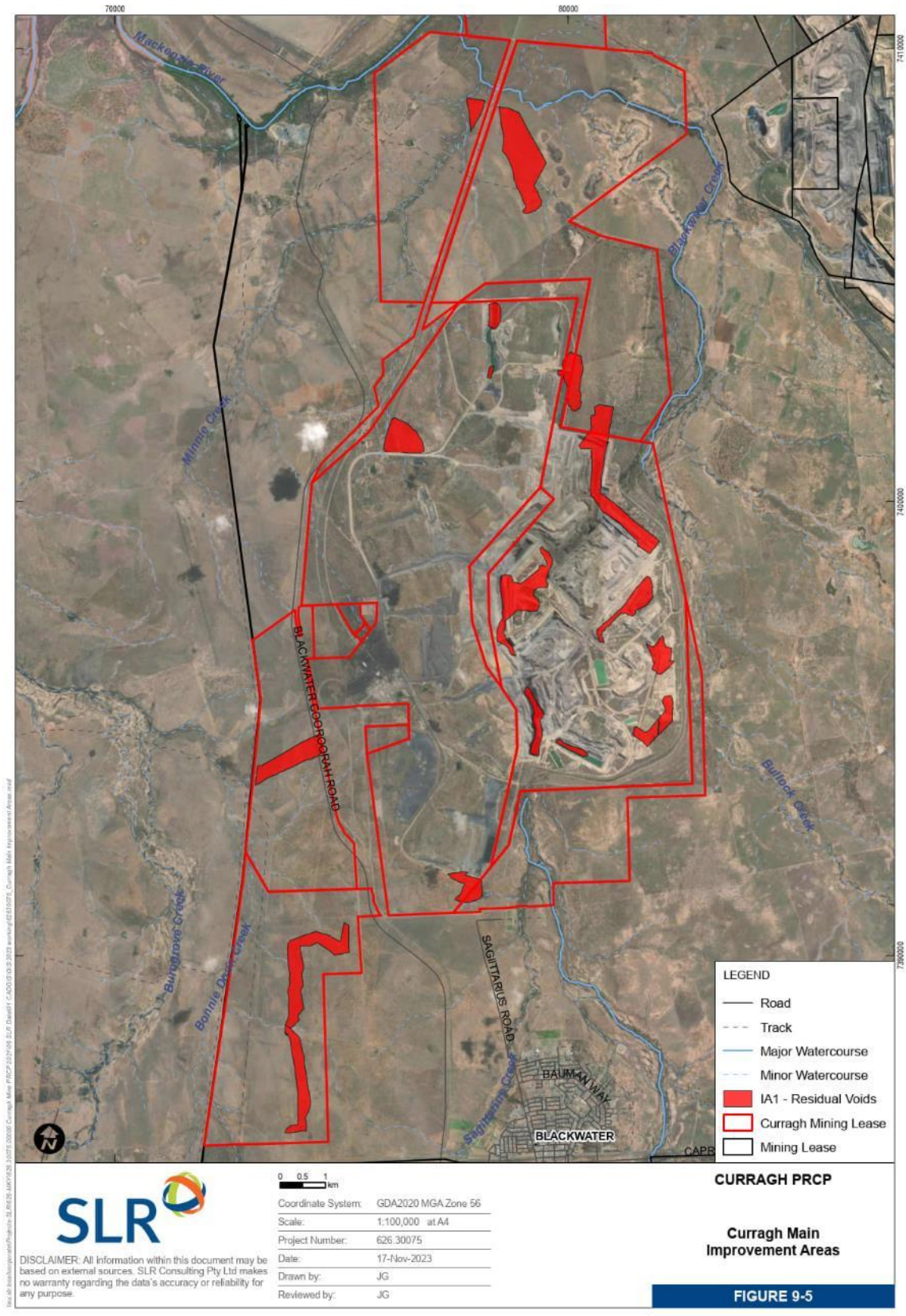


Figure 9-5 Curragh Main Improvement Areas

9.3 Available for Rehabilitation

Available for rehabilitation is defined in section 126D of the EP Act as land that is no longer being mined, unless:

a) The land is being used for operating infrastructure or machinery for mining, including, for example, a dam or water storage facility;

b) The land is identified in the proposed PRCP schedule as containing a resource to be mined within 10 years after the land would otherwise have become available for rehabilitation;

c) The land is required for the mining of a probable or proved ore reserve mentioned in paragraph (b); or

d) The land contains permanent infrastructure identified in the proposed PRCP schedule as remaining on the land for a PMLU.

Rehabilitation areas at Curragh Complex will progressively become available throughout the life of the mine and once mining on site has ceased. CCPL has developed a rehabilitation schedule for the overburden dumps and voids in accordance with the current mine plan and availability of resources. This schedule has been used to develop the timeframes in the PRCP Schedule.

Other rehabilitation areas will commence rehabilitation after mining has ceased. The Out-of-pit TSF is proposed to be rehabilitated by 2040. While the TSF is technically available for rehabilitation now, there are potential plans to reprocess the tailings and therefore reduce the disturbance associated with the area. Hence, the rehabilitation of this area will be delayed allowing these plans to be finalised and actioned.

Infrastructure areas will be rehabilitated by 2061 as infrastructure will be required for the rehabilitation of overburden dumps and voids. Once these areas have completed active rehabilitation activities (reshaping, topsoil, ripping and seeding) all other areas will commence rehabilitation.

9.4 Milestones and Milestone Criteria

Rehabilitation milestones and the associated criteria have been developed using the information presented in this PRCP. A review of existing rehabilitation and completion criteria for the Curragh Complex was also undertaken by SLR to assist in the justification of milestone criteria and to develop achievable criteria and milestones for the site. The review took into consideration the achievability of the current milestone and criteria to develop updated rehabilitation milestones, as well as providing recommendation for increasing rehabilitation success for the proposed PMLUs (Appendix Q).

These milestones have been reflected in the proposed PRCP schedule and are shown in **Table 9-2**.

Table 9-2 Proposed Milestones and Milestone Criteria

Milestone reference	Rehabilitation milestone	Milestone criteria	Justification
RM1	Infrastructure Decommissioning and Removal	a) With the exception of any infrastructure to remain as part of the post-mining land use (PMLU) or where infrastructure is agreed to be retained by the landholder as evidenced by a signed landholder agreement, the following are complete: i. All services (water, electricity, gas, etc.) disconnected; ii. All hazardous materials removed; iii. All buildings demolished and removed; iv. All pipelines decommissioned; v. All fencing removed; vi. All roads decommissioned; and vii. All boreholes decommissioned. b) All general waste and demolition waste has been: i. Removed; or ii. Disposed of where authorised by environmental authority EPML00643713.	The criteria proposed for this milestone is consistent with the steps undertaken as part of the infrastructure decommissioning process. While CCPL does not currently have any landholder agreements, it has been raised by landholders as an area of further interest and therefore the possibility of these agreements has been allowed for in the criteria.
RM2	Landform Development and reshaping / reprofiling	a) All major earthworks completed. b) Average slope angle of 16%. c) Installation of erosion and sediment control systems to design and certified by an appropriately qualified person. d) Slopes create surface which is free draining with the exception of minor ponding.	The maximum slope of 16% has been transitioned from the RMMP.

Milestone reference	Rehabilitation milestone	Milestone criteria	Justification
RM3	Surface Preparation	a) Topsoil or growth medium placed at a depth ≥200 mm (millimetres) for approximately 65% of overburden dump area. b) Topsoil or growth medium placed at a depth ≥200 mm (millimetres) to 100% of all other areas. c) Contour ripping completed at a depth 600-750 mm. d) Amelioration products have been applied where appropriate and required.	Topsoil will be applied in strips to 65% of the overburden dumps as per the rehabilitation methodology. All other areas will be 100% of the area topsoiled. Amelioration will only be applied if required. Soil testing will occur before topsoil is applied.
RM4	Revegetation	a) The seed mix contains species appropriate for the nominated PMLU. b) Seed mix applied at a rate ≥10 kilograms per hectare (kg/ha). c) Livestock are excluded from newly seeded areas via physical or virtual fencing.	The seed species list is based on the previously used seed mixes, the regional ecosystems in the area and literature.
RM5	Remediation of contaminated land	a) Preliminary site investigation (PSI) completed. b) A detailed site investigation (DSI) has been completed where the PSI completed under criterion RM2(a) identifies contamination is present, or is likely to be present, and said contaminated material is likely to result in a risk to human health or cause environmental harm. c) Where contaminated material is identified, all contaminated material is either: d) Remediated; e) Removed and disposed of at a licenced facility; or f) Disposed of as per the Contaminated Land Investigation Document (CLID) and Site Management Plan (SMP). g) The mine suitability statement states the land is not contaminated land and is not unsuitable for the proposed PMLU. h) Auditor certifies, as per Environmental Protection Act 1994 (EP Act) (Qld), that all contaminated materials have been remediated, or removed and disposed of. i) Land is removed from Environmental Management Register if applicable.	This criteria is consistent with other proposed PRCPs and provides detail on the contaminated land process.

Milestone reference	Rehabilitation milestone	Milestone criteria	Justification
RM6	Rehabilitation of Dams	a) All dams, which are to remain as part of the PMLU or are to be retained as evidenced by a written and signed landholder agreement for their retainment, comply with the following: b) Safely accessible by humans and livestock; c) All contaminated sediment has been removed; and d) Electrical conductivity is ≤ 7500 µS/cm. e) All dams which are not to remain or be retained under criterion RM1(a), comply with the following: i. Where present, liners are removed; ii. All contaminated sediment has been removed; and Earthworks are completed to decommission dam walls.	This criterion allows for water storages to be either retained or rehabilitated. Either method will tie in with the proposed post mining land use.
RM7	Installation of cover system / cap	a) Installation of cover system is designed and signed off by an appropriately qualified person. b) The out-of-pit TSF is designed and completed to the following: i. Geotechnical analysis confirms the tailings storage facility (TSF) is geotechnically stable. ii. The TSF has been fully encapsulated with a cap of ≥2m of non-acid forming (NAF) material. Additional cover material may be required to maintain final design heights following settlement; iii. The TSF maintains a water shedding profile, other than minor ponding. c) The in-pit TSF is designed and completed to the following: i. At least 1 m of inert material covers the tailings. Additional cover material may be required to maintain final design heights following settlement ;	The cover system design criteria has been transitioned from section 6.1.8 of the PRCP report.
RM8	Stable Embankment Development	a) Stable embankment is built to a height suitable to keep 0.1% AEP flood event from infiltrating residual voids. b) The watercourse side slope is built to a maximum of 19° and is applied with rock mulch.	This criteria has been transitioned from section 6.1.1 of the PRCP report. The rock mulch is required to prevent erosion.

Milestone reference	Rehabilitation milestone	Milestone criteria	Justification
RM9	Achievement of Stable Condition (Light Grazing)	a) Average vegetative groundcover is >50%. b) 5 Year average pasture yield of 1500 kg DM/ha c) Presence of 3P (pastural, perennial and productive) grass species. d) Proportion of Category 3 restricted invasive plant species and Weeds of National Significance are not >10% of total vegetative groundcover. e) Soil testing demonstrates the following quality parameters are met: i. Electrical Conductivity <800 dS/m; ii. pH 5.5 – 9; and iii. Exchangeable sodium percentage <15%. f) Rill erosion <0.3 m deep and no gully erosion present. g) Surface water runoff quality on site complies with the most current version of the contaminant limits in Table C2 and Table C3 in the EA EPML00643713. h) Groundwater quality complies with the most current version of the contaminant limits in Table C13 in the EA EPML00643713. i) Stored water quality meets the requirements for stock watering under the ANZEEC Guidelines. j) All fencing used to prevent stock access to revegetation has been removed, except where fencing is agreed to be retained by the landholder as evidenced by a signed landholder agreement. k) Risk Assessment completed demonstrates risks in the rehabilitation area are similar to hazards in neighbouring unmined landscapes subject to a similar PMLU.	CCPL have proposed criteria with the objective of meeting light grazing while not being required to actually graze the land. The average pasture yield and presence of 3P grass species demonstrates that there is suitable food for grazing.
RM10	Achievement of Stable Condition (Watercourse)	a) Groundcover average of >75%. b) Proportion of Category 3 restricted invasive plant species and Weeds of National Significance are not >10% of total vegetative groundcover. c) Groundcover diversity an average of >6 species. d) For the Blackwater Creek Diversion in Zone B1 only a Median height of plants approximately 125 cm e) Plant diversity an average of >6 species	These criteria have been transitioned from the Blackwater Creek Diversion Monitoring and Management Plan

Milestone reference	Rehabilitation milestone	Milestone criteria	Justification
RM11	Achievement of Stable Condition (Open Woodland)	a) Key species presence: i. At least one Eucalyptus species. ii. At least two Acacia species. b) Evidence of second-generation recruitment of native tree/shrub species. c) Evidence of native fauna utilising area. d) Proportion of Category 3 restricted invasive plant species and Weeds of National Significance are not >10% of total vegetative groundcover. e) Soil testing demonstrates the following quality parameters are met: i. Electrical Conductivity <800 dS/m; ii. pH 5.5 – 9; and iii. Exchangeable sodium percentage <15%. f) Rill erosion <0.3 m deep and no gully erosion present. g) Surface water runoff quality on site complies with the most current version of the contaminant limits in Table C2 and Table C3 in the EA EPML00643713. h) Groundwater quality complies with the most current version of the contaminant limits in Table C13 in the EA EPML00643713. i) Risk Assessment completed demonstrates risks in the rehabilitation area are similar to hazards in neighbouring unmined landscapes subject to a similar PMLU. j) Average groundcover on slopes >7% is >50% (this includes the proportion of rock, litter, and groundcover vegetation). k) Evidence of flowering and/or fruiting on tree and shrub species. l) Evidence of litter breakdown and nutrient recycling	A number of the criteria has been transitioned from the Rehabilitation Management and Monitoring Plan. Other criteria is consistent with other proposed PRCPs with a similar PMLU.
RM12	Achievement of Stable Condition (Fauna Habitat)	a) Evidence of native fauna utilising area. b) Rill Erosion <0.3m deep and no gully erosion present. c) Geotechnical investigations of the stable embankments demonstrate geotechnical stability has been achieved.	The stable embankments form a small part of the overall landform and does not exclude grazing. The rock mulch required for the stable embankments will form a unique fauna habitat for a number of species

Milestone reference	Rehabilitation milestone	Milestone criteria	Justification
MM1	Landform Development and reshaping / reprofiling	a) Highwall slopes have a maximum of 65°. b) Highwall safety bunds are constructed in accordance with The Department of Industry and Resources (1997) Guideline Safety Bund Walls Around Abandoned Open Pit Mines or as recommended by an appropriately qualified person.	The maximum highwall slope as per the Geotechnical Study is 65°. The highwalls will be constructed to the suitable slope based on geology type.
MM2	Achievement of sufficient improvement	a) Signage along highwalls and end walls. b) Geotechnical investigations of the high wall, low wall, end wall and ramp walls demonstrates geotechnical stability has been achieved. c) All highwalls achieve a Static Factor of Safety >1.5 and Dynamic Factor of Safety >1.1. d) Groundwater and void lake monitoring / modelling confirms that the void acts as a sink. e) Residual voids are protected from possible inflow from nearby watercourses. f) The void will not cause environmental harm outside of the tenure boundaries.	This criterion has been transitioned from the CRVA with the intention to reduce human and livestock access to the highwall.

9.5 Timeframes

To determine the completion dates for the milestones in the PRCP schedule, some general guidance regarding the timing of milestones to complete have been developed (Table 9-3). These rules have been adapted in the PRCP schedule with consideration to overall delivery.

Table 9-3 Milestone completion dates

Milestone Reference	Rehabilitation Milestone	Approximate timeframe for completion	Comments
RM1	Infrastructure Decommissioning and Removal	2 years	The removal and decommissioning of all infrastructure and services are included in this timeframe. Landholder consultation will take place to ensure that any Infrastructure to be retained is identified. This time allows for interruptions due to weather and limited workforce.
RM2	Landform Development and reshaping/reprofiling	1-5 years	Earthworks associated with overburden dumps will occur in accordance with the rehabilitation schedule developed by CCPL which considers mine plan and available resources (e.g. equipment). Other areas which are smaller and simpler in size will be completed quicker.
RM3	Surface Preparation	2 years	This timeframe allows for the spreading of topsoil, ripping and amelioration (if required) prior to seeding. Some time as a contingency has been allowed for testing of soil and to coordinate with seeding.
RM4	Revegetation	2 years	Seeding will take place directly after topsoil application. This timeframe ensures that seeding takes place during the correct time of year and accounts for re-seeding, if required.
RM5	Remediation of Contaminated Land	2 years	This timeframe allows for a suitably qualified person to visit site and conduct preliminary contaminated land investigations. This includes any sampling and analysis of material, as well as to action any required works.
RM6	Rehabilitation of Dams	3 years	Dependent on the water remaining in the structures, water may need to be pumped to the pits before rehabilitation can commence.
RM7	Installation of cover system / cap	1-3 years	It will take approximately 2 years to complete the cover design with an additional year for RPEQ signoff.
RM8	Stable Embankment Development	2 years	Landform development and rock mulching.
RM9	Achievement of Stable Condition (Light Grazing)	5 years	Grazing establishes relatively quickly and therefore only needs 5 years following revegetation.
RM10	Achievement of Stable Condition (Watercourse)	Completion at surrender	The diversion has already been constructed to design and is regularly monitored. This milestone is for final sign off at surrender.

Milestone Reference	Rehabilitation Milestone	Approximate timeframe for completion	Comments
RM11	Achievement of Stable Condition (Open Woodland)	10 years	Trees take longer to establish and therefore there is a longer completion period.
RM12	Achievement of Stable Condition (Fauna Habitat)	10 years	It may take some time for fauna to be attracted to the area following revegetation.
MM1	Landform Development and reshaping/reprofiling	1-5 years	Landform development of the highwalls and bunds.
MM2	Achievement of sufficient improvement	2 years	It will take approximately 2 years to assess the area for geotechnical stability.

Please note that the above has been used only as general guidance for completing the PRCP schedule. The timing of when these milestones will be achieved must also be considered for rehabilitation to be completed effectively and efficiently. For example, seeding should take place at the end of the year before the wet season and ideally is done soon after the application of topsoil. Milestones should also be aligned to maximise efficiency, where possible.

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APPENDIX A

Community Consultation Plan

APPENDIX B

Environmental Authority EPML00643713

APPENDIX C

Blackwater Creek Diversion Monitoring and Maintenance Plan

APPENDIX D

Concept Residual Void Assessment

APPENDIX E

Rehabilitation Management and Monitoring Plan

APPENDIX F

Erosion Assessment

APPENDIX G

Groundwater Report

APPENDIX H

Topsoil Quality Assessment Report

APPENDIX I

Waste Characterisation Memorandum

APPENDIX J

Flood Modelling Report

APPENDIX K

Residual Void Modelling

APPENDIX L

Geotechnical Investigation and Assessment of Capping

APPENDIX M

Pit B Design Plan

APPENDIX N

Geotechnical Stability Analysis

APPENDIX O

Risk Assessment

APPENDIX P

PRCP Schedule

APPENDIX Q

Review of Existing Rehabilitation and Completion Criteria

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