KESTREL COAL RESOURCES

Kestrel SHMS - Report

Transitional Progressive Rehabilitation and Closure Plan

Cover Page

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ACARP	Australian Coal Association Research Program
AEP	Annual exceedance probability
AHD	Australian Height Datum
ANC	Acid neutralising capacity
ARD	Acid rock drainage
ATCW	ATC Williams
BOM	Bureau of Meteorology
CEC	Cation exchange capacity
CDSF	Co-disposal storage facility
CHPP	Coal handling and preparation plant
CoA	Commonwealth of Australia
DEHP	Department of Environment and Heritage Protection
DERM	Department of Environment and Resource Management
DES	Department of Environment and Science
DNRM	Department of Natural Resources and Mines
DSITI	Department of Science Information Technology and Innovation
DSITIA	Department of Science Information Technology Innovation and the Arts
DoR	Department of Resources
EA	Environmental Authority
EC	Electrical conductivity
EFA	Ecosystem Function Analysis
ERA	Environmentally relevant activity
LiDAR	Light detection and ranging
LOD	Land outcome document
LSC	Land suitability classes
MIA	Mine infrastructure area
ML	Mining Lease
NAF	Non-acid forming
NAG	Non-acid generating
NAPP	Non-acid producing potential
NUMA	Non-use management area
PAF	Potentially acid forming
PED	Personal emergency device
PMLU	Post-mining land use
PRCP	Progressive Rehabilitation and Closure Plan
RA	Rehabilitation Area
REMP	Receiving environment monitoring program
RIDA	Regional Interests Development Approval
RM	Rehabilitation milestones
ROM	Run-of-mine
RPL	Reduced permeability layer

RUSLE	Revised Universal Soil Loss Equation
SCL	Strategic Cropping Land
SEP	Stakeholder engagement plan
TDS	Total dissolved solids
TSS	Total suspended solids
PRCP	Progressive rehabilitation and closure plan
TEC	Threatened ecological community
WEPP	Water Erosion Prediction Project
WMS	Water Management System

1 Introduction

Kestrel Coal Resources Pty Ltd (Kestrel Coal) received a Progressive rehabilitation and closure plan transition notice dated 30 July 2021 requiring submission of a proposed Progressive Rehabilitation and Closure Plan (PRCP) to the administering authority by 16 September 2022. An amended transition notice dated 29 August 2022 was subsequently received amending the due date for submission of a proposed PRCP to 15 September 2023. AARC Environmental Solutions Pty Ltd (AARC) has assisted Kestrel Coal in developing the PRCP which has been prepared in accordance with the requirements of the *Environmental Protection Act 1994* (EP Act).

This PRCP is applicable to mining leases (MLs) 1978, ML 70301, ML 70302, ML 70330 and ML 70481. The current version of the Environmental Authority (EA) EPML00693413 for the Project was issued on 24 December 2021 to Kestrel Coal Resources Pty Ltd and Mitsui Kestrel Coal Investment Pty Ltd.

The EA authorises the environmentally relevant activity (ERA) of mining black coal (ERA 13) under Schedule 3 of the Environmental Protection Regulation 2019 and the following ancillary activities:

- Ancillary 8 – Chemical Storage 3: storing more than 5,000 m^3 of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c);
- Ancillary 31 – Mineral Processing, 2: Processing, in a year, the following quantities of mineral products other than coke, (b) more than 100,000 t;
- Ancillary 60 - Waste disposal, 1: operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1)(a)— (d) more than 200,000 t;
- Ancillary 63 – Sewage Treatment, 1. operating sewage treatment works, other than no-release works, with a total daily peak design capacity of— (b) more than 100 but not more than 1,500 EP— (ii) otherwise.

2 Scope and objective

The purpose of this PRCP is to describe how progressive rehabilitation will be carried out at the Kestrel Coal Mine (the Project). The PRCP has been developed in accordance with the requirements of the Progressive Rehabilitation and Closure Plan Guideline (DES 2021) (PRCP Guideline), which states that the PRCP must include the following parts:

Rehabilitation Planning part:

The purpose of the rehabilitation planning part of the PRCP is to support and justify the development of the proposed PRCP schedule. This part must detail how progressive rehabilitation and closure will be carried out over the entire Project site and on both a rehabilitation area basis and improvement area basis. The key components of the rehabilitation planning part for the Project are:

- community consultation information (refer Section 3.1.8.3);
- post-mining land use (PMLU) and/or non-use management area (NUMA) determination (refer Section 3.3 and Section 3.4);
- rehabilitation and management methodology (refer Section 3.5);
- risk assessment (refer Section 3.6); and
- a monitoring and maintenance program (refer Section 3.7).

Rehabilitation Schedule part:

The rehabilitation schedule is a required element of a PRCP. Once approved, the schedule becomes a legally binding and enforceable instrument with which the Project must comply. The schedule must include:

- nomination of either a PMLU or NUMA for all land within the relevant resource tenures, including land uses for undisturbed land;
- identification of when land becomes available for rehabilitation or improvement;
- rehabilitation or management milestones to achieve the PMLU or NUMA outcomes;
- milestone criteria that demonstrate when each milestone has been completed;
- completion dates for each milestone to be achieved; and
- any conditions considered necessary or desirable.

The administering authority may impose a condition on a draft PRCP schedule or a PRCP schedule if it considers the condition is necessary or desirable (section 4.2 of the PRCP Guideline). Two deemed conditions are to be included in all PRCP schedules in accordance with section 206A of the EP Act. The first condition states that when carrying out a relevant activity under the PRCP schedule, the holder must comply with a requirement stated in the EA relevant to carrying out the activity.

The second condition states that the holder must comply with the following matters stated in the schedule:

- each rehabilitation milestone and management milestone, and
- when each rehabilitation milestone and management milestone is to be achieved.

3 Project planning part

3.1 Project planning

3.1.1 Project description

The Project is located in the Bowen Basin, approximately 40 km northeast of Emerald in central Queensland, Australia (Figure 1). The mine is an underground operation producing high quality coking coal for export using longwall mining methods. Coal is mined from the German Creek coal seam. The mine commenced production in 1992 and, apart from a closure period from October 1997 to February 1999, has since remained operational.

Since the commencement of mining at Kestrel, five series of underground longwall panels have been or are being developed for the purpose of coal extraction. The sequence of longwall panel series consists of the 100, 200, 300, 400 and 500 series panels.

Initial production at Kestrel was from the 100 and 200 series of longwall panels. Production in these areas ceased in 2004 when production in the 300 series of longwall panels commenced. Production of the 300 series was completed in 2013. Currently, within the 400-series panels, coal extraction and production occurs at depths of 300–450 m, with production rates of 8–10 Mt run-of-mine (ROM) coal per year. The current approved life of mine includes mining of a further series of longwall panels, referred to as the 500 series, which extends into ML 70481 at depths of between 360 m and 470 m. Typical mining seam thickness ranges from 2.5–3.6 m with longwall typical extraction heights being 2.6–3.1 m.

The mine is held as a joint venture of Kestrel Coal Resources (80%) and Mitsui Coal Pty Ltd (20%), with Kestrel Coal Resources as the operations entity.

3.1.1.1 Mining tenements

The Project consists of five MLs comprising a total area of approximately 11,974 ha (Table 1) as shown in Figure 2. Surrounding tenements are shown in Figure 1. Kestrel Coal Resources Pty Ltd is the authorised holder of all MLs associated with the Project.

Table 1: Mining lease details

Longwall panel series	ML	Grant date	Expiry date	Area (ha)
200, 300, 400	1978	12 April 1990	30 April 2041	5,839
300	70330	11 June 2009	30 June 2039	9.35
300	70302	22 November 2004	30 November 2034	79.77
400, 500	70301	25 September 2003	30 September 2033	3,579
500	70481	21 March 2016	31 March 2041	2,467

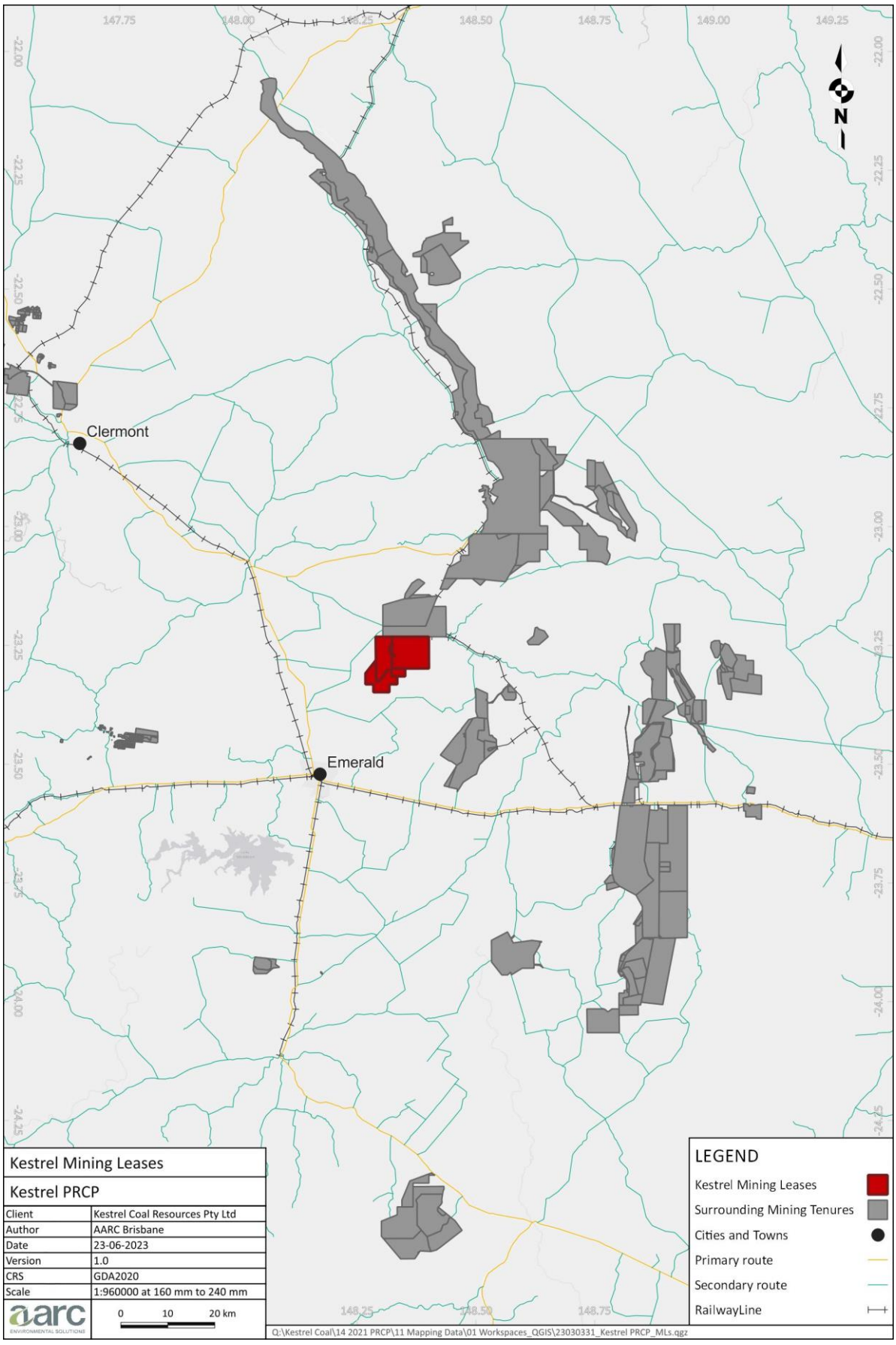


Figure 1: Project locality

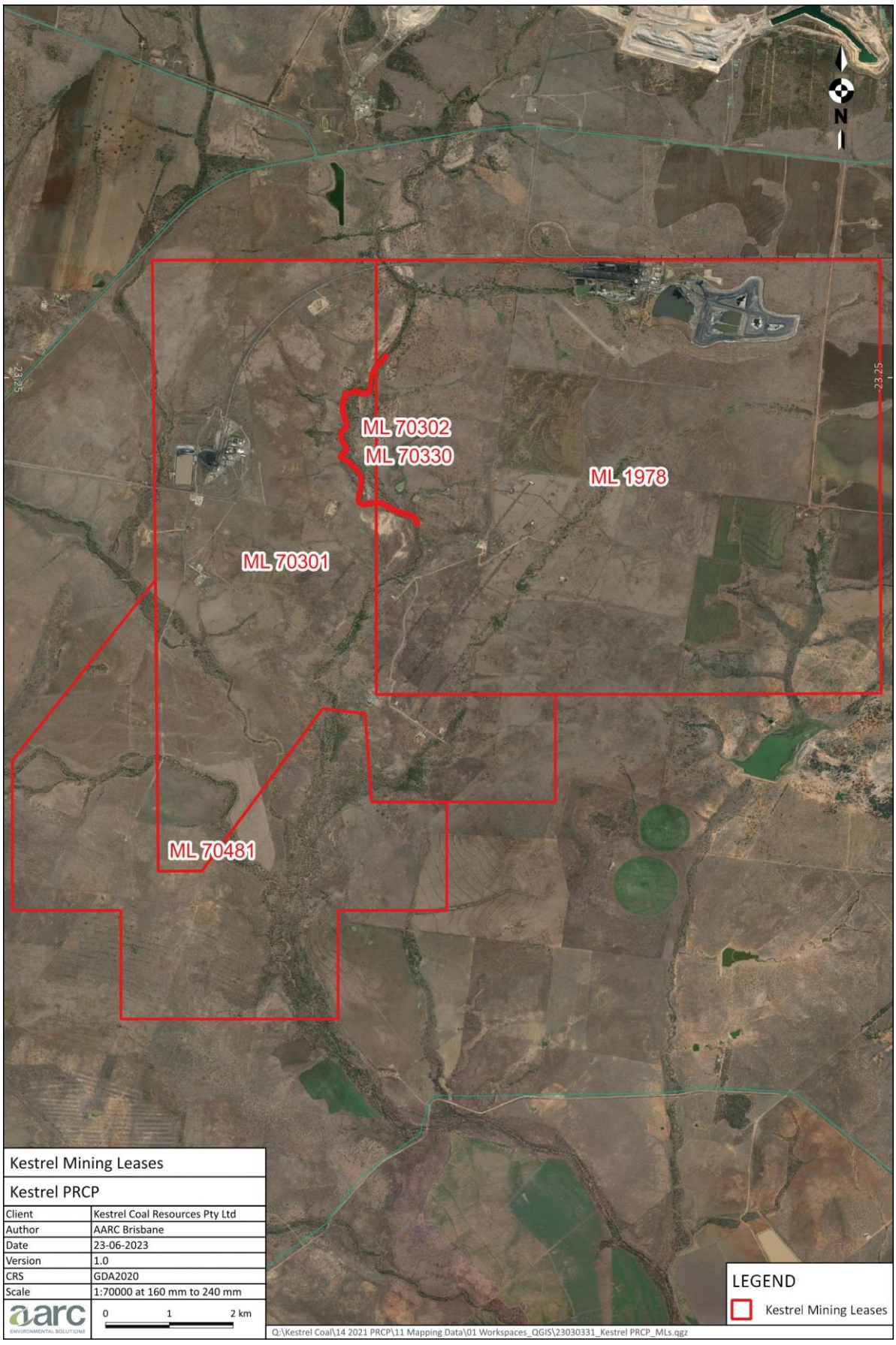


Figure 2: Kestrel mining leases

3.1.1.2 Mining operations

Coal extraction and production at the Project occurs underground at depths of 100–450 m, via a sequence of longwall panel series (Figure 3).

The operations generally consist of:

- longwall mining currently of the 400 longwall panel series with longwall panel widths ranging from 375–424 m (400 and 500 series panels);
- processing of coal in a coal handling and preparation plant (CHPP);
- disposal of coal rejects following washing in a co-disposal storage facility (CDSF);
- water storages including raw water dams, the Rejects Return Dam, the Environmental Dam and the holding dam;
- mine infrastructure including administration facilities at both Kestrel North and Kestrel South locations, ROM and product stockpile areas, workshops, underground mining supporting infrastructure, tracks and haul roads (Figure 4).

Development mining is conducted using continuous miners, with occasional blasting as required. ROM coal is extracted via a portal at Kestrel South and conveyed 7.9 km to be washed at the Kestrel CHPP (Figure 3). Coal is washed, stockpiled and blended to meet market requirements. After dewatering, product coal is stockpiled according to product type, prior to reclaiming and conveying to the train load-out facility. Coarse rejects and dewatered tailings are trucked to the CDSF (Figure 3).

Following the cessation of production in the 400 series panels, production from the 500 series panels is expected to commence in late 2023. Production from the 500 series panels is planned to continue through to 2034.

3.1.2 Existing rehabilitation

Rehabilitation of disturbance areas at the Project can be considered to be comprised of two main types:

1) disturbance arising as a result of subsidence caused by longwall mining operations. Active rehabilitation is only required where subsidence-induced geomorphological changes in the landform causes symptoms such as erosion, ponding or cracking that are unacceptable in extent or effect; and

2) ground disturbance occurring as a consequence of the development of surface mine infrastructure. With the exception of the CDSF, ground disturbance is associated with most of the major infrastructure, which is located outside of longwall panel footprint areas, as well as surface infrastructure required to support underground mining operations (typically gas drainage boreholes, pipelines and access tracks) that exists largely within the longwall panel footprints (and therefore mostly overlapping with subsidence disturbance areas). The requirement for gas drainage operations has only arisen within the deeper mining operations associated with parts of the 400 and 500 series panels.

Rehabilitation of mine disturbance has been undertaken progressively as areas have become available. Rehabilitation of subsidence impacted areas currently includes the footprint of mining panels from the 100 series (not including areas under the mine infrastructure area [MIA] or CDSF), 200 series, 300 series, and 400 series up to and including longwall panel 407 (LW407) as shown in Figure 3. The existing rehabilitated area is equivalent to approximately 45% or 2,815 ha of the total of the planned subsidence disturbance area (sum of RA7 and certified rehabilitation area). Most of the 200 series longwall panel area (570.5 ha per the certificate but 576 ha when mapped to the certificate coordinates and transformed to GDA2020) comprises certified progressive rehabilitation that was approved in 2012 (DERM 2012). This equates to 9% of the planned subsidence disturbance area. The uncertified rehabilitation area (2,239 ha) is equivalent to 36% of the total of planned subsidence disturbance area.

The areas mapped as existing rehabilitation not yet certified are based on the rehabilitation methodology and the durations specified in Section 3.5.13. The progression of these rehabilitation areas has been shown

in sequential Plans of Operations submitted to the administering authority up until the most recent Plan of Operations which completed on 31 December 2020; as well as estimated rehabilitation cost submissions and various inspections and 'rehabilitation sign-offs' by the Department of Environment and Resource Management from 2006 to 2009 covering the 200 series panels, and panels 301–306 (Appendix F).

It should also be noted that, since the cessation of mining of the 100, 200 and 300 series panels, the original portal located at Kestrel North has been sealed and the area reprofiled to ground level with all redundant surface infrastructure removed. This area remains within the general MIA of Kestrel North.

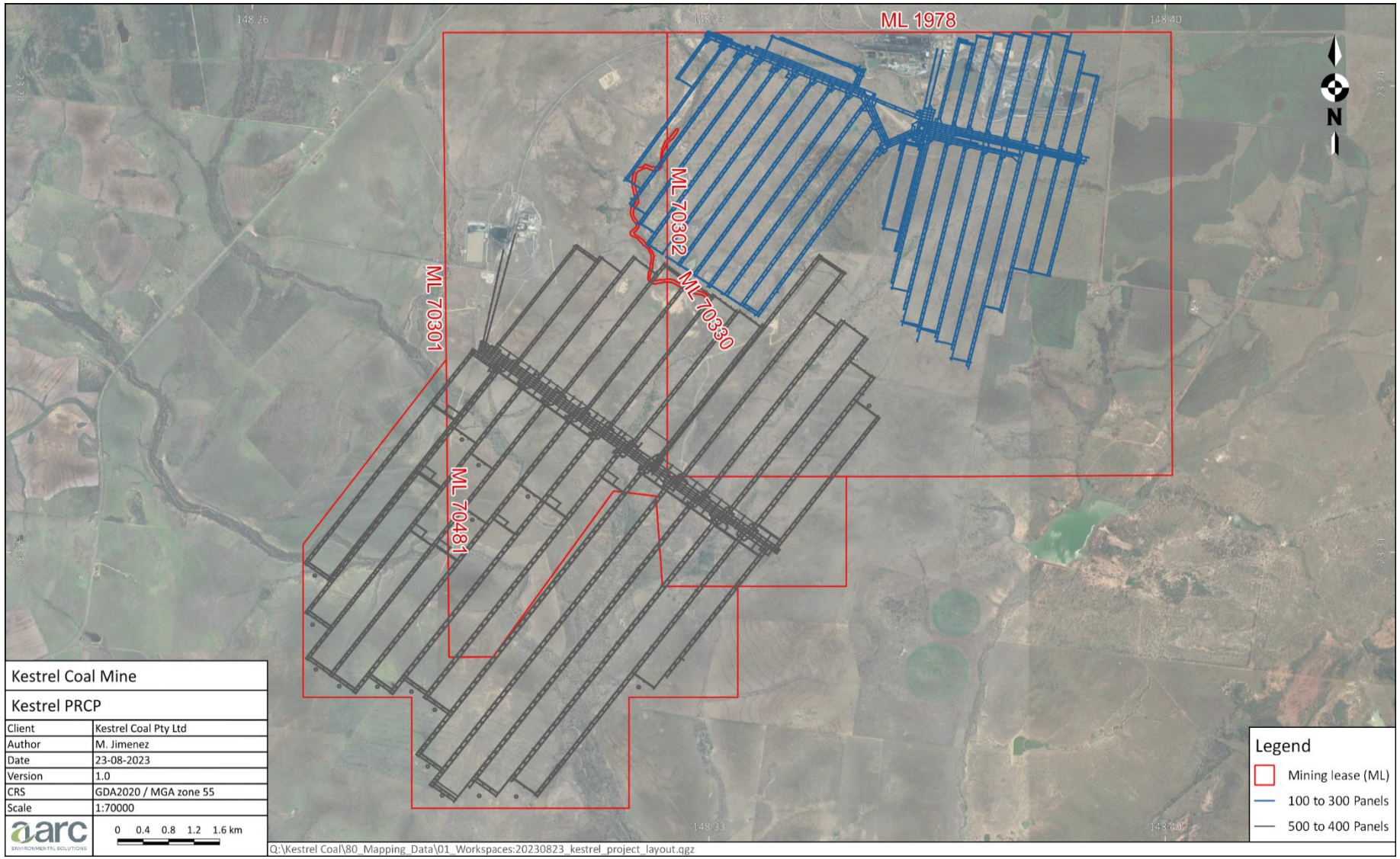


Figure 3: Kestrel longwall panel series

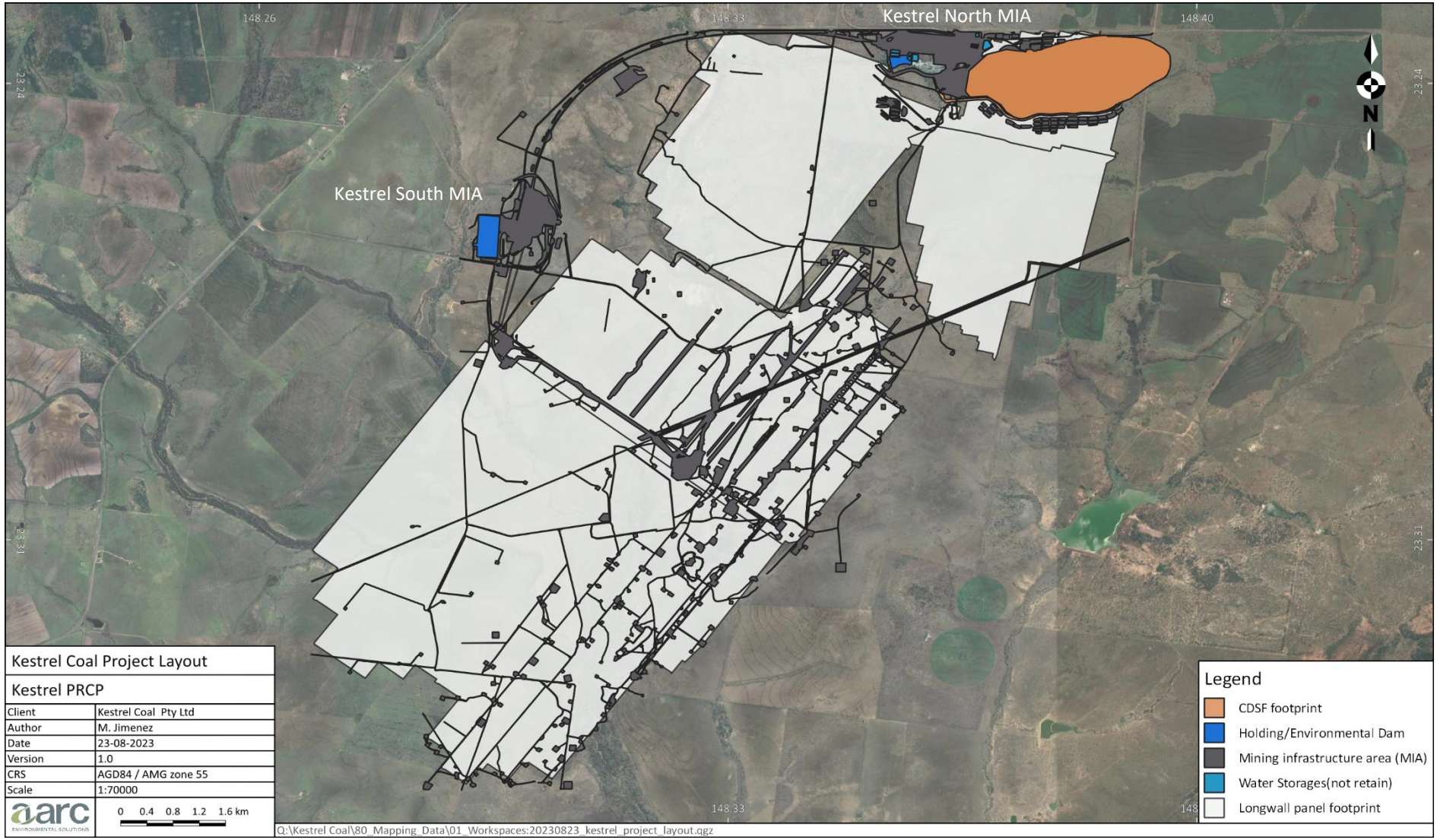


Figure 4: Kestrel layout

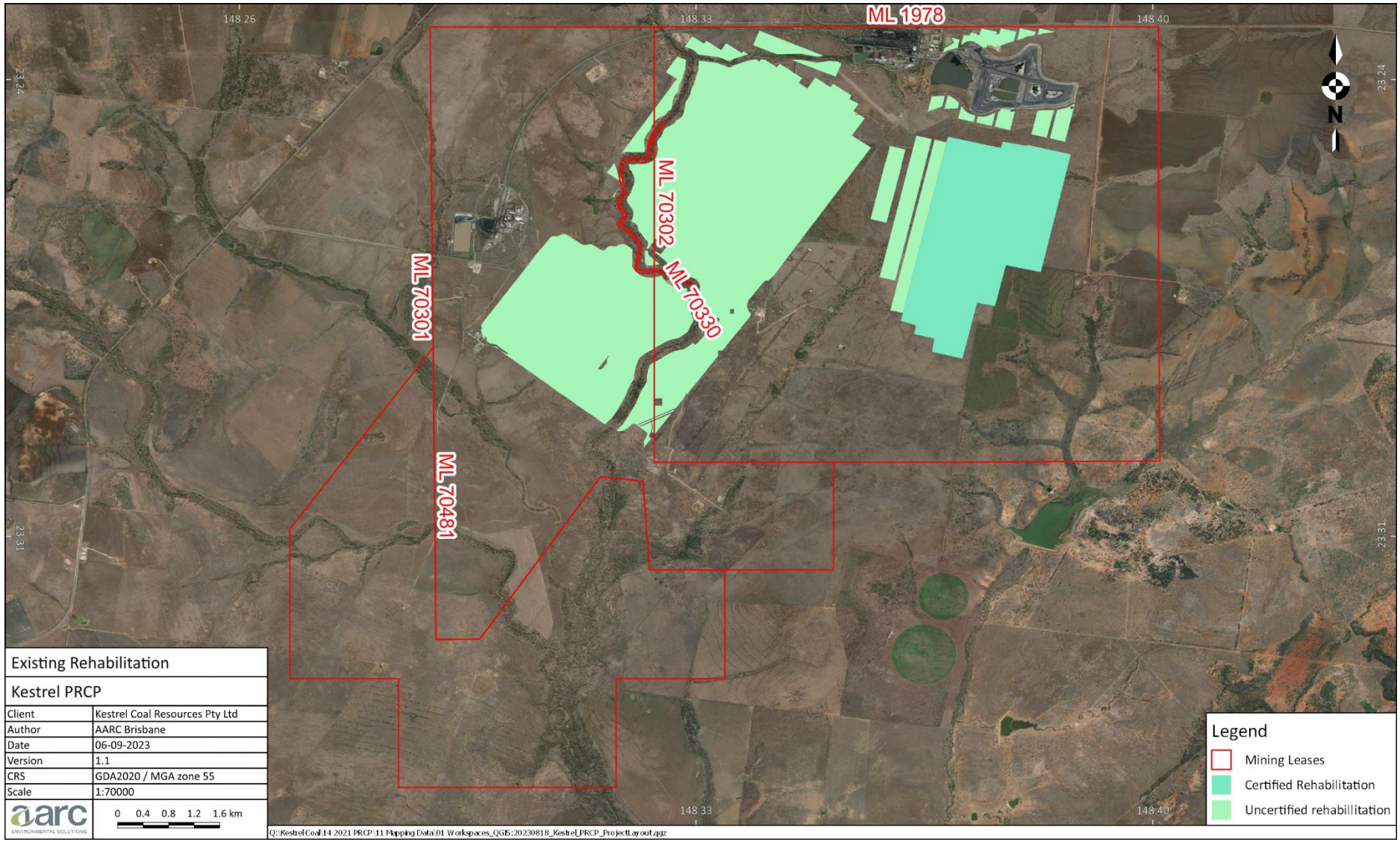


Figure 5: Existing rehabilitation

3.1.3 Climate

The climate data presented in Figure 6 has been drawn from SILO (Queensland Government 2022). The climate of the region is described as subtropical with warm wet summers and mild, dry conditions in winter. The warmest months are November to February. Average temperatures range from 22.3°C to 34.6°C in January to 9.1°C to 23.4°C in July (Emerald Airport ID 035264). Average annual rainfall for the area is 582 mm (SILO -23.25, 148.35) with a wet season that generally aligns with the November to March period and accounts for over 65% of the region's annual average rainfall.

Evaporation records are available from SILO (-23.25, 148.35) which estimates an annual average evaporation (Class A pan) of approximately 2,096 mm; approximately three to four times the average rainfall (Figure 6). Based on the available datasets, measured, monthly average potential evaporation is approximately three to four times higher than the average rainfall.

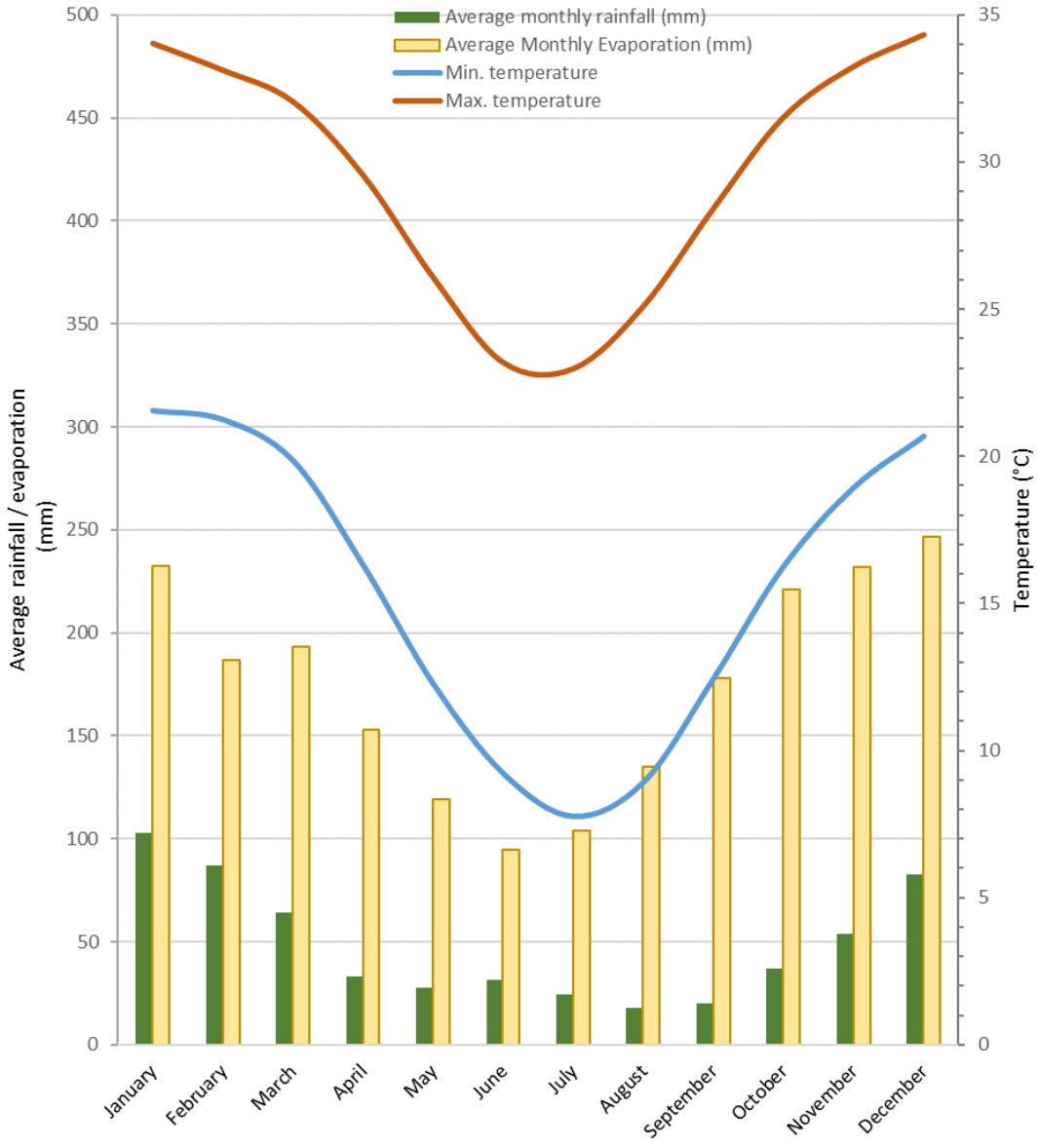


Figure 6: Average monthly climate data for Kestrel

In Australia, climate change is generally expected to result in a shift towards more arid conditions, warmer temperatures, and reduced rainfall. According to the Queensland Government (2019), rainfall in central Queensland is predicted to decrease due to climate change. By 2050, median annual rainfall is projected to decrease by:

- 2% under a lower emissions scenario (with emissions reduced from 'business as usual'); and
- 8% under a high emission, or 'business as usual' scenario.

Long-term climate projections predict that conditions will become warmer, with hotter and more frequent hot days. Rainfall events are predicted to become more intense, and tropical cyclones are predicted to become less frequent but more intense.

3.1.4 Geological setting

Kestrel is located within the German Creek Formation of the Bowen Basin, which is a sedimentary basin comprising Permian geology (300 million years ago (Ma) to 250 Ma) to Triassic geology (250 Ma to 200 Ma). Regionally, a veneer of more recent Tertiary geology (66 Ma to 2.5 Ma) and Quaternary geology (2.5 Ma to present) typically overlies the Bowen Basin strata. The Permian Bowen Basin rocks, and in particular the German Creek Formation, were formed in an eastward pro-grading delta combined within major fluvial systems. The Permian and Triassic depositional environment formed a regular layered sedimentary sequence, while the Tertiary and Quaternary geology is more complex and irregular.

The Kestrel coal deposit forms part of the German Creek Seam, which lies at the base of the German Creek Formation. The German Creek Formation consists of interbedded and laminated sandstones, shales, and mudstones, as well as several thinner coal seams, within 100 m of the German Creek Seam. The German Creek Seam typically has a thickness of 2.5–3.6 m. Several other coal seams are present but are not suitable for underground mining. The stratigraphic sequence across Kestrel comprises a Permian sandstone/coal sequence with lesser siltstone and a mudstone, and a Tertiary sand/clay/basalt sequence. A general lithological section for the area is shown in Figure 7.

3.1.5 Topography and surface hydrology

The Project is located within the Fitzroy Basin catchment and the Nogoa River sub-basin, an area encompassing 27,706 km^2. The site topography is of low relief, gently undulating land, predominantly cleared of vegetation for agricultural use. Elevations range from 210 m above Australian Height Datum (AHD) in the east, falling to 160 mAHD in the south along Crinum Creek, and rising to 190 mAHD in the west. Slope gradients are typically between 1% and 5%.

The Project is situated in the mid-reaches of the Crinum Creek catchment which drains south-east into the Nogoa River near Emerald. The Nogoa River is a tributary of the Mackenzie River, which joins the Fitzroy River before flowing into the Coral Sea near Rockhampton. The Project area is traversed by Crinum, Belcong and Homestead Creeks, and a number of small ephemeral gullies and tributaries. The main drainage features are shown in Figure 8.

Crinum Creek itself is an ephemeral watercourse flowing into the Project area from the north after having passed through the MLs of the neighbouring Gregory-Crinum Mine. It is classified as a fourth order stream until its confluence with Belcong Creek in the south of Project area where it becomes a fifth order stream. Flow is highly variable but is predominantly very low or non-existent.

Where Crinum Creek overlies the 300 series panels in ML 1978 and ML 70302 it is characterised by a wide, relatively incised channel with relatively steep banks, and a predominantly alluvial stream bed comprising silt, sand, and gravel. The section of Crinum Creek overlying the 400 series panels in ML 1978 and ML 70301 has a relatively narrow channel with steep banks, and a stream bed of alluvial sediments which have formed a rough profile of dunes or scour holes. The section of Crinum Creek overlying the 500 series panels in ML 70481 is characterised by a deeply incised channel with long, ephemeral in-stream pools.

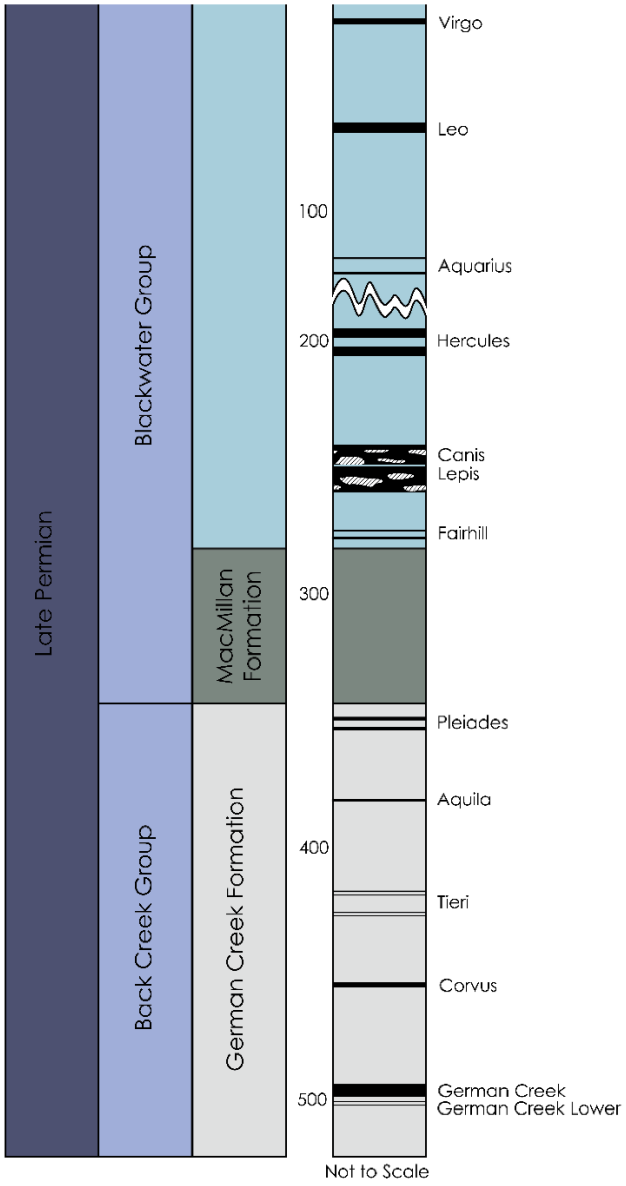


Figure 7: Permian coal measures stratigraphic column (KCB 2022a)

Belcong Creek, a fifth order stream and major tributary of Crinum Creek, flows from the west of the Project area through ML 70481 and ML 70301, overlying the area of the 500 series panels. It is characterised by an incised channel with variable flood terraces and a bed predominantly comprised of mobile sediments (sand and silt). The downstream sections contain a series of large bends with high, and often retreating, banks on the outside apex of the bends.

Homestead Creek (a second order stream) is a small tributary of Crinum Creek which meanders in a south-westerly direction through ML 1978, ML 70301 and ML 70481 where it converges with Crinum Creek. The reaches of Homestead Creek overlying the 200 series panels in ML 1978 comprises a small first and second order gully which is characterised by a series of small depressions in an ill-defined flow path, a shallow swale channel and a small, incised channel which follows a meandering flow path. The stream bed is dominated by loose alluvial sediments (predominantly silt, sand and scattered gravel). Where Homestead Creek overlies the 400 series panels in ML 1978 and ML 70301, it transitions from a shallow, wide swale to a more defined and incised channel, and continues over the area of the 500 series panels in ML 70481 to its confluence with Crinum Creek.

Junction Creek is a small tributary of Crinum Creek flowing in a westerly direction through the north of ML 1978, with the downstream reaches traversing the 300 series panels. It is diverted around the CDSF, the Environmental Dam and the industrial area *via* a licensed diversion (discussed further in Section 3.5.7).

Environmental values for the waters in the Nogoa River sub-basin area are described in the *Nogoa River sub-basin environmental values and water quality objectives* document (DEHP 2011). Environmental values ascribed to *Lower Nogoa/Theresa Creek tributaries – developed areas* include:

- aquatic ecosystems;
- irrigation;
- farm supply/use;
- stock water;
- human consumer;
- primary, secondary and visual recreation;
- drinking water;
- industrial use; and
- cultural and spiritual values.

Primary surface water uses in the Project region are livestock drinking water, agricultural uses, and recreational uses.

Water quality has been sampled annually as part of the receiving environment monitoring program (REMP) and to meet EA monitoring requirements. The results of water quality analyses from the 2021 and 2022 REMP monitoring events are summarised below (Gauge 2021; Gauge 2022). The REMP reports have been included within Appendix F.

The REMP study monitored water quality, stream flow, sediment quality and bio-indicators since January 2010. Monitoring sites included control sites up-gradient of Kestrel Mine activity and test sites downstream of the mine. The overall finding was that although a few stream quality characteristics were at times outside of relevant Queensland or Australian guidelines, sites downstream of the mine were usually of similar quality to those upstream of the mine or were within acceptable levels of change.

- salinity, turbidity, dissolved oxygen, total suspended solids (TSS), sulphate, ammonia and nitrate were at times outside guidelines, however, concentrations were similar both upstream and downstream of mining;
- pH was typically similar upstream and downstream, and is consistently between pH 7 – 8, one monitoring event during 2022 recorded a pH below the ecosystem guideline (pH 6.32) and another recorded elevated levels after a mine water release (pH 9.87);
- TSS is elevated above guidelines and the EA trigger levels at most sites upstream of the Project with the highest concentration on Belcong Creek outside of mining influence;
- dissolved metals (Al, Cd, Cr, Cu, Ni, Mn, V and Zn) and total metals (Al, Cd, Cr, Fe, Mn, Ni and V) were detected above guidelines; however, concentrations downstream were similar to those upstream. Exceedances in chromium (Cr) and cadmium (Cd) have been recorded on two occasions at both upstream and downstream monitoring sites;
- petroleum hydrocarbons (C10-C36) were mostly below detection with any elevations attributed to sample contamination; and
- for aluminium, copper, zinc and suspended solids, the background 80th percentiles were greater than the EA trigger values.

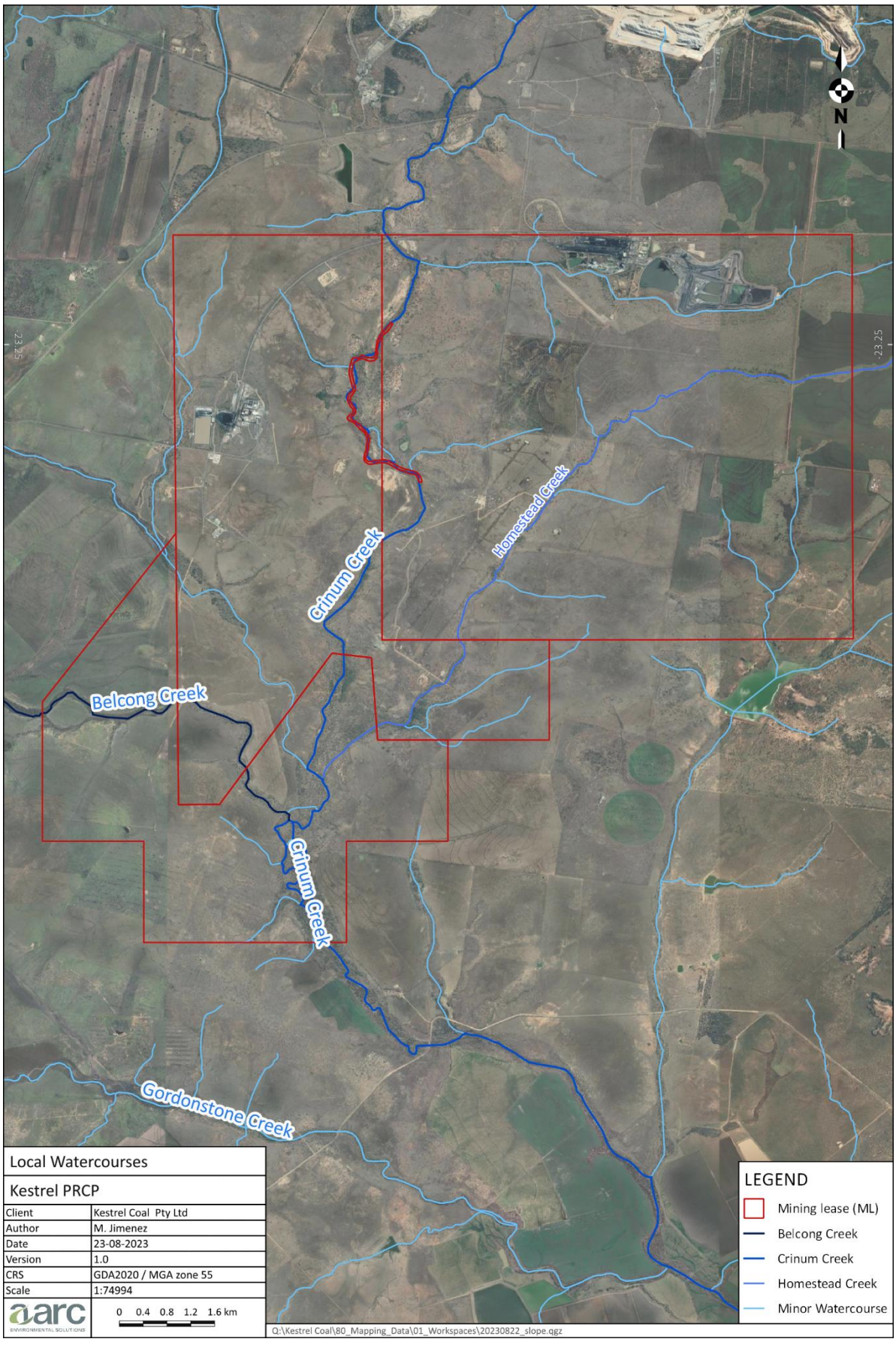


Figure 8: Local watercourses

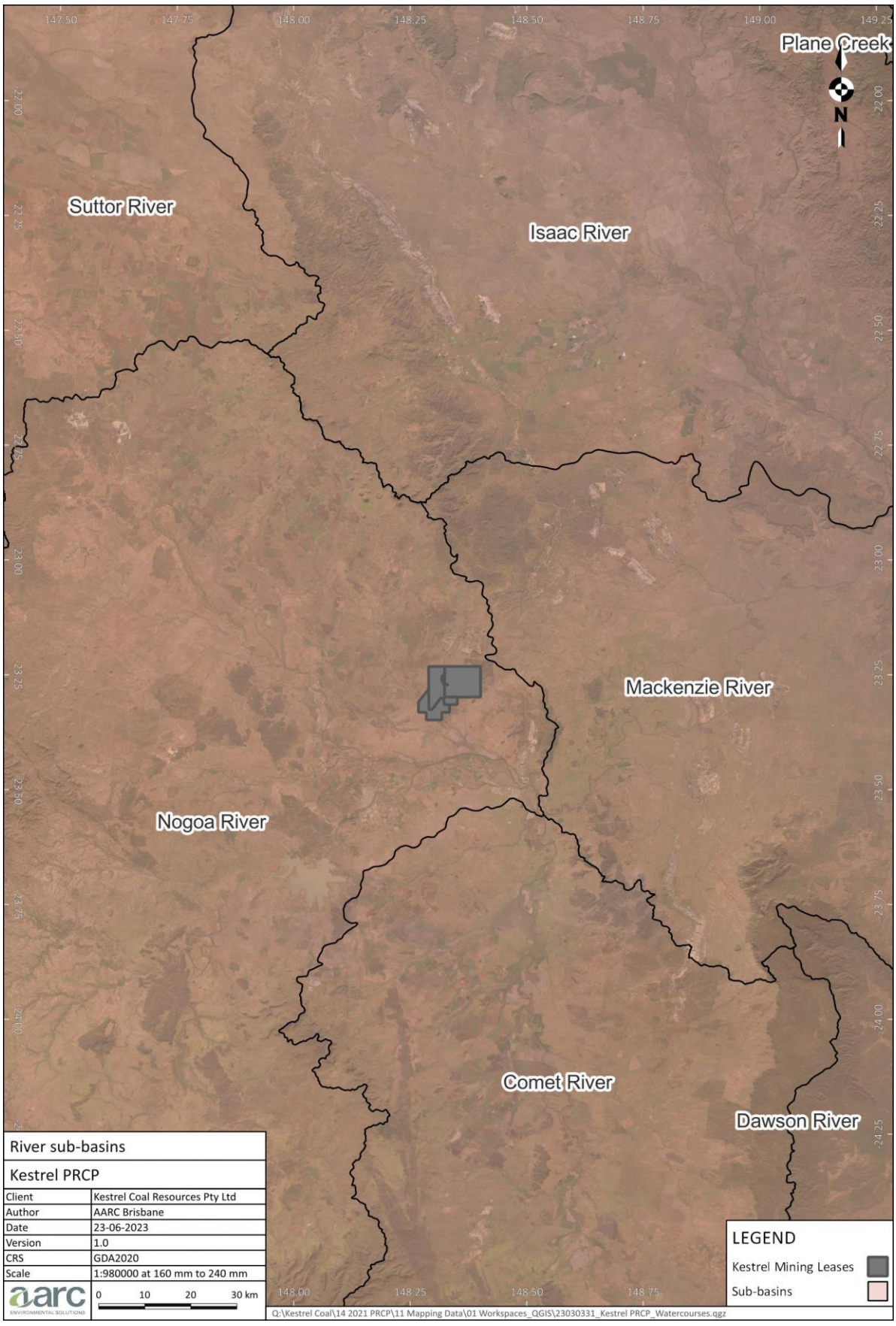


Figure 9: Location of the Project within the Nogoa River sub-basin

3.1.6 Groundwater

3.1.6.1 Hydrostratigraphic units

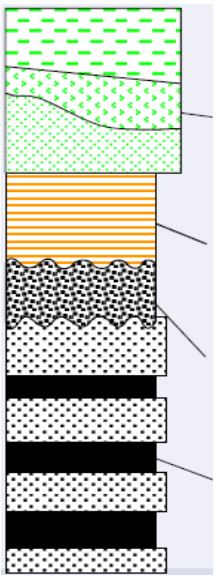
The hydrogeological regime of the Project area consists of a Tertiary aquifer system with an upper basalt aquifer separated by a thick clay sequence from a deep basal sand aquifer and an underlying Permian coal seam aquifer (Matrix+ 2006).

The subsurface strata that occur within the Project area can be grouped into five hydrostratigraphic units based on aquifer properties:

- *Tertiary basalt aquifer* – consists of multiple basalt flows separated by clays;
- *Tertiary clay aquitard* - present between and at the base of the basalt flows;
- *Basal sand aquifer* – comprises highly weathered Permian sandstones and/or Tertiary stream deposits that can form a productive aquifer;
- *Permian interburden aquitards* – the Permian strata includes sandstones, siltstone and mudstones that are typically 'tight' and low yielding; and
- *Permian coal seams* – form low to moderate yielding aquifers confined by overlying interburden units.

Table 2 summarises the hydrostratigraphic and lithological units occurring in the mining area and surrounding region.

Table 2: Kestrel aquifer stratigraphy

Symbol	Approximate thickness (m)	Description	Aquifer characteristics
	10 to 60 (typically about 40)	Tertiary basalts Basalt aquifer • Ba0 • Ba1 • Ba2	Three lava flows have been recognised. Groundwater movement and storage is in vesicles and fractures. Weathered clay intervals separating the flows result in discrete aquifers containing fresh water
	0 - 24	In situ weathered basalt and sediments	Clay, impermeable
	<2 - 14	Tertiary/Permian basal sand (Sa0) aquifer	Weathered Permian sandstones and/or Tertiary stream deposits. Good aquifer, brackish water
		Permian coal measures	Coal seam aquifers, poor aquifers, saline water

The groundwater resource located within the Kestrel mining leases is mainly associated with the basalt aquifer (upper Tertiary) and basal sand aquifer (lower Tertiary), both of which are selectively targeted by regional landholders where quality is suitable for stock and domestic water supply. These aquifers are typically separated by a clay aquitard. The Permian aquifer is not usually considered a resource, particularly the coal seam aquifers, due to the depth of water bearing strata and the typical high salinity of this type of water. The coal seam bearing unit is interbedded with less permeable rock units such as siltstone, mudstone and shale.

The hydrostratigraphic units are described in the Kestrel-Gregory-Crinum Groundwater Model Report (KCB 2022a) and are summarised below. The geological sections discussed are presented in Figure 10 and Figure 11.

Quaternary alluvium

Quaternary-age alluvium is not extensive across the Project area, limited to an area within the vicinity of Crinum Creek. Alluvium deposits are also associated with the Nogoa River and its flood plains south of the Project area.

Tertiary basalt aquifer

Tertiary basalt underlies Quaternary alluvium (where present) and outcrops at surface in the Gregory-Crinum and Kestrel area. Tertiary basalt typically occurs as a single composite unit comprising massive and vesicular lava, tuff, and ash flows. Regional thicknesses were estimated at up to 90 m (in the southwest). Maximum basalt thickness occurs to the north at the Crinum South and Crinum East longwall panel areas. The basalt unit is a significant aquifer in the region, and an important water supply west of mining operations. Airlift yields of up to 10 L/s were previously reported (Douglas Partners 2006).

Tertiary clay aquitard

Tertiary clay provides a relatively consistent aquitard between the basalt and basal sand units. Thickness is variable across the site, between 5 m and 40 m (AGE 2015). The low hydraulic conductivity clay comprises weathered basalt and sediments.

Basal sand aquifer

A basal sand unit is located at the base of the Tertiary sequence unconformably overlying Permian units. The unit comprises highly weathered Permian sandstones and/or Tertiary stream deposits that can constitute a productive aquifer. Thickness varies between 2 m and 30 m, as well as the unit being absent in some areas. The unit is thickest at the Kestrel LW300 series area, extending northwest. This area has previously been interpreted by Douglas Partners (2006) as being the location of a palaeochannel.

Permian coal measures

The Permian coal measures comprise alternating layers of fine to medium-grained sedimentary rock (siltstone, sandstone) with interbedded coal. The Permian coal measures are typically fully saturated prior to mining. The coal seams (including the German Creek Seam, Corvus seam and Tieri seams) are the primary groundwater-bearing units and are confined by hydrogeologically tight, interbedded sedimentary units which act as aquitards to adjacent units. Groundwater flow and storage within the coal seams are a function of cleating. Spacing and distribution of cleating is the primary control on hydraulic conductivity.

3.1.6.2 Groundwater levels

Groundwater monitoring is undertaken at the Project site and the adjacent Gregory-Crinum Mine for both compliance and investigative purposes. Figure 12 shows the regional monitoring locations by hydrostratigraphic unit. Groundwater elevation responses across the Kestrel and Gregory-Crinum Mines are discussed in the Kestrel-Gregory-Crinum Groundwater Model Report (KCB 2022a) and are summarised below.

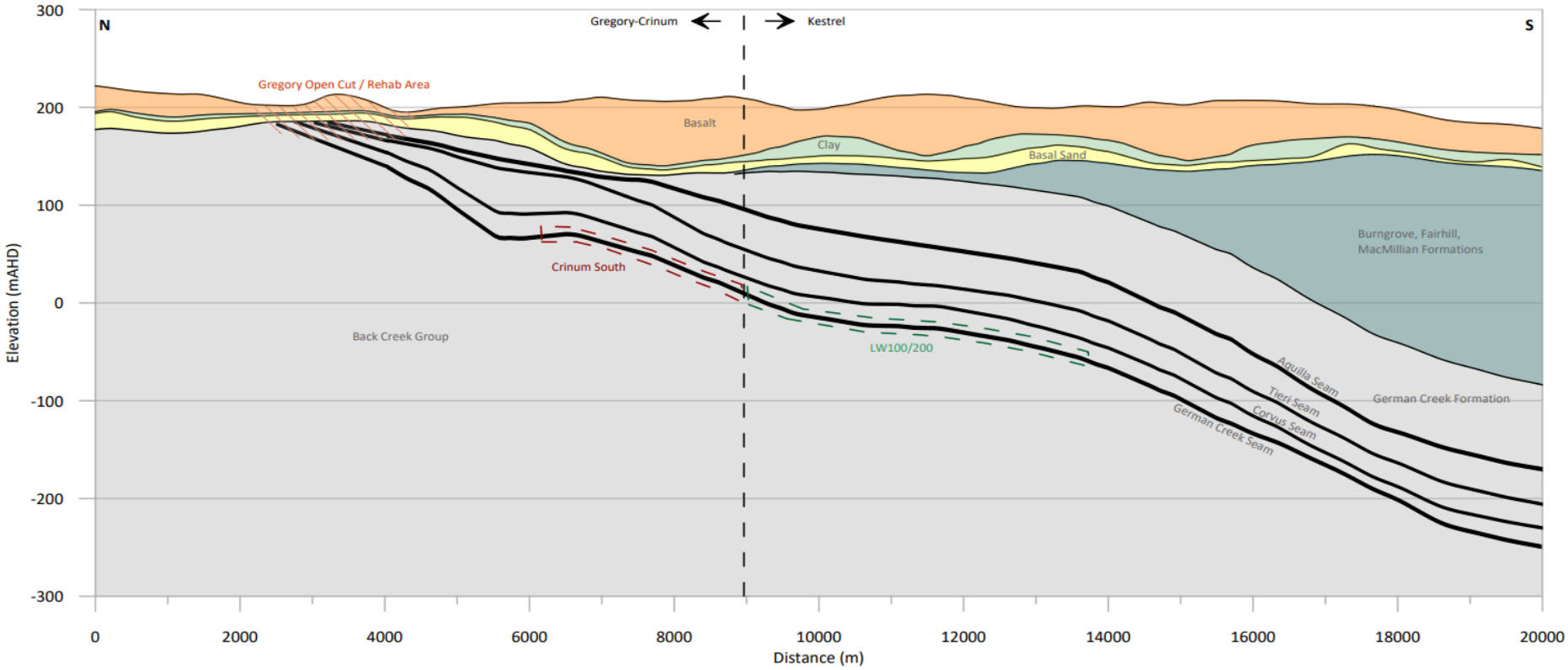


Figure 10: North-south geological section through Gregory-Crinum and Kestrel (KCB 2022a)

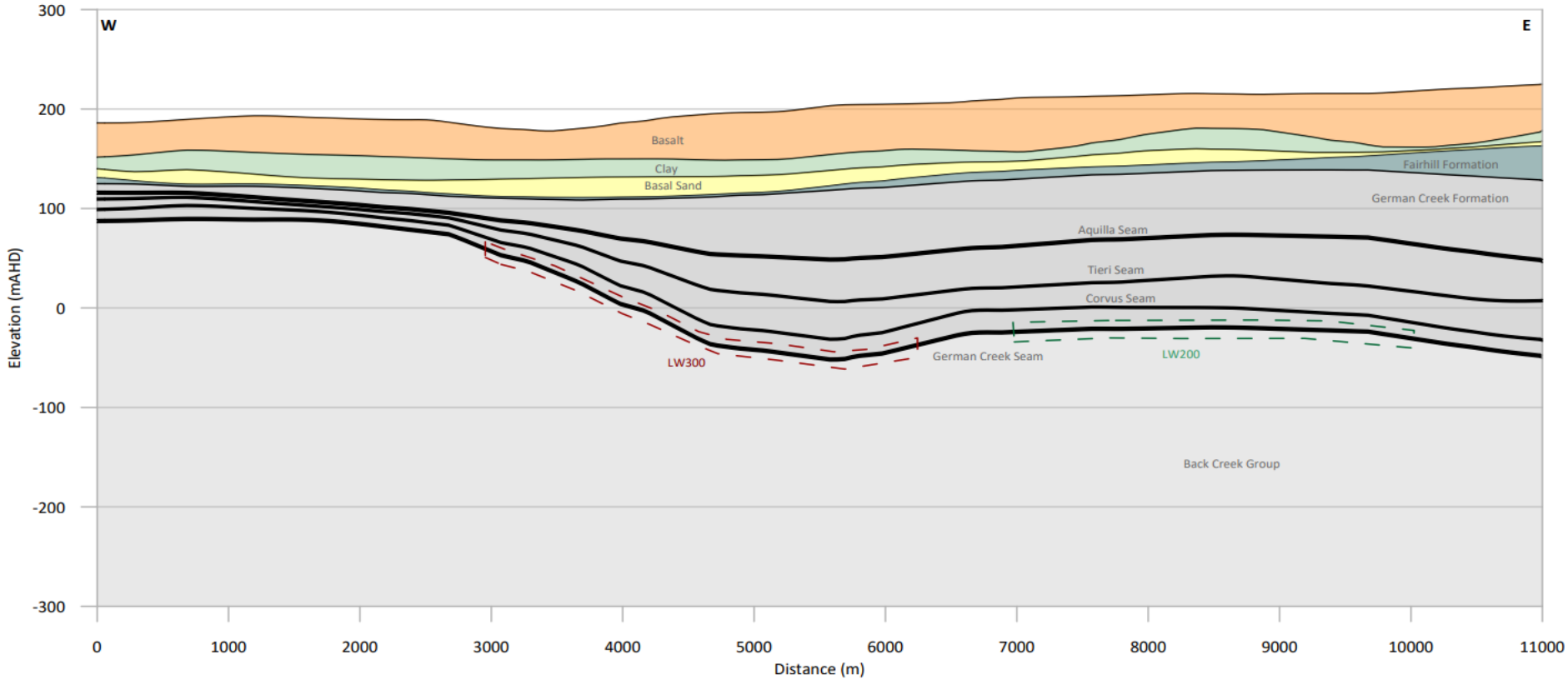


Figure 11: West-east geological section through Kestrel (KCB 2022a)

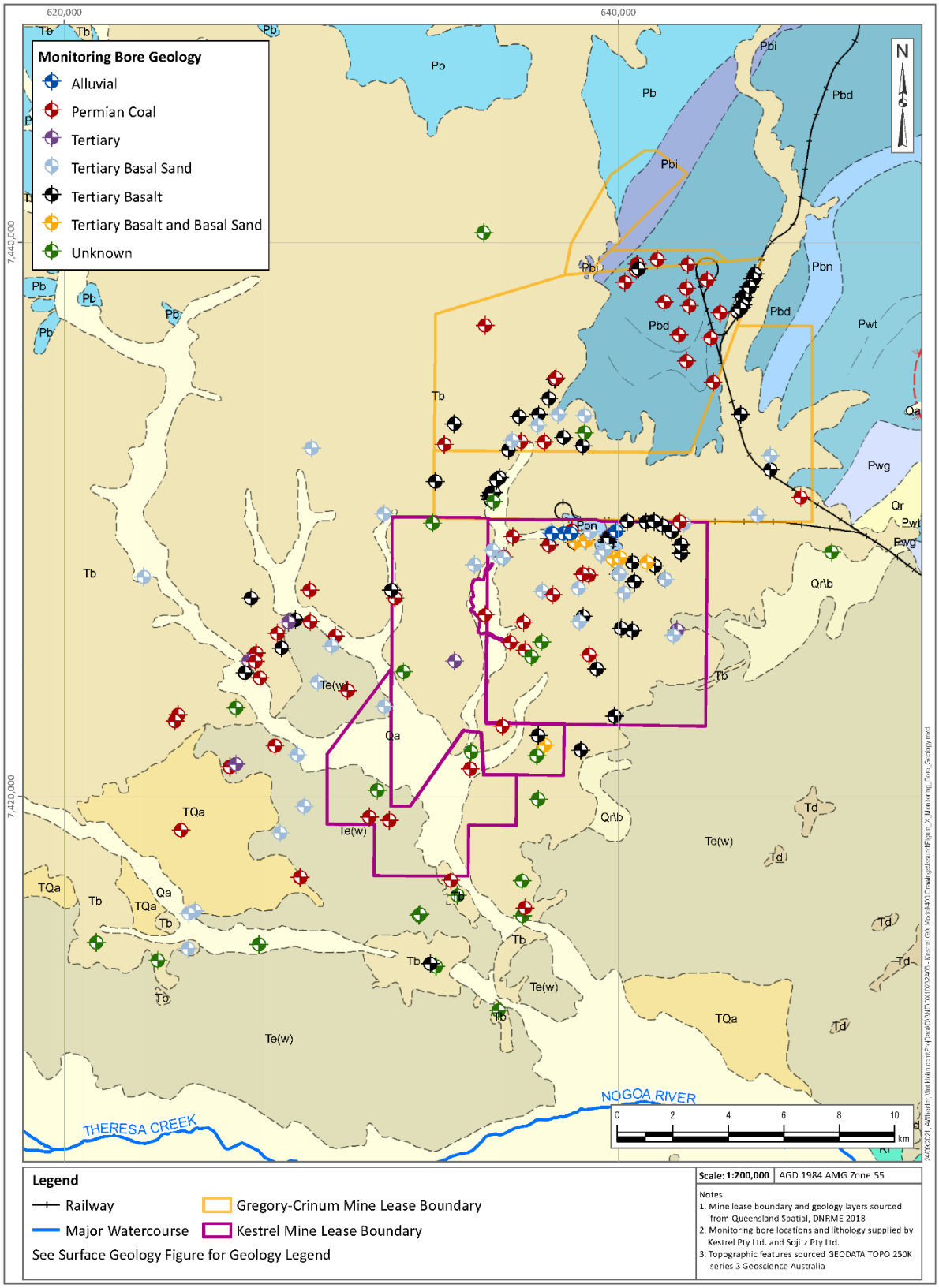


Figure 12: Location of groundwater monitoring bores by hydrostratigraphic unit (KCB 2022a)

Permian

The groundwater elevations monitored in the Permian strata are significantly altered by mining activities. Data from monitoring bores located in the immediate vicinity of the Kestrel LW100/200/300 series panels provide the longest records for the Permian hydrostratigraphic unit and shows drawdown from mining and mining development. Recovery post-mining is variable with responses to date either back to pre-mining levels or to within 40–60 m of pre-mining levels (noting that longwall mining activities are ongoing). Impacts from mining operations to the north of Kestrel are also evident in the monitoring bore records on the neighbouring ML, although there are no monitoring bores for the Permian in the same period at Crinum to correlate. KCB (2022a) provides additional detailed analysis of monitoring records from bores surrounding the Kestrel mining area.

Basal sand

Monitoring of the basal sand unit shows significant variation, with influence from climate trends at several monitoring bores, and an influence from mining in some locations. The groundwater levels range between 125 mAHD and 195 mAHD across the LW100/200/300 series panel area. All of the records show a decline until 2012, followed by further decline, and then stabilisation or increase from 2017. A number of monitoring bore records indicate that the unit has moved from confined to unconfined conditions.

Basalt

The basalt monitoring bores in the vicinity of Kestrel provide the following general observations about the basalt aquifer:

- it is responsive to large rainfall events (e.g. 2010),
- depending on location, shows variable annual seasonality responses to annual wet-dry cycles; and
- generally correlate with the long-term climate trend.

Responses to mining are observed at a limited number of monitoring bores, and in general those impacts are where the interburden thickness between the mined coal seams is less than 105 m. Impacts from surface water storages and seepage from the CDSF is also noted in select monitoring bores.

3.1.6.3 Groundwater chemistry

Groundwater chemistry data for Kestrel has been analysed in the Kestrel-Gregory-Crinum Groundwater Model Report (KCB 2022a). All hydrostratigraphic units generally have a pH within the neutral range, with some alkaline values recorded. The alkaline values are not considered to be naturally occurring and may be due to grout contamination during bore installation. Total dissolved solids (TDS) values are less than 8,000 mg/L across all units, with some higher readings for the Permian units (up to 24,000 mg/L); the Permian units are generally higher in salinity. The basalt and basal sand have relatively similar groundwater types (calcium / magnesium-bicarbonate), with the basal sand also showing sodium enrichment (compared to the basalt) and a calcium / sodium-sulphate signature. Permian groundwater is also variable, with two dominant groundwater types present, namely sodium / potassium-chloride and sodium / potassium-bicarbonate.

3.1.6.4 Groundwater modelling

A numerical groundwater model was developed for Kestrel and the adjacent Gregory-Crinum Mine which both target the same coal seams (KCB 2022a). Although the Gregory-Crinum Mine and Kestrel are independent operations, the combined mining operations generate cumulative impact on the surrounding groundwater regime. Consequently, the owners of the operations jointly commissioned development of a groundwater flow model to predict changes in groundwater levels and flows within significant hydrostratigraphic units of the area. The model is used independently by each operation.

Three previous modelling projects were completed for Gregory-Crinum and Kestrel by Matrix+ Consulting (2008) and AGE (2015 and 2017), with the 2017 model focused on potential groundwater level drawdown and aquifer depressurisation within ML 70481 only. Details of the hydrogeological conceptualisation,

numerical model construction and calibration are provided in the *Kestrel Gregory-Crinum Groundwater Model Report* (KCB 2022a). The results for Kestrel are presented in the *Kestrel Gregory-Crinum Groundwater Model Report: Kestrel Predictions* (KCB 2022b) and are summarised below.

- At the end of 2023, no drawdown is predicted in the basalt hydrostratigraphic unit.
- The maximum drawdown in 2023 in the basal sand hydrostratigraphic unit is 10.7 m, located in the vicinity of the 400 series panels.
- Drawdown in the German Creek Seam at the end of 2023 centres on the 400 series panel area where mining is occurring. The maximum drawdown is approximately 400 m.
- At the end of 2033, and the end of mining the 500 series, the maximum drawdown in the basalt in the vicinity of Kestrel is approximately 3 m, with the drawdown located to the west of the 500 series panels.
- Drawdown in the basal sand at the end of the 500 series mining occurs across the 400/500 series panel area to a maximum of 38 m.
- The maximum extent of drawdown in the German Creek Seam at the end of mining is predicted to occur within the 500 series panel area, with a maximum of approximately 247 m of drawdown predicted.

Groundwater monitoring records show that drawdown of groundwater levels occurs in preparation for and during mining, with recovery of groundwater levels as mining activities cease or as mining moves to new areas (KCB 2022a). Groundwater monitoring from Permian monitoring bores (the German Creek Seam) to the west LW300 series recorded a minimum groundwater level of 20 mAHD in 2010, which had recovered to the inferred pre-mining levels of 160 mAHD by 2013. Groundwater elevations since 2010 have shown an increase in groundwater level of approximately 130 m which can be correlated with the cessation of mining of the LW300 series. The basal sand and basalt monitoring bores show variation in groundwater recovery levels, with subsequent lowering of the groundwater level resulting from mining activities.

3.1.7 Land and soil

3.1.7.1 Pre-mining land use and underlying landholders

The underlying tenure for the land upon which Kestrel operates is predominantly freehold land with the exception of one parcel of Unallocated State Land located within ML 70481 (Figure 13). Freehold lands within the footprint of the MLs are predominantly owned by Kestrel Coal, with some non-operational areas of freehold land underlying ML 1978 owned by other parties, with access through private agreements and small area underlying ML 70481 (Figure 13). Areas not required for mining purposes are leased to agricultural businesses for rural uses; currently grazing.

Prior to mining, regional and local land use comprised grazing of native and improved pastures, and cropping. Since mining commenced and associated lands acquired, some areas have experienced a change in land use from a cropping regime producing organically grown grains and requiring very intensive cultivation for weed control in the early 2000s to a grazing land use based on annual forage cropping, perennial forage species and native and naturalised pastures. The property is now predominantly used for grazing based on native and naturalised grasses including buffel grass (*Cenchrus ciliaris*), butterfly pea (*Clitoria ternatea*) and perennial Sorghum (*Sorghum spp*.), as well as leucaena (*Leucaena leucocephala*). The surface freehold lands have been fenced to facilitate grazing and crop management.

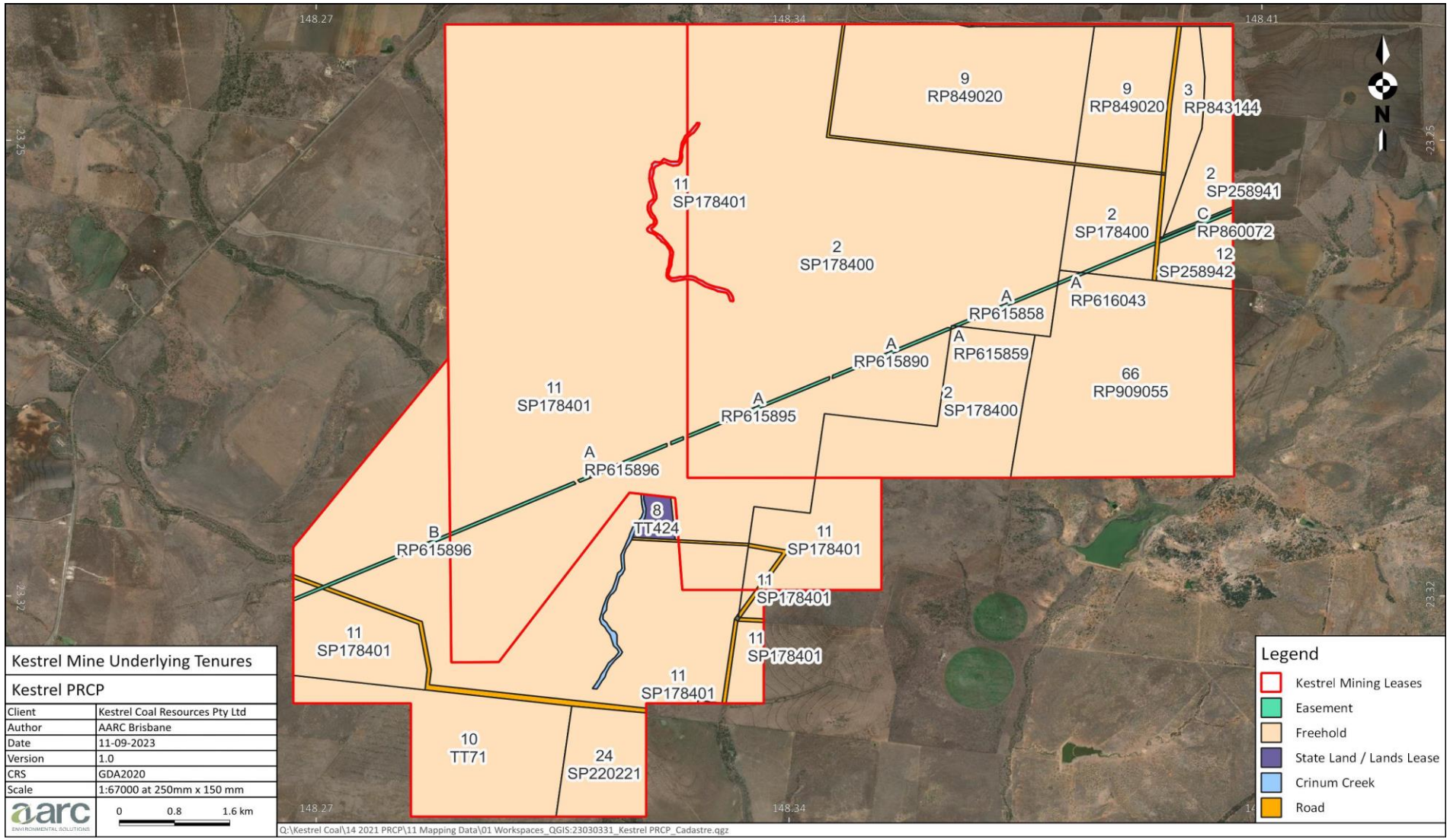


Figure 13: Underlying property ownership

Current soils knowledge is based on several soil surveys that have been undertaken across the various MLs as follows:

- 1993 (Emmerton): conducted a soils and land suitability assessment for dryland cropping in the Gordonstone West area (1:25,000 scale). Note that the prior name of Kestrel was the Gordonstone Mine;
- 1996 (Cannon): addressed soils and land suitability for the Gordonstone Mine, Gordonstone Extension and Gordonstone West Mines (1:25,000 scale);
- 2002 (MWH): conducted a pre-mining condition soil and land capability study of Gordon Downs; effectively covering ML 1978, ML 70301, ML 70302, ML 7030 and parts of ML 70481 excluding the immediate area of existing surface infrastructure, and improving the mapping scale to 1:10,000; and
- 2011 (MWH): surveyed the remainder of ML 70481 at 1:10,000 scale as part of the Environmental Assessment Report Kestrel Extension #4 November 2012 (EMM 2012). This study also addressed land capability, land suitability and SCL aspects.
- 2022 (Highlands Environmental): *Agricultural land evaluation on Mining Lease 70481, Gordon Downs, central Queensland*. This study includes an agricultural land evaluation, land suitability assessment and SCL zonal criteria assessment and determination.

The distribution of soil types within the Project area includes soils formed on:

- Alluvium (Quaternary alluvium);
- Cainozoic sediments;
- Tertiary basalt;
- Colluvium (mainly basalt derived); and
- Highly calcareous materials.

Table 3 provides a summary and brief descriptions of the soil management units identified by MWH (2002 and 2011) across all of the Project MLs to ML 70481. Soil management units are shown in Figure 14.

Table 3: Soil types - Kestrel MLs to ML 70481 (from MWH 2002 and 2011)

Soil and classification	**Brief description**
Soils formed on Alluvium	
A – Alluvium Grey or Black Vertosols	Strongly self-mulching grey or black medium to medium heavy clay or occasionally light medium clay A horizon overlying strongly structured grey or black medium heavy clay B horizon to greater than 1.3m. Alkaline to strongly alkaline throughout or alkaline soil reaction trend. Carbonate may occur throughout and gypsum may occur below about 0.3m.
Afs – Fine Sandy or Silty Surfaced Alluvium Black, Brown or Grey Vertosols and Dermosols	Massive to weakly self-mulching black, brown or grey fine sandy clay to silty clay to occasionally light clay A horizon over black, grey or brown light medium clay to medium clay A horizon. Alkaline to strongly alkaline throughout or alkaline soil reaction trend. Carbonate may occur throughout and gypsum may occur below about 0.3m. Alluvial layering may be evident below about 1m.
Agc – Soils overlying mottled greenish-grey or green smectite clays Black and Grey Vertosols	Strongly self-mulching grey or black medium to medium heavy clay. A horizon overlying strongly structured grey or black medium heavy clay B horizon to greater than 1.3m overlying mottled greenish or green clay at depth. Alkaline to strongly alkaline through or alkaline soil reaction trend. Carbonate may occur throughout the dark horizons but is absent in the green layer. Occurs both high in the landscape and in lower alluvial sites, suggesting the presence of old Tertiary sediments on residual landforms.

Soil and classification	Brief description
Soils formed on Colluvium	
C – Colluvium Black or Grey Vertosols	Strongly self-mulching grey or black medium clay to medium heavy clay A horizon over black or occasionally grey medium heavy clay B horizon. Alkaline to strongly alkaline throughout or alkaline soil reaction trend. Carbonate nodules may occur throughout and Vertosols gypsum may occur below about 1m.
Cg – Colluvium; linear gilgai Black or Grey Vertosols	Strongly self-mulching grey or black medium clay to medium heavy clay A horizon over black or occasionally grey or brownish black medium heavy clay. B horizon. Alkaline to strongly alkaline throughout or alkaline soil reaction trend. Carbonate nodules may occur throughout. Gilgai not strongly defined in grassland sites and difficult to detect in cultivated areas. Often associated with sites higher in the landscape on the older residual surface.
Cgc – Colluvium; Soils overlying. mottled greenish-grey or green smectite clays Black and Grey Vertosols	As for Cg but overlies greenish-grey mottled or green smectite clays at depth. No gilgai found associated with this unit.
Soils formed on Cainozoic sediments	
CS – Cainozoic Sediments Grey and Black Vertosols	Weakly crusting to moderately self-mulching, grey or occasionally brown or black light medium clay to medium clay A horizon over grey or occasionally brown medium heavy clay B horizon. Profile alkaline to about 0.6m but frequently neutral to acid below. Carbonate nodules may occur in alkaline materials and gypsum may occur in neutral or acid materials. C horizon of clay-rich sediments may commence below about 1m.
CSk – Cainozoic Sediments crusting; Grey and Greyish Brown Vertosols with strongly developed surface crust	Strongly crusting grey or greyish brown medium heavy clay A horizon over grey medium heavy clay b horizon. Profile usually neutral to acid. Gypsum may occur below about 0.7m. C horizon of clay-rich sediments may commence below about 1m.
CStc – Texture Contrast soils on Cainozoic Sediments Red and Brown Sodosols and Chromosols	Massive brown, reddish brown to black loamy sand to sandy clay loam A horizon over frequently mottled red or brown light clay to medium clay B horizon. Alkaline soil reaction. Carbonate nodules occur below about 0.4m. Horizons showing sedimentary layering may commence below about 0.6m.
Soils formed on Calcereous materials	
Krb – Red and Brown soils on Calcareous Materials Red and Brown Vertosols	Strongly or self-mulching (with soft granular aggregates) red, brown or occasionally black light clay to medium clay A horizon over red, brown or occasionally black, light clay to medium heavy clay B horizon. Profile alkaline or strongly alkaline throughout. C Horizon dominated by carbonates encountered at or below 0.45m. Brown or occasionally black, light clay A horizon over brown or occasionally black light clay to light medium clay B horizon. Profile strongly alkaline throughout. C horizon dominated by carbonates encountered at or before 0.45m
Ks – Shallow Calcareous Brown Dermosols and Tenosols	Brown or occasionally black, light clay A horizon over brown or occasionally black light clay to light medium clay B horizon. Profile strongly alkaline throughout. C horizon dominated by carbonates encountered at or before 0.45m.

Soil and classification	Brief description
Soils formed in situ on Basalt	
B – Basalt Black, Brown and Grey Vertosols	Strongly self-mulching black or occasionally grey or brown medium to medium heavy clay or occasionally light medium clay A horizon over black medium heavy clay or occasionally medium clay B horizon. Alkaline to strongly alkaline throughout or alkaline soil reaction trend. Carbonate nodules or soft segregations may occur throughout the profile. Massive or occasionally weakly lenticular pan present in upper B horizon in intensively cultivated situations. Weathered basalt C horizon not encountered before 0.6m.
Bs – Shallow Basalt Black, Brown and Grey Vertosols	Strongly self-mulching black or occasionally brown medium clay to medium heavy clay or occasionally light medium clay A horizon over black medium heavy clay or occasionally medium clay B horizon. Alkaline or occasionally neutral soil reaction trend. Carbonate nodules or soft segregations may occur below about 0.2m. Massive or occasionally weakly lenticular pan present in upper B horizon in intensively cultivated situations. Weathered basalt C horizon encountered at or below 0.45m but before 0.6m.
Bvs – Very Shallow Basalt Dermosols and Black or Brown Vertosols	Strongly self-mulching black or brown medium clay or occasionally light medium clay or medium heavy clay A horizon over black medium to medium heavy clay B horizon. Profile neutral to alkaline. Massive pan present in intensively cultivated situations. Weathered Black or Brown basalt C horizon encountered before 0.45m.
Bvsb – Brown Very Shallow Basalt Brown Dermosols or Brown Tenosols	Weakly crusting brown, reddish brown or occasionally black light clay to light medium clay A horizon over brown or occasionally black moderately structured light clay to light medium clay. Profile neutral or alkaline. Weathered or hard basalt C horizon encountered before 0.45m.
Bvsc – Very Shallow High Carbonate Basalt Black or Brown Dermosols or occasionally Black or Brown Vertosols	Strongly self-mulching black or brown medium clay or occasionally light medium clay or medium heavy clay A horizon over black or brown medium to medium heavy clay B horizon. Profile alkaline or strongly alkaline throughout or alkaline soil reaction trend. Weathered basalt C horizon containing 10% or more of carbonates encountered before 0.45m.

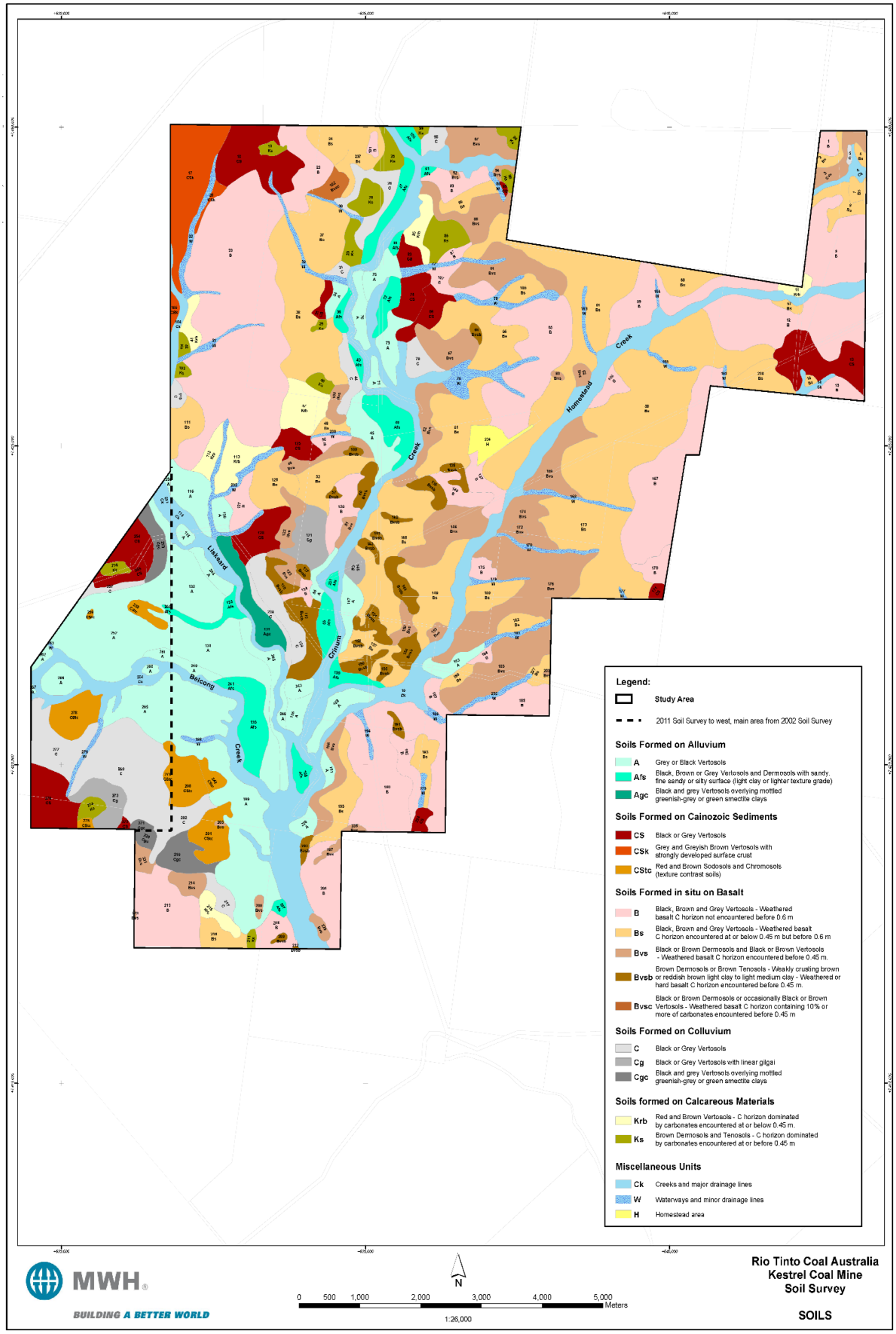


Figure 14: Soil management units (MWH 2011)

The principal land disturbance impact associated with underground mining activities at Kestrel is subsidence. The potential impacts of subsidence include surface cracking and deformation, erosion and ponding. The majority of the Project MLs are dominated by Vertosols which are characterised as expansive soils with a high shrink-swell potential that change volume with changes in soil water content. The nature of these expansive cracking clays is such that, typically over one to two seasons, there will be general compensation to subsidence movement resulting in little or no impact on soil suitability for cropping or grazing land uses.

These cracking clay soils naturally open, crack and shrink when dry with the cracks then closing when wet due to the soil's inherent characteristics of pedoturbation. This allows soil material to fall down the cracks and be incorporated in the profile. Thus, though cracks may initially be caused when subsidence first occurs, this natural characteristic of pedoturbation leads to crack closure and re-formation of the soil profile over one or two wetting and drying cycles.

The resilience of the soil types within the Project area to movement and the gentle, undulating topography also make the landform generally resistant to erosion. However, increases in localised erosion rates occurring post-disturbance is still a risk, particularly on landforms more prone to erosion, for example, watercourses and steeper slopes; and therefore this still requires monitoring.

Ponding can occur within the landform dependent on the co-incidence of subsidence changes on the pre-existing landform. To date, ponding has not been considered a significant issue with existing ponded areas seen as offering additional stock watering and ecological opportunities.

3.1.7.2 Soil erosion assessment

Pre- and post-disturbance erosion rates have most recently been estimated for the soils of ML 70481 using the Revised Universal Soil Loss Equation v2 (RUSLE2); a method used to estimate average annual soil loss caused by hillslope and rill erosion. The equation is limited to making predictions for long-term annual soil loss. The equation is:

$$A = R \, x \, K \, x \, LS \, x \, C \, x \, P$$

Where:

- **A** is the predicted annual average rate of soil loss by surface and rill erosion in t/ha/year;
- **R** is the rainfall erosivity factor based on the total erosive power of storms during an average year and is dependent on local weather conditions;
- **K** is the soil erodibility factor, specifically derived for the ML 70481 area as described below;
- **LS** is the slope length and gradient factor, specifically the distance between the point of commencement of water runoff on the land and the point of sediment deposition or the point where runoff enters a well defined channel, and the effect of slope steepness on erosion;
- **C** is referred to as the cover and management factor which compares cropping practices, residue management, and soil cover to a standard clean fallow plot. C-factors for different agricultural uses and management practices are developed based on their observed deviation from the standard clean fallow plot; and
- **P** is the conservation or support practice factor and reflects the impact of support practices on the average annual erosion rate. It reflects the ratio of soil loss with contouring and/or strip cropping to that with straight row farming up-and-down slope.

Climate parameters

A climate model for ML 70481 was constructed using SILO data and erosion density values sourced from Australian climate profiles contained in RUSLE2. The erosivity distribution for the climate model was estimated from monthly erosion density values (ratio of SI units), average temperature (°C) and precipitation (m). Surface water runoff was also calculated in the model using 10-year, 24-hour rainfall event precipitation data (m) sourced from the Bureau of Meteorology Design Rainfall Data System.

Soil parameters

Soil parameters are estimated by the following inputs:

- Soil erodibility ('K' factor);
- Clay fraction (<0.002 mm) (%);
- Silt fraction (0.002-0.05 mm) (%); and
- Sand fraction (0.05-2 mm) (%).

Derivation of the soil erodibility or K factor was undertaken by Titmarsh (2018) while the derivation of the other input factors is described in the following sub-sections.

LS factor derivation

Slope profiles for the gradient and slope length segments of 'slope complexity' in RUSLE2 were constructed from pre- and post-disturbance digital elevation models. Slope profiles were selected down the dominant slope for a map unit of each relevant soil type covering the revised longwall 500-series mine plan. L and S factors were determined through the RUSLE2 model. Each soil map unit was chosen as a major representative of the soil type over the longwall panels and the slope profiles were taken as the steepest slope sections for either the pre-disturbance or post-disturbance topography, providing a worst case erosion loss.

C and P factor derivation

Vegetation management was kept consistent across pre- and post-disturbance landforms, with the default RUSLE2 management "range grass" of the "long-term vegetation" category selected for all slopes. It should be noted that while RUSLE2 also supports, and was originally designed for, cropland vegetation management, such vegetation parameters are not appropriate given the final land use. Cropland vegetation management in RUSLE2 relates primarily to annual cropping rotations, compared to the perennial nature of grazing. As such, incorporating a cropland vegetation management simulation would not be representative of the current or proposed PMLUs.

Calculated rates of pre-and post-disturbance soil erosion using RUSLE2

Predicted soil loss rates for pre-and post-disturbance topography have been derived by applying the factors identified above to the RUSLE2 model across all 12 of the soil types of ML 70481. The slope profiles have been selected as being among the steepest (complex slope) gradients represented within each soil type map unit. It must be noted that the soil map unit boundaries are only approximate and do not directly correlate with the contour map of the extant topography (as they would on the ground), while the contour map of the post-disturbance scenario is based on mine subsidence predictions considered to be accurate. It should be noted that for much of the Kestrel MLs, few slope gradient changes post-disturbance go beyond ±2% and few absolute slope gradient increases to over 3% occur.

Soil loss estimates for the soil types within ML 70481 are provided in Table 4 along with the calculated difference between pre-and post-disturbance soil loss predictions. The estimated pre-disturbance soil loss ranges from 1.3 to 13 t/ha/year with an average of 5.03 t/ha/year and estimated post-disturbance soil loss ranges from 2.4 to 16 t/ha/year with an average of 6.75 t/ha/year.

It can be seen from Table 4 that both these ranges include two soil/slope profiles (Bvsb and Krb) that have significantly higher values, of over 10 t/ha/yr, than the rest. The Bvsb soil/slope profile is a very shallow, comparatively erodible soil on a short, steep, stony slope; not mapped as SCL. The slope profile for this soil unit lessens in gradient but is less complex in the post-disturbance scenario. The Krb soil/slope profile is similarly short and steep within a small map unit (< 20 ha) and having a less complex, straighter slope but with the same average gradient in the post-disturbance topography. These soils/slopes would be expected to

have high erosion rates compared to the rest of those assessed and can be considered as both uncommon and as 'risk zones'.

Without these two higher than average soil loss values, the estimated pre-disturbance soil loss ranges from 1.3 to 8.1 t/ha/year with an average of 3.76 t/ha/year while the estimated post-disturbance soil loss ranges from 2.4 to 9.0 t/ha/year with an average of 5.25 t/ha/year (refer Table 4). It should be noted that the derivation of these soil loss values is based on using worst case LS factors which have then been applied to the whole soil map unit. Consequently, the soil loss rates determined are unlikely to result in practice and will be further mediated by those areas within the soil map unit where slopes have decreased as a consequence of subsidence. Erosion rates *within this range are classed as 'medium', with 61% of Australia experiencing erosion within this range (Lu et al.* 2001). When considering the 'low' erosion rate suggested by Lu *et al.* (2001), such a rate is established based on an undisturbed soil formation rate of 0.5 t/ha/year.

Considering grazing land specifically, a target erosion rate of 4.5-5 t/ha/year has been suggested as acceptable for such a land use (Landloch 2013; Howard and Loch 2019; McCormack *et al.* 1982; Rollins 1981).

An initial assessment of these soil erosion rates is considered best guided by Lu *et al.* (2001) and Roswell (1996), which have attempted to quantify erosion rates across Australia. Against an average Australian erosion rate of 6.3 t/ha/year, the study suggested that:

- a low rate of erosion could be defined as less than 0.5 t/ha/year; and
- a high erosion rate could be defined as greater than 10 t/ha/year.

Erosion rates for ML 70481, would be categorised as moderate to low for both pre- and post-disturbance scenarios by this measure, without the two exceptional soil/slope profiles, and well below the average Australian erosion soil loss rate. The erosion risk for the ML 70481 area at Kestrel is therefore classified as moderately low in both scenarios.

3.1.7.3 Strategic Cropping Land

The Project is located within the western cropping zone SCL management area. An amended Regional Interests Development Approval (RIDA) under Section 53 of the *Regional Planning Interests Act* (the RPI Act) was issued on 29th August 2016 (reference number RPI16/002/RIO TINTO) as part of the approval process for ML 70481. The RIDA authorises impacts to SCL within ML 70481 to a total of 949 ha of SCL. It requires Kestrel to progressively restore disturbed strategic cropping area to the best possible class of agricultural land, with the necessary rehabilitation works being completed promptly following disturbance. Various management plans exist to address requirements associated with the RIDA. A minor amendment to the RIDA is currently in progress to update the panel layout included within the RIDA to that currently planned to be mined.

3.1.7.4 Land suitability assessment

The land suitability class system relies on data collected on the physical, chemical and nutritional characteristics of soils to assess and rank land according to the five land suitability classes (LSCs) which are described as follows.

Class 1	Suitable land with negligible limitations which is well suited to a proposed use.
Class 2	Suitable land with minor limitations which is suited to a proposed use but which may require minor changes in management to sustain use.
Class 3	Suitable land with moderate limitations which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use.
Class 4	Marginal land with severe limitations which is marginally suited for a proposed use and would require major inputs to ensure sustainability. These inputs may not be justified by the benefits to be obtained in using the land for a particular purpose and is hence considered presently unsuitable.

Class 5 Unsuitable land with extreme limitations which preclude its sustainable use for the proposed purpose.

Table 4: Pre- and post-disturbance predicted soil loss for each soil type slope profile

SMU	Soil Loss pre-disturbance (t/ha/yr)	Soil Loss post-disturbance (t/ha/yr)	Difference
A – Alluvium; Grey or Black Vertosols	1.3	2.8	1.5
Afs – Alluvium; Fine sandy or silty surfaced Black, Brown or Grey Vertosols and Dermosols	2.2	2.4	0.2
B – Basalt; Black, Brown and Grey Vertosols >0.6 m deep	4.1	5.1	1
Bs – Black, Brown and Grey Vertosols <0.6 m deep	4.1	5.4	1.3
Bvs –Shallow Basalt; Black or Brown Dermosols; and Black or Brown Vertosols	8.1	9	0.9
Bvsb – Very Shallow Basalt; Brown Dermosols or Brown Tenosols	13	16	3
C – Colluvium; Black or Grey Vertosols	1.4	4.1	2.7
Cg – Colluvium; Black or Grey Vertosols with gilgai	4.3	6.1	1.8
Cgc – Colluvium, Black and Grey Vertosols overlying mottled greenish- grey or green cracking clays	5.3	4.8	-0.5
CStc – Texture Contrast Soils on Cainozoic Sediments; Red and Brown Sodosols and Chromosols	5.1	6.8	1.7
Krb – Red and Brown Vertosols on Calcareous Materials	11	14	3
Ks – Shallow Calcareous; Brown Dermosols and Tenosols	4.8	6.1	1.3
Average	**5.03**	**6.75**	**1.72**
Average without Bvsb and Krb	**3.76**	**5.25**	**1.49**

3.1.7.5 Land capability assessment

A key EA requirement is for disturbed lands to achieve the land capability classes nominated within the EA, which is generally a return to its pre-mining agricultural capability. The pre-mining land capability for the Project area is shown in

Figure 15. Land capability assessments have been undertaken for the site at various stages; the most recent land capability study was undertaken by MWH (2011) for the ML 70481 area to determine the maximum sustainable intensity of land use. The study included a re-evaluation of an earlier 2002 study (MWH 2002) of MDL176 and MDL345, to take into account subsidence impacts on surface water flows. The study found the main agricultural land capability classes represented across the Project site were Class III and Class VII, with smaller areas of Class IV, Class V and Class VI lands also identified. Land capability classes are described in Table 5.

Table 5: Land capability classes

Class	Land capability
I	Land suitable for all agricultural and pastoral uses
II	Land suitable for all agricultural uses but with slight restrictions for cultivation
III	Land suitable for all agricultural uses but with moderate restrictions for cultivation
IV	Land primarily suited to pastoral use but which may be safely used for occasional cultivation with careful management
V	Land that in all other characteristics would be arable but has limitations that make cultivation impractical and/or uneconomic
VI	Land that is not suitable for cultivation but is well suited to pastoral use
VII	Land that is not suitable for cultivation but on which pastoral use is possible only with careful management
VIII	Land that has such severe limitations that it is unsuited for either cultivation or grazing

A 2011 soil survey was conducted by MWH to determine the LSCs on ML 70481. Previous soil surveys conducted in 2002, site landscape investigations undertaken in 2010, and pervious mapping of the site by Cannon (1996) and Emmerton (1993) were used, in conjunction with the 2022 soil survey, to develop a comprehensive LSC for the majority of the Kestrel MLs (MWH 2011). Both the 2002 and 2011 LSCs were determined in accordance with the *Guidelines for Agricultural Land Evaluation in Queensland* (Land Resources Branch Staff 1990). The pre-mining Summer and Winter LSCs for the Project are shown in Figure 16 and Figure 17 respectively.

A more recent (2022) LSC assessment was undertaken by Highlands Environmental and included soil sampling and evaluation within ML 70481. The soils were assessed in accordance with the *Queensland Government procedures and guidelines for land suitability classification* (DRNM & DSITIA 2013, DSITI & DNRM 2015). The site was assessed for dryland cropping of winter (wheat and chickpea)(Figure 18) and summer (Sorghum)(Figure 19) crops.

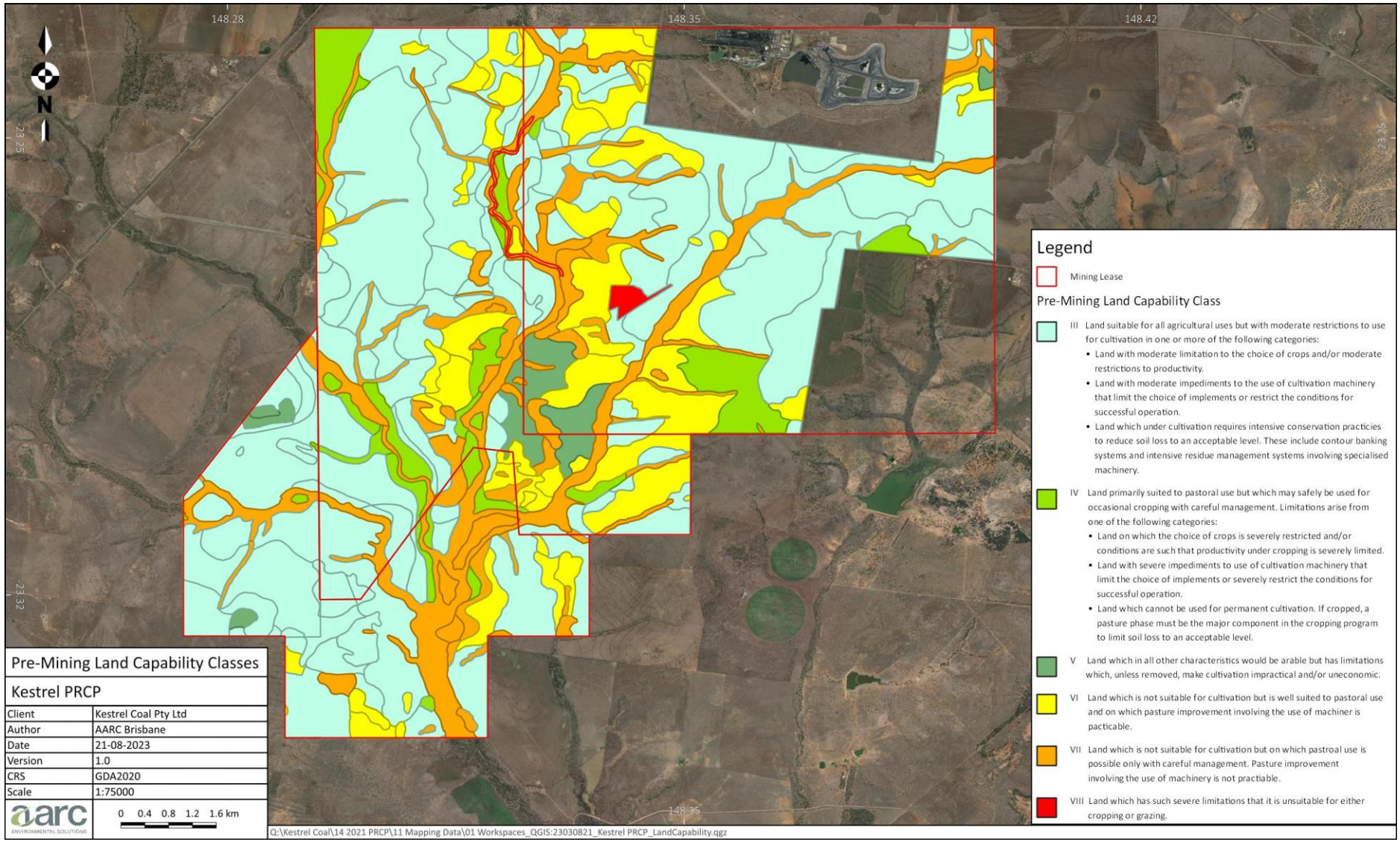


Figure 15: Pre-mining agricultural capability

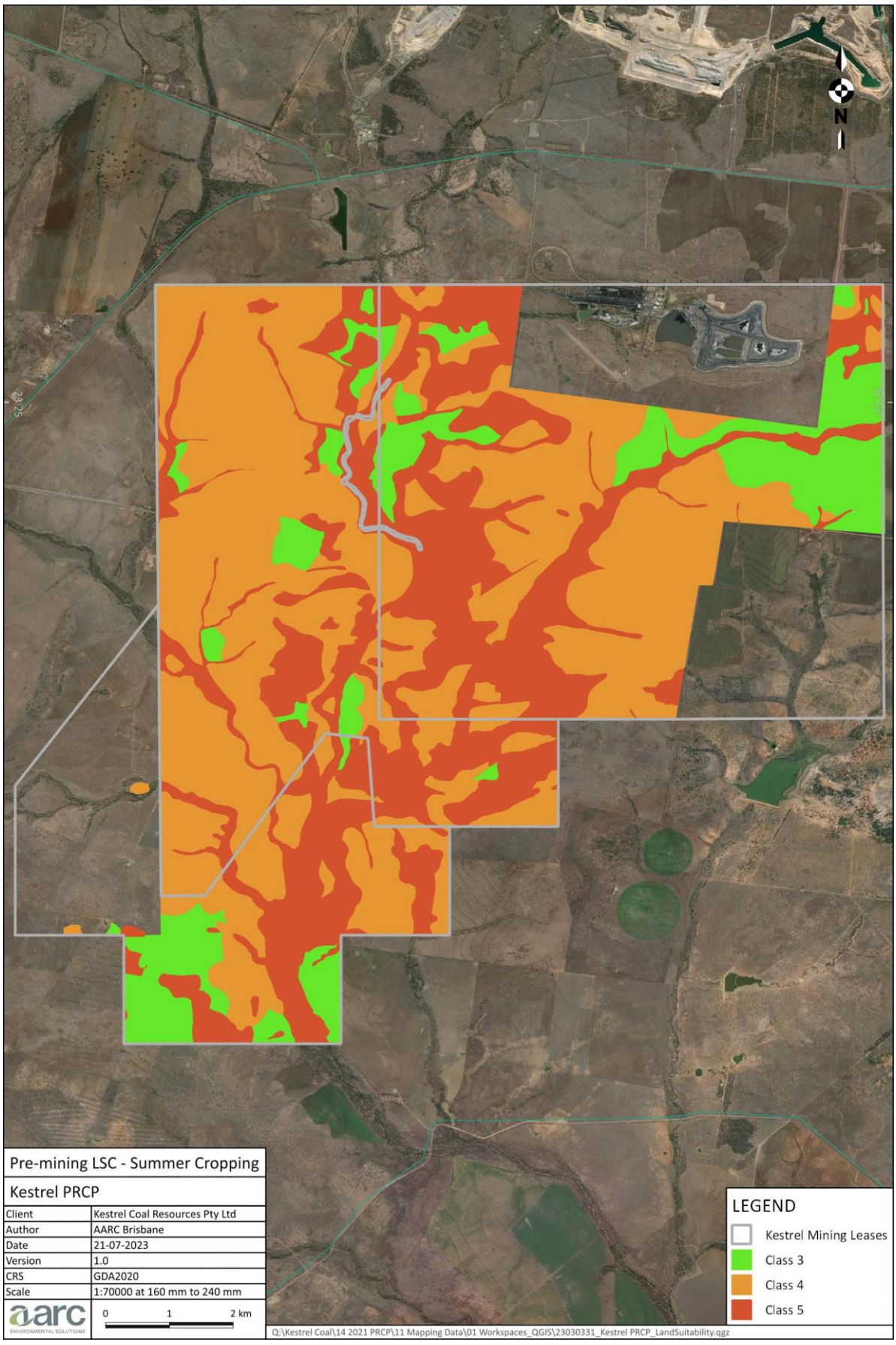


Figure 16: Pre-mining Summer crop LSC (MWH 2011)

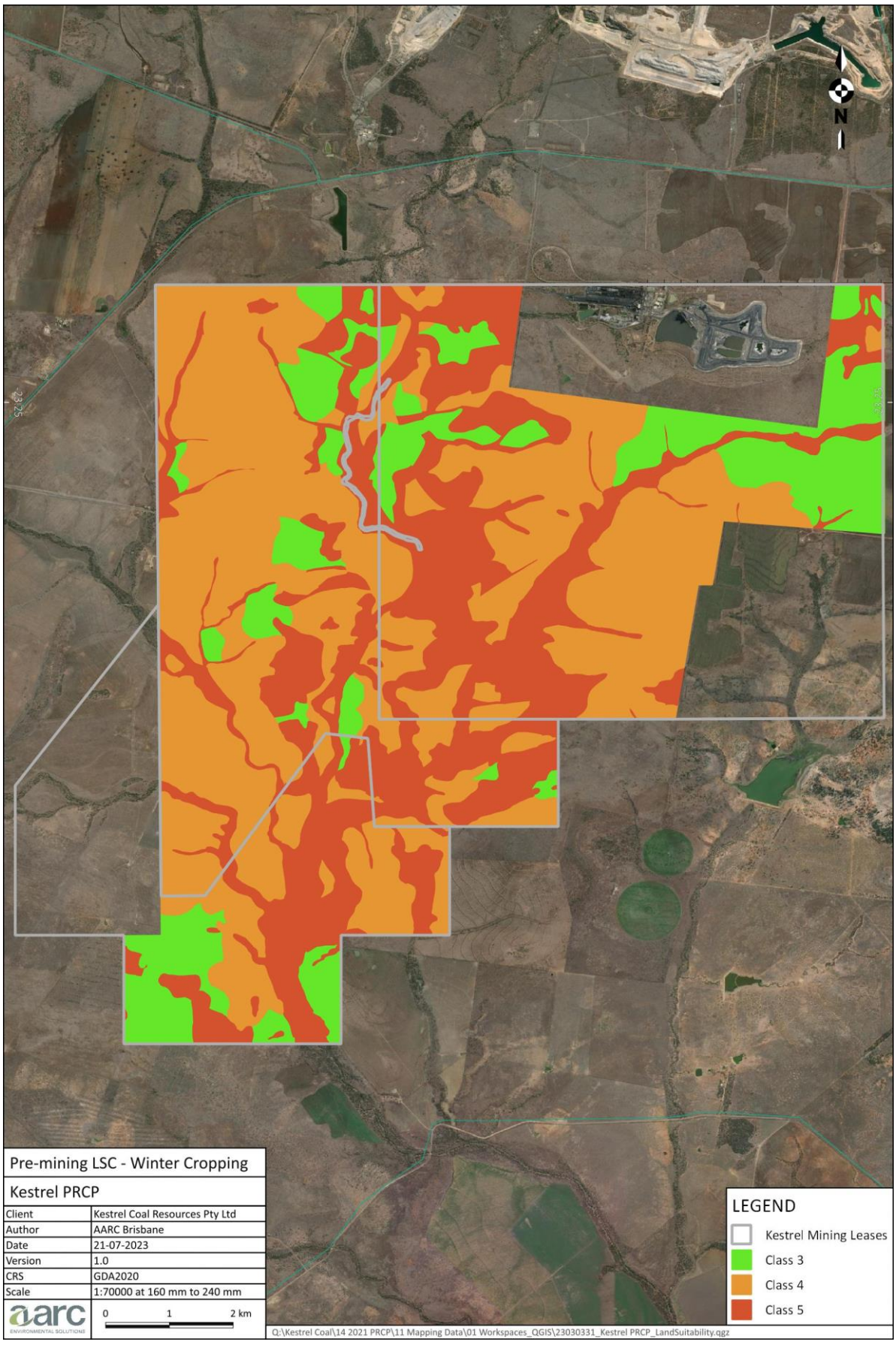


Figure 17: Pre-mining Winter crop LSC (MWH 2011)

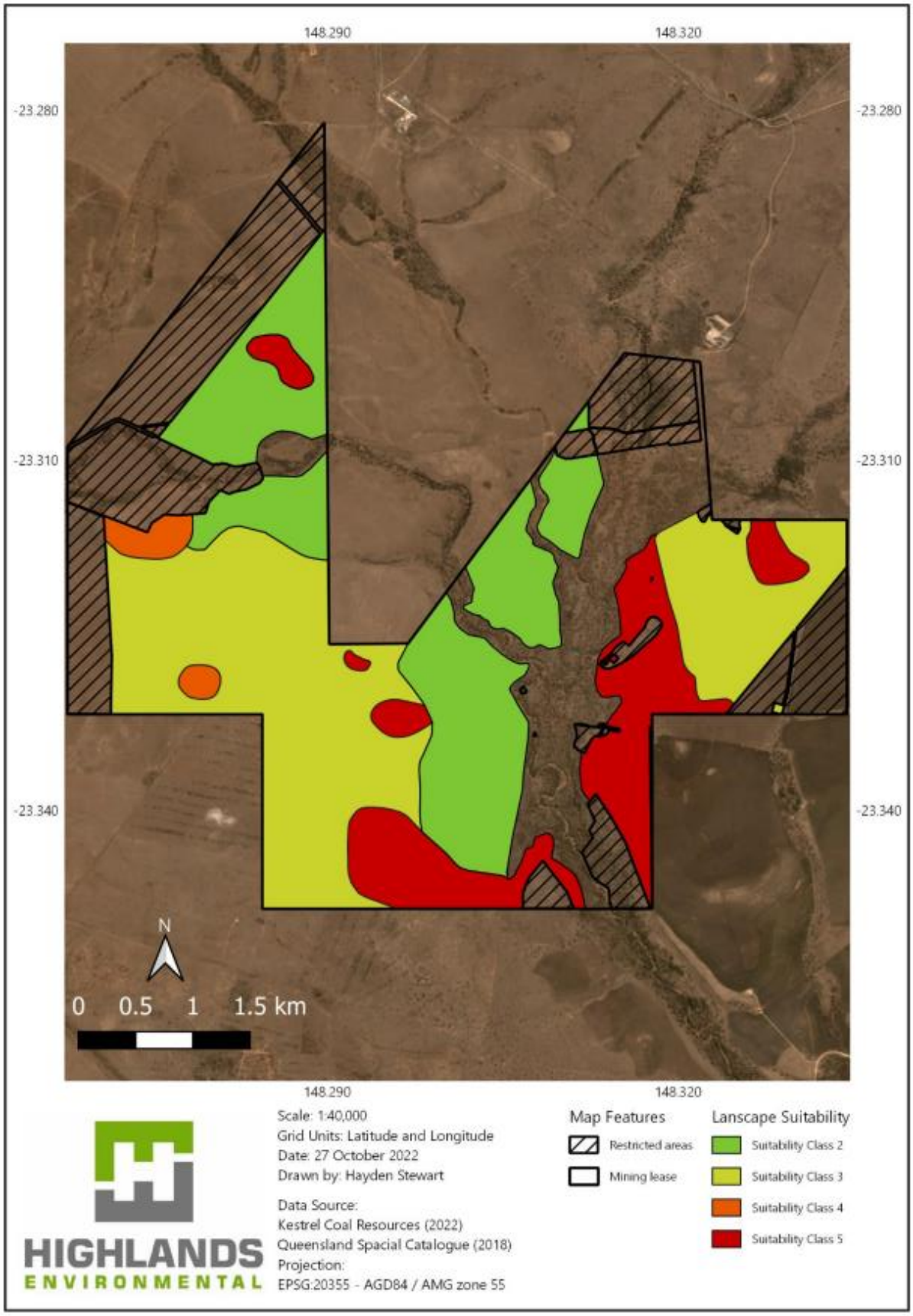


Figure 18: Dryland Winter cropping LSC (wheat and chickpea)

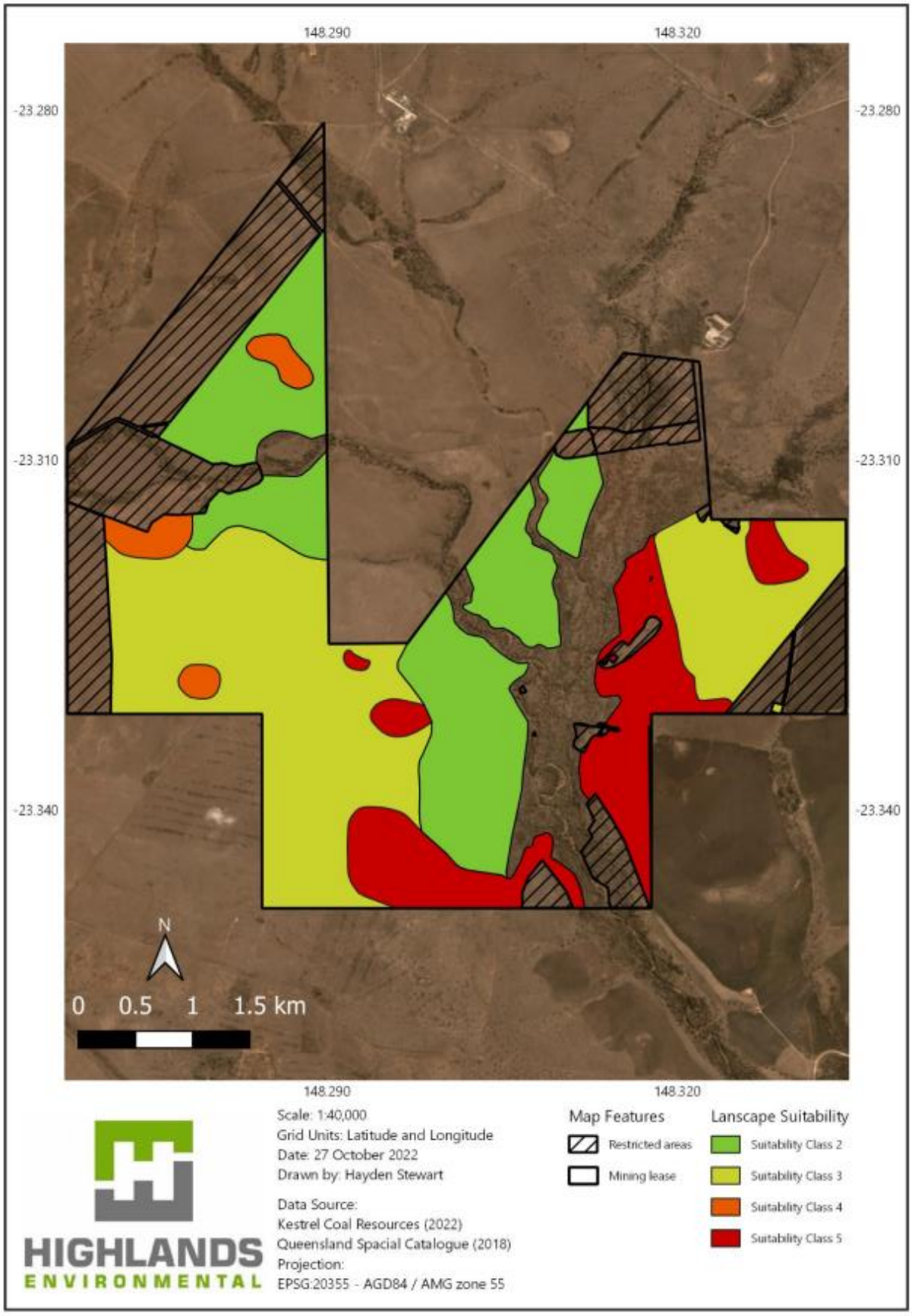


Figure 19: Dryland Summer cropping LSC (Sorghum)

3.1.8 Flora and fauna

A flora and fauna assessment across the Project was undertaken in 2022 to determine the biodiversity values within the Kestrel MLs (ML 1978, ML 70330, ML 70302, ML 70301 and ML 7048) (Umwelt 2023).

3.1.8.1 Flora

The Umwelt (2023) and AARC (2022) flora assessments determined that the majority of the site had been previously cleared for intensive cropping purposes (for cattle grazing and cultivation). The remaining vegetation identified on site (Table 6 and Figure 20) is mostly comprised of non-remnant vegetation communities. The agricultural use of the land has resulted in a reduction in the conservation significance of much of the remaining vegetation through the alteration of species composition within the mid and understorey.

The flora surveys undertaken across the site identified 201 species across 54 families and 129 genera (Umwelt 2023). Approximately 20% (42) of the species were identified as introduced, with several species classified as Category 3 Restricted Matters under the *Biosecurity Act* 2014 including:

- Parthenium Weed (Parthenium hysterophorus);
- Parkinsonia (Parkinsonia aculeata);
- Velvety Tree Pear (*Opuntia tomentosa*); and
- Opuntia stricta.

One threatened ecological community (TEC), *Natural grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin* (RE 11.8.11), was verified during field surveys (Umwelt 2023). The grasslands are primarily dominated by Bluegrasses (*Dichanthium spp*.), Wiregrasses (*Aristida spp*.) and Panic (*Panicum spp*.), with drier areas potentially comprising a higher proportion of Mitchell Grass (*Astrebla spp*.). Bluegrass grasslands (RE 11.8.11) are listed as 'Endangered' under the *Environment Protection and Biodiversity Act 1999* (EPBC Act). Bluegrass grasslands are known habitat in the region for King Bluegrass (*Dichanthium queenslandicum*), which is listed as 'Vulnerable' under the EPBC Act 1999. This species has most recently been recorded in the 2017 (AARC) and 2023 (Umwelt) surveys, which also noted that grazing pressures and dry conditions impact the condition of the Bluegrass grasslands community across the Project site.

One other threatened flora species, *Dicanthium setosum,* was identified within ML 1978 during the 2022 (AARC) survey. This species is listed as Near Threatened under the Nature Conservation Regulation and Vulnerable under the EPBC Act.

Brigalow (*Acacia harpophylla*) was identified on the Project site (AARC 2022). Remnant Brigalow woodlands are listed as 'Endangered' under the EPBC Act 1999, but the community found on site did not have the necessary characteristics for it to be classed as remnant vegetation and is therefore not considered significant at a national level.

Table 6: Ground-truthed vegetation communities at the Project site (Umwelt, 2023)

Regional ecosystem	Short description	VM Act[1] status	Biodiversity status[2]	Remnant status	Area (ha)
RE 11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of Concern	Of Concern	Remnant	975.7
				Regrowth	16.9
RE 11.3.3a	*Melaleuca bracteata* woodland on alluvial plains	Of Concern	Of Concern	Remnant	91.2
				Regrowth	22.3
RE 11.3.8	*Acacia argyrodendron* woodland on alluvial plains	Of Concern	Least Concern	Remnant	3.2
RE 11.8.4	*Eucalyptus melanophloia* woodland to open woodland on Cainozoic igneous rocks	No Concern at Present	Least Concern	Remnant	163.7
RE 11.8.5	*Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks	No Concern at Present	Least Concern	Remnant	341.0
				Regrowth	13.4
RE 11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	Of Concern	Least Concern	Remnant	1,066.8
Non-remnant	-	-	-	Non-remnant	8,983.4

1 Vegetation Management Act 1999
2 Regulated under the Environment Protection Act 1994

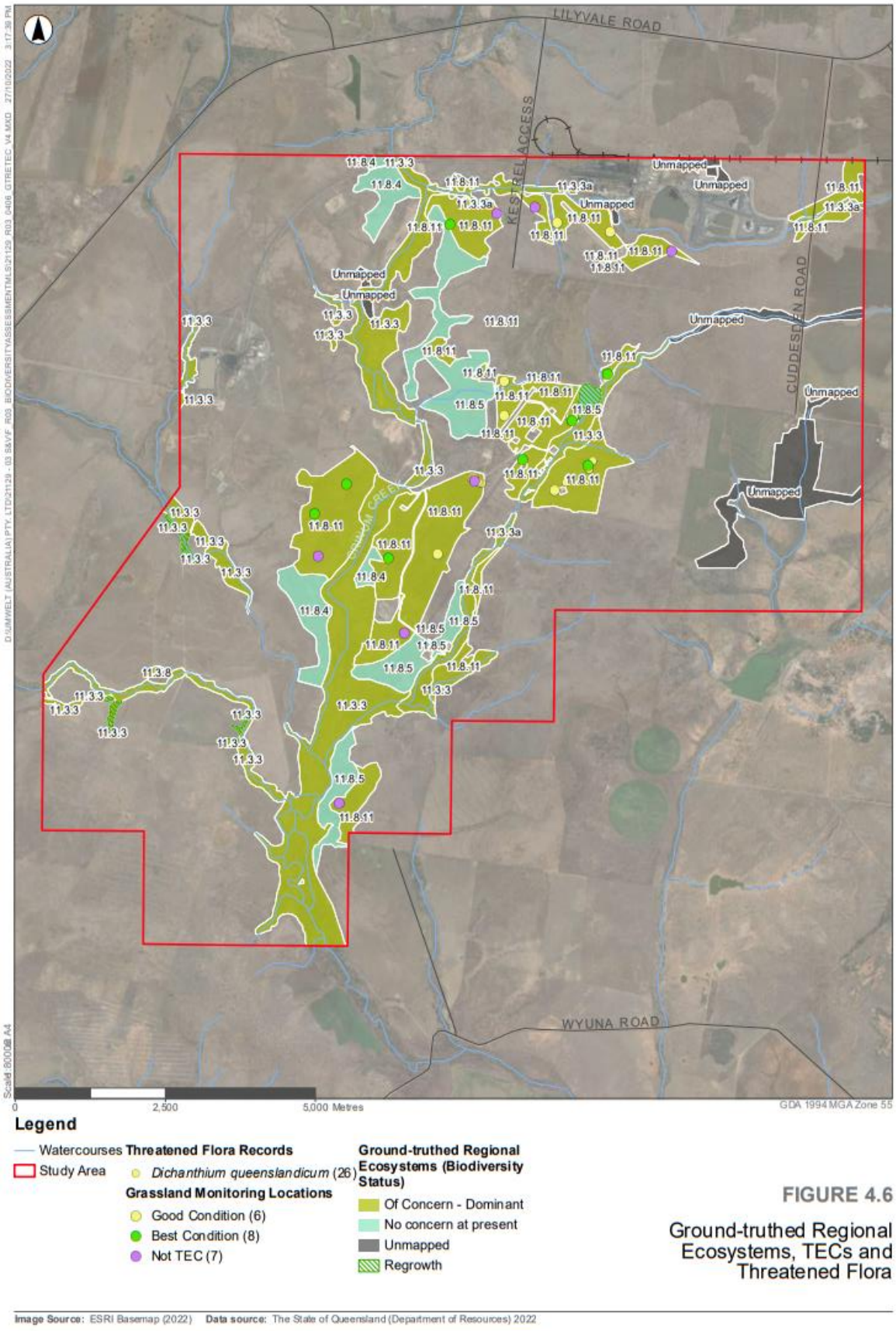


Figure 20: Ground-truthed REs, TECs and threatened flora (Umwelt 2023)

3.1.8.2 Groundwater dependent ecosystems

Two potentially groundwater dependent areas have been identified (KCB 2022a) within the Project area and Gregory-Crinum Mine: the Lilyvale Waterhole (within Gregory-Crinum Mine ML) and Policemans Lagoon (within the Project ML), shown in Figure 21.

Lilyvale Waterhole is a permanent waterbody to the north of the Kestrel MLs situated within a deep incision of Crinum Creek creating a 'window' into the water table. The waterhole is mapped as being directly underlain by alluvium deposits, which overlies the Tertiary basalt. It is likely to receive drainage via overland flow from the north, however, such drainage may have been altered or redirected by the presence of mining to the north. The waterhole is considered to be of historic significance due to previously being a drinking water source for the Lilyvale township previously situated at the location; it is now considered of cultural significance due to being used for recreational purposes in the community. The waterhole hosts a habitat of aquatic and terrestrial wildlife and has been established as a site of ecological significance. Due to the historic, cultural and ecological significance of Lilyvale Waterhole, it is classified as a sensitive receptor.

Poliecemans Lagoon is located at the base of the shallow valley of Crinum Creek, and consists of a flat area of topography extending approximately 250 m to 300 m either side of the creek with gently rising slopes of 8° to 10° to the east and west. Immediately south of the lagoon, the valley floor flattens out to form a wide floodplain due to the Crinum Creek being joined by tributaries flowing from the northeast and northwest. Policemans Lagoon is directly underlain by the Tertiary basalt but is situated on the contact of the basalt with alluvium deposits associated with Crinum Creek. Based on the location of the lagoon, it is anticipated that the lagoon receives overland flow draining from the surrounding topography from the east, north and west following periods of rainfall. It is likely that such drainage is attenuated within the lagoon before discharging south along the course of the Crinum Creek.

Desktop mapping indicates the occurrence of potential terrestrial groundwater dependent ecosystems, as shown in Figure 22. They are associated with the watercourses and described as being 'Quaternary alluvial aquifers with fluctuating, intermittent groundwater connectivity regime', with the majority being low confidence terrestrial groundwater dependent ecosystems.

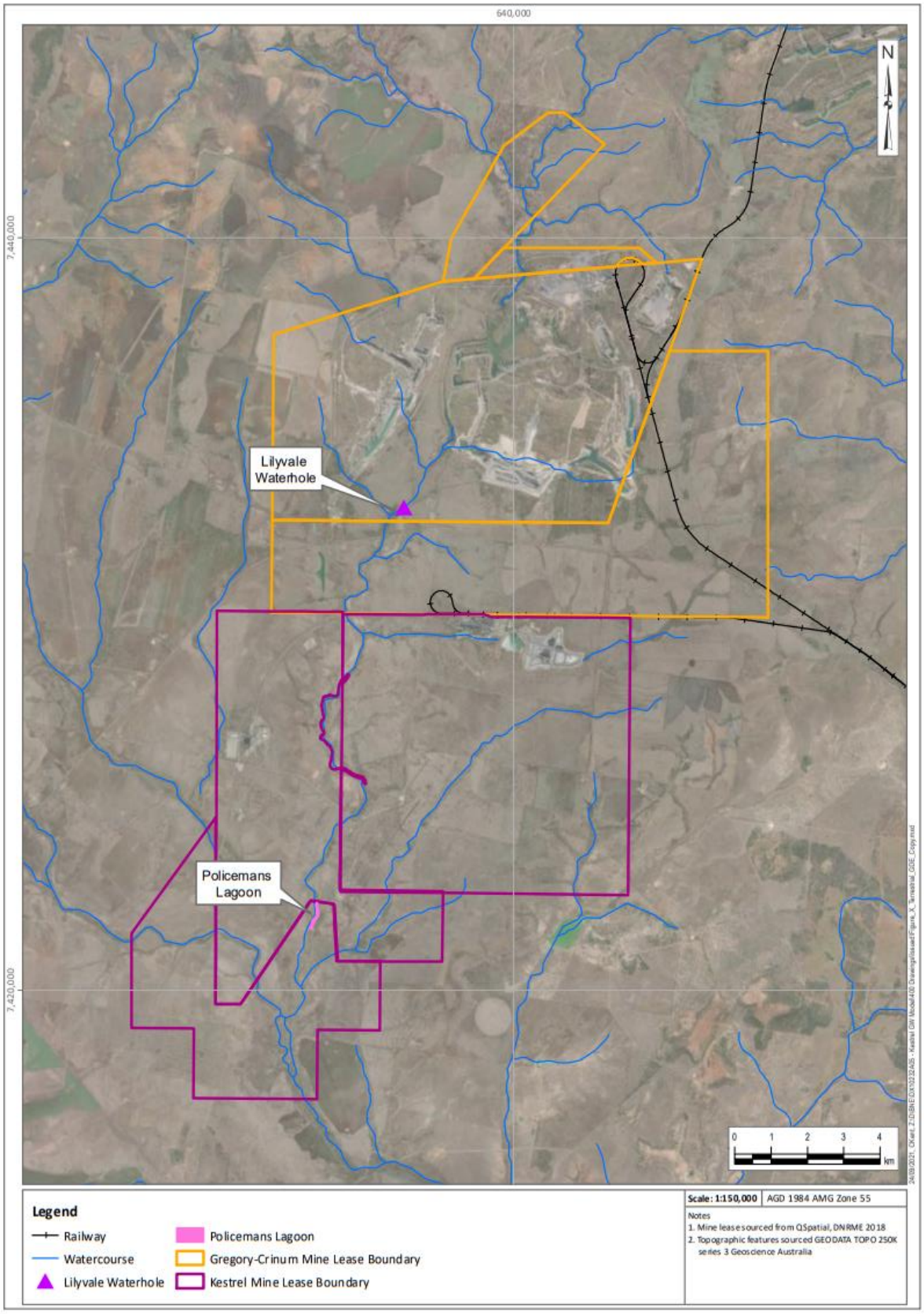


Figure 21: Location of Policemans Lagoon and Lilyvale Waterhole (KCB 2022a)

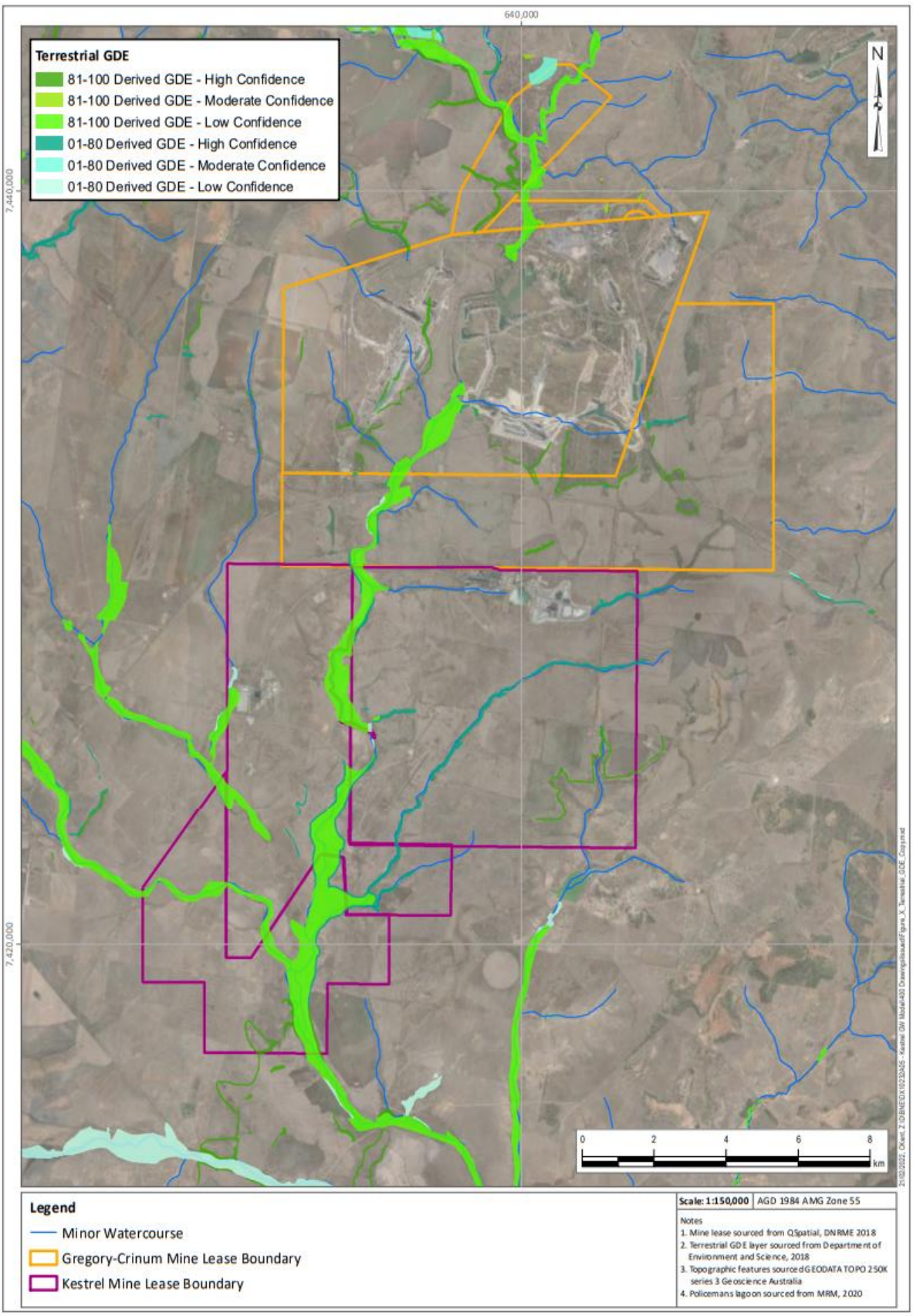


Figure 22: Location of mapped potential terrestrial groundwater dependent ecosystems (KCB 2022a)

3.1.8.3 Fauna

The 2023 ecology assessment (Umwelt 2023) recorded a total of 91 fauna species with no threatened species identified within the survey area. The short-beaked echidna (*Tachyglossus aculeatus*), listed as 'Special Least Concern' under the *Nature Conservation Act* 1992 (NC Act), was recorded during field surveys.

A previous field study conducted in 2002 (AARC) identified 84 species, however, it should be noted that this includes an area not located on the Kestrel MLs to the west. The 2002 study also recorded a further 20 species at the Lilyvale Waterhole, the closest permanent water supply located approximately 2.5 km north of the Project site on Crinum Creek.

Field survey observations are summarised in Table 7.

Table 7: Fauna observed at the Project site and the closest permanent water supply

Fauna type	Observed on site (AARC 2002)	Additional species observed at Lilyvale Waterhole (AARC 2002)	Observed on site (Umwelt 2022)
Butterflies	7	3	-
Amphibians	2	1	8
Reptiles	8	-	8
Birds	51	14	60
Mammals	16	2	15
Total	84	20	91

Of the 91 fauna species recorded within the study area (Umwelt 2023), four are introduced:

- European Cattle (*Bos taurus*);
- Dingo (*Canis familiaris*) – Category 3, 4, 5 and 6 Restricted Matter under the *Biosecurity Act 2014*;
- Feral Cat (*Felis catus*) – Category 3, 4 and 6 Restricted Matter under the *Biosecurity Act 2014*; and
- Cane Toad (Rhinella marina).

The 2023 ecology assessment (Umwelt 2023) conducted a likelihood of occurrence assessment of threatened species, communities and migratory species. This assessment reviewed desktop and field records, known habitat preferences and verified vegetation communities across the Project site. The species assessed as 'Known', 'High', and 'Moderate' are provided in Table 8.

The aquatic assessment of Junction Creek and Crinum Creeks reported in the *Environmental Assessment Addendum Report* (Matrix+ 2007) concluded that the diversity of aquatic species in the area of Kestrel was typical of central Queensland inland waterways and that none of the species identified were afforded State or Commonwealth conservation status. In central Queensland, the primary ongoing adverse impacts on the conservation value of watercourses relate to agriculture including cattle access to waterholes, clearing of adjacent land and erosion; as opposed to subsidence related effects associated with underground mining.

Table 8: Likelihood of occurrence assessment (Umwelt 2023)

Common name	Scientific name	EPBC Act status	NC Act status	Likelihood
Threatened Ecological Communities				
Natural Grassland of the Queensland Central Highlands and Northern Fitzroy Basin		Endangered	-	Known
Threatened flora species				
-	Cyperus clarus	-	Vulnerable	High
King Bluegrass	Dichanthium queenslandicum	Endangered	Vulnerable	Known
Bluegrass	Dichanthium setosum	Vulnerable	-	High
Threatened Fauna Species				
Common Death Adder	Acanthophis antarcticus	-	Vulnerable	Moderate
Ornamental Snake	Denisonia maculata	Vulnerable	Vulnerable	Moderate
Squatter Pigeon (southern)	Geophaps scripta scripta	Vulnerable	Vulnerable	High
Migratory and Special Least Concern Species				
Fork-tailed Swift	Apus pacificus	Migratory	Special Least Concern	Moderate
Rufous Fantail	Rhipidura rufifrons	Migratory	Special Least Concern	High
Caspian Tern	Hydroprogne caspia	Migratory	Special Least Concern	Moderate
Satin Flycatcher	Myiagra cyanoleuca	Migratory	Special Least Concern	High
Barn Swallow	Hirundo rustica	Migratory	Special Least Concern	Moderate
Short-beaked Echidna	Tachyglossus aculeatus	-	Special Least Concern	High

3.2 Community consultation

Kestrel is aware of, and responsible and accountable for its position as a local and regional community member. Consultation regarding operations, environmental performance, rehabilitation and closure is being, and will continue to be undertaken as part of community engagement activities, and in accordance with a stakeholder engagement plan (refer Appendix C).

The majority of Kestrel-owned land related to the mining tenements and not required for mining activities, are leased to a commercial pastoral company. With respect to land management practices and activities, the pastoral lessee is both a neighbour and a key stakeholder. Kestrel coordinates meetings as required with the current lessee to discuss mine plans and discuss land management actions as an ongoing part of property management.

Further, Kestrel seeks to maintain transparency regarding its mining operations and land management activities with all neighbours. Kestrel hosts an annual meeting with neighbours, that includes the offer of a field inspection across the relevant MLs, with an open invitation to all neighbours to discuss any matters relating to mine operations. Any matters that are raised by neighbours and/or the local community are recorded and responded to in accordance with Kestrel's external obligations and stakeholder management processes.

3.2.1 Community consultation

Community and stakeholder consultation regarding rehabilitation and closure planning has been undertaken by Kestrel Coal as well as by previous owners of Kestrel. Consultation processes have included the following:

- legislated consultation processes undertaken for each of the approvals stages of Kestrel;
- information bulletins to near neighbours and stakeholders covering relevant news and operational changes;
- at various times and periods a community liaison group has operated with a wide-ranging brief including but not limited to sponsorships, community participation, rehabilitation, closure and related environmental aspects;
- one-on-one meetings on request; and
- near-neighbour site visits and information days which have typically occurred on an annual basis.

Identified stakeholders include:

- Traditional Owner groups;
- near neighbours;
- lessees (currently AACo. Previously NAPCO);
- Central Highlands Regional Council; and
- schools, and various local community organisations.

A Landowner Reference Group was established in 2015 and ran until about 2019; with the purpose of providing "a formal link between the neighbouring landowners and Kestrel, for open and cooperative communication on aspects of environmental management". The objective of these meetings was to provide a forum for:

- presentation of information on the mine operation and environmental management;
- updates on environmental monitoring data and learning;
- identifying and discussing issues of concern;
- providing constructive input as to how issues may be addressed;
- providing feedback on actions taken to address issues; and
- fostering a good working relationship between Kestrel and the neighbouring landowners.

Ongoing consultation will occur at key stages of the Project life and where any significant milestones are reached or changes in Project activities proposed. The stakeholder engagement framework (Appendix C) provides current and ongoing methods of communication to maintain contact with the local community throughout the life of the Project. These include, but are not limited to:

- information sessions, briefings, and meetings;
- operational and environmental newsletters/notices; and
- coordination of meetings between the liaison committee and relevant stakeholders as and when required.

Feedback from the consultation process will be entered into the consultation register, as it currently is. The relevant Project team member will review the feedback that has been entered into the consultation register for action and implementation of appropriate mitigation strategies where required. This process will ensure that mitigation strategies are developed for the potential adverse environmental and socioeconomic impacts that have been identified through consultation.

3.2.2 Stakeholder engagement plan

To meet the requirements of Section 126C(1)(c)(iv) of the EP Act, and the PRCP Guideline, Kestrel has developed a stakeholder engagement plan (SEP) that aims to build upon previous engagement activities (Appendix C). The SEP is intended to act as a framework to guide consultation and ensure stakeholders are provided the opportunity to engage on, among other things, rehabilitation and closure matters relating to the Project.

3.3 Post-mining land use

This section of the PRCP describes the PMLUs proposed for the Project in accordance with section 126C(1)(d) of the EP Act.

3.3.1 Land outcome documents

For this Project, Table G1 (Land capability) of the resource activity EA identifies various disturbance types, projected surface disturbance areas, as well as 'rehabilitation landform criteria' including a 'post-mine land use', post-mine land capability for grazing (see also Section 3.1.7.5), and an 'interim cover range' interpreted to mean ground vegetation cover. In the absence of other documents that might satisfy the definition of a land outcome document (LOD) as per section 750 of the EP Act, the EA (specifically Schedule G and Table G1), is considered to constitute the LOD for the Project. Table G1 of the EA is reproduced here as Table 9.

Table 9: EA, Table G1 (Land capability)

Disturbance type	Approx. projected surface area (ha)	Post-mine land use	Post-mine capability for grazing	Interim cover range (%)
Subsidence	3,616	Good Quality Agricultural Land	III	70
Co-disposal Facility (including Rejects Return Dam and brine evaporation ponds)	310	Grass community	VII	70
Industrial areas and roads	195.48	Good Quality Agricultural Land	III	70
Environmental Dam/ Holding Dam	27.3	Water Storage	VIII	N/A

In addition to the requirements of Table G1, condition G12 of the resource activity states:

> *All areas significantly disturbed by mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover in accordance with Table G1: Land capability.*

Further, in accordance with condition G13 of the resource EA:

> *Progressive rehabilitation of land, other than land subject to subsidence and co-disposal, must commence within eighteen (18) months of when areas are excluded from future mining developments.*

It should be noted that the areas shown in the column under the heading "Approx. projected surface area" are not representative of current existing or planned areas. It would appear that successive, approved EA amendments have not resulted in this table being updated to reflect the updated approved projected area. To ensure alignment of the PRCP with the actual approved projected surface area, an EA amendment is being progressed in parallel with this PRCP application. The corrected areas that are expected to be proposed in the EA amendment are presented in Table 10.

Table 10: Updated disturbance areas

Disturbance type	Approx. projected surface area (ha)	Updated areas (ha)[1]
Subsidence	3,616	7,150
Co-disposal Facility (including Rejects Return Dam and brine evaporation ponds)	310	310
Industrial areas and roads	195.48	441
Environmental Dam/ Holding Dam	27.3	28

1 – subject to change

3.3.2 Proposed post-mining land uses

While 'post-mine land uses' for the Project are listed in Table G1 of the EA, and are proposed to be transitioned into the PRCP, the terminology used pre-dates the introduction of the PRCP legislation and is not well defined. For the purposes of developing appropriate rehabilitation completion criteria, the PMLUs proposed are defined in the following sections.

Similarly, the completion criteria nominated in the EA require additional definition to conform with PRCP Guideline requirements. With respect to use of the land capability classification system, it is proposed that the post-mine capability classes identified in Table G1 of the EA be replaced with, as near as is practicable, equivalent land suitability classifications as milestone criteria - refer also Section 3.5.4.

The proposed PMLUs are discussed in the following sections, while milestone criteria are addressed at Section 3.5.4.

3.3.2.1 Good quality agricultural land (grazing) PMLU

'Good quality agricultural land' was a term used in the planning framework associated with the now repealed *State Planning Policy 1/92: Development and the Conservation of Agricultural Land*, and defined as:

> *land which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources.*

This definition includes pasture land which is suitable for improved or native pastures due to limitations which preclude continuous cultivation for crop production. Given the limited nature of the disturbance associated with the Project, the intent of mine rehabilitation is to retain the economic benefits realised pre-mining and to deliver a beneficial environmental outcome by reinstating, as far as practicable, lands having a

land suitability class similar to or equivalent to that existing pre-mining. Disturbed land will be returned to its pre-mining land use of grazing based on native and naturalised grasses and forbs.

Given that the EA terminology of 'good quality agricultural land' is more of a statement of resource rather than a description of use, it is proposed to amend the term to provide an indication of use. The terminology proposed is 'good quality agricultural land (grazing)' which best reflects the general land suitability of the area as well as the actual current use of the land.

The proposed PMLU of 'good quality agricultural land (grazing)' will be applicable to all disturbance types (introduced later as rehabilitation areas [RAs] – see Section 3.5.2) excluding the CDSF and retained water storages. For the majority of the Project area (and RAs), subsidence resulting from the progression of longwall mining constitutes the largest disturbance type if assessed by area. Impacts associated with subsidence include changes in elevation and slope, with potential for surface tensile cracking and changed drainage systems including ponding. Experience gained from longwall panel mining to date has demonstrated that there is a low risk of not achieving the proposed PMLU for subsidence areas.

In accordance with condition G15 of the EA, any disturbance of land identified as Bluegrass 'Of concern' Regional Ecosystem 11.8.11 will be remediated with the dominant species identified in baseline monitoring reports, including *Dicanthium setosum* and *D. queenslandicum* (Umwelt 2023). This aspect will be addressed by appropriate milestone criteria.

3.3.2.2 Grass community PMLU

The PMLU of 'grass community' is nominated within the Project EA as applicable for the rehabilitated CDSF (RA3). There is no further definition provided. The species list proposed is based on endemic native grasses, and exotic species where required for initial and longer term erosional stability.

3.3.2.3 Water storage (stock watering) PMLU

The EA nominates the existing Environmental Dam and Holding Dam as water storages to be retained at closure. To be compatible with the good quality agricultural land (grazing) PMLU, these storages will be required to meet stock water quality criteria (ANZECC & ARMCANZ 2000).

3.3.2.4 Retained infrastructure

Non-mine infrastructure is present within the Project MLs either as pre-existing agricultural infrastructure or established for use as part of current pastoral activities. Such infrastructure includes homesteads, sheds, yards, farm tracks, stock watering dams and other non-mine infrastructure and is not considered relevant to the PRCP.

In the event that mining related infrastructure is deemed to be compatible with the good quality agricultural land (grazing) PMLU, and an agreement is reached with the landholder that they will accept liability for that infrastructure, then there may be instances where mining related infrastructure is retained at closure. It is currently assumed that all mining infrastructure will be removed at closure.

3.3.2.5 Planning scheme conformance

The 'Central Highlands Regional Planning Scheme' (Central Highlands Regional Council 2016) identified the Project area as being within the Rural zone. The purpose of the Rural zone is to:

a) *provide for rural uses including cropping, intensive horticulture, intensive animal industries, animal husbandry, animal keeping and other primary production activities;*

b) *provide opportunities for non-rural uses that are compatible with agriculture, the environmental features, and landscape character of the rural area where the uses do not compromise the long-term use of the land for rural purposes; and*

c) protect or manage significant natural resources and processes to maintain the capacity for primary production.

The Rural zone accommodates a wide range of rural uses, including animal husbandry (which includes grazing of livestock), cropping, aquiculture and permanent plantations. The PMLUs proposed are consistent with the regional planning scheme.

3.3.2.6 Post-mining land use outcomes

The proposed PMLUs are consistent with the expectations of the community (see Section 3.2.1), the local planning scheme and the pre-mining land use.

The proposed PMLUs are indicated in Figure 23.

3.4 Non-use management areas

No non-use management areas are proposed for this Project.

3.5 Rehabilitation management methodology

3.5.1 Rehabilitation objectives

In Queensland, mine rehabilitation is required under the EP Act. Amendments to the EP Act in late 2018 implemented key elements of the State Government's Mined Land Rehabilitation Policy (Queensland Government 2018) which intends to ensure that, for land disturbed by mining activities:

- the land is safe and structurally stable;
- there is no environmental harm being caused by anything on or in the land; and
- the land can sustain a post-mining land use (section 111A of the EP Act).

These three objectives are the general rehabilitation goals for all areas disturbed by mining in Queensland.

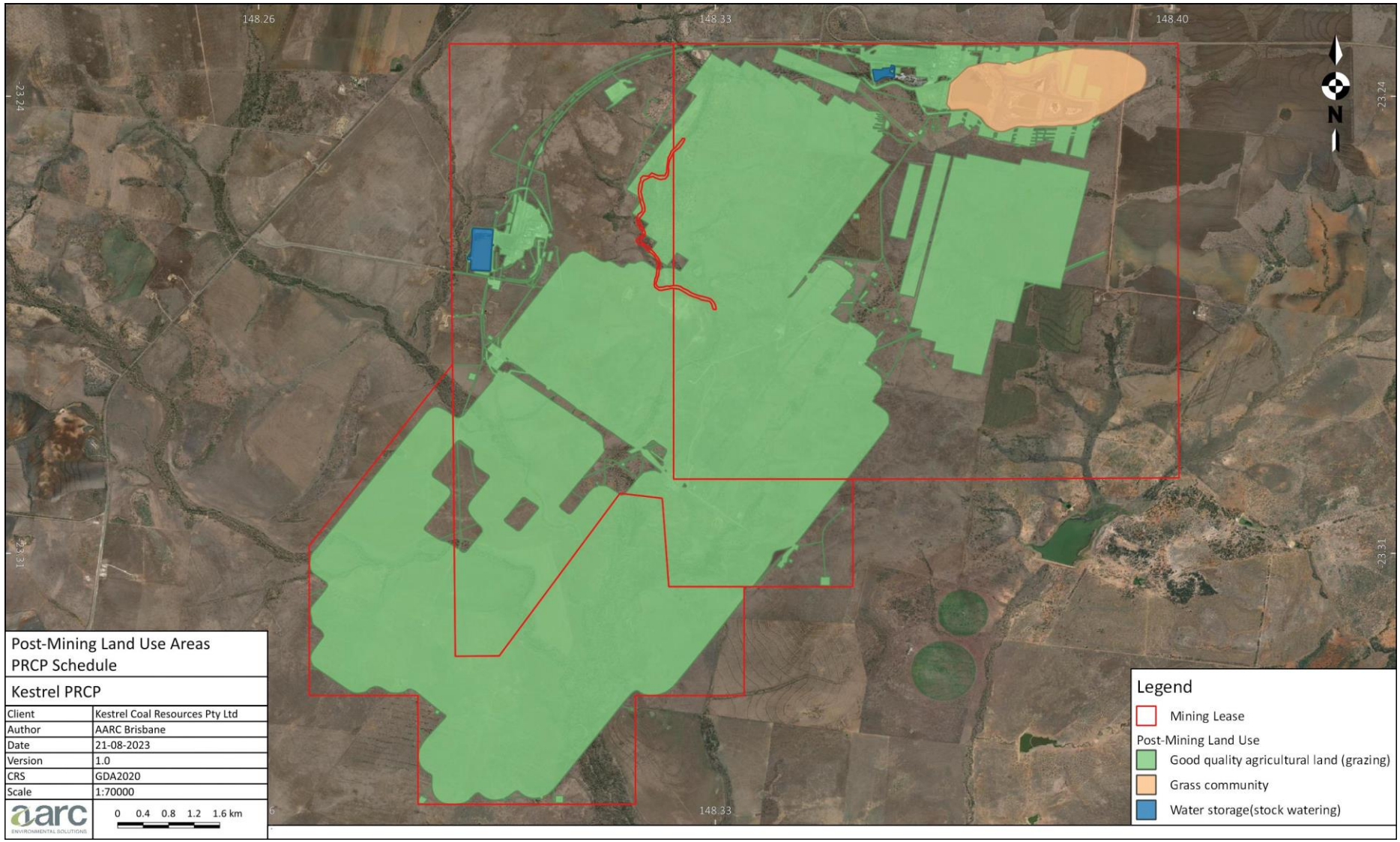


Figure 23: Post-mining land uses

3.5.2 Rehabilitation areas

To facilitate the development of a PRCP schedule that satisfies the requirements of the PRCP Guideline, discrete rehabilitation areas (RAs) have been defined for the Project. An RA is defined in the EP Regulation as an area of land in the PMLU to which a rehabilitation milestone for the post-mining use relates. RAs have been nominated for areas of disturbance within the Project with consideration of the proposed rehabilitation management methodology and the proposed PMLU. RAs are listed in Table 11 and shown in Figure 24.

It should be noted that, as advised by DES, the area of certified rehabilitation over the longwall panel 200 series (570.7 ha) is not included as either a defined RA or within the PRCP schedule.

There is also a significant area of the 100 series panels that is overlain by the CDSF footprint. In this circumstance, the rehabilitation requirements of the CDSF disturbance take precedence over any disturbance associated with the 100 series longwall mining.

Table 11: Nominated rehabilitation areas

Rehabilitation Area reference	Description	Area (ha)	PMLU
RA1	MIA outside of subsidence zones (incl. roads and access tracks, CHPP, product and ROM stockpile areas, buildings, offices)	440.6	Good quality agricultural land (grazing)
RA2	CDSF (including Rejects Return Dam and brine dam evaporation ponds)	310.7	Grass community
RA3	Water management infrastructure (retained dams) Environmental Dam & Holding Dam	28.2	Water storage (stock watering)
RA4	Water management infrastructure (retained creek diversion)	10.8	Good quality agricultural land (grazing)
RA5	Water storages (not retained)	4.5	Good quality agricultural land (grazing)
RA6	Subsided land–riparian (excluding MIA)	510.2	Good quality agricultural land (grazing)
RA7	Subsided land–pasture (excluding MIA but including non-certified rehabilitation areas)	5,630.6	Good quality agricultural land (grazing)

3.5.3 Rehabilitation milestones

The nominated rehabilitation milestones (RMs) and their applicability to the various rehabilitation areas are outlined in Table 12 and described in detail in Sections 3.5.9 through 3.5.13. It should be noted that not all RMs are applicable to all rehabilitation areas.

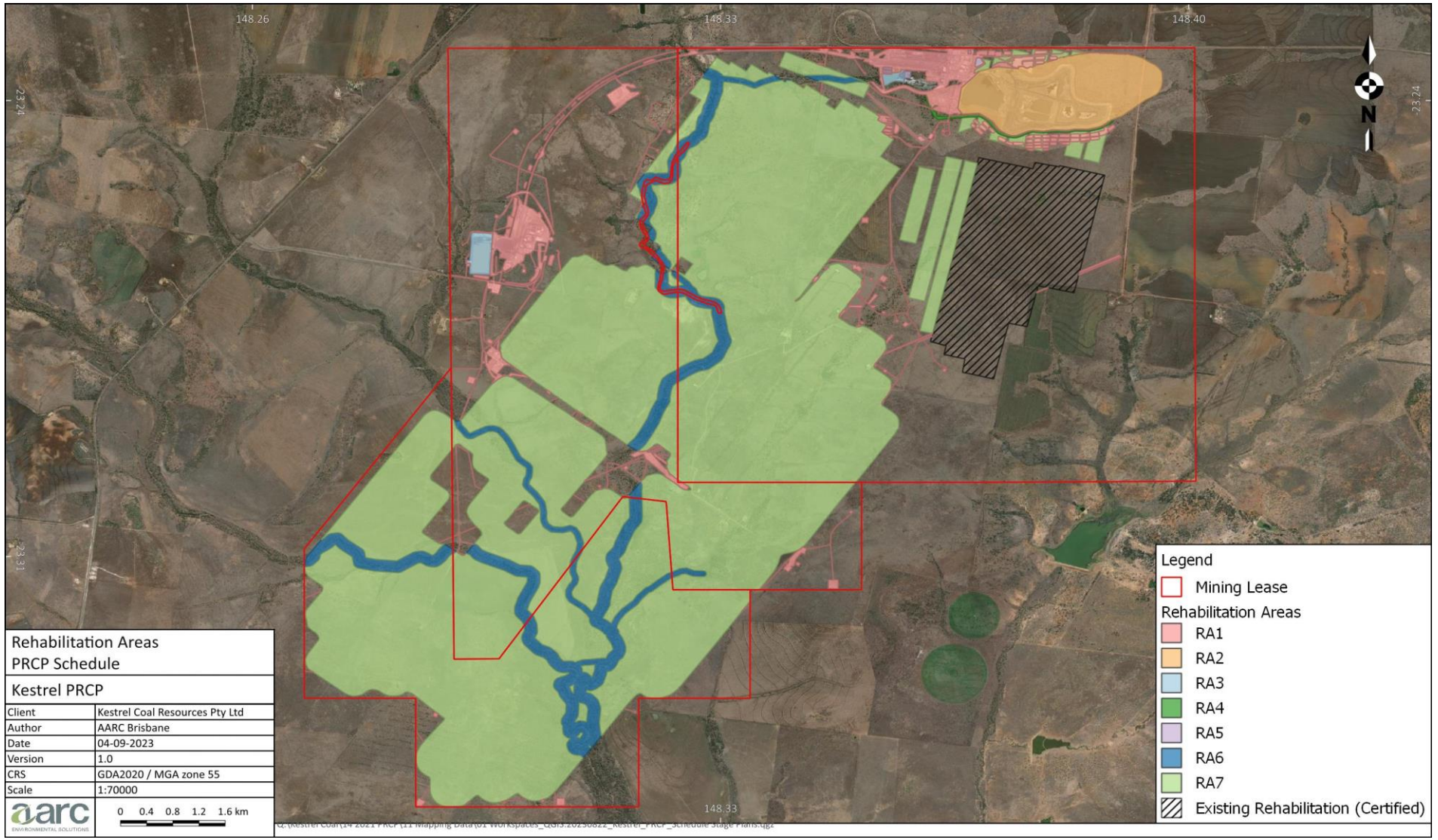


Figure 24: Rehabilitation areas

Table 12: Milestones and their applicability to rehabilitation areas

Milestone reference	Description	Applicability						
		RA1	RA2	RA3	RA4	RA5	RA6	RA7
RM1	Infrastructure decommissioning and removal	✓	✓	✓	✓	✓		✓
RM2	Determination/ management of contaminated land status	✓	✓	✓		✓		
RM3	Landform development (reshaping, reprofiling, topdressing, contour ripping/discing, soil amelioration) of good quality agricultural land (terrestrial)	✓	✓	✓	✓	✓		✓
RM4	Landform development (reshaping, reprofiling, topdressing, contour ripping/discing, soil amelioration) of good quality agricultural land (riparian zones)						✓	
RM5	Capping installation		✓					
RM6	Revegetation	✓	✓	✓	✓	✓	✓	✓
RM7	Achievement of surface stability (good quality agricultural land PMLU - terrestrial)	✓		✓	✓	✓		✓
RM8	Achievement of surface stability (grass community PMLU)		✓					
RM9	Achievement of surface stability (good quality agricultural land - riparian zones)						✓	

Milestone reference	Description	Applicability						
		RA1	RA2	RA3	RA4	RA5	RA6	RA7
RM10	Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land PMLU - terrestrial)	✓				✓		✓
RM11	Achievement of target post-mining land use to safe and sustainable condition (grass community PMLU)		✓					
RM12	Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land PMLU - riparian zones)						✓	
RM13	Achievement of target post-mining land use to safe and sustainable condition (retained water storage)			✓				
RM14	Achievement of target post-mining land use to safe and sustainable condition (permanent creek diversion)				✓			

3.5.4 Milestone criteria

Critical to assessing the success of rehabilitation and improvement is the definition of milestone criteria. In accordance with the PRCP Guideline, milestone criteria are used to demonstrate the completion of a specific milestone and should be appropriate for achieving the milestone and facilitate achieving subsequent RMs. Milestone criteria are preferably specific, measurable, achievable, realistic and timely. The final milestone criteria should:

- be outcome-based (linked to the end land use);
- be flexible to adapt to changing circumstances;
- be able to evolve as the mine life progresses;
- include metrics suitable to demonstrate that rehabilitation is trending positively;
- undergo periodic review; and
- include a measurement approach that details how the criterion will have been met (CoA 2016, ANZMEC & MCA 2000).

Milestone criteria have been identified for the Project that provide a clear definition of milestone completion and successful rehabilitation for each rehabilitation area. The milestone criteria demonstrate the completion of progressive rehabilitation steps and events. Completion criteria for each RA will be used as the milestone criteria for the final milestone in the proposed schedule, and will demonstrate achievement of the PMLU to a stable condition at surrender.

The nominated rehabilitation milestone criteria are provided in Table 13.

Table 13: Rehabilitation Milestone criteria

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM1	Infrastructure decommissioning and removal	RA1 RA2 RA3 RA4 RA5 RA7	• All non-required services disconnected and removed • All concrete, bitumen and gravel roads removed (where not retained) to a depth of 1 m. • All operational pipelines drained and removed • All boreholes capped and buried (including gas drainage infrastructure, drill pads) • All fencing that is not compatible with PMLU requirements removed • All non-retained buildings demolished and/or removed • Underground drifts and portals sealed and reprofiled to ground level • All machinery and equipment decommissioned and removed • All surface water drainage infrastructure that is not retained in the final landform removed • All rubbish removed
RM2	Determination/ management of contaminated land status	RA1 RA2 RA3 RA5	• Contaminated land assessment undertaken by an appropriately qualified person. If required, a site investigation report including a site suitability statement/ management plan (as required) prepared and submitted in accordance with the provisions of Chapter 7, Part 8 of the EP Act; • Contaminated material either: o remediated in situ; o removed/transported to an approved landfill for disposal and waste tracking information recorded and submitted; or o retained and managed under a site management plan (e.g. tailings)

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM3	Landform development (reshaping, reprofiling, topdressing, seed bed preparation, soil amelioration) of good quality agricultural land (terrestrial)	RA1 RA2 RA3 RA4 RA5 RA7	• All landform works completed to design specifications (applicable to RA4) • Landform constructed with outer slope angles up to 1(V) in 10(H) (10°) or 1(V) in 6(H) for existing slopes (southern end) applicable to RA2 only): • Reinstatement of drainage lines to design specifications and certified by and appropriately qualified person • Regrading of tracks not being retained • Instances of ponding assessed for retention or where mitigation is required, drainage and landform works completed to design (applicable to 500 series footprint of RA7) • Contour banks removed/regraded from land affected by subsidence (applicable to RA7) • Geotechnical assessment by an appropriately qualified person confirming that long-term geotechnical stability has been achieved for each relevant landform (applicable to RA2) • Prior to each rehabilitation event, soil health and suitability are assessed and documented by an appropriately qualified person, and a recommendation made for ameliorants to ensure sodicity, salinity, pH and fertility levels are suitable to achieve the relevant post-mining land use (applicable to RA1) • Records of ameliorants applied and incorporated into surface, as recommended by an appropriately qualified person (excluding RA3) • Topsoil placement to a minimum depth of 0.3 m (excluding RA3) • Preparation of a cultivated seed bed suitable for revegetation (excluding RA3)
RM4	Landform development (reshaping, reprofiling, topdressing, seed bed preparation, soil amelioration) of good quality agricultural land (riparian zones)	RA6	• Stream condition survey undertaken by appropriately qualified person, and a recommendation made for a rehabilitation strategy to support stabilisation of beds and banks adversely affected by subsidence • Implementation of the recommended rehabilitation strategy and records maintained to demonstrate implementation

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM5	Capping installation	RA2	• Installation of surface capping layer(s) in accordance with engineering design specification: o clay cover placement over co-disposed materials (0.5 m); and o placement of rock mulch (1 m) o topsoil (minimum 0.3 m) • Installation of drainage infrastructure on the CDSF as per the engineering design specification. • Topsoil health and suitability assessed and documented by an appropriately qualified person, and a recommendation made for ameliorants to ensure sodicity, salinity, pH and fertility levels are suitable to achieve the relevant post-mining land use, including: o pH; o electrical conductivity; and o major ions
RM6	Revegetation	RA1 RA2 RA3 RA4 RA5 RA6 RA7	• Completed seeding using a minimum of three of the species listed in Table 21 • Where disturbance of land identified as Bluegrass 'Of concern' Regional Ecosystem 11.8.11 occurs, revegetation species must include *Dicanthium setosum* and *D. queenslandicum* • Minimum seeding rate of 10 kg/ha • Records demonstrating species used, seeding rates, area sown, germination certificate, and seed origin
RM7	Achievement of surface stability (good quality agricultural land PMLU - terrestrial)	RA1 RA3 RA4 RA5 RA7	• Total percentage of ground cover (i.e. ground foliage cover, woody debris, organic litter and rock) is ≥70% • Dominant pasture species identified in representative analogue sites are present • No active erosion present as demonstrated by no increase in erosion classification[1] over 3 consecutive years

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM8	Achievement of surface stability (grass community PMLU)	RA2	• Total percentage of ground cover (i.e. ground foliage cover, woody debris, organic litter and rock) is ≥70% • No erosion classified[1] as 'severe' or 'extreme' • No active erosion present as demonstrated by no increase in erosion ratings over time • Assessed as geotechnically stable by an appropriately qualified person • No evidence of surface water ponding or settlement • Installation of rock armouring in drainage lines has been completed to design specifications
RM9	Achievement of surface stability (good quality agricultural land - riparian zones)	RA6	• Creek beds and banks are trending towards a geomorphologically stable condition, demonstrated by evidence from stream condition surveys undertaken by an appropriately qualified person • Downstream water quality is not significantly different to up steam water quality • Creek beds and banks have no: ○ No erosion classified[1] as 'severe' or 'extreme' ○ No active erosion present as demonstrated by no increase in erosion ratings over time
RM10	Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land PMLU - terrestrial)	RA1 RA5 RA7	• Rehabilitation polygons have a median fractional vegetation cover greater than the first quartile of reference polygons for at least 85% of all sample times, as determined using the satellite-derived fractional vegetation cover method • Certification by an appropriately qualified person that the land suitability class for rehabilitated areas are re-instated to the pre-mining land suitability class. • Groundwater quality is equivalent to baseline data in accordance with: ○ EA Table J2 (Groundwater contaminant trigger levels) • No prohibited invasive or restricted invasive plants, and weed cover is ≤5% (excluding exotic pasture grasses). Weed abundance is no greater than at representative analogue sites
RM11	Achievement of target post-mining land use to safe and sustainable condition (grass community PMLU)	RA2	• Groundwater monitoring program confirms no environmental harm from migration of contaminants of concern, including: o sulphate; o total dissolved solids; and o metals • Installation of appropriate monitoring equipment to determine the performance of the adopted cover system • Infiltration rates and net flux are no greater than the defined performance objectives: o Less than 10% of total rainfall depth reports as net infiltration per year o The number of days with infiltration exceeding 100 mm/day is less than 10 days per year • No prohibited invasive or restricted invasive plants, and weed cover is ≤5% (excluding exotic pasture grasses) • Hazard and Safety Assessment completed by an appropriately qualified person assesses hazards to be low risk with no significant increase in risk expected over time

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM12	Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land PMLU - riparian zones)	RA6	• Evidence of woody tree species recruitment (individuals with <5cm diameter at breast height), for the dominant species present at the time of monitoring • Creek beds and banks demonstrate a similar geomorphologically stable condition to upstream and downstream sections of the creek as determined by an appropriately qualified person • No prohibited invasive or restricted invasive plants, and weed cover is ≤5% (excluding exotic pasture grasses). Weed abundance is no greater than at representative analogue sites. • Hazard and Safety Assessment completed by an appropriately qualified person demonstrates hazards in rehabilitation areas are consistent with the type and severity of hazards typical of the adjacent equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time
RM13	Achievement of target post-mining land use to safe and sustainable condition (retained water storage)	RA3	• All retained water storages assessed as safe and stable by an appropriately qualified person • Retained storage water quality parameters are below the 'low risk' trigger values for livestock drinking water defined in *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000)

RM14	Achievement of target post-mining land use to safe and sustainable condition (permanent creek diversion)	RA4	• Rehabilitation polygons have a median fractional vegetation cover greater than the first quartile of reference polygons for at least 85% of all sample times, as determined using the satellite-derived fractional vegetation cover method
			• No prohibited invasive or restricted invasive plants, and weed cover is ≤5% (excluding exotic pasture grasses). Weed abundance is no greater than at representative analogue sites.
			• Downstream water quality is not significantly different to up steam water quality
			• Diversion bed and banks demonstrate a geomorphologically stable condition as determined by an appropriately qualified person
			• Diversion bed and banks have:
			  ○ No erosion classified[1] as 'severe' nor 'extreme' gully erosion or washout features
			  ○ No active erosion present as demonstrated by no increase in erosion ratings over 3 consecutive years

1. Erosion classification framework:

Erosion classification	**Minor**	**Moderate**	**Severe**	**Extreme**
Sheet erosion	Shallow soil deposits downslope	Partial exposure of roots; moderate soil deposits downslope, etc.	Loss of surface horizons; root exposure, etc.	Loss of surface horizons; root exposure, etc.
No. of rills/ gullies	< 15	15 - 30	31 - 50	> 50
Greatest observed depth (cm)	<10	10 - 30	30 - 60	>60
Tunnel erosion	-	-	Present	Present
Mass movement	-	-	Present	Present

3.5.5 Rehabilitation timeframes

Rehabilitation milestones are required to be achieved as soon as practicable after land becomes available for rehabilitation. Land is considered to become available for rehabilitation at the completion of mining, except where land is being used for operating infrastructure or topsoil stockpiles, or is identified as being retained infrastructure post-closure.

Rehabilitation milestone timeframes have been developed with consideration for the size of the rehabilitation area, the activities applicable to the milestone and interim rehabilitation activities that are scheduled to occur or anticipated to be required prior to the area becoming available for rehabilitation. Milestones that involve revegetation activities, including monitoring of revegetation, make provision for unfavourable growing seasons and unforeseen extreme events such as droughts or storms that could negatively impact vegetation establishment; requiring longer timeframes for the milestone to be achieved.

The nominated rehabilitation timeframes considered for scheduling the RMs are shown in Table 14.

3.5.6 General rehabilitation practice

The rehabilitation practices used at any mining site inevitably evolve as a result of increasing knowledge gained from experience in the following areas:

- early rehabilitation successes and failures;
- weather, subsoils, soils, local flora and fauna and revegetation species; and
- site preparation, seeding practices, the maintenance and repair of previously rehabilitated areas and/or local agricultural practices.

For this reason, the rehabilitation practices outlined in the following subsections should not be interpreted as the precise method that will be used from this point on, but rather as a record of the current rehabilitation knowledge and intent at the time of writing; and with the expectation that rehabilitation practices will further evolve and develop from this point on. A record of the existing rehabilitation efforts at site is provided at Section 3.1.2.

While rehabilitation objectives, performance indicators and milestone criteria for the Project are detailed at Sections 3.5.1 and 3.5.4, from the perspective of operational rehabilitation planning and practice, the following overarching principles are considered key:

- Ensuring that areas to be rehabilitated meet the rehabilitation design specification for the area, and that local site drainage has been considered and erosion and sediment control measures are properly implemented.
- Topdressing materials, final surface preparation methods and any required soil amelioration activities have the objective of supporting vegetative growth.
- Revegetation species selection, seeding and/or planting methods, and fertiliser applications target rapid vegetative ground cover effective at mitigating soil erosion, during the period of initial revegetation when areas are most at risk.
- Ongoing monitoring and maintenance are used both to assess rehabilitated area performance against completion criteria as well as to feedback to, and update rehabilitation practices; and to identify maintenance or modification requirements such that rehabilitation areas are proceeding along a trajectory towards the designated PMLU.

Table 14: Proposed timeframes for RMs associated with each RA

Rehabilitation Area (RA)	Rehabilitation Milestones (RM)	Summary rehabilitation methodology	Associated risks	Risk level assigned	Proposed timeframe (years)	Justification for assigned timeframe
RA1 RA2 RA3 RA4 RA5 RA7	RM1: Infrastructure decommissioning and removal	• Infrastructure decommissioning and disposal	• Few environmental impact risks associated with infrastructure decommissioning	Low	2	Mine infrastructure will be required approximately 1 year post-mining to facilitate ROM processing once underground mining is completed. Decommissioning activities are considered low risk and expected to take approximately 1 year. However, given the significant extent of infrastructure in the MIA (RA1), 2 years has been allowed for decommissioning and removal.
RA1 RA2 RA3 RA5	RM2: Determination/ management of contaminated land status	• Remediation or removal of contaminated material (where applicable) • Determination of contaminated land status by appropriately qualified person	• Contaminated land • Surface water impacts • Groundwater impacts	Low	1	Timeframe allows for contaminated land assessment to be undertaken and contaminated material to be either remediated or removed. A contaminated land assessment will be undertaken by an appropriately qualified person. If contaminated land is identified, remediation works will be undertaken promptly. Given the moderate risk classification associated with this activity, the timeframe assigned is 1 year.

Rehabilitation Area (RA)	Rehabilitation Milestones (RM)	Summary rehabilitation methodology	Associated risks	Risk level assigned	Proposed timeframe (years)	Justification for assigned timeframe
RA1 RA2 RA3 RA4 RA5 RA7	RM3: Landform development (reshaping, reprofiling, topdressing, seedbed preparation [tilling/discing etc.], soil amelioration)) of good quality agricultural land (non-riparian)	• Installation of drainage features • Minor earthworks reshaping and reprofiling • Geotechnical assessment of stability (RA2 only)	• Surface cracking • Erosion • Increased slope steepness • Subsidence impacts • Surface roughness in excess of that expected for the PMLU	Low	2	Given that the size of areas becoming available at any point in time is highly variable and the need to coordinate works with climatic seasons, the timeframe assigned is 2 years. Landform development activities are expected to only be required across a limited proportion of the area affected by subsidence. Monitoring will identify areas that require landform development as well as any areas that require interim rehabilitation prior to land becoming available. Areas affected by subsidence not expected to require significant surface preparation. Project site has fertile soils, therefore soil amelioration is generally not expected to be required. Timeframe of 2 years should be sufficient to complete RM2.
RA6	RM4: Landform development (reshaping, reprofiling, topdressing, seedbed preparation [tilling/discing etc.], soil amelioration) of good quality agricultural land (riparian zones)	• Installation of drainage features • Earthworks reshaping and reprofiling	• Surface cracking • Erosion • Increased slope steepness • Subsidence impacts • Surface roughness in excess of that expected for the PMLU	Moderate	2	Landform development activities are expected to be required across only a limited proportion of the riparian area affected by subsidence. Monitoring will identify areas that require landform development as well as any areas that require interim rehabilitation prior to land becoming available. Timeframe of 2 years should be sufficient to complete RM3.
RA2	RM5: Capping installation	• Geotechnical assessment by an appropriately qualified person • Landform constructed to design parameters	• Erosion • Localised settlement • Contaminants impacting environment • Insufficient topsoil resources	Moderate	1	Installation of capping material on CDSF area only not expected to take more than 12 months

Rehabilitation Area (RA)	Rehabilitation Milestones (RM)	Summary rehabilitation methodology	Associated risks	Risk level assigned	Proposed timeframe (years)	Justification for assigned timeframe
RA1 RA2 RA3 RA4 RA5 RA6 RA7	RM6: Revegetation	• Revegetation with seed species consistent with the PMLU	• Erosion • Insufficient density/diversity of vegetation	Low	1	Revegetation (seeding/planting) will likely be undertaken at the same time or closely following surface preparation. 12 months allows for vegetation establishment and infill seeding if failures are identified through monitoring.
RA1 RA3 RA4 RA5 RA7	RM7: Achievement of surface stability (good quality agricultural land PMLU – non-riparian)	• Vegetation monitoring and maintenance as required • Erosion monitoring	• Pests and weeds • Erosion • Vegetation failure (e.g. disease, drought)	Low	3	Slope gradients are low for all areas. 3 years allows time for sufficient ground cover to be achieved such that erosion is minimised. Note: Interim milestone to assess that rehabilitation area is on a trajectory to achieve final RM completion criteria.
RA2	RM8: Achievement of surface stability (grass community PMLU)	• Vegetation monitoring and maintenance as required • Erosion monitoring	• Pests and weeds • Erosion • Vegetation failure (e.g. disease, drought)	Moderate	3	3 years allows time for sufficient ground cover to be achieved such that erosion is minimised. Note: Interim milestone to assess that rehabilitation area is on a trajectory to achieve final RM completion criteria.

Rehabilitation Area (RA)	Rehabilitation Milestones (RM)	Summary rehabilitation methodology	Associated risks	Risk level assigned	Proposed timeframe (years)	Justification for assigned timeframe
RA6	RM9: Achievement of surface stability (good quality agricultural land - riparian zones)	• Vegetation monitoring and maintenance as required • Erosion monitoring	• Pests and weeds • Erosion • Vegetation failure (e.g. disease, drought)	Moderate	5	Timeframe should allow for vegetation establishment and stream bank and bed erosion to begin to stabilise through natural processes, revegetation and other controls (e.g. rock armouring, stock exclusion etc.). Note: this is an interim milestone to assess that rehabilitation area is on a trajectory to achieve final RM completion criteria.
RA1 RA5 RA7	RM10: Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land [grazing] PMLU – non-riparian)	• Vegetation structure is consistent with analogue sites	• Insufficient density/diversity of vegetation	Moderate	5	Timeframe allows time for vegetation establishment, evidence of recruitment and final assessments/certification to be completed.
RA2	RM11: Achievement of target post-mining land use to safe and sustainable condition (grass community PMLU)	• Vegetation structure is consistent with analogue sites	• Insufficient density/diversity of vegetation	Moderate	5	Timeframe allows time for vegetation establishment, evidence of recruitment and final assessments/certification to be completed.
RA6	RM12: Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land PMLU – riparian zones)	• Vegetation structure is consistent with analogue sites	• Insufficient density/diversity of vegetation • Insufficient recruitment	High	10	Timeframe should allow for creek bank and bed erosion to trend towards stable condition and not require further active rehabilitation controls (including stock exclusion).

Rehabilitation Area (RA)	Rehabilitation Milestones (RM)	Summary rehabilitation methodology	Associated risks	Risk level assigned	Proposed timeframe (years)	Justification for assigned timeframe
RA3	RM13: Achievement of target post-mining land use to safe and sustainable condition (retained water storage)	• Safety and geotechnical assessments	• Erosion • Pests and weeds	Moderate	5	Timeframe allows for any unexpected instances of poor water quality to be addressed
RA4	RM14: Achievement of target post-mining land use to safe and sustainable condition (permanent creek diversion)	• Vegetation structure is consistent with analogue sites • Safety and geotechnical assessments	• Insufficient density/diversity of vegetation • Insufficient recruitment • Erosion • Pests and weeds	Moderate	15	Monitoring diversion stability and revegetation success for a period of at least 20 years to confirm revegetation objectives have been achieved prior to decommissioning of the mine. The 20-year timeframe allocated to monitoring of the diversion includes the 15 year time frame allocated here and the timeframe for RM10 (5 years).

The development of rehabilitation methodologies at Kestrel is in response to the following potential land disturbance types:

- surface subsidence arising from underground longwall panel progression;
- ground disturbance associated with fixed surface infrastructure development and operation; and
- ground disturbance associated with infrastructure required to support underground mining operations (typically gas drainage boreholes, pipelines and access tracks).

3.5.6.1 Flooding and surface water impacts

Available flood studies (DoR 2022a) indicate only localised flooding associated with the watercourses crossing the Project MLs. Belcong Creek services the largest upstream catchment and therefore presents the widest potential floodplain crossing the MLs. The confluence of Belcong, Crinum and Homestead Creeks, and Liskeard Gully, which occurs on ML 70481 results in a localised floodplain area with a width of up to approximately 3 km across at its widest point.

There are no voids associated with mining operations at Kestrel, and surface infrastructure is located away from any localised floodplains.

Predicted impacts to surface water relate to the effects of subsidence on both watercourses and pastoral areas. Surface water assessments have been undertaken by Gilbert & Associates in 2002, 2006 and 2012 to assess the impacts of subsidence on watercourses flowing across the Project site. These studies have identified the following potential impacts:

- redirection of overland flows;
- changes to flood prone areas in the floodplains of major drainages;
- changes to end stream and floodplain water holes in the major drainages; and
- effects on the sediment transport regime and geomorphic stability of the major drainages.

The effects of subsidence on the flood inundation area above the 400 series panels has been determined to be minor, with an increase in inundation area of the western bank of Crinum Creek at the northern end of the 400 series panels and a corresponding increase in raised areas (i.e. islands) adjacent (Gilbert & Associates 2006).

While there have since been changes to the 500 series panel layout, the 2012 modelled flood inundation work (Gilbert & Associates 2012) is still considered sufficiently representative of likely outcomes. This assessment shows increased inundation in all the longwall panel footprints intersected by watercourses and the formation of a series of semi-regularly spaced embayments at the edges of the floodplain with reduced inundation at pillar locations. A more recent simplified assessment of ponded areas has been undertaken utilising the most recent subsidence prediction dataset to identify closed contours signifying depressions within the 500 series panels.

Ponding instances that have occurred within the 300 series and 400 series panel footprints have been retained as part of the landform and constitute shallow stock watering points with fringing vegetation developing, and are generally considered to be complementary to the grazing land use.

Rehabilitation and management of ponded areas is discussed at Section 3.5.13.

3.5.6.2 Soil and capping material balance

The Project site has highly fertile soils, therefore fertiliser is not expected to be required for general rehabilitation activities. If low fertility is identified during the planning phase of rehabilitation or if initial revegetation fails, fertiliser will be applied as required to support the target vegetation.

Topsoil resources are shown in Table 15 and are generally reserved for rehabilitation works at closure (e.g. the CDSF, mine infrastructure areas and water storage infrastructure). The estimated volume of material

required for rehabilitation of the landform is presented in Table 16. The location of stockpiled topsoil is shown in Figure 25. The CDSF capping materials balance assessment is summarised at Table 17.

Table 15: Topsoil available for rehabilitation

Location (topsoil polygon ID)	**Volume of material available (m^3)**
ML 70301 and ML 70481: TS-35 to TS-63; TS-71 to TS-75	729,300
ML 1978 TS-1 to TS-34; TS-101 to TS-155; TS-64 to TS-70	831,855
Topsoil available from undisturbed CDSF footprint	429,000
Total material volume	1,990,155

Table 16: Topsoil required for rehabilitation

Rehabilitation area	**Volume of material required (m^3)**
CDSF	848,000
Mine infrastructure areas (incl. water storages)	558,000
Total material volume	1,406,000

CDSF capping materials

The provisional construction quantities and materials for the final landform of the CDSF were assessed by ATC Williams (ATCW) and are presented in Table 17. The materials selected are based on the cover system adopted for the final landform design (refer Section 3.5.11.2). The quantity provisions are based on a 265 ha footprint of waste.

Materials are expected to be available from the borrow areas to the south of the CDSF. It is likely that additional materials are available if material can be ripped with a suitable dozer and if the borrow area extends further south. The material volumes available from the borrow areas are presented in Table 18.

Investigation of the borrow area was undertaken prior to development of the final landform and capping system. The estimates for the material availability was based on test pitting investigations and it is considered likely that the additional materials are available. The borrow area investigations also focused on areas within 1 km of the CDSF such that and any shortfalls in materials could be accounted for with expansion of the borrow area to the south. Inferred permeability of materials was assessed based on Atterberg limits and particle size distribution. When considering the achievement of low permeability conditions of the cover, a reasonable volume of weathered basalt would be suitable for use to construct the RPL. Further work is anticipated to determine the location of suitable materials.

Table 17: CDSF capping materials required (ATCW 2023b)

Description	Unit	Depth (m)	Quantity
Reprofiling of the waste to provide uniform continuous surface without sudden change in direction or gradient	m^2	-	2,650,000
Compact co-disposal surface to form competent surface. Removal of soft, compressible layers and replacement with suitable material	m^3	1.0	2,650,000
Source, moisture condition, place, compact RPL	m^3	0.3	795,000
Source, moisture condition, place, compact Rocky Mulch	m^3	0.8	2,120,000
Final (top) 0.4 m to comprise rocky mulch and topsoil mix, assuming 0.8:0.2 ratio of topsoil/rocky mulch	m^3	0.4	1,060,000
Place separation geotextile in extents for rock armouring of batter drains, feeder drains and the central drain	m^2	-	95,000**
Place D_{50} of 150 mm rockfill in drain extents including batter drains, feeder drains and central drain*	m^3	0.3	30,000
Place separation geotextile in extents for chutes	m^2		2,000**
Place D_{50} of 300mmm rockfill in extents for chutes*	m^3	0.6	1,100

Notes:
All quantities in BCM. No bulking factors have been included.
*Rock sizing to be determined during detailed design. Quantities uses on 2 x D50 rock size (150 mm) for all drains and D50 of 300 mm for chutes based on similar project experience.
**10% contingency included for wastage.

Table 18: Material available from the borrow areas (ATCW 2023b)

Material	Description	Volume available (m^3)	Volume required (m^3)
Rocky mulch	Basalt at various stages of weathering	3,000,000*	3,120,000
Reduced permeability layer	Extremely to highly weathered basalt, selectively sourced from the borrow area, which can be compacted to achieve low permeability fill	See discussion below	795,000
Topsoil	Topsoil from various stockpiles on site	1,990,155	848,000
Rock	Rockfill in drain extents including batter drains, feeder drains and central drain	To be imported from local quarry	To be determined during detailed design phase

*the material available for the rocky mulch are expected to be higher than recorded with expansion of the borrow pit area

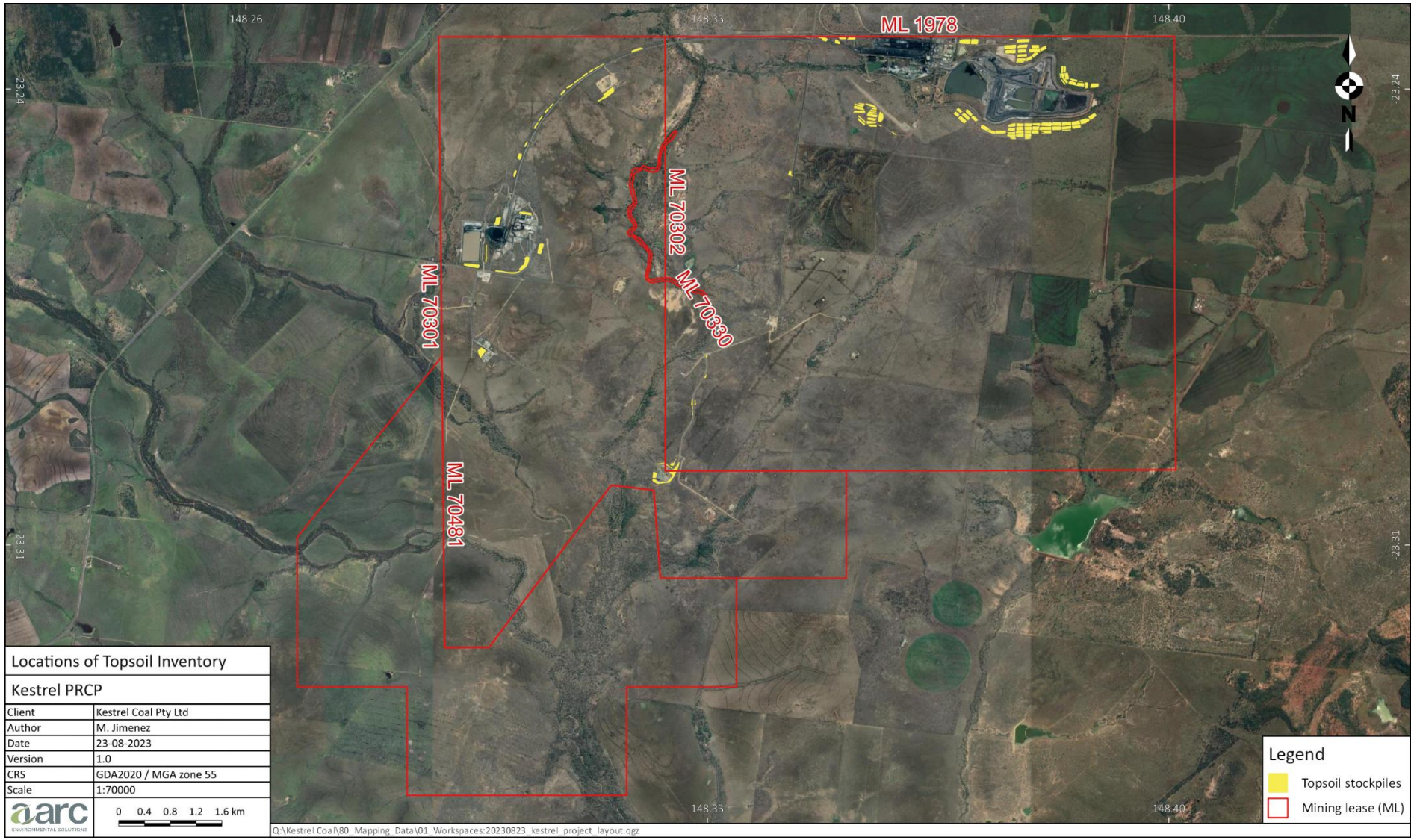


Figure 25: Locations of topsoil inventory

3.5.6.3 Waste characterisation and cover design

Spoil extracted from portal areas

There is a relatively small volume of waste rock that originated from development of the Kestrel South portals and drifts. This material has been determined to be primarily non-acid forming (NAF); however, there is interspersed a portion of potentially acid forming (PAF) material. The PAF materials are primarily associated with the coal seam units (1–8 m) above and below the coal seams, however, they can also occur as discrete interburden units. The portal was constructed with Tertiary material which was predicted to be NAF, while the shaft and drift spoils from Permian horizons will be a mixture of PAF and NAF. Total sulphur (S) ranged from below detection (<0.01%S) to 12%S, of which 15% of samples had S values greater than 1%S. The median S value was 0.3%S.

Kinetic testing of samples indicated that PAF materials are likely to produce acid in days to a month. It was also determined that the NAPP may overestimate acid potential due to the presence of non-acid generating S forms. Results also indicated that the total ANC measured is poorly available, and that long residence times may be required to ensure acid buffering matches acid generation rates in pyritic NAF samples.

The non-acid producing potential (NAPP) was assessed with approximately 80% of samples being NAPP negative. Most samples (>75%) had an acid neutralising capacity (ANC) to capacity to generate acid (MPA) greater than 2, indicating a high factor of safety. Most Tertiary samples are NAPP negative with an ANC/MPA ratio of greater than 2. The Permian non-coal and coal show a broad range of S and ANC values, with 83% of non-coal samples and 60% of coal samples being NAPP negative.

All spoil materials extracted from the portals, drifts and ventilation shafts will be placed back into the portals, drifts and ventilation shafts, reprofiled and covered with a minimum 1 m of topsoil and revegetated. These areas have been included within the MIA rehabilitation domain (RA1).

Tailings and rejects

Rejects from the 400 and 500 series were compared against the 100, 200 and 300 series materials to determine the potential for acid generation (EGI 2006). The results for sulphur showed that the 400 and 500 series materials were within the same range for total sulphur but had lower median and mean values. These results suggested that the rejects from the 400 and 500 series have a lower sulphur, possibly lower pyrite, and lower acid generation potential than the 100, 200 and 300 series rejects.

A recent assessment indicates that the coarse rejects and fine rejects are dominated by sulphide containing minerals (Golder Associates 2017). Historical co-disposal samples had a higher fraction of oxidised sulphur as evidenced from the low sulphide content but elevated total sulphur percentages. This may be due to either mixing with material that has oxidised over an extended timeframe or secondary mineral deposits which contain jarosite or similarly sulphate associated minerals. A 2013 study indicated that co-disposal material retains both sulphate and sulphide near the surface (SRK 2013).

The pH levels of the rejects are associated with electrical conductivity (EC), such that the reduction in pH reflects elevated EC levels. A small subset of samples was collected from the fine and coarse rejects for kinetic testing in 2012 which confirmed that most samples were PAF. It was the assumption of this assessment that these findings are indicative of the general system and that the use of non-acid generating (NAG) pH and NAPP classification is correct.

The variability of material properties was assessed at Kestrel included capping materials (rock mulch and semi-weathered nodular material), and reworked wet disposal material. The results indicated that samples contain low levels of arsenic, cobalt, chromium, manganese, nickel, lead, vanadium and zinc with moderate percentage values for iron and sulphur in the fine rejects and co-disposal material. The highest concentration of sulphur is detected in the fresh co-disposal material and black and yellow co-disposal samples from older material. It could be indicative of a limiting oxidation potential in these zones as it is comparable to the fresh co-disposal sample.

Mineralogical analysis confirmed the presence of pyrite in the waste material although there were significant levels of siderite present in these samples. These two components indicate a high potential for acid generation although these factors are moderated due to the presence of dolomite and calcite. A second moderation factor is the presence of clays such as illite and kaolinite in the samples which represent approximately 30% of each sample. The presence of neutralising potential and clay components in the waste material would indicate that movement of water and oxygen would be retarded in the system resulting in neutral saline leachate. The rock mulch from basalt and the semi-weathered material contained calcite and smectitic clays, although it was anticipated that these values would have been more comparable. In essence, these materials exhibit a high neutralisation potential.

Samples were evaluated to determine leachate generation potential. Sulphate leachate potential is evident for all waste types with the anionic component dominated by sulphate release. Leachate potential of metal(oid)s were assessed with iron (average 1.29 mg/L), aluminium (average 0.8 mg/L) and strontium (0.14 mg/L) being the most notable. Most metal(oid)s were below detection levels in the leachate. This indicates that the greatest risk factors would be associated with neutral sulphate enriched leachate from the waste facility and the impact this type of water would have on the cover and liner systems.

Results from samples analysed for acid producing potential for the fresh co-disposal and two mature co-disposal samples show the potential to produce acid forming leachate. Although these materials present a risk of acidification, it should be noted that the material has been buried for an extensive period and rapid oxidation did not occur readily.

To reduce the risks associated with the CDSF, an engineered capping layer will be installed, comprising:

- 0.3 m of compacted extremely to highly weathered basalt;
- 0.7 – 0.9 m rocky mulch; and
- 0.3 – 0.5 m of rocky mulch/topsoil mix.

Topsoil will be utilised as a growth medium to facilitate vegetation establishment and growth with the objective of minimising erosion risk. In the unlikely event that potentially sodic/dispersive materials may remain exposed on landform surfaces, they will be assessed and treated (e.g. with gypsum) prior to revegetation if erosion cannot otherwise be controlled. At an appropriate frequency, sampling and testing will be undertaken waste materials to monitor for risks of neutral mine drainage and ARD.

3.5.6.4 Quality assurance / quality control

Quality assurance and quality control activities are included at various stages of the rehabilitation process. These activities typically include:

- ground survey control of longwall panel subsidence areas with data utilised to calibrate future subsidence predictions;
- the use of a ground disturbance permit system to manage and condition surface ground disturbance;
- development of rehabilitation/restoration plans for all rehabilitation activities as detailed within the Subsidence Management Plan;
- reporting on rehabilitation activities as part of the sites environmental management system; and
- monitoring of rehabilitation activity outcomes.

For the CDSF rehabilitation works, the following quality assurance/quality control measures will be implemented:

- survey control to ensure that the construction tolerances specified are met including the thickness of cover layers and final fill levels;
- material characterisation at an appropriate frequency to ensure that materials used for rehabilitation works comply with design requirements;

- fill placement testing to ensure that compaction of materials and moisture content meets design specifications; and
- documentation of as-built construction and design to demonstrate that works were completed in accordance with the design specifications.

Rehabilitation activities will be carried out in accordance with the applicable methods described in this PRCP and records maintained to demonstrate achievement of RMs. The monitoring and maintenance program (refer Section 3.7) has been developed to ensure that rehabilitation progresses towards achievement of milestone criteria and ultimately relinquishment of the mining tenures. Regular rehabilitation monitoring will allow for timely identification of the need for corrective action or maintenance work, and changes to the rehabilitation strategy based on rehabilitation successes and failures and as new information/techniques becomes available.

3.5.7 Final landform design

With the exception of the CDSF, the final landform design for Kestrel is almost solely influenced by existing and predicted subsidence resulting from longwall panel progression. The timing of rehabilitation activities related to subsidence impacts is determined by the life-of-mine plan which identifies the predicted progression of the longwall panel (Figure 26).

Rehabilitation of surface ground disturbance arising from infrastructure development is not anticipated to result in any substantial difference to the pre-existing topography. While some redundant surface infrastructure has been previously rehabilitated, given the current, relatively, short remaining life of mine, it is now the case that all remaining surface infrastructure will be required until cessation of mining.

The proposed CDSF landform design has been determined based on technical studies relating to the geochemical and geotechnical properties of the rejects and tailings materials and planned required capacity to closure. This work has been collated and a capping and rehabilitation plan completed by ATCW Pty Ltd (ATCW 2023).

Figure 27 represents the final landform for the Project. The rehabilitation approach for each mine domain is discussed in the following sub-sections.

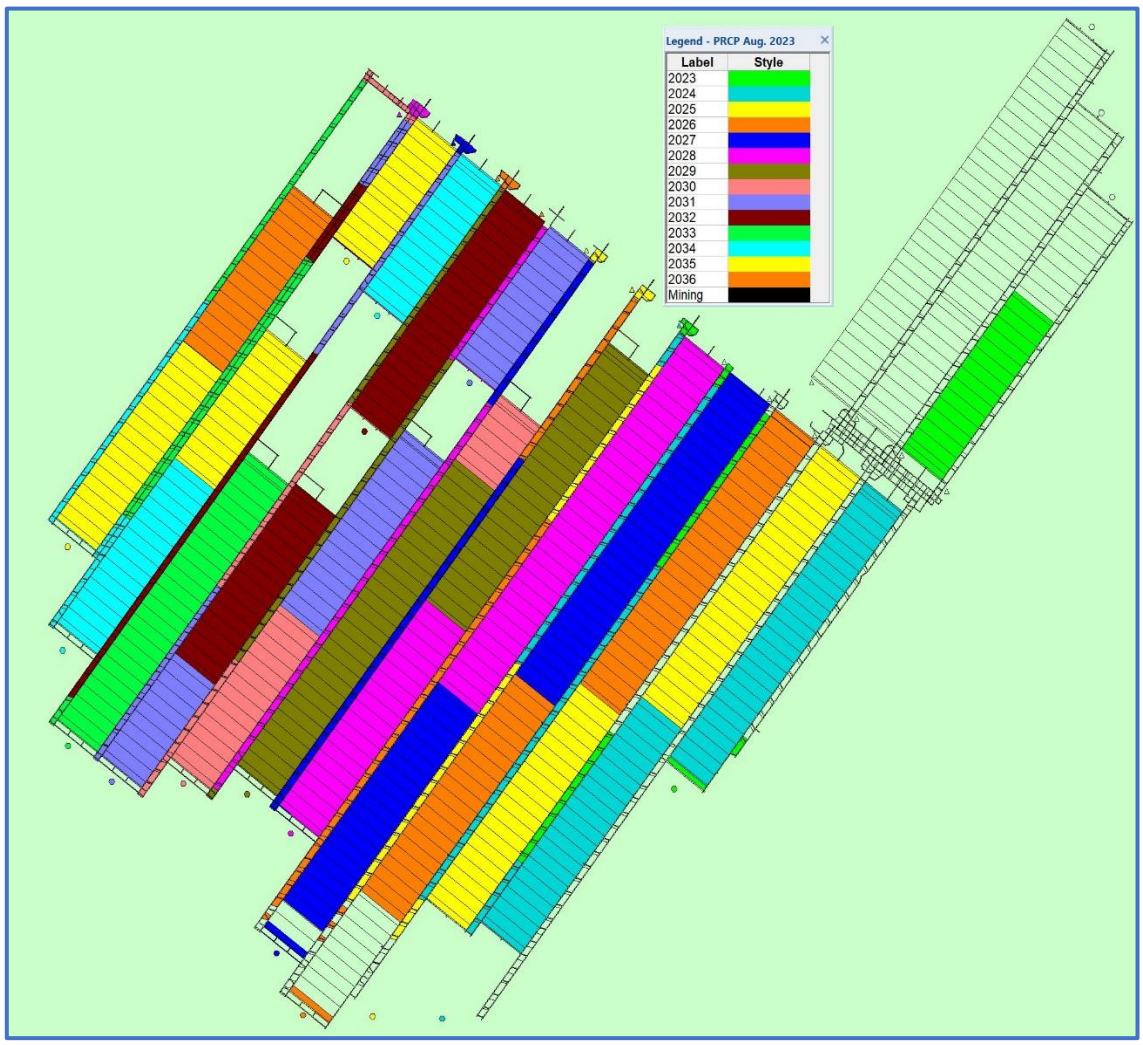


Figure 26: Longwall LOM Plan (August 2023)

3.5.8 Water management

The Project Water Management System (WMS) is based on separation of clean water catchments and mine affected water catchments. Mine affected water has the potential to become contaminated from various sources which have been identified as outlined in Table 18.

A current consolidated schematic of the Project WMS is presented in Figure 28.

Acid rock drainage (ARD) has been identified as a risk for the Project; predominantly associated with the acid-producing potential of washery rejects and tailings. As discussed at Section 3.5.11, the CDSF design addresses this risk and ongoing monitoring of surface and groundwater is undertaken to monitor the effectiveness of applied controls.

Stormwater runoff is managed to avoid excess sediment movement throughout the mine site. Stormwater runoff from the primary infrastructure area catchments is directed to sediment retention structures and the site Erosion and Sediment Control Plan is used to manage runoff from gas drainage and other surface infrastructure located within the longwall panel footprints. Mine water releases are controlled by EA conditions.

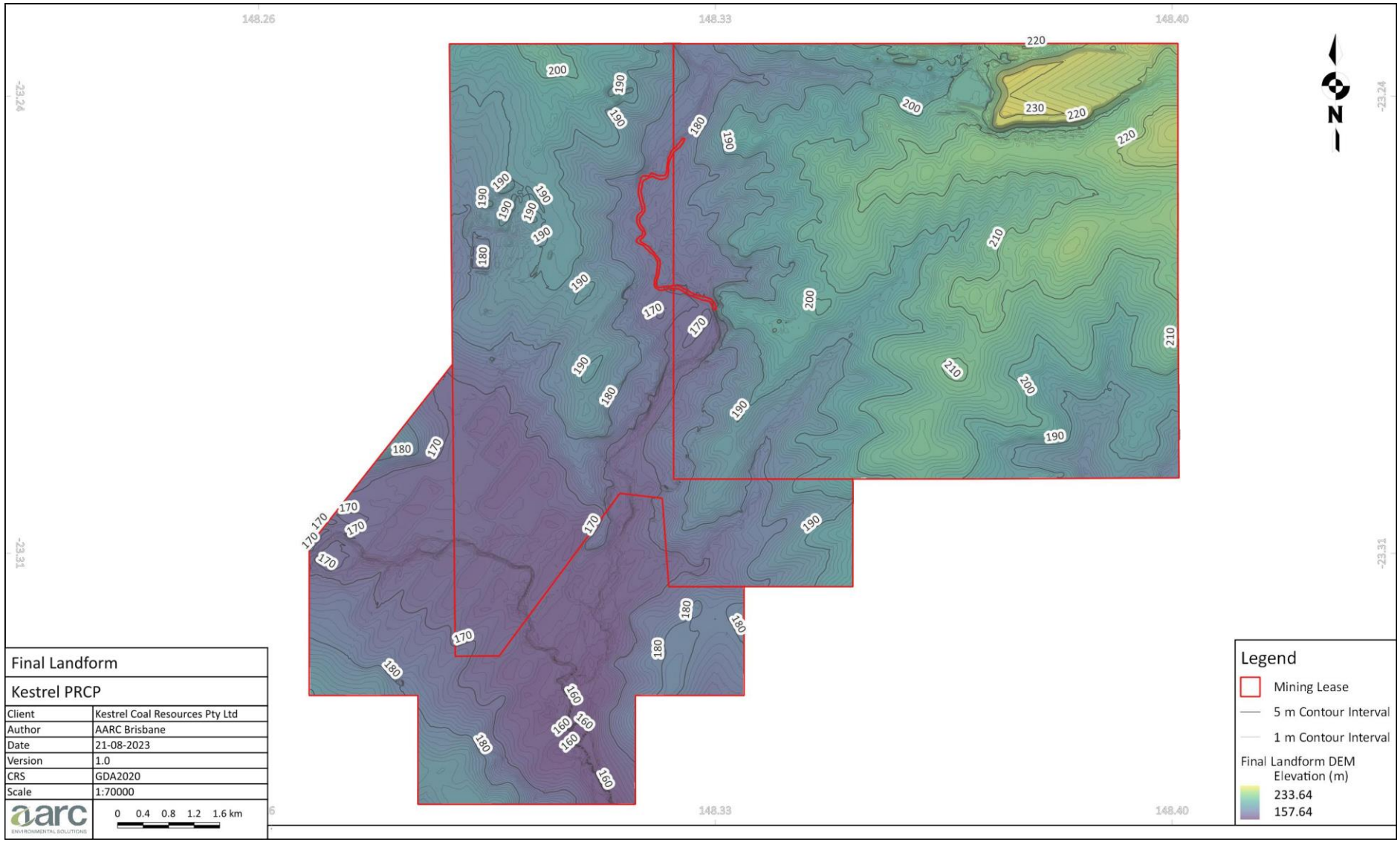


Figure 27: Final landform design

Table 19: Potential contaminant sources

Area	Potential contaminants
Topsoil stockpiles	Sediment, altered pH, dissolved metals
ROM and product coal stockpiles	salinity, altered pH, dissolved metals
Topsoil stripped areas	Sediment
Cleared areas	sediment, weed seeds
Industrial area – workshop and warehouses	sediment, hydrocarbons, salinity
Industrial area – bunded areas, refuelling areas, vehicle washdown facilities	hydrocarbons, chemicals, detergents
Sewerage treatment plants	nutrients, biological pathogens, BOD, altered pH, chlorine
Explosives magazine	hydrocarbons, chemical concentrates
Undisturbed areas	weed seeds
Mine water dams	elevated salinity, algae, hydrocarbons, altered pH, sediment, dissolved metals
Sediment dams	elevated salinity, algae, weed seeds, altered pH, sediment
CHPP and coal stockpiles	altered pH, salinity, hydrocarbons, ARD, dissolved metals
Co-disposal decant and leachate (ARD)	elevated salinity, sulphates, potential for elevated metals due to potential for low pH conditions
Transportable fuelling stations	hydrocarbons
Water treatment plant	altered pH, chemicals
Subsided areas	sediment
Compressor station	hydrocarbons, chemical concentrates
Longwall emulsion and other hydrocarbons underground	oil and TPH

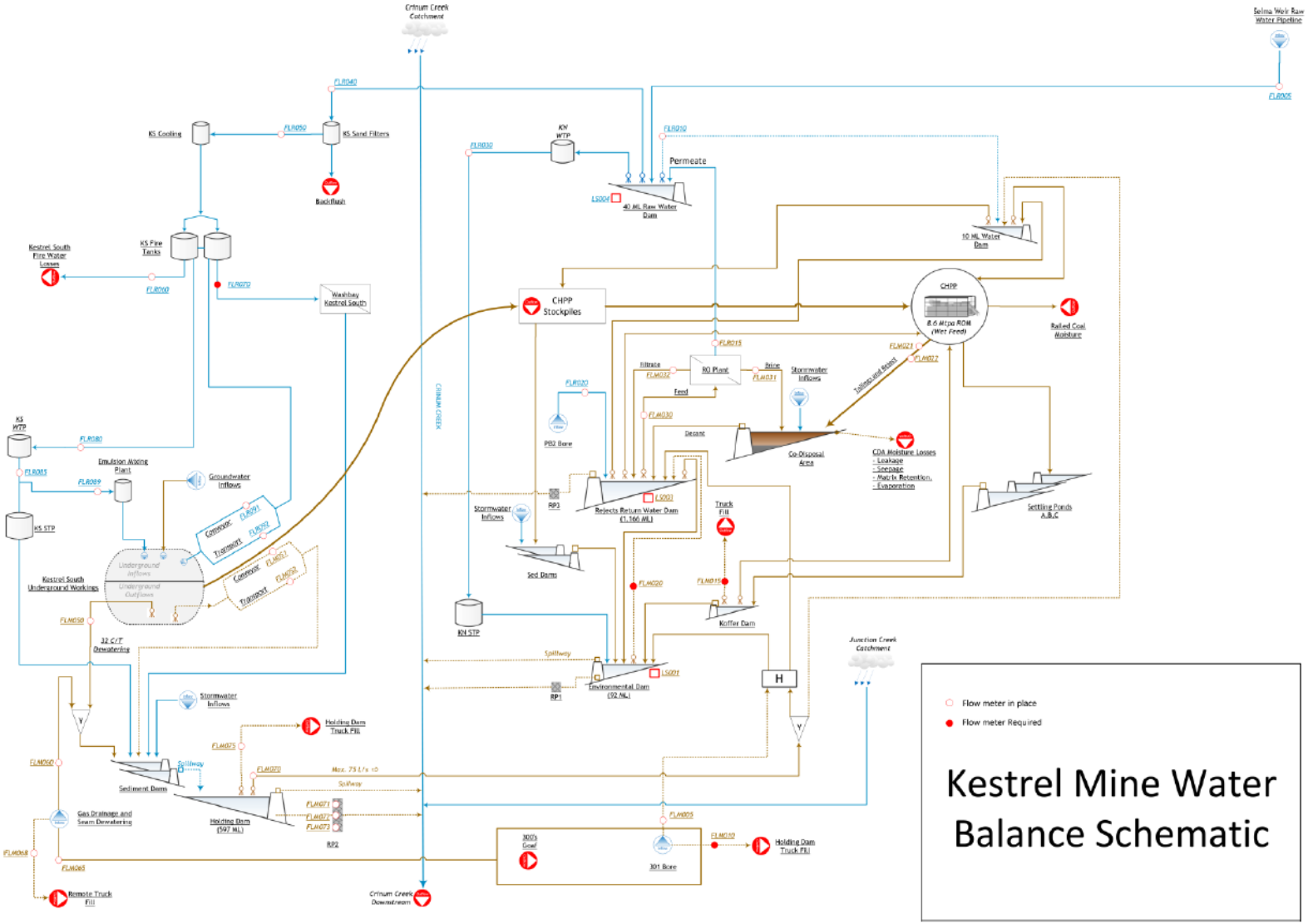


Figure 28: Project water management system schematic (WRM 2020)

Reverse osmosis plant

A reverse osmosis plant exists on site consisting of a number of mobile containerised units and various above ground water tanks which are required for each of the treatment stages. The total footprint area of the reverse osmosis plant is less than 0.2 ha. Above ground pipelines are utilised for the supply of input water from the process water dam, and to transfer concentrate/backwash waters to a water cart standpipe for disposal at specific evaporation cells located within the CDSF. As the mine progresses, evaporation cells will be covered by dry-stack tailings waste deposited in the CDSF.

Water storages

Key parameters of major water storages utilised within the WMS are detailed in Table 20. Water storages to be decommissioned will be rehabilitated in accordance with their final PMLU as soon practicable once mining is completed. Non-mine affected water dams will either be pumped to mine release points for release in accordance with EA release requirements and/or allowed to dry through evaporation prior to being re-filled using embankment materials and recontoured back to a level similar to that existing prior to mining.

Mine affected water structures will have linings removed (where applicable) and appropriately disposed of. Sediments will be moved to temporary drying ponds and sampled and analysed for contaminants. Depending on analysis results, sediments will either be buried onsite or within the CDSF or removed from site to a licensed disposal facility. Associated infrastructure (pumps and pipelines) will be decommissioned and removed from site. Dams will then be backfilled, reprofiled, topsoiled, tyned or disced to create a seedbed and seeded with a pasture seed mix suitable for grazing (see also Section 3.5.9).

The Holding Dam and Environmental Dam are planned to be retained post-closure and will be monitored to ensure that stock water quality guidelines are achieved.

Junction Creek diversion

Junction Creek is diverted around the CDSF, the Environmental Dam and the Kestrel North infrastructure area via a licensed diversion. The southern diversion channel diverts Junction Creek around the CDSF, while a smaller northern channel is used to direct upstream catchment flow away from the CDSF footprint and to the southern diversion. The two diversions meet approximately 500 m downstream of the Rejects Return Water Dam.

Both diversions are to be retained at closure and will be revegetated with endemic grass species suited to the PMLU and that are able to provide protection against erosion. A key objective for the revegetation of the creek diversion will be to ensure that self-sustaining vegetation communities are achieved.

Rehabilitation of the creek diversions will include:

- planting a diverse mix of endemic grasses;
- weed management;
- monitoring diversion stability and revegetation success for a period of at least 20 years to confirm revegetation objectives have been achieved prior to decommissioning of the mine.

The final landform design of the Junction Creek diversion is presented in Section 3.5.12.1.

Table 20: Key water storage characteristics

Water storage	Dam contents	Volume (ML)	Description	Type of dam construction	Regulated structure	Retained post-closure
10 ML Raw Water Dam	Raw water	10	Raw water and mine affected water storage	HDPE lined, compacted earth embankment turkey nest	No	No
40 ML Raw Water Dam	Raw water	40	Receives raw water imported from the Selma Weir and supplies water to the 10 ML Raw Water Dam	HDPE lined, compacted earth embankment turkey nest	No	No
Rejects Return Water Dam	Mine water	1,166	Receives runoff and seepage from CDSF, decant water and water pumped from underlying aquifers and underground workings	Compacted earth embankment dam	Yes – 'Significant' rating for 'failure to contain – dam break'	No
Holding Dam	Mine water	597	Located to the west of the Kestrel South MIA. Captures runoff from the Kestrel South MIA and receives waters from mine dewatering and other storage infrastructure. Releases to Woolshed Creek via two gate valves	HDPE lined, compacted earth embankment	Yes – 'Significant' rating for 'failure to contain – dam break'	Yes
Environmental Dam	Mine water	92	Located to the southwest of the Kestrel North MIA. Captures runoff via settlement ponds from the product coal stockpile area, workshops, administration, CHPP, groundwater dewatering and other water storage infrastructure. Releases to Junction Creek via two gate valves	Compacted earth embankment dam	No	Yes

3.5.9 Surface preparation and revegetation

The primary objective of surface preparation and revegetation is to rapidly produce a self-sustaining vegetation community suited to the target PMLU. The plant species selection aims to reproduce good quality agricultural land suited to a pastoral use, with the exception of the CDSF area which is to be rehabilitated to a grass community. Apart from the CDSF and the Kestrel North and Kestrel South infrastructure areas, the majority of revegetation requirements are of a very small scale. Consequently, it is important that species selection is representative of those species already present in the surrounding land.

3.5.9.1 Surface preparation

In areas cleared of vegetation, namely tracks and drill pads, hardstand areas and the CDSF, 0.3 m of topsoil will be respread over the area. Deep ripping is generally not proposed given that the majority of disturbance constitutes relatively flat areas. Disturbed areas will be cultivated to produce a seed bed suited to effective germination using farm equipment with appropriate cultivation implements such as tynes or discs.

The Project site has fertile soils, therefore fertilisers or other ameliorants are not expected to be required for general rehabilitation activities. The topsoil present in the stockpiles located adjacent to the existing CDSF

will be tested prior to placement to assess loss of viability given the extended period of storage. If low fertility is identified during the planning phase of rehabilitation or if initial revegetation fails, fertiliser will be applied as required to support the target vegetation.

Areas affected by subsidence are unlikely to require surface preparation or reseeding except where increased slope gradients have resulted in instances of erosion. In these cases the principles outlined above will be adhered to.

3.5.9.2 Seed mix and application

Seed mixes used for revegetation purposes will be based on the vegetation mix in the surrounding areas; with the objective of creating a consistent vegetation mix across the property and that is appropriate for the PMLU. The seed mix to be used for revegetation purposes will be a selection from those shown in Table 21, which has been tailored to achieve a mixture of native and improved pasture grassland which is appropriate to the area and its soils.

RE 11.8.11 is a native grassland system present within the ML which, along with RE 11.8.5 and RE 11.8.4, provides potential native species assemblages appropriate for black vertosol soils. The selection of grasses and forbs has been provided based on field observations within these REs, with a focus on RE 11.8.11, from the *Biodiversity Assessment Report for the Kestrel Mining Leases* (Umwelt 2023). Additional legume species were identified within the technical description for RE 11.8.11, as the presence of these species may aid rehabilitation success if soils have become nitrogen deficient.

Final seed mixes utilised for the good quality agricultural land (grazing) PMLU will also be discussed with key stakeholders including the pastoral lessee(s) and neighbours and species sowing rates will be informed through discussions with seed suppliers to favour species with greater survival rates.

Where disturbance to areas of mapped Bluegrass community (RE 11.8.11) occurs, the area will be revegetated using a seed mix that includes both *Dicanthium sericeum* and *Dicanthium queenslandicum* species. The species list provided in Table 21 includes species characteristic of the Bluegrass community in the Project area.

Revegetation of Bluegrass areas will occur using commercially available seed stock, and where practicable, indigenous stock from the community disturbed. It is noted that Bluegrass is perennial and effective at recruiting areas such as drill pads and tracks where the topsoil is not removed.

Remnant vegetation cover of RE 11.8.11, based on vegetation management regional ecosystem mapping (DoR 2022b), is shown in Figure 29.

Species provided in Table 21 are suitable for the revegetation of both the grass community PMLU and the good quality agricultural land PMLU.

Table 21: Species selection for revegetation

Common name	**Scientific name**	**Classification**
Feathertop Wiregrass	*Aristida latifolia*	Grass
White Wiregrass	*Aristida leptopoda*	Grass
Curly Mitchell Grass	*Astrebla lappacea*	Grass
Satin Top	*Bothriochloa erianthoides*	Grass
King Bluegrass	*Dichanthium queenslandicum*	Grass
Queensland Bluegrass	*Dichanthium sericeum*	Grass
Spreading Umbrella Grass	*Digitaria divaricatissima*	Grass
Cup Grass	*Eriochloa crebra*	Grass
Black Spear Grass	*Heteropogon contortus*	Grass
Native Millet	*Panicum decompositum*	Grass
Sago Grass	*Paspalidium globoideum*	Grass
Kangaroo Grass	*Themeda triandra*	Grass
Buffel Grass	*Cenchrus ciliaris*	Grass
Hairy Trefoil	*Desmodium rhytidophyllum*	Forb (legume)
Dwarf Morning Glory	*Evolvulus alsinoides*	Forb
Snail Flower	*Galactia tenuiflora*	Forb (legume)
	Glycine latifolia	Forb (legume)
Woolly Glycine	*Glycine tomentella*	Forb (legume)
Nine-leaved Indigo	*Indigofera linnaei*	Forb (legume)
Native bean	*Vigna lanceolata*	Forb (legume)

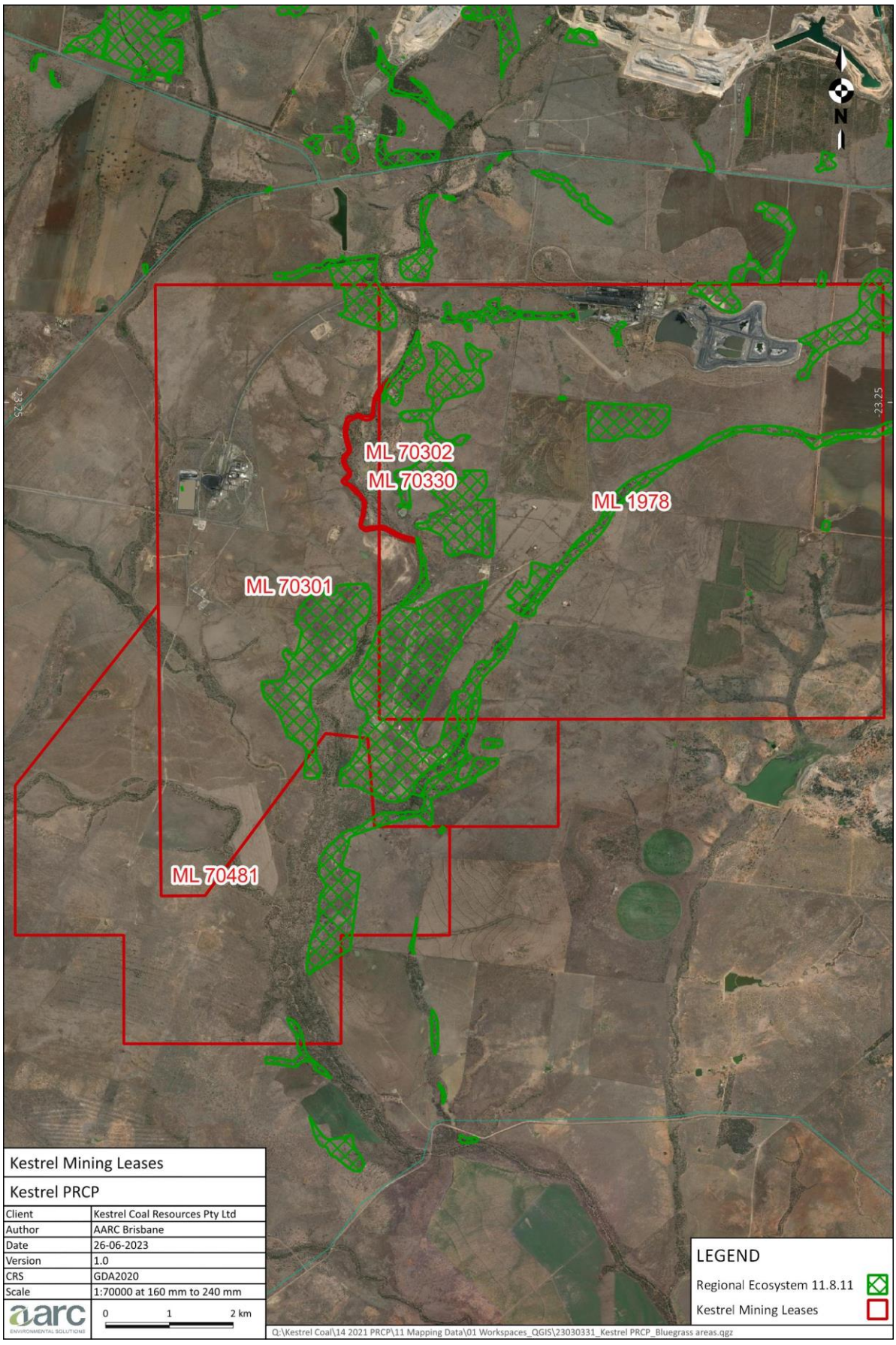


Figure 29: Bluegrass communities (RE 11.8.11)

3.5.10 Mine infrastructure areas (RA1)

At the end of the Project life, all remaining infrastructure will be decommissioned and removed except where an agreement with the landholder exists that states they will accept liability for that infrastructure.

- Built infrastructure associated with RA1 includes the following components: Portals and coal handling infrastructure;
- ROM and product coal stockpiles;
- overland conveyor;
- workshops;
- administration offices;
- warehousing facilities;
- access tracks;
- weather station and environmental monitoring equipment;
- airstrip;
- borrow pits;
- CDSF haul road;
- CHPP;
- waste transfer facility dump;
- equipment hardstand and laydown areas; and
- Reverse osmosis plant.

Surface infrastructure has been determined to be required until mining of the 500 series panels has completed. There may be instances where infrastructure is determined to be no longer required and may be able to be decommissioned prior to closure however, such instances are considered to be minor and have therefore not been incorporated within the rehabilitation schedule. It should be noted that all infrastructure associated with the Kestrel North portal and access to the 100, 200 and 300 series panels has previously been removed and the portal areas sealed and reprofiled to ground level; now constituting an MIA laydown.

Infrastructure will be decommissioned and removed from site once processing of all ROM coal has finished and all product coal removed from the site. Where notifiable activities have occurred or a risk of contamination exists by virtue of the activity undertaken, a contaminated land investigation will be conducted by an appropriately qualified person, and if contamination is identified, a remediation plan will be developed. Following remediation, a validation report will be prepared to verify that the remediation actions were adequate, and the site is suitable for the proposed PMLU.

Infrastructure areas will then be regraded to blend with the surrounding landscape and drainage lines reinstated to an acceptable profile and a capacity equivalent to that existing pre-mining. The final profile of any reconstructed drainage lines will comprise a flat base and sloped banks to allow for free drainage. The channel width will depend on the volume of water that is anticipated to flow down the channel. When constructing the channel all effort will be made to blend the constructed channel in with any natural drainage lines.

Apart from foundations associated with larger structures, which will be excavated to at least a depth of 1 m from the surface, disturbances associated with the majority of mine infrastructure are largely surficial. No steep slopes are anticipated to result from regrading of infrastructure areas. Surface preparation and revegetation will then be undertaken in accordance with the methods described in Section 3.5.9.

3.5.11 Co-disposal storage facility (RA2)

3.5.11.1 Cover trial assessment

Several cover designs have been investigated for capping of the CDSF with trials undertaken to determine the suitability of capping materials. A trial cover was placed over the co-disposal waste in 2002 and monitoring conducted for the preceding four years, until 2006, with a further assessment in 2009. The cover consisted of 1 m clay overlain by 0.3 m topsoil.

Monitoring was also conducted on an uncovered area of the co-disposal to determine the difference in water flux and oxygen distributions. Previous studies by Davidson and Garvie (2002), Garvie *et al.* (2003) and SPK (2007) identified that:

- Water infiltration into both covered and uncovered areas was less than 3% of rainfall (approximately 15 mm/year).
- Between November 2005 and April 2006, the average flux into the covered material was less than uncovered areas however, there was considerable variation in measurements across both areas.
- Oxygen concentrations varied in a cyclic manner suggesting diurnal atmospheric pressure influence. The estimates of oxidation depth were therefore uncertain due to cyclic variations.
- Oxygen did not penetrate deeper than 4.7 m into the covered co-disposal area and, as of April 2006, the depth of oxygen penetration was less than 2 m.
- Modelling suggested that the flux into the co-disposal areas was strongly dependent on rainfall intensity.

In 2009, measurements were taken at both covered and uncovered locations and compared oxygen distribution throughout the surface of the co-disposal to previous monitoring (2002 – 2006). It was determined that:

- The oxygen profiles remained consistent with previous measurements with a sharp drop from atmospheric concentrations at the surface to very low or negligible concentrations at depth.
- There were temporal (24 hour) fluctuations in both oxygen concentration and oxygen penetration depth with a variation of approximately 0.25 m.
- Oxygen penetration recorded in 2009 (1–1.5 m) is less than reported in 2007 (2 m).

The KCB (2022c) report detailed the configuration of the landform for the cover trials which was constructed to 10V:1V slope. Rejects were covered with approximately 1 m of decomposed basalt and then spread with 300–500 mm of black cracking clay topsoil previously stripped from the footprint of the co-disposal facility (LRS Environmental 2017). The clay topsoil was reported to be a residual soil formed from the natural weathering of the basalt.

The intent of the cover was to create a stable surface for revegetation that also reduced the direct interaction/percolation between rainfall and the co-disposal waste. Early cover trials detailed in the KCB (2021) report utilised clay-rich materials from weathered basaltic material or incorporated into the topsoil overburden on site. Testing of these covers determined that a low permeability could be achieved (see various Ansto reports and EGi 2001). The Golder (2008) report detailed that the ‘clay’ layer and topsoil materials were similar in nature, demonstrating good water storage and sealing capability. These materials reported a high water retention capacity and very low saturated hydraulic conductivity values, in the order of 1×10^{-7} m/s. The rock mulch cover of fresh blast rock and a growth medium was a mixture of black clay and topsoil.

The proportion of soil/clay to rock (< 600 mm) will determine the properties of the material in use. Although detailed modelling was not undertaken in the KCB (2021) assessment, it was suggested that the proposed cover would act to reduce direct infiltration from rainfall. This is due to the moisture retention capacity of the rock mulch cover. The larger particle size of the underlying material (basalt matrix) would inhibit unsaturated flow, acting as a capillary break. The contrast between the high permeability of the basalt layer and the compacted tailings material should allow water shedding down the slope rather than ponding (KCB 2021). Tested samples from earlier trials suggest that it is likely the ‘clay’ layer will not function as a ‘barrier’ or ‘seal’ to limit infiltration (Golder 2008).

An additional potential aim of the cover is be to limit the transport of oxygen through the materials and reduce potential for acid drainage. Although the cover was not considered to limit oxygen transport, potential acid generation was not expected based on geochemical assessments and water quality modelling (Golder 2018) and the construction methodology used. Testing has confirmed that the cover materials are not expected to leach high salinity or metal-rich water. The geochemical properties of the cover, from the perspective of not adding an additional contaminant load to the environment are considered appropriate.

The current trial cover demonstrates that, in order to manage infiltration through the cover to the underlying waste, a reduced permeability layer (RPL) is required. Therefore, a key component of the cover system design adopted for the CDSF is an RPL as discussed in the following sub-sections.

3.5.11.2 Final landform design

ATCW (2023b) assessed several CDSF cover designs with the most suitable being the store and release cover option (Cover 4). Cover option 4 consists of 1.2 m rocky mulch with 0.3 – 0.5 m topsoil/rocky mulch mix overlying 0.3 m of compacted clay. The preferred final landform of the CDSF will have slopes in the order of 1(V) in 10(H) (10°). There is an existing batter on the southern end of the CDSF (1(V) in 6(H)) that was considered to present a stability risk if reprofiled and therefore is to remain in the final landform. The flattening of this area was also not proposed due to the southern diversion drain alignment and natural topography to the south. The CDSF footprint area of 310 ha includes the Rejects Return Dam. The total area included within RA3 has allowed for reduction in landform height which subsequently reduces batter angles and erosion risks.

Modelling of the performance of cover system selected for the final landform (cover option 4) demonstrated that surface runoff comprises 22% of rainfall, without infiltrating the cover system. Moisture losses through evaporation and transpiration are 33% and 51% respectively. Results indicate that the moisture content of rocky mulch cover (0.15 m BGL and 0.4 m BGL) is controlled by climatic conditions with moisture content rising following rainfall events. Moisture content subsequently reduces through evaporation and transpiration. The average rate of flux is approximately $4x10^{-11}$ m/s with negative rates indicating infiltration. The modelled net flux is -0.022 m and the sum of the negative and positive flux are $2.3x10^{-3}$ m and 0.023 m respectively. Results indicate that net percolation (i.e. rainfall infiltrating through the cover system into the waste) is zero. Results of the water balance modelling and infiltration are presented in Table 22.

Table 22: CDSF cover design water balance (ATCW 2023)

Parameter	Modelled Value
Runoff	22%
Net Infiltration	-4%
Evaporation	33%
Transpiration	51%

Note: values do not necessarily add up to 100% due to initial moisture conditions

Following drainage, the first step of rehabilitation of the CDSF will occur by placing a compacted clay layer (RPL) over the exposed tailings surface to a depth of 0.3 m. This cover will form a relatively impermeable layer over the underlying tailings surface. The clay will be cover by 1.2 m of rocky mulch to provide for a store and release cover. The method of cover placement will depend on the bearing capacity of the tailings at the time of rehabilitation.

Specific construction methodology will be detailed in a construction specification to be completed as part of detailed design work. ACTW (2023) detailed that the typical construction preparation of the CDSF will include, but is not limited to:

- Removal of any freestanding water.
- Clearing and grubbing (only if vegetation establishes on CDSF prior to construction of cover system), to remove debris, trees, stumps, scrub and fallen timber. Clearing in areas to be excavated or filled upon shall also include the grubbing of stumps and roots in excess of 25 mm diameter.
- Removal or *insitu* treatment of unsuitable material as required to remove soft and compressible material to form a competent surface on which to construct the cover system.
- Final trim to form design surface.
- Establishment of erosion and sedimentation control measures.

The construction of the cover system will include (but is not limited to):

- material source testing;
- source, haul, place, spread and compact clay fill with moisture conditioning as required in accordance with the construction specification;
- source, haul, place, spread rocky mulch with moisture conditioning and compaction as required in accordance with the construction specification;
- source, haul, place and spread topsoil with moisture conditioning and compaction as required in accordance with the construction specification; and
- seeding and revegetation works to be undertaken in accordance with the revegetation plan.

The outer slope geometry and surface treatment will ensure adequate geotechnical stability and safe accessibility, while minimising the catchment and erosion potential of the slope. Excess rainfall runoff from the remediated landform will be directed to purpose-built drain structures and not be directed over the outer slopes, to avoid the concentration of rainfall runoff and the heightened potential for erosion that might result.

Once the CDSF has been covered it will be revegetated (as per Section 3.5.9) to a PMLU of grass community (see Section 3.3.2.2).

Further information on the capping design of the CDSF is in Appendix F.

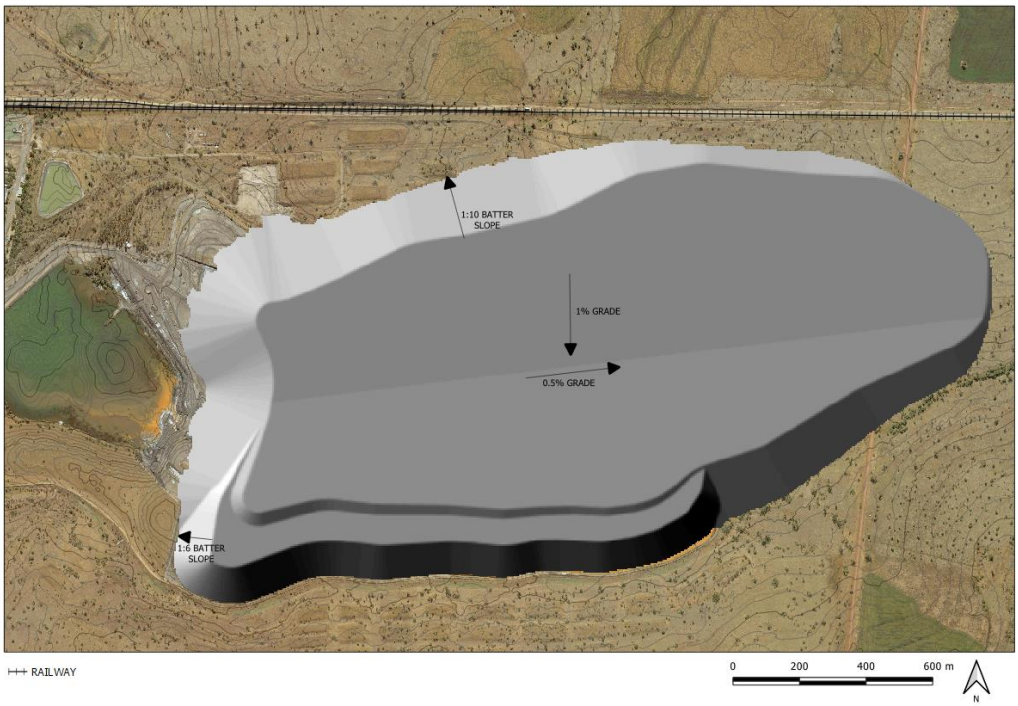


Figure 30: CDSF landform design (ATCW 2023)

Drainage infrastructure

Perimeter drains located at the toe of the CDSF will divert runoff of clean water off site, once the runoff demonstrates it meets release criteria defined in the EA. Drainage of surface runoff on the plateau of the CDSF will be facilitated by the final landform gradient of 1% towards the centre of the structure. A central drain will be constructed at a 0.5% gradient south-east to north-west to direct water to an outlet which reports to a chute that will divert flows to the toe of the CDSF. To reduce the overland flow path, feeder drains directing water to the central drain will be spaced at intervals of approximately 200 m. Both batter slopes of 1V:10H and 1V:6H require a drain mid-way on the batter based on the calculated spacing of 100 m and 50 m respectively.

The landform design is presented in Figure 31 and the drain conceptual designs are presented in Figure 32, Figure 33, and Figure 34.

Table 23: Drain designs (ATCW 2023)

Item	Description
Central Drain	Rock armoured channel to collect runoff from feeder drains and discharge runoff from the CDSF plateau to the Chute.
Feeder Drain	Channel and bund configuration with 1% longitudinal grade. Channel dimensions to maintain low velocity by maximising channel width (compared to depth). Rock lined with geotextile underlay
Chute	Rock armoured channel to discharge runoff from CDSF batters and plateau. Chutes will be constructed on steeper grades (i.e. 10%) and will require rock armouring to reduce erosion.

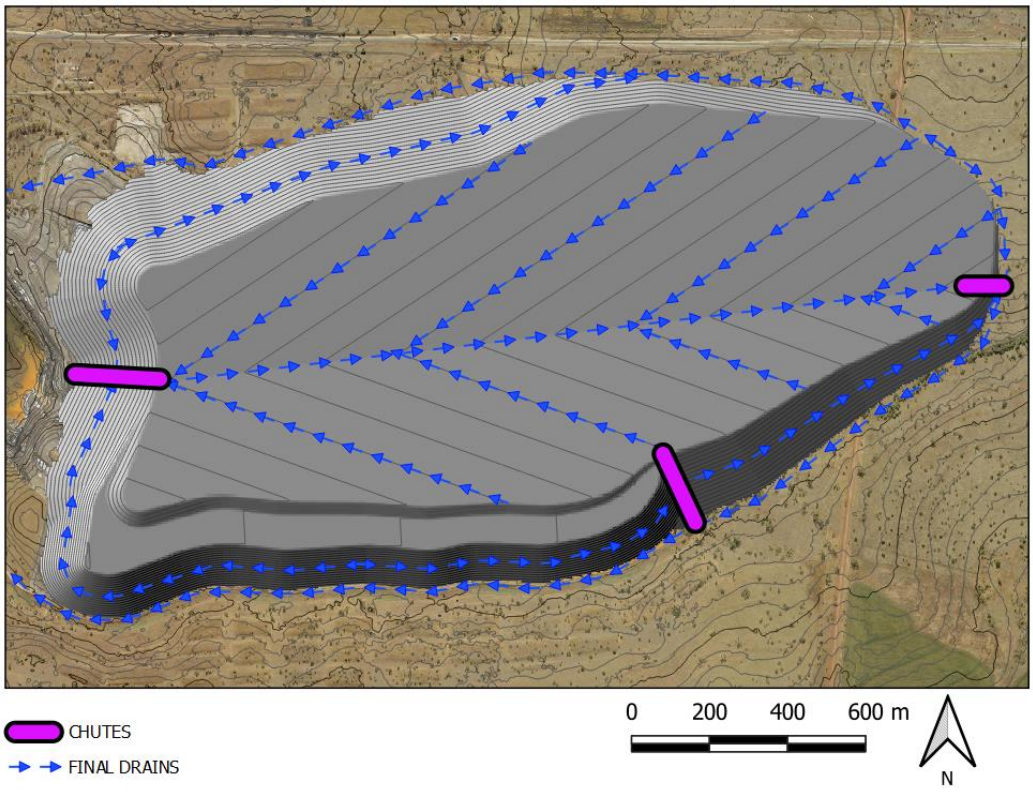


Figure 31: Final drainage design

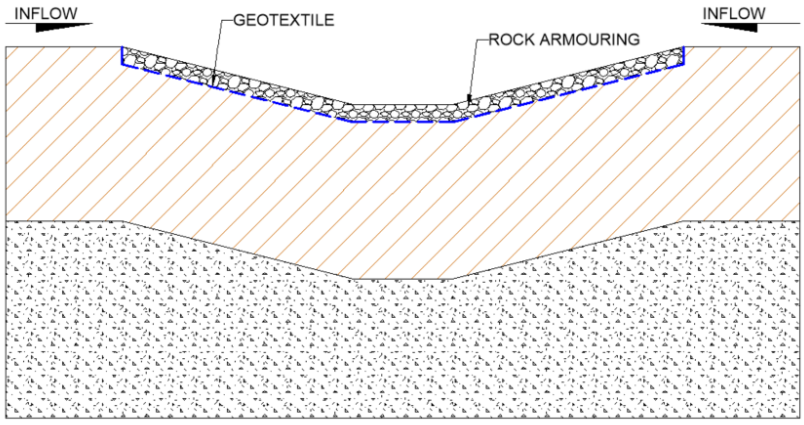


Figure 32: Central drain conceptual design

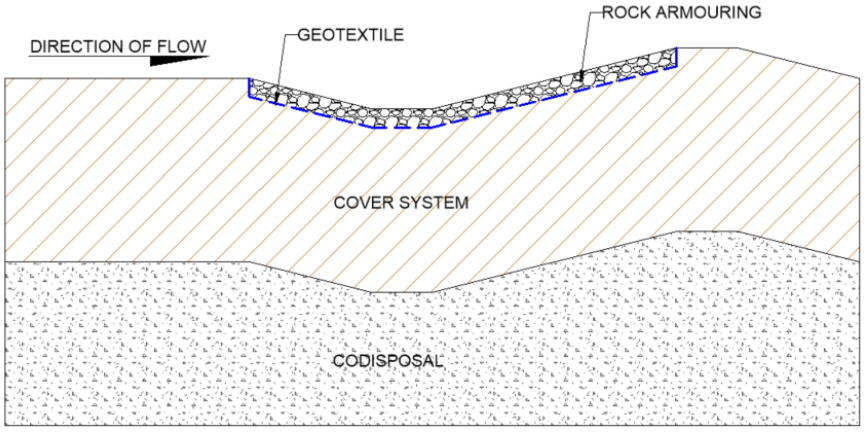


Figure 33: Feeder drain conceptual design

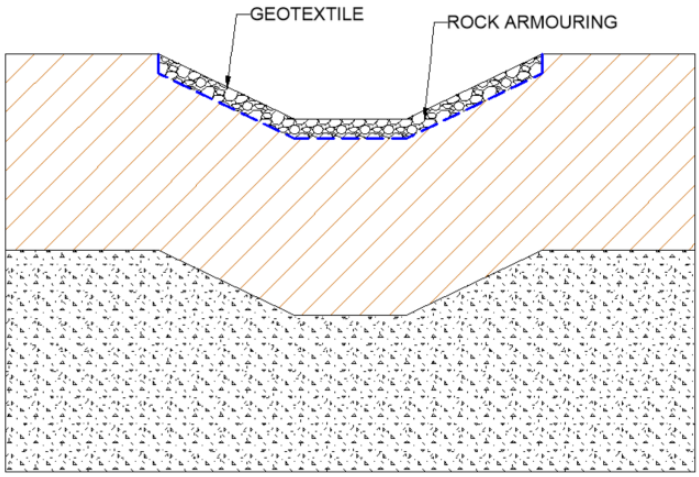


Figure 34: Chute conceptual design

3.5.11.3 Water Erosion Prediction Project

An Erosion Stability Assessment using the Water Erosion Prediction Project (WEPP) model was undertaken to assess the long-term stability of the final landform. The WEPP model is a process-based, distributed parameter, continuous simulation erosion prediction model. It considers various factors including slope design, climate information, vegetation management structures and soil parameters (National Soil Erosion Research Laboratory 1995).

ACTW (2023a) completed WEPP modelling to assess the long-term stability of the CDSF. The cover design assessment included cover option 4, as discussed above, modelled over a 20-year time period to allow for years of high and low rainfall. Stable erosion rates were shown in modelling over a 20 year period and it is expected that longer model duration would present similar findings, therefore demonstrating model sensitivity to accurate climate records.

Soil parameter inputs were estimated using laboratory results for topsoil obtained during 2023 material investigation conducted by ATCW. Organic percentage and cation exchange capacity (CEC) were not available and a sensitivity analysis was undertaken. It was determined that the assessment outcome is unlikely to change as a result of varying organic percentage and CEC. The adopted soil parameters for the model included 70.8% clay, 18.7% sand, and 10.5% rock.

Vegetation groundcover of 100% was adopted for the model with a maximum root depth of 30 cm, maximum groundcover height of 20 cm, and plant spacing or 0.6 cm. Initial modelling indicated that drains would be required to reduce erosion rates. Drains at various spacing were trialled to achieve target average erosion rates of <10 t/ha/yr and are presented in Table 24.

Table 24: Average annual soil loss (ATCW 2023)

Area	Without Drains (t/ha/yr)	With Drains (t/ha/yr)	Drain Spacing (m)
Plateau	18.4	8.1	200
Batters 1V:10H	40.4	6.9	100
Batters 1V:6H	50.9	5.9	50

3.5.11.4 Landform evolution modelling

The soil erosion landform evolution model SIBERIA was used to predict the type of erosion) i.e. sheet wash, gullying) and the gully initiation and evolution. The result indicate minimal erosion on the plateau of the CDSF and the cover system performing adequately when modelled for 1,000 years. Average soil loss modelled for the plateau is approximately 0.03 m, which, over the modelling period, resulted in the accumulation of 150 mm of soil in the central drain.

As with the WEPP model, implementation of drainage controls reduces erosion to acceptable levels. Modelling of the 1V:10H batter slopes indicate minimal erosion will occur for the first 100 years, with rilling commencing after 250 years approximately 100 m from the top of the batter. The rills propagate upslope in the 500 and 1,000 year results indicating that drains would be required at approximate intervals of 100 m to minimise rilling.

Figure 35 shows the CDSF from the plateau on the south side of the figure to the embankment to on the north..

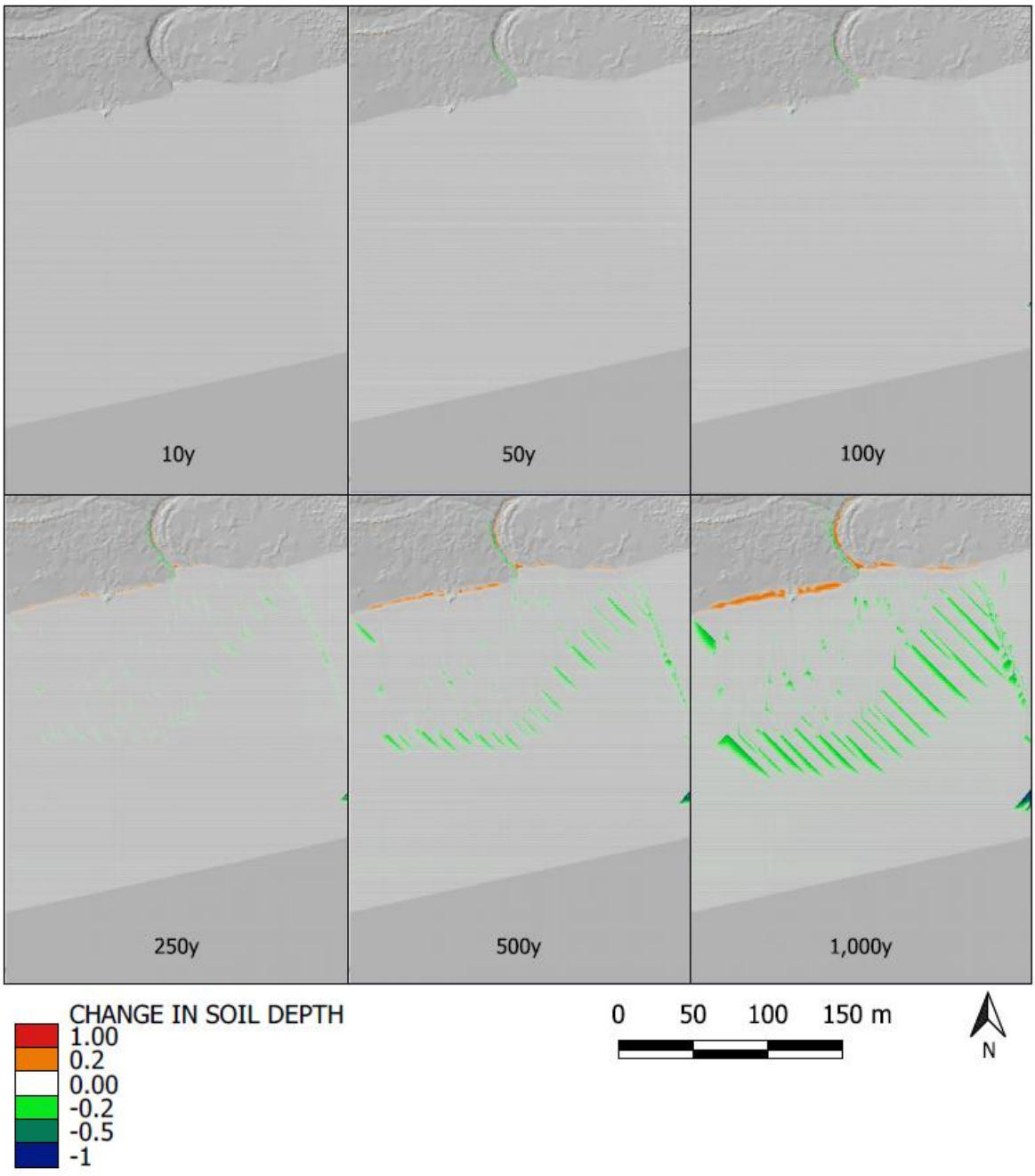


Figure 35: Change in soil depth (1V:10H slopes)

Modelling of the 1V:6H batter slopes indicate minimal erosion will occur for the first 100 years, with rilling commencing after 200 years approximately halfway up the batter. The rills propagate upslope in the 500 and 1,000 year results indicating that drains would be required at approximate intervals of 50 m to minimise rilling.

Figure 36 shows the CDSF from the plateau on the north side of the figure to the embankment toe on the south.

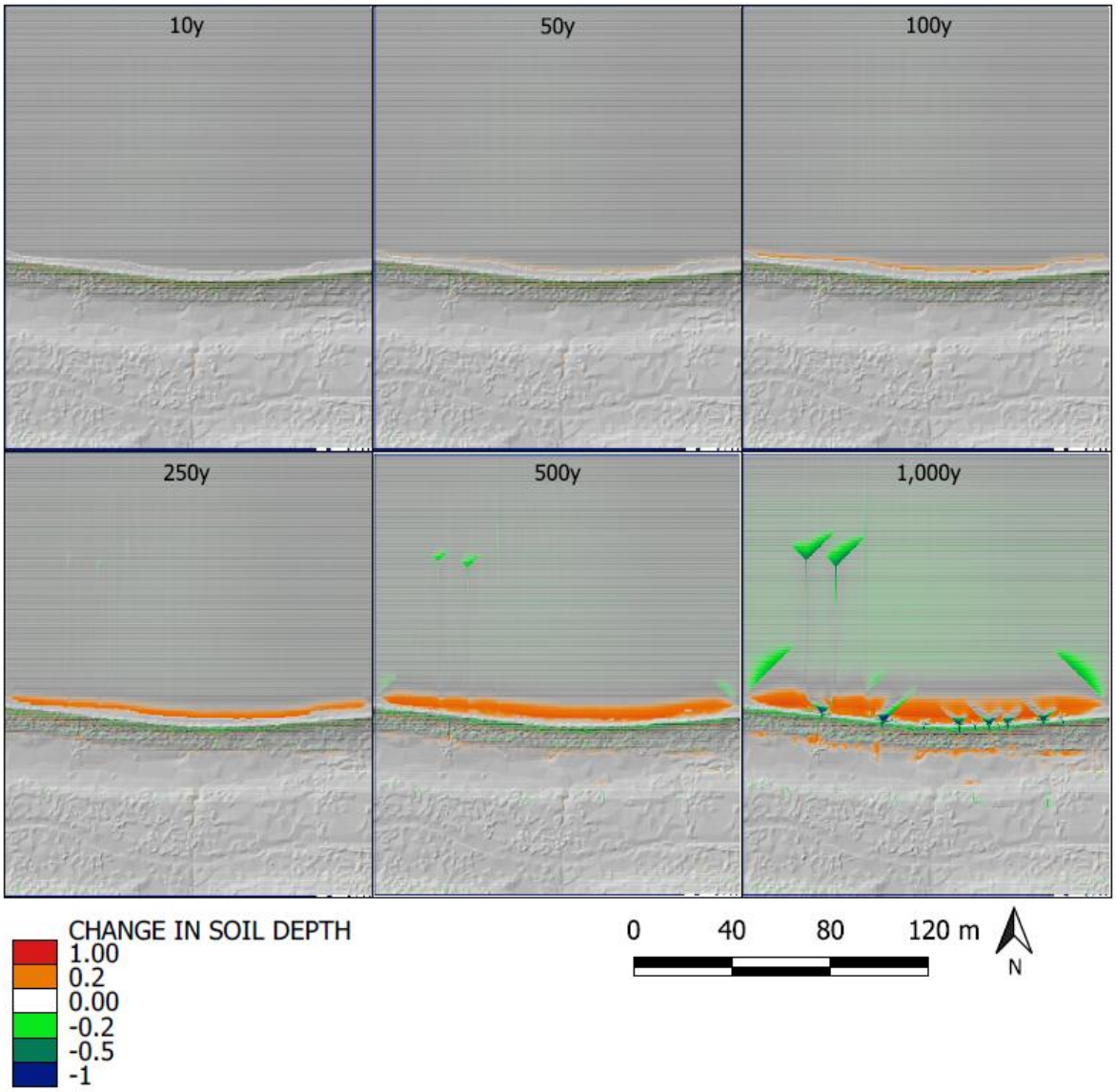


Figure 36: Change in soil depth (1V:6H slopes)

3.5.11.5 Seepage

The selected cover system adopted for the final landform design was assessed to determine seepage and discharge of contaminants to groundwater (ATCW 2023a). The key contaminants of concern were sulphate, TDS, and metals. The primary indicator of potential seepage from the CDSF is elevated sulphate levels in groundwater monitoring bores in close proximity to the CDSF. TDS was not considered suitable a indicator as assessment of salts, ionic compounds, and other solids is not definitive and reflects the general groundwater chemistry. Metals concentrations were also not considered to be a reliable indicator due to the variability in metal concentrations observed to date (ATCW 2023a).

The seepage model was undertaken for three scenarios including the current CDSF (steady-state), uncapped after 50 years (transient), and capped after 50 years (transient). Two cross-sections were developed, allowing the simulation of vertical and longitudinal water flow subject to boundary conditions and hydraulic parameters.

Results of seepage modelling demonstrate that the cover system reduces seepage rates when compared to current conditions (ATCW 2023a). There is a reduction in seepage rates, peaking at 0.16 L/day/m in the longitudinal domain and 0.22 L/day/m in the transverse domain. Seepage rates were comparable on the

southern and northern boundaries of the model regardless of capping presence. This result was likely to be from model boundary conditions on seepage rate rather than seepage flux.

Contaminant migration was also simulated to determine the seepage velocity and migration path for water or contaminant through the CDSF. There is an observed reduction between 30–94% (averaging 3.75 x 10^{-7} m/s) in the velocity of particles through the CDSF when capping is simulated over the CDSF. There is a marked decrease in particle velocity over 50 years which can be attributed to reduced recharge and infiltration through the cover system. These results demonstrate that the selected cover design will effectively manage seepage through the CDSF.

3.5.11.6 Performance monitoring

Monitoring of the adopted cover system will be undertaken to determine performance of the cover against rehabilitation objectives (ATCW 2023b). This will include use of existing weather station and installation of additional monitoring equipment including:

- Fredlund thermal conductivity sensor;
- piezometers; and
- survey monuments.

Conceptual locations of the monitoring equipment to be utilised is provided in Figure 37.

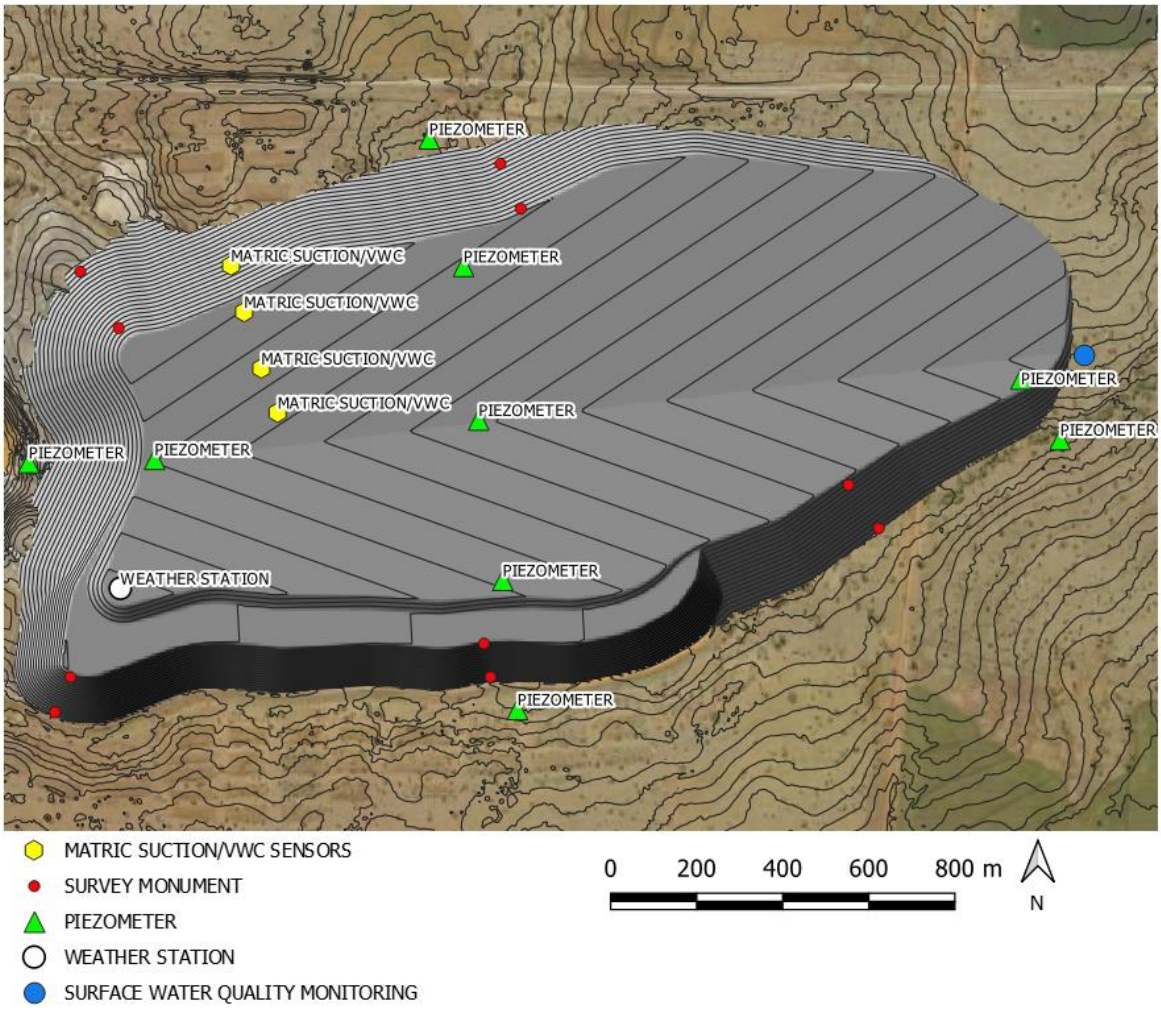


Figure 37: Conceptual locations for monitoring instrumentation

Seepage monitoring is also recommended to evaluate the efficacy and dependability of the CDSF during closure and rehabilitation phases of the Project. Groundwater monitoring should occur to demonstrate the cover system effectiveness and to monitor changes in groundwater quality for the post-closure period. Current monitoring bores have been selected to allow for continuous monitoring and identification of long-term trends, and proximately to the CDSF.

To monitoring for performance of the cover system, the key contaminants of concern are:

- sulphate;
- total dissolved solids; and
- metals (dissolved and total).

General water quality and field parameters should also be monitored, including:

- pH;
- electrical conductivity; and
- major ions (which are defined as calcium, magnesium, sodium, potassium, chloride, carbonate, bicarbonate, sulphate).

Table 25: CDSF performance groundwater monitoring bores

Aquifer	Hole ID	Easting (MGA Zn 55)	Northing (MGA Zn 55)	Ground Level (m)	Groundwater Depth bgl (m)	Inferred Groundwater RL (m)
Basalt	CD01	640333.73	7429928.8	212.917	18.36	194.557
	NB1	642278.9	7429085	209.918	18	191.918
	CD06	640519.74	7428442.3	208.515	10.82	197.695
Permian	P1	636198.05	7429367.3	180.992	56.4	124.592
	P2	642222.78	7429911.2	220.045	38.8	181.245
	P3	638933.36	7427991.6	210.993	173.15	37.843
Basal Sand	NS3	639945.06	7428476.1	212.774	32.37	180.404

3.5.12 Water management infrastructure (RA3, RA4 and RA5)

Table 20 identifies the key water storages associated with the Project and their fate post-closure. With respect to retained water storages (RA3); the following activities will be undertaken:

- Associated infrastructure no longer required will be decommissioned and removed.
- An assessment will be undertaken to determine if there is any risk of environmental harm associated with the potential contamination of sediments.
- The holding dam, which is currently classified as a regulated structure, will be assessed to determine if there is a pathway to declassify the structure or alternatively, the landholder agreement will need to include the transfer of responsibilities associated with regulated structures to the landholder.
- Water quality data will be collated and assessed post-closure to assess achievement of a water quality suited to the PMLU.

Water storages to be rehabilitated (RA5) include those listed in Table 20 as well as various sedimentation and operational storages associated with the mine infrastructure areas. The following activities will be undertaken:

- Non-mine affected water will either be pumped to mine release points for release in accordance with EA release requirements and/or allowed to dry through evaporation. Water not able to be released will be either utilised for dust suppression, allowed to evaporate or processed through the RO plant prior to release.
- Pump and pipework infrastructure no longer required will be decommissioned and removed.
- Where linings exist, these will be removed and appropriately disposed of.
- Sediments will be moved to temporary drying ponds and, where deemed necessary, sampled and analysed for contaminants. Depending on analysis results, sediments will either be buried onsite or within the CDSF or removed from site to a licensed disposal facility.
- Storages will be backfilled using adjacent embankment materials and recontoured back to a level similar to that existing prior to mining.

Surface preparation and revegetation works will be undertaken as outlined in Section 3.5.9.

3.5.12.1 Creek diversion closure design

The existing Junction Creek diversion is approximately 3,290 m long with a grade of approximately 0.450 and batter slope of 1 in 3 and is to be retained at closure. The original diversion design incorporated three drop structures with the intent to control flow velocities and mitigate erosion potential within the diversion and assist in long-term control of natural channel grade. These drop structures are now considered as requiring removal to allow the diversion to be retained at closure (ATCW 2023a).

To address this, ATCW (2023a) has undertaken an updated hydraulic analysis of the diversion and its contributing catchment of Junction Creek using the two dimensional finite difference program TUFLOW to derive stream power, velocity and shear stress within the diversion drain for the 50% and 2% annual exceedance probability (AEP) scenarios. The probable maximum flood (PMF), 1 in 1,000 AEP and 1% AEP was also modelled.

The hydraulic design criteria of the creek diversion were developed based on assessment of existing Bowen Basin streams and watercourse diversions as well as the DNRME (2019) and White *et al.* (2014) guidelines (ATCW 2023b). The criteria are considered reflective of stable hydraulic conditions for ephemeral systems in central Queensland.

In accordance with the DNRME (2019) design requirements, maximum values for stream power, shear stress and velocity were modelled for a 2% AEP rainfall event (with vegetation). The removal of the drop structures in the Junction Creek diversion has resulted in the channel not consistently meeting the requirements for stream power and shear stress. The stream power modelling for diversion is 344 W/m^2 and shear stress if 152 N/m^2 compared to the DNRME (2019) guideline of <150 and <50 respectively. The velocity modelled (2.4 m/s) is within the guidelines values of <2.5 m/s (ATCW 2023a). Additional scour protection will be required to ensure the 2% AEP flows meet the DNRME (2019) requirements.

As an outcome of this assessment, the channel will be widened to 20 m and batters flattened to 1 in 6. Diversion drain design parameters are detailed in Table 26. The creek diversion will be further stabilised using vegetation.

Table 26: Diversion design (ATCW 2023a)

Channel Geometry	Existing	Closure
Length	3,290 m	4,550 m
Grade	0.50%	0.42%
Channel Bed Wdith	10 m	20 m
Channel Depth	2.5 m	2.5 m
Batter Slope	1 in 3	1 in 6

Hydraulic modelling of Junction Creek diversion for the PMF, 0.1% AEP and 1% AEP scenarios are presented in Table 27 and locations shown in Figure 38. The 0.1% AEP flood maps for flood depth and velocity are shown in Figure 39 and Figure 40 respectively. The maximum flow velocity and maximum flood depth for the 0.1% AEP are 2.12 m/s and 1.99 m respectively.

Table 27: Junction Creek diversion hydraulic modelling (ATCW 2023a)

Location	Parameter	PMF	0.1% AEP	1% AEP
Junction Creek	Ground Elevation Level (m AHD)	186.58	186.58	186.58
	Maximum Water Surface Elevation (m AHD)	189.47	188.20	187.86
	Maximum Flood Depth (m)	2.89	1.62	1.28
	Maximum Flow Velocity (m/s)	3.28	2.07	1.73
US SDD	Ground Elevation Level (m AHD)	212.58	212.58	212.58
	Maximum Water Surface Elevation (m AHD)	215.25	213.70	213.44
	Maximum Flood Depth (m)	2.67	1.12	0.86
	Maximum Flow Velocity (m/s)	1.48	1.18	0.97
SDD	Ground Elevation Level (m AHD)	204.95	204.95	204.95
	Maximum Water Surface Elevation (m AHD)	209.03	206.77	206.24
	Maximum Flood Depth (m)	4.08	1.82	1.29
	Maximum Flow Velocity (m/s)	2.82	2.12	1.89
DS SDD	Ground Elevation Level (m AHD)	193.29	193.29	193.29
	Maximum Water Surface Elevation (m AHD)	196.45	195.28	194.97
	Maximum Flood Depth (m)	3.16	1.99	1.67
	Maximum Flow Velocity (m/s)	1.53	0.70	0.48

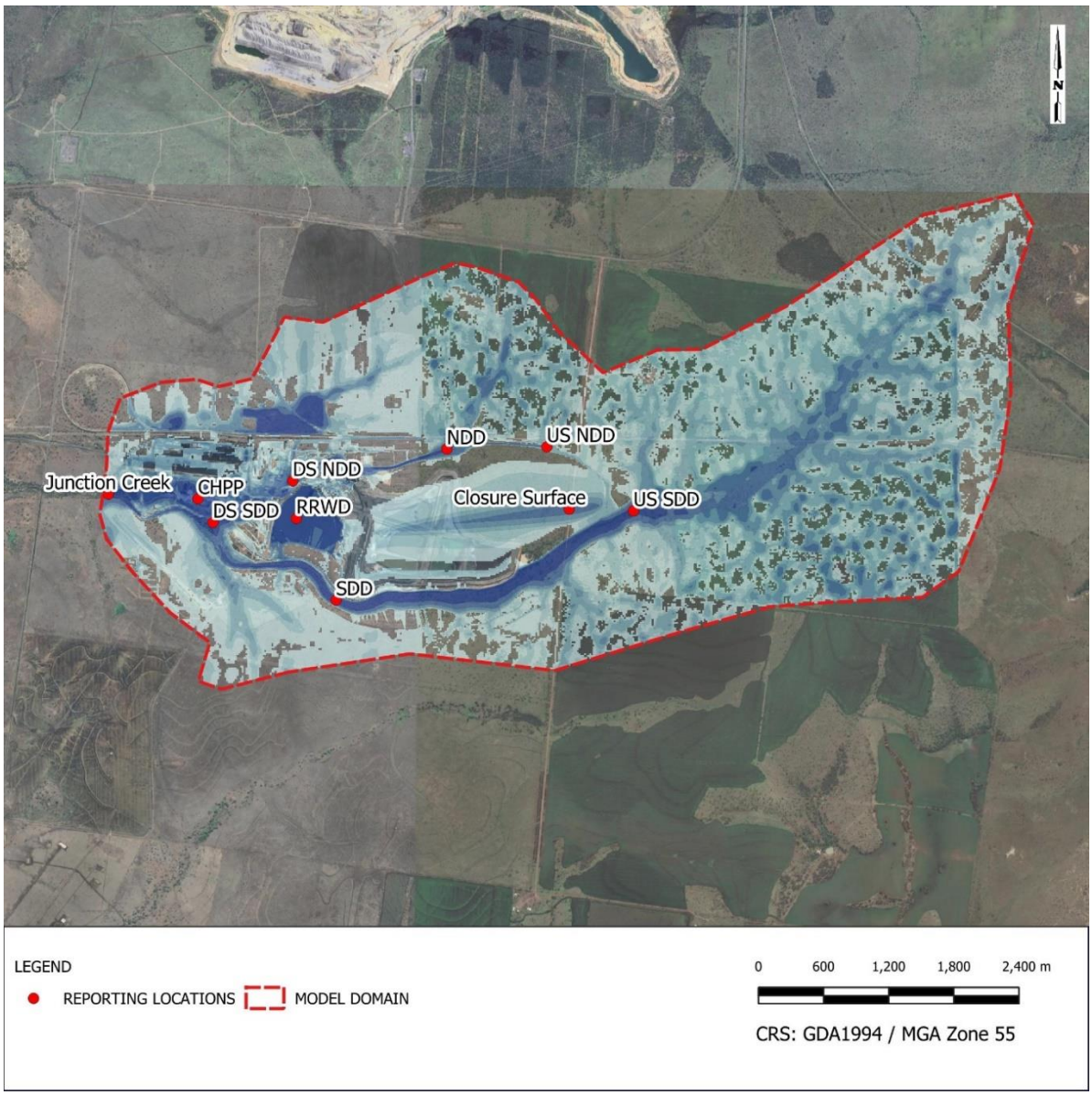


Figure 38: Junction Creek diversion modelling locations (ATCW 2023a)

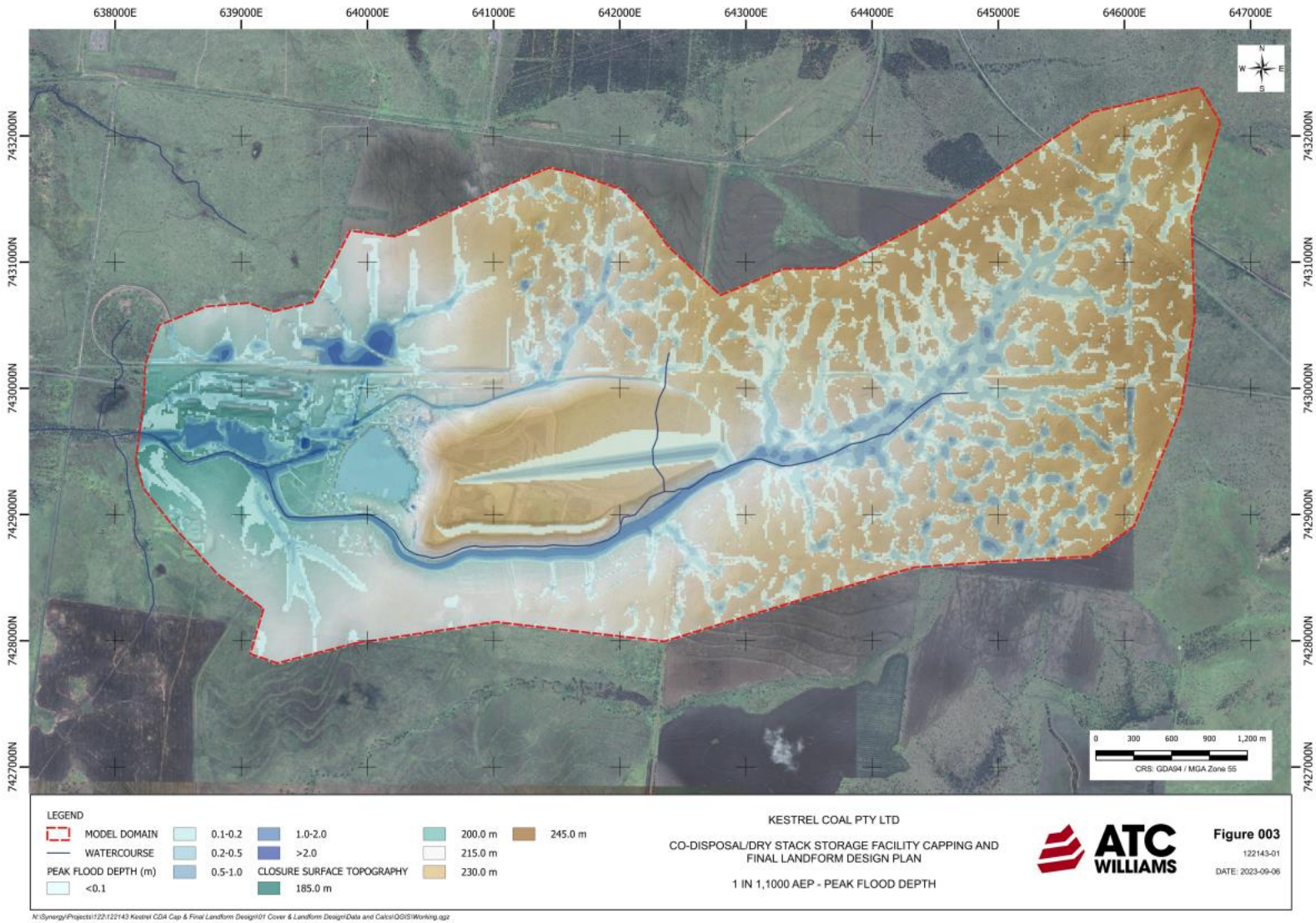


Figure 39: Junction Creek diversion 0.1% AEP flood depth (ATCW 2023a)

Figure 40: Junction Creek diversion 0.1% AEP velocity (ATCW 2023a)

3.5.13 Areas subject to subsidence (RA6 and RA7)

The principal land disturbance impact associated with underground mining activities at Kestrel is subsidence arising as longwall panels progressively extract the coal seam. The extent of subsidence impacts is defined by the underground mining footprint, depth of the coal seam and the angle of draw to the surface. Subsidence predictions have been undertaken for all Kestrel longwall panel series out to completion of the 500 series and have been updated as and when mine planning changes occur. Subsidence monitoring of prior longwall panels is used to verify the relative accuracy of subsidence predictions as well as informing subsequent subsidence predictions. Data referred to in this PRCP is taken from the most recent update for panels LW500 to LW510.

Subsidence predictions for the 500 series have been undertaken by Mine Subsidence Engineering Consultants (MSEC 2022) using the Incremental Profile Method developed by Waddington and Kay (1995); being an empirical method used to predict subsidence, tilts, curvatures and strains likely to be experienced as longwall mining occurs and to assess the effects of mining on surface infrastructure.

The Incremental Profile Method has been tested for Kestrel at the time of each subsidence prediction by comparing predicted and ground surveyed movements during the mining of the 400 series of longwalls. For predictions undertaken in 2022, monitoring data from longwalls 401–409 has been used for calibration of the model.

Maximum vertical subsidence over the 300, 400 and 500 series longwall panels ranges between 1.4–2.3 m mid-panel to 0.1–0.3 m over longwall inter-panel pillars. Longwall panel widths have ranged from 250–375 m (100 to 400 series panels) to planned widths of either 396 m (LW500) or 424 m (500 series panels). Maximum slopes arising from subsidence typically occur within 100–150 m of the panel edge. As a conservative comparison, measured maximum slopes from the adjacent 400 series panels are approximately 1.5–2% (or approximately 1°).

Timing of subsidence at Kestrel is well understood from subsidence monitoring undertaken across the prior series longwall footprints. Monitoring indicates that at mining rates of 80–100 m per week, the majority of the subsidence on the surface occurs about 300 m behind the mining face with minor residual subsidence (subsoil settlement) of approximately 20–30 mm thereafter. At these rates of longwall retreat, 97% of maximum subsidence is achieved between four and six weeks of the longwall face retreating past any given point on the surface.

The slopes and troughs formed as a result of subsidence are subtle and not easily distinguishable from the surrounding topography, as the range of movement associated with subsidence is well within the range of natural elevation variation. In other words, the topography of subsided areas is not inconsistent with the surrounding un-subsided topography (i.e. gently rolling country with low relief).

Potential land impacts associated with subsidence include localised changes in slope, surface tensile cracking, and changed drainage systems including, in some areas, localised ponding. Where waterways traverse subsidence areas, localised longitudinal slope increases and waterway re-alignment may occur. These impacts are discussed in the following subsections.

3.5.13.1 RA7 surface infrastructure (drill holes, drill pads and sumps and access tracks)

Underground mining operations at Kestrel are supported by a range of surface-located services and infrastructure including:

- Exploration and pre-production drilling infrastructure such as gas drainage and dewatering works. Pre-production dewatering and gas drainage occurs via wells drilled to intersect the working coal seam to ensure safe operating conditions during mining. Associated surface works consist of vertical wells drilled along each longwall panel alignment, and connected via a pipeline, gas pump and flare unit. Disturbance is surficial and limited to that area required for drill rigs and ancillary equipment as well as interconnecting pipelines and access tracks.
- A personal emergency device (PED) surface line installed along the line of each longwall panel.

- Ventilation shafts and ancillary equipment (generators and access tracks), surface to underground mine services boreholes.

As indicated at Section 3.5.10, surface infrastructure has been determined to be required until mining of the 500 series panels has completed. There may be instances where infrastructure is determined to be no longer required and may be able to be decommissioned prior to closure however, such instances are considered to be minor and have therefore not been incorporated within the rehabilitation schedule.

All drill hole collars will be excavated, the casing cut and capped and a concrete cover placed over the cap. The top of the concrete cap will be a minimum of one (1) metre below ground level. Surface preparation and revegetation will then be undertaken in accordance with the methods described in Section 3.5.9.

Drill pads will be reshaped to their original contour and appropriate drainage reinstated. All sumps will be filled in to the surface contour, allowing for subsidence. Surface preparation and revegetation will then be undertaken in accordance with the methods described in Section 3.5.9.

Access tracks will be rehabilitated once they serve no ongoing purpose for either the Project or other land users. Consultation with relevant stakeholders will be undertaken prior to track closure and rehabilitation.

Once tracks are no longer required, culverts (e.g. pipes, logs) will be removed and natural drainage pathways reinstated. Tracks will be ripped or roughened, which is more practicable, then surface preparation and revegetation will be undertaken in accordance with the methods described in Section 3.5.9.

3.5.13.2 Subsidence impacts

Subsidence-induced erosion impacts

With respect to slope gradient impacts,

Figure 41 provides an assessment of final landform slope gradients post-mining. It can be seen that almost all of the slope gradients greater than 5% are associated with natural watercourses, the CDSF batter slopes, dam embankments or material stockpiles. Overall the post-mining landform retains its pre-mining character and topography.

Despite the low slope gradients, erosion impacting both land and/or watercourses is a potential outcome from subsidence-induced increases in slope. The soil types located within the MLs are predominantly well-structured, high shrink-swell clays throughout their profile with low erodibility (K factor) and calculated low rates of soil loss. Site experience and subsidence monitoring observations to date reinforce the current understanding that these soils are resilient to movement and, at the low, comparatively short slopes present in ML 70481, under the current grazing land use, have demonstrated low rates of erosion.

Despite the favourable inherent characteristics of the soils, and the absence of previous examples of erosion arising from subsidence, increases in localised erosion rates occurring post-disturbance is still a risk that requires monitoring and that may, in some cases require remediation. Certain surface landforms that are naturally more prone to erosion, for example watercourses and steeper slopes, and soils of known higher erodibility, will be given specific attention.

While the whole of the subsidence impacted area will be observed and monitored during and after longwall panel progress, the slopes predicted to change by up to +2% (refer Figure 41) will be a particular focus of post-mining monitoring activities to ensure any resultant erosion is addressed.

It should be noted that, at the time of drafting this PRCP revision, a subsidence prediction that incorporated some late adjustments to the ends of panels LW503 to LW509 and the final panel arrangements of LW510 and LW511 was not available. Figure 41 illustrates the slope changes based on the most recently available subsidence prediction. Updated subsidence predictions will be undertaken well in advance of these panels being mined and are not expected to identify any impacts beyond those previously predicted and observed.

Subsidence-induced surface cracking

While also not commonly observed, there is potential for surface tension cracks to occur as a result of longwall panel subsidence. The specific extent and potential impact of surface tension cracks at Kestrel is naturally mitigated by a range of operational parameters and existing environmental conditions.

The majority of the Kestrel MLs are dominated by Vertosols, as all but the Lascelles Soil Landscape are mapped as cracking clay soils (Highlands Environmental 2022), which are characterised as expansive clay-rich soils with a high shrink-swell potential that change volume with changes in soil water content. The nature of these expansive cracking clays is such that, typically over one to two seasons, natural soil movement will compensate for any subsidence-induced cracking, resulting in no measurable impact on the soil.

The cracking clay soils naturally open, crack and shrink when dry, with the cracks then closing when wet as part of the soils inherent characteristics of pedoturbation. Thus, though cracks may result when subsidence first occurs, this natural characteristic of pedoturbation has been observed to lead to crack closure over one or two seasonal wetting and drying cycles.

Observations have demonstrated that, in many cases, tension cracks open as a function of the longwall panel face passing, closing up again as the panel progresses. Tension cracks are more likely to remain along the line of the inter-panel pillars and at the ends of each longwall panel. Hinchcliffe *et al.* (2003) state that 'obvious visual effects of a subsidence event are sometimes seen as surface tension cracks. Cracks may open up when the mining of the coal face is nearby and may close up once the face has moved on, yet some cracks may remain, especially along the edges of the panel'.

Tension cracks have been observed over the earlier 300-series longwall panels in areas with Vertosols. These areas were monitored and observed to either self-heal or were able to be restored by cross-ripping with scarifiers. It should be noted that the 300 panels were mined at 100 m to 280 m depth, and therefore the surface expression of subsidence was greater than is expected in the deeper 500 series panels.

Subsidence-induced hydrological impacts

Kestrel is located in the upper to mid-reaches of the Crinum Creek catchment and is drained by a number of small ephemeral gullies and tributaries of Crinum, Belcong and Homestead Creeks. Gilbert & Associates have undertaken stream condition surveys across the whole of the Kestrel ML areas using an Index of Diversion Condition method since 2003 which provides an historic record of watercourse condition pre-mining and impact post-subsidence.

The observed impacts to overland flow and watercourses arising from subsidence related to earlier longwall panels have included:

- Localised re-direction of overland flow and changes to minor drainage paths, disruption to remnant contour banks, localised changes to runoff patterns and creation of surface ponding areas.
- Changes to flood prone areas in the flood plains of major drainage lines (e.g. Crinum Creek).
- Changes to the longitudinal slopes of watercourses. Where watercourses lie generally perpendicular to the panel direction, potential exists for ponding to occur immediately upstream of an inter-panel pillar, with increased potential for scouring immediately downstream of an inter-panel pillar due to localised increases in slope. This can have subsequent impacts on the sediment transport regime and geomorphological stability of a watercourse; in turn affecting the movement of bed/bank sediment and creek channel stability. It should be noted though that the overall longitudinal slope of the watercourse will not change.

Minor depressions may occur in areas of flatter topography and which are isolated from the mainstream channels during low flows. These depressions may retain localised rainfall runoff and form ponds following rainfall events. Ponded areas may partially waterlog soils during summer events of high rainfall, but this is likely to be temporary where there is no gilgai; and is less likely during the rest of the year when rainfall is typically low.

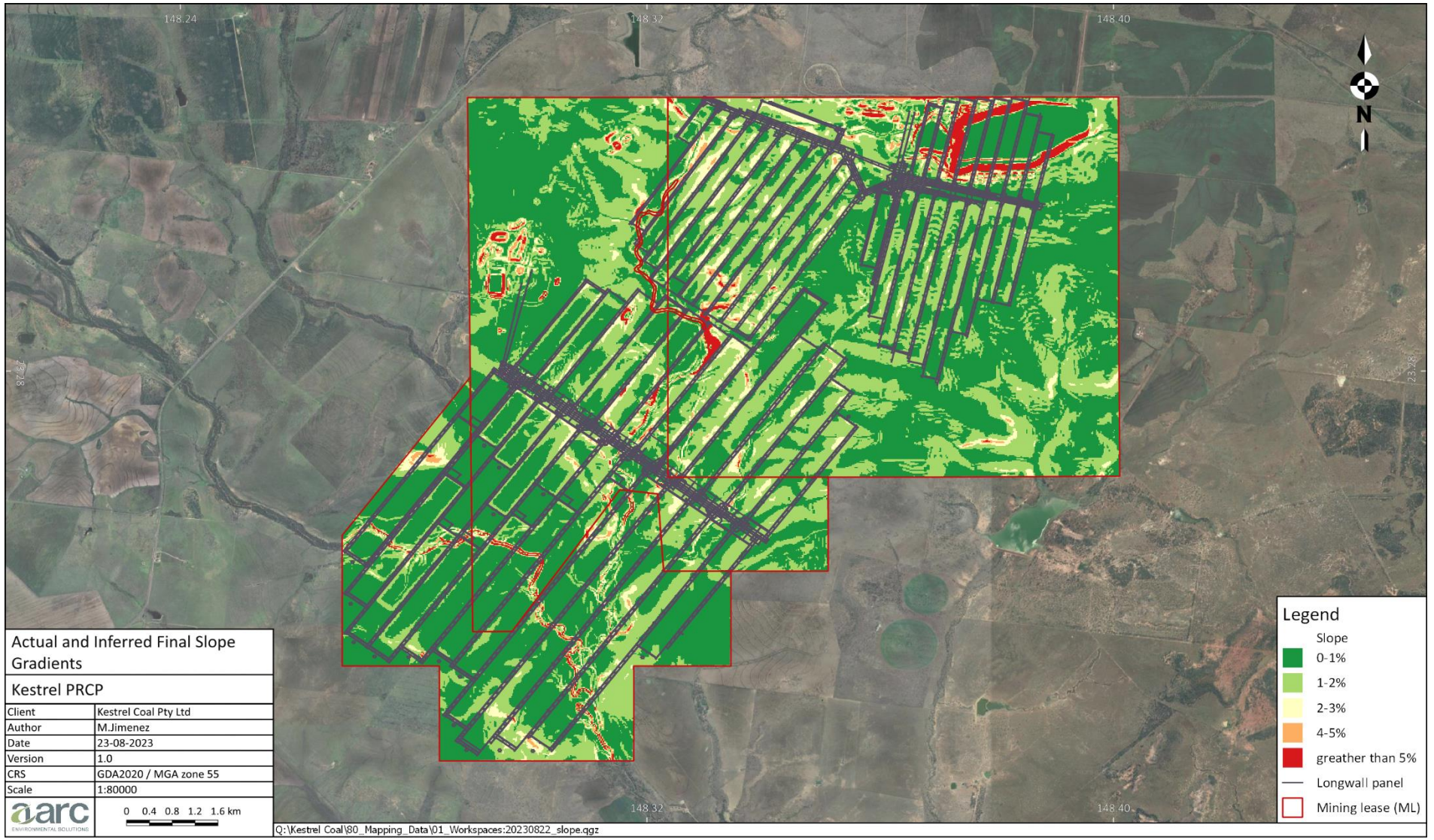


Figure 41: Inferred post-mining slope gradients

Ponding instances that have occurred within the 300 series and 400 series panel footprints to date have been retained as part of the landform and constitute shallow stock watering points with fringing vegetation developing, and are generally considered to be complementary to the grazing land use. However, EA requirements for the 500 series limits the areal extents of 'permanent' ponding to 200 m^2, however, there was no definition of permanence provided or any description of how permanence or ponding should be assessed. A review of previous approvals submissions could find no reference to this requirement or any justification for its inclusion.

A simplified assessment of ponded areas has been undertaken utilising the most recent subsidence prediction dataset to identify closed contours signifying depressions that may hold water. This assessment identified areas of potential ponding ranging from 5,000 m^2 to approximately 50 ha (two occurrences of approximately 40 ha and 50 ha in area, 10 occurrences of 2–10 ha, with the remainder being less than 1 ha in area, refer Figure 42).

The specific location of ponded areas, soil drainage characteristics, and depth of ponding will be factors influencing the 'permanence', or duration and extent of ponding. It should be noted that all of the predicted instances of ponding within the 500 series occur on the Grey or Black Vertosols formed on alluvia located within the floodplain of Belcong Creek and Crinum Creek which is likely to promote drainage and a lesser risk of permanent ponding. Further, when comparing this assessment with current instances of ponding, it is clear that not all predicted occurrences result in actual ponding, and also that many instances would not be considered to be of a permanent nature by virtue of location or size.

The two largest areas of predicted ponding lie within the floodplain of Belcong Creek with one intersecting Liskeard Gully just upstream of its confluence with Crinum Creek. These two areas will be assessed as detailed at Section 3.5.13.3, and will be subject to drainage works to link to the adjacent watercourses, if this does not result as a consequence of surface change.

The management of smaller areas of ponding is also detailed in Section 3.5.13.3 which has a focus of assessing each instance, post-subsidence, to determine the level of environmental impact associated with retaining any confirmed permanent ponding against the environmental risks that may be associated with required mitigation works.

Subsidence-induced impacts to land suitability

Subsidence monitoring was undertaken at Kestrel in August 2008 as part of ACARP project C15013 (ACARP 2010), designed to quantify the impacts of mine subsidence on the production and quality of agricultural vegetated environments. Monitoring was undertaken above longwall panels 301 to 305, comparing pillars, transition areas and areas of maximum subsidence within the panels. The research program employed a variety of traditional ground-based sampling techniques including biomass harvests and techniques, Leaf Area Index, pasture height, species composition and soil sampling along with proximal sensor data capture using a proximal crop reflectance sensor. Satellite imagery was also collected, and the high-resolution imagery used to monitor large areas of subsidence-affected areas and adjacent unmined land. A forage Sorghum site and an improved pasture were monitored. The outcomes of the research concluded there was no variance between subsided and unmined areas with respect to soil physical and chemical characteristics.

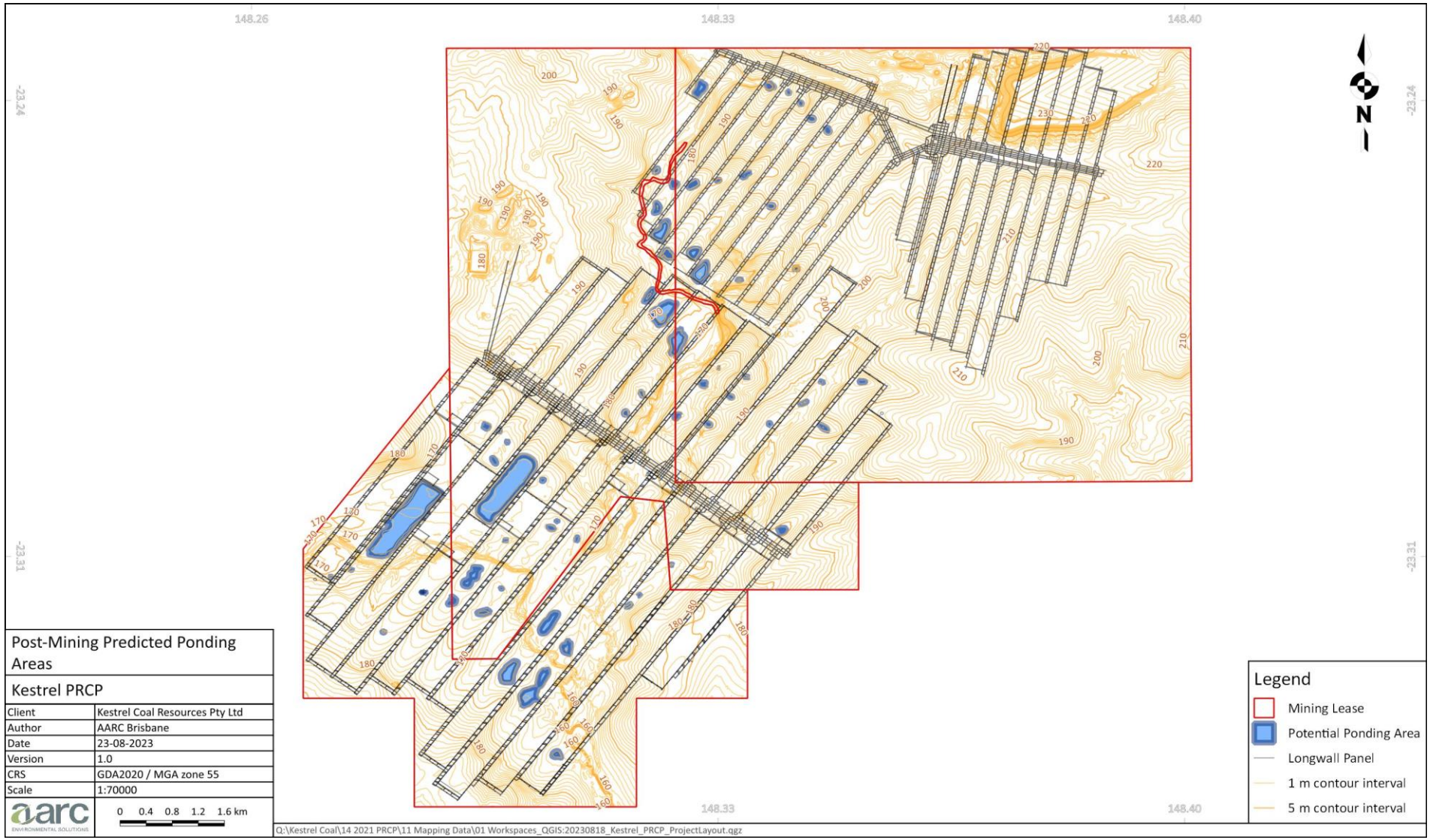


Figure 42: Inferred ponding subsequent to subsidence (revised mine plan incl. LW510)

3.5.13.3 Subsidence rehabilitation methodology

Rehabilitation of subsided land at the Project site is undertaken where subsidence-induced geomorphological landform change causes symptoms such as erosion, ponding or cracking that are unacceptable in extent or effect. Technical studies and experience to date have demonstrated that the majority of subsided land at the Project site does not require active or extensive rehabilitation i.e. where earthworks of any scale, is required to be undertaken. Where active rehabilitation is required, the objective is the return of the land to its pre-mining agricultural suitability as required by the relevant conditions of the RIDA.

Subsidence prediction assessments are typically undertaken in advance of each new panel series and updated as required to align with mine planning changes or where subsidence monitoring identifies a variation from predicted subsidence behaviour. Where longwall panels traverse watercourses or other sensitive landforms, these areas are delineated on the surface and observed during and following the passage of the longwall face. Pre- and post-subsidence survey monitoring is undertaken to assess and validate subsidence predictions.

Rehabilitation is planned and implemented in response to observations of adverse impact arising following the passage of each longwall panel. Exposure of non-riparian subsidence areas to at least two sufficiently large rainfall events and two wet seasons provides an indication of the landform's response to subsidence through erosion and vegetation growth. Unless observations indicate that earlier intervention is required, land subject to subsidence is observed for a period of at least two wet seasons (typically 30 months) to ensure that no further settlement has occurred and that adjacent areas are not subject to further subsidence which may result in additional changes to slope gradient.

Rehabilitation activities are typically contingent on the soils, slope gradients, and land use of the impacted area; and the impact type (subsidence, surface infrastructure or land management activities).

Pre-subsidence disturbance mitigation activities

Agricultural activities will be managed in advance of subsidence occurring to ensure that adequate pasture cover exists to minimise erosion potential. Any agricultural / soil control infrastructure in the path of subsidence will be removed or, if required to be retained, subject to structural engineering assessment with any management recommendations implemented.

As per watercourse assessment recommendations (Gilbert and Associates 2012), in areas where subsidence movements are predicted to result in moderate- or high risk instability to the bed and banks of a watercourse, stock will be excluded from the immediate bank and overbank areas prior to planned subsidence. Fencing will be installed as required to enable effective stock management to occur.

Rehabilitation of erosion / surface cracking arising from slope increases due to subsidence

Where changes to surface slopes result in localised instances of erosion, one or more of the following controls will be implemented:

- Where an erosion instance is identified; the location will be recorded, and the appropriate management and/or restoration approach determined.
- Where active erosion is present, erosion and sediment controls will be put in place in accordance with existing Project Erosion and Sediment Control Plan. This may include the installation of silt fences, hay bales, coir logs, or other erosion controls appropriate to the circumstances of the instance of erosion.
- Where required, stock controls will be put in place to exclude cattle from the area while mitigation and restoration activities are undertaken.
- Minor localised drainage works will be installed if there is a need to minimise run-on flows to the impacted area.

- Scarification and active revegetation of the impacted area in accordance with the methods described in Section 3.5.9. This procedure has been implemented successfully at the Project site over previous longwall panel series.
- Monitoring of the area will be undertaken in accordance with the rehabilitation monitoring and maintenance plan until the area is declared as having been fully restored.

Rehabilitation of ponding occurrences arising from subsidence

Where instances of ponding are predicted to occur as a result of surface elevation changes associated with subsidence, the following actions will be implemented:

- Instances of predicted ponding occurrences will be verified by detailed ground survey following the completion of longwall mining to confirm the possible extents of ponding and the associated catchment area.
- For the larger ponds (i.e. typically those larger than 2 ha), a hydrological assessment will be undertaken to assess the likely duration and areal extents of ponding.
- If ponding is assessed to be permanent and not be beneficial or complementary to the grazing PMLU, options to ameliorate through drainage works and/or regrading will be developed and assessed.
- Where the additional area to be disturbed as a result of remediation works is less than the area impacted by ponding, earthworks to provide localised drainage of the ponding area will be undertaken. Such works are expected to link ponded areas to existing drainage lines.

Rehabilitation of impacted watercourses and riparian zones

Where watercourses are observed to have been adversely impacted by subsidence – potentially exhibited as creek bed or bank erosion and associated bank steepening or undercutting – relevant expertise will be obtained to develop an appropriate rehabilitation strategy and program. Such works may include:

- exclusion of stock from creek bed and banks;
- vegetation re-establishment of watercourse banks in accordance with the methods described in Section 3.5.9;
- construction of rock armouring over high energy sections; and
- regrading of bed and banks to produce stable longitudinal profiles.

Stabilisation of watercourses is expected to occur naturally over time and with the implementation of effective rehabilitation strategies. A stream condition survey of Homestead Creek, which overlies the 200 series longwall panels, identified subsidence related channelisation and bed-cutting, and retreat of an outside bend 12 years from the cessation of mining 2004 (HEC 2016). The scale of these impacts was considered small and was expected to continue to trend towards a stable form over time without the need for active rehabilitation controls. The rehabilitation milestone completion criteria and schedule reflect that active rehabilitation is expected to be required in some areas for several years following longwall retreat, with continued monitoring to assess the trajectory towards a stable condition.

Where monitoring identifies sequential pooling and scouring of streambeds due to increased variation in longitudinal bed slope, watercourse monitoring will be instigated to ensure that detailed monitoring of the impacted sections is occurring. It is considered most beneficial to carefully monitor the natural re-establishment of the watercourse bed and only intervene if a critical area of pooling or scouring is observed. In this event the following activities could be considered, dependant on the severity of the impact:

- stabilise the pooled area inlets / outlets through regrading; and
- rock armouring of scouring sections as required.

3.6 Risk assessment

3.6.1 Risk assessment requirements

Section 126C(1)(f) of the EP Act requires the PRCP to identify the risks, for each PMLU, of a stable condition not being achieved and how the applicant intends to manage or minimise the risk.

A risk assessment has been carried out in accordance with the following standards:

- AS/NZS ISO 31000:2018 Risk management - Guidelines; and
- HB203:2012 Managing environment-related risk.

3.6.2 Risk assessment process

Any risk assessment needs to be undertaken with consideration of the scope, context and criteria relevant to the assessment. For this risk assessment, the following scope and purpose was discussed and agreed to:

> *The purpose of this risk analysis is to identify the risks of a stable condition for land not being achieved for the agreed PMLUs nominated, and the approach to be taken by the Project to manage and minimise the risks identified.*

For this risk assessment, risk scenarios (or 'threats') were identified and considered for each rehabilitation area associated with the Project. The causes attributable to each risk scenario were documented as well as the potential impacts. Existing controls were noted, defined as those reasonably expected to be in place for a Project of this nature and having appropriate and contemporary management systems. Each risk scenario was then assessed with respect to health, safety, the environment and compliance against the risk assessment schema outlined in Section3.6.3.

3.6.3 Risk assessment schema

Risks specific to the rehabilitation of the Project were classified using the risk classification schema which is described below. The risk assessment schema is based on Kestrel's risk assessment process and is comparable to those used widely within the mining industry. The schema comprises the following components:

- a control effectiveness ranking (Table 28) used for assessing the operational controls expected to be in place for a project of this type;
- a likelihood classification descriptors table (Table 29); and
- a consequence classification descriptors table (Table 30) intended to guide a consistent assessment of consequence.

Following a consensus determination of likelihood and consequence, the risk level was determined using the matrix shown in Table 31. For any risks classified as 'high' or above, mitigation and management measures were identified and documented. Mitigation and management measures were also documented for some lower-level risks.

Table 28: Control effectiveness ranking

Control Rank	Description	Guidance
C1	Substantially effective/adequate design	Controls are considered adequately designed and are operating effectively on almost all occasions
C2	Mostly effective/adequate design	Controls are considered adequately designed and are operating effectively on most occasions
C3	Inadequate design/partially effective	Controls are considered inadequately designed or are only operating to partial effectiveness on most occasions
C4	No controls/ineffective	There are no controls designed or the existing controls are operating ineffectively on all occasions

Table 29: Likelihood of exposure to the hazard

Likelihood	Descriptors
A – Almost certain	• Happens • Recurring event during the lifetime if a project / operation • Expected in usual circumstances • 100% - occurs several times a year
B - Likely (probable)	• Could easily happen • Event may occur frequently during the lifetime of an operation / project • Probably occur in most circumstances • 10% - occurs once or twice a year
C - Possible	• Could happen and has occurred at our operation or others • Event that may occur during the life of an operation / project • Might occur at some time • 1% - infrequent
D - Unlikely	• Has not happened yet, but could • Event that is unlikely or occur during the life of an operation / project • Could occur at some future time • 0.1% - few instances in industry or setting
E - Rare	• Conceivable, but only in extreme circumstances • Event that is very unlikely to occur during the life of an operation / project • Only occur in exceptional circumstances • <0.01% - relatively unknown in industry or setting

Table 30: Consequence classification descriptors

Category	Consequence Scale				
	1 -Minor	**2 – Medium**	**3 – Serious**	**4 – Major/Severe**	**5 - Catastrophic**
Safety	• Report only or minor injury requiring first aid treatment • Able to perform routine duties	• Minor injury requiring single occurrence of medical treatment • Able to perform routine duties	• Extensive injuries requiring complex medical treatments or surgery • Unable to perform routine duties and/or time off work	• Severe irreversible injury to one person up to potential / actual single fatality	• Severe irreversible injury to more than one person, up to potential / actual multiple fatalities
Health	• Minor exposure/ discomfort with little impact, no impairment	• Minor harm, no permanent impairment, isolated incident, limited OEL exceedances	• Harm or discomfort impacting quality of life • High exceedance level or pattern of exceedances	• Permanent significant impairment/discomfort impacting quality of an individual's life • Multiple areas & trend of frequent exceedances • Mines Inspectorate involvement	• Major to fatal impairment of multiple persons • Continual &/or widespread high OEL exceedances • Mines Inspectorate involvement, censure, potential for litigation
Environment and cultural heritage	• Localised or reversible impact/harm • Recovery of <1 shift • Isolated administrative/minor breach of heritage agreement without harm	• Localised or reversible impact/harm • Recovery of >1 week • Breach of heritage, harm able to be mitigated	• Widespread but reversible impact or harm • Recovery of > 1 month. Serious breach of heritage agreement, marked harm to heritage, likely settlement/potential litigation	• Significant on or offsite impact • Recovery >1-year • Major/continued breach of heritage agreement harm and heritage • Breakdown of relationship and settlement/likely litigation	• Catastrophic offsite impact and/or residual environment impairment • Long-term system recovery • Breach of heritage agreement and significant harm to heritage • Ongoing litigation & liability

Table 31: Risk level classification matrix

Likelihood	Consequence				
	Minor	**Medium**	**Serious**	**Major/Severe**	**Catastrophic**
A. Almost Certain	Moderate	High	Critical	Critical	Critical
B. Likely	Moderate	High	High	Critical	Critical
C. Possible	Low	Moderate	High	Critical	Critical
D. Unlikely	Low	Low	Moderate	High	Critical
E. Rare	Low	Low	Moderate	High	High

3.6.4 Risk assessment outcomes and management

Detailed risk assessment outcomes are provided in Appendix G. For the Project, a total of 52 individual risk scenarios were identified resulting in:

- no risk scenarios classified as 'Critical';
- 8 risk scenarios classified as 'High';
- 19 risk scenarios classified as 'Moderate'; and
- 25 risk scenarios classified as 'Low'.

A summary of risk outcomes is shown in Table 32.

The eight (8) High risks identified from the risk assessment can be grouped into the following categories:

- weed management risks; and
- geotechnical, erosional stability, contamination and PMLU achievement risks associated with the CDSF.

The 19 Moderate risks identified, span the same categories as the High risk group, but with the following additional categories:

- pollution and PMLU achievement risks associated with mine infrastructure areas including rehabilitated water storages;
- PMLU achievement within subsidence areas; and
- erosional risks with the diversion channel and contaminant risks with retained water storages.

Table 32: Risk assessment outcomes by rehabilitation area

Rehabilitation area	Risk level				
	Low	Moderate	High	Critical	Total
Mine infrastructure areas	5	4	1	0	10
Subsidence areas	9	3	1	0	13
Retained water management infrastructure (including drainage diversions)	3	3	0	0	6
Rehabilitated water management infrastructure	6	4	1	0	11
Co-disposal dry-stack facility	2	5	5	0	12
Total	**25**	**19**	**8**	**0**	**52**

3.6.4.1 Safety risks

No safety risks were identified above a risk ranking of low. This reflects the low disturbance levels associated with the operation.

3.6.4.2 Geotechnical and erosional stability risks

Geotechnical and erosional stability risks were solely associated with the CDSF landform which presents an elevated landform with higher slope gradients and specific material characteristics that create greater challenges to landform design and stability than the remaining areas of the Project site. As a consequence significant engineering design effort has been expended to mitigate these risks through engineering design.

3.6.4.3 Non-polluting risks

The potential for environmental harm arising from contaminants leaving the site relates to mine infrastructure areas and the CDSF which has a defined geochemical risk. Mine infrastructure areas will be assessed for contaminants with consideration of their specific uses and appropriate management measures developed and implemented. The CDSF has been designed specifically to mitigate the geochemical risks associated with the tailing and rejects stored therein.

3.6.4.4 The risk of not achieving a sustainable PMLU

For the majority of the Project site, the most significant risk of not achieving a sustainable PMLU is related to land management practices, particularly in relation to the management of weed species. Significant expertise exists in the region and local area related to land management practices for valued pasture establishment. This expertise will be utilised to best manage this risk.

3.7 Monitoring and maintenance

With respect to determining the achievement of the Project RMs, criteria have been defined for each rehabilitation milestone (see Section 3.5.4). Assessment of rehabilitation against milestone criteria will be a key objective of ongoing environmental monitoring undertaken for the Project. Monitoring of surface disturbance rehabilitation will commence following completion of activities of the first rehabilitation milestone applicable to the relevant rehabilitation area.

The completion criteria for each PMLU will be used as the milestone criteria for the final milestone in the proposed schedule, which shows achievement of the PMLU to a stable condition at surrender. When the final rehabilitation milestone applicable to the rehabilitation area is deemed to have been achieved, a final rehabilitation assessment will be undertaken before an application for progressive certification of the land is made.

The Rehabilitation Monitoring Plan for the Project is included in Appendix D.

Table 33: Rehabilitation milestone management and monitoring measures

Rehabilitation milestone	Description / criteria	Proposed management / monitoring measure(s)
RM1: Infrastructure decommissioning and removal	Applicable to all infrastructure identified to be decommissioned/ removed from site. Considered to be met when the area can be transitioned to the next milestone.	Infrastructure decommissioned/ removed at closure will be subject to strict environment and safety planning requirements including completion inspections. A visual inspection(s) will be conducted to determine that no infrastructure remains that does not form part of a Landholder Agreement.
RM2: Determination/ management of contaminated land status	Applicable to the mine infrastructure areas, rehabilitated water storages, and the CDSF (i.e. where notifiable activities have been carried out) and, at a minimum, involves the completion of a Phase 1 contaminated land investigation undertaken by an appropriately qualified person. Considered to be met when contaminated material has been placed removed from site, or remediated in situ, a validation report has been completed, and, if required, a site suitability statement has been prepared. Where required, remediation activities will be undertaken and recorded, and notifications completed.	A completed Phase 1 contaminated land investigation report, as well as any consequent reports where required. Visual inspection of potential sites or sources of contaminated material will be conducted, and samples collected as required. The contaminated land investigation will determine the presence of any contaminants. Remediation activities will be undertaken if required following consultation on appropriate remediation activities. A validation report will detail the remediation of contaminated land and, if required, a site suitability statement prepared by an appropriately qualified person that states that the land is suitable for use according to the nominated PMLU.
RM3: Landform development (reshaping, reprofiling, topdressing, seed bed preparation, soil amelioration) of good quality agricultural land (terrestrial)	Applicable to all RAs (excluding RA6) where bulk earthworks and other grading are required to achieve target landform shape and drainage characteristics. Considered to be met when final landform water storages are cleared and natural drainage is established and all other applicable disturbance areas have been reprofiled to suit the surrounding landform. Additionally, a geotechnical assessment will be conducted for RA3 to confirm that long-term geotechnical stability has been achieved. Applicable to all areas requiring revegetation. Includes final profiling and application of topsoil materials, soil testing, and soil amelioration. Considered to be met when surface preparation activities have been completed and soil condition is conducive to plant germination and growth.	Land based and/or remote sensing survey techniques will be employed to confirm that graded slopes meet design specifications. Additionally, visual inspections will be done to determine if any future maintenance/repair action is required. A geotechnical assessment will be conducted by an appropriately qualified person to confirm that long-term stability has been achieved for all relevant landforms. Records of topsoil placement indicating achievement of a target depth of the ≥ 0.3 m. Records to include any ameliorants applied, including types, rates and timing of applications. Visual inspections and documentation of contour ripping, including depth, spacing and machinery used.

Rehabilitation milestone	Description / criteria	Proposed management / monitoring measure(s)
RM4: Landform development (reshaping, reprofiling, topdressing, seed bed preparation, soil amelioration) of good quality agricultural land (riparian zones)	Applicable only to RA6 and required to achieve target landform shape and drainage characteristics. Applicable to all areas requiring revegetation. Includes final profiling and application of topsoil materials, soil testing, and soil amelioration. Considered to be met when surface preparation activities have been completed and soil condition is conducive to plant germination and growth.	Survey and stream condition assessment by an appropriately qualified person of completed areas. Records of topsoil placement indicating achievement of a target depth of the ≥ 0.3 m. Records to include any ameliorants applied, including types, rates and timing of applications. Visual inspections and documentation of contour ripping, including depth, spacing and machinery used.
RM5: Capping installation	Applicable to the CDSF and required to achieve target landform shape and drainage characteristics and demonstrate geotechnical stability. Considered to be met when surface preparation activities have been completed and soil condition is conducive to plant germination and growth.	Records of capping design and cover placement/depth in accordance with design criteria. Records to include any ameliorants applied, including types, rates and timing of applications.
RM6: Revegetation	Applicable to all RAs requiring revegetation. Includes seeding and/or planting of target revegetation species. Considered to be met when records demonstrate that seeding and/or planting of target species has been completed, with the understanding that remedial works such as reseeding or infill planting may be necessary to meet target vegetation completion criteria.	Survey of completed areas, and record of revegetation method retained. Records of seeded and/or planted species consistent with the species listed in Table 21: Species selection for revegetation
RM7: Achievement of surface stability (good quality agricultural land PMLU)	Involves monitoring and remediation works if monitoring identifies risks to the final rehabilitation criteria being achieved. Considered to be met when all completion criteria have been achieved and land is safe, stable, does not cause environmental harm and can sustain the nominated PMLU.	Recommendations for remedial works will be made where required, and remedial activities undertaken as soon as practicable.
RM8: Achievement of surface stability (grass community PMLU)	Involves monitoring and remediation works if monitoring identifies risks to the final rehabilitation criteria being achieved. Considered to be met when all completion criteria have been achieved and land is safe, stable, does not cause environmental harm and can sustain the nominated PMLU.	Recommendations for remedial works will be made where required, and remedial activities undertaken as soon as practicable.

Rehabilitation milestone	Description / criteria	Proposed management / monitoring measure(s)
RM9: Achievement of surface stability (riparian zones)	Involves monitoring and remediation works if monitoring identifies risks to the final rehabilitation criteria being achieved. Considered to be met when all completion criteria have been achieved and land is safe, stable, does not cause environmental harm and can sustain the nominated PMLU.	Recommendations for remedial works will be made where required, and remedial activities undertaken as soon as practicable.
RM10: Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land PMLU - terrestrial)	Rehabilitated areas to be assessed against all completion criteria developed with reference to analogue sites of similar characteristics and land use. Considered to be met when land can be transitioned to progressive certification.	Field surveys, drone and satellite data analysis as part of the annual rehabilitation monitoring.
RM11: Achievement of target post-mining land use to safe and sustainable condition (grass community PMLU)	Rehabilitated areas to be assessed against all completion criteria developed with reference to analogue sites of similar characteristics and land use. Considered to be met when land can be transitioned to progressive certification.	Field surveys, drone and satellite data analysis as part of the annual rehabilitation monitoring.
RM12: Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land PMLU - riparian zones)	Rehabilitated areas to be assessed against all completion criteria developed with reference to analogue sites of similar characteristics and land use. Considered to be met when land can be transitioned to progressive certification.	Field surveys, drone and satellite data analysis as part of the annual rehabilitation monitoring.
RM13: Achievement of target post-mining land use to safe and sustainable condition (retained water storage)	Rehabilitated areas to be assessed against all completion criteria developed with reference to analogue sites of similar characteristics and land use. Considered to be met when land can be transitioned to progressive certification.	Field surveys, drone and satellite data analysis as part of the annual rehabilitation monitoring.

Rehabilitation milestone	Description / criteria	Proposed management / monitoring measure(s)
RM14: Achievement of target post-mining land use to safe and sustainable condition (permanent creek diversion)	Rehabilitated areas to be assessed against all completion criteria developed with reference to analogue sites of similar characteristics and land use. Considered to be met when land can be transitioned to progressive certification.	Field surveys, drone and satellite data analysis as part of the annual rehabilitation monitoring. Visual inspections will be done to determine if any future maintenance/repair action is required. Recommendations for remedial works will be made where required, and remedial activities undertaken as soon as practicable.

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Appendix A. PRCP Schedule

Post-mining land uses (PMLU)										
Rehabilitation area	RA1									
Relevant activities	MIA outside of subsidence zones (incl. roads and access tracks, CHPP, product and ROM stockpile areas, buildings, offices)									
Total rehabilitation area size (ha)	440.6									
Commencement of first milestone: RM1	Land available prior to 2023 (PRCP implimentation) / All other land available commencing from 10/12/2023									
PMLU	Good quality agricultural land (grazing)									
Date area is available	Prior 2023	10/12/25	10/12/30	10/12/35	10/12/40	10/12/45	10/12/50			
Cumulative area available (ha)	115.3	115.3	115.3	440.6	440.6	440.6	440.6			
Milestone completed by	10/12/25	10/12/30	10/12/35	10/12/40	10/12/45	10/12/50	10/12/51			
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	115.3			440.6						
RM2	115.3			440.6						
RM3	115.3			115.3	440.6					
RM6	115.3			115.3	440.6					
RM7	115.3			115.3	115.3	440.6				
RM10		115.3	115.3	115.3	115.3	115.3	440.6			

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA2									
Relevant activities	CDF (including Rejects Return Dam and brine dam evaporation ponds)									
Total rehabilitation area size (ha)	310.7 ha									
Commencement of first milestone: RM1	10/12/2038									
PMLU	Grass Community									
Date area is available	10/12/38	10/12/40	10/12/45	10/12/50	10/12/55	10/12/60				
Cumulative area available (ha)	257.5	310.7	310.7	310.7	310.7	310.7				
Milestone completed by	10/12/40	10/12/45	10/12/50	10/12/55	10/12/60	10/12/63				
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	257.5		310.7							
RM2		257.5	310.7							
RM3		257.5	310.7							
RM5		257.5	310.7							
RM6		257.5	310.7							
RM8			257.5	310.7	310.7					
RM11				257.5	257.5	310.7				

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA3									
Relevant activities	Water management infrastructure (retained dams) Environmental Dam & Holding Dam									
Total rehabilitation area size (ha)	28.2									
Commencement of first milestone: RM1	10/12/2041									
PMLU	Water storage (stock water)									
Date area is available	10/12/41	10/12/45	10/12/50							
Cumulative area available (ha)	28.2	28.2	28.2							
Milestone completed by	10/12/45	10/12/50	10/12/55							
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	28.2									
RM2	28.2									
RM3		28.2								
RM6		28.2								
RM7		28.2								
RM13			28.2							

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA4									
Relevant activities	Water management infrastructure (retained creek diversion)									
Total rehabilitation area size (ha)	10.8									
Commencement of first milestone: RM1	10/12/2033									
PMLU	Good quality agricultural land (grazing)									
Date area is available	10/12/33	10/12/35	10/12/40	10/12/45						
Cumulative area available (ha)	10.8	10.8	10.8	10.8						
Milestone completed by	10/12/35	10/12/40	10/12/45	10/12/56						
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	10.8									
RM3		10.8								
RM6		10.8								
RM7			10.8							
RM14				10.8						

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA5									
Relevant activities	Water storages (not retained)									
Total rehabilitation area size (ha)	4.5									
Commencement of first milestone: RM1	10/12/2037									
PMLU	Good quality agricultural land (grazing)									
Date area is available	10/12/37	10/12/40	10/12/45							
Cumulative area available (ha)	4.5	4.5	4.5							
Milestone completed by	10/12/40	10/12/45	10/12/51							
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	4.5									
RM2	4.5									
RM3		4.5								
RM6		4.5								
RM7			4.5							
RM10			4.5							

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

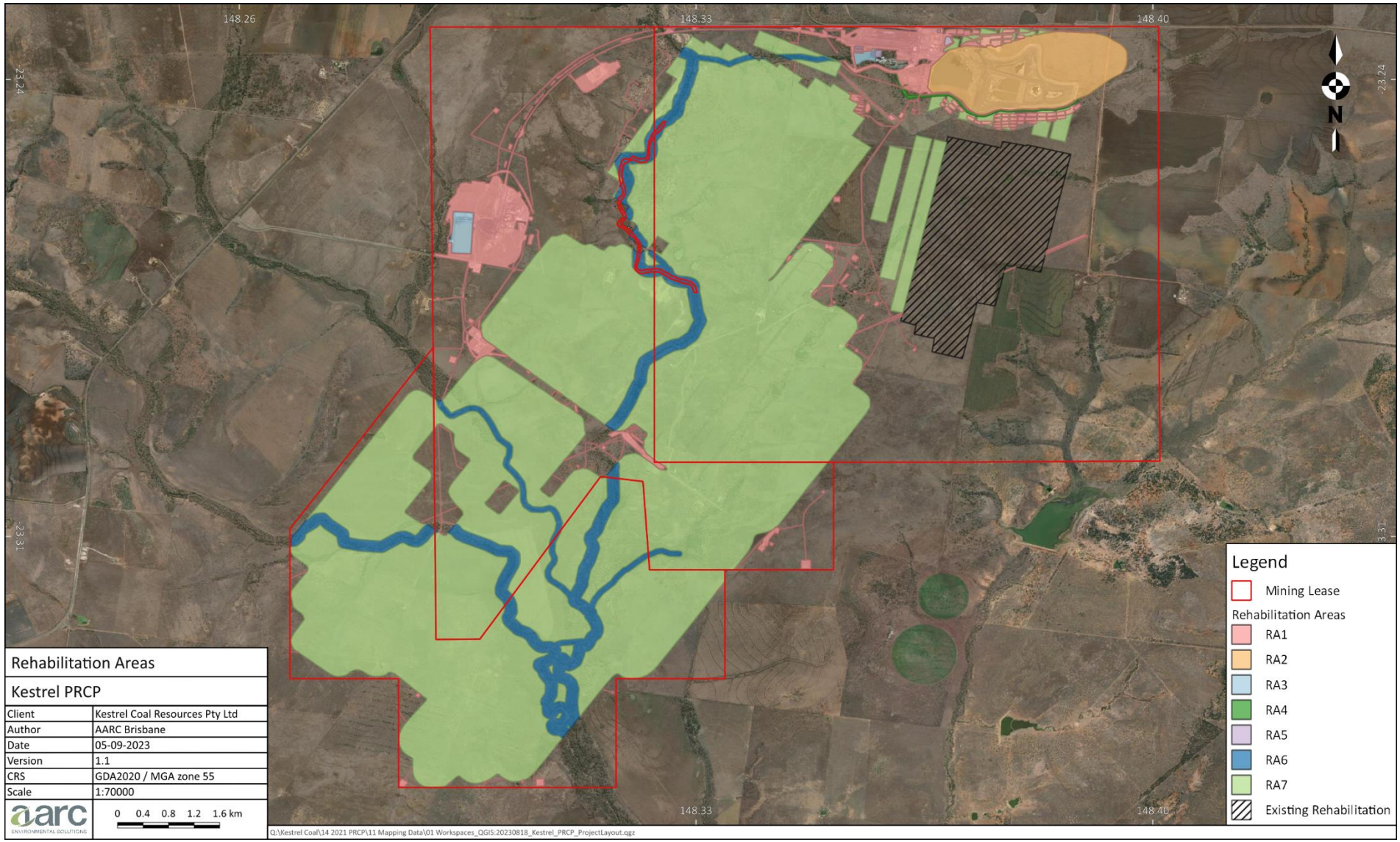
Post-mining land uses (PMLU)										
Rehabilitation area	RA6									
Relevant activities	Subsided land – riparian (excluding MIA)									
Total rehabilitation area size (ha)	510.2 ha									
Commencement of first milestone: RM1	Land available prior to 2023 (PRCP implimentation) / All other land available commencing from 10/12/2023									
PMLU	Good quality agricultural land (grazing)									
Date area is available	Prior 2023	10/12/23	10/12/30	10/12/35	10/12/40					
Cumulative area available (ha)	178.3	317.6	419.9	489	510.2					
Milestone completed by	10/12/23	10/12/30	10/12/35	10/12/40	10/12/45	10/12/50	10/12/55	10/12/57		
Milestone Reference	**Cumulative area achieved (ha)**									
RM4	178.3	97	419.9	489	510.2					
RM6	178.3	42.3	398.1	470.7	510.2					
RM9		178.3	220.6	398.1	470.7	510.2	510.2			
RM12			178.3	178.3	220.6	398.2	470.7	510.2		

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA7									
Relevant activities	Subsided land– pasture (excluding MIA, uncertified rehabilitation areas)									
Total rehabilitation area size (ha)	5,630.6 ha									
Commencement of first milestone: RM1	Land available prior to 2023 (PRCP implimentation) / All other land available commencing from 10/12/2023									
PMLU	Good quality agricultural land (grazing)									
Date area is available	Prior 2023	10/12/23	10/12/30	10/12/35	10/12/40	10/12/45	10/12/50			
Cumulative area available (ha)	2071.6	3549.2	4540.2	5412.3	5630.6	5630.6	5630.6			
Milestone completed by	10/12/23	10/12/30	10/12/35	10/12/40	10/12/45	10/12/50	10/12/52			
Milestone Reference	**Cumulative area achieved (ha)**									
RM2	2071.6	3549.2	4540.2	5412.3	5630.6					
RM3	2071.6	2978.9	4315.7	5035.9	5630.6					
RM6	2071.6	2812.7	4051.7	5035.9	5630.6					
RM7		2303.1	3310.2	4315.7	5203.9	5630.6				
RM10		2071.6	2303.1	3310.2	4315.7	5203.9	5630.6			

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Appendix B. PRCP Reference Map, Final Site Design and Stage Plans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148.33
148.40
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Legend
Mining Lease
Rehabilitation Areas
RA1
RA2
RA3
RA4
RA5
RA6
RA7
Existing Rehabilitation
Rehabilitation Areas
Kestrel PRCP
Client
Kestrel Coal Resources Pty Ltd
Author
AARC Brisbane
Date
05-09-2023
Version
1.1
CRS
GDA2020 / MGA zone 55
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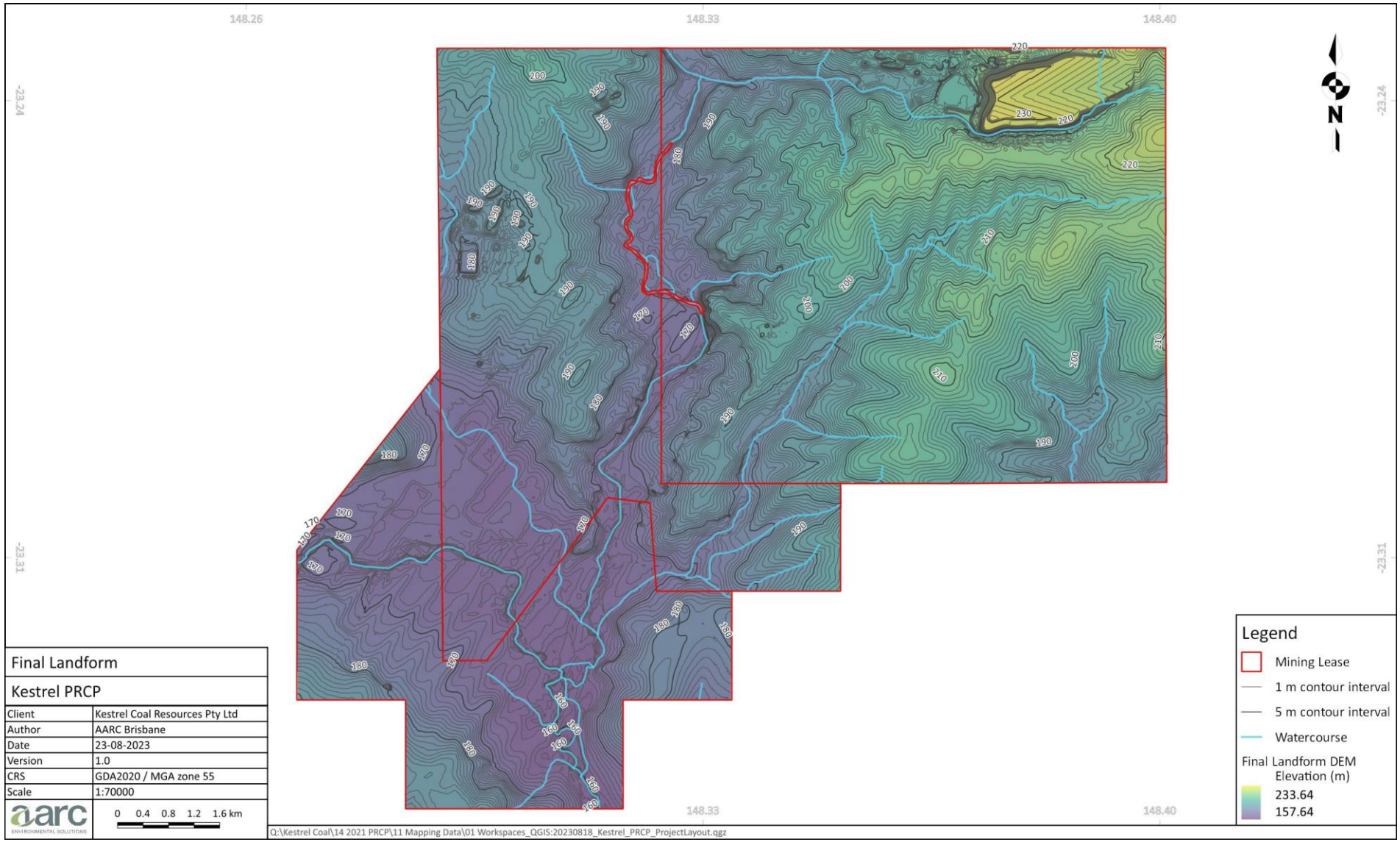
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148.33
148.40
-23.24
-23.31
N
Legend
Mining Lease
1 m contour interval
5 m contour interval
Watercourse
Final Landform DEM Elevation (m)
233.64
157.64
Final Landform
Kestrel PRCP
Client Kestrel Coal Resources Pty Ltd
Author AARC Brisbane
Date 23-08-2023
Version 1.0
CRS GDA2020 / MGA zone 55
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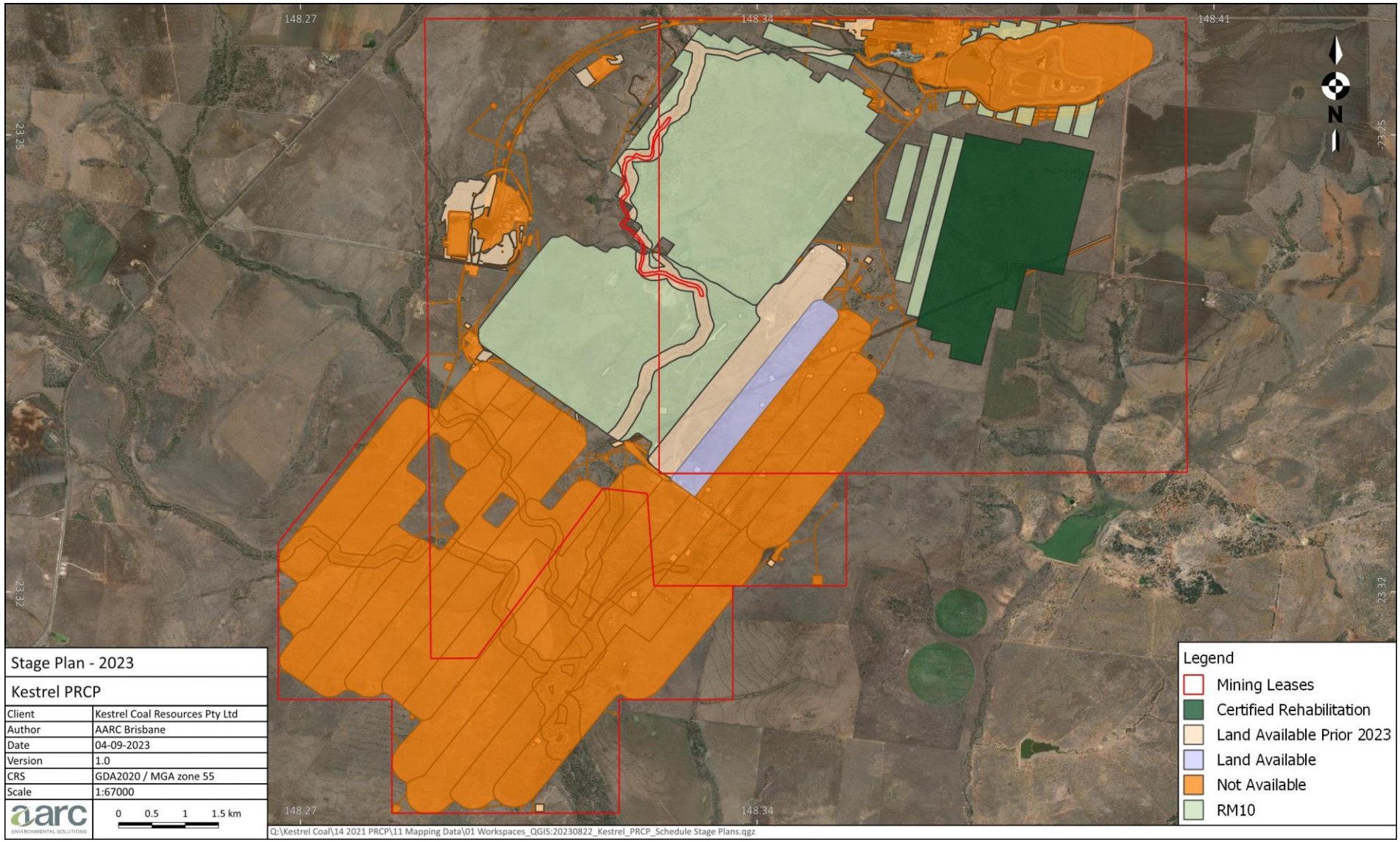
148.27
148.34
148.41
-23.25
-23.32
N
Stage Plan - 2023
Kestrel PRCP
Client | Kestrel Coal Resources Pty Ltd
Author | AARC Brisbane
Date | 04-09-2023
Version | 1.0
CRS | GDA2020 / MGA zone 55
Scale | 1:67000
0 0.5 1 1.5 km
Legend
Mining Leases
Certified Rehabilitation
Land Available Prior 2023
Land Available
Not Available
RM10
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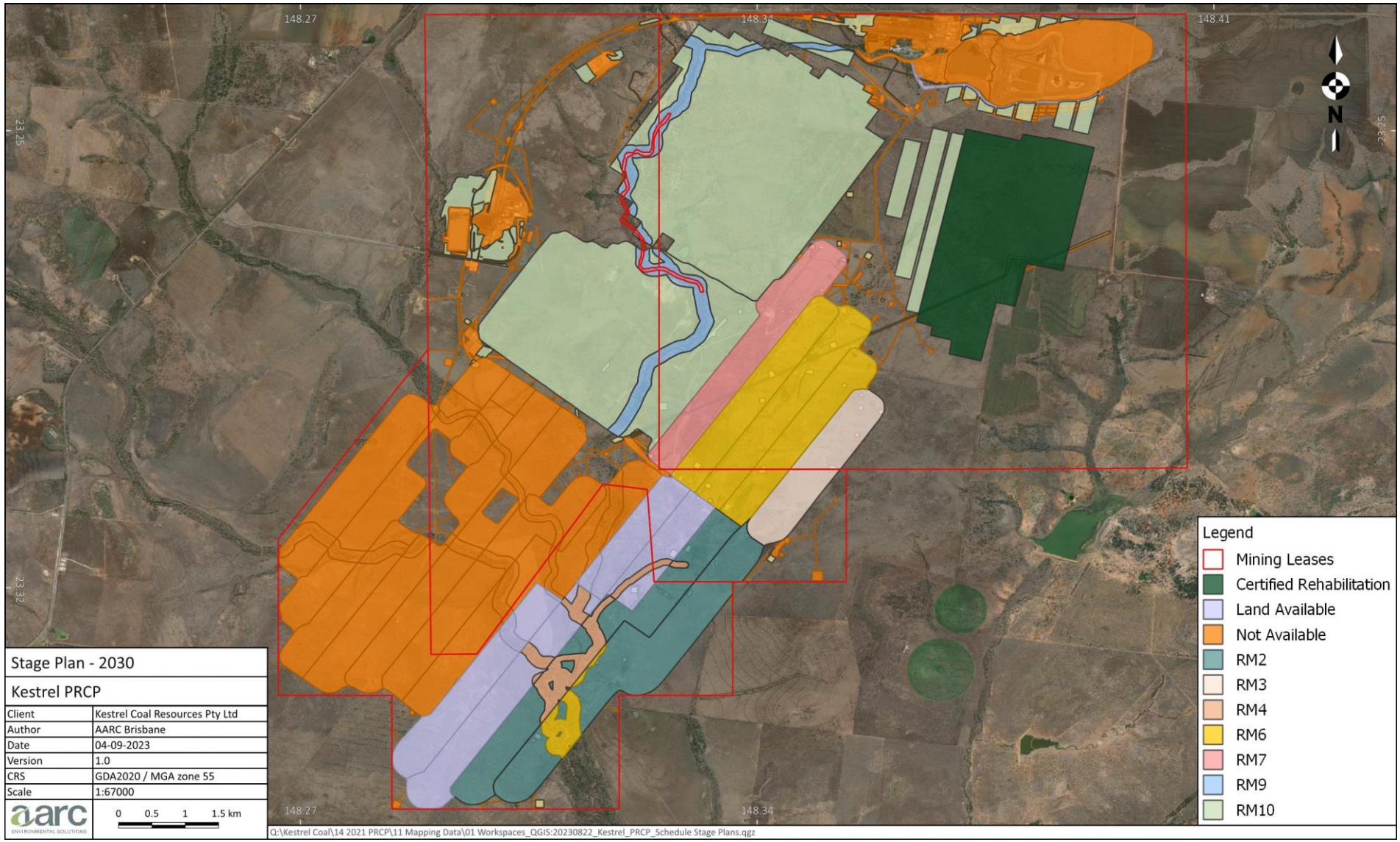
148.27
148.34
148.41
-23.25
-23.32
N
Legend
Mining Leases
Certified Rehabilitation
Land Available
Not Available
RM2
RM3
RM4
RM6
RM7
RM9
RM10
Stage Plan - 2030
Kestrel PRCP
Client
Kestrel Coal Resources Pty Ltd
Author
AARC Brisbane
Date
04-09-2023
Version
1.0
CRS
GDA2020 / MGA zone 55
Scale
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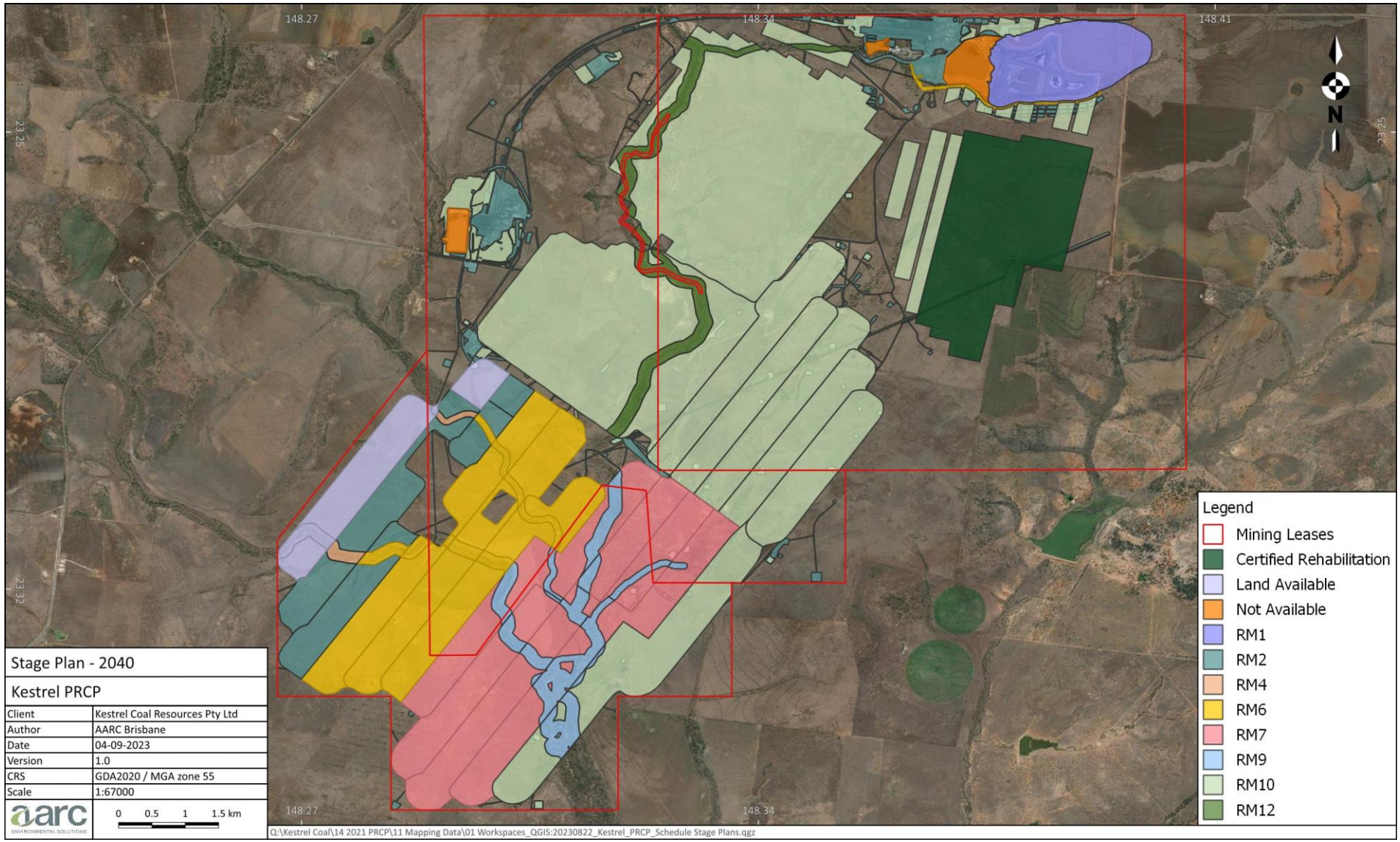
148.27
148.34
148.41
23.26
23.32
N
Legend
Mining Leases
Certified Rehabilitation
Land Available
Not Available
RM1
RM2
RM4
RM6
RM7
RM9
RM10
RM12
Stage Plan - 2040
Kestrel PRCP
Client
Kestrel Coal Resources Pty Ltd
Author
AARC Brisbane
Date
04-09-2023
Version
1.0
CRS
GDA2020 / MGA zone 55
Scale
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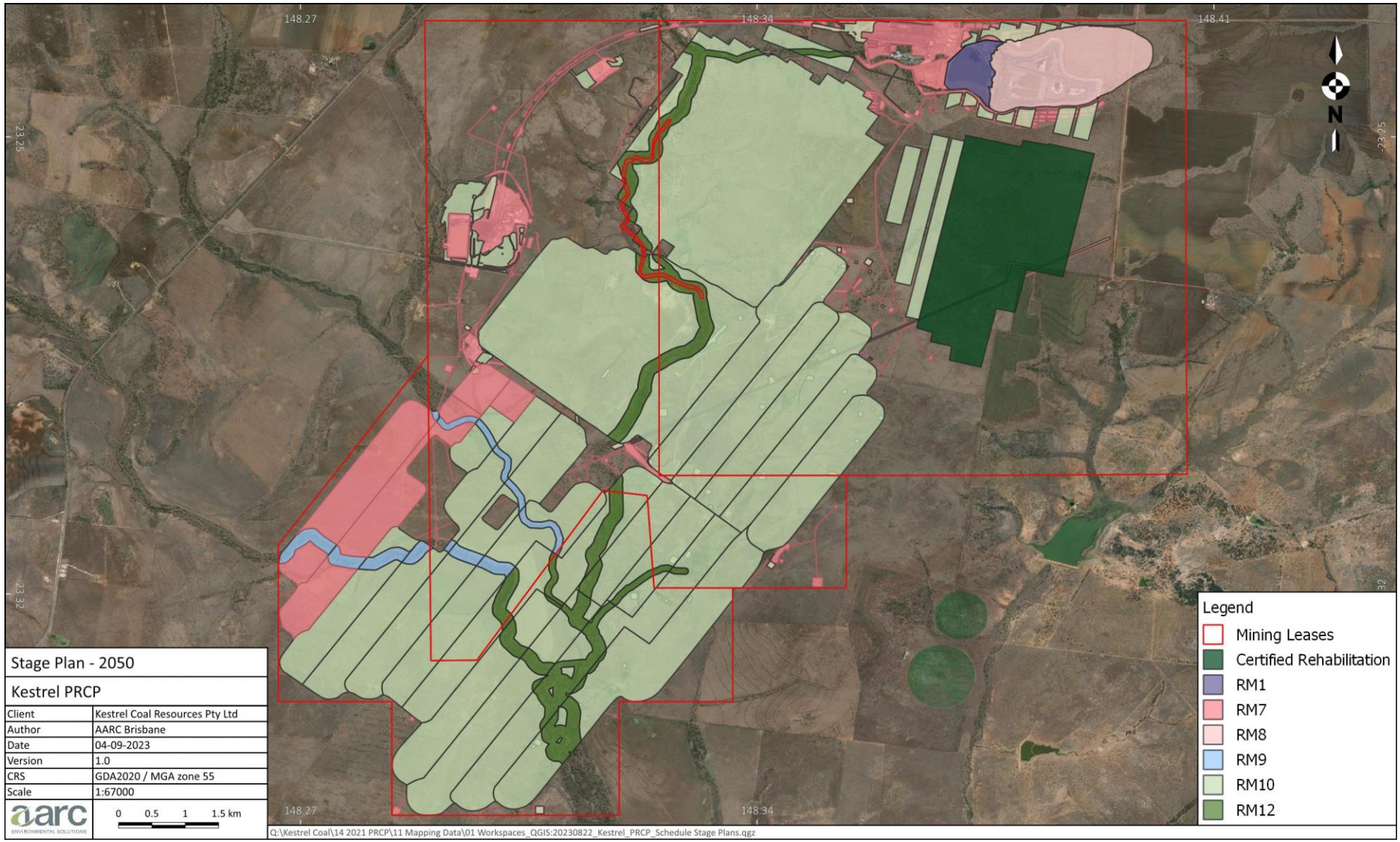
148.27
148.34
148.41
-23.25
-23.32
N
Legend
Mining Leases
Certified Rehabilitation
RM1
RM7
RM8
RM9
RM10
RM12
Stage Plan - 2050
Kestrel PRCP
Client | Kestrel Coal Resources Pty Ltd
Author | AARC Brisbane
Date | 04-09-2023
Version | 1.0
CRS | GDA2020 / MGA zone 55
Scale | 1:67000
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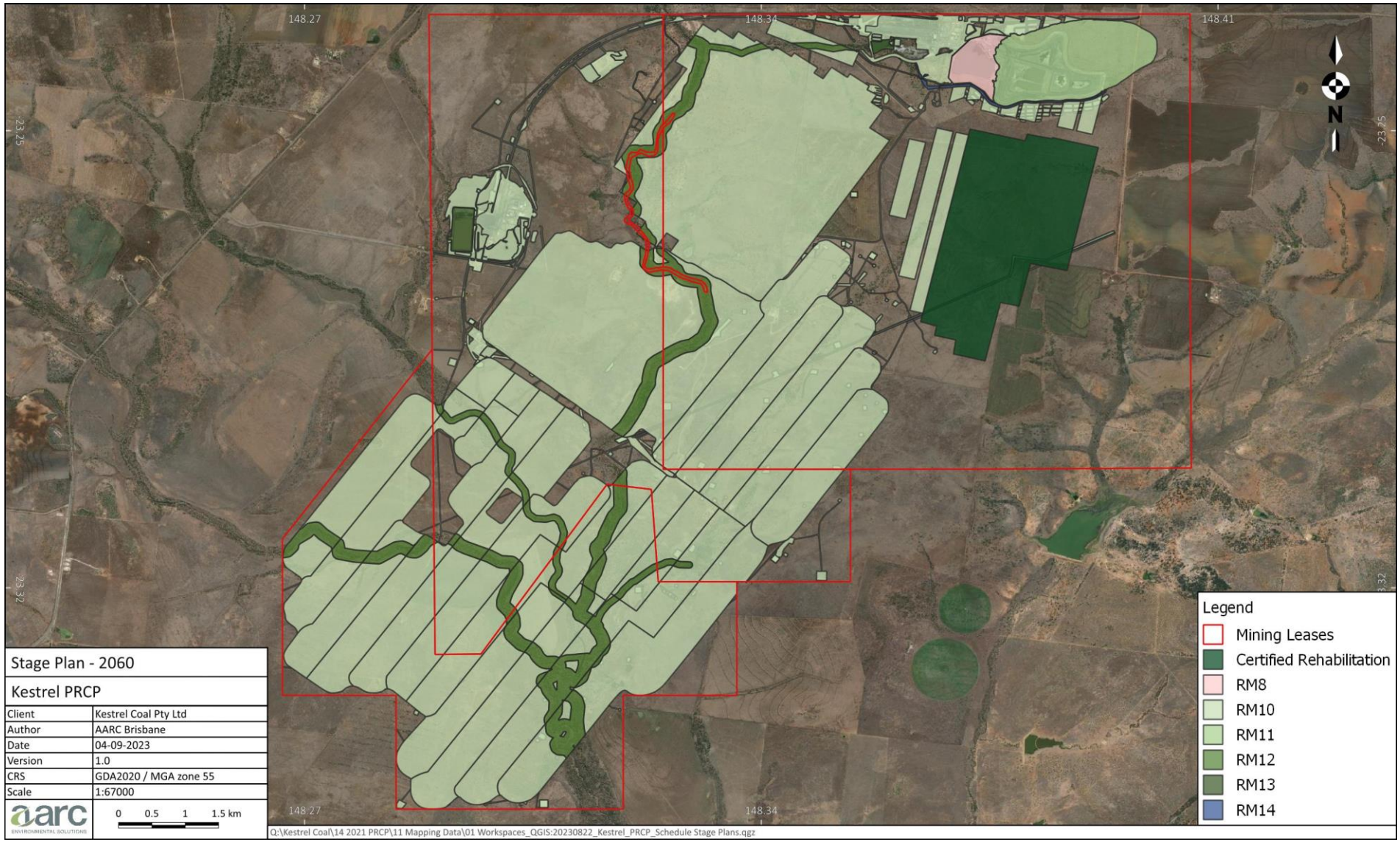
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148.34
148.41
-23.25
-23.32
N
Legend
Mining Leases
Certified Rehabilitation
RM8
RM10
RM11
RM12
RM13
RM14
Stage Plan - 2060
Kestrel PRCP
Client | Kestrel Coal Pty Ltd
Author | AARC Brisbane
Date | 04-09-2023
Version | 1.0
CRS | GDA2020 / MGA zone 55
Scale | 1:67000
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148.27
148.34
148.41
-23.25
-23.32
N
Legend
Mining Leases
Certified Rehabilitation
RM10
RM11
RM12
RM13
RM14
Stage Plan - 2063 (EOM)
Kestrel PRCP
Client | Kestrel Coal Resources Pty Ltd
Author | AARC Brisbane
Date | 04-09-2023
Version | 1.0
CRS | GDA2020 / MGA zone 55
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Q:\Kestrel Coal\14 2021 PRCP\11 Mapping Data\01 Workspaces_QGIS:20230822_Kestrel_PRCP_Schedule Stage Plans.qgz

Appendix C. Stakeholder Engagement Plan

Kestrel Coal Resources - Stakeholder Engagement Framework							
Engagement Grouping	**Purpose**	**Examples of Activities**	**Stakeholders**	**Actions Required**	**Timing or Frequency**	**Responsible for Delivery**	**Resources & Tools**
Information Sessions and Briefings	Sharing relevant information, at a time appropriate to project requirements	Groundwater and Environmental information sessions Neighbour's/ Open Day Community UNLEASHED	Landowners or Land Managers impacted by activities relating to delivery of PRCP.	Identify Target Audience Coordinate invitations, distribute accordingly Preparation and approval of presentation materials relevant to target audience	As required	Site Teams Sustainability Team Communications Team Contracts & Commercial Services Team	Presentation Templates
Operational Notices	Inform potentially affected groups on changes to Kestrel operations that may cause impacts or interruptions.	Notice of Entry Blast Notifications Road Closures	Internal and external stakeholders requiring visibility of operational activities that may cause interruptions to stakeholder activity	Identify Target Audience, dependent on action to be notified Preparation and approval of notice to be distributed	As required	Site Team (Operations / Environment / Geotech)	Operations Notice Template and Email notification
Environmental Notices	Inform potentially affected groups on changes to Kestrel operations that may cause impacts or interruptions.	Water related Notifications Environmental Notifications Backburn Notifications	Internal and external stakeholders requiring visibility of operational activities that may cause interruptions to stakeholder activity	Identify Target Audience, dependent on action to be notified Preparation and approval of notice to be distributed	As required	Superintendent Environment	Environmental Management Plan Environmental Notice Template
Liaison Committee	Maintain regular communications with parties to the LC, and meet commitments within the CHIMA	Conduct relevant meetings as required under the CHIMA	Western Kangoulu Appointed Representatives Kestrel Appointed Representatives	Coordinate invitations, distribute to Committee Members Preparation and approval of Meeting Agenda and materials relevant Committee Members	As required	GM Strategy & Planning Manager Sustainability	CHIMA Liaison Committee minutes
Major Projects	Consult with relevant parties as required to meet the expectations of relevant stakeholders.	Mine Development Plans Environmental Approvals Emission reduction initiatives PRCP Delivery Plan	Neighbours Nearby Landowners DOR / DES / DAWE Western Kangoulu People Govt Referral Agencies Other impacted parties	Identify Target Audience Prepare specific Engagement Mgt Plan, where required Consolidate relevant information, in preparation for submission of applications	As required	GM Strategy & Planning Manager Sustainability Superintendent Environment	Engagement Plan
Geological Exploration	Engagement with landowners who may be impacted by KCR's proposed exploration activities	Stakeholder meetings Procurement of Contractor Services	Impacted Landowners	Identify Target Audience, dependent on action to be notified Preparation and approval of communication material to be distributed	As required	Superintendent Geology	Notice of Entry Template

Kestrel Coal Resources - Stakeholder Engagement Framework							
Engagement Grouping	**Purpose**	**Examples of Activities**	**Stakeholders**	**Actions Required**	**Timing or Frequency**	**Responsible for Delivery**	**Resources & Tools**
Cultural Heritage works on country	Maintain appropriate communications with Native Title Applicants regarding Cultural Heritage works onsite	Cultural Heritage Surveys Cultural Heritage Awareness Program WK Ed (School engagement program) Monitoring	Western Kangoulu Representatives and supporting Service Providers	Identify Target Audience Prepare targeted Engagement Plan (if required) Consolidate relevant information, in preparation for execution of activities	As required	Sustainability Team	Cultural Heritage Mgt Plan CHIMA
Consultation Management	Maintain a register of all formal complaints and consultation, as required under EA	Complaints Register Consultation Register Consultation Manager	Internal and external stakeholders potentially impacted by Kestrel operational activities	Follow incident reporting process Adhere to Consultation Management process	As required	Site Teams Sustainability Team Communications Team Contracts & Commercial Services Team	Engagement Register HSMS Incident Reports for Complaints
Community Goodwill	Nurture genuine commitment to community through partnerships that build strong relationships and foster growth and opportunity.	Goodwill Gestures Community Grants Program Ad hoc Sponsorships	Landowners or Land Managers impacted by activities relating to development of Kestrel West.	Identify Target Audience Prepare specific Engagement Mgt Plan, where required Consolidate relevant information, in preparation for execution of activities	As required	Sustainability Team Communications Team	Kestrel website Internal channels

Appendix D. Monitoring and Maintenance: Subsidence Management Plan

DDD-XXX-NNNNN

Kestrel SHMS - Report

<Subsidence Management Plan: ML70481>

Status: <.>
Revision: <NN> (DD MM.YYYY)
Business Owner: <>
MoC Reference: <if applicable>

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Abbreviations

ALS	Airborne laser scanning
AMU	Agricultural Management Unit
EA	Environmental Authority
ESCP	Erosion and Soil Conservation Plan
GDP	Ground Disturbance Permit
Kestrel Mine	Kestrel Coal Mine
Kestrel Coal	Kestrel Coal Resources Pty Ltd
Lidar	Light detection and ranging
ML	Mining Lease
PMLU	Post mining land use
RIDA	Regional Interests Development Approval
RUSLE	Revised Universal Soil Loss Equation
SCL	Strategic Cropping Land
SCP	Soil Conservation Plan
SLSA	Soil and land suitability assessment
SMP	Subsidence Management Plan

1 Purpose

This subsidence management plan (SMP) has been developed to meet conditions G4 and G5 of environmental authority (EA) EPML00693413. These conditions were added to the EA at the time of approval of ML70481 and state:

> ***G4 Subsidence***
>
> *A Subsidence Management Plan must be developed by an appropriately qualified and experienced person to deal with actual or potential impacts of subsidence and submitted to the administering authority at least three (3) months prior to the commencement of extension no. 4 (500 series) mining activities.*
>
> ***G5***
>
> *The Subsidence Management Plan must:*
>
> *a) provide for the proper and effective management of the actual and potential environmental impacts, including not limited to land, surface and groundwaters resulting from the mining activity and to ensure compliance with the conditions of this environmental authority;*
>
> *b) describe the proposed impacts of subsidence on any land, watercourse and floodplain including but not limited to:*
>
> *i. physical condition of surface drainage;*
>
> *ii. overland flow;*
>
> *iii. water quality;*
>
> *iv. land condition: current land condition to be impacted by subsidence;*
>
> *v. infrastructure: detail of existing infrastructure (pipelines, railway, power lines and haul roads) should be identified where there is a potential impact from effects of land subsidence; and*
>
> *c) propose options for mitigating any impacts associated with subsidence and how these mitigation methods will be implemented.*

It should be noted that a number of additional conditions apply to management of the 500-series panels relating to annual inspections which must be undertaken between 1 April and 1 November each year (refer conditions G7 to G9); as well as condition G10 which related to ponding occurring as a result of subsidence.

It should also be noted that the *Regional Planning Interests Act 2014* (RPI Act), which identifies and protects areas of regional interest throughout Queensland, applies to much of ML70481 as this area is located within a trigger-mapped Strategic Cropping Area. Consequently, other management plans exist that apply to the ML70481 area which must also be adhered to.

1.1 Background

The Kestrel Coal Mine (Kestrel Mine) is located in the Bowen Basin, approximately 51 km northeast of Emerald in central Queensland, Australia.

Coal extraction and production occurs at depths of 300–450 m, with production rates of 8–10 Mt run of mine coal per year. The current approved life of mine includes mining of a further series of longwall panels, referred to as the 500 series, which extends into ML70481 at depths of between 220 m and 470 m. Typical mining seam thickness ranges between 2.5–3.1 m with the longwall minimum extraction height being 2.6 m.

Mining operations up to and including the 400 series longwall panels have occurred on mining leases (MLs) ML1978, ML70301, ML70302, and ML70330. In 2016, ML70481 was granted to enable operation of the 500 series longwall panels.

Kestrel holds all of the freehold titles for all surface properties associated with the MLs with the exception of a parcel of State-owned land (Lot 8 on TT424), which lies within a watercourse reserve (see Figure 1) and Lot 23 on SP220221. Kestrel manages agricultural lessees carrying out pastoral activities across all freehold lands not utilised for mining activities.

1.2 Scope

The scope of this SMP is to manage subsidence associated with the 500 series of longwall panels. The controls and mitigation measures outlined here have generally been applied across all previous longwall panel operations. Figure 1 shows the current layout of the LW500 panel footprint and the boundary of ML70481.

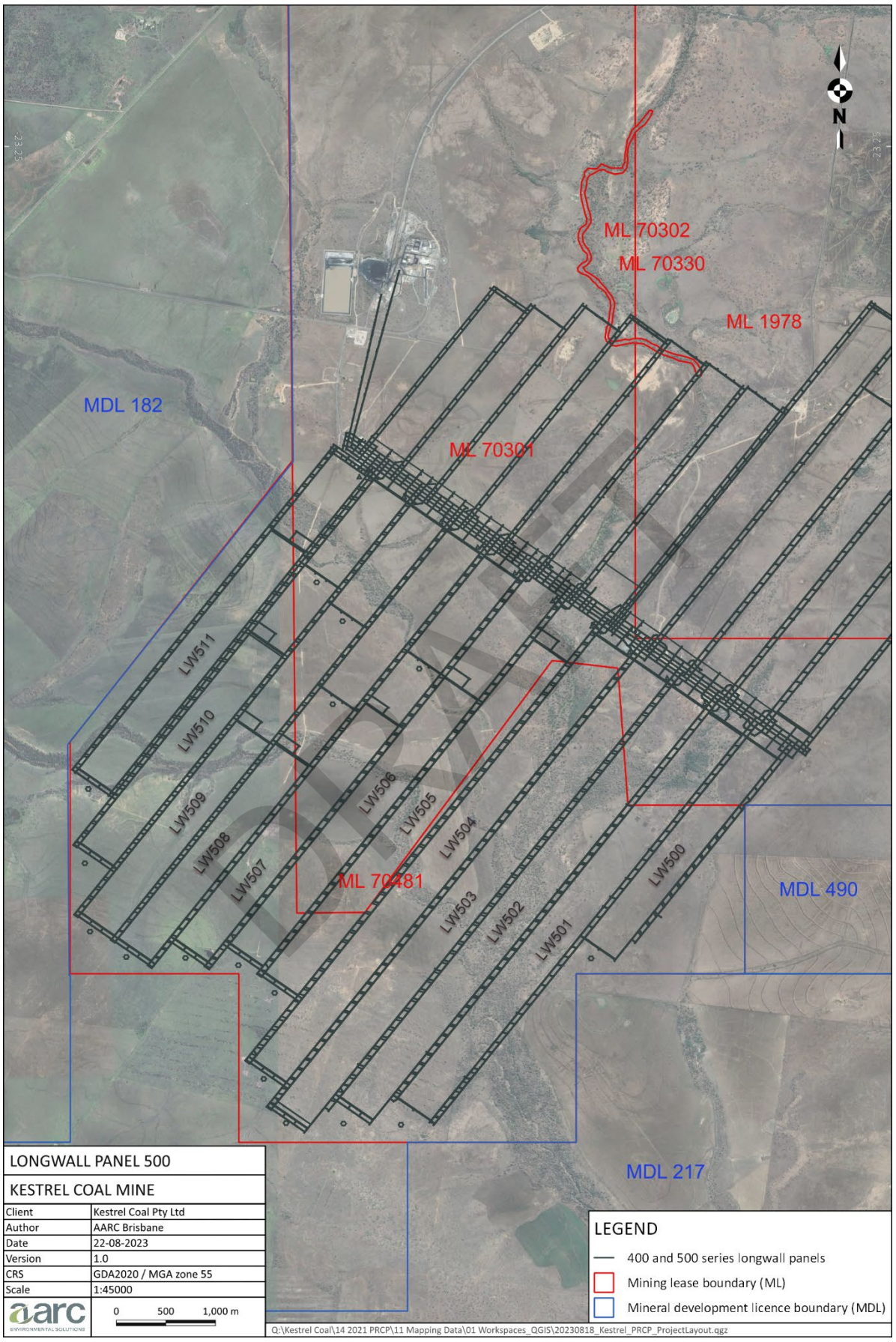

Figure 1: 500 series mine plan

2 Baseline ground conditions

2.1.1 Soil characterisation

From Highlands Environmental (2022), the distribution of soil unit types (as 'Soil Landscapes') for ML70481 is based primarily on lithology/parent material and then discriminated according to the Agricultural Management Unit (AMU) classification of Bourne and Tuck (1993) – refer Table 1, Table 2 and Figure 2.

Table 1: Soil Landscapes classification of ML70481

Soil Landscape lithology / parent material	Soil Landscapes /AMU
Derived from recent Quaternary alluvium (Qa) sediments	Adelong; Isaac; College; Lascelles
Derived from Tertiary basalt (Tb) sheets	Orion; Jimbaroo
Derived from older Emerald Eocene (Te, w) reworked sediment	Picardy, Springton

* After Highlands Environmental 2022

Table 2: Soil Landscapes description of ML70481

Land resource area	Soil landscape		Description
Undulating Downs	Orion	1a	Deep clay soils (>60 cm depth) with surface stone on gently undulating plains and rises.
	Jimbaroo	1b	Shallow clay soils (<60 cm depth) with surface stone on undulating plains and rises.
Alluvial Plains	Adelong	2a	Deep uniform (>100 cm depth) clay soils on level alluvial plains.
	Isaac	2b	Deep (>100 cm depth) uniform sandy clay soils on levees and alluvial plains.
	College	2c	Deep (>100 cm depth) clay soils with highly saline and sodic subsoils.
	Lascelles	2d	Deep (>100 cm depth) duplex soils with sandy A horizons and poorly drained subsoils.
Undulating Scrub Plains	Picardy	3a	Deep clay soils (>100 cm depth) on gently undulating plains and rises.
	Springton	3b	Deep (>100 cm depth) clay soils with calcareous subsoil on gently undulating plains and rises.

* After Highlands Environmental 2022

Full soils characterisations (including soil profile descriptions and soil depths, site and soil hydrology, and soil surface condition) are provided within the Highlands Environmental (2022) report.

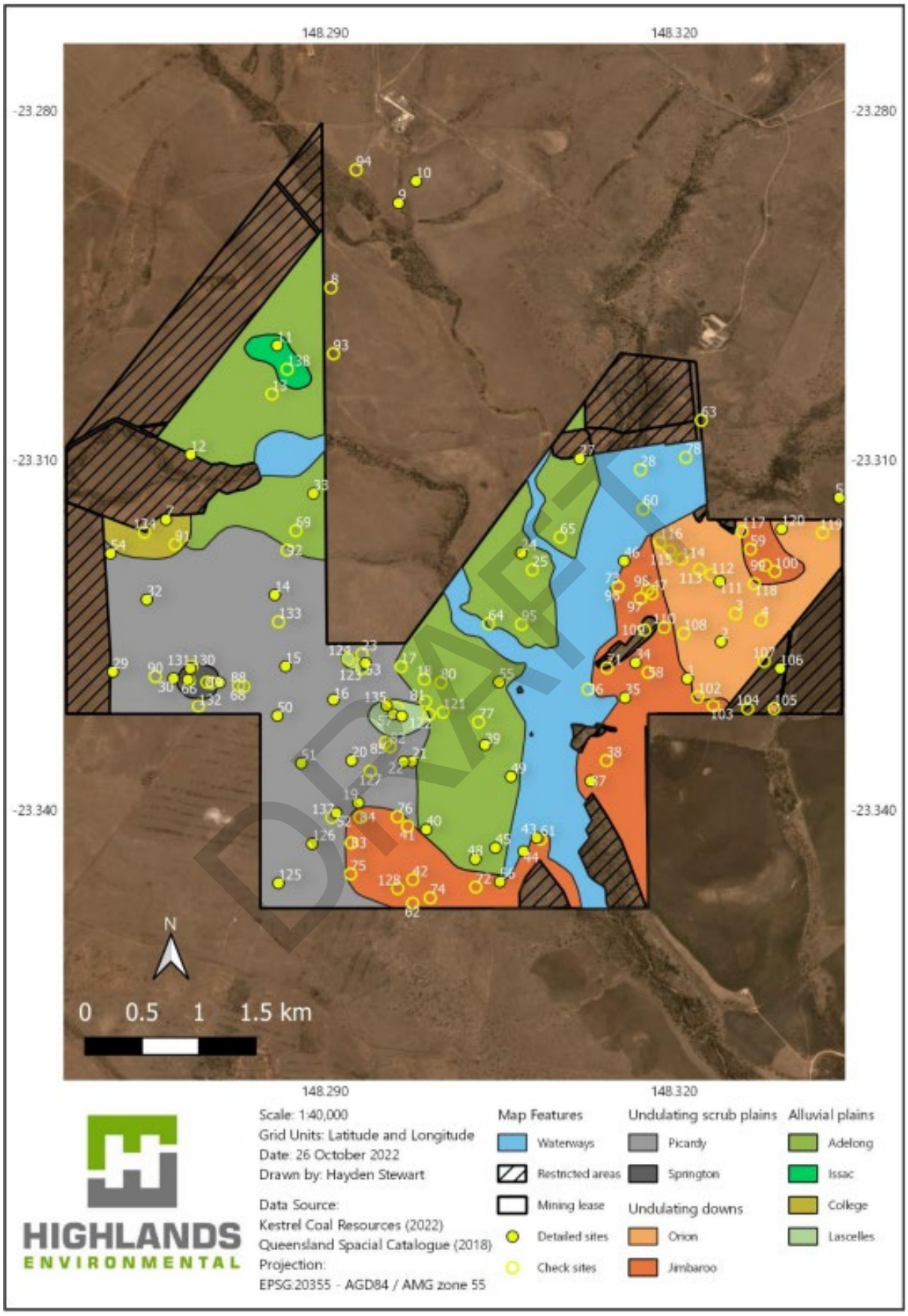

Figure 2: Soils of ML70481 (Highlands Environmental 2022)

3 Impacts from land disturbance activities

4.2 Longwall panel subsidence

The principal land disturbance associated with underground mining activities at Kestrel Mine is subsidence arising as the longwall progressively extracts the coal seam. Subsidence predictions have been undertaken for the 500 series showing the maximum vertical subsidence is predicted to range from between 1.4–2.4 m mid-panel (LW500) to 2.4 m 0.1 m over longwall inter-panel pillars.

3.1 Longwall panel subsidence impacts

Subsidence predictions for the 500 series, have been undertaken by Mine Subsidence Engineering Consultants (MSEC 2022) using the Incremental Profile Method developed by Waddington and Kay (1995); being an empirical method used to predict subsidence, tilts, curvatures and strains likely to be experienced as longwall mining occurs and to assess the effects of mining on surface infrastructure.

A detailed description of the standard Incremental Profile Method is provided in background reports that can be found at www.minesubsidence.com. The prediction profiles are revised from time to time as more observed subsidence data is collected and can be calibrated to local conditions based on local monitoring data.

The Incremental Profile Method has been tested for Kestrel Mine at the time of each subsidence prediction by comparing predicted and ground surveyed movements during the mining of the 400 series of longwalls. For predictions undertaken in 2022, monitoring data from longwalls 401 to 409 has been used for calibration of the IPM model.

Data referred to in this SMP is taken from the most recent update for panels LW500 to LW510 (MSEC 2022).

The slopes and troughs formed as a result of subsidence are subtle and not easily distinguishable from the surrounding topography, as the range of movement associated with subsidence is well within the range of natural elevation variation. In other words, the topography of subsided areas is not inconsistent with the surrounding un-subsided topography (i.e. gently rolling country with low relief).

Potential land impacts associated with subsidence include localised changes in slope, surface tensile cracking, and changed drainage systems including, in some areas, localised ponding. Where waterways traverse subsidence areas, localised longitudinal slope increases and waterway realignment may occur. These impacts are discussed in the following subsections.

Timing of subsidence at Kestrel is well understood from subsidence monitoring undertaken across the prior series longwall footprints. Monitoring indicates that at mining rates of 80–100 m per week, the majority of the subsidence on the surface occurs about 300 m behind the mining face with minor residual subsidence (subsoil settlement) of approximately 20–30 mm thereafter. At these rates of longwall retreat, 97% of maximum subsidence is achieved between four and six weeks of the longwall face retreating past any given point on the surface.

Subsidence reports are prepared annually in accordance with Condition 2 of the Special Lease Conditions of ML1978.

3.1.1 Subsidence-induced erosion impacts

Erosion impacting both land and/or watercourses, is a potential outcome from subsidence-induced increases in slope. Site experience and subsidence monitoring observations to date reinforce the current understanding that the soil types located within the ML70481, being high shrink-swell clays throughout their profile, are resilient to movement and, at the low slopes present and under the current grazing land use, have demonstrated low rates of erosion given their low erodibilities and calculated rates of soil loss.

Despite the favourable inherent characteristics of the soils, increases in localised erosion rates occurring post-disturbance is a possible risk that requires monitoring and that may, in some cases require remediation. Certain surface landforms, and particularly those more prone to erosion naturally, for example watercourses and steeper slopes, may require additional attention. Management measures are outlined in Section 4.

3.1.2 Subsidence-induced hydrological impacts

Kestrel is located in the upper and middle reaches of the Crinum Creek catchment and is drained by a number of small ephemeral gullies and tributaries of Crinum, Belcong and Homestead Creeks.

The observed impacts to overland flow and surface drainage arising from subsidence related to earlier longwall panels have included:

- localised re-direction of overland flow and changes to minor drainage paths, disruption to remnant contour banks, localised changes to runoff patterns and creation of surface ponding areas;
- changes to flood prone areas in the flood plains of major drainage lines (e.g. Crinum Creek); and
- changes to the longitudinal slopes of watercourses.

Minor depressions may occur in areas of flatter topography, and which are isolated from the mainstream channels during low flows. These depressions may retain localised rainfall runoff and form ponds following rainfall events. These ponded areas may partially waterlog soils during summer events of high rainfall, but this is less likely during the rest of the year when rainfall is typically low.

Predictions of subsidence changes on the existing topography provide an indication of the locations of areas where ponding may occur. For ML70481, minor ponding is predicted to occur above up to five of the longwall panels, while one larger area of ponding (up to approximately 48 ha) may occur above longwall 510. However, no ponding is predicted for LW500. Figure 3 indicates the inferred extent of these ponded areas. The specific location of ponded areas, soil drainage characteristics, and depth of ponding are factors influencing the duration and extent of ponding.

Changes to local drainages are likely limited to minor realignment of first order drainage lines and there are not likely to be any significant ponds created outside the floodplain as a result of subsidence. The loss of water through evaporation and infiltration will still dominate hydrological processes over time.

Proposed management measures to mitigate any impacts are outlined in Section 4.

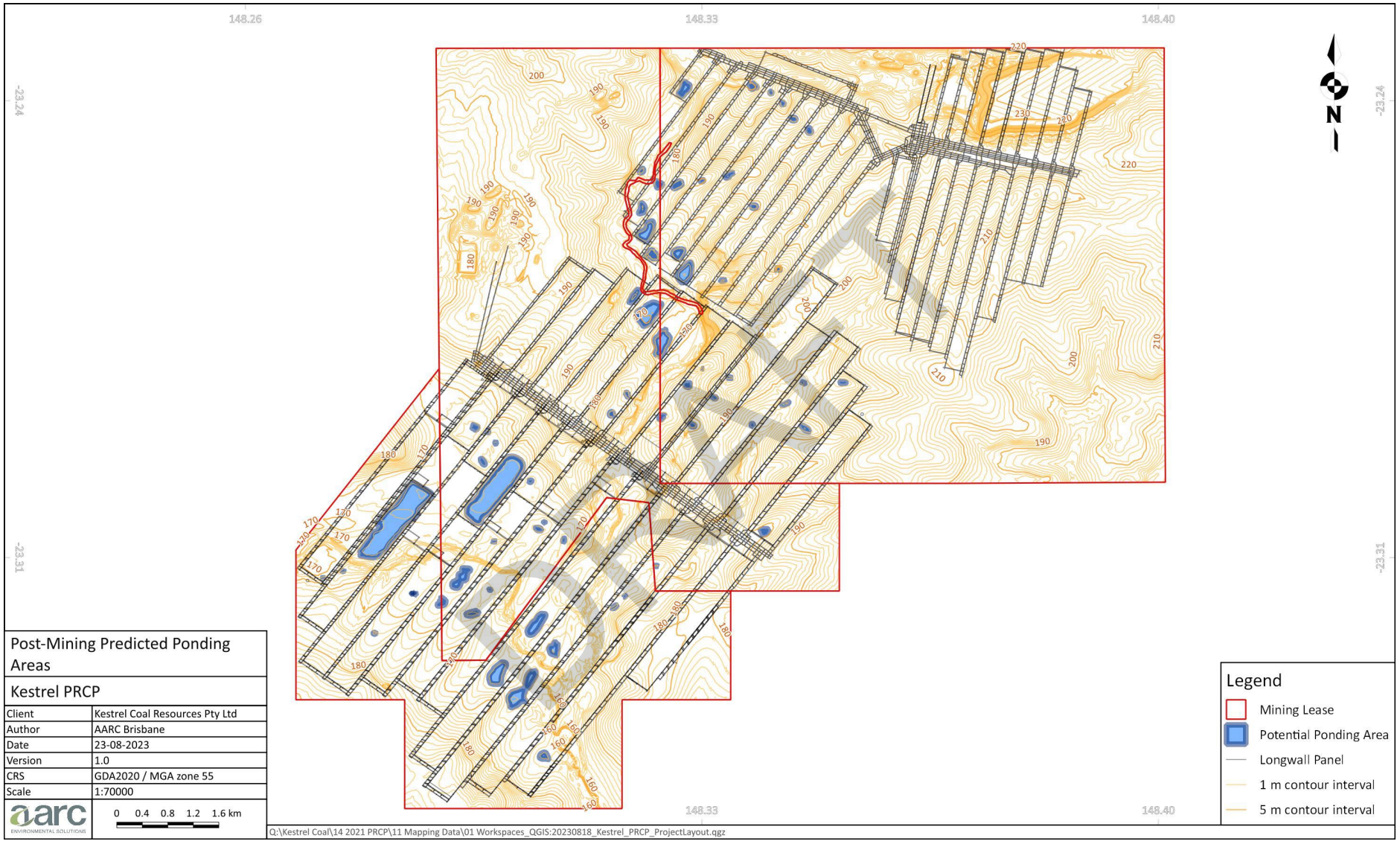

Figure 3: Inferred ponding subsequent to subsidence (revised mine plan incl. LW510)

3.1.3 Subsidence-induced surface cracking

Surface tension cracks may occur as a result of longwall panel subsidence.

The majority of the Kestrel MLs are dominated by Vertosols which are characterised as expansive soils with a high shrink-swell potential that change volume with changes in soil water content. The nature of these expansive cracking clays is such that, typically over one to two seasons, natural soil movement will compensate for any subsidence-induced cracking, resulting in no measurable impact on the soil.

The cracking clay soils naturally open, crack and shrink when dry, with the cracks then closing when wet as part of the soils inherent characteristics of pedoturbation. Thus, though cracks may result when subsidence first occurs, this natural characteristic of pedoturbation has been observed to lead to crack closure over one or two seasonal wetting and drying cycles.

Observations have demonstrated that, in many cases, tension cracks open as a function of the longwall panel face passing, closing up again as the panel progresses. Tension cracks are more likely to remain along the line of the inter-panel pillars and at the ends of each longwall panel. Hinchcliffe *et al.* (2002) state that 'obvious visual effects of a subsidence event are sometimes seen as surface tension cracks. Cracks may open up when the mining of the coal face is nearby and may close up once the face has moved on, yet some cracks may remain, especially along the edges of the panel'.

For earlier Kestrel panel series, tension cracks have been observed over the 300-series longwall panels in areas with Vertosols. These areas were monitored and observed to either self-heal, or were able to be rehabilitated by cross-ripping with a scarifier.

Cracking will be identified and monitored for any remaining cracking subsequent to cessation of the proposed activities will be subject to management measures as described in Section 4.

4 Subsidence management

4.1 General measures

The following general management measures relevant to subsidence related impacts will be employed, as applicable, for the 500 series panels:

- Subsidence prediction assessments will continue to be undertaken, at a minimum in advance of each new panel series and updated as required to align with mine planning changes or where monitoring identifies a variation from predicted subsidence behaviour.
- Pre- and post-subsidence survey monitoring (via airborne light detection and ranging (lidar) or other methods) will continue to be undertaken to assess and validate subsidence predictions.
- Where longwall panels pass under watercourses, and for areas where slopes are predicted to increase to greater than 3%, these areas are to be observed and monitored during and following passage of the longwall face.
- In areas where subsidence movements are predicted to result in moderate or high-risk of instability to the bed and banks of a watercourse, stock are to be excluded from the immediate bed, bank and overbank areas, as recommended by Gilbert & Associates (2012). Fencing is to be installed as required to enable effective stock management to occur.
- Agricultural activities will be managed in consultation with the lessee as required in advance of subsidence occurring to ensure that a high level of pasture cover exists, such that erosion potential is minimised.
- Any agricultural/soil erosion control infrastructure in the path of subsidence will be removed or, if required to be retained, subject to observation and monitoring to identify any potential soil erosion or drainage risk.

4.2 Restoration/rehabilitation measures

Rehabilitation and restoration of subsided land at Kestrel is undertaken where subsidence-induced geomorphological changes in the landform result in erosion, ponding or cracking impacts that are deemed unacceptable in extent or effect as permanent impact.

Technical studies and experience to date have demonstrated that the majority of subsided land at Kestrel does not require extensive rehabilitation works to be undertaken i.e. where earthworks of significant scale is required. Where active rehabilitation is required, the objective is the return of the land to its pre-mining agricultural capability as required by the relevant conditions of the RIDA and Environmental Authority (EA).

Rehabilitation is planned and implemented in response to any observations of adverse impact(s) arising following the passage of a longwall panel or panels. Unless observations indicate that earlier intervention is required, land subject to subsidence is observed for a period of at least two wet seasons (typically 30–36 months) to ensure:

- that all expected settlement has occurred;
- that immediately adjacent areas will not be subject to further subsidence;
- that any potential for erosion impacts has had time to present; and
- that a practical package of aggregated works can be compiled for contract administration purposes.

The rehabilitation activities required will be contingent on soils, slopes, the land use of the impacted area, and the impact type i.e. erosion, excessive cracking or ponding. The following rehabilitation activities may be required either alone or sequentially as a component of a larger rehabilitation program:

4.2.1 Rehabilitation of erosion / surface cracking arising from slope increases due to subsidence

Where changes to surface slopes result in localised instances of erosion, one or more of the following controls will be implemented:

- Where an erosion instance is identified; the location will be recorded, and the appropriate management and/or restoration approach determined.
- Where active erosion is present, erosion and sediment controls will be put in place in accordance with existing Project ESCP. This may include the installation of silt fences, hay bales, coir logs, or other erosion controls appropriate to the circumstances of the instance of erosion.
- Where required, stock controls will be put in place to exclude cattle from the area while mitigation and restoration activities are undertaken.
- Minor localised drainage works will be installed if there is a need to minimise run-on flows to the impacted area.
- Scarification and active revegetation of the impacted area in accordance with the methods described in Section 4.2.4. This procedure has been implemented successfully at the Project site over previous longwall panel series.
- Monitoring of the area will be undertaken in accordance with the rehabilitation monitoring and maintenance plan until the area is declared as having been fully restored.

4.2.2 Rehabilitation of ponding occurrences arising from subsidence

Condition G10 of the EA limits ponding within the 500 series panels to no greater than 200 m^2. Where such instances of ponding are predicted to occur as a result of surface elevation changes associated with subsidence, the following actions will be implemented:

- Instances of predicted ponding occurrences will be verified by detailed ground survey following the completion of longwall mining to confirm the possible extents of ponding and the associated catchment area.
- A hydrological assessment will be undertaken to assess the likely duration/permanence of ponding.
- If ponding is assessed to be of a permanent nature, options to ameliorate through drainage works or regrading will be developed and assessed.
- Where the additional area to be disturbed as a result of remediation works is less than the area impacted by ponding, earthworks to provide localised drainage of the ponding area will be undertaken.

4.2.3 Rehabilitation of impacted watercourses and riparian zones

Where watercourses are observed to have been adversely impacted by subsidence – potentially exhibited as creek bed or bank erosion and associated bank steepening or undercutting – relevant expertise will be obtained to develop an appropriate rehabilitation strategy and program. Such works may include:

- exclusion of stock from creek bed and banks;
- vegetation reestablishment on watercourse banks in accordance with the methods described in Section 4.2.4;
- construction of rock armouring over high energy sections; and
- regrading of bed and banks to produce stable longitudinal profiles.

Stabilisation of watercourses is expected to occur naturally over time and with the implementation of effective rehabilitation strategies. A stream condition survey of Homestead Creek, which overlies the 200 series longwall panels, identified subsidence related channelisation and bed-cutting, and retreat of an outside bend 12 years from the cessation of mining 2004 (HEC 2016). The scale of these impacts was considered relatively small and was expected to continue to trend towards a stable form over time without the need for active rehabilitation controls. The rehabilitation milestone completion criteria and schedule reflect that active rehabilitation is expected to be required in some areas for several years following longwall retreat, with continued monitoring to assess the trajectory towards a stable condition.

Where monitoring identifies sequential pooling and scouring of streambeds due to increased variation in longitudinal bed slope, watercourse monitoring will be instigated to ensure that detailed monitoring of the impacted sections is occurring. It is considered most beneficial to carefully monitor the natural reestablishment of the watercourse bed and only intervene if a critical area of pooling or scouring is observed. In this event the following activities could be considered, dependant on the severity of the impact:

- stabilise the pooled area inlets / outlets through regrading; and
- rock armouring of scouring sections as required.

4.2.4 Surface preparation and revegetation

The primary objective of surface preparation and revegetation is to rapidly produce a self-sustaining vegetation community suited to the target PMLU. Based on experience to date, areas affected by subsidence impacts are not generally expected to require surface preparation or reseeding activities. The most likely circumstance is where increased slope gradients have resulted in instances of erosion. In these cases the principles outlined below will be adhered to.

Where surface disturbance does occur, those areas will be cultivated to produce a seed bed suited to effective germination using farm equipment with appropriate cultivation implements such as tynes or discs. The Project site has fertile soils, therefore fertilisers or other ameliorants are not generally expected to be required for subsidence related rehabilitation activities.

Given that, for subsidence areas, the majority of revegetation requirements are of a very small scale, it is important that species selection is representative of those species already present in the surrounding landscape.

The seed mix to be used for revegetation purposes will be a selection from those shown in Table 3 which has been tailored to achieve a native pasture which is appropriate to the area and its soils. RE 11.8.11 is a native grassland system present within the MLs which, along with RE 11.8.5 and RE 11.8.4, provides potential native species assemblages appropriate for the soils of the area. The selection of grasses, forbs, shrubs and trees has been provided based on field observations within these REs, with a focus on RE 11.8.11, from the *Biodiversity Assessment Report for the Kestrel Mining Leases* (Umwelt 2023). Additional legume species were identified within the technical description for RE 11.8.11, as the presence of these species may aid rehabilitation success if soils have become nitrogen deficient.

Before finalising any seed mixes to be utilised for the good quality agricultural land (grazing) PMLU, the proposed mix should be discussed and agreed with key stakeholders including the pastoral lessee(s) and neighbours and species sowing rates are to be informed through discussions with seed suppliers to favour species with greater survival rates, and commercial availability.

Where disturbance to areas of mapped Bluegrass community (RE 11.8.11) occurs, the area will be revegetated using a seed mix that includes both *Dicanthium sericeum* and *Dicanthium queenslandicum* species. The species list provided in Table 3 includes species characteristic of the Bluegrass community in the Project area.

Revegetation of Bluegrass areas will occur preferentially using seed stock collected from the Bluegrass community in the vicinity of the disturbance, where practicable. While it is preferable to use indigenous stock from the community disturbed, it may be necessary to use commercially available stock. It is noted that Bluegrass is perennial and effective at recruiting areas such as drill pads and tracks where the topsoil is not removed.

Table 3: Species selection for revegetation

Common name	Scientific name	Classification	PMLU suitability
Feathertop Wiregrass	*Aristida latifolia*	Grass	Grazing, grassland community
White Wiregrass	*Aristida leptopoda*	Grass	Grazing, grassland community
Curly Mitchell Grass	*Astrebla lappacea*	Grass	Grazing, grassland community
Satin Top	*Bothriochloa erianthoides*	Grass	Grazing, grassland community
King Bluegrass	*Dichanthium queenslandicum*	Grass	Grazing, grassland community
Queensland Bluegrass	*Dichanthium sericeum*	Grass	Grazing, grassland community
Spreading umbrella grass	*Digitaria divaricatissima*	Grass	Grazing, grassland community
Cup Grass	*Eriochloa crebra*	Grass	Grazing, grassland community
Black Spear Grass	*Heteropogon contortus*	Grass	Grazing, grassland community
Native Millet	*Panicum decompositum*	Grass	Grazing, grassland community
Sago Grass	*Paspalidium globoideum*	Grass	Grazing, grassland community
Kangaroo Grass	*Themeda triandra*	Grass	Grazing, grassland community
Hairy Trefoil	*Desmodium rhytidophyllum*	Forb (legume)	Grazing, grassland community
Dwarf Morning Glory	*Evolvulus alsinoides*	Forb	Grazing, grassland community
Snail Flower	*Galactia tenuiflora*	Forb (legume)	Grazing, grassland community
	Glycine latifolia	Forb (legume)	Grazing, grassland community
Woolly Glycine	*Glycine tomentella*	Forb (legume)	Grazing, grassland community
Nine-leaved Indigo	*Indigofera linnaei*	Forb (legume)	Grazing, grassland community
Native bean	*Vigna lanceolata*	Forb (legume)	Grazing, grassland community
Bauhinia	*Lysiphyllum hookeri*	Shrub/Tree	Grassland community
Sandalwood	*Santalum lanceolatum*	Shrub/Tree	Grassland community
Yellow-wood	*Terminalia oblongata subsp. oblongata*	Shrub/Tree	Grassland community
Red Bloodwood	*Corymbia erythrophloia*	Tree	Grassland community
Silver-leaved Ironbark	*Eucalyptus melanophloia* #	Tree	Grassland community
Mountain Coolibah	*Eucalyptus orgadophila* #	Tree	Grassland community

5 Monitoring and reporting program

The following monitoring and reporting program have been developed to identify any actual impact(s) of the resource activities on the 500 series area

Landform

Condition 2.7 of the 'Special Lease Conditions' of ML1978 requires the lease holder to monitor subsidence and evaluate its impact on land resources, in particular agriculture, irrigation and surface drainage structures. For Kestrel, this is undertaken through an established routine of drafting annual subsidence reports that has occurred since the commencement of mining. The annual report outlines the areas of Kestrel impacted by longwall subsidence, results of subsidence monitoring and impacts on groundwater resources. Predictions of subsidence profiles and magnitudes are made in addition to projected impacts on agriculture and drainage structures.

The Kestrel EA also requires the longwall panel to be inspected annually by a suitably qualified and experienced person (EA condition G6). Topographical changes occurring due to the subsidence are to be measured and assessed by both ground survey traverses and airborne lidar technology which provides high accuracy topographic survey enabling landform changes to be tracked over time.

Soil erosion, cracking and ponding

Identification of active erosion, instances of ponding and tension cracking is to be determined on regular observations of subsided areas for a period of at least two wet seasons following the passage of a longwall face. Where subsidence-induced erosion is observed to have initiated, and assessed to be deteriorating, more detailed erosion surveys will be undertaken using a standard transect methodology, and a mitigation plan developed. To date, more detailed monitoring specifically for erosion has not been required for any of the previous longwall panel series at Kestrel, and is not anticipated for the 500 series panels within ML70481.

Similarly, instances of ponding will be monitored to ensure that data defining the depth and duration of ponding can be captured, with rainfall records to be maintained and inspections of ponded areas at an appropriate frequency to occur following rainfall events and recording of rainfall events.

The program and procedures for monitoring and recording of these land conditions are provided in the following sections.

5.1 Monitoring program

The main elements and sequence of the monitoring program are outlined in Figure 4.

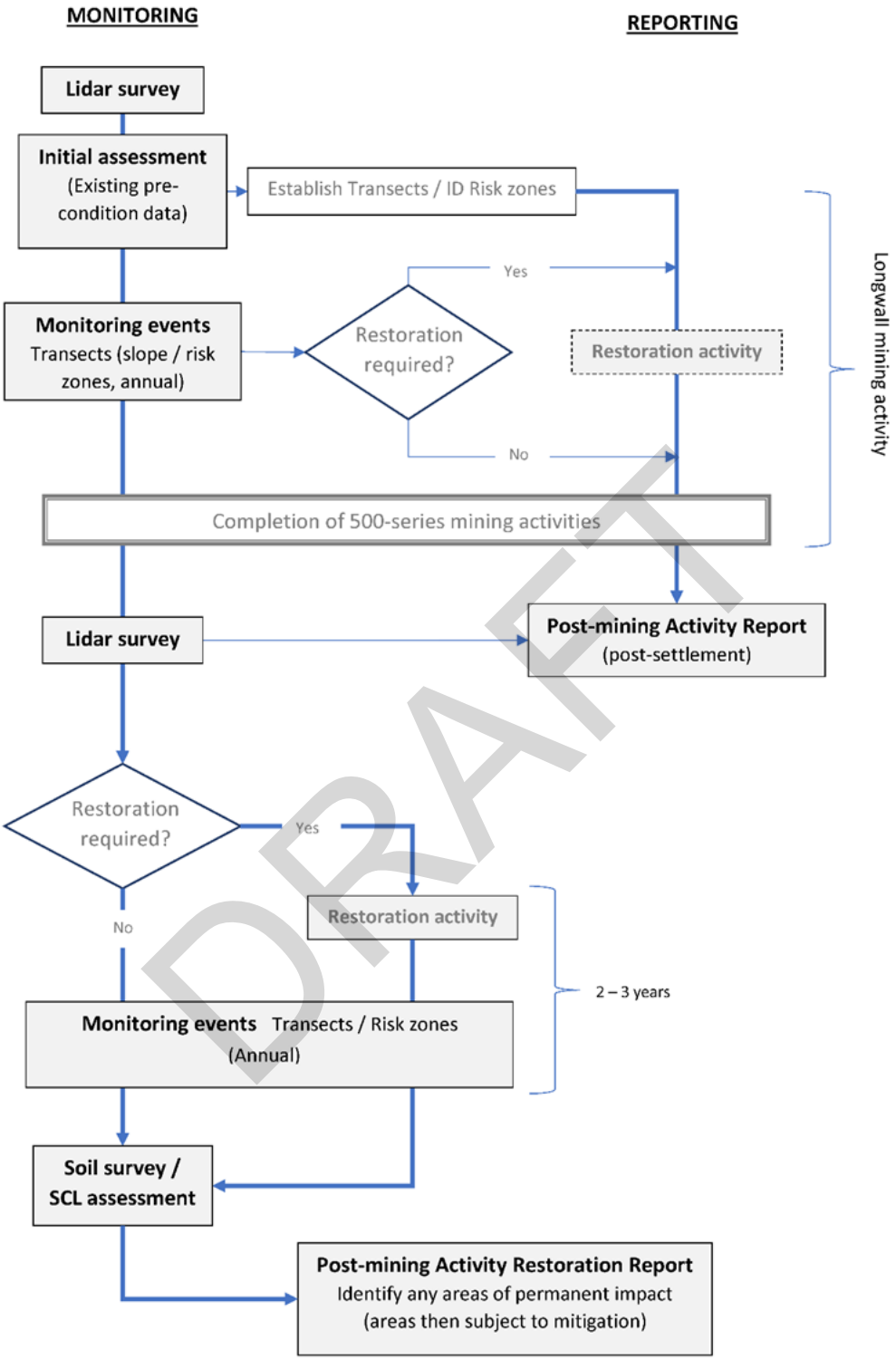

Figure 4: Diagrammatic view of the monitoring and reporting process

5.1.1 Monitoring assessment method

5.1.1.1 Pre-activity condition assessment

This assessment for specific subsidence impact criteria applies to the areas that are mapped as SCL. The initial assessment comprises the complete body of knowledge in relation to land use, soils characterisation, topography and other aspects relevant to SCL within ML70481.

While much of this information has already been assessed and reported, the establishment of on-ground monitoring transects for impact observations and ground truthing of subsidence movement will be undertaken progressively in advance of longwall panel operations within the mining disturbance area (see Figure 4).

The body of information relevant to defining the pre-activity condition of SCL within ML70481, along with baseline ground survey information acquired ahead of advancing 500 series mining activities will be collated and retained for use in assessing any identified impacts.

5.1.1.2 Annual impact monitoring

Impact monitoring inspections will be undertaken annually from the commencement of longwall mining activities to identify any areas of observable or measurable impact that might be associated with longwall panel subsidence or associated surface disturbance.

To focus monitoring efforts, risk zones will be identified within the disturbed area that include areas of predicted maximum slope, any existing drainage lines, and areas of surface disturbance. Within the risk zones, random transects or meandering survey will be established where appropriate.

Monitoring will be accomplished by observations along set transects and any identified zones more at risk to subsidence impacts. Monitoring events will continue until material subsidence is considered to have finalised (expected to be no more than two wet season cycles following completion of longwall mining activities). While monitoring transects and high-risk zones are required to be established/ identified within mapped SCL, there may be other higher risk zones identified that area also subject to monitoring activities.

Impact monitoring will also identify areas requiring some level and type of restoration that can be initiated during mining activities if necessary. Any areas requiring restoration activities will be identified and a plan for undertaking the restoration works will be developed. Subsequent monitoring events will assess the ongoing effectiveness and impacts of the restoration activities.

Longwall transects

Transects will be established primarily utilising the ground survey transects used by Kestrel Mine surveyors for their annual subsidence report both parallel to the progressing longwall panel on either side of the panel, and perpendicular to the progressing panel. Eight (8) observation sites will be used for each transect.

Each monitoring event will include:

- Observations along specific transects, using a specific check-sheet, to identify:
  - instances of erosion, cracking, ponding or drainage impediment;
  - rockiness photographic record at each observation site and estimate of rockiness (as per RPI Act Guideline 08/14: DSDMIP 2019c);
  - instances of vegetation change or other impacts including a description and photographic record.
- Ground survey along transects to identify/ confirm:
  - elevation and slope changes;
  - location of any surface cracking or other impacts.

- A photographic record to be made at each observation site i) along the line of transect, ii) perpendicular to line of transect, iii) land surface condition, cracking, and rockiness at all four cardinal points.

Risk zones

Risk zones will be identified within the disturbed area based on areas expected to have a greater risk of impact from subsidence or surface disturbance. These zones will include areas where slope changes are predicted to be greatest or where existing surface conditions (slope, drainage) may be more susceptible to impacts. Any areas where specific mitigation or restoration works are deemed to be required and undertaken will be included as a risk zone and mapped accordingly.

Risk zones will be subject to random meander surveys and observations with each monitoring event comprising:

- Observations made during random meander surveys to identify:
  - instances of erosion, including a description and photographic record;
  - instances of vegetation change or other impacts including a description and photographic record;
  - instances of surface cracking, including survey of initial large cracks observed, and photographic record; and
  - surface ponding, prolonged wetness or drainage impediment, including marking of the occurrence and estimation of areal extent, and photographic record.
- A photographic record to be made where any instances of potential impact are identified.
- Any changes effected by ongoing restoration activities.

Results and outcomes from this sequence of monitoring events and any resulting restoration activities will be collated and reported following completion of longwall mining activities in the area.

5.1.1.3 Lidar survey

Airborne laser scanning (ALS) is to be undertaken at the following frequencies (or more frequently):

- prior to commencement of longwall panel operations within ML70481 (this data has already been acquired); and
- once subsidence associated with 500-series mining activities is considered to have ended (likely to be at approximately six (6) to 12 months from completion of longwall mining activities). These requirements do not preclude lidar survey work being undertaken within this stated period.
- progressive assessments may also be undertaken on a panel by panel basis to address operational requirements.

Slope changes and areas of surface soil loss or gain by can be determined by DEM of Difference analysis from this ALS data in comparison with that of the pre-mining condition ALS survey.

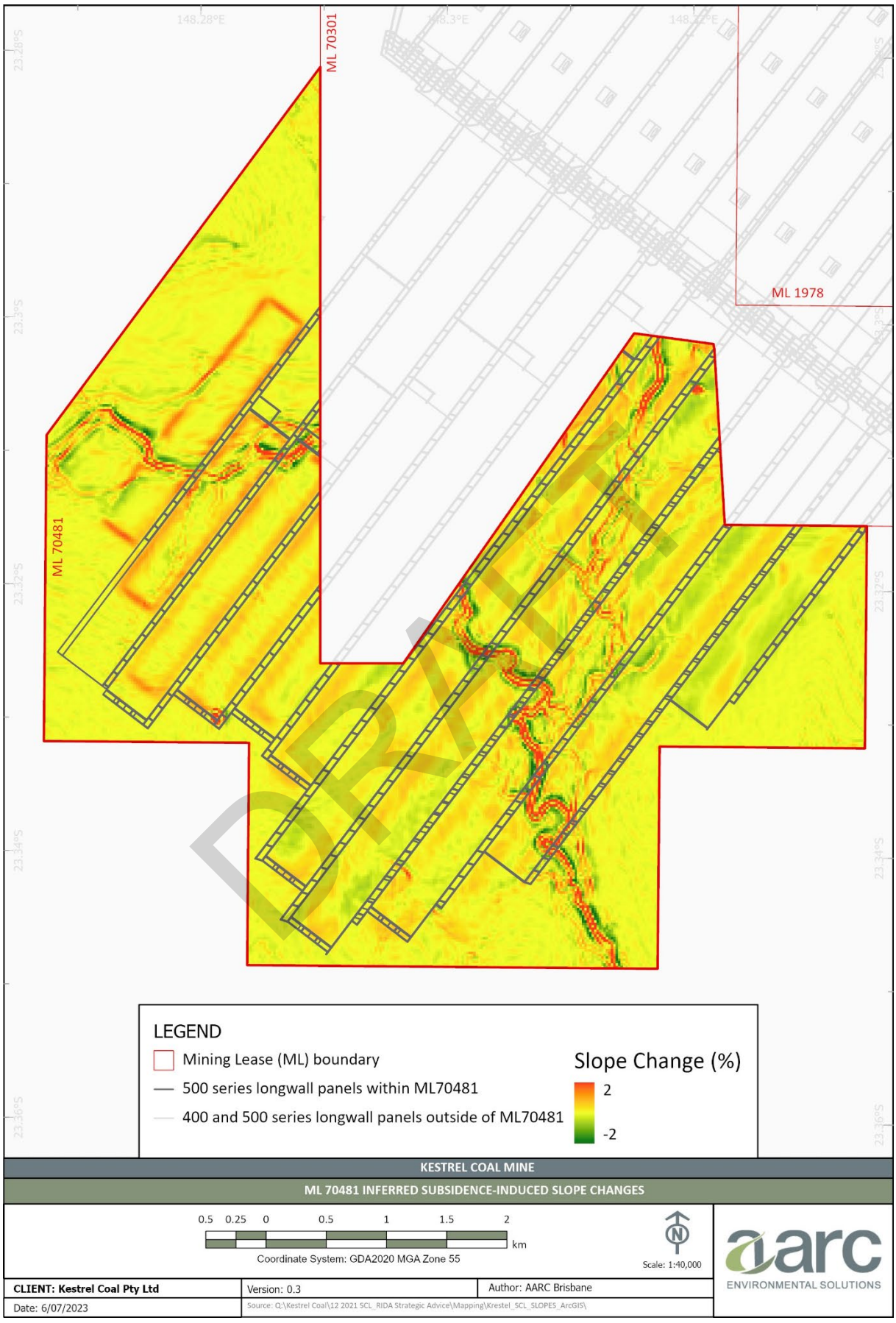

Figure 5: Inferred subsidence-induced slope changes between +2% and -2%

5.1.2 Post-mining activity restoration monitoring

As a part of the annual monitoring program, any areas where mining is completed and/or that have had restoration activities undertaken, will continue to be monitored for an expected period of approximately two (2) years.

The post-mining activity restoration monitoring consists of:

- annual monitoring events along the original transects in areas relevant to the restoration activity; and
- annual monitoring events in the relevant risk zones subject to restoration.

5.1.3 Post-mining activity and land suitability assessment

Land suitability assessment to be conducted once the following conditions have been met:

- annual subsidence monitoring, including transects, risk areas and restoration monitoring, indicates that no further management or mitigation activities required; and
- following a minimum of at least two consecutive wet seasons post any restoration activities.

Kestrel will undertake the land suitability assessment (SLSA), including an SCL assessment, in accordance with the requirements of RPI Guidelines 09/14 (DSDMIP 2019a) and 08/14 (DSDMIP 2019c) at the appropriate scale and intensity. This survey will set the post-mining activity soil characteristics and land productive capacity and will be compared with the pre-mining activity SLSA/SCL reporting from the initial assessment.

5.1.4 Post-restoration soil and land suitability assessment

Within a period of three years from completion of restoration activities occurring within the Relevant Area, Kestrel will undertake a second soil and land suitability assessment, including an SCL assessment, in accordance with the requirements of RPI Guidelines 09/14 (DSDMIP 2019a) and 08/14 (DSDMIP 2019b) at the appropriate scale and intensity for the Relevant Area. This survey will set the post-mining activity soil characteristics and land productive capacity and will be compared with the pre-mining activity SCL/SLSA reporting from the initial assessment.

6 Administration

6.1 Incident and complaint management

Kestrel's established incident management process will be utilised for any incidents or non-compliances related to erosion and sediment control. This procedure outlines:

- managing any related complaints;
- the process to resolve any disputes with lessees, property owners, landowners or other persons;
- the process to respond to any non-compliances with the EA and ML70481 RIDA;
- the process to respond to any related incidents or emergencies.

In accordance with Schedule 3(b) of the RIDA, any incident, or serious non-compliance with the Soil Conservation Plan (SCP) (including the receipt of monitoring results demonstrating serious non-compliance) will be reported in writing to the Chief Executive (of the Department administering the *Regional Planning Interests Act 2014*) within ten business days. The information to be reported includes:

- details of the nature of the incident or serious non-compliance;

- results and interpretation of any samples taken and analysed;
- the outcome of actions taken to rectify the incident, and the associated impacts;
- and details of the actions proposed to prevent a recurrence of the incident or serious non-compliance.

7 Accountabilities

The following accountabilities have been identified for this SMP:

Role	Accountability
General Manager & SSE	• Ensure compliance with the requirements of this SMP • Provide the required resources and systems to ensure that Managers, Supervisors, Employees Contractors and Visitors are aware of their responsibilities under this SMP • this SMP is to be implemented in all applicable areas of ML70481 • Training for personnel to meet requirements of this SMP
Area Managers	• Familiarity with requirements of this SMP • Maintain working knowledge of GDP procedure and system • Maintain working knowledge of SMP requirements
Technical Services Manager	• Ensure that all works and activities under their control or influence are conducted in accordance with the requirements of this SMP
Superintendent Environment	• Maintain familiarity with this SMP • Responsibility for correct operation and maintenance of GDP procedure and system, including review and sign-off of GDPs • Knowledge of and accountability for implementation of SMP Plan requirements • Maintain this SMP within the Site Document Register • Initiate review of this SMP at intervals not exceeding 3 years • Communication of the requirements of this SMP to relevant personnel.
Environment Team	• Maintain familiarity with this SMP and its operation • Initiate rehabilitation and monitoring requirements of this SMP • Maintain regular monitoring of works being undertaken within the jurisdiction of this SMP
General workforce (employees and contractors)	• Familiarisation with requirements of this SMP and management through GDP process and obligations • Ensure all persons are competent to perform the tasks they are assigned.
Supervisors	• Have familiarity with the requirements of this SMP sufficient to identify Plan application and to report non-compliances

8 References

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Appendix E. Monitoring and Maintenance: Rehabilitation Monitoring Plan

DDD-XXX-NNNNN

Kestrel SHMS - Report

<Rehabilitation Monitoring and Maintenance Plan >

Status: <.>
Revision: <NN> (DD MM.YYYY)
Business Owner: <>
MoC Reference: <if applicable>

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Abbreviations

CDSF	Co-Disposal Storage Facility
EA	Environmental Authority
IQR	Interquartile Range
ML	Mining Lease
PMLU	Post mining land use
RA	Rehabilitation area
RM	Rehabilitation milestone
RRMP	Rehabilitation Monitoring and Maintenance Plan

1 Introduction

1.1 Purpose

The purpose of this rehabilitation monitoring and maintenance plan (RMMP) is to inform the development and implementation of rehabilitation monitoring and maintenance programs at Kestrel Coal Mine (the Project).

Rehabilitation monitoring is undertaken to provide a scientific basis to support:

- an informed assessment of rehabilitation performance able to support the progressive rehabilitation and eventual relinquishment of the Kestrel mining leases following mine closure;
- the identification of rehabilitated areas not achieving a trajectory towards successful completion and the implementation of remedial action; and
- the continuous review and development of rehabilitation methodologies suited to Kestrel Coal Mine.

Effective rehabilitation monitoring plans are designed through consideration of the following steps:

- the definition of the post-mining land uses (PMLUs) to be achieved;
- the identification of specific rehabilitation areas (RAs) where different post-mining land uses might be targeted;
- the nomination of appropriate rehabilitation milestones (RMs) for each rehabilitation area;
- the definition of completion criteria for each milestone; and
- the identification of performance indicators and metrics that can be used to assess performance against the completion criteria established for each rehabilitation and improvement area.

1.2 Scope

This RMMP is applicable to all RAs across the Kestrel Mine mining leases (MLs) 1978, ML 70301, ML 70302, ML 70330 and ML 70481. The current version of the Environmental Authority (EA) EPML00693413 for the Project was issued on 24 December 2021 to Kestrel Coal Resources Pty Ltd and Mitsui Kestrel Coal Investment Pty Ltd.

This RMMP should be read in conjunction with the Kestrel Subsidence Management Plan with specifically addresses monitoring and maintenance of subsidence related impacts specific to RA7 and RA8 refer to the Kestrel Subsidence Management Plan. RAs are listed in Table 1 and shown in Figure 1.

1.3 Rehabilitation objectives and completion criteria

Key to assessing the success of rehabilitation is the definition of performance indicators and completion criteria. Rehabilitation performance indicators are intended to be specific, measurable, achievable, realistic and timely. They should:

- be outcome-based (linked to the end land use);
- be flexible to adapt to changing circumstances;
- be able to evolve as the mine life progresses;
- include metrics suitable to demonstrate that rehabilitation is trending positively; and
- undergo periodic review.

Table 1: Rehabilitation areas and PMLUs

Rehabilitation Area reference	Description	PMLU
RA1	MIA outside of subsidence zones (incl. roads and access tracks, CHPP, product and ROM stockpile areas, buildings, offices)	Good quality agricultural land (grazing)
RA2	CDSF (including Rejects Return Dam and brine dam evaporation ponds)	Grass community
RA3	Water management infrastructure (retained dams) Environmental Dam & Holding Dam	Water storage (stock watering)
RA4	Water management infrastructure (retained creek diversion)	Good quality agricultural land (grazing)
RA5	Water storages (not retained)	Good quality agricultural land (grazing)
RA6	Subsided land–riparian (excluding MIA)	Good quality agricultural land (grazing)
RA7	Subsided land–pasture (including non-certified rehabilitation areas)	Good quality agricultural land (grazing)

A set of performance indicators has been identified for the Project to provide a clear definition of milestone completion and successful rehabilitation for each rehabilitation area.

Milestone criteria for the Project are shown in Table 2.

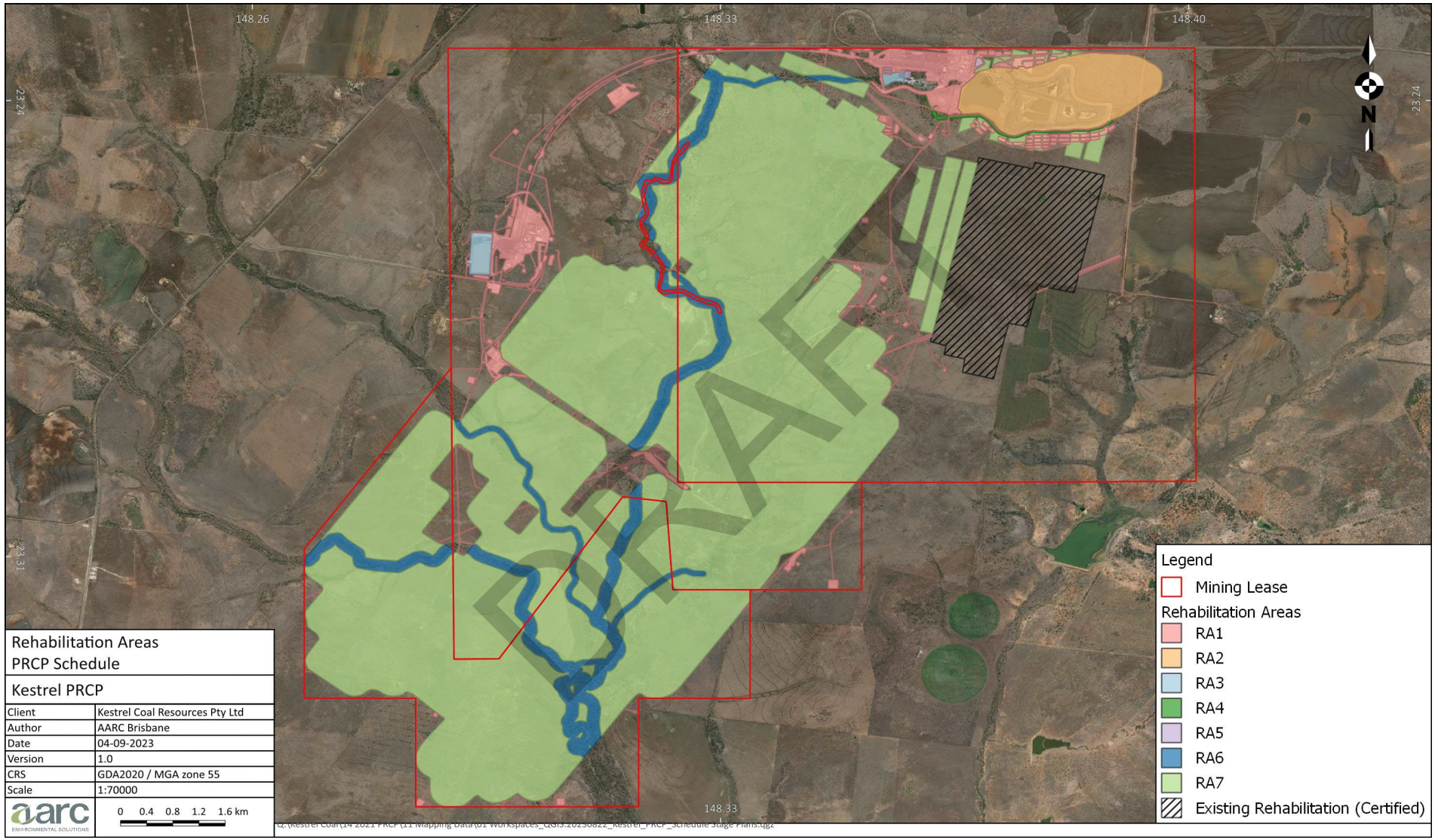

Figure 1: Rehabilitation areas

Table 2: Completion criteria – rehabilitation milestones

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM1	Infrastructure decommissioning and removal	RA1 RA2 RA3 RA4 RA5 RA7	• All non-required services disconnected and removed • All concrete, bitumen and gravel roads removed (where not retained) to a depth of 1 m. • All operational pipelines drained and removed • All boreholes capped and buried (including gas drainage infrastructure, drill pads) • All fencing that is not compatible with PMLU requirements removed • All non-retained buildings demolished and/or removed • Underground drifts and portals backfilled and sealed • All machinery and equipment decommissioned and removed • All surface water drainage infrastructure that is not retained in the final landform removed • All rubbish removed
RM2	Determination/ management of contaminated land status	RA1 RA2 RA3 RA5	• Contaminated land assessment undertaken by an appropriately qualified person. If required, a site investigation report including a site suitability statement/ management plan (as required) prepared and submitted in accordance with the provisions of Chapter 7, Part 8 of the EP Act; • Contaminated material either: o remediated in situ; o removed/transported to an approved landfill for disposal and waste tracking information recorded and submitted; or o retained and managed under a site management plan (e.g. tailings)

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM3	Landform development (reshaping, reprofiling, topdressing, seed bed preparation, soil amelioration) of good quality agricultural land (terrestrial)	RA1 RA2 RA3 RA4 RA5 RA7	• All landform works completed to design specifications (applicable to RA4) • Landform constructed with outer slope angles up to 1(V) in 10(H) (10°) or 1(V) in 6(H) for existing slopes (southern end) applicable to RA2 only): • Reinstatement of drainage lines to design specifications and certified by and appropriately qualified person • Regrading of tracks not being retained • Instances of ponding assessed for retention or where mitigation is required, drainage and landform works completed to design (applicable to 500 series footprint of RA7) • Contour banks removed/regraded from land affected by subsidence (applicable to RA7) • Geotechnical assessment by an appropriately qualified person confirming that long-term geotechnical stability has been achieved for each relevant landform (applicable to RA2) • Prior to each rehabilitation event, soil health and suitability are assessed and documented by an appropriately qualified person, and a recommendation made for ameliorants to ensure sodicity, salinity, pH and fertility levels are suitable to achieve the relevant post-mining land use (applicable to RA1) • Records of ameliorants applied and incorporated into surface, as recommended by an appropriately qualified person (excluding RA3) • Topsoil placement to a minimum depth of 0.3 m (excluding RA3) • Preparation of a cultivated seed bed suitable for revegetation (excluding RA3)
RM4	Landform development (reshaping, reprofiling, topdressing, seed bed preparation, soil amelioration) of good quality agricultural land (riparian zones)	RA6	• Stream condition survey undertaken by appropriately qualified person, and a recommendation made for a rehabilitation strategy to support stabilisation of beds and banks adversely affected by subsidence • Implementation of the recommended rehabilitation strategy and records maintained to demonstrate implementation
RM5	Capping installation	RA2	• Installation of surface capping layer(s) in accordance with engineering design specification: o clay cover placement over co-disposed materials (0.5 m); and o placement of rock mulch (1 m) o topsoil (minimum 0.3 m) • Topsoil health and suitability assessed and documented by an appropriately qualified person, and a recommendation made for ameliorants to ensure sodicity, salinity, pH and fertility levels are suitable to achieve the relevant post-mining land use

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM6	Revegetation	RA1 RA2 RA3 RA4 RA5 RA6 RA7	• Completed seeding using a minimum of three of the species listed in **Error! Reference source not found.** • Where disturbance of land identified as Bluegrass 'Of concern' Regional Ecosystem 11.8.11 occurs, revegetation species must include *Dicanthium setosum* and *D. queenslandicum* • Minimum seeding rate of 10 kg/ha • Records demonstrating species used, seeding rates, area sown, germination certificate, and seed origin
RM7	Achievement of surface stability (good quality agricultural land PMLU - terrestrial)	RA1 RA3 RA4 RA5 RA7	• Total percentage of ground cover (i.e. ground foliage cover, woody debris, organic litter and rock) is ≥70% • Dominant pasture species identified in representative analogue sites are present • No active erosion present as demonstrated by no increase in erosion classification[1] over 3 consecutive years
RM8	Achievement of surface stability (grass community PMLU)	RA2	• Total percentage of ground cover (i.e. ground foliage cover, woody debris, organic litter and rock) is ≥70% • No erosion classified[1] as 'severe' or 'extreme' • No active erosion present as demonstrated by no increase in erosion ratings over time • Assessed as geotechnically stable by an appropriately qualified person • No evidence of surface water ponding and settlement

RM9	Achievement of surface stability (good quality agricultural land - riparian zones)	RA6	• Creek beds and banks are trending towards a geomorphologically stable condition, demonstrated by evidence from stream condition surveys undertaken by an appropriately qualified person
			• Downstream water quality is not significantly different to up steam water quality
			• Creek beds and banks have no:
			  ○ No erosion classified[1] as 'severe' or 'extreme'
			  ○ No active erosion present as demonstrated by no increase in erosion ratings over time

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM10	Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land PMLU - terrestrial)	RA1 RA5 RA7	• Rehabilitation polygons have a median fractional vegetation cover greater than the first quartile of reference polygons for at least 85% of all sample times, as determined using the satellite-derived fractional vegetation cover method • Certification by an appropriately qualified person that the land suitability class for rehabilitated areas are re-instated to the pre-mining land suitability class. • Groundwater quality is equivalent to baseline data in accordance with: ○ EA Table J2 (Groundwater contaminant trigger levels) • No prohibited invasive or restricted invasive plants, and weed cover is ≤5% (excluding exotic pasture grasses). Weed abundance is no greater than at representative analogue sites
RM11	Achievement of target post-mining land use to safe and sustainable condition (grass community PMLU)	RA2	• Groundwater monitoring program confirms no environmental harm from migration of contaminants • Infiltration rates are less than XXX • No prohibited invasive or restricted invasive plants, and weed cover is ≤5% (excluding exotic pasture grasses) • Hazard and Safety Assessment completed by an appropriately qualified person assesses hazards to be low risk with no significant increase in risk expected over time
RM12	Achievement of target post-mining land use to safe and sustainable condition (good quality agricultural land PMLU - riparian zones)	RA6	• Evidence of woody tree species recruitment (individuals with <5cm diameter at breast height), for the dominant species present at the time of monitoring • Creek beds and banks demonstrate a similar geomorphologically stable condition to upstream and downstream sections of the creek as determined by an appropriately qualified person • No prohibited invasive or restricted invasive plants, and weed cover is ≤5% (excluding exotic pasture grasses). Weed abundance is no greater than at representative analogue sites. • Hazard and Safety Assessment completed by an appropriately qualified person demonstrates hazards in rehabilitation areas are consistent with the type and severity of hazards typical of the adjacent equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time
RM13	Achievement of target post-mining land use to safe and sustainable condition (retained water storage)	RA3	• All retained water storages assessed as safe and stable by an appropriately qualified person • Retained storage water quality parameters are below the 'low risk' trigger values for livestock drinking water defined in *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000)

Milestone reference	Rehabilitation milestone	Applicable RAs	Milestone criteria
RM14	Achievement of target post-mining land use to safe and sustainable condition (permanent creek diversion)	RA4	• Rehabilitation polygons have a median fractional vegetation cover greater than the first quartile of reference polygons for at least 85% of all sample times, as determined using the satellite-derived fractional vegetation cover method • No prohibited invasive or restricted invasive plants, and weed cover is ≤5% (excluding exotic pasture grasses). Weed abundance is no greater than at representative analogue sites. • Downstream water quality is not significantly different to up steam water quality • Diversion bed and banks demonstrate a geomorphologically stable condition as determined by an appropriately qualified person • Diversion bed and banks have: ○ No erosion classified[1] as 'severe' nor 'extreme' gully erosion or washout features ○ No active erosion present as demonstrated by no increase in erosion ratings over 3 consecutive years

1. Erosion classification framework:

Erosion classification	Minor	Moderate	Severe	Extreme
Sheet erosion	Shallow soil deposits downslope	Partial exposure of roots; moderate soil deposits downslope, etc.	Loss of surface horizons; root exposure, etc.	Loss of surface horizons; root exposure, etc.
No. of rills/ gullies	< 15	15 - 30	31 - 50	> 50
Greatest observed depth (cm)	<10	10 - 30	30 - 60	>60
Tunnel erosion	-	-	Present	Present
Mass movement	-	-	Present	Present

2 Monitoring program

2.1 Rehabilitation monitoring frequency

Rehabilitation monitoring provides the opportunity to acquire scientific, quantitative data relating to rehabilitation performance. The Projects approach to monitoring is described in the following subsections. The detailed rehabilitation monitoring methodologies to be used are described in section 3.

Initial establishment monitoring

Initial establishment monitoring is relevant to recently revegetated areas i.e. having recently achieved RM6; and has a key purpose of identifying areas that mar require some form of maintenance rehabilitation work. Monitoring should occur annually for the first three years, or until monitoring results indicate a low risk of erosion or vegetative failure will occur; and that the area is on a trajectory to achievement of RM7, RM8 or RM9 within the required timeframe.

Longer term monitoring

At this point, monitoring frequency should be adjusted to take into account the following factors:

- Local climatic risks to rehabilitation success (e.g. drought and severe storm events);
- Timing to achieve the next RM; specifically a rehabilitation monitoring event should ideally be timed at or before the next RM to be achieved to demonstrate achievement of all milestone criteria associated with that RM. For longer timeframes, intermediate monitoring events should be scheduled to ensure the next RM criteria will be met and to allow sufficient time for any maintenance that may be required to achieve those criteria.
- The specific monitoring parameters to be assessed.

The monitoring frequency determined may range from annual to every five years.

Event-based monitoring

Given that critical milestone criteria include rehabilitation aspects such as erosion, ground-cover and water quality, where climatic events occur that can have an immediate impact on these aspects, event-based monitoring is a key part of the monitoring program.

For Kestrel, storm events greater than 50 mm, determined on a rolling 24-hour average basis will prompt an inspection of any recent revegetation efforts or erosion control works in place. This is in addition to event-based monitoring required under the SMP. The following data should be collected:

- photographs of any new instances of erosion, graded bank failure, capacity and condition of water storages, loss of vegetation or other biota;
- where possible, estimate the extent of any new instances of erosion including, for example, rehabilitation area, rill lengths, widths and depths, slope and location on slope;
- observations of vegetation health, cover, instances of lack of vegetation;
- stability and function of erosion and sediment control and water management structures;
- presence of weeds and/or pests; and
- any other relevant observations.

Where inspections indicate loss or damage to existing rehabilitation areas, this may trigger the following actions:

- Where environmental harm or a serious incident has occurred: notification to either or both of DES and DSDILGP.
- Where loss or damage has occurred, it may be necessary to obtain quantitative data on extents, downstream water quality, event data, identification of contributing factors etc.
- Development of an appropriate incident response and remediation plan.

Timing of monitoring events

Rehabilitation monitoring events involving assessments of vegetation, erosion, water quality and sediments should be timed to occur at a consistent time of year (ideally post-wet season).

Monitoring for other parameters is less sensitive to timing, but will typically be undertaken coincidentally with other monitoring events.

2.2 Monitoring parameters

2.2.1 Vegetation and erosion

Milestone criteria require the collection of the following data vegetation and erosion-related data to be collected:

- vegetation composition:
  - native pasture species;
  - exotic pasture species;
  - grass species (non-palatable);
  - shrubs;
  - forbs; and
  - noxious weeds
- vegetation composition compared with sown species;
- percentage estimate of ground cover components (litter, bare soil, rock);
- observations of erosion including depth, width, and suspected cause (e.g., soil dispersibility, run-on drainage, graded bank failure etc.);
- observations of any pests species (e.g., feral pigs); and
- photo point monitoring.

In addition, fractional vegetation cover (FVC) assessments (refer Section 3.1.4) may be undertaken using satellite imagery, where set as a milestone criteria.

2.2.2 Soil quality monitoring

Prior to each rehabilitation event topsoil assessment will be undertaken during the landform development stage (RM3) in order to maximize vegetation establishment and minimize any potential soil erosion.

- analysis of pH, electrical conductivity (EC), and exchangeable sodium percentage (ESP); and

- determination if any type of amelioration is needed based on the results of the aforementioned parameters.

2.2.3 Spatial data monitoring

Spatial data collected via remote sensing techniques will be analysed for three purposes, namely:

- to provide an indication of rehabilitation success across a broader spatial scale and compare to findings of the field based monitoring;
- identify locations requiring rehabilitation repair and maintenance, particularly areas of lower vegetation cover and high erosion; and
- identify presence of weeds and pest requiring management.

2.3 Rehabilitation records

For all rehabilitation activities (e.g. RM3, RM4, RM6 to RM12), the following details are to be recorded:

- topsoil source, analysis results and pre-treatments applied;
- surface preparation works (e.g., reshaping and reprofiling work design parameters, topdressing, seed bed preparation, addition of ameliorants including type and rate);
- climatic records;
- revegetation species, rates and sowing method(s);
- fertiliser applications including types, rates and timing; and
- maintenance works undertaken.

For closure related activities (e.g. RM1, RM2, RM5 and RM13), the following details are to be recorded:

- records of services disconnection, decommissioning and demolition completion reports;
- contaminated land assessment and, if applicable, remediation reports;
- as-built confirmation of CDSF landform and capping works implementation;
- surface water quality and flow and groundwater quality and level records;
- climatic records;

Where possible, records will be maintained, including rehabilitation area polygons, using a geographic information system.

2.4 Rehabilitation monitoring plan review

A review of the effectiveness of this RMMP is to be undertaken at least every three years. The following aspects will be considered as a minimum:

- PMLU, completion criteria, and indicator validity and effectiveness;
- appropriateness of inspection and monitoring frequency;
- overall rehabilitation performance; and
- requirements for maintenance works including frequency and severity of works required.

3 Monitoring methodology

The following subsections detail the monitoring methodology implemented. A combination of field surveys and aerial and satellite imagery will be utilised for the monitoring of rehabilitation activities. Monitoring will involve the collection of quantitative data relevant to assessing the progression towards, and the achievement of the completion criteria detailed in Table 2 and for the purpose of determining the achievement of each rehabilitation milestone (RM).

3.1 Vegetation and soil erosion surveys

3.1.1 Vegetation surveys

The survey methodologies outlined below have been adapted from the Queensland Herbarium survey technique 'Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland' (Neldner *et al.* 2019) and the 'Method for the Establishment and Survey of Reference Sites for BioCondition' (Eyre *et al.* 2017).

BioCondition monitoring assesses a suite of parameters at different landscape positions on each site, namely on flats, slopes and in troughs (Eyre *et al*. 2017). Vegetation monitoring will involve the collection of quantitative data relevant to the land use and vegetation being monitored. This may include:

- permanent vegetation;
  - native pasture species (native grass species that are palatable to stock);
  - exotic pasture species (exotic grass species that are palatable to stock);
  - grass species (grass species that are not palatable to stock);
  - shrubs;
  - forbs; and
  - noxious weeds;
- species diversity;
- erosion rates; and
- restricted invasive plant species.

It is recommended that the frequency and timing of monitoring of reference sites coincides with monitoring of rehabilitation areas. To ensure sampling repeatability over the life of the monitoring program, each transect is to be located in an area that is accessible. Results from reference sites will be used to compare monitoring results obtained from rehabilitated site transects.

To establish transects, at each monitoring site a 50 m tape is extended, with a star picket installed at each end of the transect to consistently and precisely identify the transect location during each monitoring event. The coordinates of each end of the transect are recorded, to establish a permanent 50 m transect. The transect area extends 5 m on either side of the 50 m tape.

Field sheets should be used to collect rehabilitation survey data.

Monitoring of vegetation will preferably be undertaken after the wet season to ensure the presence of ephemeral herbaceous plants and to assist with identification of species that require the presence of flowers/fruiting material for accurate identification.

3.1.1.1 Ground cover

Ground cover monitoring involves the collection of quantitative data on average ground cover (percent) where the percentage of all types of ground cover within ten 1 m x 1 m quadrats is determined. The quadrat shall be placed every 5 m on alternating sides of the transect, commencing at 0 m on the right and the final quadrat at 45 m. In each quadrat the total percentage ground foliage cover of each plant species and the percentage cover of bare soil, rock and organic litter is to be recorded.

Ground foliage cover incorporates native perennial grass cover, native annual grass cover, native forbs and other species, native shrubs (< 1m height), non-native grass, non-native forbs and shrubs, litter, rock and bare ground.

3.1.1.2 Species diversity

Species diversity is assessed using the method outlined in Eyre *et al*. (2017) where all vascular plants that occur within a 10 m x 50 m plot area are recorded. The surveyor is to walk along each side of the 50 m transect centre-line and record all trees, shrubs, forbs/other species, and grasses occurring within 5 m of either side of the centre-line. Species that cannot be identified within the field are collected for later identification or sent to the Queensland Herbarium for identification.

3.1.1.3 Stem density

Woody stem density is calculated using a methodology adapted from the 'Method for the Establishment and Survey of Reference Sites for BioCondition' (Eyre *et al*. 2017). All woody stems for each tree and shrub species are counted within the 10 m x 50 m plot area (i.e., 5 m either side of each 50 m transect). From this data, both total woody stem density as well as the density of each individual tree or shrub species is calculated. The density of species and growth forms on the monitoring sites is then calculated using the following equation:

Density per hectare (ha) = number of stems recorded within the transect x 20.

3.1.2 Soil erosion

3.1.2.1 Erosion monitoring

An erosion monitoring methodology has been developed with consideration to relevant guidelines, research, and experience (Neldner *et al*. 2020, Eyre *et al*. 2017 and Eyre *et al*. 2015). Erosion monitoring is to be conducted across all analogue and rehabilitation monitoring locations. Rehabilitation areas will be inspected to assess the extent of erosion features and an erosion rating for each site will be determined. Erosion features or indicators may include wind or sheet erosion, erosion rills, gullies or tunnels, or signs of slumping.

Erosion at survey sites is monitored through visual assessment over time. Assessment is undertaken by traversing the 50 m transects and recording the number and average depth of any erosion features or rill lines. Table 3 is used to record and classify these observations. The overall classification of erosion at each transect site is determined by the higher classification attributed to either the number of rills/gullies or the greatest observed depth. For example, a transect may present less than 15 rills/gullies ('Minor') but a depth recorded between 10 – 30 cm ('Moderate'), in which case the transect will be classified as presenting a Moderate erosion classification. The occurrence of a gully requires a classification of 'Severe' or 'Extreme'.

Obvious cases of localised settlement which are not causing any subsequent erosion are not considered instances of erosion.

Table 3: Erosion classification

Erosion classification	Minor	Moderate	Severe	Extreme

Sheet erosion	Shallow soil deposits downslope	Partial exposure of roots; moderate soil deposits downslope, etc.	Loss of surface horizons; root exposure, etc.	Loss of surface horizons; root exposure, etc.
No. of rill/ gully*	< 15	15 - 30	31 - 50	> 50
Greatest observed depth (cm)	<10	10 - 30	30 - 60	>60
Tunnel erosion	-	-	Present	Present
Mass movement	-	-	Present	Present

* Gully: highly visible form of soil erosion, with steep-sided, incised, drainage lines greater than 30 cm deep

It should be noted that the placement of permanent transects may not be representative of the level of erosion across the entire rehabilitation area landforms. To compensate for this, general observations undertaken during the survey are also utilised in assessing rehabilitation performance. The location of any severe erosion outside the transect (i.e., tunnels, mass wasting, large gullies) is recorded and marked with a handheld GPS instrument.

The following information is recorded at each site:

- general description of type of erosion (gully [>30 cm], rill line [<30 cm], circular failure, tunnelling etc.) and possible causes;
- depth of erosion;
- width of erosion;
- length of erosion;
- where eroded material is being deposited;
- whether the erosion line is being stabilised by vegetation; and
- GPS reading of location.

3.1.3 Photographic monitoring

Photographic monitoring provides a visual record of the vegetation, ground cover, erosion, and general appearance of each analogue and rehabilitation site, allowing these sites to be compared over time (Eyre *et al*. 2015). A digital camera is used to take photos so that a permanent record can be kept for each site. The process of taking the monitoring photos is as follows:

- the site, date the photo was taken and the direction the photo was taken should be recorded for each photograph taken. A data board included in the photograph can be useful for this purpose;
- the person taking the photograph stands at the star picket which marks the beginning of the 50 m;
- the camera is aimed directly towards the end of the 50 m transect and a single, landscape photograph is taken;
- the person then stands at the star picket which marks the end of the 50 m transect; and
- the camera is aimed directly towards the start of the 50 m transect and a single photograph is taken.

The digital photographs are to be downloaded and stored for future reference.

3.1.4 Satellite-derived fractional vegetation cover

To align with contemporary rehabilitation monitoring methods and provide further evidence of rehabilitation success and land stability, fractional vegetation cover (FVC) surveys are proposed.

FVC is defined as that fraction of a satellite imagery pixel representing ground condition across three ground cover classes being:

1) photosynthetic vegetation;

2) non-photosynthetic vegetation; and

3) bare ground.

A median value of FVC can be determined for all satellite imagery pixels within a defined polygon area (or set of combined polygons). Subject to certain limitations, a median FVC value can be determined for polygons enclosing a rehabilitation area which is then able to be compared with polygons enclosing a reference/analogue area that is representative of unmined land having similar landform, land cover and land use.

Satellite-derived indices will be reported annually based on one imagery acquisition per calendar month (12 per annum). Except where cloud cover or cloud shadow occlude the study area in a calendar month, imagery of the study area and acquisition metadata are assessed.

FVC is reported in graphical form with median and interquartile ranges for each rehabilitation polygon and combined reference area polygons. In addition, dates and duration of failure to achieve the target are reported in tabular form with mapping information for sources of non-compliance

3.1.4.1 Source data

Satellite imagery from the Sentinel 2 global earth observation mission acquires imagery on a 5–12-day interval at wavelengths between 400-2,500 nm. Reflectance indices based on the spectral reflectance profiles of photosynthetic vegetation, non-photosynthetic vegetation and bare ground is calculated and directly correlated with field-collected data to calculate FVC for each rehabilitation and reference polygon.

Field calibration and validation are required to be re-established if a significant disturbance occurs (e.g., fire/drought)

3.1.4.2 Calibration and validation

Calibration and validation of FVC is to be conducted during fixed transect monitoring using either (a) point intercept transects per Muir *et al.* (2011) modified to 50 m or (b) sub-10 cm UAV imagery captured as 1 ha blocks ISODATA clustering and supervised spectral class assignment provide FVC where UAV imagery is available.

3.2 Water quality monitoring

Water quality sampling is to be carried out in accordance with the Queensland *Monitoring and Sampling Manual* (DES 2018) methodology. In situ measurements are to be taken with a multi-parameter water quality meter that has been calibrated to the manufacturers' specifications. Monitoring will be in accordance with the EA (Table 4 and Table 6) and on water contained on the retained dams (Table 7). Measurements are to be taken following the wet season and/or after a significant rainfall event that will enable surface water to runoff the rehabilitated areas. Field readings of pH, dissolved oxygen, EC, temperature and total dissolved solids (TDS) are to be measured and compared against the completion criteria for RM9, RM10, RM12, RM13, and RM14. Data for each monitoring event should be compiled and presented in a time series detect any trends in water quality over time.

Laboratory analysis will also be performed on the water samples to comply with the completion criteria of RM9, RM10, RM12, RM13, and RM14. Samples are to be collected in laboratory-provided sample collection bottles with preservatives added where required. All water samples are to be kept on ice or refrigerated during storage and transported to a National Association of Testing Authorities (NATA) accredited laboratory for analysis.

A box-and-whiskers plot is to be used in the reports to visually show the distribution of data of each monitoring site for selected parameters over time. The boxplots will show the summary of a set of data including the minimum score, lower quartile, median, upper quartile, maximum score, whiskers, and the Interquartile Range (IQR). This method allows the visualisation of detected outliers in the dataset.

3.2.1 Groundwater monitoring

Groundwater quality monitoring will be undertaken biannually and will be compared with reference groundwater data. This will allow the identification of impacts from surface water storages and seepage from the co-disposal storage facility (CDSF) to groundwater. Monitoring will be undertaken by a competent person and will be in accordance with the latest edition of the administering authority's water quality sampling manual. Groundwater quality parameters to be sampled have been adopted from the EA and are summarised in Table 4.

Table 4: Groundwater contaminant trigger levels (EA – Table J2)

Parameter	**Unit**	**Trigger levels**			
		Basalt (west)	Basalt (east)	Basal sand (west)	Basal sand (east
Standing water level	RL	>2m drawdown from background level			
pH	pH units	6.5 – 9.5			
Electrical conductivity	µS/cm	4,950	1,500	3,720	1,790
Total dissolved solids	mg/L	3,000	940	2,060	970
Iron	mg/L	0.3			
Aluminium	mg/L	0.55			
Arsenic[1]	mg/L	0.13			
Cadmium	mg/L	0.0002			
Copper	mg/L	0.001			
Lead	mg/L	0.0034			

1. Analysis is based on total/combined species of the element.

3.2.2 Surface water quality monitoring

Surface water quality monitoring for the Project will be undertaken to meet the water quality objectives identified within the EA. Monitoring will be undertaken at background (control) sites located upstream of the Project. These sites are located outside the immediate zone of influence from the Project. Monitoring will also be undertaken at impact sites located downstream from the Project and within the potential zone of influence. Proposed water monitoring locations are presented in Table 5.

Table 5: Receiving water monitoring locations (EA – Table C8)

Monitoring points	Receiving waters location description	Latitude (decimal degree, GDA 94)	Longitude (decimal degree, GDA 94)
Upstream background monitoring points			
Monitoring Point W2	Woolshed Creek 4km upstream of RP2	-23.22364	148.294787
Monitoring Point B1	Approx. 700m upstream of the confluence of Junction and Crinum creeks and approx. 100m downstream of the lease boundary.	-23.232588	148.324979
Downstream monitoring points			
Monitoring Point C4	Approximately 1.5km upstream of the intersection of Crinum Creek and Wyuna Road. Approximately 12km downstream of RP2 and 17km downstream of RP1	-23.357543	148.320622
Monitoring Point SW2	<6km downstream of the confluence of Junction and Crinum Creek	-23.279950	148.329074
Monitoring Point SW3B	On Woolshed Creek approx. 250m upstream of the confluence of Woolshed and Crinum Creeks.	-23.317612	148.309652

Additional or alternative monitoring locations (e.g. other water storages on-site and/or surrounding environmental features) will be developed as part of site-specific plans as required.

Water quality monitoring will be undertaken using a combination of laboratory and in situ sampling by trained personnel and in accordance with the Queensland 'Monitoring and Sampling Manual' (DES 2018). Water quality parameters to be sampled are summarised in Table 6 for the receiving environment and Table 7 for onsite water storages.

Table 6: Receiving water trigger levels (EA – Table C3)

Quality characteristic	Trigger levels (µg/L)	Comment on trigger level
Aluminium	55	80th percentile of background water quality data
Cadmium	0.2	For aquatic ecosystem protection, based on SMD guideline
Chromium	1	For aquatic ecosystem protection, based on SMD guideline
Copper	2	For aquatic ecosystem protection, based on LOR for ICPMS
Nickel	11	For aquatic ecosystem protection, based on SMD guideline
Zinc	8	80th percentile of background water quality data
Boron	370	For aquatic ecosystem protection, based on SMD guideline

Manganese	1,900	For aquatic ecosystem protection, based on SMD guideline
Molybdenum	34	For aquatic ecosystem protection, based on low reliability guideline
Uranium	1	For aquatic ecosystem protection, based on LOR for ICPMS
Vanadium	10	For aquatic ecosystem protection, based on LOR for ICPMS
Nitrate	1,100	For aquatic ecosystem protection, based on ambient Qld QR Guidelines (2006) for TN
Petroleum hydrocarbons (C6 – C9)	20	
Petroleum hydrocarbons (C10 – C36)	100	
Fluoride (total)	2,000	Protection of livestock and short term irrigation guideline
Sodium	250,000	80th percentile of background water quality data

NOTE:
SMD—slightly moderately disturbed level of protection, guideline refers ANZECC & ARMCANZ (2000).
LOR—typical reporting for method stated. ICPMS/CV FIMS—analytical method required to achieve LOR.

Table 7: Onsite water storage contaminant limits (EA – Table C6)

Quality characteristic	Test value	Contaminant limit
pH	Range	4 – 9[1]
EC (µS/cm)	Maximum	5,970
Sulphate (SO_4^{2-}) (mg/L)	Maximum	1,000[1]
Fluoride (mg/L)	Maximum	2[1]
Aluminium (mg/L)	Maximum	5[1]
Arsenic (mg/L)	Maximum	0.5[1]
Cadmium (mg/L)	Maximum	0.01[1]
Cobalt (mg/L)	Maximum	1[1]
Copper (mg/L)	Maximum	1[1]
Lead (mg/L)	Maximum	0.1[1]
Nickel (mg/L)	Maximum	1[1]
Zinc (mg/L)	Maximum	20[1]

1. Contaminant limit based on the ANZECC & ARMCANZ (2000) guidelines for livestock drinking water quality.

3.3 Soil quality monitoring

Soil observation and sampling will be conducted in accordance with the Australian Soil and Land Survey Field Handbook, 3rd edition (National Committee on Soil and Terrain 2009) and the Guidelines for Surveying Soil and Land Resources (Mckenzie *et al* 2008). The sampling intensity should take into consideration the land area, available resources, land access, soil complexity, and land management units. A jack hammer operated soil corer will be used to excavate cores to a maximum of 120 cm. Soil samples will be collected at standard depths and sealed in clean, plastic zip-lock bags. They will be labelled with the site number, date, depth of sampling, and the initials of the sampler. They will be sent to a NATA accredited laboratory for analysis of the following parameters:

- pH;
- electrical conductivity;
- moisture content;
- chloride (soluble);
- exchangeable cations (Ca, Mg, Na, K);
- cation exchange capacity (CEC);
- exchangeable sodium percentage (ESP);
- organic matter (%);
- sulphate;
- N as nitrate;
- extractable metals (Fe,Cu,Zn,Mn);
- particle size analysis; and
- emerson class.

4 Data analysis, interpretation, and reporting

4.1 Laboratory analysis

All water and soil samples collected during rehabilitation monitoring will be sent to a NATA certified laboratory for analysis of the recommended parameters.

In the event that any plants cannot be identified in the field, samples will be sent to the Queensland Herbarium for identification.

4.2 Progress reporting

Rehabilitation monitoring reports will be prepared at an appropriate frequency following the collection of monitoring data with the purpose of presenting analyses of monitoring results and evaluating rehabilitation progress towards completion criteria. This ongoing evaluation will enable the early detection of unfavourable trends in measured indicators and identify any requirements for adaptive management practices to ensure rehabilitation success and certification in the long-term.

4.3 Interpretation

Rehabilitation monitoring results will be analysed both categorically and temporally. Results obtained from rehabilitation sites will be compared to analogue sites from the same final land use vegetation community. Rehabilitation monitoring results will also be compared with historical data where possible to detect any trends over time. Common variables such as climatic conditions, seasonal variation and other event specific circumstances will also be considered in the analysis of rehabilitation data.

4.4 Statistical analysis

The analysis of rehabilitation monitoring results will involve comparing rehabilitation sites generally across the Project using the following analytical methods where appropriate:

- Statistical analysis will be undertaken where required to identify any significant differences between sample means. To determine any significant differences ($\alpha = 0.05$) between the means of rehabilitation characteristics recorded across analogue and rehabilitation sites, it is recommended that rehabilitation performance be assessed using a t-test (where a minimum of three sites are available providing sufficient statistical replication) or a similar nonparametric test where the data is not normally distributed. Variables measured at analogue and rehabilitation sites are considered statistically comparable where no significant difference between the means is detected.
- In relation to vegetation characteristics, the mean values +/- 1 standard deviation will be calculated for comparison of analogue and rehabilitation site data.
- Temporal variation will be presented graphically for vegetation variables as required to identify any outliers or ongoing trends.

5 Maintenance

5.1 General maintenance

Following rehabilitation activities, access to rehabilitated areas should be limited to monitoring, maintenance and management activities, until the corresponding milestone attributed to a stable PMLU is achieved. Where initial plantings show poor survival rates, supplementary planting may be required throughout the maintenance period.

Follow-up maintenance (e.g., weed and grass suppression) is deemed critical to the success of the rehabilitation areas. Maintenance activities will involve the following weed suppression techniques, as required:

- A weed eradication program will be developed and implemented on site to target potential sources of weed contamination.
- Periodic slashing and/or mulching should be undertaken and accompanied with herbicide application (as required) for a duration deemed appropriate to achieve the final milestone criteria.

Fencing may be used on rehabilitation areas to control access by grazing cattle in line with recommended land management techniques and grazing best management practices.

5.2 Remediation activities

Significant rainfall events, localised flooding, fire, drought, pest species outbreaks or other factors may also result in a requirement to maintain rehabilitated areas. Visual inspection of revegetated areas should be undertaken regularly to determine maintenance requirements. Maintenance of rehabilitated areas or reparation may be required where the expected trajectory towards achieving completion criteria is not being met. Depending on the underlying cause of failed rehabilitation, reparation maintenance activities may include:

- seeding and/or hay mulching;
- the application of gypsum and/or fertiliser at rates dependent on the results of soil testing;
- revegetation of affected areas; and
- earthworks to repair eroded areas and modifications to final landform slopes.

5.3 Weed and pest management

The first few years following planting are critical for controlling the spread of invasive species. As pioneer species, weeds tend to out-compete native species on disturbed soils before desirable species have had time to set roots and adequately cover a rehabilitated area. Remote sensing data has proven to be a powerful tool when assessing distribution and high-density areas of weeds at the Jellinbah Mine.

Category 3 restricted invasive plants, as classified under the *Biosecurity Act 2014,* that are known to impact the Project site include:

- Parkinsonia (*Parkinsonia aculeata*);
- Parthenium Weed (*Parthenium hysterophorus*);
- Common Pest Pear (*Opuntia stricta)*; and
- Velvety Tree Pear (*Opuntia tomentosa*).

Weed control strategies should include the management actions recommended by the Department of Agriculture and Fisheries (DAF) as shown in Table 8.

Table 8: Weed Control Strategies recommended by DAF

Species	Management Actions
Parkinsonia (*Parkinsonia aculeata*)	Herbicide application through pellets, with a product like Graslan Herbicide or similar, is recommended for Parkinsonia. Most rapid results can be obtained by application just prior to the rainfall season given that rain helps to move the chemical to the root zone where it is absorbed. Methods and rates of application can be found in the FMC fact sheet for Graslan Herbicide.
Parthenium Weed (*Parthenium hysterophorus*)	The most appropriate control method for parthenium weed is herbicide control applied to non-crop areas. Registered herbicides are listed in DAF fact sheet for Parthenium Weed Hand pulling of small areas is not recommended as there is a health hazard from allergic reactions and a danger that mature seeds will drop off and increase the area of infestation
Velvety Tree Pear (*Opuntia tomentosa*)	The control method most appropriate for Opuntia species at the Project site is herbicide control. Mechanical control using machinery is difficult because Opuntia pads can easily re-establish. The velvety tree pear fact sheet (DAF 2020) elaborates on herbicides registered for the control of Opuntia species.
Common Pest Pear (*Opuntia stricta)*	The control methods most appropriate for the common pest pear are physical, biological and herbicide controls. A suitable physical control measure is completely digging out the plant and beep burying. Other methods, including ploughing, is not considered an effect control measure. Mechanical control using machinery is difficult because prickly pear pads can easily re-establish. Suitable biological control information and registered herbicides are listed in DAF fact sheet for *Opuntia stricta.*

Species listed as restricted invasive animals under the *Biosecurity Act 2014,* that have been identified on the Project in the past include feral cats (*Felis catus*), and dingos (*Canis familiaris*). The Project will take reasonable and practicable steps to minimise or prevent the occurrence of pest fauna. Management strategies to minimise the occurrence of invasive pest species are outlined below:

- store domestic waste in appropriate receptacles in areas that are inaccessible to fauna species;
- ensure stored waste is disposed of in landfill on a regular basis;
- keep landfill sites covered to reduce the occurrence of feral cats and pigs; and
- formal and informal monitoring and record keeping of pest species observations.

If regular sightings of a certain pest species are reported, further action is recommended in accordance with the DAF fact sheets as described in Table 9.

Table 9: Pest control strategies recommended by DAF

Species	Management Actions
Feral cat (*Felis catus*)	Control methods for feral cats include exclusion fencing, trapping, shooting and poisoning. For true feral cats (as opposed to semi-feral urban cats) leg hold traps are more effective than box traps. Night shooting is assisted by the cat's distinctive, green eyeshine. Cats have been successfully attracted by the use of a fox whistle. Poisoning with fresh meat baits containing 1080 may also be used.
Dingos (*Canis familiaris*)	Dingos must not be moved, kept, fed, given away, sold, or released into the environment. A permit to deal with dingoes maybe given in limited circumstances.

6 References

Department of Agriculture and Fisheries-Biosecurity Queensland (DAF) 2020, Restricted invasive plant – Parthenium. Queensland.

Department of Agriculture and Fisheries-Biosecurity Queensland (DAF) 2020a, Restricted invasive plant – Parkinsonia. Queensland.

Department of Agriculture and Fisheries-Biosecurity Queensland (DAF) 2020b, Restricted invasive animal – Wild dog control (*Canis familiaris)*.

Department of Agriculture and Fisheries-Biosecurity Queensland (DAF) 2021, Restricted invasive plant – Velvety tree pear. Queensland.

Department of Agriculture and Fisheries-Biosecurity Queensland (DAF) 2021, Restricted invasive plant – Common pest pear or prickly pear. Queensland.

Department of Agriculture and Fisheries-Biosecurity Queensland (DAF) 2023, Restricted invasive animal – Feral cat (*Felis catus)*.

Eyre, T, Kelly, A, Neldner, V, Wilson, B, Ferguson, D, Laidlaw, M and Franks, A 2015, *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland*. Assessment Manual, Version 2.2, Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane, QLD.

Eyre, T, Kelly, A, Neldner, V 2017, *Method for the Establishment and Survey of Reference Sites for BioCondition*, Version 3.0, Queensland Herbarium, Department of Science, Information Technology, and Innovation, Brisbane, QLD.

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Addicott, E.P. and Appelman, C.N. 2020, *Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland*. Version 5.1. Updated March 2020. Queensland Herbarium, Queensland Department of Environment and Science, Brisbane.

Appendix F. Provided Technical Studies

- ATCW 2023a, *Kestrel CDA Cover & Final Landform Design - Surface Water Report*, report prepared for Kestrel Coal Resources Pty Ltd by ATC Williams (ATCW), Brisbane.
- ATCW 2023b, *Kestrel Mine Capping and Final Landform Design Plan: Co-disposal/Dry-stack Storage Facility*, report prepared for Kestrel Coal Resources Pty Ltd by ATC Williams (ATCW), Brisbane.
- Cardno 2012, *Bluegrass assessment and management recommendations*, report prepared for Rio Tinto Coal Australia by Cardno Pty Ltd, Brisbane.
- Department of Environment and Resource Management (DERM) 2006, *201-208 Subsidence rehabilitation approval*, Department of Environment and Resource Management (DERM), Brisbane.
- Department of Environment and Resource Management (DERM) 2006, *301-303 Subsidence rehabilitation approval*, Department of Environment and Resource Management (DERM), Brisbane.
- Department of Environment and Resource Management (DERM) 2006, *304-306 Subsidence rehabilitation approval*, Department of Environment and Resource Management (DERM), Brisbane.
- Department of Environment and Resource Management (DERM) 2012, *Notice of Decision – Progressive Rehabilitation*, notice issued for Kestrel Mine, Department of Environment and Resource Management (DERM), Brisbane.
- EGI 2006, *Preliminary ARD Review of the 400-500 series Extension at Kestrel*, report prepared for Matrix Plus Consulting Pty Limited by Environmental Geochemistry International (EGI), Brisbane.
- Gauge 2022, *Receiving Environment Monitoring Program (REMP) Annual Report – end June 2022*, report prepared for Kestrel Coal Resources by Gauge Industrial & Environmental Pty Ltd (Gauge), Brisbane.
- Klohn Crippen Berger (KCB) 2022a, *Kestrel-Gregory-Crinum groundwater model – Groundwater modelling report*, report prepared for Kestrel Coal Resources and Sojitz Gregory-Crinum. Brisbane.
- Klohn Crippen Berger (KCB) 2022b, *Kestrel-Gregory-Crinum groundwater model – Groundwater modelling report – Kestrel predictions*, report prepared for Kestrel Coal Resources by Klohn Crippen Berger (KCB), Brisbane.
- Umwelt 2023, *Biodiversity assessment report for the kestrel mining leases*, report prepared for Kestrel Coal Resources by Umwelt (Australia) Pty Ltd, Brisbane.
- WRM 2020, *Kestrel water balance model update: summary of water balance modelling*, report prepared for Kestrel by WRM Water and Environment Pty Ltd (WRM), Brisbane.

Appendix G. Rehabilitation Risk Assessment

Ref.				Risk Description				Control Effectiveness	Risk Evaluation						Risk Rating				Count				Final Risk Rating
Risk Type (T=Threat)	Category	Subcategory	Item	Risk Scenario/Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls		Likelihood - Frequency	Likelihood - Probability	Health	Safety	Environment	Compliance	Health	Safety	Environment	Compliance	C	H	M	L	
T	A			**Mine infrastructure areas**																			
T	A	01		**Safe**																			
T	A	01	01	Surface roughness (rockiness, depressions) in excess of that expected for PMLU	Inadequate surface preparation, localised settlement, erosion gullies	Safety hazard for personnel, stock and wildlife	Surface preparation measures (initial), monitoring, maintenance controls (pre-closure)	C1		U		Me				L			0	0	0	1	L
T	B	02		**Stable - geotechnical risk**																			
T	B	02	01	Not applicable															0	0	0	0	
T	A	03		**Stable - erosional risk**																			
T	A	03	01	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Erodible topsoils and subsoils, adverse weather events	Localised land impacts and downstream water quality impacts	Landform design moderating slope, adequate/effective subsoil and topsoil amelioration, prompt revegetation establishment, revegetation monitoring and management as required	C2		U			Me				L		0	0	0	1	L
T	A	03	02	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Inadequate rehabilitation drainage capacity and/or design	Localised land impacts and downstream water quality impacts	Drainage network design with acceptable design standards for drainage structures, avoidance of flow concentration, sub-catchment delineation, sufficient water storage structures, engineered flow channels (where required), effective revegetation techniques, rehabilitation monitoring and management as required	C2		U			Me				L		0	0	0	1	L
T	A	03	03	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Adverse climatic events and/or climatic sequences beyond design capacity	Localised land impacts and downstream water quality impacts	Downstream sedimentation controls, revegetation, monitoring and maintenance	C2		U			Me				L		0	0	0	1	L
T	A	03	04	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas (medium-long term risk)	Rehabilitation failure/ vegetation disease/loss, climatic events (drought)	Localised land impacts and downstream water quality impacts	Landform design moderating slope, adequate/effective subsoil and topsoil amelioration, prompt revegetation establishment, revegetation monitoring and management as required	C2		U			Me				L		0	0	0	1	L
T	A	04		**Non-polluting - geochemical risk**																			
T	A	04	01	Not applicable															0	0	0	0	
T	A	05		**Non-polluting - other environmental harm**																			
T	A	05	01	Contaminated land	Operational phase industrial use of land	Land contamination, surface water impacts	Appropriate infrastructure management; storage and bunding of hazardous materials, housekeeping and proactive spills management. Phase 1 assessment at closure	C2		U			Se				M		0	0	1	0	M
T	A	05	02	Inadequate rehabilitation of boreholes/shafts	Bore holes and shafts not sealed properly	Release of elevated concentrations of methane to the atmosphere	Established shaft sealing and borehole sealing procedures	C2		U			Se				M		0	0	1	0	M
T	A	06		**Sustainable - PMLU**																			
T	A	06	01	Insufficient pasture density/diversity and recruitment	Weather, poor soil characteristics, poor management practices impacting germination, vegetation establishment and PMLU density/diversity metrics	Insufficient pasture productivity	Improving rehabilitation methodologies, management and maintenance activities, rehabilitation performance monitoring	C2		U			Se				M		0	0	1	0	M
T	A	06	02	Pests and weeds	Poor local, regional or site property management practices.	Increased risk of not achieving designated PMLU	Pest and weed management practices, monitoring programs to allow early detection and management	C2		P			Se				H		0	1	0	0	H
T	A	06	03	Insufficient quality topsoil resources onsite available to undertake rehabilitation activities	Poor management practices, shortage of topsoil resources	Increased risk of not achieving PMLU	Implementation of topsoil management plan, annual review of topsoil inventory.	C2		U			Se				M		0	0	1	0	M

Ref.				Risk Description				Control Effectiveness	Risk Evaluation						Risk Rating				Count				Final Risk Rating
Risk Type (T=Threat)	Category	Subcategory	Item	Risk Scenario/Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls		Likelihood - Frequency	Likelihood - Probability	Health	Safety	Environment	Compliance	Health	Safety	Environment	Compliance	C	H	M	L	
T	B			**Subsidence areas**																			
T	B	01		**Safe**																			
T	B	01	01	Initial/ongoing surface cracking	Tensile strain around perimeter of subsidence troughs	Trip hazard for personnel, stock and wildlife	Monitoring and maintenance (pre- and post-mining). Rehabilitation activities (infilling, regrading, revegetation etc) commencing after 2 wet seasons if required	C2		U		Me				L			0	0	0	1	L
T	B	01	02	Localised increases in slope	Subsidence	Trip hazard for personnel, stock and wildlife	Monitoring and maintenance (pre- and post-mining). Rehabilitation activities (infilling, regrading, revegetation etc) commencing after 2 wet seasons if required	C2		U		Me				L			0	0	0	1	L
T	B	02		**Stable - geotechnical risk**																			
T	B	02	01	Surface land disturbance beyond predicted subsidence	Unknown geological anomalies	Unpredicted surface disturbance, trip hazard for personnel, stock and wildlife	Surface monitoring to validate expected subsidence	C1		R		Me				L			0	0	0	1	L
T	B	02	02	Post-closure residual subsidence	Potential long-term settlement	Unpredicted surface disturbance, trip hazard for personnel, stock and wildlife	Medium term monitoring surveys of additional subsidence	C1		R		Me				L			0	0	0	1	L
T	B	03		**Stable - erosional risk**																			
T	B	03	01	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Surface cracking	Localised land impacts and downstream water quality impacts; loss of Class III grazing capability	Landform reshaping to moderate slope, infilling or regrading to stabilise cracks, prompt revegetation establishment, revegetation monitoring and management as required, sediment controls during establishment	C2		U			Me				L		0	0	0	1	L
T	B	03	02	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Inadequate rehabilitation drainage capacity and/or design	Localised land impacts and downstream water quality impacts	Drainage network design with acceptable design standards for drainage structures, avoidance of flow concentration, sub-catchment delineation, sufficient water storage structures, engineered flow channels, effective revegetation techniques, rehabilitation monitoring and management as required	C2		U			Me				L		0	0	0	1	L
T	B	03	03	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Adverse climatic events and/or climatic sequences beyond design capacity	Localised land impacts and downstream water quality impacts	Landform design moderating slope, adequate/effective subsoil and topsoil amelioration, prompt revegetation establishment, revegetation monitoring and management as required	C2		U			Me				L		0	0	0	1	L
T	B	03	04	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas (medium-long term risk)	Rehabilitation failure/ vegetation disease/loss, climatic events (drought), other	Localised land impacts and downstream water quality impacts	Landform design moderating slope, adequate/effective subsoil and topsoil amelioration, prompt revegetation establishment, revegetation monitoring and management as required	C2		U			Me				L		0	0	0	1	L
T	B	04		**Non-polluting - geochemical risk**																			
T	B	04	01	Not applicable																			
T	B	05		**Non-polluting - other environmental harm**																			
T	B	05	01	Not applicable																			

Ref.				Risk Description				Control Effectiveness	Risk Evaluation						Risk Rating				Count				Final Risk Rating
Risk Type (T=Threat)	Category	Subcategory	Item	Risk Scenario/Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls		Likelihood - Frequency	Likelihood - Probability	Health	Safety	Environment	Compliance	Health	Safety	Environment	Compliance	C	H	M	L	
T	B	06		**Sustainable - PMLU**																			
T	B	06	01	Rehabilitated subsidence areas do not meet closure criteria and regulatory requirements for agricultural land (specifically, Strategic Cropping Land subject to RIDA reference number RPI16/002/RIO TINTO)	- Rehabilitation and/or maintenance of rehabilitated subsidence areas inadequate for re-instating pre-mining land capability. - Surface water management inadeqaute for preventing ponding, scouring, sheet erosion and gully erosion. - Any scouring or streambank erosion resulting from subsidence related changes not rectified or stabilised.	Sheet and gully erosion of subsidence areas and waterways; ponding over subsidence areas causing waterlogging, elevated water table, saline soils, inundation of pasture and damage to off site farm infrastructure through flooding; downstream water quality and aquatic ecology impacts from sedimentation; a residual risks payment may be required (under the EP Act)	No evidence to date of impact to land suitability; ACARP study indicates no impact to date; existing procedures for contour bank survey and reinstatement; contour banks maintained as part of regular farming activities; monitoring of riparian areas that are being subsided; SCL and subsidence conditions	C2		U			Me				L		0	0	0	1	L
T	B	06	02	Rehabilitation of subsidence in riparian zones is insufficient to meet regulatory requirements, including requirementsto rectify and stabilise any scouring or streambank erosion resulting from subsidence-related changes to flows, and rehabilitate land to stable landform	Surface water management inadequate for preventing ponding and scouring; any scouring or streambank erosion resulting from subsidence-related changes not rectified or stabilised	Long term impact to riparian eosystems causing delayed sign-off; more extreme subsidence and cracking than predicted; significant impacts on drainage lines causing erosion; groundwater impacts from subsidence (loss of more valuable Tertiary aquifers); damage to or insufficient protection of riparian habitat from agricultural practices; and/or inadequate erosion control measures, and land use practices, causing land degradation; a residual risks payment may be required (under the EP Act)	Baseline surveys and impact prediction studies, regular monitoring of areas of subsidence within riparian zones and ongoing remediation of identified impacts as required.	C2		U			Se				M		0	0	1	0	M
T	B	06	03	Insufficient pasture density/diversity and recruitment	Weather, poor soil characteristics, poor management practices impacting germination, vegetation establishment and PMLU density/diversity metrics	Insufficient pasture productivity	Improving rehabilitation methodologies, management and maintenance activities, rehabilitation performance monitoring	C2		U			Se				M		0	0	1	0	M
T	B	06	04	Alteration to existing aquatic habitats	Surface water management inadequate for preventing ponding and scouring; inadequate drainage design alters flows, availability of aquatic habitat and fish passage in impacted watercourses	Changes to local catchment drainage patterns resulting in localised ponding impacting on aquatic habitat connectivity	Drainage network design with acceptable design standards for drainage structures, avoidance of flow concentration, sub-catchment delineation, engineered flow channels, appropriate species selection, effective revegetation techniques, rehabilitation	C2		U			Se				M		0	0	1	0	M
T	B	06	05	Pests and weeds	Poor local, regional or site property management practices.	Increased risk of not achieving designated PMLU	Pest and weed management practices, monitoring programs to allow early detection and management	C2		P			Se				H		0	1	0	0	H

Ref.				Risk Description				Control Effectiveness	Risk Evaluation						Risk Rating				Count				Final Risk Rating
Risk Type (T=Threat)	Category	Subcategory	Item	Risk Scenario/Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls		Likelihood - Frequency	Likelihood - Probability	Health	Safety	Environment	Compliance	Health	Safety	Environment	Compliance	C	H	M	L	
T	C			**Retained water management infrastructure (including drainage diversions)**																			
T	C	01		**Safe**																			
T	C	01	01	Dam failure (overtopping) of retained structures	Extreme rainfall events	Downstream hazard to public	Retained dams will be assessed as safe and stable by appropriately qualified person prior to relinquishment; Where environmental dam is to be retained the spillway will be raised to probable maximum flood level.	C1		U		Me				L			0	0	0	1	L
T	C	02		**Stable - geotechnical risk**																			
T	C	02	01	Wall failure/dam break of retained structures (including levees)	Extreme rainfall events	Downstream hazard to public	Only minor stock dams or engineered water storages to be retained at closure; to be assessed as safe and stable by appropriately qualified person prior to relinquishment	C1		U		Me				L			0	0	0	1	L
T	C	03		**Stable - erosional risk**																			
T	C	03	01	Ongoing erosion of diversion channel	Inadequate rehabilitation drainage capacity and/or design; inadequate rehabilitation management	Localised land impacts and downstream water quality impacts	Drainage network design with acceptable design standards for drainage structures, avoidance of flow concentration, sub-catchment delineation, sufficient water storage structures, engineered flow channels, effective revegetation techniques, rehabilitation monitoring and management as required	C2		U			Se				M		0	0	1	0	M
T	C	04		**Non-polluting - geochemical risk**																			
T	C	04	01	Poor water quality in retained water storages	Adverse geochemical characteristics of disturbed materials in catchment	Downstream water quality impacts	Mine affected water to be removed from dam, water quality monitoring program to allow early detection and management of poor water quality	C2		U			Se				M		0	0	1	0	M
T	C	05		**Non-polluting - other environmental harm**																			
T	C	05	01	Not applicable															0	0	0	0	
T	C	06		**Sustainable - PMLU**																			
T	C	06	01	Insufficient in-channel and riparian vegetatation establishment in diversion channels	Weather, poor erosion management, poor management practices impacting germination, vegetation establishment and PMLU density/diversity metrics	Lack of establishment of target vegetation, increased erosion and instability of the banks	Drainage channels designed to acceptable standards, avoidance of flow concentrations, effective revegetation techniques, rehabilitation minitoring and maintenance as required	C2		U			Se				M		0	0	1	0	M
T	C	06	02	Water quality in retained storages not meeting PMLU water quality requirements	Adverse geochemical characteristics of disturbed materials in catchment	Livestock health	Mine affected water to be removed from dam, water quality monitoring program to allow early detection and management of poor water quality	C2		U			Me				L		0	0	0	1	L
T	D			**Rehabilitated water management infastructure**																			
T	D	01		**Safe**																			
T	D	01	01	Surface roughness (rockiness, depressions) in excess of that expected for PMLU	Inadequate surface preparation, localised settlement, erosion gullies	Safety hazard for personnel, stock and wildlife	Surface preparation measures (initial), monitoring, maintenance controls (pre-closure)	C1		U		Me				L			0	0	0	1	L
T	D	01	02	Significant slope or surface failure	Inadequate surface preparation, localised settlement, excessive slope steepness, physical material properties, poor drainage, adverse rainfall event	Safety hazard for personnel, stock and wildlife	Surface preparation measures (initial), monitoring, maintenance controls (pre-closure)	C1		U		Me				L			0	0	0	1	L

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Risk Type (T=Threat)	Category	Subcategory	Item	Risk Scenario/Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls		Likelihood - Frequency	Likelihood - Probability	Health	Safety	Environment	Compliance	Health	Safety	Environment	Compliance	C	H	M	L	
T	**D**	**02**		**Stable - geotechnical risk**																			
T	D	02	01	Wall failure/dam break of retained structures	Extreme rainfall events	Downstream hazard to public	Dam will be assessed as safe and stable by appropriately qualified person prior to relinquishment	C1		U		Me				L			0	0	0	1	L
T	**D**	**03**		**Stable - erosional risk**																			
T	D	03	01	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Erodible topsoils and subsoils, adverse weather events	Localised land impacts and downstream water quality impacts	Landform design moderating slope, adequate/effective subsoil and topsoil amelioration, prompt revegetation establishment, revegetation monitoring and management as required	C2		U			Me				L		0	0	0	1	L
T	D	03	02	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Inadequate rehabilitation drainage capacity and/or design	Localised land impacts and downstream water quality impacts	Drainage network design with acceptable design standards for drainage structures, avoidance of flow concentration, sub-catchment delineation, sufficient water storage structures, engineered flow channels (where required), effective revegetation techniques, rehabilitation monitoring and management as required	C2		U			Se				M		0	0	1	0	M
T	D	03	03	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Adverse climatic events and/or climatic sequences beyond design capacity	Localised land impacts and downstream water quality impacts	Downstream sedimentation controls, revegetation, monitoring and maintenance	C2		U			Se				M		0	0	1	0	M
T	D	03	04	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas (medium-long term risk)	Rehabilitation failure/ vegetation disease/loss, climatic events (drought)	Localised land impacts and downstream water quality impacts	Landform design moderating slope, adequate/effective subsoil and topsoil amelioration, prompt revegetation establishment, revegetation monitoring and management as required	C2		U			Me				L		0	0	0	1	L
T	**D**	**04**		**Non-polluting - geochemical risk**																			
T	D	04	01	Not applicable																			
T	**D**	**05**		**Non-polluting - other environmental harm**																			
T	D	05	01	Contaminated land (applicable to environmental and sediment dams)	Inadequate assessment and remediation prior to rehabilitation	Land contamination, surface water impacts, poor vegetation establishment	Contamintated land assessment, water quality monitoring, records of remediation activities	C2		U			Me				L		0	0	0	1	L
T	**D**	**06**		**Sustainable - PMLU**																			
T	D	06	01	Insufficient pasture density/diversity and recruitment	Weather, poor soil characteristics, poor management practices impacting germination, vegetation establishment and PMLU density/diversity metrics	Insufficient pasture productivity	Improving rehabilitation methodologies, management and maintenance activities, rehabilitation performance monitoring	C2		U			Se				M		0	0	1	0	M
T	D	06	02	Pests and weeds	Poor local, regional or site property management practices.	Increased risk of not achieving designated PMLU	Pest and weed management practices, monitoring programs to allow early detection and management	C2		P			Se				H		0	1	0	0	H
T	D	06	03	Insufficient quality topsoil resources onsite available to undertake rehabilitation activities	Poor management practices, shortage of topsoil resources	Increased risk of not achieving PMLU	Adequate topsoil stockpiling and management strategies	C2		U			Se				M		0	0	1	0	M

Ref.				Risk Description					Risk Evaluation						Risk Rating				Count				
Risk Type (T=Threat)	Category	Subcategory	Item	Risk Scenario/Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls	Control Effectiveness	Likelihood - Frequency	Likelihood - Probability	Health	Safety	Environment	Compliance	Health	Safety	Environment	Compliance	C	H	M	L	Final Risk Rating
T	F			**Co-disposal / Dy-stack facility**																			
T	F	01		**Safe**																			
T	F	01	01	Surface roughness (rockiness, depressions) in excess of that expected for the PMLU	Materials used for capping, capping methodology	Safety hazard for personnel, stock and wildlife	Geotech testing, surface preparation measures; material capping constructed to design specifications	C1		U		Me				L			0	0	0	1	L
T	F	02		**Stable - geotechnical risk**																			
T	F	02	01	Differential settlement	Materials used for capping, capping methodology	Localised land impacts and downstream water quality impacts	Geotech testing, surface preparation measures; material capping constructed to design specifications no observed differential settlement	C2		P			Me				M		0	0	1	0	M
T	F	02	02	Significant structural failure	Retaining structure failure, physical material properties, poor drainage, adverse rainfall event	Localised land impacts and downstream water quality impacts	Geotech testing, surface preparation measures; material capping constructed to design specifications no observed differential settlement	C2		U			Ma				H		0	1	0	0	H
T	F	03		**Stable - erosional risk**																			
T	F	03	01	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Erodible cover materials, adverse weather events	Localised land impacts, exposed tailings	Adequate/effective cover material amelioration, prompt revegetation establishment, revegetation monitoring and management as required	C2		U			Se				M		0	0	1	0	M
T	F	03	02	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Inadequate design, adverse weather events	Localised land impacts, exposed tailings	Tailings contained with capping material constructed to design specifications, surface preparation measures, surface drainage away from capped tailings area, adequate revegetation	C2		U			Se				M		0	0	1	0	M
T	F	03	03	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Adverse climatic events and/or climatic sequences beyond design capacity	Localised land impacts and downstream water quality impacts	Tailings contained with capping material constructed to design specifications, surface preparation measures, surface drainage away from capped tailings area, adequate revegetation	C2		P			Se				H		0	1	0	0	H
T	F	03	04	Initial/ongoing gully, pipe and/or sheet erosion of rehabilitated areas (medium-long term risk)	Rehabilitation failure / revegetation disease, climatic events	Localised land impacts, exposed tailings and downstream water quality impacts	Adequate / effective revegetation establishment, revegetation monitoring and management as required	C2		U			Se				M		0	0	1	0	M
T	F	04		**Non-polluting - geochemical risk**																			
T	F	04	01	Contaminated drainage generated within co-disposal / dry-stack facility and released to groundwater causing significant impacts to groundwater quality	Co-disposal /dry-stack facility design not effective in preventing generation and/or release of contaminants to groundwater.	Groundwater contamination; significant impacts on landholder bore water quality causing impacts to land use; a residual risks payment may be required (under EP Act).	Routine groundwater monitoring and annual analysis to enable early detection of impacts and reporting to regulatory authorities. Capping contructed to design criteria. Drainage away from capped materials, design to minimise/prevent ponding on the surface and leaching through material.	C2		P			Se				H		0	1	0	0	H
T	F	04	02	Acid rock drainage generated within co-disposal / dry-stack facility and released to groundwater causing signfiicant impacts to surface water quality	Cover design and water management system not effective in preventing generation and/or release of acid rock drainage or saline drainage to surface water.	Residual impact on groundwater aquifer; impacts on downstream water quality; a residual risks payment may be required (under EP Act)	Groundwater and surface water monitoring and annual analysis to enable early detection of impacts and reporting to regulatory authorities. Capping contructed to design criteria. Drainage away from capped materials, design to minimise/prevent ponding on the surface and leaching through material.	C2		P			Se				H		0	1	0	0	H

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T	F	05		**Non-polluting - other environmental harm**																			
T	F	05	01	Not applicable															0	0	0	0	
T	F	06		**Sustainable - PMLU**																			
T	F	06	01	Insufficient density/diversity of vegetation for grass community PMLU	Weather, poor soil characteristics and slopes impacting germination, vegetation establishment and PMLU density/diversity metrics, weed infestations	Increased risk of not achieving designated PMLU	Soil amelioration, pasture performance monitoring	C2		P			Se				H		0	1	0	0	H
T	F	06	02	Pests and weeds	Poor local, regional or site property management practices, weed invasion	Increased risk of not achieving designated PMLU	Pest and weed management practices, monitoring programs to allow early detection and management, intensify monitoring and management measures as appropriate.	C2		P			Me				M		0	0	1	0	M
T	F	06	03	Insufficient quality capping resources onsite available to undertake rehabilitation activities	Poor management practices, shortage of topsoil resources	Increased risk of not achieving PMLU	Implementation of topsoil management plan, annual review of topsoil inventory.	C2		U			Me				L		0	0	0	1	L
				End of record																			