BHP Mitsubishi Alliance

CVM-PLN-0052

Terrestrial GDE Monitoring & Management Plan

Caval Ridge Mine
(Horse Pit Extension Project EPBC 2021/9031)

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Declaration of accuracy

In making this declaration, I am aware that section 491 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed 

Full name (please print) LACHLAN KERR

Organisation (please print) BHP MITSUBISHI ALLIANCE

Date 13/05/25

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1 Introduction

1 This Terrestrial Groundwater Dependent Ecosystem Management and Monitoring Plan (TGDEMMP) has been developed as per Condition 22 of *Environment and Protection Conservation Act 1999* (EPBC) approval of the Horse Pit Extension Project, (the Project) at Caval Ridge Mine (EPBC 2021/9031). The outcomes of groundwater dependent ecosystem (GDE) impact assessment completed for the Project is based largely on the groundwater modelling undertaken that predicted the extent and rate of groundwater drawdown in proximity to the Project area. This TGDEMMP aims to facilitate verification that the modelled impacts are materialising as predicted, and to prompt identification and implementation of appropriate management measures in the event impacts are outside those predicted.

2 This plan has been prepared by 2Rog Consulting Pty Ltd with PHD-level expertise in the fields of ecology, hydrology, hydrogeology, eco-hydrology and planning for adaptive environmental management. 2Rog Consulting Pty Ltd are a suitably qualified GDE expert in accordance with Condition 23 of the EPBC approval for the Project.

1.1 Objective and Performance Criteria

3 The scope of this plan is to provide a structured approach, informed by monitoring, to assessing impacts to GDEs, and developing and implementing appropriate management or mitigation responses. This plan only addresses terrestrial GDEs (TGDEs), which are defined as vegetation communities that require access to groundwater to meet all or some of their ecological water requirements (Richardson et al. 2011).

4 Objectives of the TGDEMMP are as follows:

- **a** Mapping identifying the groundwater area of investigation for assessment.
- **b** Details and results of a GDE field assessment within the groundwater area of investigation.
- **c** The evidence used to determine which, if any, ecosystems within the groundwater area of investigation are terrestrial GDEs.
- **d** A description, map/s and shapefiles of any ecosystems determined likely to be terrestrial GDEs, which clearly defines the location and boundaries of terrestrial GDEs and shows where they include habitat for protected matters.
- **e** The proposed methodology and timing for the monitoring and detection of any harm to terrestrial GDEs as a result of the action, including baseline data if any ecosystems within the groundwater area of investigation is determined likely to be terrestrial GDEs. This must include specifications of associated:
  - **i** Trigger thresholds that, if reached, the approval holder commits to investigate the cause of.
  - **ii** Corrective measures that will be implemented if any trigger threshold is reached to bring values below the trigger threshold and prevent any limit being reached.
- **f** Details of the investigations that will be undertaken if trigger thresholds are reached.

5 The performance criterion for the monitoring and management of TGDE relating to the execution of the Project can be described as follows:

- **a** Project impacts to TGDE are less than or equal to impacts predicted and approved for the Project.

1.2 Structure of the Plan

6 The key sections of the TGDEMMP include:

- **a** A summary of the TGDE values within the Project area, and subject of this plan.
- **b** A management plan for TGDEs.
- **c** Arrangements for reporting and monitoring compliance with management plan actions.
- **d** A description of how this plan is consistent with the GDE toolbox.

7 The TGDE management framework provides the following information:

- **a** The assessed impacts of the Project on ecological and groundwater resources and associated threats to TGDEs.
- **b** The monitoring program for TGDEs across the pre-impact and impact phases of the Project, to supplement baseline monitoring completed to date.
- **c** Triggers for groundwater and ecological values associated with TGDEs.
- **d** Details of mitigation and management measures to be implemented to avoid or reduce potential impacts on TGDEs, including corrective actions.

8 This plan has been developed to allow future amendments. To facilitate practical implementation of management measures, this TGDEMMP provides for the inclusion of ongoing review outcomes through an adaptive management framework.

1.3 Background Information

9 The presence and potential impact to TGDEs, as a result of the Project, is documented in the following reports:

- **a** BHP Mitsubishi Alliance Caval Ridge Mine Horse Pit Extension Preliminary Documentation (EPBC 2021/9031) (BMA 2024)
- **b** BHP Mitsubishi Alliance Caval Ridge Mine Horse Pit Extension Preliminary Documentation (EPBC 2021/9031) Appendix E1 Groundwater Dependent Ecosystems Impact Assessment Report (E2M 2021a)
- **c** BHP Mitsubishi Alliance Caval Ridge Mine Horse Pit Extension Preliminary Documentation (EPBC 2021/9031) Appendix E2 Groundwater Dependent Ecosystem Risk Assessment (E2M 2021b)

1.4 Consistency with GDE Toolbox

10 This management plan has been developed to be consistent with the approach detailed in the GDE Toolbox as described in the following sections.

1.4.1 GDE Toolbox Stage 1 – GDE location, classification and conceptualisation

11 GDE Toolbox Stage 1 assessment focuses on developing a baseline understanding of where GDEs exist, classification of ecosystem type and conceptualisation of the ecohydrogeologic setting (Richardson et al. 2011).

12 Classification and conceptualisation of GDEs associated with the Project area was completed as part of the impact assessment process. This monitoring plan incorporates additional baseline data collected to further develop the classification and conceptualisation of likely TGDE relevant to the Project.

1.4.2 GDE Toolbox Stage 2 – Characterisation of groundwater reliance

13 GDE Toolbox Stage 2 assessment seeks to characterise potential reliance of identified GDEs on groundwater. To determine the groundwater interactions and dependency for each GDE, collection of time-series data is required to quantify the seasonal use of groundwater. The timing of groundwater use by each of the GDEs is a consideration in the development of ecological water requirements (EWRs; Richardson et al. 2011).

14 Characterisation undertaken for the impact assessment has relied on modelling of groundwater, surface water and conceptualisation of groundwater-surface water interactions to identify a potential reliance. The monitoring design for this TGDEMMP has been developed to verify the predicted potential reliance, whilst collecting additional data that may be used to further characterise any detected reliance.

1.4.3 GDE Toolbox Stage 3 – Characterisation of ecological response to change

15 GDE Toolbox Stage 3 involves creating a detailed and quantified understanding of the ecological and biotic responses of GDEs to fluctuations and changes in groundwater. This will primarily be achieved through monitoring designed to detect any decline in ecological function of the likely TGDE vegetation. Such characterisation will occur by understanding the pre-impact condition (i.e. including response to natural seasonal variation) and impact condition (i.e. response to mining-related impacts), as well as monitoring condition of control sites. Monitoring will focus on the biotic responses of TGDEs.

2 Assessment area/s

16 The identification and assessment of impacts to GDEs was conducted via desktop and field methods. GDEs were identified within the Predicted Drawdown Extent, representing the area of modelled groundwater drawdown associated with the Project. Figure 2-1 displays the Predicted Drawdown Extent and the Project Footprint.

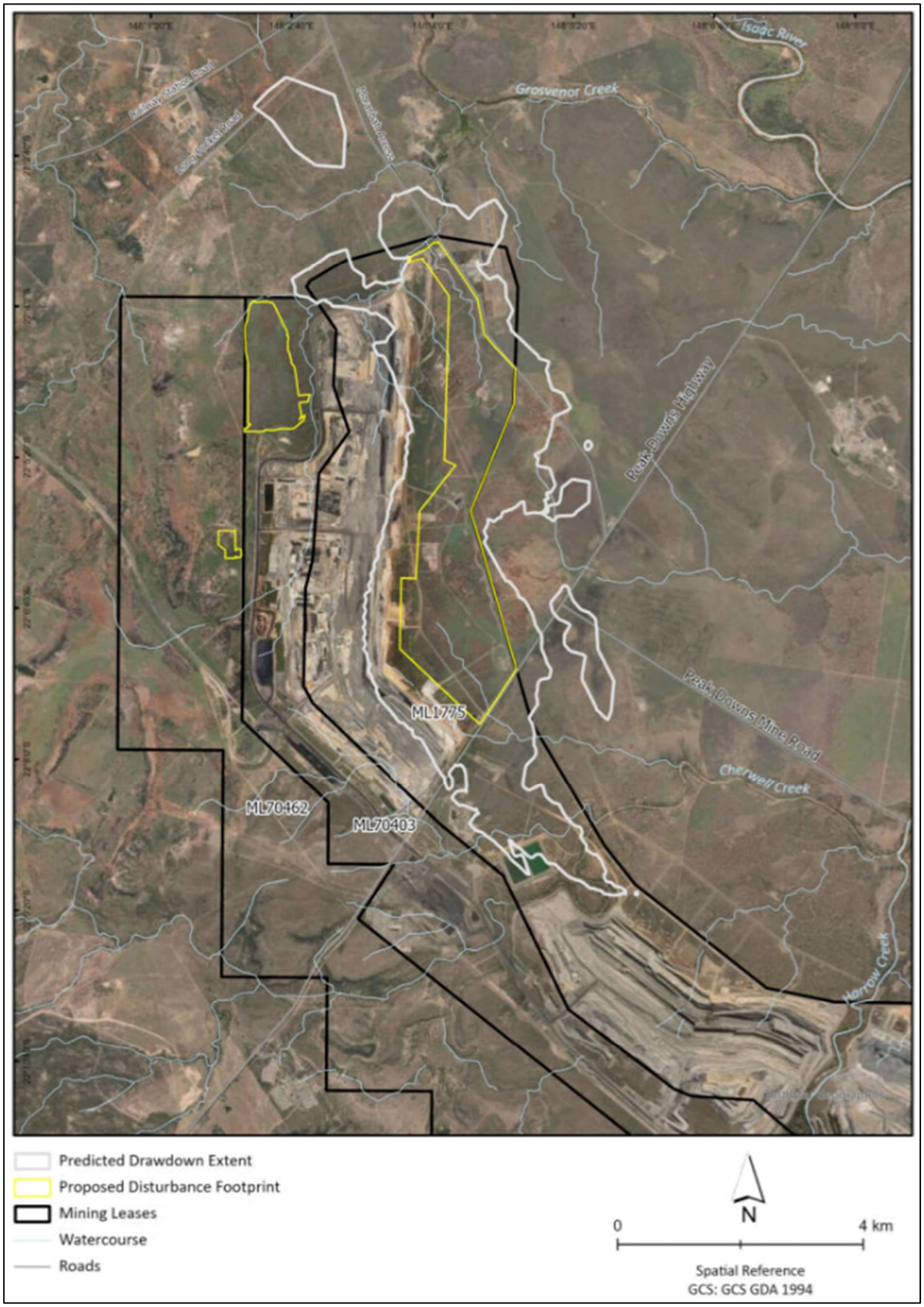

Figure 2-1 Assessment Area/s for GDEs

3 GDEs associated with the Project

17 The potential presence of other GDE types in the Predicted Drawdown Extent is discussed within the Preliminary Documentation (PD), noting (BMA 2024):

- **a** The generally high salinity of groundwater regionally suggests that the groundwater environment of the Isaac River catchment is not ideal for stygofauna. Studies within the region indicate a limited presence of stygofauna, and where present, stygofauna taxa are not obligate groundwater inhabitants (i.e. may also be found within surface water features). The Project area has a low likelihood of supporting stygofauna communities (aquifer/cave ecosystem GDEs).
- **b** Aquatic habitats in the vicinity of the Project were representative of ephemeral waterways and wetland sites, with no obvious surface-expression of groundwater at these sites. The value of mapped potential surface-expression expression GDEs was low to moderate at wetland and waterway sites. Field assessments were consistent with previous aquatic ecology survey in the region.

18 TGDEs are defined by Eamus et al. (2006) as ecosystems dependent on access to subsurface groundwater (which includes many riparian communities). To identify TGDEs, and determine potential reliance on groundwater, a cumulative evidence-based decision approach (CEDA) has been applied (BMA 2024). Evidence was collected via three approaches:

19 Desktop assessment

- **a** GDE remote sensing:
  - **i** Review and application of a Groundwater Dependent Ecosystem Mapping (GEM) method (2rog 2021). This approach was used to identify TGDEs using the Normalised Difference Vegetation Index (NDVI) and Normalised Differentiation Moisture Index (NDMI).
- **b** GDE and Regional Ecosystem (RE) mapping:
  - **i** Review of available mapping products to identify potential GDEs (e.g. Bureau of Meteorology GDE Atlas; Map of Queensland Wetland Environmental Values).
  - **ii** Review of Queensland RE mapping.
- **c** Geological overview:
  - **i** Examination of geology associated with the Project.
- **d** Literature review:
  - **i** Vegetation communities associated with groundwater use.
  - **ii** Species known to utilise groundwater on facultative or obligate basis.
  - **iii** Ecological attributes critical to groundwater use (e.g. rooting depth).

20 Groundwater modelling

- **a** Existing depth to water (DTW) via analysis of CVM monitoring bore data.
- **b** Predicted scale of drawdown.
- **c** Predicted Drawdown Extent.

21 Field surveys

- **a** Assessment of potential TDGE vegetation communities based on initial desktop assessment.
- **b** Baseline condition assessment of potential TGDEs:

i BioCondition Assessment (impact and control sites) within the Preliminary Drawdown Area.

22 Cumulatively, the above approaches identified several vegetation communities that likely, or may possibly, function as TGDEs within the Project's Predicted Drawdown Extent. Likelihood of a vegetation community functioning as a TGDE was assessed as a factor of:

a The presence of known indicator species (i.e. tree species that are known to use / be reliant on groundwater) within present vegetation communities.

b Likely rooting depth of indicator species within vegetation communities, noting that in order for vegetation to access groundwater in the subsurface, root structures need to access the capillary zone located above the groundwater level.

c Sufficient DTW in strata under vegetation communities[1].

d The application of remote sensing diagnostics (indicating the use of groundwater within vegetation communities - e.g. via the GEM approach) where appropriate (refer BMA 2024, Section 4.4.4.3).

23 Per the PD, 32.71 ha of vegetation communities are considered likely TGDE. These areas are riparian communities associated with RE 11.3.25 (BMA, 2024). Vegetation considered possible TGDE, totals 42.43 ha. These areas include REs 11.3.2 and 11.5.3 along floodplains and sandy plains within the southern section of the Predicted Drawdown Extent, nearby Caval and Cherwell Creeks. Likely and possible TGDEs also intersect with habitat for EPBC Protected Matters (refer BMA 2024, Section 3.3). These values are displayed in Figure 3-2.

24 Based on available literature and the modelled groundwater table, all of the likely and possible TGDEs identified are considered to comprise facultative TGDE species, utilising groundwater when available, however, not considered dependent on access for ongoing persistence (E2M 2021a). All other vegetation within the Predicted Drawdown Extent were considered unlikely to be groundwater dependent. A summary of the REs identified as likely or potential TGDEs is provided in Table 3-1. The summary comprises RE types, present of indicator species, area, and a rationale for likelihood.

RE	*Indicator Species*	*Area (ha)*	*TGDE likelihood and rationale*

11.3.2	*Eucalyptus populnea*	0.78 High Value Regrowth (HVR)
		3.85 Remnant
			• Possible GDE (facultative):
			  • Mapped as low potential by GDE Atlas.
			  • Field assessment identified one GDE indicator species (i.e. *E. populnea*) dominated the community.
			  • Modelled DTW for the community to be between 15-25 mbgl = possible GDE.

11.3.25	*Eucalyptus camaldulensis*
	Eucalyptus populnea
	Melaleuca fluviatilis
	Casuarina cunninghamiana
		6.21 HVR
		26.5 Remnant
			• Likely GDE (facultative):
			  • Mapped high and moderate potential by GDE Atlas.
			  • Field assessment identified potential GDE indicator species (e.g. *E. camaldulensis* and *E. populnea*) occurring within the community.
			  • Modelled DTW for 6.21 ha within the northern section of the Predicted Drawdown Extent between 5 to 10 mbgl = likely GDE.
			  • Modelled DTW for 26.5ha within the southern section between 15 to 20 mbgl = possible GDE.

11.5.3	*Eucalyptus populnea*	9.28 HVR 28.52 Remnant	• Possible GDE (facultative): • Mapped low potential by GDE Atlas

[1] Eamus et al. (2006) suggests that groundwater located greater than 10 meters below ground level (mgbl) has reduced importance to vegetation. The use of groundwater is generally considered likely where depth to water (DTW) is 0 to 10 mbgl, possible at depths of 10 to 20 mbgl and unlikely at depths greater than 20 mbgl (Eamus, Hatton, et al. 2006).

RE	Indicator Species	Area (ha)	TGDE likelihood and rationale
			• Field assessment identified one GDE indicator species (i.e. *E. populnea*) dominated the community • Modelled DTW for 34.06 ha of the community between 15 to 25 mbgl = possible GDE • Other areas of the community located where >20 m DTW = unlikely GDE.

Table 3-1 Likely and Possible TGDEs in Predicted Drawdown Extent

25 Baseline condition assessments (i.e. BioCondition) were conducted within each of the vegetation communities identified in Table 3-1. Vegetation condition is the primary parameter by which impacts associated with the Project are assessed. Assessments were undertaken at seven (7) impact and eight (8) control sites within the relevant REs. BioCondition assessments of vegetation communities were generally of moderate condition. Scores varied from 5 to 7 (of the maximum BioCondition score (10)), with HVR sites typically lower than remnant ecosystems. Lower Habitat Quality scores were associated with (E2M, 2021a):

a Low native grass and native forb species richness and cover.

b High non-native plant cover.

c Selective clearing, thinning and dieback of large trees.

26 Table 3-2 provides an overview of the baseline condition of vegetation communities which are considered likely or possible TGDEs. Locations of baseline condition assessments are consistent with indicative monitoring sites (refer Figure 6-1) and are also provided in Figure 3-1.

RE	Site	Samples	Vegetation	Score
11.3.2	Impact	2	Remnant	5.06
	Control	1		5.56
11.3.25	Impact	2	Remnant	6.59
		1	HVR	5.13
	Control	5	Remnant	6.33
11.5.3	Impact	2	Remnant	6.68
	Control	2		6.94

Table 3-2 BioCondition scores for REs containing TGDEs

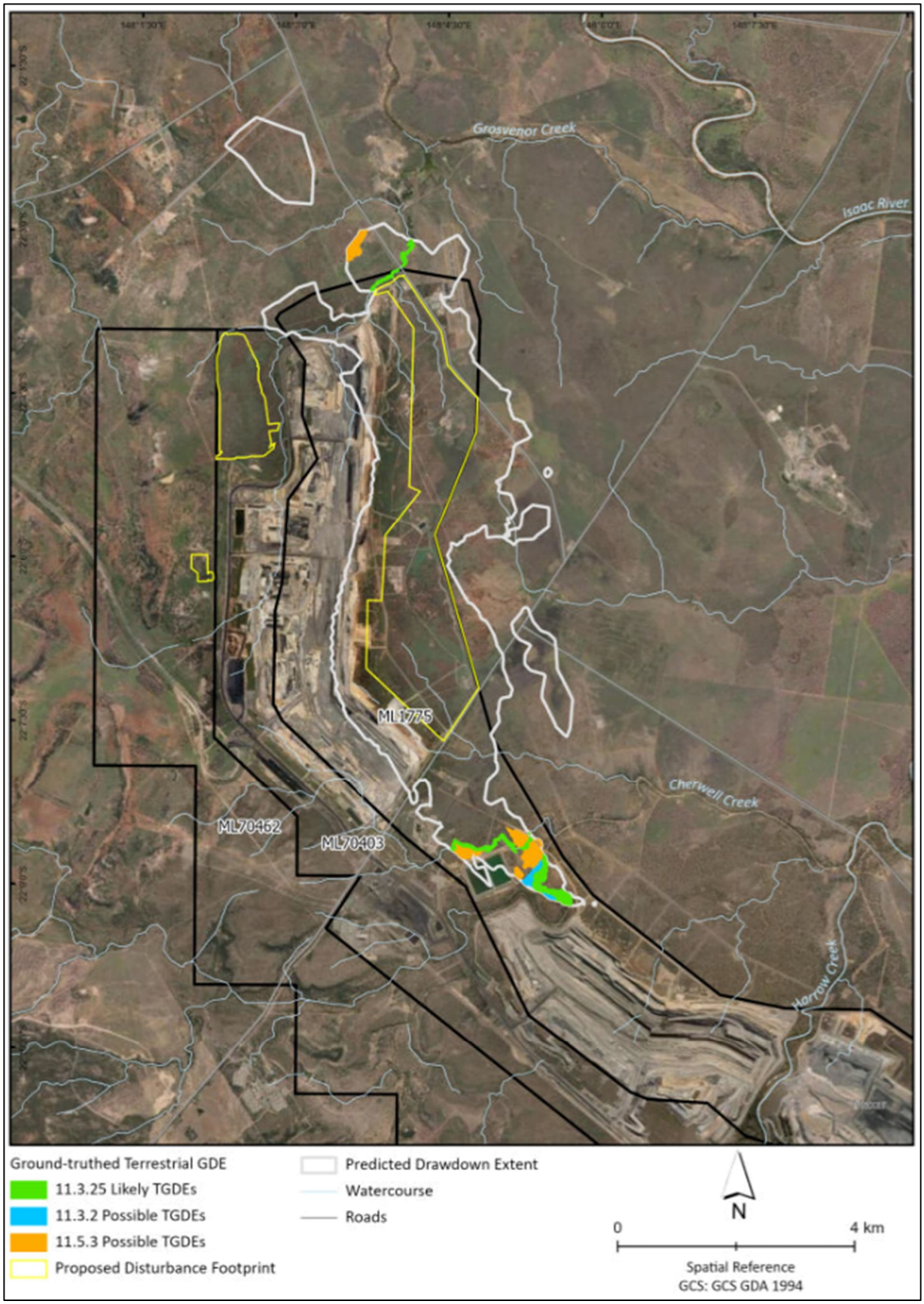

Figure 3-1 Likely and Possible TGDEs in the Predicted Drawdown Extent

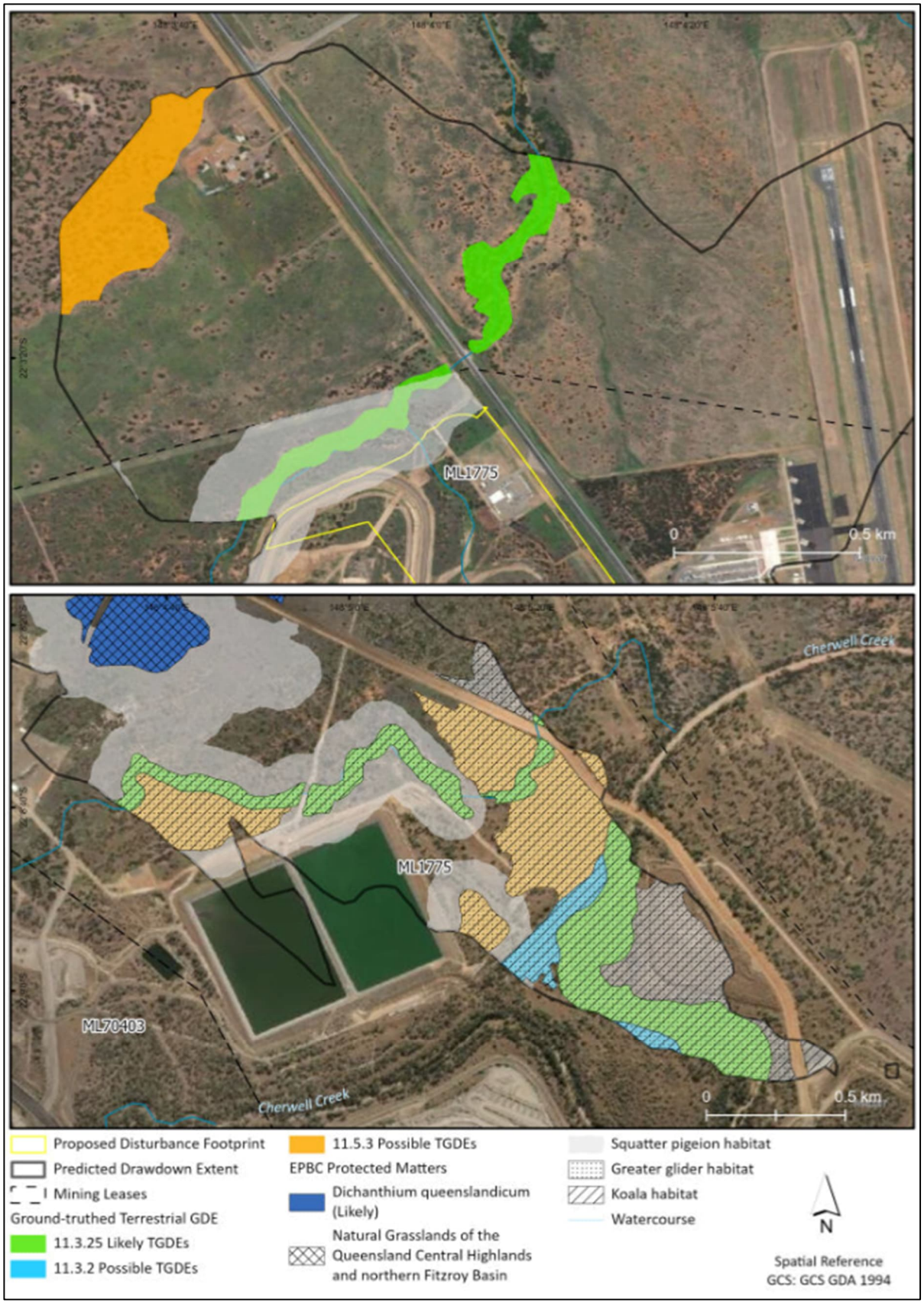

Figure 3-2 TGDEs and habitat for EPBC Protected Matters within the Predicted Drawdown Extent

4 Potential Impacts

4.1 Impacts

28 Potential impacts to TGDEs have been collated from relevant policy documents (e.g. Barnett et al. 2012; ISEC 2024; Richardson et al. 2011) and the impact assessment process undertaken for the Project (E2M 2021a). These include:

- **a** Direct disturbance – in the event vegetation clearing is required.
- **b** Groundwater drawdown – specifically a reduced access to water at the root depth for some species within the present vegetation communities.
- **c** Changes in groundwater quality – specifically if there is a spill event that leads to a contamination of groundwater.
- **d** Changes in surface water quality and flows– noting the facultative nature of the indicator species identified, an event that leads to a deterioration of surface water quality also has potential to impact TGDE.

29 A formal risk assessment was undertaken with respect to the above impacts (E2M, 2021b). This assessment provides a comprehensive analysis of the likelihood, consequence and resultant risk from each type of impact, both prior to, and after the application of appropriate mitigation measures. This assessment determined a 'low' residual risk rating for all potential impacts to TGDEs, as a result of the Project. The following sub-sections provide an overview of the extent, likelihood and significance of these potential impacts to TGDEs, as essential context for the development of the monitoring and management framework (Section 5). The detailed risk assessment is provided in Appendix B.

30 Potential impacts have been assessed with respect to vegetation communities considered likely to function at TGDEs. Impacts are primarily considered to occur within the bounds of the Predicted Drawdown Extent; however, it is likely that riparian communities downstream of the Project may be impacted via some of the following impact pathways

4.1.1 Direct disturbance

31 No likely or possible TGDEs occur within the Disturbance Footprint of the Project. As such no direct impacts are anticipated (refer E2M 2021a, Figure 5).

4.1.2 Groundwater drawdown

32 Potential impacts to TGDEs may indirectly occur as a result of the mining process, increasing the DTW in present groundwater units. Impacts may manifest where the function of a TGDE is altered as a result of movement of groundwater away from the vegetation root zone of indicator species identified within relevant vegetation communities. The extent to which this process occurs depends on a range of factors, including the extent of drawdown, the rooting depth of species potentially utilising groundwater (based on literature review) (refer BMA 2024, Section 4.4.4.2), local geology of alluvial sediments and their permeability to water movement.

33 The risk of impacts to TGDEs has been examined (BMA 2024) and is described in Figure 4-1 and the text below.

- **a** Where the groundwater level remains above root zone at maximum drawdown, TGDEs are unlikely to be impacted as access to groundwater will be maintained.
- **b** Where the groundwater level remains within 1 m above root zone at maximum drawdown, TGDEs may potentially be impacted by drawdown as access to groundwater may be affected.

c Where the groundwater level is below root zone at maximum drawdown, TGDEs are likely to be impacted as access to groundwater will be compromised.

34 An analysis of modelled drawdown scenarios (refer Figure 4-1) and the associated potential impacts to likely TGDEs has been undertaken (refer BMA 2024, Table 4-7). This analysis considers the reduction in groundwater against the assumed rooting depth of species present with likely TGDES (i.e. RE 11.3.25), including *Eucalyptus camaldulensis*, *E. populnea*, *Melaleuca fluviatilis* and *Casuarina cunninghamiana*. It concludes that (BMA 2024):

a The total area of likely TGDE where drawdown is considered to potentially impact the community is 8.42 ha (drawdown predicted to maintain within 1 m above root zone at maximum drawdown).

b The total area of likely TGDE where drawdown is considered likely to impact the community is 7.49 ha (drawdown predicted reduce groundwater level below the root zone at maximum drawdown).

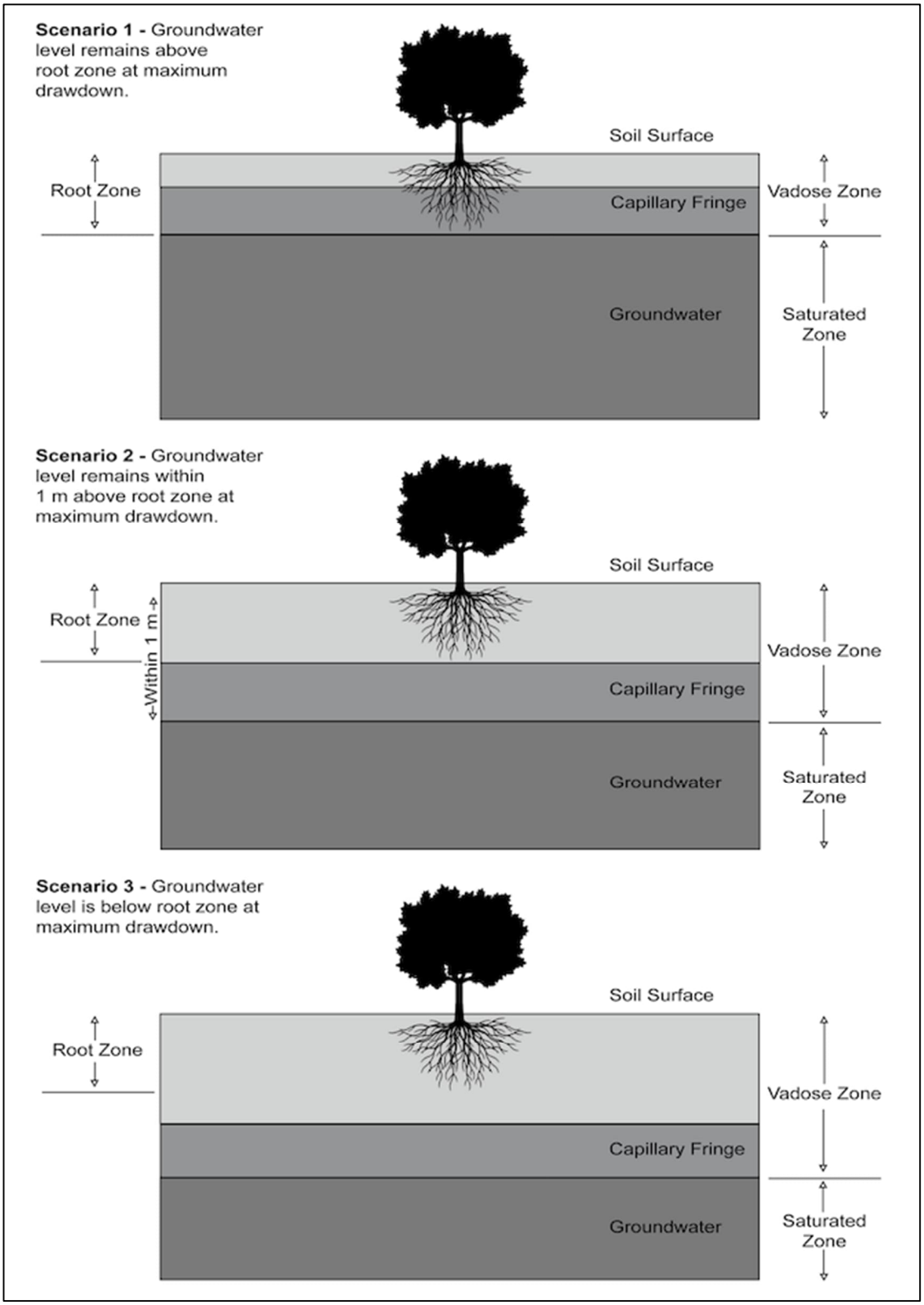

Figure 4-1 Conceptual Model of Groundwater Drawdown Scenarios

4.1.3 Change in groundwater quality

35 Potential impacts on groundwater quality may indirectly occur where leaks, spills and improper disposal of wastes, including waste rock, leads to the leaching of compounds into the groundwater following rainfall events. Contamination of groundwater can impact the condition and health of TGDEs as they access this water source in the root zone. These potential impacts have been assessed (BMA 2024) and are considered unlikely to occur, given the following:

- **a** Implementation of appropriate mitigation measures outlined within the conditions of the existing Environmental Authority (EA), including:
  - **i** Implementing of annual and quarterly monitoring of groundwater quality to identify trends and changes over time (as per Schedule I of EA EPML00562013)
  - **ii** Fuel, dangerous goods and, hazardous chemicals will be managed as outlined by current standards, guidelines and in compliance with statutory requirements.

36 Additional monitoring programs / plans exist that are designed to detect change in groundwater quality within CVM and in the surrounding region. Data from these programs may be used to support the TGDEMMP where required (refer Section 6.1.1). These include the:

- **a** CVM Groundwater Monitoring and Management Plan (GMMP).
- **b** Receiving Environment Monitoring Program (REMP) (i.e. the Fitzroy Regional REMP).

4.1.4 Change in surface water quality and flows

37 Potential impacts to TGDEs may indirectly occur via (BMA 2024):

- **a** Erosion and sedimentation.
- **b** Reductions quality of surface water, including accidental and controlled releases from identified release points (i.e. Cherwell Creek).
- **c** Changes to hydrological flows affecting groundwater recharge and subsequent groundwater availability for TGDEs.

38 Erosion and sedimentation

- **a** TGDEs found on floodplains or near drainage lines have the potential to be impacted where vegetation clearing occurs. Erosion of soils may occur in de-vegetated areas and lead to increased sedimentation of waterways, degrading the value of aquatic and riparian habitats. Erosion and sediment control (ESC) will be undertaken during the Project where necessary, consistent with the CVM PRO Erosion & Sediment Control Plan. Mitigating actions relevant to surface water quality are provided within the associated impact assessment (refer E2M 2021a, Section 6.2).
- **b** Monitoring of sedimentation is undertaken as part of the Fitzroy Regional REMP, with water quality data taken downstream of the Project analysed to determine if changes (downstream of mining) were within limits as defined by the Queensland Water Quality Guidelines 2009. While some moderate turbidity was found downstream of Cherwell creek, there is no indication of a regional risk to surface water quality within the Issac River.

39 Uncontrolled Releases

- **a** TGDEs have the potential to be impacted by the release of contaminants (spills or leaks etc), ESC water (from containment structures), and Mine Affected Water

(MAW). Riparian and aquatic environments are sensitive to contaminants via the accumulation of pollutant or chemicals and their potential effects on the condition of vegetation / habitats (Boulton et al. 2003).

b Surface contaminants and waste material (including general waste and that produce via the mining process) at CVM are currently controlled via management plans and systems as described under the conditions of the EA. These include:

i CVM Water Management Plan (including a detailed description of the Mine Water Management System).

ii Mining Waste Management Plan.

iii Erosion & Sediment Control Plan.

iv Waste Management Plan.

c Control measures and associated monitoring of surface water quality is consistent with the CVVM Water Monitoring Procedure. Details of this are provided in the PD (refer BMA 2024, Section 4.4.5.4). Due to the implementation of these measures, risk of impact to downstream environments is considered negligible.

40 Controlled releases

a Controlled releases are conducted consistent with current EA release criteria. These were developed under the original CVM Environmental Impact Statement (EIS) approval process.

b The associated Surface Water Impact Assessment Report (SLR 2021) details the existing CVM surface water management measures that are suitable to mitigate potential surface water quality impacts from controlled releases of water to receiving waters. Potential impacts to aquatic / riparian environments (and TGDEs) at release points are considered minimal.

41 Change to hydrological flows

a TGDEs may be impacted by changes to surface flow volume and direction in waterways associated relevant RE types (i.e. RE 11.3.25). Reduced surface flows may lower aquifer recharge, affecting indicator species like *Eucalyptus camaldulensis* and *E. populnea* during dry conditions. An analysis using flow gauge data showed minor changes to high or medium flows and minimal impact on spell durations (SLR 2021). Considering potential mitigations like controlled releases from dams, normal hydrological function of the watercourses should be maintained, and any potential impacts to TGDEs are considered to be minor.

4.1.5 Significance of impacts

42 The PD describes the significance of impacts to TGDEs as: (BMA 2024):

a TGDEs may be impacted as a result of groundwater drawdown, including:

i 7.49 ha of vegetation likely TGDE impacted – associated with RE 11.3.25.

ii 8.42 ha of potential TGDE impacted – associated with REs 11.3.2 and 11.5.3.

b In the Predicted Drawdown Extent, potential TGDEs only occur along Horse Creek (north), and in association with Caval and Cherwell creeks (south).

c RE 11.3.25 comprises *Eucalyptus camaldulensis* woodlands occurring along riparian corridors. Associated species within the community include *E. populnea, Melaleuca fluviatilis, Casuarina cunninghamiana, Lysiphyllum hookeri and Acacia salicina* (BMA 2024).

i BioCondition assessments determine the community to in moderate condition, with some evidence of non-native plant cover in ground layers.

ii This community is known to provide preferred habitat for both koala (*Phascolarctos cinereus*) and squatter pigeon (southern) (*Geophaps scripta scripta*) – though neither have been identified as present.

d Potential impacts to groundwater and surface water quality require management to avoid potential indirect impact to TGDEs.

43 Noting the above, likely / potential impacts to TGDEs are not considered significant. Rationale is provided in the PD and summarised below (BMA 2024):

a The total extent of impacts to likely TGDEs from groundwater drawdown is 15.91 ha (with only 7.49 ha likely to be impacted). As such, the scale of impact from drawdown are considered small.

b Indicator species in TGDEs are considered to use groundwater on a facultative basis, likely resulting in small declines in vegetation condition during dry periods rather than total loss of ecosystem function.

c Changes to groundwater or surface water quality and flows, are considered to be negligible or unlikely to occur where appropriate mitigation and controls are implemented / maintained.

5 Monitoring and Management Framework

5.1 General Approach

44 This TGDEMMP has been specifically developed to verify that the impacts to TGDEs, which have been determined as part of the impact assessment process, materialise as predicted. Additionally, it will provide a range of management measures in the event that impacts to TGDEs are outside those predictions.

45 The plan will monitor actual vegetation condition (as a proxy of ecosystem function) impacts in comparison with those predicted. Monitoring will also assess areas located on the fringe of the Predicted Drawdown Extent, and in areas modelled as not subject to groundwater drawdown (control sites) to provide a dataset suitable for analysis.

46 A key component of the monitoring program within this TGDEMMP is to provide a framework for intervention if impacts occur outside what was predicted. In the event impacts are greater than what was predicted, corrective actions and other compensatory measures (e.g. offsets) will be explored to account for any loss of ecosystem function.

47 An adaptive management framework has been established to review and assess the effectiveness of management and mitigation measures at the completion of each monitoring stage.

48 The overall monitoring and adaptive management approach of the TGDEMMP is visualised in Figure 5-1. The approach was informed by and is consistent with the GDE Toolbox, with consideration also given to the recent IESC Guidelines update (Australian Government 2024), and the GDE risk assessment (E2M, 2021b).

49 The approach is described in the following sections and includes:

- **a** How an environmental baseline (i.e. pre impact monitoring) (inclusive of impact and control sites) will be determined.
- **b** How and when verification (i.e. impact) monitoring will be undertaken, including:
  - **i** Indicators of TGDE condition and function.
  - **ii** The analysis required to compare baseline and impact monitoring results.
- **c** The process of adaptive management, as it relates to the above, including:
  - **i** Investigating if mining activities are the source of any change in condition.
  - **ii** Established mitigation and management measures.
  - **iii** Action trigger thresholds.
  - **iv** Corrective actions.
  - **v** Updates to the TGDEMMP (where necessary).

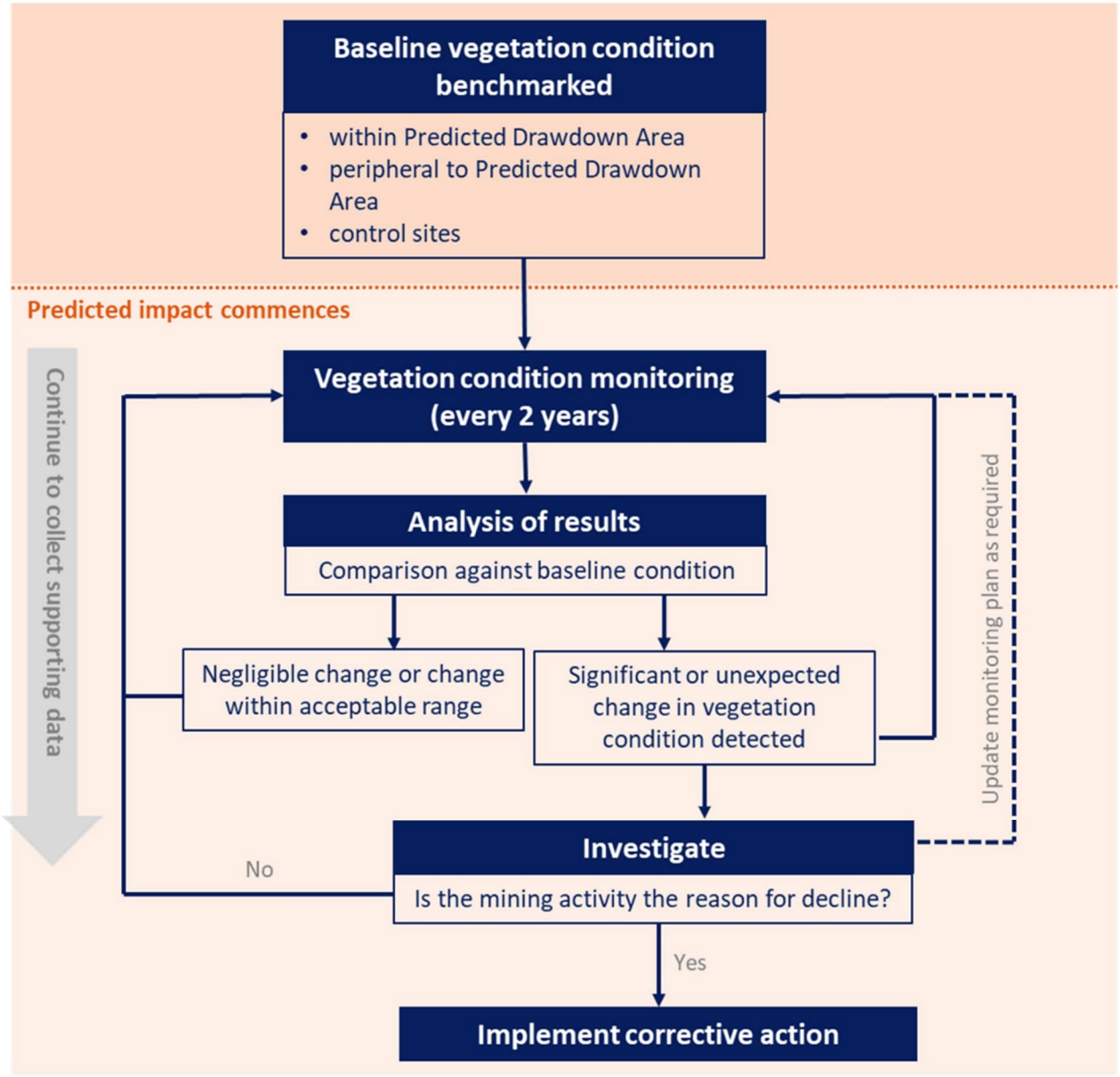

Figure 5-1 Adaptive Management Framework

6 Monitoring

50 The monitoring methodology described in the following sections is designed to enable the measurement and separation of mining and non-mining influences on the indicators for TGDEs. This is achieved in part through the effective designation of control and impact monitoring sites.

51 There are a number of key criteria that must be addressed through the implementation of the monitoring program:

- **a** Accommodate natural variation in environmental variables, including those influenced by wet and dry seasons.
- **b** Ensure that monitoring and investigation can distinguish between the influences / impacts of mining and non-mining activities through the various phases of the Project.
- **c** Ensure that data are collected over an appropriate time-scale that is relevant to the indicator being monitored.
- **d** Ensure that the magnitude of change relevant to a trigger is likely to be detectable.

52 The location of indicative pre-impact and impact monitoring sites is shown on Figure 6-1. Final locations of impact and control monitoring sites will be confirmed by ecologists completing pre-impact surveys, based on the suitability of the sites with respect to presence of relevant ecological values and land access.[2]

[2] Note that monitoring locations for groundwater quality and surface water quality/flow are described in the associated Groundwater Management and Monitoring Plan (GMMP) and the Fitzroy Regional Receiving Environment Management Plan (REMP).

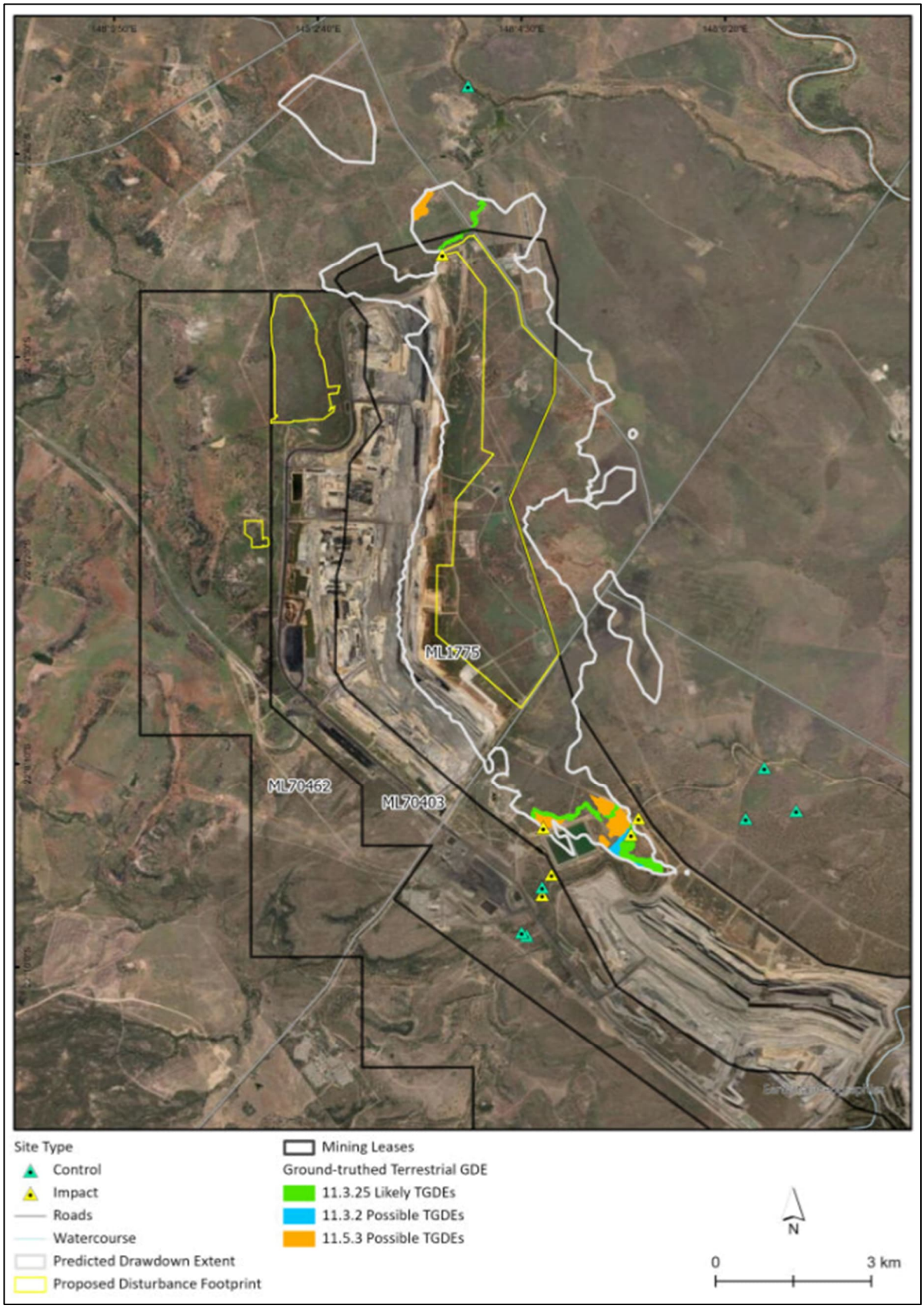

Figure 6-1 Indicative Monitoring Sites

6.1 Monitoring Type

6.1.1 Relationship to other monitoring plans

53 The existing activities at the mine operate under a series of management plans and processes (in accordance with existing approvals) and the Project will utilise data collected by existing monitoring programs where appropriate. Specifically, this includes results obtained from:

a CVM Groundwater Management and Monitoring Plan (GMMP).

b Fitzroy Regional Receiving Environment Monitoring Program (REMP).

54 The results of the GMMP monitoring provide important supporting data to assess the condition of the TGDEs, with groundwater level at nearby bores providing a measurement of how drawdown is materialising in comparison to modelled outcomes.

55 Table 6-1 summarises the monitoring frequency, duration, type and indicators from the TGDEMMP, and those relevant in the GMMP and REMP. In the event a vegetation condition level is triggered (refer Section 6.2), data from the GMMP and REMP will be available to support investigations and analysis relating to TGDE assessment as required.

Monitoring description	Frequency and duration	Monitoring type	Indicators	Plan for implementation
TGDE condition surveys	Twice per year (wet and dry season) - over minimum 12 months pre-impact.	Pre-impact	Vegetation condition, vegetation health, foliage cover[3]. NDVI remote sensing.	TGDEMMP
	Once a year every second year (wet season)	Impact		
Groundwater levels	Quarterly (refer GMMP, Table 5.1)	Supporting Data: Current and on-going and required by existing environmental approvals. In the context of this plan, data collection during both pre-impact and impact phases	Groundwater level	GMMP
Surface water flow	Continuously (daily) (refer REMP, Table 1)		Surface water flow	REMP
Groundwater quality	Quarterly / Annual (refer GMMP, Table 5.1)		Groundwater quality	GMMP
Surface water quality	Continuously (daily) (refer REMP, Table 1)		Surface water quality (EC and pH only)	REMP

Table 6-1 Monitoring supporting the TGDEMMP

6.1.2 Pre-impact monitoring

56 Monitoring will be undertaken over a minimum 12 month period prior to relevant Project impacts occurring. The results of pre-impact monitoring, combined with survey results obtained to support the impact assessment (refer Table 3-2), is considered to be adequate for baseline characterisation.

57 Pre-impact monitoring of vegetation condition will be undertaken for the TGDE communities identified as likely to or having the potential to be impacted by groundwater drawdown, as well as suitable control sites. The monitoring results will be used to describe the pre-impact conditions, including any seasonal variations. Monitoring will assist in characterising the TGDE's reliance on groundwater and establish the baseline health upon which potential impacts outside of those that have been predicted will be monitored.

[3] Incorporated into BioCondition score

58 Collation and collection of pre-impact monitoring data will be undertaken on a seasonal basis to capture seasonal variability in the vegetation communities. The location of pre-impact monitoring sites (refer Figure 6-1) is indicative and will be finalised during first monitoring event.

6.1.3 Impact Monitoring

59 Impact monitoring of vegetation condition will begin after activities that may impact TGDEs commence. This will be undertaken once every second year during the wet season (refer Table 6-1Table 6-1). Results from the impact monitoring will be evaluated at the time of data collection to assess whether there has been any change from baseline conditions.

60 Note that the purpose of this monitoring is to determine how closely actual impacts align with those predicted in the impact assessment, and to allow for the early identification of any deviations from approved or anticipated impacts. In particular, monitoring will aim to inform an understanding of the 'Ecological Water Requirements' (EWR) and ecological response of the TGDEs to changes in groundwater (consistent with GDE Toolbox stage 3).

6.2 Indicators and triggers

61 In accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000, 2018), ecological indicator trigger levels have been determined for TGDEs. Ecological triggers aim to provide an early detection of potential impacts prior to ecological disturbance occurring and ensure appropriate management actions to minimise impacts.

62 These triggers follow the approach outlined in Section 3.2.4.2 of the ANZECC (2000) Guidelines, which seeks to identify a statistically significant deviation from baseline conditions. Triggers are established relative to the parameters of vegetation condition and community health captured by monitoring, which include:

- **a** BioCondition score (site-base attributes)[4].
- **b** Foliage cover.
- **c** Vegetation health (NDVI).
- **d** Spatial extent of TGDEs.
- **e** Condition of vegetation (evidence of poor health including fire damage, erosion or drought stress).

63 These parameters are consistent with those captured during the impact assessment process (refer E2M 2021a, Sections 2.2.3 and 3.1.2) and are designed specifically for the detection of change in ecological function and community health (both pre and post-impact).

64 Where relevant vegetation condition triggers are reached or exceeded (refer Table 6-2 and Table 6-3), an investigation will be promptly conducted.

[4] Collection of site-based attributes as per Eyre et al 2015: https://www.qld.gov.au/__data/assets/pdf_file/0029/68726/biocondition-assessment-manual.pdf

Indicator	Relevant trigger	Design	Parameters
TGDE vegetation condition and community health	Reduction in vegetation health and condition indices as indicated in Table 6-3	BioCondition survey (plots) Foliage cover measures using either hemispherical cameras or wide angle digital cameras from set positions at each monitoring sites NDVI remote sensing	BioCondition data – site-based attributes Foliage cover Vegetation health (NDVI) Spatial extent of terrestrial GDEs Condition of vegetation (evidence of poor health including fire damage, erosion or drought stress)

Table 6-2 Indicators and triggers

6.2.1 Vegetation condition and triggers for action

65 As the nature and magnitude of impacts to vegetation can vary significantly, a scaled system of impact rating has been adopted (Table 6-3)Table 6-3. The scale focusses on the loss of ecosystem function within a TGDE community and also provides information on when action is required. Triggers for TGDE vegetation health are based on BioCondition indicators and scores, as well as signs of dieback in trees (e.g. loss of ecosystem function).

Loss of ecosystem function scale	Impact description	Action required
Negligible	<10% decline in BioCondition scores against baseline or pre-impact score. The regional ecosystem is retained as a functional ecosystem. There are reduced numbers of microhabitat features available for fauna.	No action required, drawdown does not appear to influence potential TGDE.
Minor	10% decline in the BioCondition Scores against baseline or pre-impact scores. The regional ecosystem is retained as a functional ecosystem. There are reduced numbers of microhabitat features available for fauna.	Continue to monitor. No further action required, impact is within range predicted (refer BMA 2024, Table 4-7).
Moderate	50% decline in BioCondition Scores against baseline or pre-impact scores. Canopy cover < 50% of baseline or pre-impact condition, or canopy height <70% of baseline or pre-impact condition. Vegetation no longer meets the Regional Ecosystem description. Vegetation provides ecosystem services, including minimising erosion and some fauna habitat, but with elevated weed cover. There is limited microhabitat features for fauna, such as hollows.	Further investigation required. Additional data may be required to investigate possible causes of decline, such as: • Establish additional impact and control monitoring sites. • Increase frequency of monitoring to every year (wet season). • Undertake detailed ecological water requirement measures (e.g. leaf water potential, stable isotope and soil moisture). On-ground mitigation actions may be appropriate to proactively prevent further decline – to be determined based on outcomes of investigation.
Major	90% decline in the BioCondition Scores against baseline or pre-impact scores. Vegetation no longer meets the Regional Ecosystem description. Vegetation community still existing and provides some ecosystem services in limiting erosion, but significant change in structure and composition (increased weed cover) is evident, with reduced habitat values. Limited microhabitat features for fauna.	Compensatory measures (e.g. offsets) to be developed to account for loss of ecosystem function.

Table 6-3 Scaled ratings for impacts on terrestrial GDEs

66 In addition to the assessment of BioCondition scores against the benchmark, foliage cover will be a key indicator of vegetation health, as measured using either hemispherical cameras or wide angel digital cameras from set positions at each monitoring site. If moderate signs of loss are observed, the foliage data can be further interpreted using leaf water potential, isotope and soil moisture potential data, to determine whether changes in the water stress of vegetation has occurred over time as a result of the Project.

67 Vegetation health will also be assessed using the remote sensing technique of NDVI (or similar greenness index). This is a numerical indicator that uses the visible and near-infrared bands of the electromagnetic spectrum and assists in assessing whether the target contains live green vegetation or not. The method is useful for identifying areas where vegetation and/or foliage dieback is occurring, with triggers associated with a statistically significant change from baseline and pre-impact values.

7 Adaptive Management and Investigations

7.1 Adaptive Management

68 An adaptive management framework will be employed to mitigate impacts from the Project and will include ongoing review of monitoring data to identify trigger exceedances, as well as a review of trigger levels during the course of the Project, particularly in response to long term monitoring and studies undertaken during each assessment and monitoring stage. In general, the approach to adaptive management will involve:

- **a** An investigation to determine whether fluctuations in vegetation condition are the result of mining activities, seasonal variation or neighbouring land use.
- **b** May require multiple stakeholder input such as BHP Environment representative, suitably qualified specialists (e.g. hydrogeologists, modellers, ecologists).
- **c** Document the nature and extent of any environmental harm in relation to TGDE.
- **d** Require development of suitable mitigation or corrective actions. Where items can be solved in the short term, work order notifications will be raised for implementation (e.g. eliminate contaminant source). For major actions, a plan for completion will be developed in consideration of budgeting cycle or if the work is considered urgent, escalated for prioritisation.
- **e** Notification to the administering authority within 2 business days of the detection, if the impact is beyond what has been approved (Approval Condition 54).
- **f** Provide to the administering authority, within 12 business days, details of the exceedance incident, including any corrective actions and investigations already undertaken (Approval Condition 55).
- **g** Update the TGDE MMP if required.

7.2 Investigations

69 If the vegetation condition trigger is reached (e.g. moderate or major loss of ecosystem function) the first step of investigation will be to identify the key drivers/parameters that relate to the reduction in vegetation condition (e.g. the source of the impact, impact pathway). As described in Section 4.1 impacts may relate to:

- **a** Direct disturbance
- **b** Groundwater drawdown
- **c** Change in groundwater quality
- **d** Change in surface water quality or flows

70 Impacts to TGDEs have been assessed and approved (EPBC 2021/9031) as part of the impact assessment and approval process for the project. The TGDE MMP aims to detect and manage any additional impacts that are beyond those predicted in the impact assessment.

71 Investigations will be instigated and managed by the CVM Site Environment Team, with support from subject matter experts as required (refer Section 7.3). As a guide, the following approach will generally be applied and tailored to the environmental variables of interest:

- **a** A detailed review of all existing data relevant to the environmental parameter will be completed, to quantify the nature, magnitude and reliability of the observed result.
- **b** Site-specific investigations will be implemented involving the collection and interpretation of additional data (where required).

c A review will be completed of relevant data related to potential non-mining causes of variability in environmental variables (e.g. climatic data). This will seek to either identify or rule out the contribution of non-mining activities to the identified trigger exceedance.

d A detailed model of relevant environmental variables will be developed.

e Expert opinion on the potential for environmental harm will be sought.

f The investigation process should not delay the implementation of corrective actions, once identified, and should be completed as soon as possible. Results of investigations should be reported to DCCEEW within 12 business days (per Condition 55 of the EPBC approval). Where additional detailed analyses are required, investigations should not exceed a maximum sixth month period.

72 The approach to investigations and responses for potential vegetation condition and groundwater level scenarios is presented in Table 7-2.

7.3 Roles and Responsibilities

73 Effective implementation of this TGDE MMP requires clear understanding of the roles and responsibilities of internal staff and contractors who will monitor, manage, investigate and review the outcomes of the plan.

74 Roles and Responsibilities specific to this TGDE MMP are outlined in Table 7-1.

Role	Responsibilities
General Manager and Site Leadership Team	• Support implementation of management and monitoring activities outlined within this plan. • Ensure management activities identified within this management included in budget cycles.
CVM Site Environment Team	• Manage investigations if vegetation condition trigger is reached (e.g. moderate loss of ecosystem function) and groundwater levels are outside those predicted to occur (see section 7.2). • Notification to the Commonwealth and State governments for any TGDE vegetation condition decline, outside predicted (as detailed above) • Engaging and managing the Suitably qualified GDE expert • Coordination and management of implementation of TGDE corrective actions from the CVM WMP and CVM GMMP • Notification to the Commonwealth and State governments identifying any GDE not previously identified and reported in the Predicted Drawdown Extent.
Suitably qualified GDE expert	• Prepare baseline description report confirming the field sampling plan requirements for impact monitoring. • Prepare reports as detailed in this plan. • Undertake monitoring as detailed in this plan. • Documenting investigations and assessments undertaken in response to monitoring results. • Review and update TDGEMMP as required.
Technical environment teams (e.g. ecologists)	• Completing pre-impact surveys. • Support investigation.

Table 7-1 Roles and Responsibilities for TGDE MMP implementation

Vegetation condition	Trigger level	Response		Notify DCCEEW	Update GDEMMP	Report kept of record
<10% decline in BioCondition scores against baseline	Negligible	**No action required** **Continue to monitor** Review monitoring frequency and consider additional monitoring events to allow for early detection of potential decline.		N/A	✓ (if required)	✓
10-49% decline in BioCondition score against baseline	Minor	**No action required** **Impact is within predicted range and has been approved as part of the Project.** **Continue to monitor** Review monitoring frequency and consider additional monitoring events to allow for early detection of potential decline.		N/A	✓ (if required)	✓
50-89% decline in BioCondition score against baseline	Moderate	**Investigate** Review results against control sites and assess potential influence of factors e.g groundwater level groundwater quality, climatic conditions, surface water changes (from GMMP, WMP and REMP data). **Document nature and extent of environmental harm in relation to TGDE**				
		Decline determined not related to Project mining activities	**No action required** **Continue to monitor** Review monitoring frequency and consider additional monitoring events to allow for early detection of potential decline.	N/A	✓ (if required)	✓
		Project mining activities groundwater drawdown determined to be primary driver of reduction in condition	**Defer to GMMP investigation processes for development of corrective actions** **Revise monitoring approach** • Establish additional impact and control monitoring sites to assess extent of change. • Increase frequency of monitoring to every year (wet season). • Undertake detailed ecological water requirement measures (e.g. leaf water potential, stable isotope and soil moisture) within a maximum 6 month period. • Follow Plan-Do-Check-Act cycle by confirming efficacy of any corrective actions implemented.	N/A	✓ (if required)	✓
		Project mining activities groundwater quality determined to be primary driver of reduction in condition	**Defer to CVM GMMP and CVM WMP investigation processes for development of corrective actions** **Revise monitoring approach** • Increase frequency of monitoring to establish permanence of condition decline and for early detection (and mitigation) of Major decline trigger.	N/A	✓ (if required)	✓

Vegetation condition	Trigger level	Response		Notify DCCEEW	Update GDEMMP	Report kept of record
		Project mining activities surface water factors determined to be primary driver of reduction in condition	**Defer to CVM WMP investigation processes for development of corrective actions** **Revise monitoring approach** • Increase frequency of monitoring to establish permanence of condition decline and for early detection (and mitigation) of Major decline trigger. • Follow Plan-Do-Check-Act cycle by confirming efficacy of any corrective actions implemented.	N/A	✓ (if required)	✓
90% decline in BioCondition scores against baseline	Major	**Investigate** Review results against control sites and assess potential influence of factors e.g. groundwater level groundwater quality, climatic conditions, surface water changes (from GMMP, WMP and REMP data). **Document nature and extent of environmental harm in relation to TGDE**				
		Decline determined not related to Project mining activities	**No action required** **Continue to monitor** Review monitoring frequency and consider additional monitoring events to allow for early detection of potential decline.	✓	✓ (if required)	✓
		Project mining activities groundwater drawdown determined to be primary driver of reduction in condition	**Defer to GMMP investigation processes for development of immediate term corrective actions** **Revise monitoring approach** • Establish additional impact and control monitoring sites to assess extent of change. • Increase frequency of monitoring to every year (wet season). • Undertake detailed ecological water requirement measures (e.g. leaf water potential, stable isotope and soil moisture) within a maximum 6 month period. • Follow Plan-Do-Check-Act cycle by confirming efficacy of any corrective actions implemented. **Compensatory Action** Compensatory measures to be developed to account for loss of ecosystem function, in accordance with relevant offset policy.	✓	✓ (if required)	✓

Vegetation condition	Trigger level	Response		Notify DCCEEW	Update GDEMMP	Report kept of record
		Project mining activities groundwater quality determined to be primary driver of reduction in condition	**Defer to CVM GMMP and CVM WMP investigation processes for development of immediate term corrective actions** **Revise monitoring approach** • Increase frequency of monitoring to establish permanence of condition decline and monitor effectiveness of corrective actions • Follow Plan-Do-Check-Act cycle by confirming efficacy of any corrective actions implemented. **Compensatory Action** Compensatory measures to be developed to account for loss of ecosystem function, in accordance with relevant offset policy.	✓	✓ (if required)	✓
		Project mining activities surface water factors determined to be primary driver of reduction in condition	**Defer to CVM WMP investigation processes for development of immediate term corrective actions** **Revise monitoring approach** • Increase frequency of monitoring to establish permanence of condition decline and monitor effectiveness of corrective actions. • Follow Plan-Do-Check-Act cycle by confirming efficacy of any corrective actions implemented. **Compensatory Action** Compensatory measures to be developed to account for loss of ecosystem function, in accordance with relevant offset policy.	✓	✓ (if required)	✓
Total loss	Maximum	**Investigate -** Identify responsible party for removing TGDE vegetation. **Document nature and extent of environmental harm in relation to TGDE** **Compensatory Actions** Compensatory measures to be developed in the event Project activities are responsible for accidental clearing of TGDE area.		✓	✓ (if required)	✓

Table 7-2 Summary of investigation approaches

7.4 Corrective Actions

75 Appropriate corrective actions will be developed and implemented where impacts predicted as part of the Project impact assessment process are greater than expected and investigation confirms these are result of Project activities, and in the event early preventative actions are considered appropriate. This will follow the Plan-Do-Check-Act continuous improvement cycle (see WMP Appendix A). Corrective actions will be tailored to the particular environmental variables or trigger levels of relevance, and in response to outcomes of investigations.

76 Examples of potential preventative and/or corrective actions, which may be considered for implementation following an event are provided in the table below. The timing and responsibility for implementation of these actions is identified within each of the CVM WMP and CVM GMMP. Overall, the CVM Site Environment Team is responsible for managing the investigation process, follow up implementation of any corrective actions and monitoring of effectiveness of corrective actions.

77 Corrective actions will also be carried out as required by the relevant CVM WMP or CVM GMMP.

78 Revision of monitoring frequency, locations and parameters, where determined required from an investigation, will be undertaken within 3 months of conclusion of the investigation.

79 For corrective actions implemented activities will be conducted to evaluate effectiveness, and where determined ineffective revised actions may be required.

80 Compensatory actions, where required, will be developed in consultation with, and with approval of the appropriate administering authority. Timeframes for delivery of the compensatory action will be determined through consultation with the administering authority at the time. The offset will be managed and monitoring in accordance with an appropriate plan developed.

Event Type	Examples of Potential Preventative and/or Corrective Actions
Moderate or Major reduction in vegetation condition due to drawdown	• Support maintaining TGDE ecological functions through rehabilitation or remediation efforts (e.g. planting, threat management). This would involved design of a rehabilitation or remediation plan that includes monitoring and reporting. • Identify and establish an appropriate environmental offset
Moderate or Major reduction in vegetation condition due to groundwater quality	Actions and improvements to site operational practices • Inspection and maintenance requirements • Installation of containment infrastructure • Pumping of contaminated water into the mine water system In accordance with the Plan-Do-Check-Act continuous improvement cycle inspections will be undertaken to confirm effectiveness in accordance with appropriate routines.
Moderate or Major reduction in vegetation condition due to surface water quality or flow	Actions and improvements to pipeline and site operational practices • Inspection and maintenance requirements • Telemetry and alert systems • Training of personnel Actions and improvements to drainage • Construction or modifications to site drainage structures In accordance with the Plan-Do-Check-Act continuous improvement cycle inspections will be undertaken to confirm effectiveness in accordance with appropriate routines
Maximum impact due to accidental clearing	Improvements to site operational practices • Review of Permit to Disturb process • Training of personnel Identify and establish an appropriate environmental offset

Table 15 Examples of Preventative and/or Corrective Actions

8 Updates, Reporting and Compliance

8.1 Plan Review

81 The TGDEMMP will be reviewed within two years of commencement of mining and then every five years. The TGDEMMP will be amended as required, and in response to outcomes of any investigations undertaken. This may include updates to the conceptual models of TGDEs and vegetation condition trigger levels.

8.2 Reporting

82 Reports will be generated throughout the implementation of the TGDEMMP and include:

- **a** A baseline description report detailing the pre-impact, or baseline, condition for comparison against once the Project commences. It will confirm the field sampling plan requirements for impact monitoring and will be kept on file with the TGDEMMP.
- **b** Reports of the findings of vegetation condition monitoring after each 2-yearly monitoring event, including all monitoring results and interpretations, comparison against baseline vegetation condition and recommendations for further investigations (if required).
- **c** Documentation of any investigations and assessments undertaken in response to monitoring results.
- **d** Notification to the Commonwealth and State governments identifying any GDE not previously identified and reported in the Predicted Drawdown Extent.
- **e** Notification to the Commonwealth and State governments if:
  - **i** A TGDE vegetation condition decline, outside predicted, is identified.

83 This TGDEMMP will be available to all employees, contractors and subcontractors. The TGDEMMP will be amended in response to regular reviews, monitoring results and changes in legislation, in consultation with regulatory authorities.

9 Terms and Definitions

Term	Definition
ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
BMA	BM Alliance Coal Operations Pty Ltd
CEDA	Cumulative evidence-based decision approach
CVM	Caval Ridge Mine
DTW	Depth to Water
EA	Environmental Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESC	Erosion and Sediment Control
EWR	Ecological Water Requirements
GDE	Groundwater Dependent Ecosystem
GEM	Groundwater Dependent Ecosystem Mapping
GMMP	Groundwater Management and Monitoring Plan
ISEC	Independent Expert Scientific Committee
NDVI	Normalised Difference Vegetation Index
NDVI	Normalized Difference Vegetation Index
PD	Preliminary Documentation
RE	Regional Ecosystem
REMP	Receiving Environment Monitoring Program
TGDE	Terrestrial Groundwater Dependent Ecosystem
TGDEMMP	Terrestrial Groundwater Dependent Ecosystem Monitoring and Management Plan

10 References

Reference Number	Title	Document Number
Legislative Requirements Documents		
	Australian and New Zealand Environment and Conservation Council [ANZECC] (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.	
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	Richardson, S., Irvine, E., Froend, R., Boon, P., Barber, S. & Bonneville, B. (2011). *Australian groundwater-dependent ecosystem toolbox part 1: assessment framework*. Waterlines report. National Water Commission.	
	SLR Consluting Australia [SLR] (2021). *Caval Ridge Mine Horse Pit Extension Project – Surface Water Impact Assessment*. Prepared for BHP.	
BHP/BMA Documents		
	BHP Mitsubishi Alliance [BMA]. (2024). *Caval Ridge Mine Horse Pit Extension Preliminary Documentation (EPBC 2021/9031).*	015148882
	BHP Mitsubishi Alliance Caval Ridge Mine Horse Pit Extension Preliminary Documentation (EPBC 2021/9031) Appendix E1 Groundwater Dependent Ecosystems Impact Assessment Report (E2M 2021a)	015148899
	BHP Mitsubishi Alliance Caval Ridge Mine Horse Pit Extension Preliminary Documentation (EPBC 2021/9031) Appendix E2 Groundwater Dependent Ecosystem Risk Assessment (E2M 2021b)	015148900
CVM-PLN-0014	CVM PLN Mining Waste Management	000200219
CVM-PLN-0004	CVM PLN Waste Management	000196976
CVM-PLN-0009	CVM PLN Water Management Plan	000179272
CVM-PRO-0019	CVM PRO Water Monitoring	000183357

Reference Number	Title	Document Number
	Kerswell, A., Kaveney, T., Evans, C. & Appleby, L. (2020). *Habitat descriptions for 12 threatened species, specific to central Queensland*. Report commissioned by BHP.	
Literature and Research		
	Boulton, A. J., Humphreys, W. F., & Eberhard, S. M. (2003). Imperilled subsurface waters in Australia: Biodiversity, threatening processes and conservation. *Aquatic Ecosystem Health and Management*. 6(1).	
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11 Version Management

Version	Details	Date
0.0	Initial Draft	13 February 2025
1.0	Initial Release	21 February 2025
2.0	Amended based on DCCEEW feedback	14 April 2025

12 Appendix A – Condition Approvals

Approval Condition[5]	Details	Section Addressed
22	The approval holder must submit a Terrestrial Groundwater Dependent Ecosystem Monitoring and Management Plan (Terrestrial GDEMMP) to the department for the Minister's approval to avoid and mitigate harm to protected matters. The approval holder must not commence the action unless the Minister has approved the Terrestrial GDEMMP in writing. The approval holder must implement the approved Terrestrial GDEMMP from when it is approved until the expiry date of this approval	N/A
23	The Terrestrial GDEMMP must be prepared by a suitably qualified GDE expert. All commitments, including environmental outcomes, management measures, corrective measures, trigger thresholds, limits and performance indicators in the Terrestrial GDEMMP must be SMART and based on referenced or included evidence of effectiveness. The Terrestrial GDEMMP must be consistent with the Environmental Management Plan Guidelines, and must include:	
23 (a)	Mapping identifying the groundwater area of investigation for assessment	Figure 2-1
23 (b)	Details and results of a GDE field assessment within the groundwater area of investigation	Section 3
23 (c)	The evidence used to determine which, if any, ecosystems within the groundwater area of investigation are terrestrial GDEs	Section 3
23 (d)	A description, map/s and shapefiles of any ecosystems determined likely to be terrestrial GDEs, which clearly defines the location and boundaries of terrestrial GDEs and shows where they include habitat for protected matters	Section 3 Figure 3-1 Figure 3-2
23 (e)	The proposed methodology and timing for the monitoring and detection of any harm to terrestrial GDEs as a result of the action, including baseline data if any ecosystems within the groundwater area of investigation is determined likely to be terrestrial GDEs. This must include specifications of associated:	Section 6
23 (e - i)	Trigger thresholds that, if reached, the approval holder commits to investigate the cause of.	Section 6.2
23 (e - ii)	Corrective measures that will be implemented if any trigger threshold is reached to bring values below the trigger threshold and prevent any limit being reached.	Section 7.4 Appendix B
23 (f)	Details of the investigations that will be undertaken if trigger thresholds are reached.	Table 7-2
24	The approval holder must not exceed any limit specified in the approved Terrestrial GDEMMP	N/A

[5] Per Annexure A of the Notification of approval decision

13 GDE Risk Assessment (E2M 2021b)

Table A.1: Risk assessment matrix

Qualitative measure of likelihood (how likely is it that this event/circumstance will occur after management activities are implemented)	
Highly likely	Is expected to occur in most circumstances
Likely	Will probably occur during the Project
Possible	Might occur during the Project
Unlikely	Could occur but is considered unlikely or doubtful
Rare	May occur in exceptional circumstances

Qualitative measure of consequences (what will be the consequence/result if the event does occur)	
Minor	No impact identifiable above baseline ecological conditions
Moderate	Plant stress linked to mining activity that results in the reduction in volume and duration of groundwater supporting a GDE system that does not result in more than 5% dieback of 'mature canopy trees'*. Impact localised and reversible with mitigation.
High	Plant stress linked to mining activity that results in the reduction in volume and duration of groundwater supporting a GDE system that does not result in more than 25% dieback of mature canopy trees (defined as a canopy tree with DBH >60cm). Impact is reversible with mitigation.
Major	Significant harm (loss of 25 to 50% of mature canopy trees). Impact is reversible although a significant lag in return to pre-disturbance condition occurs (lag>20yrs). Vegetation is converted from remnant to non-remnant status and significant impacts to habitat for protected fauna species occurs. Biodiversity offsets may be required.
Critical	Irreversible impact to > 50% 'mature canopy trees'* that cannot be mitigated. Vegetation is converted from remnant to non-remnant status and significant impacts to habitat for protected fauna species occurs. Biodiversity offsets will be required.

Likelihood	Consequence				
	Minor	Moderate	High	Major	Critical
Highly likely	Low	Medium	High	Severe	Severe
Likely	Low	Medium	High	High	Severe
Possible	Low	Medium	Medium	High	Severe
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Low	Medium

Table A.2: Formal risk assessment

Impact and risk description	Initial risk rating			Mitigation measures	Residual risk rating		
	Likelihood	Consequence	Result		Likelihood	Consequence	Result
Groundwater drawdown	Possible	High	Medium	• Ongoing monitoring of terrestrial GDEs will be undertaken as part of a GDEMMP and with adaptive management this will assist in identifying potential indirect impacts to terrestrial GDEs resulting from the Project and trigger appropriate corrective actions. This includes baseline characterisation of vegetation condition of the likely terrestrial GDEs prior to any predicted impacts. • Annual monitoring of groundwater will be implemented to identify trends and changes over time.	Possible	Minor	Low
Reduced groundwater quality	Likely	High	High	• Annual monitoring of groundwater quality will be implemented to identify trends and changes over time. • Sediment dams, pit water storage and other water management structures (e.g. bunds and drains) will be designed and operated in accordance with BMA's standards and within the current framework specified in the existing CVM Water Management Plan. • Bunding and appropriate storage of fuels and other hazardous and flammable materials will be undertaken in accordance with AS1940:2004, and where practical, will be located away from any waterbodies. • The Project's water management will be based on the separation and management of clean and mine affected water catchments • The current REMP and associated water quality monitoring program will be continued. The program is designed to ensure the MWMP is effective, to demonstrate compliance with the Mine's strict discharge limits, and to ensure the downstream water quality (physico-chemical parameters, at a minimum) is not being adversely impacted. • Oil spill recovery equipment will be available when working adjacent to drainage channels with the ability to discharge off site. Spill kits will be located with construction crews conducting	Unlikely	Moderate	Low

Impact and risk description	Initial risk rating			Mitigation measures	Residual risk rating		
	Likelihood	Consequence	Result		Likelihood	Consequence	Result
				activities with the potential for significant spills. CVM existing SOP for spill management will be utilised. • Ongoing monitoring of terrestrial GDEs will be undertaken as part of a GDEMMP and with adaptive management this will assist in identifying potential indirect impacts to terrestrial GDEs resulting from the Project and trigger appropriate corrective actions. This includes baseline characterisation of vegetation condition of the likely terrestrial GDEs prior to any predicted impacts.			
Reduced surface water quality through erosion and sedimentation	Likely	High	High	• Appropriate erosion and sediment control measures will be established as required to reduce the amount of runoff from disturbed areas in accordance with industry standards and guidelines. • Construction of the haul road crossing will occur over the dry season to minimise soil disturbance on adjacent waterways. • As soon as practical, disturbed areas will be rehabilitated to reduce the amount of exposed soils. • Sediment dams, pit water storage and other water management structures (e.g. bunds and drains) will be designed and operated in accordance with BMA's standards and within the current framework specified in the existing site MWMP. • Disturbed areas within the Project site will be diverted to sediment dams for treatment, and possible reuse for dust suppression and process water requirements. This will maximise their storage capacity to reduce the risk of off-site discharges. • The road crossing of the Horse Creek will be managed in accordance with the measures outlined for construction and operations.	Unlikely	Moderate	Low
Reduced quality of surface water	Likely	High	High	• Appropriate erosion and sediment control measures will be established as required to reduce the amount of runoff from disturbed areas in accordance with industry standards and guidelines.	Unlikely	Moderate	Low

Impact and risk description	Initial risk rating			Mitigation measures	Residual risk rating		
	Likelihood	Consequence	Result		Likelihood	Consequence	Result
				• Bunding and appropriate storage of fuels and other hazardous and flammable materials will be undertaken in accordance with AS1940:2004, and where practical, will be located away from any waterbodies. • Sediment dams, pit water storage and other water management structures (e.g. bunds and drains) will be designed and operated in accordance with BMA's standards and within the current framework specified in the existing Mine Water Management Plan. • The Project's water management will be based on the separation and management of clean and mine affected water catchments. • Disturbed areas within the Project site will be diverted to sediment dams for treatment, and possible reuse for dust suppression and process water requirements. This will maximise the storage capacity to reduce the risk of off-site discharges. • The current REMP and associated water quality monitoring program will be continued. The program is designed to ensure the MWMP is effective, to demonstrate compliance with the Mine's strict discharge limits, and to ensure the downstream water quality (physico-chemical parameters, at a minimum) is not being adversely impacted. • Fuel, dangerous goods and hazardous chemicals will be managed as outlined by current standards, guidelines and in compliance with statutory requirements. • The existing SOP for spills and emergency response procedures will continue to be utilised. Spill recovery and containment equipment will be available when working adjacent to sensitive drainage paths and within other areas, such as workshops. • Water Quality monitoring will be conducted as part of the Project's EA conditions and in accordance with the REMP.			
Direct clearing of terrestrial GDE	Unlikely	Critical	High	• No potential terrestrial GDEs will require clearing as a result of the Project. Terrestrial GDEs are located outside of the Disturbance Footprint.	Rare	Major	Low

Impact and risk description	Initial risk rating			Mitigation measures	Residual risk rating		
	Likelihood	Consequence	Result		Likelihood	Consequence	Result
				• The existing Caval Ridge Mine infrastructure will be utilised where possible to minimise the need for additional disturbance. • Ongoing monitoring of terrestrial GDEs will be undertaken as part of a GDEMMP and with adaptive management this will assist in identifying potential indirect impacts to terrestrial GDEs resulting from the Project and trigger appropriate corrective actions.			
Changes to hydrological flows affecting groundwater recharge	Possible	High	Medium	• Existing hydrological function of watercourses will be maintained, allowing recharge of associated aquifers. • The current REMP and associated water quality monitoring program will be continued. The program is designed to ensure the MWMP is effective, to demonstrate compliance with the Mine's strict discharge limits, and to ensure the downstream water quality (physico-chemical parameters, at a minimum) is not being adversely impacted. • Ongoing monitoring of terrestrial GDEs will be undertaken as part of a GDEMMP and with adaptive management this will assist in identifying potential indirect impacts to terrestrial GDEs resulting from the Project and trigger appropriate corrective actions. This includes baseline characterisation of vegetation condition of the likely terrestrial GDEs prior to any predicted impacts.	Unlikely	Moderate	Low
Cumulative impacts from mining and climatic extremes, e.g. drought	Possible	Major	High	• Ongoing monitoring of terrestrial GDEs will be undertaken as part of a GDEMMP and with adaptive management this will assist in identifying potential indirect impacts to terrestrial GDEs resulting from the Project and trigger appropriate corrective actions. This includes baseline characterisation of vegetation condition of the likely terrestrial GDEs prior to any predicted impacts. • On-going monitoring of groundwater levels and quality will be undertaken.	Unlikely	Moderate	Low