CVM PLN Groundwater Monitoring & Management Plan

Caval Ridge Mine

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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

1.1 Purpose

1 This Groundwater Monitoring & Management Plan (GMMP) has been prepared to satisfy the groundwater monitoring and reporting regulatory conditions for BHP Mitsubishi Alliance (BMA) Caval Ridge (CVM) coal mine in accordance with:

- **a** Environmental Authority (EA) EPML00562013 issued and administered by the Queensland Department of Environment, Technology, Science and Innovation (DETSI).
- **b** Environment Project and Biodiversity Conversation Act 1999 (EPBC Act) approval 2021/9031 for the Caval Ridge Mine Horse Pit Extension issued and administered by the Australian Government Department of Climate Change, Energy, the Environment and Water

2 In addition, the document aims to satisfy BHP's internal groundwater requirements, as detailed in the Technical Centre of Excellence & Legacy Assets (TCoE) Water Management Standard.

3 This GMMP has been prepared by BMA / BHP suitably qualified hydrogeologists.

1.2 Scope

4 This GMMP applies to all personnel conducting activities at CVM including planning and executing exploration, operational, ancillary or closure activities that have the potential to impact on the immediate and surrounding receiving groundwater environment within the Area of Influence.

5 This GMMP deals with management of groundwater resources. It should be noted that surface water management is dealt with in the CVM PLN Water Management Plan (CVM-PLN-009), accordingly has not been included in this GMMP.

6 CVM operates under the BMA Environmental Management System (EMS), which is aligned with ISO14001:2015 Environmental Management Systems. This GMMP forms part of the CVM EMS documents and is laid out to follow the Plan-Do-Check-Act continuous improvement cycle.

7 The GMMP has been designed to detect and mitigate unavoidable and accidental impacts to groundwater.

1.3 Document History

8 The GMMP was originally prepared for BHP by suitably qualified hydrogeologists of AQ2 Pty, following a comprehensive review of the monitoring network, completed by SLR in 2020. The GMMP was then revised in 12th June 2023 by suitably qualified BMA hydrogeologists.

9 A revision of the GMMP (this document) has been developed by suitably qualified BMA hydrogeologist following the major amendment of EPML00562013 that took effect on 16 May 2024 to permit the Horse Pit Extension.

1.4 Groundwater Conditions

10 Schedule I (EA) – EPML00562013 stipulates requirements for this GMMP as summarised in in Table 1.1.

11 Condition 16 of the EPBC Act Approval for the Caval Ridge Mine Horse Pit Extension (2021/9031) stipulates management plan requirements relating to the monitoring and management of groundwater. This GMMP incorporates the groundwater specific requirements.

Table 1.1 Summary of EA Groundwater Conditions – EPML00562013 – effective 3 December 2024

Condition Number	Condition / Obligation Text	Relevant GMMP Section
I1	**Groundwater** The holder of this environmental authority must not release contaminants to groundwater.	**Section 4**
I2	**Groundwater Monitoring and Management Program** A Groundwater Monitoring and Management Program must be: a) developed by an appropriately qualified person; and b) implemented by the environmental authority holder for all stages of mining activities	**Section 1**
I3	The Groundwater Monitoring and Management Program required by condition **I2** must: a) identify potential groundwater impacts due to the mining activities; b) include a site conceptual groundwater model; c) describe the sampling and monitoring methodology; d) detail an appropriate quality assurance and quality control program; and e) provide the process for notifying the administering authority and investigating exceedances in accordance with conditions I4-I5.	**Sections 1 to 6** Section 4 Section 3.1 Section 5.3 Section 5.4 – 5.5 Section 6
I4	**Groundwater monitoring** Groundwater quality and standing water levels must be monitored: a) at the locations and at the frequencies specified in **Table I1 (Groundwater Monitoring Locations and Frequency)**; and b) for the quality characteristics specified in **Table I2 (Groundwater Trigger Levels)**.	Section 5 Section 6.1
I5	If the groundwater contaminant trigger levels defined in **Table I2 (Groundwater Trigger Levels)** are exceeded on **three (3) consecutive monitoring occasions**, the environmental authority holder must complete an investigation into the potential for environmental harm and notify the administering authority within **twenty (20) business days** of receiving the analysis results.	Section 6
I6	The Groundwater Monitoring and Management Program must be reviewed by **31 November 2023**, and thereafter every **two (2) years**, by an appropriately qualified person. The review report must: a) analyse the results of groundwater monitoring to: i. describe any impacts to groundwater levels and groundwater quality due to the mining activity; ii. determine trends in groundwater levels and groundwater quality; b) assess the adequacy of the Groundwater Monitoring and Management Program; and c) provide recommendations to the environmental authority holder to address the findings of parts (a) and (b) of the review.	Section 7 Table 7.1

Condition Number	Condition / Obligation Text	Relevant GMMP Section
I7	Within **twenty (20) business days** of receiving the review report, required by condition **I6**, the environmental authority holder must provide to the administering authority: a) the review report; b) if applicable, any actions being taken by the environmental authority holder to address the recommendations of the review report; and c) if action is not being taken to address a recommendation, the environmental authority holder must provide justification for not taking action.	Section 7 Table 7.1
I8	Annual groundwater monitoring data must be submitted to the administering authority via WaTERS by **30 September** each calendar year.	Section 7 Table 7.1
I9	**Bore construction** The construction, management, maintenance and decommissioning of groundwater monitoring bores must be undertaken in a manner that: a) prevents contaminants entering the groundwater; b) ensures the integrity of the bores to obtain representative groundwater samples from the target aquifer; and c) maintains the hydrogeological environment within the aquifer.	Section 5.2
I10	The environmental authority holder will determine interim groundwater trigger values for inclusion in **Table I2 (Groundwater Trigger Values)** to replace all TBC values when a data set of **eight (8) samples** becomes available and supply them to the department via an amendment application.	Section 5

2 Project Description

2.1 Location & Site Layout

12 CVM is located 6km south of Moranbah and approximately 160km southwest of Mackay, Queensland. Mining occurs within ML1775 and ML70403 and comprises open-cut pits with associated coal handling and processing infrastructure. Peak Downs Mine (to the southeast) neighbours CVM, with the two mines separated by Harrow Creek (Figure 2.1).

13 CVM achieved first production in October 2014. Mining activities to date have been focused on two open-cut pits, Horse Pit (to the north of the Peak Downs Highway) and Heyford Pit (to the south of the highway). Mining below water table at CVM began at Heyford Pit in 2014.

2.2 Potential Contamination Sources

14 Operating open cut coal mines have a range of well recognised contaminant sources which have significant potential to adversely impact water quality. Potential sources of contamination at CVM are summarised in Table 2.1.

Table 2.1 Summary of potential contamination sources at Caval Ridge

Contaminant Source	Potential Contaminants	Mechanisms of Contamination
Disturbed land	Suspended Solids (Turbidity), Dissolved Solids (sodium, chloride, sulphate), +/- pH, metals	Erosion, overland flow, capillary rise of salts, sodic spoils (elevating pH), acid generating rejects (lowering pH).
Rehabilitated land	Suspended Solids (Turbidity), Dissolved Solids, +/- pH, Dissolved Solids (sodium, chloride, sulphate), +/- pH, metals	Erosion, overland flow, capillary rise of salts, sodic spoils (elevating pH).
Mine affected water (MAW) from tailings dams, sewage treatment plants, industrial areas, etc.	Suspended Solids (Turbidity), Dissolved Solids (sodium, chloride, sulphate), +/- pH, hydrocarbons, pathogenic micro-organisms, metals	Releases from dams (seepage, catastrophic failure, by wash), pipes, drains, spills, acid generating rejects (lowering pH) ineffective sewage treatment, release from sewage ponds
Waters from pits and storages	Suspended Solids (Turbidity), Dissolved Solids (sodium, chloride, sulphate), +/- pH, metals	Releases from dams (seepage, catastrophic failure, by wash), pipes, drains, etc.
Waters from sediment dams	Suspended Solids (Turbidity), Dissolved Solids (sodium, chloride, sulphate), +/- pH, metals	By wash, capacity reduced due to sedimentation.
Uncontrolled release of flammable and combustible liquids and chemicals	Hazardous or toxic products, +/- pH, metals.	Contamination of land and surface runoff causing impact to regional water systems.

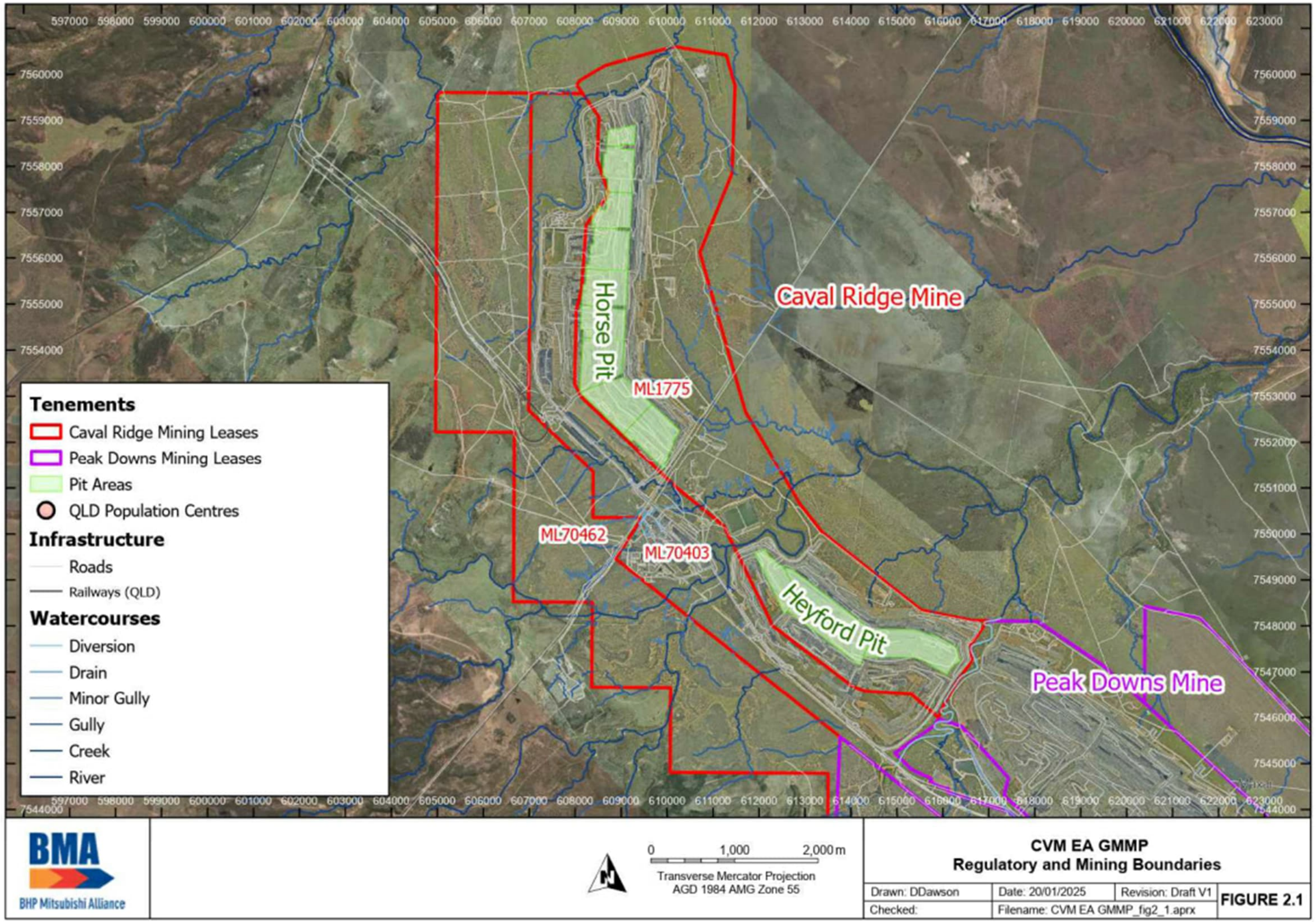


Figure 2.1 Regulatory and Mining Boundaries

3 Conceptual Hydrogeological Model

15 The intent of this section is to describe the current conceptual hydrogeological model (i.e., based on the interpretation of all available data to date), summarising the baseline (pre-mining) conditions where these have been documented, or the earliest available data sets. The subsequent changes to the hydrogeological system over time are reported as per Table 3.1.

16 CVM is located on the western flank of the Bowen Basin, with strata dipping gently to the east towards the axis of a local syncline that is truncated by the north - south trending Isaac thrust fault. The stratigraphy of the area is characterised by a thick sequence of Permian Coal Measures, comprising an interbedded sequence of coal, sandstone and siltstone, overlain by Tertiary-aged basalt and Quaternary-aged sediments. (GHD, 2018).

17 CVM is located within the Isaac River catchment, a major drainage area of the Fitzroy Catchment. The ephemeral Isaac River flows south for approximately 230 km to join with the McKenzie River which flows onwards to the Fitzroy. All surface water in and around CVM are tributaries of the Isaac River. The significant water courses at CVM are Cherwell Creek, Horse Creek, Nine Mile Creek, Harrow Creek; and Caval Creek. These water courses are ephemeral in nature and seasonal habitat for aquatic fauna.

3.1 Hydrogeological Units

18 The hydrogeological regime relevant to the CVM area comprises the hydrogeological units presented in Table 3.1 below. A visual representation of the conceptual model is provided in Figure 3.1 (after GHD, 2018).

Table 3.1: Hydrogeological units at CVM (URS, 2009)

Age	Group	Geological Unit	Aquifer
Quaternary	Undifferentiated alluvium and colluvium	Alluvium (mainly clay, silt, sand and gravels)	Sand and gravel deposits within the alluvium forming unconfined aquifer
Tertiary	Undifferentiated basalts	Olivine basalt lava flows	Groundwater flow occurs mostly via fractures and is influenced by the spatial variability in fracturing, weathering and lava flows. Generally, the basalt floor dips at a very shallow angle to the west, away from the pit (Jacobs, 2017).
	Undifferentiated sediments	Soil, alluvium, gravel, scree, sand, duricrust	Sandy and gravely sections of the sediment pile represent an unconfined to confined aquifer depending on location.
Permian	Blackwater Group	Fort Cooper Coal Measures (Sandstone, conglomerate, mudstone, carbonaceous shale, coal, cherty tuff)	The coal seams are identified as the main aquifer. The sandstone/ siltstone of the interburden / overburden is considered an aquitard
		Moranbah Coal Measures (fine-grained sandstone, siltstone, mudstone, claystone and coal)	The coal seams are identified as the main aquifer. The sandstone/ siltstone of the interburden / overburden is considered an aquitard

Age	Group	Geological Unit	Aquifer
	Back Creek Group	German Creek Formation (Sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite)	Higher permeability zones / layers within the bedrock strata

19 The Quaternary alluvium and Tertiary sediments consist of unconsolidated clay, silt, sand and gravel and are generally less than 20m in thickness. Saturated sediments are discontinuous and limited to drainage lines and paleochannels.

20 Basalt flows are present in two main areas: in the north of the mine (Horse Pit) and the central part of the mine near Cherwell Creek. Basalt flows are up to 50m thick with saturated thickness up to 25m but most commonly less than 10m.

21 Groundwater in the deeper Permian aquifers is characterised by low permeability and storage, poorer water quality, low recharge rates and historically low yields.

22 Faults are present throughout the mining area. Three faults have been identified within the Horse North Pit north of Ramp 50S, two of which extend through basalt flow. Two faults (approx. 2km long) trend northeast-southwest while a short (300m long) conjugate fault near PZ03-S/D tends northwest-southeast. No faults have been mapped in the Cherwell Pit area (Jacobs, 2017).

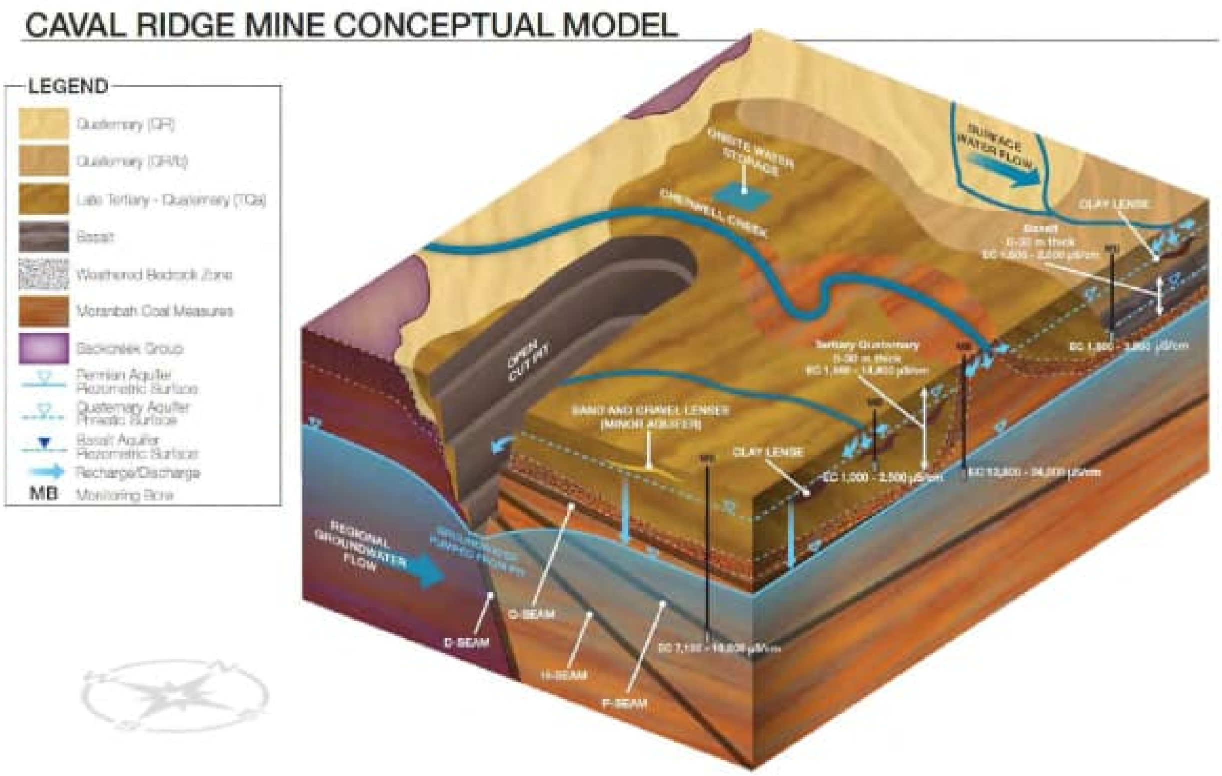


Figure 3.1 Caval Ridge Mine CHM (GHD, 2018)

3.2 Recharge

23 Primary recharge mechanisms for the key hydrogeological units are summarised below (GHD, 2018).

a Alluvial Aquifer

i Recharge of the alluvial aquifers is considered to be linked to surface water with recharge occurring during flow events. The creeks in the vicinity of CVM are ephemeral and recharge of the alluvium is by:

- Recharge from infiltration of rainfall, surface water flow or flooding (losing stream).
- Surface infiltration of direct rainfall and overland flow, where alluvium is exposed, and no substantial clay barriers occur in the shallow sub-surface.

b Tertiary Sediments

i Recharge of the Tertiary sediment aquifers occur via:

- Direct infiltration of rainfall and overland flow where Tertiary sediments outcrop and no substantial clay barriers exist in the subsurface.
- Overlying Quaternary alluvial aquifers.

c Tertiary Basalt

i Groundwater recharge of the Tertiary basalt occurs via:

- Infiltration of rainfall in outcrop areas where no substantial clay barriers exist in the shallow subsurface.
- Vertical seepage from overlying or adjacent alluvial or Tertiary aquifers.

d Permian Strata Aquifers

i Groundwater recharge in these aquifers occurs via:

- Infiltration of rainfall and overland flow in outcrop areas.
- Downward seepage or though flow from overlying or adjacent alluvial or tertiary aquifers where no significant clay barriers exist.
- Leakage between aquifers by faulting and other structural discontinuities.

3.3 Groundwater Levels, Flow Direction and Discharge

24 Quaternary Alluvial,

a The pre-mining depth to water in monitoring bores in the Quaternary alluvium aquifer was typically less than 15 m below ground level (mbgl).

b Due to the heterogeneity and discontinuity of the Quaternary alluvial aquifers, the pre-mining groundwater flow direction was not determined on a regional scale for this aquifer.

c The groundwater flow direction is likely to be topographically controlled, flowing from higher elevations to lower elevations.

d Groundwater within the alluvium is discharged as downstream throughflow, with some potential for evapotranspiration from deeper rooted riparian vegetation growing along the Isaac River, as well as potential baseflow contributions after significant rainfall and flood events. Groundwater within the alluvium is also discharged through the landholder use of bores in the region, particularly along the Isaac River (SLR, 2021)

25 Tertiary Sediment and Tertiary Basalt Aquifers

- **a** The depth to water in the Tertiary basalt aquifer was less than 30 mbgl.
- **b** No pre-mining depth to groundwater information existed for the Tertiary sediment as the Tertiary sediment encountered during the 2009 monitoring bore installation was shallow and dry but is likely to be similar to the depth to groundwater in the Quaternary alluvium and basalt aquifers in areas of thicker sediment accumulation.
- **c** Due to the heterogeneity and discontinuity of the Tertiary sediment and basalt aquifers, the pre-mining groundwater flow direction was not determined on a regional scale for these aquifers.
- **d** The groundwater flow direction is likely to be topographically controlled, flowing from higher elevations to lower elevations.
- **e** The groundwater level in the Cherwell Creek alluvium falls from approximately 218 to 212 mAHD as it traverses the site (PZ08-S to PZ07-S), indicating that groundwater in the tertiary quaternary alluvium associated with this creek will generally flow along the line of the creek (URS, 2009).
- **f** The groundwater level in the basalt in the north of the site falls from approximately 220 to 214 mAHD (PZ03-S to PZ02) to the north.

26 Permian Strata Aquifers

- **a** The depth to water in the coal measures is between 8 and 67 mbgl.
- **b** The pre-mining groundwater flow direction in the coal seam aquifers north of Cherwell Creek was from west to east across the site. This flow direction is consistent with recharge to the coal seams occurring at the sub-crops in the west of the site. The flow direction has been altered locally with groundwater flow towards the existing mine pits in the Peak Downs Mine to the south of Cherwell Creek.
- **c** Due to the low hydraulic conductivity of the interburden material, groundwater largely flows horizontally within the coal measures, along the bedding plane of the coal seams.
- **d** Discharge occurs via evaporation and inflow from active mine areas (SLR, 2021)3

3.4 Environmental Values

27 Environmental values (EVs) for groundwater in the Isaac Rivers catchment (Isaac Groundwaters) are defined under the Environmental Protection (Water) Policy 2009 (EPP (Water)) in Isaac River Sub-basin Environmental Values and Water Quality Objectives (EHP, 2011).

28 The EVs for groundwater have been reviewed in the context of the conceptual model, to identify those applicable to the CVM area and to identify the most sensitive of these EVs for protection (refer Table 3.2). Of those identified, the Aquatic Ecosystem EV is considered the most sensitive for protection.

29 Existing groundwater users in the vicinity of CVM have been identified as part of the CVM Impact Assessment (URS, 2009) and CVM Horse Pit Extension (SLR, 2020) through reviews of the QLD Groundwater Database (GWDB).

30 From the 2009 assessment, 13 registered bores were identified within a 10 km radius of Heyford Pit.

- **a** Of the 13 groundwater bores installed, 9 have been installed for private use, and 4 have been installed by DRDMW for groundwater monitoring and assessment.
- **b** Of the 9 bores installed for private use, none have been installed in the Moranbah Coal Measures,
    - **i** 4 have been installed in the Back Creek Group underlying the coal measures to the west of the site,

ii 4 have been installed to unknown depth by Mitsubishi Gas Company (MGC) for coal seam gas exploration, and

iii 1 (RN 103210) has been installed into the Fort Cooper Coal Measures overlying the Moranbah Coal Measures (URS, 2009).

31 From the 2020 assessment, in addition to the 2009 identified bores, 7 registered bores were identified within a 5 km radius of Horse Pit and are interpreted to be used for groundwater supplies. Of these 7 registered bores, three have drill dates recorded in 2018 or 2019, one has a drill date of 1992, one has a drill date of 2002, and the other two have drill dates recorded as prior to 1950 (SLR, 2020).

32 The locations of the above-mentioned bores are shown in Appendix A.

33 Local groundwater use is primarily for livestock watering purposes owing to the variable salinity levels and generally low yields (URS, 2009). It is believed that there are no industrial users of the groundwater within the local area (SLR, 2020).

Table 3.2: Summary of Environmental Values Applicable to the CVM Area (from GHD 2018)

Environmental Value	Description	Is the EV Applicable to CVM?
Aquatic ecosystem	The mapped Palustrine systems (wetlands) to the east of CVM in proximity to Cherwell Creek and Harrow Creek are not considered to be supported by shallow groundwater perched within the Quaternary alluvium and Tertiary/ Quaternary alluvium (SKM, 2013; GHD, 2017). The depth to groundwater measured in shallow alluvial monitoring bores near creeks ranges from around 10 to 12 mbgl (PZ08-S and RN-162144) indicating that the water table is generally disconnected from the creeks. Additionally, the lack of springs and seeps in the area indicate that the groundwater dependent ecosystems (GDEs) are unlikely to occur in the area (URS, 2009). The relatively shallow groundwater is likely to also support vegetation and ecosystems along the creeks (SKM, 2013).	Yes
Irrigation	The shallow groundwater within the Quaternary alluvium is potentially suitable for irrigation use, given the sodium adsorption ratio (SAR) of between 4.1 – 6.9 where a SAR below 10 indicates low sodium water which poses almost no risk of exchangeable sodium. A search of the Water Entitlements Database (DRDMW, 2023), within a 10 km radius of CVM did not find any groundwater or surface water licences for the purpose of irrigation.	No
Farm supply	The shallow groundwater within the Quaternary alluvium is potentially suitable for farm supply, given an EC in the order of 1,600 to 3,500 µS/cm. The water is not however suitable for drinking without treatment.	Yes
Stock water	The shallow groundwater within the Quaternary alluvium and Tertiary/Quaternary alluvium, and the groundwater in some of the Permian bedrock strata, is potentially suitable for stock watering. The measured EC of the Moranbah Coal Measures (in the order of 15,000 – 25,000 µS/cm) however, indicates that groundwater from this stratigraphic unit is not suitable for stock.	Yes
Primary recreation	No appreciable water bodies, groundwater springs or seeps that supply surface water bodies have been identified in proximity to the CVM that are used for recreational use.	No
Drinking water	Groundwater EC in the vicinity of CVM (ranging from 1,600 to 26,000 µS/cm across all aquifers) is consistently higher than the Australian drinking water guideline and is therefore considered unsuitable for human consumption without treatment. It is noted that two of the registered bores where the use is classified as water supply recorded 'potable' water quality (located between 7.3 km and 7.7 from CVM); however given bore yields were relatively low (0.4 – 0.7 L/s) and they do not have an associated licence listed on Water Entitlements Database (DRDMW, 2023), it is likely that these bores are for stock and domestic purposes. Further information is required to conclusively determine if these bores are used for potable drinking water.	No

Environmental Value	Description	Is the EV Applicable to CVM?
	No licences for town water supply for groundwater or surface water extraction were identified in a search of the Water Entitlements Database (DRDMW, 2023), within a 10 km radius of CVM.	
Cultural and spiritual values	The EV of aquatic ecosystem in relation to groundwater is identified as being applicable to the CVM area, given the mapped wetlands associated with some of the surface water courses and alluvial deposits. The wetland areas are considered to have significance to present and future generations. However, previous studies (URS, 2009) suggest that given there are no known groundwater springs or seeps in the vicinity of area that the surface water bodies are unlikely to have known significant cultural or spiritual values.	Yes

3.5 Water Quality

34 The physico-chemical results indicate the water chemistry pre-mining was typically of near neutral pH for all formations. The coal seam and basalt formation groundwaters had a variable salinity level (measured as electrical conductivity), ranging from brackish to saline, while the alluvium groundwaters were fresh to brackish (URS, 2009).

35 The pre-mining laboratory analytical results indicated that sodium was the dominant cation in the groundwater from all monitoring bores apart from PZ07-S in the alluvium which was calcium dominant.

36 The dominant anion was chloride in monitoring bores in the coal measures (PZ01, PZ03-D, PZ05, PZ07-D, PZ08-D, PZ09, PZ10 and PZ11), basalt (PZ03-S) and alluvium (PZ08-S) while the dominant anion was bicarbonate in the other monitoring bores in the coal measures (PZ04 and PZ06-D), basalt (PZ02 and PZ06-S) and alluvium (PZ07-S).

37 Water quality data for the alluvium within the region indicates it can be fresh to saline and highly spatially and temporally variable. The alluvium in the vicinity of CVM is mostly suitable for stock water supply and irrigation but is not suitable for drinking water and freshwater aquatic ecosystems. Alluvial bores within the site monitoring network were found to be on average, not be suitable for long-term irrigation, with concentrations of iron, chromium, and manganese exceeding guideline levels.

38 Water quality data for the tertiary alluvium and sediments indicates it is generally highly saline but can be brackish to moderately saline. Water within the tertiary sediments is generally of poor quality and not considered suitable for stock, irrigation, aquatic ecosystems or drinking water. Water quality within the basalt, where saturated, is generally of poor quality but is considered suitable for stock and short term irrigation.

39 Water quality data indicates water within the Permian coal measures is generally saline in the vicinity of CVM but can range between fresh to highly saline. Groundwater within the coal measures of the site is only considered suitable for some stock, with the type of stock dependent on the TDS range (i.e. beef cattle or sheep). Some bores screened within the interburden and the coal seams display highly variable concentrations of aluminium and nickel, exceeding the guidelines for stock watering.

4 Potential Groundwater Impacts

40 The impacts on groundwater from the development, operation, closure and post-closure of the mining activity were evaluated and detailed within:

- **a** the original CVM Environmental Impact Statement (EIS; URS, 2009). This assessment detailed impacts from originally approved activities related to mining of Heyford Pit in the south of CVM and mining of Horse Pit in the north; and
- **b** the Horse Pit Extension (HPE) Groundwater Impact Assessment (SLR, 2021a). This more recent assessment detailed impacts from the extension of Horse Pit from the previously approved pit extent to the ML boundary.

41 Predictions from the CVM numerical groundwater flow models (GHD 2017 and SLR, 2021b) were used to support the impact assessments.

42 The impacts evaluated from both assessments are summarised below and discussed in detail in the following sections:

- **a** groundwater interception by mining within the Isaac Connors Groundwater Management Area;
- **b** drawdown in groundwater level in the adjacent alluvium, basalts, Tertiary sediments and coal measures;
- **c** contamination of groundwater and/or changes to groundwater quality;
- **d** impacts on private bores;
- **e** drawdown at potential groundwater dependent ecosystems (GDEs);
- **f** cumulative groundwater level drawdown.

4.1 Groundwater Model Development

43 No numerical modelling was completed for the 2009 CVM EIS.

44 A numerical groundwater model was developed for the HPE assessment using MODFLOW-USG.

45 MODFLOW-USG is the latest version of industry standard MODFLOW code and was chosen as the most suitable modelling code for accomplishing the model objectives. The numerical groundwater model for the CVM Horse Pit Extension builds on the Olive Downs Project EIS model (the foundational regional Bowen Basin model) (HydroSimulations, 2018). The foundational model was subsequently updated for the Moorvale South Project in 2019 (SLR, 2019b), for the Winchester South Project EIS in 2020 (SLR, 2020), and most recently for the Lake Vermont North Project (in conjunction with the major amendment of EPML00562013 to permit the Horse Pit Extension).

46 The numerical model includes HPE, the impacts of mining elsewhere at CVM, Peak Downs Mine and Saraji Mine by BMA and the impacts of other, non-BMA mining in the model domain.

47 BMA has established groundwater data sharing agreements with the owners of each of these projects/mines, which allows for the sharing of groundwater data, models and documentation. Under these agreements, the groundwater models developed as part of each mine's groundwater assessment were adopted as a basis for the HPE groundwater assessment where relevant. Of note, the current update of the groundwater model reported herein is the first iteration to include data and information from the Lake Vermont North Project as well as several BHP mine sites (the CVM, Poitrel, Daunia and Saraji).

48 A range of model updates were required to ensure that the regional Bowen Basin model was fit-for-purpose for CVM and the major amendment of EPML00562013 to permit the Horse Pit Extension, including extension of the model, grid and updated layers of mined seams and strata at the CVM.

4.2 Groundwater Drawdown

49 The process of mining reduces water levels in surrounding groundwater units due to interception of groundwater in the mined geology. The extent of the zone affected is dependent on the properties of the aquifers/aquitards and is referred to as the zone of drawdown. Aquifer drawdown is greatest at the working coal-face, and generally, gradually decreases with distance from the mining operations.

50 The following subsections outlines predicted drawdown in each of the main hydrogeological units; predicted maximum incremental drawdown; and the predicted cumulative drawdown.

4.2.1 Predicted Drawdown within Hydrogeological Units

51 If the pits encounter the Quaternary alluvium, pit inflow will occur. Due to their shallow depth and lack of continuity and thickness, the Quaternary alluvium is not considered a significant aquifer. However, during periods of creek flow, the alluvium may become fully saturated and discharge to the pits.

52 No drawdown impacts are predicted for the Quaternary alluvium as a result of HPE mining activities at CVM (SLR, 2021a). Any predicted reduction in alluvial groundwater largely relates to the potential for leakage from the alluvium to the underlying Permian coal measures that are depressurised by the mining activity.

53 The predicted drawdown extent within the Tertiary sediments is largely confined to the Horse Pit extension area and is influenced by the distribution of predicted saturated zones in the sediments. At the northern end of the CVM mining lease, the 1 m drawdown influence is predicted to extend up to 2.9 km north of the lease boundary in the Tertiary sediments.

54 Based on the heterogeneity and discontinuous nature of the Tertiary basalt, it is anticipated that the mining activities will not have a significant impact on the isolated areas of basalt. Review of State (Queensland Government) Detailed Surface Geology (SDSG) mapping shows that the predicted drawdown intercepts basalt deposits located to the north east of the Hose Pit extension area. No groundwater users are located within the predicted drawdown extent. There are therefore no known relevant potential receptors located within this zone.

55 The coal seams of the Moranbah Coal Measures are the primary groundwater bearing units intercepted by mining activities, and will experience drawdowns as a direct result of mining. Groundwater level drawdown within the mined coal seams is influenced by unit structure and is confined to unit extents.

56 The extent of maximum predicted depressurization of the Permian coal measures related to the HPE is limited to the west of CVM due to the structural geology (i.e. coal seams subcrop and the units do not exist west of the subcrop). The extents of maximum predicted incremental drawdown in the Moranbah Coal Measures seams are between 10 to 12 km to the east and north east of the ML boundary (SLR, 2021a).

4.2.2 Predicted Maximum Drawdown

57 The maximum drawdown is predicted at the mine, where the piezometric heads are lowered to the floor of the mine (URS, 2009). Drawdown hydrographs from the predictive modelling indicate a maximum drawdown of approximately 190m at piezometer PZ09 by around the year 2030 (GHD, 2017). Predicted water table drawdown contouring at 2070 (end of mining) indicates a maximum drawdown of 202mbgl, which is confined to the pit area with steep hydraulic gradients along the edge of the pits due to the low transmissivity of the hydrostratigraphic units. The predicted drawdown extent is also greater to the east of the mine (GHD, 2017)

58 The EIS (URS,2009) indicated that drawdown (radius of influence) of the Heyford Pit extended to approximately 1.8km and therefore drawdowns for proposed pits were expected to be similar, taking in to account the reduction of recharge to the coal measures.

4.2.3 Predicted Cumulative Drawdown

59 The cumulative drawdown predictions outline the impacts, based on the groundwater model parameters, of the existing approved works (such as mining) and water entitlements within the model domain. The simulated cumulative drawdown predictions also show whether the zone of impact from the approved neighbouring operations is predicted to interact with the zone of impact from CVM in the different aquifers (SLR, 2021b).

60 The surrounding mines included within the model are the Olive Downs Project (Olive Downs South and Willunga), Moorvale South Project, Poitrel Mine, Daunia Mine, Peak Downs Mine, Grosvenor Mine, Lake Vermont Mine, Eagle Downs Mine, Saraji Mine, Saraji East Project and the Winchester South Project. The vast majority of the predicted cumulative drawdown impacts are not related to CVM but result from these other approved mining activities represented in the model.

61 There are no cumulative drawdown impacts predicted for the Quaternary alluvium within or around CVM. Maximum predicted cumulative drawdown impacts are predicted within the extents of the Isaac River alluvium in the south of the model domain near the Olive Downs South operations, which are more than 32 km southeast from CVM.

62 Cumulative impacts within Tertiary sediments are observed connecting CVM-related drawdown to drawdown impacts at Peak Downs, south of CVM. For the Leichhardt and Vermont coal seams, there is no drawdown interaction between CVM and the neighbouring mines that target the Rangal Coal Measures which are not present within CVM. The extents of maximum predicted cumulative drawdown in the Moranbah Coal Measures coal seams are approximately 13 km to the east and 10 km to the north of CVM.

4.3 Potential Impacts on Groundwater Users

63 There will be no direct interception of the alluvium, including that associated with the Isaac River, by the open cuts at CVM. Any predicted interference of alluvial groundwater largely relates to the potential for increased leakage from the alluvium to the underlying Permian coal measures that are depressurised by CVM. Over the extent of Quaternary alluvium, model predictions show that there is zero predicted loss of water from the alluvium because of exercising the underground water rights for CVM, i.e., there is no predicted direct or indirect interference with alluvial groundwater because of CVM.

64 The model predicts that over the life of mine (LOM), the change in the average rate of seepage from the Isaac River to the alluvium is insignificant and considered within the error threshold of model predictions (less than 3.65 ML/year). The model estimates less than 0.01% increased seepage from the Isaac River to the alluvium because of mining at CVM, an insignificant potential for flow rate reduction. There is also no change in net flow predicted in the creeks located within the vicinity of the CVM.

4.3.1 Isaac Connors Groundwater Management Area

65 As mining progresses, pits intercept aquifers resulting in passive groundwater inflow to pits. As the pit depth increases, the inflow rate into the pit void increases.

66 Derived from predictive modelling (GHD, 2017) groundwater inflow rates for originally approved mining activities at CVM, indicted an inflow rate range from 2.7 to 6.8 ML/d with an average of 4.4 ML/d. The predicted groundwater inflow rates do not include loss of water due to evaporation. The predicted average total inflow rate over the duration of mining associated with HPE is 198.1 ML/year (0.55 ML/day) (SLR, 2021a).

67 Mining activities are not predicted to directly intercept groundwater from Isaac Connors Groundwater Unit 1 (Quaternary alluvium) under the Water Plan (Fitzroy Basin) 2011, meaning, all direct groundwater take by the open cut pits for the Project is from Isaac Connors Groundwater Unit 2 (sub-artesian aquifers).

68 The predicted direct take over time indicates that groundwater take would be in the order of up to 275.2 ML/year (average 133.9 ML/year) from Groundwater Unit 2 (SLR, 2021a).

69 The model predicts that for the long-term equilibrium condition post mining, there is negligible groundwater take from Groundwater Unit 1, and 146.5 ML/year groundwater take from Groundwater Unit 2 to the final voids.

4.3.2 Third Party Supply Bores

70 Chapter 3 of the Water Act 2000 provides bore drawdown threshold triggers of 2 m for unconsolidated aquifers, and 5 m for consolidated aquifers.

71 There are no known privately owned bores within the unconsolidated (Alluvium and Tertiary sediments) or consolidated (Permian coal measures) aquifers that lie within the predicted extent of CVM-related drawdown greater than 1 m (SLR, 2021a).

72 The uncertainty results showed that no water supply bores in the alluvium are predicted to experience drawdowns greater than 1 m due to CVM even at the 95th percentile confidence interval.

73 The uncertainty results showed that the 95th percentile maximum cumulative drawdown is predicted to be greater than 5m at two water supply bores. Both bores are located to the west of CVM and are screened within the Fort Cooper Coal Measures. As per Table 2 of IESC (2020), in terms of likelihood of exceedance, a percentile greater than 90% means that it is very unlikely that the maximum cumulative drawdown will be greater than 5m at these bores.

4.3.3 Groundwater Dependent Ecosystems

74 The aquatic in-stream ecosystems associated with the Isaac River and Cherwell Creek are largely not dependent on the surface expression of groundwater. The wetlands and farm dams in the locality are not likely to be aquatic GDEs.

75 The water level measurements undertaken as part of the 2009 EIS indicated that the water table within the alluvium of Cherwell Creek is approximately 13 to 14 mbgl, and that other areas of alluvium may be dry. The water level in the coal measures is between 8 and 67 mbgl and the water table in the basalt is approximately 25 to 26 mbgl.

76 Modelling has shown that CVM would result in negligible increased leakage from surface flows of the Isaac River to the underlying alluvium (SLR, 2021a). Therefore, impacts to surface flows and subsequently aquatic ecosystems downstream of CVM are not expected (Ecological Service Professionals, 2020).

77 There would be negligible drawdown in the alluvium along the Isaac River and Cherwell Creek outside ML 1775 as a result of CVM, as well as no impacts to groundwater quality. Therefore, there would be no adverse impacts to riparian vegetation associated with the Isaac River and Cherwell Creek outside ML 1775 as a result of CVM (SLR, 2021a).

78 Any dependency on groundwater for riparian vegetation surrounding ephemeral wetlands on Isaac River or Cherwell Creek is likely to be facultative. These ephemeral wetlands are not likely to be aquatic GDEs as these wetlands do not receive groundwater discharge, rather, the clay-rich substrates of these wetlands are likely to hold surface water run-off for extended periods (E2M, 2020). Further, as there would be no impacts from mining activities on groundwater quality and resources, there would be no adverse impacts to riparian vegetation surrounding these ephemeral wetlands.

79 Terrestrial GDE communities have been assessed within the extent of predicted drawdown (extent of 1m water table drawdown) from CVM (E2M, 2021b). Field survey information describing the vegetation communities present has been compared to depth to groundwater (depth to water table) predictions from HPE groundwater model with respect of literature information on rooting depths of the observed species. This analysis has identified that for the most part, the pre-mining water table across the predicted CVM-related groundwater drawdown extent lies beyond the reach of the vegetation communities, and therefore those communities can not be considered GDEs. Only two locations within the 1m water table drawdown extent were determined to be potential or likely GDEs; riparian vegetation along a small section of Horse Creek at the northern extent of CVM including onto ML 1775 (likely GDE), and riparian vegetation along a small section of Caval and

Cherwell Creeks at the southern extent of CVM wholly within ML 1775 (possible GDE). However, in both cases the communities in these areas were also determined to be facultative, with vegetative condition and persistence likely to have dependence on surface flows.

80 There would be no impacts to vegetation on the Isaac River, Horse Creek and Cherwell Creek floodplains (outside of wetlands) that may access water from the alluvium, as there would be negligible drawdown to the alluvium and no changes to groundwater quality within the alluvium.

81 These depths to groundwater, and the lack of springs or seeps in the area, indicate that GDEs are not likely to exist in the vicinity of the site. CVM is therefore not predicted to have any material impacts on potential or actual GDEs due to changes in groundwater quality or resources.

4.4 Potential Impacts on Surface Drainage

82 All creeks within the vicinity of CVM are ephemeral and there are no perennial water holes or groundwater dependant environments present, as discussed. Under dry season conditions, groundwater does not contribute to surface water flow within these creeks. In exceptionally wet years it is possible that the Quaternary alluvium and shallow Tertiary aquifers may contribute some groundwater to the surface water system along water courses. The drawdown of the potentiometric surface of the Permian strata aquifers during mining is unlikely to have an impact on these discharges as the shallow aquifers sit above, and are generally poorly connected to, the aquifers below (SLR, 2021a).

83 The Isaac River is the major drainage feature of the region. It is located to the east of CVM and flows northwest to south-east in the vicinity of CVM. A natural hydraulic gradient exists between the Isaac River and the associated alluvium that results in seepage from the Isaac River to the alluvium (i.e. a losing system). The change in water levels induced by mining has the potential to increase the hydraulic gradient between the Isaac River and associated alluvium. However the HPE numerical model predicts that the average rate of seepage from the Isaac River to the alluvium will increase by an insignificant amount, considered within the error threshold of predictions (less than 3.65 ML/year) over the life of CVM. This insignificant volume is itself considered a conservative over-estimate as the groundwater model does not represent an unsaturated zone that can form between the bed of the river and the underlying groundwater unit, which would serve to limit the hydraulic gradient and interconnectivity.

84 The Isaac River is ephemeral in nature, with flows only occurring after rainfall events that generate runoff. On average, when the Isaac River flows, 161,863 ML/year of surface water is discharged downstream. The conservative estimate of less than 3.65 ML/year increased seepage from the Isaac River to the alluvium as a result of CVM therefore represents an insignificant potential reduction in flow (including shallow subsurface flow). The number of days that the Isaac River runs dry is not predicted to increase in association with ongoing approved mining activities at CVM.

4.5 Potential Impacts on Groundwater Quality

85 The EIS (URS, 2009) stated that the groundwater quality of the Permian strata is brackish to brine and not suitable for human consumption or irrigation but has some use for stock water.

86 During mining operations, water quality within aquifers surrounding the site are not expected to change from pre-mining conditions. Extraction during mining is predicted to create a depression in the potentiometric (groundwater) surface and mean that the net movement of water will be towards the pit and prevent the movement of poorer quality water into surrounding aquifers.

87 Aquifers outside of the mine pit area will continue to receive recharge via the same processes that occurred pre-mining. Groundwater in the alluvial aquifers and basalt are of similar or better quality compared to the Moranbah Coal Measures with respect to major ions and metals. Hence any inadvertent mixing of groundwater (during mining) by downward movement from the upper to lower aquifers is unlikely to result in a deterioration of water quality in either aquifer but lead to an improvement in water quality in the deeper aquifers.

88 Potential sources that may result in impacts to groundwater quality include:

- **a** Out of Pit Dumps (waste rock emplacement areas) (OoPD);

b In pit waste rock emplacement areas;

c Co-disposal of Rejects (In Pit and in spoil)

d Final voids; and

e Mine Industrial Areas (MIA)

4.5.1 Out of Pit Dumps

89 As the mining operations progress, waste rock material will be placed within selected OoPDs. The OoPD may produce seepage because of rainfall inundation, that theoretically could alter the existing groundwater quality. A geochemical assessment has been prepared by Terrenus Earth Sciences (2021) presenting the 'assumed worst case' scenario that included leachate analysis of waste rock material. The analysis found waste rock material is generally Non-Acid Forming (NAF), with the leachate averaging an EC of 391 µS/cm and low in sulfur content (SLR, 2021a).

90 The inward hydraulic flow gradients from the waste emplacement areas (comprising the OoPD and in pit waste rock disposal) to the open cut void would inhibit seepage to the alluvium and Cainozoic sediments present between the alluvium and Tertiary sediments and the OoPD generally comprise surficial soil and clays, up to 10 m thick. The clays will inhibit potential seepage from the OoPD to the underlying Regolith and alluvium. Therefore, there would be no mechanism for seepage from the OoPD to impact on groundwater quality in the alluvium and Tertiary sediments. Notwithstanding, leachate from the OoPD would generally be fresh and low in sulfur content, minimising the potential for a change in groundwater quality in the unlikely event seepage enters the groundwater system (SLR, 2021a).

4.5.2 In pit waste rock emplacement areas

91 In-pit waste rock emplacement areas will be rehabilitated progressively as the mining operations progress. Progressive backfilling of the open cut pit as space becomes available with water levels within backfilled areas predicted to recover back towards pre-mining levels.

4.5.3 Reject disposal (In Pit and in spoil)

92 Reject materials from the Coal Handling and Processing Plant (CHPP) will consist of coarse reject, spiral tailings and flotation tailings generated from Caval Ridge Northern and Southern ROMs.

93 Rejects (coarse and dewatered tailings) from the CHPP (approximately 20% moisture) are combined and truck-dumped into the Horse and Heyford Pits where they are mechanically mixed via dozer back into the spoil material.

94 As part of the CVM EIS (URS, 2009), a geochemical assessment was carried out to determine the potential for acid mine drainage (AMD), the concentration of trace metals in spoil and the feasibility of using this spoil for rehab. As per the Terreneus Earth Sciences (2021) assessment the majority of the reject material was found to be NAF with a very low total sulfur content.

95 The assessment found that a very small proportion of potential reject materials may have a low capacity to generate small quantities of acid, however the small quantity of acid that could potentially be produced from these materials (based on the very low sulphur concentrations), would be sufficiently neutralised (buffered) by the relatively high acid neutralising capacity and naturally high alkalinity of the overburden materials (URS 2009). Given the expected low potential for AMD the potential environmental impact associated with these materials, including impact to groundwater was assessed as likely to be low.

96 In general controls focus on the prevention of AMD from being generated however mitigation controls are in place to minimise potential impacts if they occur. The controls are outlined in the Mining Waste Management Plan (MWMP) and are summarised as follows:

a Selective placement and encapsulation of mining waste materials that are PAF, saline, sodic or dispersive;

- **b** Chemical amelioration of PAF, sodic, saline and dispersive materials, if no other methods, such as encapsulation, are available;
- **c** Tracking of mining waste disposal, including location and quantities;
- **d** Diversion of water around mining waste dumps;
- **e** Reject disposal areas designed and constructed to ensure that any runoff or seepage from the reject disposal areas are contained within the mine water management system (MWMS); and
- **f** Capping of any PAF materials to limit infiltration of water and oxygen to prevent acidic conditions.

4.5.4 Final Voids

97 Final voids proposed for Horse Pit and Heyford Pit are to remain in perpetuity. Modelling predicts that the final void water levels will equilibrate to 120 mAHD at Horse Pit and 50 mAHD at Heyford Pit.

98 The predicted equilibrated final void water levels are approximately between 70 m and 90 m below the pre-mining groundwater levels, which means the final voids would act as a sink to groundwater flow. Water within the final voids will evaporate from the final void water body surface and draw in groundwater from the surrounding strata and runoff from the final void catchment areas.

99 As the final voids will act as a sink, evaporation from the final void water body will overtime, concentrate salts in the final void water body. However, the gradual increase in salinity of the final void water body is not predicted to pose a risk to the surrounding groundwater regime as the final void will remain as a groundwater sink in perpetuity.

4.5.5 Mine Industrial Areas

100 The quality of the groundwater in the shallow aquifers that may exist within the project site (i.e. Quaternary alluvium and Tertiary sediments) have the potential to be impacted by chemical or fuel storage facilities.

101 All workshop and fuel/chemical storage areas at CVM are developed in accordance with current Australian Standards. This includes refuelling areas and chemical storage areas to be designed with adequate bunding and equipped for immediate spill clean-up. These controls represent standard practice and a legislated requirement at mining operations for preventing the contamination of the groundwater regime.

102 The risks from chemical or fuel storage will be minimised by implementation of the contractor's construction environmental management plan and site environmental management plan.

103 There is considered to be limited potential for groundwater contamination to occur with relation to workshops and fuel/chemical storage. Any accidental spills will be assessed on a case-by-case basis and remediated.

4.6 Cumulative Impacts

104 Cumulative impacts associated with approved and foreseeable open cut and underground coal mines surrounding CVM were assessed in accordance with IESC requirements (SLR, 2021b)

105 The results confirm that most of the predicted cumulative drawdown impacts are not related to CVM but result from these other existing and approved mining activities represented in the model.

5 Groundwater Monitoring and Management Objectives

106 The management objectives and means of identifying the potential impacts shown in Section 4 are shown in Table 5-1.

Table 5-1: Groundwater Monitoring and Management Objectives

Opportunity	Management Objective	Measurement
Baseline data knowledge	Expand the current knowledge regarding baseline conditions and identify trends to improve assessment of potential impacts related to groundwater.	Implementation of the Monitoring Program outlined in this document.
Monitoring Framework	Provide a framework for groundwater monitoring data collection, management and review.	Biennial review of the Groundwater Monitoring and Management Program.
Identification of potential impacts	Enable identification of potential impacts related to groundwater (e.g. drawdown, contamination and impacts to GDEs) from mining activities in a timely manner.	Measurement and review of groundwater levels and quality for the site. Implementation of a specific Terrestrial GDE Monitoring and Management Plan (see CVM-PLN-0052)
Management of exceedances and events	Provide a process for the management of exceedances of regulatory approvals and trigger thresholds and events associated with groundwater.	Biennial review of the Groundwater Monitoring and Management Program.

Noting that CVM activities includes all CVM operational activities (including Horse Pit Extension).

6 Groundwater Monitoring

6.1 Monitoring Program

107 Groundwater quality and standing water levels must be monitored:

- **a** at the locations and at the frequencies specified in Table 6-1– Groundwater Monitoring Locations and Frequency; and
- **b** for the quality characteristics specified in Table 7-1 – Groundwater Trigger Levels; and from the CVM groundwater monitoring network shown in Figure 6.1.

Table 6-1: Caval Ridge Mine Groundwater Monitoring Bore Network

Bore Name	Location	Easting (GDA64)[2]	Northing (GDA64)[2]	Ground RL (mAHD)	Cased Depth (mbgl)	Screened Interval (mbgl)	Monitored Aquifer	Monitoring Requirement (Parameter, Frequency)	Monitoring Rationale
Interpretation Bores									
PZ08-S[1]	Adjacent south side of 12N Dam	611411	7549709	230.58	16	10 – 16	Alluvial	Quarterly Levels Quarterly Lab WQ	Current EA interpretation monitoring bore. Upgradient alluvial monitoring along Cherwell Creek
Compliance Bores									
PZ01[1]	NE of Horse Pit	609841	7560145	220.33	85.5	82.5 – 85.5	Permian (D04 Seam)	Quarterly Levels Annual Lab WQ	Current EA compliance monitoring bore. Downgradient Permian monitoring
PZ04[1]	East of Horse Pit	610731	7555326	279.27	93.1	87.1 – 93.1	Permian (Q01 Seam)	Quarterly Levels Annual Lab WQ	Current EA compliance monitoring bore. Downgradient Permian (Q Seam) monitoring
PZ07-D[1]	Cherwell Creek East of 12N Dam	612465	7550704	226.17	44	41 – 44	Permian (Q01 Seam)	Quarterly Levels Annual Lab WQ	Current EA compliance monitoring bore. Downgradient Permian (Q Seam) monitoring
PZ09[1]	East of Heyford Pit	614326	7548822	224.82	77	71 – 77	Permian (P08 Seam)	Quarterly Levels Annual Lab WQ	Current EA compliance monitoring bore. Downgradient Permian (P Seam) monitoring
PZ11-D[1]	Harrow Creek East of Heyford Pit (Peak Downs ML)	616791	7547600	218.77	58	55 – 58	Permian (P08 Seam)	Quarterly Levels Annual Lab WQ	Current EA compliance monitoring bore. Downgradient Permian (P Seam) monitoring
PZ12-D[1]	West of Heyford Pit	610712	7557219	241.79	55.4	52.7 – 55	Interburden Siltstone	Quarterly Levels Annual Lab WQ	Current EA compliance monitoring bore. Downgradient Interburden monitoring
PZ12-S[1]	West of Heyford Pit	610721	7557164	242.24	30.2	27.5 – 29.8	Regolith Sandstone / Siltstone	Quarterly Levels Annual Lab WQ	Current EA compliance monitoring bore. Downgradient Regolith monitoring
MB19CVM09A[1]	Cherwell Creek East of 12N Dams	612448	7550698	226.94	18.5	15.5 – 18.5	Alluvial	Quarterly Levels Quarterly Lab WQ	Current EA compliance monitoring bore. Alluvial Cherwell Pit baseline monitoring Replacement for PZ07-S
MB19CVM02P[1]	Adjacent south side of 12N Dam	611424	7549705	242	36	30 – 36	Permian	Quarterly Levels Annual Lab WQ	Current EA compliance monitoring bore. Co-located with PZ08-S for vertical gradient west of Heyford Pit Cherwell Pit baseline
MB19CVM07T	2km east of Horse Pit, south of Peak Downs Highway	611464	7552357	233.87	27	21 – 27	Tertiary Basalt	Quarterly Levels Quarterly Lab WQ	Basalt Cherwell Pit baseline monitoring Replacement for PZ06-S

Bore Name	Location	Easting (GDA64)[2]	Northing (GDA64)[2]	Ground RL (mAHD)	Cased Depth (mbgl)	Screened Interval (mbgl)	Monitored Aquifer	Monitoring Requirement (Parameter, Frequency)	Monitoring Rationale
MB19CVM08P	2km east of Horse Pit, south of Peak Downs Highway	611465	7552346	233.78	163.5	157.5 – 163.5	Permian (H Seam) / Siltstone	Quarterly Levels Quarterly Lab WQ	Permian (H Seam) Cherwell Pit baseline monitoring Replacement for PZ06-D
MB20CVM01A	North-eastern edge of ML	609915	7560272	218.81	8	5 – 8	Alluvial / BHWE	Quarterly Levels Quarterly Lab WQ	Alluvial Cherwell Pit baseline monitoring
MB20CVM04T	Northern edge of ML, co-located with MB-5P	608193	7559651	231.38	28	22 – 28	Tertiary Basalt	Quarterly Levels Quarterly Lab WQ	Co-located with MB-5P for vertical gradient. Cherwell Pit baseline monitoring
MB20CVM05P	Northern edge of ML, co-located with MB-4T	608198	7559646	231.10	45	39 – 45	Permian	Quarterly Levels Quarterly Lab WQ	Co-located with MB-4T for vertical gradient. Cherwell Pit baseline monitoring
MB20CVM06A[3]	East of Horse Pit	610802	7548890	232.65	18	11.75 – 17.75	Alluvial / BHWE	Quarterly Levels Quarterly Lab WQ	Downgradient Alluvial Cherwell Pit baseline monitoring
CVMMB16_01	South East of Horse Pit	611144	7558320	237.3	14.58	10.9 – 13.9	Tertiary	Quarterly Levels Quarterly Lab WQ	Co-located with CVMMB16_02 to monitor interconnectivity between coal seams and shallow units.
CVMMB16_02	East of Horse Pit	611135	7558315	237.41	70.55	63.8 – 69.8	MCM Coal – H Seam	Quarterly Levels Quarterly Lab WQ	Co-located with CVMMB16_01 to monitor interconnectivity between coal seams and shallow units.
CVMPB07_02	South East of Horse Pit	609915	7560272	236.68		111 – 117	MCM Coal – P Seam	Quarterly Levels Quarterly Lab WQ	To monitor predicted drawdown in intercepted coal seam aquifer. Co-located with MB19CVM07T and MB19CVM08P.
CVMMB100_01	TBC						Water Table	Quarterly Levels Quarterly Lab WQ	Monitoring bore to be installed down hydraulic gradient of out of pit dump (OoPD). Location to be finalised when OoPD constructed.

[1] Denotes monitoring requirements are per EA EPML00562013 as shown in the "Monitoring Requirement" column and may change as this EA is amended.

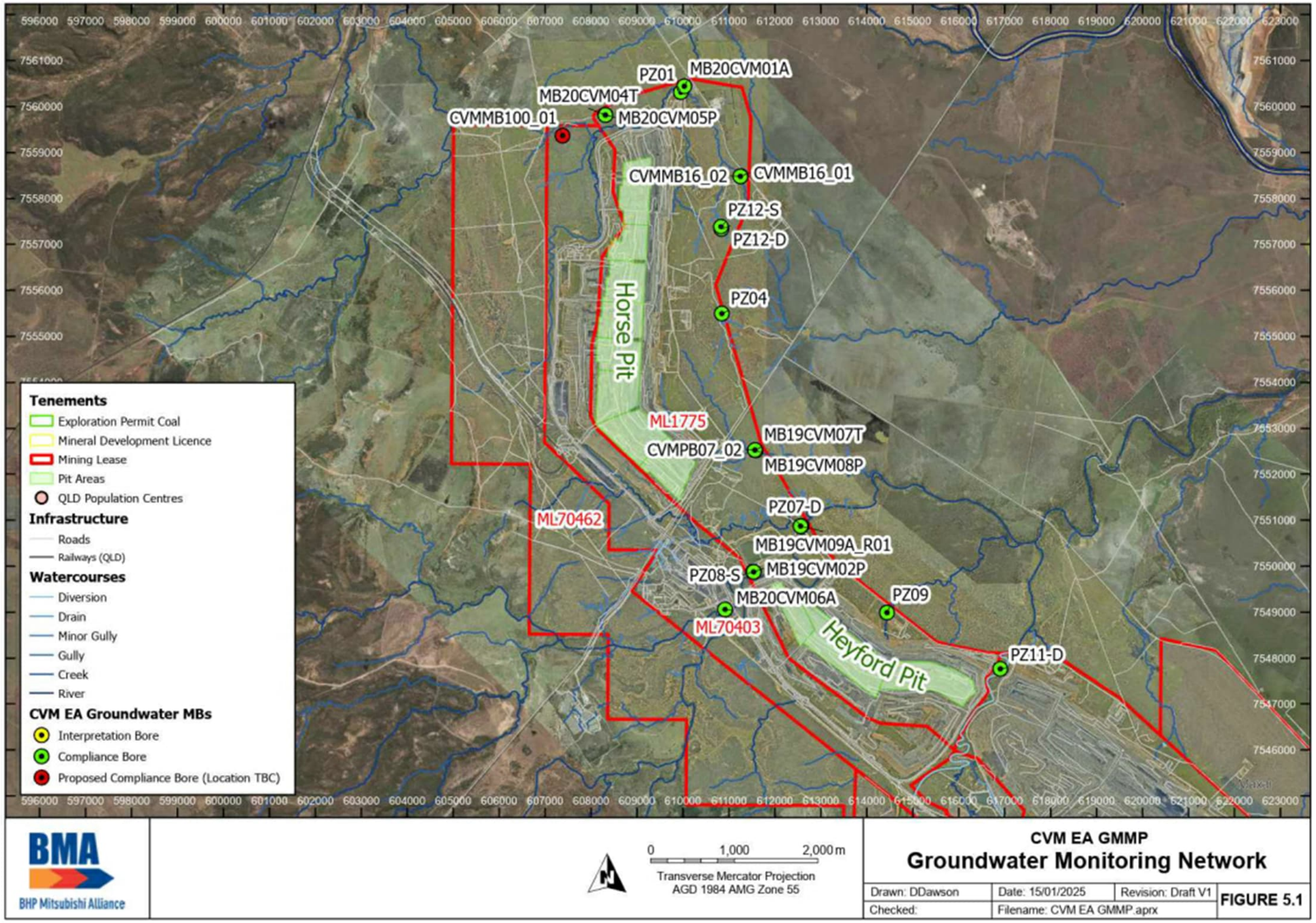
[2]Projection to be updated to AGD66 when EA next amended. Coordinates to for bores to be updated where required to reflect March 2024 survey data.

[3]Bore ID to be updated to MB20CVM06T when EA next amended.

Water Quality = WQ
***Water Quality Laboratory Analysis: pH, EC, TDS, Ca, Na, Mg, K, Cl, SO4, CO3, HCO3, Dissolved metals (Al, Fe, As, Ag, Hg, Sb, Mo, Se), TRH C6-C10, TRH C10-C40.

Mine Lease = ML

Figure 6.1 Caval Ridge EA Groundwater Monitoring Network



6.2 Monitoring Bore Construction

108 The construction, management, maintenance and decommissioning of groundwater monitoring bores must be undertaken in a manner that:

- **a** prevents contaminants entering the groundwater;
- **b** ensures the integrity of the bores to obtain representative groundwater samples from the target aquifer; and
- **c** maintains the hydrogeological environment within the aquifer

109 Construction and decommissioning must be in accordance with the **Minimum Construction Requirements for Water Bores in Australia (4th edition, 2020).**

6.3 Monitoring Methodology

110 Groundwater monitoring will be conducted in accordance with methods described in the following guiding documents:

- **a** Department of Environment and Science (2018) Monitoring and Sampling Manual: Environmental Protection (Water) Policy.
- **b** Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000, Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000)
- **c** Australian/New Zealand AS/NZS 5667.1.1: Water Quality – Sampling – Guidance on the design of sampling Programs, Sampling Techniques and the Preservation and Handling of samples.
- **d** Australian/New Zealand AS/NZS 5667.11: Water Quality—Sampling - Guidance on sampling of groundwaters.

111 Monitoring equipment used will be maintained and calibrated according to manufacture specifications.

112 Monitoring is to be carried out by appropriately qualified persons

6.4 Quality Assurance & Control

113 Quality assurance and control protocols during sampling will be undertaken in accordance with ANZECC (2000) to ensure the integrity of the dataset.

114 Samples will be transported to a NATA-accredited laboratory(s) under appropriate documented chain of custody. Laboratory guidelines on holding times for samples will be complied with where practicable.

115 Laboratory and field results will be checked for accuracy on receipt of all sampling data and laboratory certificates of analyses. Errors or discrepancies will be cross-checked with field and laboratory records and further investigation initiated if required.

6.5 Data Management

116 Validated data from the monitoring program will be entered into the BMA Environmental Data Monitoring System (EDMS).

7 Groundwater Trigger Levels & Notification

117 Groundwater level and water quality trigger levels for Alluvial and Permian bores at CVM are defined in Table I2 of EA EPML00562013 (see Table 7.1).

7.1 Exceedance Procedure

118 If the groundwater trigger levels defined in Table 6.1 are exceeded on three (3) consecutive monitoring occasions, the environmental authority holder must complete an investigation into the potential for environmental harm and notify the EA administering authority within twenty (20) business days of receiving the analysis results (Figure 7.1).

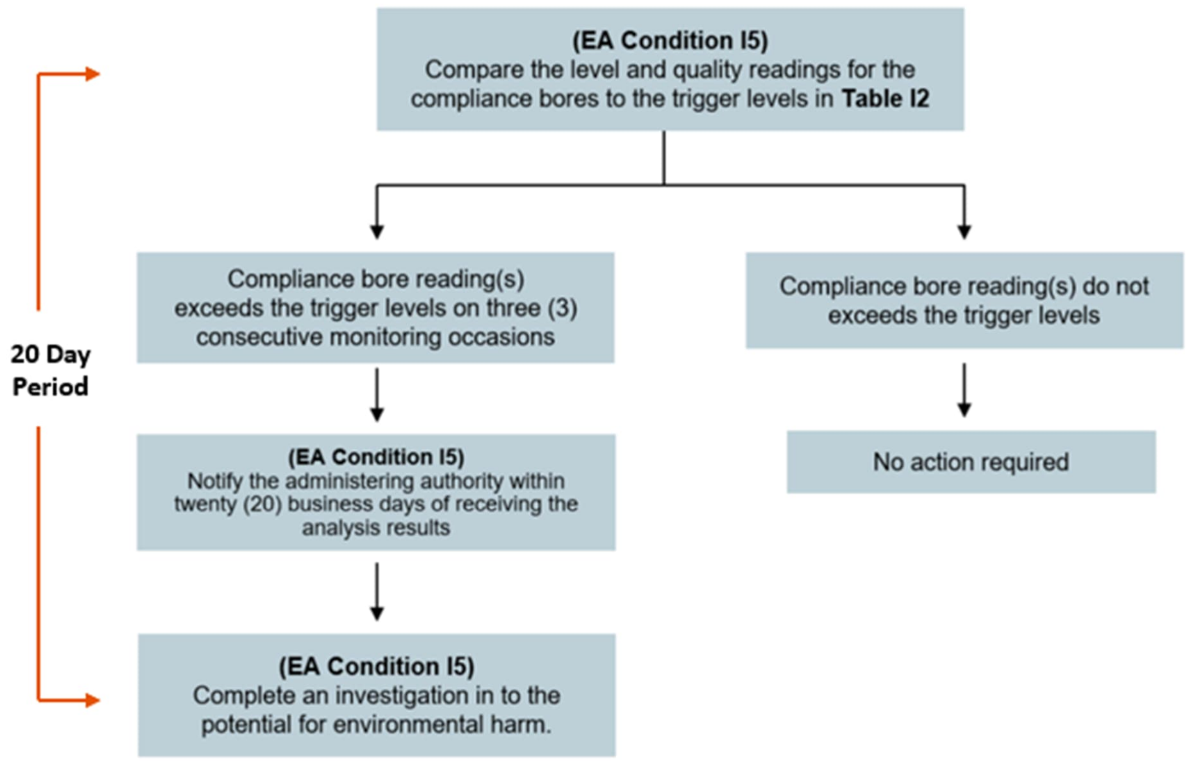


Figure 7.1 Exceedance Procedure Summary, as per Condition I5 of the EA.

119 Investigation will be commenced and managed in accordance with:

- **a** BMA Event and Escalation Management Standard;
- **b** BMA STD Investigation and Learning;
- **c** CVM PRO Event Reporting and Investigation;
- **d** BMA PRO HSEC External Reporting; and
- **e** HSEC Reporting, Event Management and Investigation Global Standard

120 The investigation will:

- **a** Identify key drivers/parameters that relate to the monitoring result not in line with trigger limit (e.g. the source of the contaminant, impact pathway).
- **b** Document the nature and extent of any environmental harm in relation to sensitive receptors.

c 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.

d The investigation may require multiple stakeholder input such as BHP Environment representative, suitably qualified specialists (e.g. hydrogeologists, modellers, other engineers).

e Define mitigation or corrective actions and responsibilities, including timeframe expectations.

f Determine effectiveness of monitoring and management measures

121 Corrective actions and the timing of their implementation will be dependent on the nature and extent of the exceedance and outcomes of the investigation. Corrective actions may be temporary or permanent. Examples of possible corrective actions are outlined below:

a Resampling of groundwater bores if required to support an investigation of Trigger Level Exceedance.

b Maintenance and/or repair of infrastructure will be carried out in a timely manner (e.g. immediately where risk is not contained, short to medium term when risk is contained). For example:

i Repair or replacement of a monitoring bore will be undertaken prior to the next monitoring event.

ii Installation of containment infrastructure (e.g. bunding) if a contaminant release has been identified

c Re-modelling or review of modelling accuracy completed within 6 months of becoming aware of trends that are not aligned with current modelling predictions

d Pumping contaminated water from receiving environment back to mine water system in a timely manner in order to reduce risk of dispersal to other areas of the receiving environment

The outcomes of the investigation, including definition of corrective actions, will be provided to the administering authority in accordance with the Conditions of the EA (and shown in Figure 7.1). Timeframes for implementation of a corrective action will be agreed with administering authority as required as part of completion of the investigation processes.

122 Investigations may require or lead to increases in monitoring frequency, changes in monitoring location or parameters.

123 The EPBC approval administering authority must be notified within 2 business days of becoming aware of any incident in accordance with Condition 54 of the EPBC Act approval. The definition of an incident is as follows:

a event which has the potential to, or does, harm any protected matter,

b potential non-compliance with these conditions, including the administrative requirements,

c actual non-compliance with these conditions, including the administrative requirements,

d potential non-compliance with one or more commitment made in a plan, and/or

e actual non-compliance with one or more commitment made in a plan.

124 The EPBC approval administering authority must be notified within 12 business days of becoming aware of any incident, the details of the incident, in accordance with Condition 55 of the EPBC Act approval.

Table 7-1: Caval Ridge Mine Groundwater Trigger Levels

Quality Characteristic	Units	Trigger Levels										
		PZ08-S	PZ01	PZ04	PZ07-D	PZ09	PZ11-D	PZ12-S	PZ12-D	MB19CVM09A	MB20CVM01A	MB19CVM07T
Groundwater Level	RL	Monitored for interpretative reasons only – no triggers apply	Fluctuations in excess of 2m per year excluding changes from pumping of licenced bores									
pH	pH units		6.0-8.5	6.4-8.5	6.5-8.5	6.3-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.3-8.5	6.5-8.5	6.5-8.5
EC	µS/cm		17,950	16,440	16,000	20,570	16,000	8910	16,000	8,910	8,910	8,910
Sulphate	mg/L		625	507	398	1300	398	318	398	318	318	318
Dissolved Aluminium	mg/L		0.055[1]	0.19	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
Dissolved Antimony	mg/L		0.0090	0.0090	0.0090	0.0090	0.0090	0.0090	0.0090	0.009	0.009	0.009
Dissolved Arsenic	mg/L		0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Dissolved Iron	mg/L		0.83[1]	8.5	0.70	4.7	1.4	0.70	0.70	1.2	0.70	0.70
Dissolved Mercury	mg/L		0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
Dissolved Molybdenum	mg/L		0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
Dissolved Selenium	mg/L		0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Dissolved Silver	mg/L		0.0010[1]	0.0010	0.0010	0.0010	0.0010[1]	0.0010	0.0010	0.001	0.001	0.001
Total recoverable hydrocarbons C6-C10	µg/L		20[1]	20[1]	20[1]	20	20[1]	20[1]	20[1]	20	20	20
Total recoverable hydrocarbons >C10-C40	µg/L		100	100	100	100	100[1]	100	100	100	100	100

Quality Characteristic	Units	Trigger Levels							
		MB20CVM04T	MB20CVM06A[3]	MB20CVM05P	MB19CVM08P	CVMMB16_01	CVMMB16_02	CVMMB07_02	CVMMB100_01
Groundwater Level	RL	Fluctuations in excess of 2m per year excluding changes from pumping of licenced bores							
pH	pH units	6.5-8.5	6.3.8.5	6.5-8.5	TBC[2]				
EC	µS/cm	12,510	22,990	20,020					
Sulphate	mg/L	456	2,110[1]	892[1]					
Dissolved Aluminium	mg/L	0.055	0.055[1]	0.055[1]					
Dissolved Antimony	mg/L	0.009	0.009	0.009[1]					
Dissolved Arsenic	mg/L	0.013	0.013	0.013[1]					
Dissolved Iron	mg/L	1.6	10[1]	1.5[1]					
Dissolved Mercury	mg/L	0.0006	0.0006[1]	0.0006[1]					
Dissolved Molybdenum	mg/L	0.034	0.034[1]	0.034[1]					
Dissolved Selenium	mg/L	0.011	0.011[1]	0.011[1]					
Dissolved Silver	mg/L	0.001	0.001[1]	0.001[1]					
Total recoverable hydrocarbons C6-C10	µg/L	20	20[1]	20[1]					
Total recoverable hydrocarbons >C10-C40	µg/L	100	100[1]	100[1]					

Notes:

[1] Fewer than the recommended 18 data points have been used to derive these trigger levels, therefore the adopted trigger levels are considered as interim and may require subsequent revision.

[2]Trigger levels have not been developed as there are fewer than 8 data points available. Trigger levels will be developed once a dataset of >8 samples is available.

[3]Bore ID to be updated to MB20CVM06T when EA next amended.

8 Administration of the GMMP

125 All monitoring data will be maintained accurate and complete at a centralised location.

126 Any amendment to this plan must be considered in accordance with Condition 31 of the EPBC Act Caval Ridge Mine Horse Pit Extension (2021/9031) approval. An amended plan may be required to be submitted to the Minister for approval.

127 This plan will be published on the bhp.com website for the period of the EPBC Act Caval Ridge Mine Horse Pit Extension (2021/9031) approval in accordance with Condition 36 of that approval.

8.1 GMMP Review and Reporting

128 The Groundwater Monitoring and Management Program must be reviewed by 31 November 2023, and thereafter every two (2) years, by an appropriately qualified person. The review report must:

- **a** analyse the results of groundwater monitoring to:
  - **i** describe any impacts to groundwater levels and groundwater quality due to the mining activity;
  - **ii** determine trends in groundwater levels and groundwater quality;
- **b** assess the adequacy of the Groundwater Monitoring and Management Program; and
- **c** provide recommendations to the environmental authority holder to address the findings of parts (a) and (b) of the review.

129 Within twenty (20) business days of receiving the review report, required by condition I6, the environmental authority holder must provide to the EA administering authority:

- **a** the review report;
- **b** if applicable, any actions being taken by the environmental authority holder to address the recommendations of the review report; and
- **c** if action is not being taken to address a recommendation, the environmental authority holder

130 In accordance with Condition 47 and 48 of the EPBC Act Caval Ridge Mine Horse Pit Extension (2021/9031) approval relevant compliance information will be collated to inform the EPBC Act approval Annual Compliance Report.

8.2 Annual Groundwater Data Submission

131 Annual groundwater monitoring data must be submitted to the administering authority via WaTERS by 30 September calendar each year.

8.3 Training & Awareness

132 Water management is a key environmental risk area for BMA sites, involving roles and responsibilities across multiple departments. Awareness of water-related risks and training in water management requirements is critical for effective site water management. Training requirements are identified and delivered in accordance with the BMA Training System.

133 The CVM training matrix defines the induction and training requirements for employees based on the type of work and the work environments that each work group is exposed to.

134 Where required as part of monitoring procedures or as per EA conditions, the CVM site environment team shall ensure that personnel undertaking monitoring are appropriately qualified and trained.

135 General environmental awareness is delivered to all BMA personnel through the BMA General Environment Induction, which includes water management awareness and responsibilities.

9 Roles and Responsibilities

136 The EA and EPBC approval holder is responsible for the implementation of this GMMP.

137 Table 8.1 below lists the roles and responsibilities relating groundwater monitoring and management at CVM.

Table 8.1 Roles and Responsibilities relating to water management at Caval Ridge Mine

Department	Responsibilities
General Manager and Site Leadership Team	• Support implementation of groundwater monitoring and management activities, initiatives and process outlined within this plan. • Participate in Field Leadership activities supporting water management activities • Ensure management activities identified within this management included in budget cycles.
CVM Site Environment Team	• Understand the operation's environmental legal requirements in regard to groundwater management. • Ensure all BMA staff and external contractors undertake groundwater monitoring in accordance with the site EA and associated procedures (this GMMP) • Ensure all BMA staff and external contractors undertaking groundwater sampling are appropriately qualified and trained to undertake groundwater sampling • Maintain accurate and complete data • Ensure accurate reporting of relevant data to both internal and external stakeholders • Comparing monitoring results against relevant trigger levels and implementing exceedance procedure • Manage event response and investigations in accordance with this GMMP, including corrective actions. • Notify EA and/or EPBC approval administering authority in accordance with approval condition requirements and required timeframes • Undertake external reporting commitments in accordance with site EA and EPBC approval. • Submit monitoring data to administering authority in accordance with EA conditions
Water Planning Team	• Review and update this plan as per Section **Error! Reference source not found.** • Develop review report and provide to CVM Site Environment Team • Assist with investigation of Trigger Level Exceedances

10 References

Reference Number	Title	Document Number
	Legislative Requirements Documents	
	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000, Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000)	
	Australian/New Zealand AS/NZS 5667.1.1: Water Quality – Sampling – Guidance on the design of sampling Programs, Sampling Techniques and the Preservation and Handling of samples.	
	Australian/New Zealand AS/NZS 5667.11: Water Quality—Sampling - Guidance on sampling of groundwaters.	
	DES, 2018. Monitoring and Sampling Manual: Environmental Protection (Water) Policy. Brisbane: Department of Environment and Science Government.	
	Department of Natural Resources, Mines and Energy (DNRM), 2018. Guideline - Quantifying the volume of associated water taken under a mining lease or mineral development licence Under the Mineral Resources Act 1989, March 2018.	
	Environmental Protection (Water) Policy 2009 (EPP (Water))	
	The Minimum Construction Requirements for Water Bores in Australia (4th edition, 2020).	
	Technical Reference Documents	
	EHP, 2011. Isaac River Sub-basin Environmental Values and Water Quality Objectives	
	GHD, 2017. Caval Ridge Mine Numerical Groundwater Model. Report prepared for BHP, December 2017.	
	GHD 2018, Caval Ridge Mine – Groundwater Contaminant Trigger Levels Report. Report prepared for BMA Coal, December 2018.	
	Jacobs, 2017. Draft Caval Ridge Mine Hydrogeological Study Technical Memorandum. Memo report prepared for BHPB, 13 February 2017.	
	SKM, 2013. Caval Ridge Mine – Groundwater Monitoring Program Review. Report prepared for BMA, March 2013.	
	SLR, 2020. Caval Ridge Mine, Horse Pit Expansion Project. Groundwater Approvals Gap Analysis and Forward Work Plan. Report prepared for BHP, May 2020.	
	SLR, 2021a. Caval Ridge Mine, Horse Pit Expansion Project. Groundwater Assessment. Report prepared for BHP, December 2021.	
	SLR, 2021b. Caval Ridge Mine, Horse Pit Expansion Project. Groundwater Modelling Technical. Report prepared for BHP, August 2021.	
	SLR, 2021c. Caval Ridge Mine. FY21 Water Licence Performance Report, Groundwater Model Support. Report for BMA. 2021.	
	URS, 2009. Caval Ridge Groundwater Impact Assessment. Report prepared for BMA Coal, March 2009.	
	BHP/BMA Documents	
BMA-STD-0008	BMA STD HSE Event and Escalation Management Standard	000205066
BMA-STD-0006	BMA STD Investigation and Learning	000199191
CVM-PRO-0091	CVM PRO Groundwater Monitoring Procedure	013987990

Reference Number	Title	Document Number
BMA-PRO-0081	BMA PRO HSEC External Reporting	012859020
CVM-SWI-0152	CVM SWI Groundwater Monitoring	000201885
GSFT-GSTD-00041	HSEC Reporting, Event Management, and Investigation Global Standard	

11 Version Management

Version	Details	Date
1.0	Initial release - Business Owner updated and References table updated	12 June 2023
2.0	Updated release - Business Owner updated and monitoring network and trigger tables updated.	20 January 2025
2.1	Amended based on DCCEEW feedback	14 April 2025

Appendix A – Registered Bores

Table A1: QLD GWDB Summary within 5km of Horse Pit – Non-monitoring bores (SLR, 2020)

Bore RN	Easting GDA94	Northing GDA94	Drill Date	Target Aquifer	Water Level	Water Quality	Status
162806	611187	7562746	<1950	Unknown	Yes	No	Abandoned but Useable
162807	611622	7562665	<1950	Unknown	No	No	Abandoned but Useable
162808	613474	7558029	<1950	Unknown	Yes	No	Abandoned but Useable
162809	610876	7559643	01/01/2002	Unknown	No	No	Abandoned but Useable
182164	609901	7562568	24/08/2018	Tertiary Basalt	Yes	No	Existing
182166	610291	7562919	04/12/2018	Alluvium and/or Tertiary Sediments	Yes	Yes	Existing
182316	606007	7562450	22/06/2019	Back Creek Group	Yes	Yes	Existing

Table A2: QLD DNRME Registered Bores within 10km of Heyford Pit (URS, 2009)

Registered Number	Facility Owner	Facility Name	Status	Easting (m)	Northing (m)	Zone (GDA)
8606	Cherwell Holding	Folsters	Existing	614390	7536451	55
38418	Cherwell Holding	Coal Hole Bore	Existing	608380	7539621	55
62719	Cherwell Holding	Coal Hole Bore	Existing	608044	7538841	55
85499	Skyville	Shellys Bore	Existing	606359	7546888	55
100224	Mitsubishi Gas Company	MGC Moranbah 1	Existing	615843	7567074	55
100225	Mitsubishi Gas Company	MGC Moranbah 2	Existing	614778	7566528	55
100253	Mitsubishi Gas Company	MGC River Paddock 1	Existing	618233	7556847	55
100254	Mitsubishi Gas Company	MGC River Paddock 2	Existing	619668	7557174	55
103210			Existing	616869	7560018	55
13040174	Department of Natural Resources and Water	B1S1	Abandoned and destroyed	617190	7562863	55
13040175	Department of Natural Resources and Water	B2S2	Abandoned and destroyed	616813	7562251	55
13040176	Department of Natural Resources and Water	B3S3	Abandoned and destroyed	616291	7561486	55
13040282	Department of Natural Resources and Water	NAP Issac River Site 1	Existing	605910	7545740	55

Registered Number	Elevation of Ground Level (mAHD)	Elevation of Reference Point (mAHD)	Date Drilled	Lithology Log Available	Stratigraphy
8606	na	na	na	No	
38418	na	na	1/01/1957	Yes	Blenheim Sandstone
62719	na	na	1/01/1986	No	
85499	na	na	30/05/1992	Yes	Blenheim Subgroup
100224	na	na	5/11/1993	No	
100225	na	na	10/10/1994	No	
100253	na	na	25/08/1993	No	
100254	na	na	16/09/1994	No	
103210	na	na	22/09/1999	Yes	
13040174	207.62	na	na	Yes	
13040175	207.94	na	na	Yes	
13040176	204.08	na	na	Yes	
13040282	275.2	275.56	27/08/2004	Yes	Undefined Quaternary, Back Creek Group

Registered Number	Aquifers	Casing Description Available	Water Chemistry Available	Water Levels
8606		No		
38418	Blenheim Sandstone	Yes		1957
62719		Yes		
85499	Blenheim Subgroup	Yes	Field parameters and laboratory results for 1992, 1997	
100224		No		
100225		No		
100253		No		
100254		No		
103210	Blackwater Group	No		
13040174		Abandoned and destroyed		
13040175		Abandoned and destroyed		
13040176		Abandoned and destroyed		
13040282	Back Creek Group	Yes		2004 to 2007