BROKEN HILL OPERATIONS PTY LTD ABN 58 054 920 893

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5 March 2024

Mandana Mazaheri
Principal Planning Officer
Energy, Resources and Industry Assessments
Department of Planning, Housing and Infrastructure
4 Parramatta Square, 12 Darcy St,
PARRAMATTA NSW 2150

Re: Rasp Mine MOD11 - Response to Request for Information (RFI-67850207) further information regarding Ground Water Impact Assessment and report (further to previous RFI-65010208)

Dear Mandana,

1. Introduction

Following Broken Hill Operations (BHO) response to agency submissions for MOD11, an additional Request For Information (RFI) was received (RFI-65045456) regarding Ground Water Impact Assessment and Water licencing. An additional RFI was requested on this matter (RFI-65010208), and then a further RFI (RFI-67850207) was requested to clarify minor issues pertaining to groundwater levels and the ground water assessment. The issues and response to RFI-67850207 are as follows;

Issue 1

Groundwater drawdown Assessment (EMM consulting memorandum 31 January 2024)

Section 2.2 - Thompsons Shaft: provide information about depth reading of its water level depth. The available information in section 2.2 about Thompson's Shaft (which is right next to workings) is noted: being dry to 85 mAHD (225m bgl) but its depth goes down to 480 mbgl and that if water level is below 40 m AHD (270 mbgl) it will be below or at proposed additional mine development and therefore as the regional groundwater is already dewatered then there would be no incremental impact.

Response
Appendix B – Section view (looking south) of the Rasp Mine workings, Thompson's shaft location and Historic 1480 drive (1480 ft. below ground level) shows the connection of Thompsons shaft to the historic 1480 drive. The 1480 drive extends across the entirety of the Line of Lode from the Perilya North Mine, through the Rasp Mine and to the Perilya South Mine. The 1480 drive is currently dry (observation from the Rasp Mine), no flows of water are visible along this drive that connects to current Rasp Mine workings. As a result it is evident that the Thompsons shaft is dry to 480mbgl.

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Appendix C - Water levels of Rasp Mine and neighboring Perilya North Mine (as at 27/2/24) shows that water levels at the Perilya North Mine were approximately 550mbgl on 01-02-18 prior to the North Mine resuming operation (including mine dewatering). 550mbgl is a lower level than the base of Thompsons Shaft. The Perilya North ground water level as at 27/2/24 is approximately 1000mbgl. With Perilya North being in proximity to Thompsons Shaft, and the water level at the Rasp Mine's Shaft 7 (Located at the Southern end of CML7/the Rasp Mine) currently 590mbgl (as at 27/2/24) this clearly indicates that no ground water is present at the level of the mining extension proposed in MOD11.

Issue 2

<u>Figure 2.1 from the EMM consulting memorandum 31 January 2024</u>

Section 2.4 – groundwater inflow to the mine workings: This section describes Section 6 of the new workings as being above the regional water table (assumed to be 85 m AHD) and that the average centreline is 89 m AHD (i.e. above the regional water table at 85 m). However, Figure 2.1 shows it to be below the regional water table and that deepest is down to 40 m AHD whereas it appears deeper for Section 8. Clarify about these matters and provide a revised Figure to reflect the information in Table 2.2.

<u>Response</u>

Figure 2.1 was a 3D image that did not present clearly. The figure has been converted to a 2D image that is clearer and easier to understand. The figure has been updated in the EMM consulting memorandum and the memorandum reissued at 22 February 2024 (enclosed as Appendix A)

If you have any questions or would like to discuss the matter further, please contact Joel Sulicich HSET Manager on 0427 610 774 or joelsulicich@cbhresources.com.au.

Yours sincerely

Giorgio Dall'Armi

General Manager

Broken Hill Operations Pty. Ltd.

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Appendix A – EMM Consulting Memorandum Rasp Mine Modification 11 - Groundwater drawdown assessment

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Memorandum

22 February 2024

To: Joel Sulicich
Health Safety Environment and Training Manager
CBH Resources - Rasp Mine
130 Eyre St
Broken Hill NSW 2880

From: Bill Bull

Subject: Rasp Mine Modification 11 - Groundwater drawdown assessment

Dear Joel,

Broken Hill Operations Pty Ltd (BHOP) has submitted a proposed modification (Modification 11; MP07_0018-Mod-11) to the Department of Planning and Environment: Water (DPE Water; now Department of Planning, Housing, and Infrastructure). This modification involves installing a new fresh air ventilation intake in the northern underground area of the mine and extending underground development workings in the Main Lode Blocks 13, 14 and 15. DPE Water has made the following request for information in relation to the potential for the works to intercept groundwater and affect the current cone of depression at the mine:

> 'The proponent should provide a statement of impact against the minimal impact considerations of the NSW Aquifer Interference Policy (2012).
>
> The potential impacts of water take are unclear, even though the take volumes have been estimated. The proponent should provide an assessment of potential impacts on the water source and nearby users.
>
> Rasp Mining is undertaking an aquifer interference activity. This activity requires assessment of the impact against criteria defined by the NSW Aquifer Interference Policy. This must include an evaluation of how the proposed developments may interact with, and potentially influence, the groundwater resources in the surrounding area. The proponent must make their statement of impact against the minimal impact considerations of the NSW Aquifer Interference Policy.'

EMM has undertaken analytical groundwater modelling to calculate potential drawdown in the regional aquifer over time due to these works, to facilitate an assessment of the potential impact on nearby groundwater receptors, to satisfy the DPE Water request for information.

1 Site setting

The project site and key site features related to this assessment are presented in Figure 1.1. The proposed workings are located in the north-east portion of CML7. Also noted are the locations of Shaft No. 7, Delprat's Shaft, Thompson's Shaft, and Shaft No. 3, where estimates of the regional groundwater level were able to be made for this assessment.

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Source: EMM (2024); CBH (2021); DPE (2019); DFSI (2017); Metromap (2024)

KEY

- Shaft location
- Proposed Mod 11 workings
- Existing underground workings
- Mining lease CML7
- Perilya mining lease
- Sublease area

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line

Rasp Mine setting

Rasp Mine Modification 11
Groundwater Drawdown Assessment
Figure 1.1

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2 Model design

2.1 Method

2.1.1 Groundwater inflows

Groundwater inflow into the mine workings was estimated using Goodman's equation (Equation 1; Katibeh & Aalianvari 2012) in conjunction with the Heuer method, where:

- Q_L is the volume of water entering the tunnel per unit of length ((m^3/day)/m)
- *K* is the hydraulic conductivity of the surrounding aquifer (m/day)
- *r* is the radius of the tunnel
- H_0 is the head of water above the centreline of the tunnel (m)
- *z* is the distance from the tunnel to the bottom of the water body (m)

$$Q_L = \frac{2\pi K H_0}{\ln\left(\frac{2z}{r}\right)}$$ Equation 1

For this assessment, *z* is assumed to be equal to H_0, i.e. the watertable is modelled as an infinite recharge boundary. It is noted that this method assumes a constant watertable height above the tunnel workings, but in reality, it is expected that groundwater inflow into the workings will lead to a drawdown in the watertable. A reduction in watertable height above the workings will reduce H_0 and therefore reduce the inflow rate. Therefore, this model is assumed to be conservative and is expected to overestimate long-term inflow rates.

The Heuer method (Heuer 1995) is an empirical adjustment that recognises that actual groundwater inflow into tunnels is generally significantly lower than the rates predicted by Goodman's Equation, particularly in shallower tunnels (approximately 100 m deep or less). This actual inflow rate is predicted to be one-eighth of the inflow predicted by Goodman's Equation.

Other assumptions associated with Goodman's Equation include:

- The tunnel is assumed to be infinitely long.
- The watertable will not be drawn down to meet the top of the tunnel.
- The hydraulic conductivity of the aquifer is the only factor limiting the rate of groundwater inflow.
- Flow is non-turbulent and the aquifer is homogeneous and isotropic.

2.1.2 Drawdown

Drawdown was estimated using the Theis Equation, which describes the reduction in groundwater level with ongoing groundwater extraction. The following parameters are used for this analysis:

- Saturated aquifer thickness (m).
- Hydraulic conductivity (m/day).
- Abstraction rate – the total inflow rate modelled from Goodman's Equation (m^3/day).

- Radius – the distance from the groundwater abstraction source where drawdown is being considered (m).
- Time – how long the abstraction has been occurring (days).
- Specific yield – the volume of water released by a saturated rock for an unconfined aquifer, due to gravity divided by the total volume of the rock.

The Theis Equation assumes the following:

- The aquifer has infinite areal extent.
- The aquifer is homogenous and of uniform thickness.
- Water is released instantly from storage with a decline of hydraulic head.
- The drawdown is small relative to the saturated thickness of the aquifer.

2.2 Regional groundwater level

Groundwater levels within the bedrock aquifer are unknown at the site of the proposed workings. The following information was provided by BHOP (pers. comms. 2024) in order to estimate groundwater levels for modelling:

- Active dewatering occurs from Shaft No. 7 to maintain groundwater levels between 580 mbgl and 620 mbgl. Shaft No. 7 extends to approximately 679 mbgl.
- Active dewatering occurs from Shaft No. 3 to maintain groundwater levels. The standing water level within Shaft No. 3 is approximately 580 mbgl (Perilya 2018).
- Delpratt's Shaft is dry to at least 300 mbgl, though it may be dry to the base of the shaft at 360 mbgl.
- Thompson's Shaft is dry to at least 225 mbgl, though it may be dry to the base of the shaft at 480 mbgl.

Based on this information, it was conservatively estimated that the regional watertable sits at 225 mbgl (approximately 85 mAHD) at the site of the proposed works. Due to the bedrock aquifer extending to at least 679 mbgl at Shaft No. 7 (approximately -360 mAHD) the saturated aquifer thickness at the site of the proposed workings is estimated to be at least 445 m (equal to the difference between the estimated watertable height of 85 mAHD and the estimated bottom of aquifer at -360 mAHD) .

It is noted that the base of the proposed workings is at approximately 40 mAHD. Therefore, if the water level in Thompson's shaft sits below 270 mbgl (approximately 40 mAHD), all of the proposed workings would occur above the watertable and would not impact groundwater.

2.3 Hydraulic properties

A hydrogeological assessment of the basement rock at the Rasp Mine was prepared by Golder (2008), which estimated the transmissivity of the bedrock to be between 20 and 80 m^2/day. With an estimated saturated thickness of 445 m, the estimated hydraulic conductivity values are 0.045 to 0.18 m/day. From these estimates, 0.045 m/day, 0.18 m/day and 0.36 m/day were adopted as low, medium, and high estimates of the hydraulic conductivity, respectively.

NZG (2006) estimates that the specific yield of the aquifer is between 0.001 and 0.01. The hydraulic properties used for modelling are summarised in Table 2.1.

Table 2.1 | Adopted hydraulic properties

Parameter	Values
Hydraulic conductivity (m/day)	0.045 (low) 0.18 (medium) 0.36 (high)
Specific yield (-)	0.005
Saturated aquifer thickness (m)	445
Regional groundwater level (mAHD)	85

2.4 Workings

To model groundwater inflow to the mine workings, the distance between the tunnel centreline and the watertable was calculated. Due to the elevation of the tunnels differing along the workings, the tunnels were split into multiple sections where the tunnels within each section had similar elevations, as shown in Figure 2.1. Goodman's equation was then applied to each of the sections separately, with the total inflow to the workings being the sum of the inflows to each section. These sections are summarised in Table 2.2 along with the assumed inputs. It is noted that H_0 has not been calculated for Section 1 through to Section 6 as these parts of the workings lie above the estimated watertable (85 mAHD).

BHOP (pers. comms. 2024) advised that all tunnels will be 5 metres by 5 metres in size. Therefore, the tunnel radius was assumed to be 5 m for all calculations.

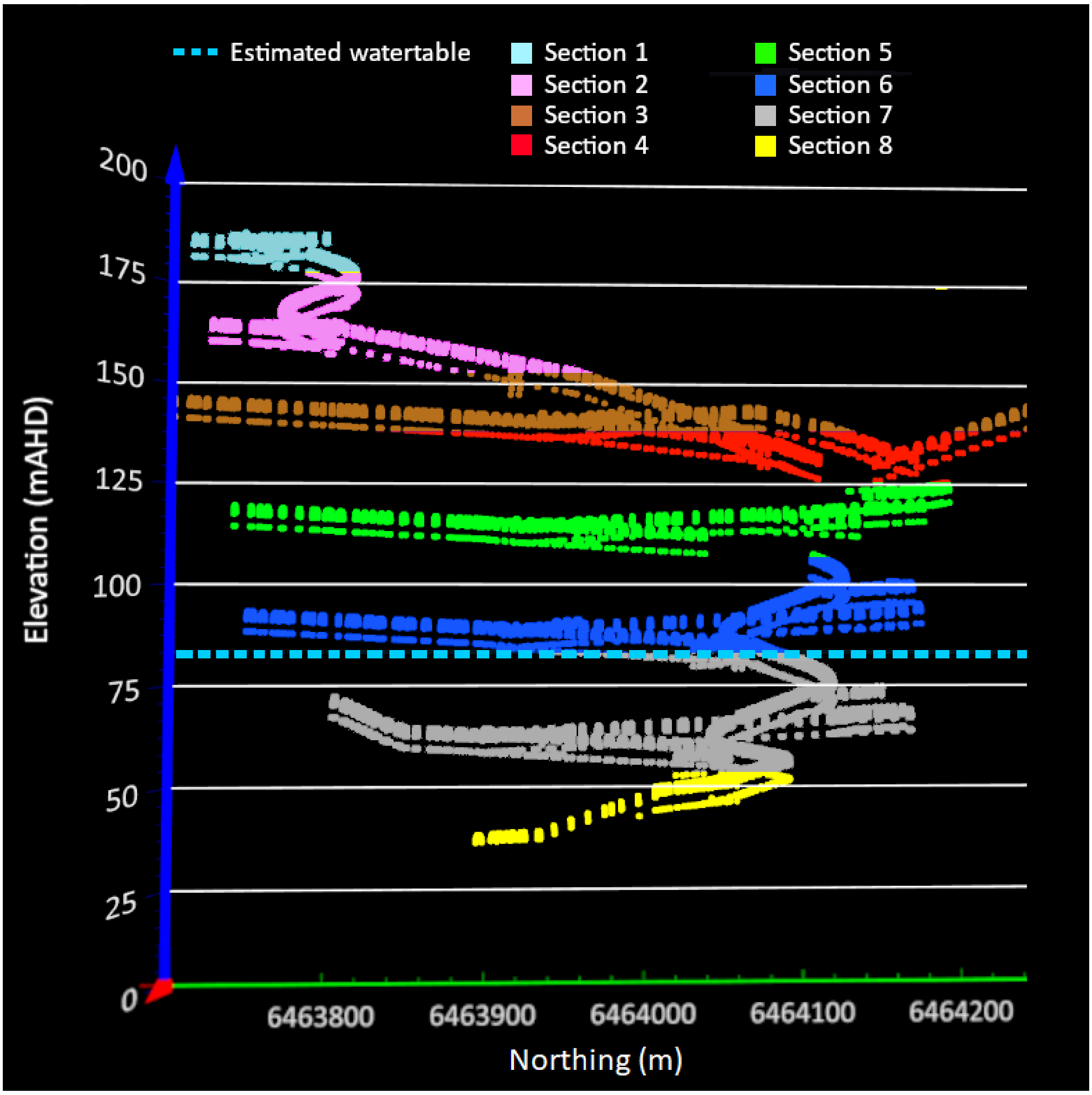


Figure 2.1 Proposed workings sectioned by tunnel elevation

Table 2.2 | Tunnel section details

Section	Length (m)	Average centreline elevation (mAHD)	H_0 (m)
Section 1	269	181	-
Section 2	344	160	-
Section 3	686	141	-
Section 4	138	134	-
Section 5	611	114	-
Section 6	611	89	-
Section 7	668	61	24
Section 8	172	44	41

3 Results

3.1 Groundwater inflows

The groundwater inflows calculated using Goodman's equation are summarised in Table 3.1. Total modelled inflows are estimated to range from 291 m^3/day to 2,094 m^3/day, which is equivalent to 106 ML/year to 764 ML/year. Perilya (2018) notes that inflows to the Broken Hill North Mine, the Southern Operations, and the Rasp Mine are estimated to be 110 ML/year, 470 ML/year and 725 ML/year, respectively. These historical values are consistent with the modelled inflows to the proposed Modification 11 workings.

Table 3.1 | Underground workings inflows

Section	Hydraulic conductivity scenario	Length (m)	Inflow rate (m^3/day/m)	Section inflow (m^3/day)	Section inflow with Heuer adjustment (m^3/day)
Section 1	-	269	-		
Section 2	-	344	-		
Section 3	-	686	-		
Section 4	-	138	-		
Section 5	-	611	-		
Section 6	-	611	-		
Section 7	Low K	668	2.53	1,689	211
	Medium K		9.10	6,080	760
	High K		18.20	12,161	1,520
Section 8	Low K	172	3.70	638	80
	Medium K		13.34	2,296	287
	High K		26.67	4,592	574
Total – Low K				2,327	291
Total – Medium K				8,377	1,047
Total – High K				16,753	2,094

Notes: Low K refers to the low hydraulic conductivity case (K=0.05 m/day)

Medium K refers to the medium hydraulic conductivity case (K=0.18 m/day)

High K refers to the high hydraulic conductivity case (K=0.36 m/day)

3.2 Drawdown

The NSW Aquifer Interference Policy (2012) states the following relevant Level 1 Minimal Impact Considerations for less productive fractured rock aquifers, such as the bedrock aquifer on site:

- Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 m from any:
  - High priority groundwater dependent ecosystem, or
  - High priority culturally significant site listed in the schedule of the relevant water sharing plan.
- A maximum of a 2 m water table decline cumulatively at any water supply work.

Based on these considerations, the Theis equation was used to calculate the extent of the 2 m drawdown contours for the low, medium and high hydraulic conductivity scenarios at the end of mining (31 December 2026). For these scenarios, the corresponding groundwater inflow rates as detailed in Table 3.1 were used as inputs. The 2-metre drawdown contour for each scenario at the end of mining is presented in Figure 3.1, along with identified nearby potential sensitive receptors comprising groundwater dependent ecosystems and nearby registered bores.

These contours show that in the low hydraulic conductivity scenario, no potential receptors are within the 2-metre drawdown contour, while the medium and high hydraulic conductivity scenarios have two and seven registered bores within their 2-metre drawdown contours, respectively. No groundwater dependent ecosystems are intercepted by the 2-metre drawdown contours under any scenario. Table 3.2 summarises the modelled end-of-mining drawdown at the seven potentially impacted bores for each scenario.

While no significant drawdown is expected at the potential groundwater dependent ecosystems identified, it is noted that extensive long-term dewatering in the area is likely to have resulted in significant local depressurisation of the regional fractured bedrock aquifer. Accordingly, it is likely that these identified groundwater dependent ecosystems are not reliant on the regional bedrock aquifer, but rather local soil moisture that is recharged via episodic rainfall or creek flows.

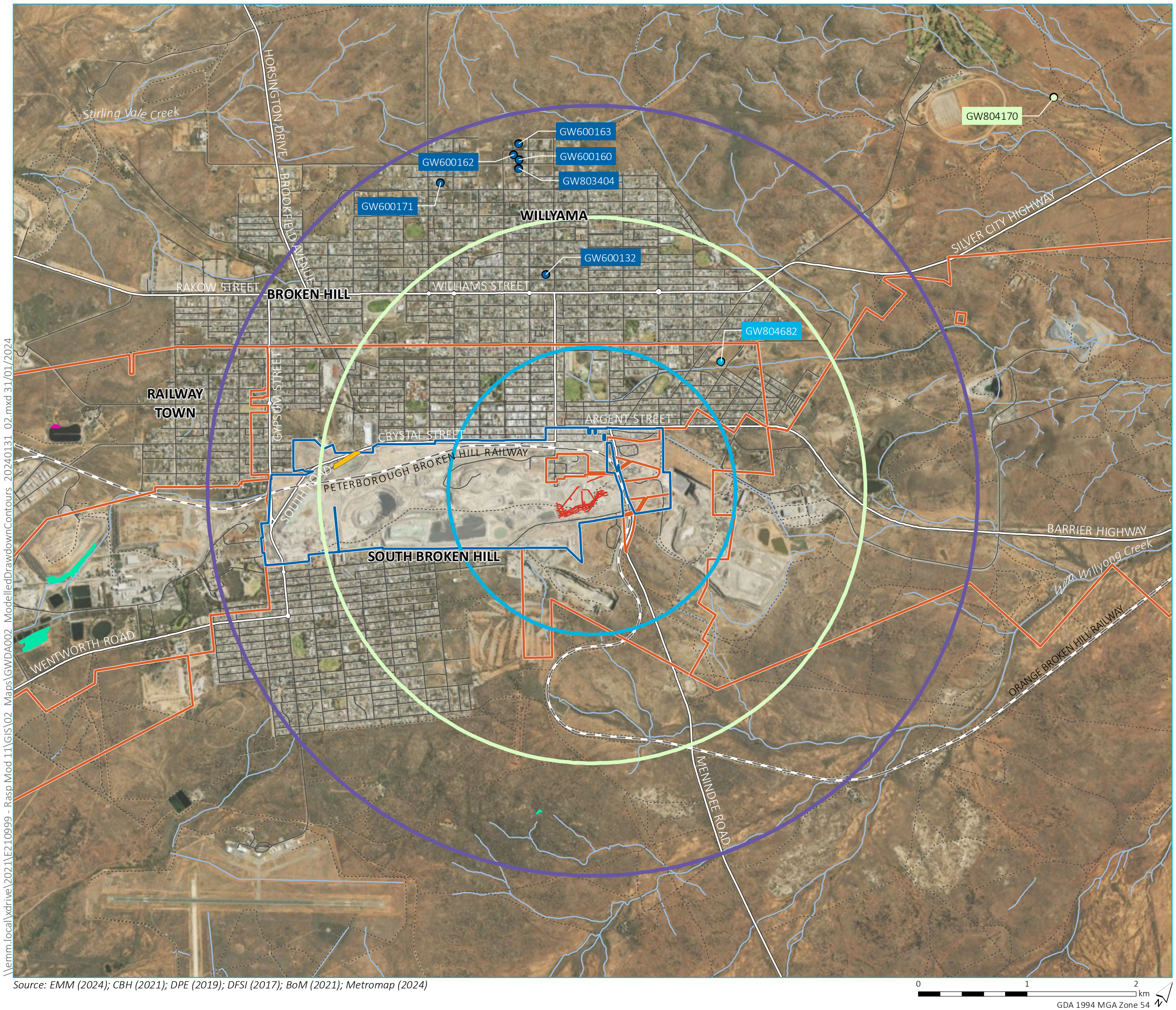
Table 3.2 | Modelled drawdown at potential receptors (end of mining)

Registered bore	Low K drawdown (m)	Medium K drawdown (m)	High K drawdown (m)
GW804682	1.67	2.91	3.61
GW600132	1.23	2.41	3.10
GW600171, GW600162, GW600163, GW600160, GW803404	0.57	1.58	2.23

It is noted that the actual drawdown experienced is likely to be lower than predicted as the modelling undertaken is considered to be conservative for the following reasons:

- Goodman's Equation assumes that the water table will stay at a constant elevation until the end of mining. In reality, the watertable elevation is expected to decrease over time due to inflows to the mine workings and nearby groundwater abstraction. As the water table elevation decreases, the predicted inflow rate would also decrease, leading to less drawdown.

- The regional groundwater level was conservatively assumed based on observations in Thompson's Shaft, which was dry to at least 225 mbgl. It is possible that the actual water table sits below this level and therefore less of the proposed workings would sit within the saturated zone of the aquifer. This would result in less groundwater inflow and therefore less drawdown. If the regional water table elevation is 40 mAHD or below, all of the proposed workings would occur above the watertable and would not impact groundwater.



Source: EMM (2024); CBH (2021); DPE (2019); DFSI (2017); BoM (2021); Metromap (2024)

Modelled drawdown contours (end of mining)

Rasp Mine Modification 11
Groundwater Drawdown Assessment
Figure 3.1

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Yours sincerely

Bill Bull
Senior Environmental Engineer

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References

Department of Primary Industries – Office of Water 2012, NSW aquifer interference policy: NSW Government policy for the licensing and assessment of aquifer interference activities, NSW Government.

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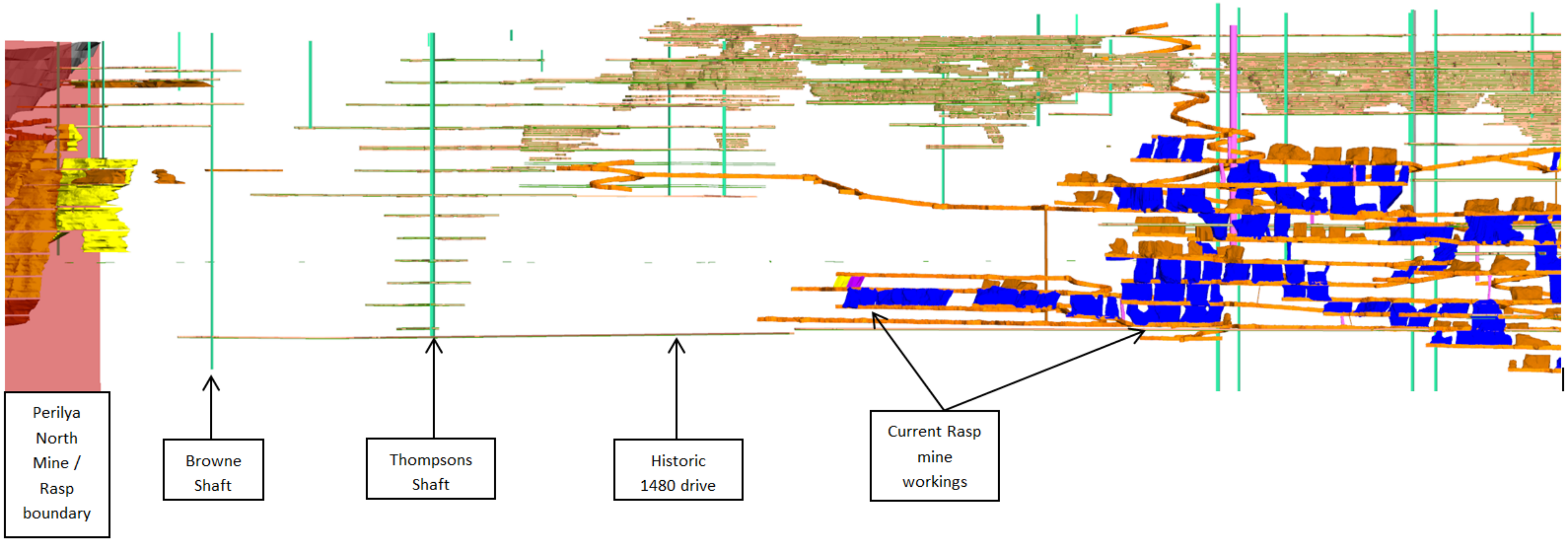
Appendix B – Section view (looking mine west) of the Rasp Mine workings, Thompson's shaft location and Historic 1480 drive.



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Appendix C – Water levels of Rasp Mine and neighboring Perilya North Mine