

Memorandum

Subject	Clarification of Havieron H3 Hydrogeological Assessment								
Date	29/07/2024								
То	Louise Cherrie	From	Jordan Forster						
CC	Jarrad Donald	Daniel Jordan							
Project No	311012-01541								
Project	Telfer-Havieron Project RSD								

Introduction

Worley Consulting (Worley) has been engaged by Newcrest Mining Limited (Newcrest) to clarify hydrogeological aspects of the Havieron Referral Supporting Document – Revision 5 (Talis Consultants, 2024) (RSD).

These clarifications are in response to requests for information (RFIs) by the Environmental Protection Authority of Western Australia (EPA) who reviewed the RSD.

Background

In April 2023 Newcrest sought approval under Part IV of the Environmental Protection Act 1986 (EP Act) for the amendment of the Ministerial Statements for the Telfer Project, to allow the inclusion of the Havieron Project as part of the Telfer Project.

As required, a Referral Supporting Document (RSD) was provided to inform the EPA of investigations and studies conducted by Newcrest to understand the environmental aspects of the project, inform management controls, and enable a reliable environmental impact assessment to be completed.

Consideration of the Project's impacts on groundwater and groundwater dependent ecosystems (GDEs) was based primarily on a H3-level hydrogeological assessment completed in 2021 (Rockwater, 2021).

While a numerical groundwater model was constructed to estimate the extent of dewatering drawdown, the extent of drawdown in the unconfined aquifer and Percival Palaeovalley was not was not presented in the report or discussed in detail.



EPA RFI Item 30

Following review of the April 2024 Revision 5 of the RSD (Talis Consultants, 2024), EPA presented a number of RFIs to Newcrest. RFI item 30 requested:

- 1. Standing water levels in metres below ground level be presented for all bores
- 2. Hydrogeological cross-sections explicitly show groundwater levels in each aquifer in relation to the Percival Palaeovalley
- 3. Clear and diagrammatic integration of hydrogeological data associated with drawdown risk to any vegetation be added.

Havieron bore data and water levels

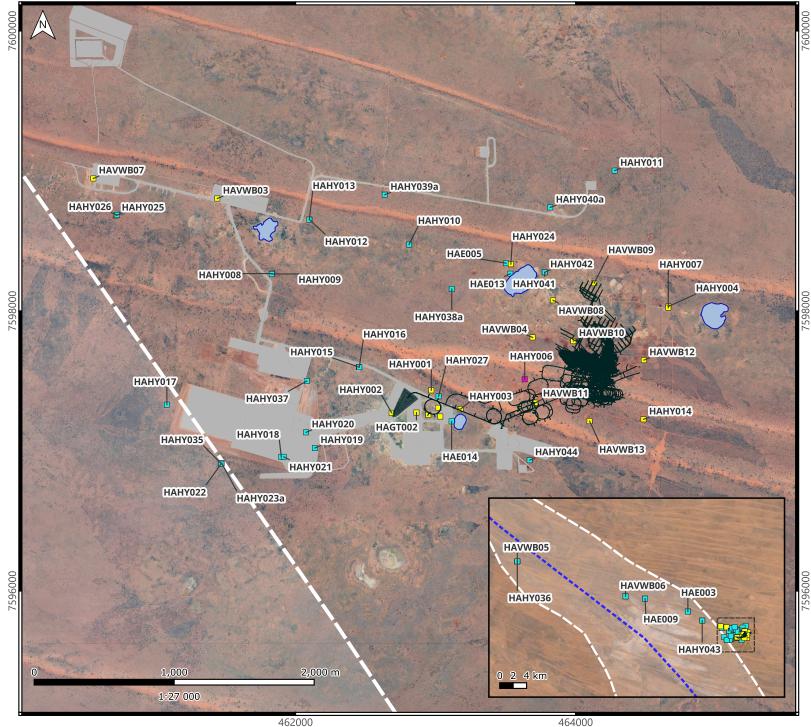
Groundwater elevations and depth-to-water for all monitoring and production bores and summary statistics for minimum, maximum and average depth to water are presented are presented on Table 1 and Table 2.

These levels were measured following bore construction, once water levels had stabilised, and therefore represent the pre-mining water level in each bore.

Bore locations are shown in Figure 1 and construction details are presented in Appendix A.

462000

464000



Havieron Project Bore Location Map Project No. 311012-01541 Figure 1 Client Notes: Project CRS: GDA94 / MGA zone 51 Exported by User: Jordan.Forster Date: 31/07/2024 Weight Consulting Legend Underground Mine Design

- Havieron Surface Infrastructure
- Playa Lakes
- ---- Palaeovalley Thalgweg (van der Graff, 1977)
 - Percival Palaeovalley (Rockwater, 2021)

Bore Locations (screened aquifer)

- Unconfined
- Upper Confined
- Lower Confined

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Table 1 Havieron bore details and first water level measurements

Bore ID	Туре	Screened Aquifer	GDA94 Zone 51		mRL (AHD)	First water le	ement	
			Easting ¹	Northing ¹		Date	Elevation (mAHD)	Depth (mbgl)
HAE003	Monitor	Unconfined	455683.8	7601140	241.54	19/11/2021	239.35	2.19
HAE005	Monitor	Unconfined	463503	7598342	254.59	30/05/2020	246.09	8.50
HAE009	Monitor	Unconfined	449318.7	7603058	245.73	19/11/2021	243.91	1.82
HAE013	Monitor	Unconfined	463533	7598267	255.38	30/05/2020	246.48	8.90
HAE014	Monitor	Unconfined	463114	7597212	253.61	11/03/2021	249.98	3.63
HAGT002	Monitor	Upper Confined	462863	7597275	253.37	11/03/2021	242.19	11.19
HAHY001	Monitor	Upper Confined	462969	7597434	254.5	30/05/2020	241.80	12.70
HAHY002	Monitor	Upper Confined	462686	7597273	253.03	16/01/2021	221.97	31.06
HAHY003	Monitor	Upper Confined	463178	7597300	253.79	30/05/2020	242.89	10.90
HAHY004	Monitor	Upper Confined	464662	7598033	258.18	30/05/2020	248.68	9.50
HAHY006	Production	Lower Confined	463636	7597513	262.3	12/12/2020	233.40	28.91
HAHY007	Production	Upper Confined	464661	7598024	258.26	14/11/2020	212.45	45.82
HAHY008	Monitor	Lower Confined	461831	7598268	250.397	22/06/2021	227.60	22.80
HAHY009	Monitor	Unconfined	461830	7598265	250.407	22/06/2021	242.84	7.57
HAHY010	Monitor	Unconfined	462810	7598475	252.323	23/06/2021	244.96	7.36
HAHY011	Monitor	Unconfined	464278	7599003	257.169	23/06/2021	253.42	3.75
HAHY012	Monitor	Lower Confined	462099	7598653	250.945	15/07/2021	231.24	19.71
HAHY013	Monitor	Unconfined	462098	7598653	250.818	15/07/2021	244.88	5.94
HAHY014	Monitor	Upper Confined	464484	7597227	259.891	1/08/2021	242.32	17.57
HAHY015	Monitor	Lower Confined	462452	7597600	253.393	13/08/2021	239.23	14.16
HAHY016	Monitor	Unconfined	462455	7597599	253.313	13/08/2021	245.74	7.57
HAHY017	Monitor	Unconfined	461081	7597332	244.936	22/08/2021	241.25	3.69
HAHY018	Monitor	Unconfined	461898	7596959	247.533	22/08/2021	241.99	5.54
HAHY019	Monitor	Unconfined	462138	7597022	248.616	22/08/2021	242.81	5.81
HAHY020	Monitor	Unconfined	462075	7597134	248.244	22/08/2021	241.84	6.40
HAHY021	Monitor	Unconfined	461916	7596959	247.478	22/08/2021	241.30	6.18
HAHY022	Monitor	Upper confined	461470	7596911	245.831	17/11/2021	239.87	5.96
HAHY023a	Monitor	Lower Confined	461472	7596914	246.134	14/12/2023	243.06	3.07
HAHY024	Monitor	Upper Confined	463537	7598335	255.015	12/12/2021	244.21	10.81
HAHY025	Monitor	Upper Confined	460720	7598683	247.729	30/09/2021	239.93	7.80
HAHY026	Monitor	Unconfined	460724	7598687	247.731	30/09/2021	243.41	4.32
HAHY035	Monitor	Unconfined	461470	7596910	245.86	17/07/2023	238.40	7.46
HAHY036	Monitor	Unconfined	430295	7608609	260.539	13/12/2021	247.08	13.46
HAHY037	Monitor	Unconfined	462080	7597500	248.476	17/07/2023	237.12	11.36
HAHY038a	Monitor	Unconfined	463115	7598158	254.21	26/11/2023	238.51	15.70
HAHY039a	Monitor	Unconfined	462637	7598831	252.07	26/11/2023	242.96	9.11
HAHY040a	Monitor	Unconfined	463818	7598740	257.537	26/11/2023	248.84	8.70
HAHY041	Monitor	Upper Confined	463779	7598277	256.25	26/11/2023	240.69	15.56
HAHY042	Monitor	Unconfined	463779	7598277	255.26	27/11/2023	248.85	6.41

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Туре	Screened Aquifer	GDA94 Zo	GDA94 Zone 51 mRL (AHD)		First water level measurement			
		Easting ¹	Northing ¹		Date	Elevation (mAHD)	Depth (mbgl)	
Monitor	Unconfined	457819	7599789	243.07	26/11/2023	238.36	4.71	
Biopad Monitor	Unconfined	463671	7596935	254.517	15/12/2023	250.05	4.47	
Monitor	Upper Confined	461441	7598804	249.07	30/05/2020	242.27	6.80	
Production	Unconfined	430295	7608609	260.539	12/12/2020	257.96	2.58	
Production	Unconfined	446404	7603403	241.219	12/12/2020	238.35	2.87	
Production	Upper Confined	460556	7598947	247.777	14/11/2020	241.43	6.35	
Production	Upper Confined	463838	7598077	256.087	11/03/2021	241.54	14.55	
Production	Upper Confined	464132	7598200	256.232	12/12/2020	237.80	18.43	
Production	Upper Confined	463983	7597786	257.088	13/12/2020	237.55	19.54	
Production	Upper Confined	463712	7597346	262.398	13/12/2020	239.29	23.11	
Production	Upper Confined	464487	7597650	258.519	12/12/2020	230.73	27.79	
Production	Upper Confined	464099	7597214	261.268	13/12/2020	235.19	26.08	
Production	Upper Confined	463033	7597247	253.778	25/02/2021	243.08	10.70	
Production	Upper Confined	462948	7597259	253.665	28/02/2021	243.99	9.68	
Production	Upper Confined	463020	7597309	253.838	16/01/2022	194.65	59.19	
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Table notes

mRL: metres above reference level

mAHD: metres above Australian Height Datum

mbgl: metres below ground level

Table 2 Summary statistics for groundwater depths measured at Havieron bores

Aquifer	No. of bores	Groundwater depth / pressure head (mbgl)						
		Minimum depth	Average depth	Maximum depth				
Unconfined	27	1.82	6.52	15.70				
Upper Confined	22	5.96	18.23	59.19				
Lower Confined	6	3.07	21.51	40.40				



Percival Palaeovalley

The Percival Palaeovalley is a large NW-SE valley about four to five kilometres west of the Havieron Project at about 242 m AHD elevation, between Havieron and Telfer. The Havieron project is situated at about 250 m AHD and the topography grades to the west toward the Palaeovalley (Rockwater, 2021) (Figure 2).

The non-glaciogenic Paleovalley is of presumed Cenozoic age. In places, these river valleys have been incised up to 60 metres down to the Permian sediments but are characteristically less than 50 metres deep and narrow (Geoscience Australia, 2015).

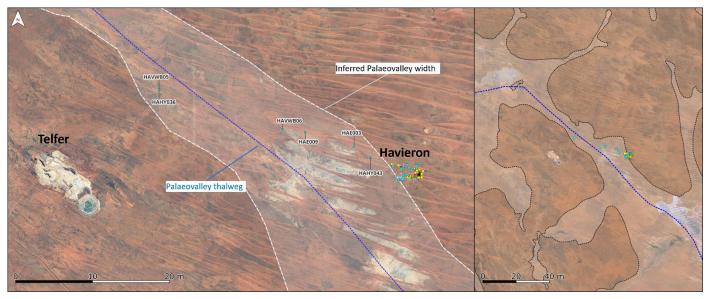


Figure 2 Havieron location plan

Pilbara Palaeovalleys typically comprise calcrete, alluvium and weathered saprolite. Havieron Project bores that intersected the thickest Palaeochannel sedimentary sequence were HAHY036 and HAVWB05, west of the inferred Palaeovalley thalweg, with calcrete and sandstone to 40 and 55 metres respectively (to EOH). Bores east of the Palaeovalley thalweg, nearer to Havieron, intersect less than 6 metres of calcrete and suggest the Palaeochannel is minimal or absent in this area.

To the west of the Havieron project, toward the Percival Palaeovalley, the Upper Williams mudstone (UWM) thins out or is absent and the underlying Upper Confined Aquifer aquifers may be in direct hydraulic connection with overlying Palaeovalley formations (Figure 3).

The potential impact of the Project on the Percival Palaeovalley is therefore contingent on the drawdowns induced in the Unconfined aquifer and Upper Confined Aquifer. Worley consulting

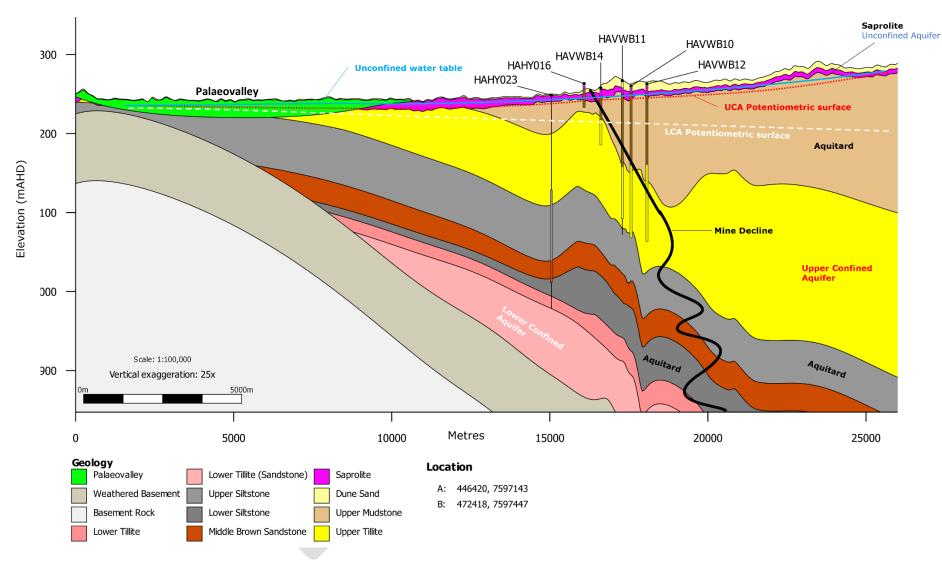


Figure 3 Havieron conceptual hydrogeological diagram and interpolated potentiometric surfaces

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Groundwater levels in each aquifer

Pre-mining groundwater levels in each aquifer were interpolated from bore water level measurements using Surfer[™] and kriging. Figure 3 shows the inferred groundwater surfaces in each aquifer.

In general:

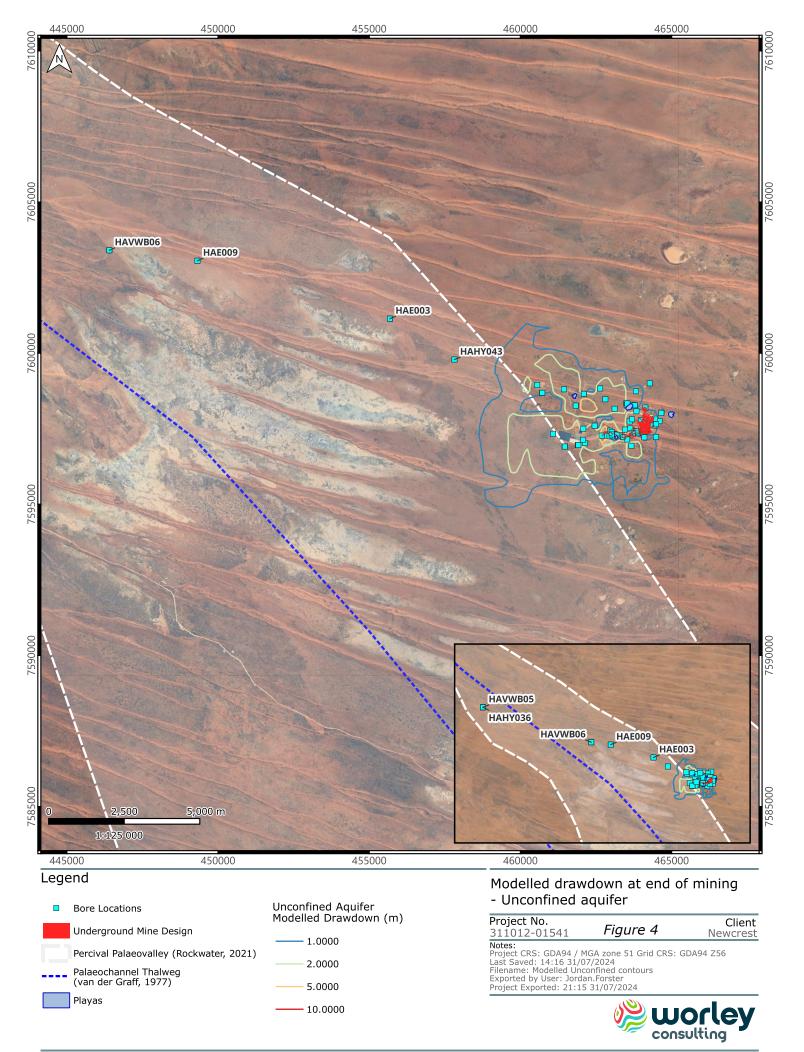
- 1. Depth to water decreases from east to west, consistent with declining surface elevation towards the Percival Palaeovalley.
- 2. In the direct vicinity of the underground mine operation, the water table depth (between dunes) is generally between 8 and 12 m bgl.
- 3. Within the Percival Palaeovalley, depth to water is inferred to be shallower than 4 m below ground level.

Aquifer drawdown

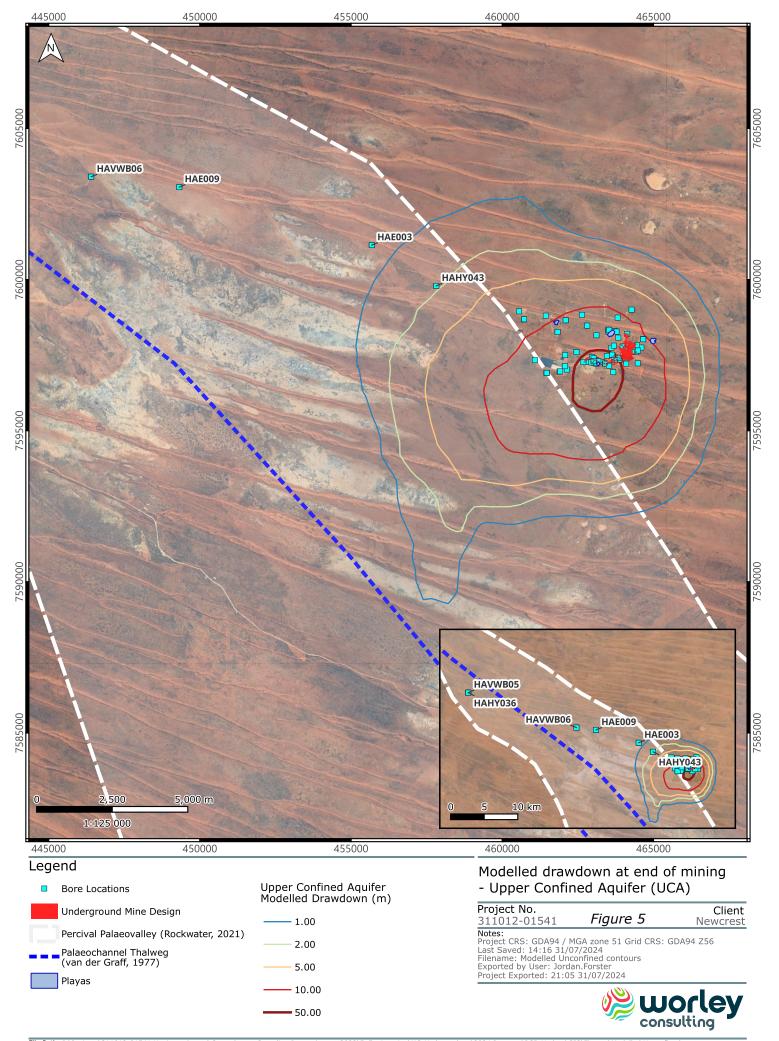
The Groundwater Vistas numerical model developed for the H3-level assessment (Rockwater, 2021) was re-run and drawdown contours extracted for the unconfined and upper confined aquifers for the end of mine life (13 years operation).

The predicted drawdowns for the Unconfined Aquifer and Upper Confined Aquifer are shown in Figure 4 and Figure 5.

Monitoring since 2019 suggests natural seasonal groundwater levels in the unconfined and upper confined aquifers vary by approximately one (1) metre.



File Path: I:\Projects\311012-01541 Havieron Annual Groundwater Sampling June - August 2022\5_Engineering\HG-Hydrogeology\2024 Program\RSD Update\GIS\Figures\Modelled Unconfined contours.qgz © Worley Pty Ltd While every care is taken to ensure the accuracy of this data, Worley makes no representations or warranties aboutits accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.



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Conclusions

Drilling results imply the Percival Palaeovalley sedimentary sequence is thickest west of the inferred Palaeovalley thalweg and minimal or absent to the east near Havieron. The results also show the Upper Williams mudstone (UWM) thins out or is absent and the underlying Upper Confined Aquifer aquifers may be in direct hydraulic connection with overlying Palaeovalley formations.

The potential impact of the Project on the Percival Palaeovalley is therefore contingent on drawdowns induced in the Unconfined aquifer and Upper Confined Aquifer.

The numerical model predicted life of mine (13 year) drawdowns for the Unconfined Aquifer and Upper Confined Aquifer show 1 metre of drawdown on the eastern margin of the Percival Palaeovalley but drawdowns do not extend to the inferred thalweg or the thickest known Palaeovalley sedimentary sequence.



Ongoing groundwater monitoring

While this memorandum has focused on clarifying aspects of the 2021 H3 Hydrogeological assessment, routine groundwater monitoring has been actively occurring at Havieron in accordance with the Havieron Water Management Plan (Advisian, 2024) and Groundwater License Operating Strategy (GLOS) since the approval of the mine license in 2021. Components of the current routine monitoring program are presented below in Table 3.

In October each year an Annual Aquifer Review document is submitted to DWER, which summarizes the results of groundwater monitoring completed over the preceding 12 months (from August to July) and provides interpretation of potential groundwater trends and emerging risks.

Monitoring	Existing or Potential	Parameter	WMP: Scheduled Frequency
Location	Receptor		
Operation	Stygofauna habitat	Water Levels	Monthly – Manual
Unconfined			Quarterly – Data logger downloads
		Field Water Quality (Temp, pH, TDS, EC)	Monthly
		Lab Water Quality (Speciation)	Quarterly
General	Stygofauna habitat	Water Levels	Monthly – Manual
Unconfined			Quarterly – Data logger downloads
		Field Water Quality (Temp, pH, TDS, EC)	Monthly
		Lab Water Quality (Speciation)	Quarterly
Service corridor	Stygofauna habitat	Water Levels	Monthly – Manual
Unconfined	Percival Palaeovalley		Quarterly – Data logger downloads
	Off-tenure groundwater	Field Water Quality (Temp, pH, TDS, EC)	Quarterly
	resources	Lab Water Quality (Speciation)	Bi-annually
Upper Confined	Stygofauna habitat (low	Water Levels	Monthly – Manual
Aquifer	risk)		Quarterly – Data logger downloads
	Percival Palaeovalley	Field Water Quality (Temp, pH, TDS, EC)	Bi-annually
	(low risk)	Lab Water Quality (Speciation)	Annually
Lower Confined	Nil	Water Levels	Monthly – Manual
Aquifer			Quarterly – Data logger downloads
		Field Water Quality (Temp, pH, TDS, EC)	Bi-annually
		Lab Water Quality (Speciation)	Annually
Production Bores	Stygofauna habitat	Extraction (via flow meter)	Monthly
	Percival Palaeovalley	Water Levels	Monthly – Manual
	(Service Corridor bores		Quarterly – Data logger downloads
	only)	Field (Temp, pH, TDS, eC)	Quarterly
		Lab Water Quality (Speciation)	Annually
Proterozoic	Nil	Water Pressures	Quarterly
(VWP Bores)			

Table 3 Havieron groundwater monitoring program



References

- Advisian. (2024). *Havieron Water Management Plan, Revision 4.* Prepared for Newcrest Mining Ltd.
- Geoscience Australia. (2015). *Paterson Province Investigation for the Palaeovalley Groundwater Project.* Canberra: Geoscience Australia.
- Rockwater. (2021). *H3-Level Hydrogeological Assessment of the Havieron Project.* Prepared for Newcrest Australia. Appendix K of the Referral Supporting Document.
- Talis Consultants. (2024). Section 38 Environmental Protection Act 1986, Referral Supporting Document Rev 5, Inclusive of Ministerial Statements 605, 606 and 650, Significant Amendment. Prepared for Newcrest Mining Limited.



Appendix A. Bore construction details



Figure A1 Summary of Havieron bore construction details

Bore ID	Completion date	Туре	Aquifer	Monitoring Location	Easting ¹	Northing ¹	Elevation (m AHD)	Drill depth (m BGL)	Casing depth (m BGL)	Slotted interval or VWP sensor depth (m BGL)
HAE003	Unknown	Monitor	Unconfined	Service corridor	455683.8	7601140	241.54	18	-	-
HAE005	Unknown	Monitor	Unconfined	General	463503	7598342	254.59	18	-	-
HAE009	Unknown	Monitor	Unconfined	Service corridor	449318.7	7603058	245.73	18	-	-
HAE013	11/04/2020	Monitor	Unconfined	General	463533	7598267	255.38	17.55	0-3.55	3.55-17.55
HAE014	10/04/2020	Monitor	Unconfined	General	463114	7597212	253.61	15.58	0-3.58	3.58-15.58
HAGT002	13/04/2020	Geotech / Monitor	Upper Confined	Mining and Infrastructure Area	462863	7597275	253.37	50	0-13.92	13.92-49.92
HAHY001	9/04/2020	Monitor	Upper Confined	Mining and Infrastructure Area	462969	7597434	254.5	60.4	0-14.4	14.4-60.4
HAHY002	11/04/2020	Monitor	Upper Confined	Mining and Infrastructure Area	462686	7597273	253.03	50	0-13.16	13.16-49.16
HAHY003	9/04/2020	Monitor	Upper Confined	Mining and Infrastructure Area	463178	7597300	253.79	120	0-12.8	12.8 - 100.8
HAHY004	27/04/2020	Monitor	Upper Confined	Central corridor	464662	7598033	258.18	180	0.7-89	89-167
НАНҮОО6	23/05/2020	Production	Lower Confined	Production bore - Southern corridor	463636	7597513	262.3	405.1	0 - 318.4	312.9 - 402.9
HAHY007	6/05/2020	Production	Upper Confined	Production bore - Central corridor	464661	7598024	258.26	167.6	0-88.4	82.1 - 166.1
НАНУОО8	19/06/2021	Monitor	Lower Confined	Central corridor	461831	7598268	250.397	253.4	0-228	228-240
НАНҮОО9	20/06/2021	Monitor	Unconfined	General	461830	7598265	250.407	24	0-9	9-21
HAHY010	20/06/2021	Monitor	Unconfined	General	462810	7598475	252.323	30.1	0 - 24.1	24.1 - 30.1
HAHY011	Jul-21	Monitor	Unconfined	General	464278	7599003	257.169	24.5	0-7	7-19
HAHY012	14/07/2021	Monitor	Lower Confined	Central corridor	462099	7598653	250.945	253.4	0-188	188-200
HAHY013	15/07/2021	Monitor	Unconfined	General	462098	7598653	250.818	18.5	0-6.5	6.5-18.5
HAHY014	25/07/2021	Monitor	Upper Confined	Southern corridor	464484	7597227	259.891	181.4	0-140 and 152-176	140-152
HAHY015	13/08/2021	Monitor	Lower Confined	Mining and Infrastructure Area	462452	7597600	253.393	313.4	0-301	301-313
HAHY016	14/08/2021	Monitor	Unconfined	General	462455	7597599	253.313	30	0-18	18-30
HAHY017	15/08/2021	Monitor	Unconfined	Operation	461081	7597332	244.936	28	0 - 16	16 - 28
HAHY018	17/08/2021	Monitor	Unconfined	Evaporation Pond	461898	7596959	247.533	30	0 - 18	18 - 30
HAHY019	20/08/2021	Monitor	Unconfined	Evaporation Pond	462138	7597022	248.616	30	0 - 18	18 - 30
HAHY020	17/08/2021	Monitor	Unconfined	Evaporation Pond	462075	7597134	248.244	30	0 - 18	18 - 30
HAHY021	16/08/2021	Monitor	Unconfined	Evaporation Pond	461916	7596959	247.478	30	0 - 18	18 - 30
HAHY022	30/08/2021	Monitor	Upper confined	Evaporation Pond	461470	7596911	245.831	105	0 - 64	74 - 86
HAHY023a	15/01/2022	Monitor	Lower Confined	Evaporation Pond	461472	7596914	246.134	270	0-251	251-263
HAHY024	5/12/2021	Monitor	Upper Confined	Mining and Infrastructure Area	463537	7598335	255.015	84	0-60	60-72
HAHY025	9/09/2021	Monitor	Upper Confined	Camp	460720	7598683	247.729	141	0 - 124	124 - 136
HAHY026	9/09/2021	Monitor	Unconfined	General	460724	7598687	247.731	30	0 - 18	18 - 30
HAHY035	6/07/2023	Monitor	Unconfined	Evaporation Pond	461470	7596910	245.86	30	0-10	10-28
HAHY036	24/11/2021	Monitor	Unconfined	Service corridor	430295	7608609	260.539	40	0-12	12-30
HAHY037	8/07/2023	Monitor	Unconfined	Evaporation Pond	462080	7597500	248.476	30	0-10	10-28
HAHY038a	5/08/2023	Monitor / stygo	Unconfined	Central Corridor	463115	7598158	254.21	26	0-7	7-25
HAHY039a	6/08/2023	Monitor / stygo	Unconfined	North of Central Corridor	462637	7598831	252.07	27	0-8	8-20
HAHY040a	3/08/2023	Monitor / stygo	Unconfined	North of Central Corridor	463818	7598740	257.537	22	0-7	7-19
HAHY041	15/07/2023	Monitor / stygo	Upper Confined	Central Corridor	463779	7598277	256.25	53	0-32	32-50



Bore ID	Completion date	Туре	Aquifer	Monitoring Location	Easting ¹	Northing ¹	Elevation (m AHD)	Drill depth (m BGL)	Casing depth (m BGL)	Slotted interval or VWP sensor depth (m BGL)
HAHY042	15/07/2023	Monitor / stygo	Unconfined	Central Corridor	463779	7598277	255.26	26	0-7	7-25
НАНҮ043	7/08/2023	Monitor / stygo	Unconfined	Service Corridor	457819	7599789	243.07	24	0-4	4-22
HAHY044	1/08/2023	Biopad Monitor	Unconfined	Bioremediation Pad (Mining and Infrastructure Area)	463671	7596935	254.517	20	0-6	6-18
HAVWB03	21/09/2019	Monitor	Upper Confined	General	461441	7598804	249.07	100	0-46	46-100
HAVWB04	29/09/2019	Production	Upper Confined	Production bore - Central corridor	463692	7597812	257.19	100	0-38	38-86
HAVWB05	12/12/2020	Production / monitoring	Unconfined	Service corridor	430295	7608609	260.539	31.1	0-13 and 25-30	13-25
HAVWB06	10/12/2020	Production / monitoring	Unconfined	Service corridor	446404	7603403	241.219	25.1	0-12.4	12.4-24.4
HAVWB07	3/11/2020	Production / monitoring	Upper Confined	Production bore - Camp	460556	7598947	247.7775	97.5	0-20.8 and 81.9- 93.9	21.9-93.9
HAVWB08	15/11/2020	Production / monitoring	Upper Confined	Central corridor	463838	7598077	256.087	91.5	0-29.5	29.5-89.5
HAVWB09	2/12/2020	Production / monitoring	Upper Confined	Central corridor	464132	7598200	256.232	195	0-93.37	93.37-183.37
HAVWB10	6/12/2020	Production / monitoring	Upper Confined	Central corridor	463983	7597786	257.088	195	0-88.5	88.5-166.5
HAVWB11	21/11/2020	Production / monitoring	Upper Confined	Southern corridor	463712	7597346	262.398	175	0-103	103-169.3
HAVWB12	30/11/2020	Production / monitoring	Upper Confined	Central corridor	464487	7597650	258.519	199.3	0-99.3	99.3-183.3
HAVWB13	25/11/2020	Production / monitoring	Upper Confined	Central corridor	464099	7597214	261.268	195.2	0-80.9	80.9-170.9
HAVWB14	24/02/2021	Production / monitoring	Upper Confined	Mining and Infrastructure Area	463033	7597247	253.778	72	0-11	11-70
HAVWB15	27/02/2021	Production / monitoring	Upper Confined	Mining and Infrastructure Area	462948	7597259	253.665	70	0-8	8-68
HAVWB16	29/11/2021	Production / monitoring	Upper Confined	Production bore - Mining and Infrastructure Area	463020	7597309	253.838	103	0-60	60-96