



Australasian Groundwater and
Environmental Consultants Pty Ltd



Report on

Cadia MOD13 Cadia Hill Tailing Completion Groundwater Assessment

Prepared for
Cadia Holdings Pty Limited

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Cadia MOD13, Cadia Hill Tailings Completion – Groundwater Assessment

1 Introduction and scope of work

The Cadia Valley Operations (CVO) are located approximately 25 kilometres (km) south-west of Orange, in the Central Tablelands of New South Wales (NSW), and comprises one open cut (Cadia Hill), and two underground mines (Ridgeway and Cadia East). Cadia Holdings Pty Limited (CHPL) owns and operates the CVO and is a wholly owned subsidiary of Newcrest Mining Limited (Newcrest).

Prior to March 2011, CHPL deposited tailings from the ore processing facilities in the Northern Tailings Storage Facility (NTSF) and the Southern Tailings Storage Facility (STSF). Following a limited breakthrough of tailings material from the NTSF embankment into the STSF on 9 March 2018, CHPL re-evaluated the long-term tailings storage options.

CHPL subsequently gained approval to deposit tailings within the completed Cadia Hill open pit, through two modifications. These approvals were “Cadia Hill Tailings Modification - Statement of Environmental Effects” (Modification 11) (CHPL, 2018a) on 20 April 2018 and “Cadia Hill Tailings Continuation Modification - Statement of Environmental Effects” (Modification 12 [MOD12]) (CHPL, 2018b) on 4 September 2018. The Cadia Modification 11 approved a tailings level up to 420 metres Australian Height Datum (mAHD), and the Cadia Modification 12 to 560 m (AHD).

CHPL plans to seek a further approval to increase the tailings emplacement within Cadia Hill open pit beyond the MOD12 level of 560 mAHD (consolidated) to a final emplacement level of approximately 713 mAHD (pre-consolidation). This will facilitate approval to fill the pit with tailings to near its maximum capacity. On this basis, CHPL proposes a further modification to PA 06_0295 under Section 4.55 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) to increase the tailings level to its full capacity, at a pre-consolidation level of approximately 713 mAHD.

The main activities associated with the Cadia Hill Tailings Completion Modification (Modification 13), include:

- increasing the tailings level from 560 mAHD (consolidated tailings level) to 713 mAHD (pre-consolidation tailings level);
- an additional 177 million tonnes (Mt) of capacity, equivalent to approximately seven years of additional deposition to this storage facility;
- decommissioning and closure of the existing ventilation adit VR101, located in the Cadia Hill open pit, which would be inundated by tailings;
- installation of a new ventilation adit within the currently approved disturbance footprint (outside of the Cadia Hill open pit);
- construction of additional buttressing for the STSF embankment; and
- a pit lake (i.e. a “wet cover”) as the final landform of the Cadia Hill open pit, consistent with the approved final landform.

Additionally, to reduce the potential impact of the south-west section of the Cadia Hill open pit forming a temporary ‘source’ during operations, CHPL would:

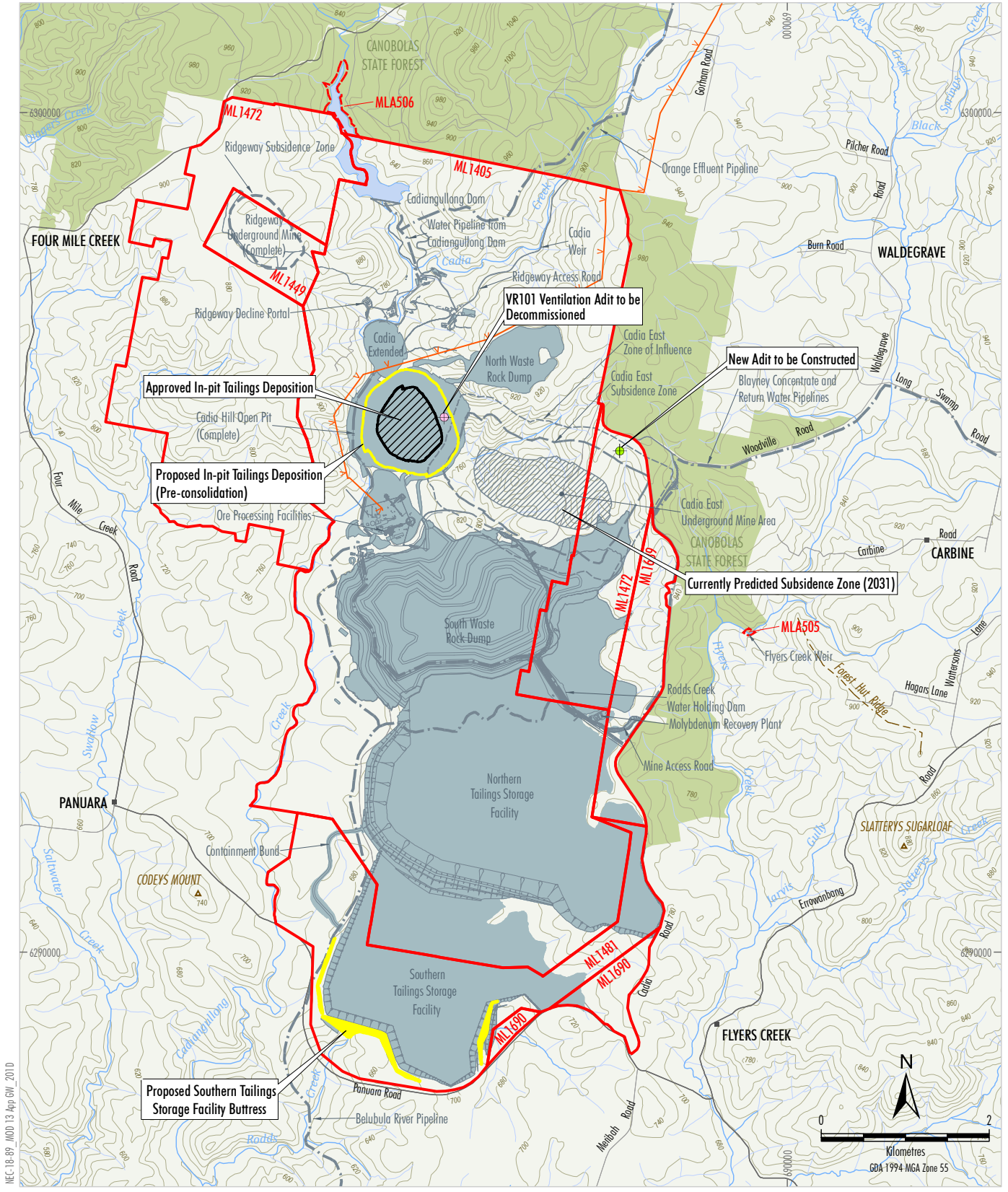
- conduct trials to assist in determining and testing the optimal treatment strategy prior to inundation of tailings;
- locate faults and cracks in the south-west corner of the Cadia Hill pit, between 694 mAHD and 713 mAHD, and treat these using, for example, a grout/polyurethane sealant (injected under pressure into fractured networks); and
- implement contingency measures should unforeseen impacts occur (e.g. cease pumping of tailings and supernatant into the pit and commence pumping out of the pit).

In addition, additional groundwater monitoring bores would be installed in the south-west corner of the Cadia Hill open pit (outside of the pit shell) and along Cadiangullong Creek to measure groundwater levels and water quality.

The approved closure strategy for Cadia Hill is to maintain a final pit void lake that is a sink to the surrounding recovered groundwater regime. The proposed Cadia Hill Tailings Completion Modification (the Modification) would not involve any change to the approved Cadia Valley Operations, except with respect to the Cadia Hill tailings deposition level.

Figure 1.1 shows the locations of Cadia Hill open pit and the footprint of the proposed tailings emplacement. Figure 1.2 includes a long section through Cadia Hill open pit and Cadia East. Previous subsidence assessments have shown the Cadia East subsidence merging with the Cadia Hill open pit. Revised subsidence assessments now show this will not occur, with Cadia Hill and Cadia East being two separate voids. It also illustrates the relationship of the tailings emplacement with the Cadia East underground mine and the surrounding environmental features including Cadiangullong Creek.

CHPL engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to assess the impacts of the additional tailings emplacement within Cadia Hill open pit on the groundwater regime. This report reviews the groundwater systems in the area of the Cadia Hill open pit and discusses the potential groundwater-related impacts of the proposed tailings emplacement. The impacts are also compared with the Minimal Impact Considerations of the *NSW Aquifer Interference Policy (AIP)* (NSW Office of Water [NOW], 2012) for completeness.



MEC18-89 MOD 13 Apr 6W 2010

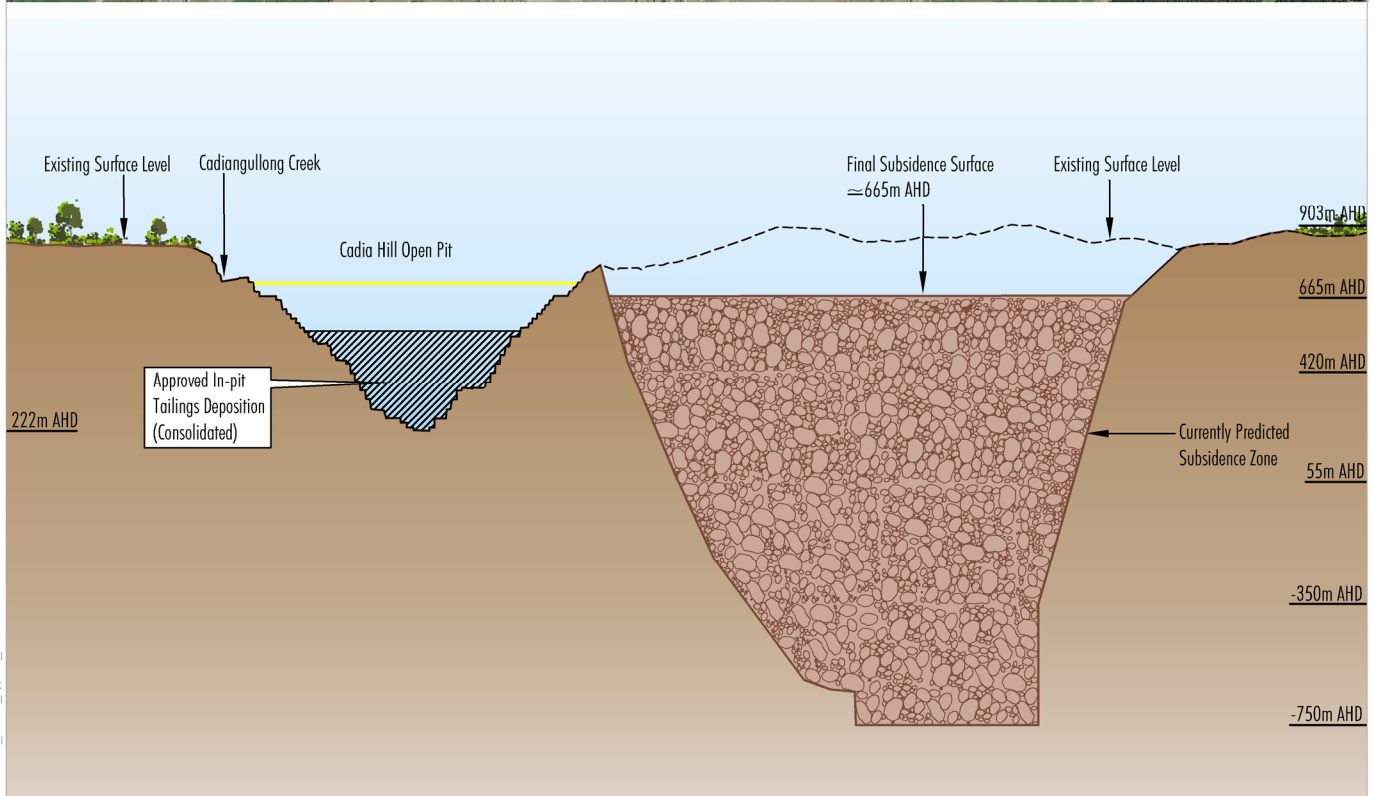
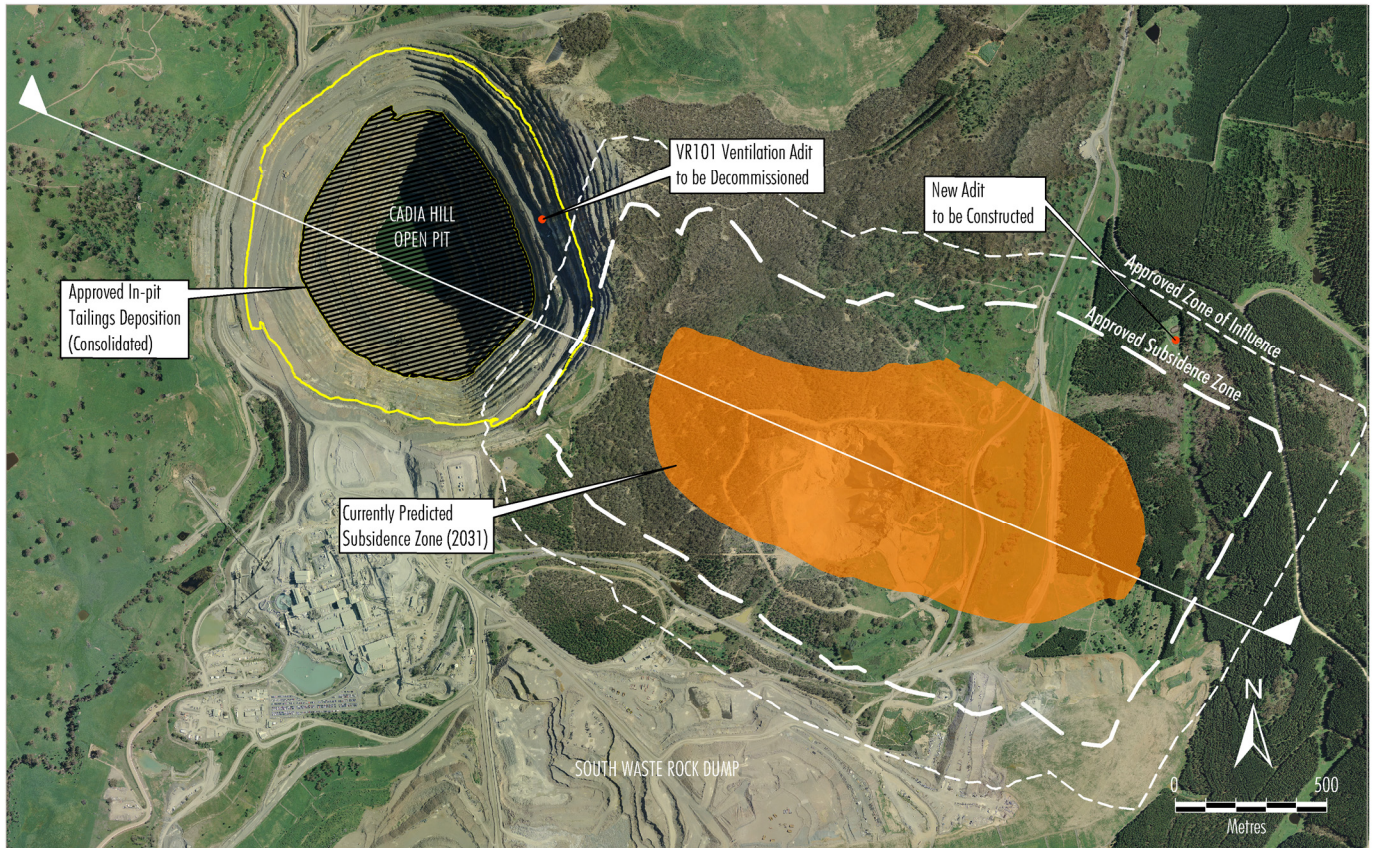
- LEGEND**
- Mining Lease Boundary
 - Mining Lease Application Boundary
 - State Forest
 - Powerline
 - Existing/Approved Mine Infrastructure and Landforms
 - Modification Component

Source: Land and Property Information (2017);
 NSW Planning & Environment Resource & Energy (2017)
 CHPL (2018)



CADIA VALLEY OPERATIONS
 Modification Location

Figure 1.1



IPEC-18-89_W0013_App 6W_101A

LEGEND
 Proposed Modification In-pit Tailings Deposition (Pre-consolidated)

Source: CHPL (2008; 2018); After AGE (2018)



CADIA VALLEY OPERATIONS
 Conceptual Long Section of the
 Cadia Hill Open Pit and the Cadia East
 Subsidence Zone

Figure 1.2

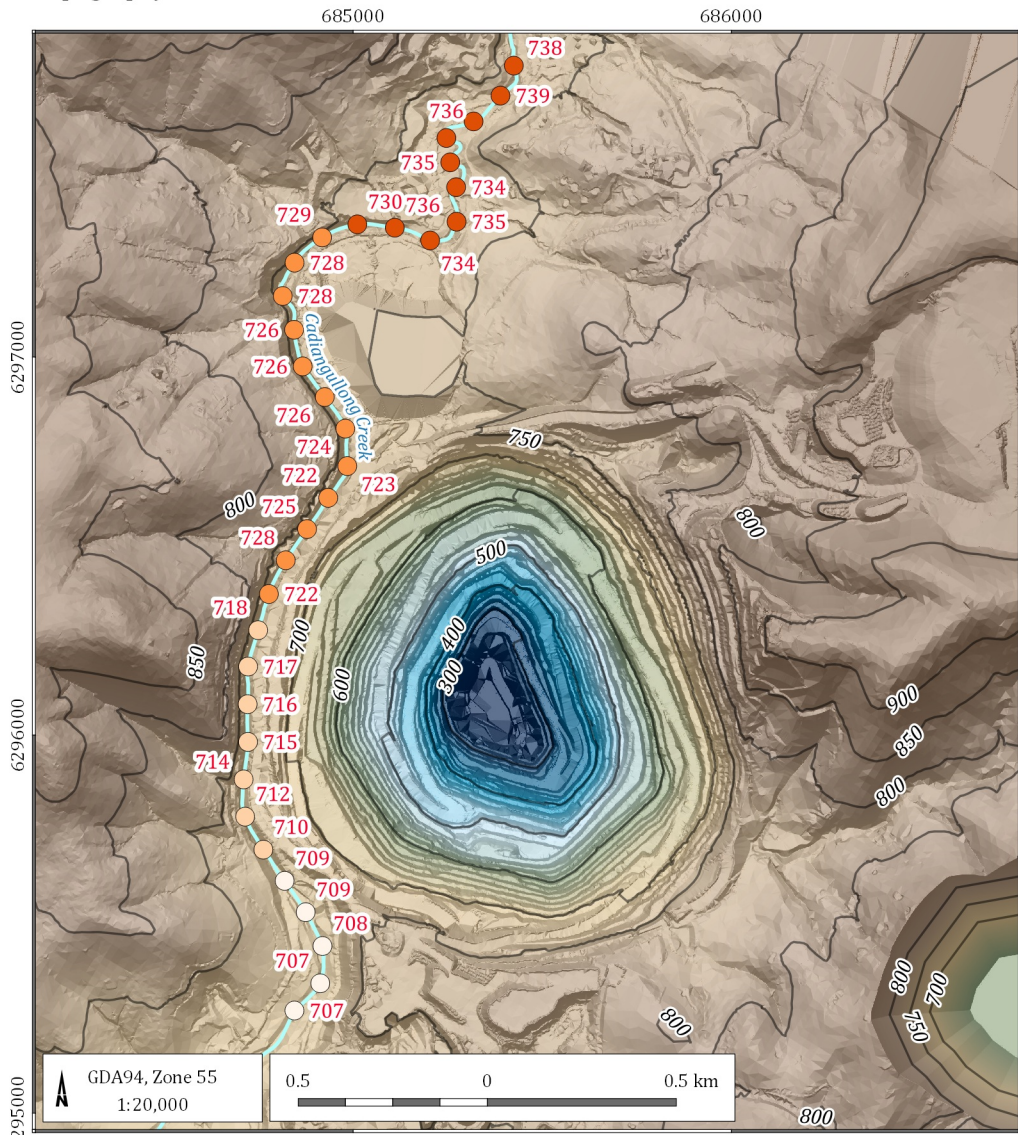
2 Setting

2.1 Surface water and catchments

The terrain surrounding Cadia Hill comprises a number of discrete catchments that drain either into the pit or into the Cadiangullong Creek Diversion. The catchment boundaries were determined for LIDAR terrain datasets and are shown in Figure 2.1. The elevation of the Cadia Hill Pit crest is 721 mAHD (AGE, 2018). The surface topography defining the surrounding catchments extends upwards from the pit crest to heights in-excess of 850 mAHD east and west of the pit, and 800 mAHD north of the pit. Also evident in this figure is the subsidence zone above Cadia East, which will change over time as the mine footprint expands.

Cadiangullong Creek drains from north to south around the western side of the Cadia Hill Pit via a diversion adjacent to the western crest. The elevation of the Cadiangullong Creek Diversion invert ranges from 741 mAHD at the northern side of the pit, to 707 mAHD at its southern side, as shown in Figure 2.1. Flow is maintained in Cadiangullong Creek by releases from the upstream Cadiangullong Dam as required by Project Approval 06_2095.

Topography

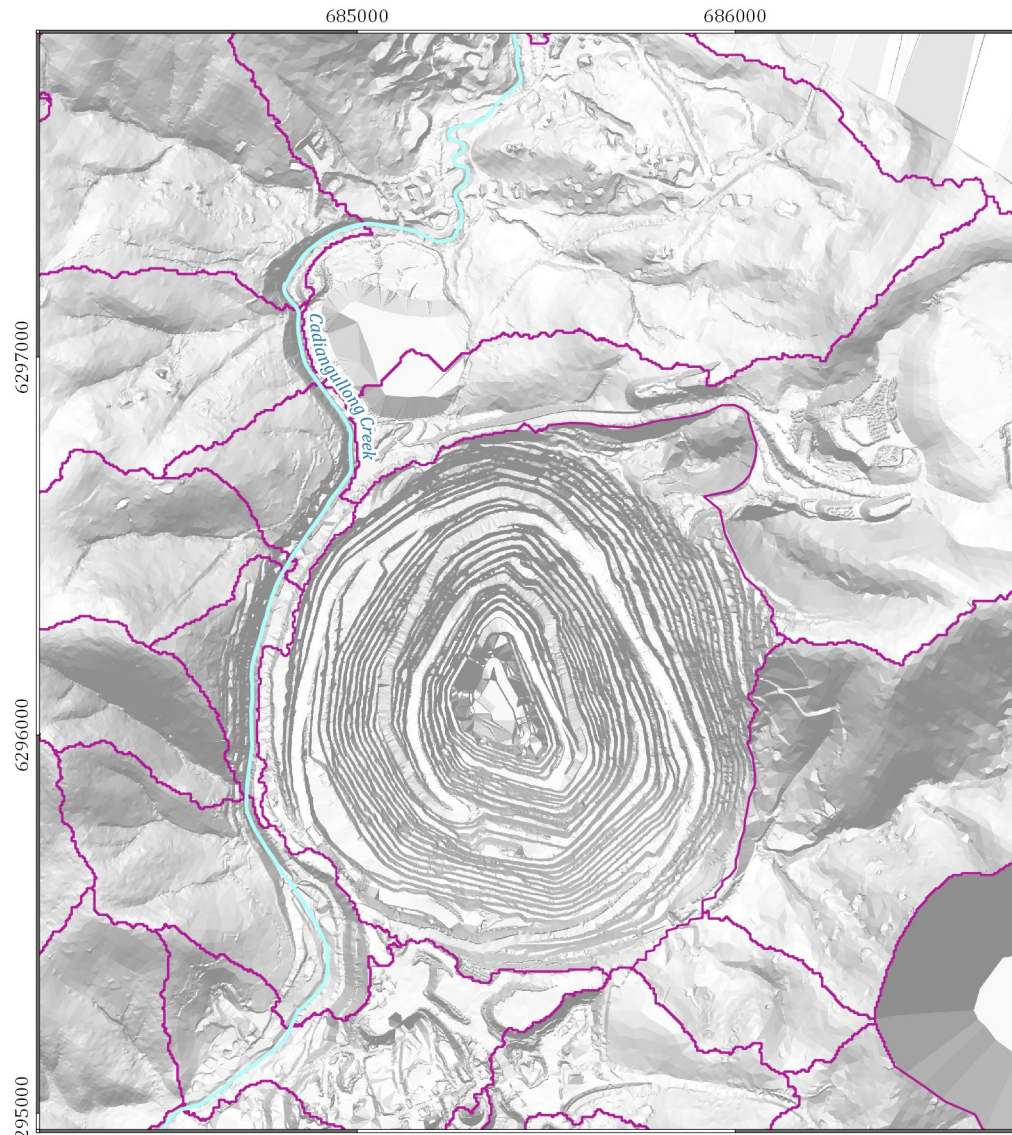


LEGEND

	Creek		Elevation contour
	Catchment		

Topography (mAHD)		Cadiangullong Creek invert level (mAHD)	
	200		700 - 710
	300		710 - 720
	400		720 - 730
	500		730 - 740
	600		740 - 750
	700		
	800		
	900		

Catchment



Cadia MOD13 Cadia Hill tailings (G1383R)



Cadia Hill Pit topography and catchment map

DATE
12/02/2019

FIGURE No:
2.1

2.2 Geology

The CVO and surrounding region comprise three main geological units. The oldest is a basement complex of Ordovician volcanoclastic rocks, overlain by Silurian sandstone, siltstone and limestone sedimentary sequences. An extensive cover of Tertiary basalt flows overlies the Silurian sediments to the north and east of CVO.

Cadia Hill open pit operated between 2002 and 2012 extracting mineralised gold-copper porphyry deposits from the Ordovician bedrock down to a level of approximately 220 mAHD, which is approximately 500 m below the pit crest at 721 mAHD. A small area of Silurian sediments was exposed in the north-east wall of Cadia Hill open pit and comprises alternating units of sandstone and siltstone. The limestone unit that can form an aquifer at the base of the Silurian sequence was not encountered at Cadia Hill. Likewise, Tertiary basalt flows were also not encountered within the pit shell.

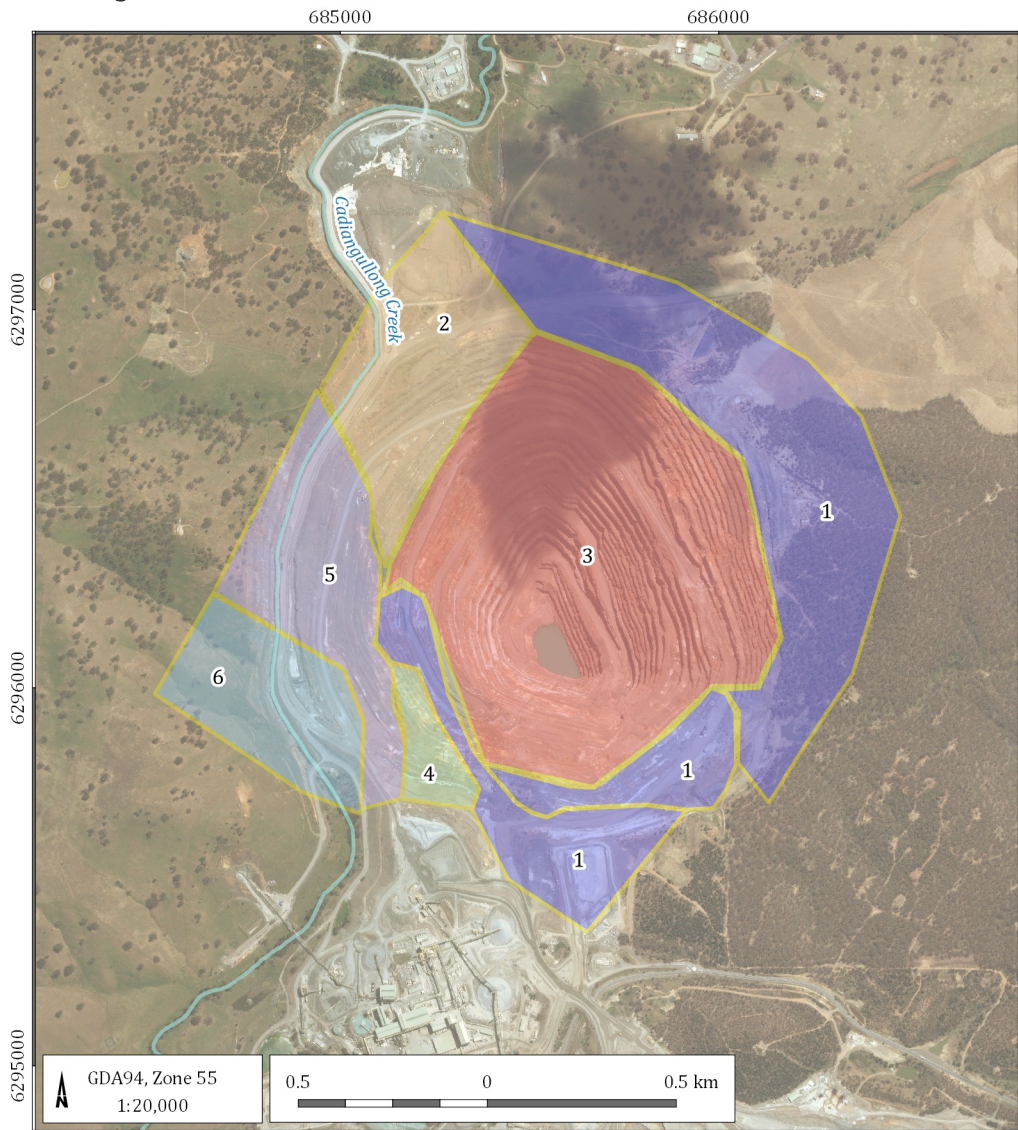
During mining, CHPL classified the Cadia Hill pit into a number of domains based on geotechnical characteristics (Newcrest 2006). There were six lithological domains with the orebody predominantly hosted in monzonite. The other lithologies include volcanics, diorite, and sedimentary units. Figure 2.2 shows the lithological domains occurring within the walls of the Cadia Hill Pit.

Structurally, these lithologies are located with two main westerly dipping thrust faults, the Cadiangullong Fault along the western side of the pit and the Gibbs Fault to the east of the pit. A series of smaller, pit scale thrust faults occur between these two main faults that also dip generally towards the west.

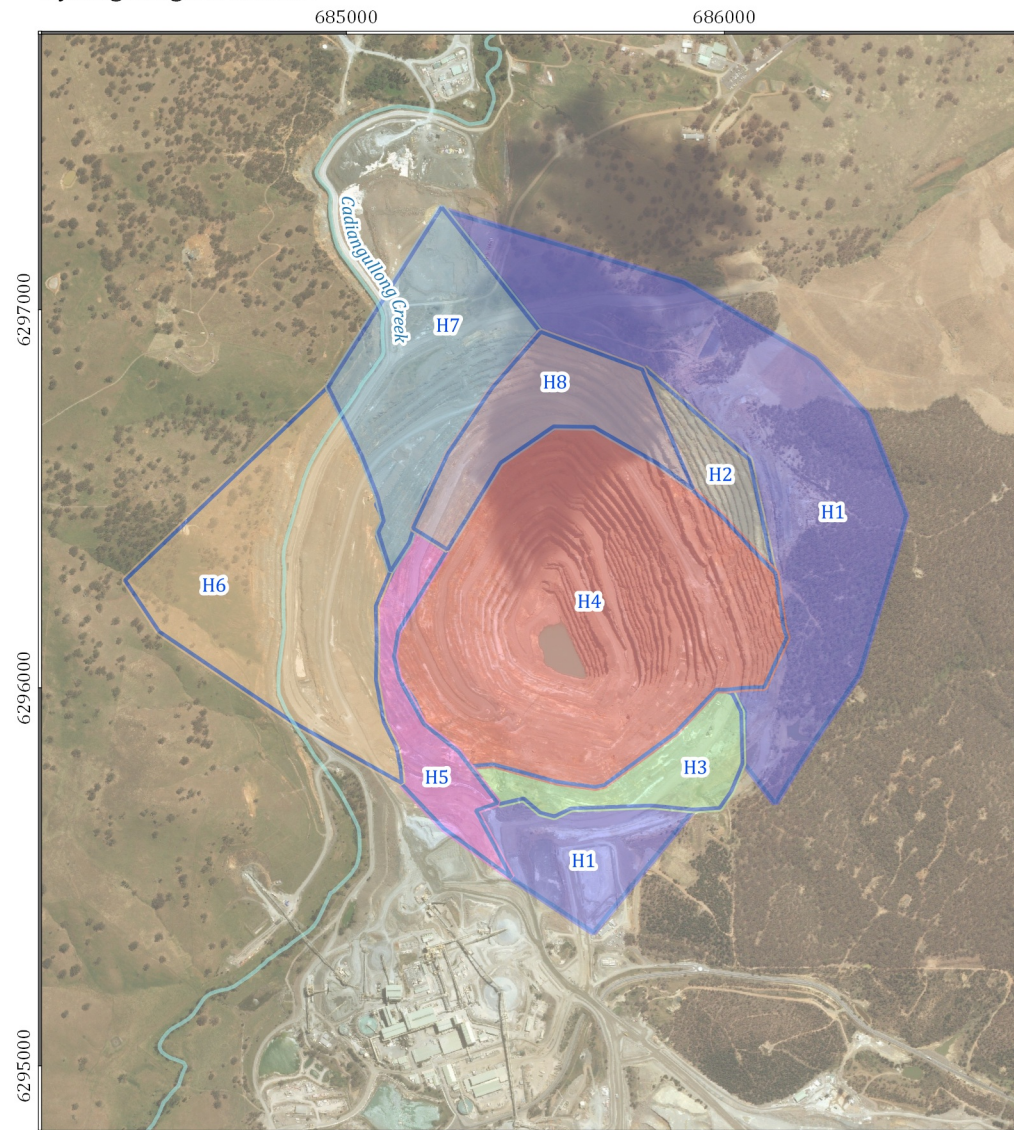
For mining purposes, CHPL also created eight hydrogeological domains (H1 to H8) within the Cadia Hill pit shell based on lithology, structures, rock mass properties and depressurisation responses. The hydrogeological domains as described by Newcrest (2015) are reproduced below and shown in Figure 2.2:

- Domain H1 - characterised as being highly fractured and jointed and therefore very permeable. Groundwater levels rise and fall rapidly in response to rainfall and when dry conditions occur. The upper weathered zone is primarily sediments.
- Domain H2 - comprises primarily fresh volcanics between the Fishtail Fault and the hanging wall side of the Black Betty Fault. The rock mass is generally tight (unfractured) and of low permeability.
- Domain H3 - comprises moderately to highly weathered and fractured volcanics that are typically depressurised with groundwater levels likely to be in excess 50 m from the slope face.
- Domain H4 - comprises monzonite that has very low permeability and low storage potential, with groundwater movement structurally controlled along particular flow paths.
- Domain H5 - located between the hanging wall of Foy's thrust zone and the Cadiangullong Fault. The rock mass is highly jointed, particularly around the thrust zones. Whilst the orientation of the thrusts intersecting the pit slope at an oblique angle provides for good slope depressurisation, the area does show some response to rainfall.
- Domain H6 - located on the hanging wall of both the Purple and Cadiangullong Faults. The domain comprises a generally solid rock mass with the groundwater being structurally controlled.
- Domain H7 - located on the footwall of Purple Fault and hanging wall of Cadiangullong Fault. The rock mass is typically fractured but with a low permeability that is probably due to clay infill within structures. Historically, groundwater levels are elevated even with mining development adjacent to the pit wall, and drainholes drilled in this area generally intersect flows.
- Domain H8 - located on the footwall of the Cadiangullong Fault and the hanging wall of the South Footwall Fault, and is also intersected by the Fishtail/Baroness thrust fault. This rock mass comprises large blocks intersected by structures. Depending on slope aspect in relation to the structures, good dewatering can be achieved.

Lithological domain



Hydrogeological domain



LEGEND

— Creek

Lithological domain

- 1: Silurian Sediments
- 2: Monzodiorite
- 3: Monzonite
- 4: Volcanics
- 5: Diorite
- 6: Weemala Sediments

Hydrogeological domain

- H1
- H2
- H3
- H4
- H5
- H6
- H7
- H8

Cadia MOD13 Cadia Hill tailings (G1383R)



Cadia Hill Pit lithological and hydrogeological domains

DATE
12/02/2019

FIGURE No:
2.2

3 Groundwater regime of Cadia Hill

3.1 Hydrostratigraphy

The main stratigraphic units in the region can be grouped into hydrostratigraphic units with similar hydraulic properties that influence groundwater flow. There are three major hydrostratigraphic units that occur at CVO and within the surrounding region:

- Tertiary basalt, which forms a productive aquifer and is utilised by surrounding properties with varying yields from low to high and consistently fresh water suitable for potable use;
- the underlying sequence of Silurian sediments, which is more variable in permeability but form a low yield aquifer from fractured sandstone and siltstones, with locally high yields where fractured limestones are present towards the base of the sequence; and
- the Ordovician volcanoclastic basement rocks, which have an essentially impermeable matrix, with groundwater flow through a widely spaced and poorly interconnected fracture network – this unit therefore forms an aquitard with very low yields and slightly brackish water quality.

Because the Tertiary basalt aquifer is not intersected by the pit shell, this report focuses on the formations that could be potentially impacted by the proposed tailings disposal which are the Silurian sediments and the Ordovician basement rocks.

3.2 Rock mass hydraulic conductivity

As discussed in Section 2.2, CHPL has mapped the lithological units intersected by the Cadia Hill pit and created six separate domains. These have in turn been modified into eight hydrogeological domains based on lithology, faulting and groundwater potential (Figure 2.2). Newcrest (2015) reports the lithological domains are typically characterised by:

- the Cadia Hill Pit rock mass having an overall very low hydraulic conductivity; and
- groundwater movement being structurally controlled within localised flowpaths associated with faults and fractured rock.

Groundwater flow in fractured rock is controlled by the primary and secondary permeability (hydraulic conductivity). Primary permeability refers to the rock matrix permeability occurring due to pore spaces between sediment grains, whereas the secondary permeability occurs due to the rock mass permeability in defects such as fractures and joints.

3.2.1 Primary matrix hydraulic conductivity

CHPL has recently completed laboratory testing of primary permeability in 195 drill core samples collected from the eight hydrogeological domains around the Cadia Hill Pit shell. Figure 3.1 shows the results of this testing graphically, and categorises the results as either impermeable, semi-permeable or permeable. The permeability values for the lithologies tested for each hydrogeological domain are typically between 10^{-4} m/day and 10^{-8} m/day with a median of 1.1×10^{-7} m/day. This is equivalent to a range of 10^{-9} m/sec to 10^{-13} m/sec with a median of 10^{-12} m/sec. The testing data therefore indicates that the rock matrix in which the Cadia Hill pit is constructed, has a very low permeability and is, in some areas, essentially impermeable. This means groundwater flow occurs largely via defects such as fractures and joints.

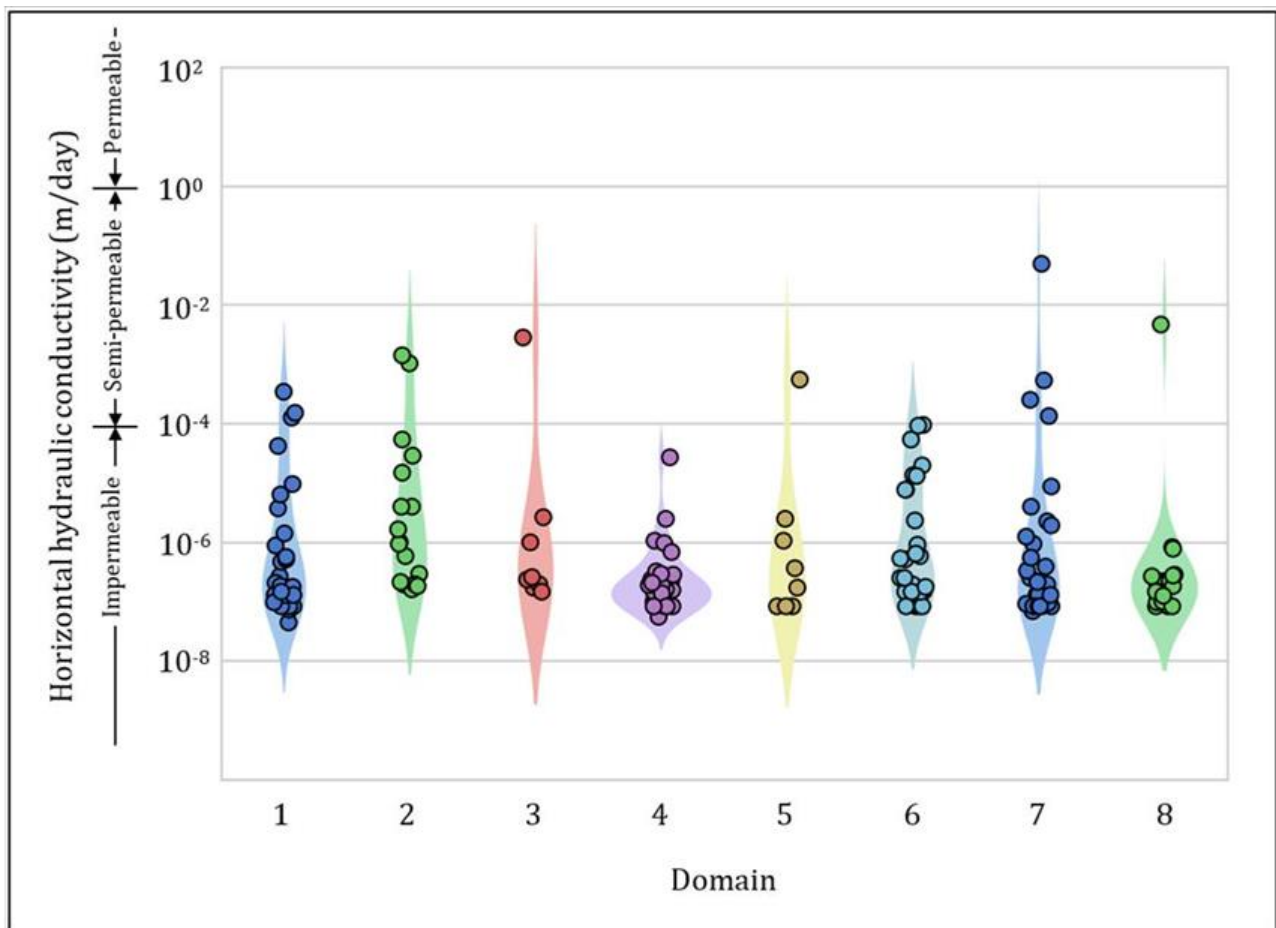


Figure 3.1 Drill core primary permeability testing results for Cadia Hill Pit

3.2.2 Secondary rock mass permeability

The permeability test data makes reference to those core samples with hydraulic conductivity values greater than 10^{-4} m/day being fractured. This indicates that where small fractures occur, and the lab methodology allowed testing, the rock mass becomes semi-permeable, potentially allowing the transmission of groundwater. The descriptions provided by Newcrest (2015) for each of the hydrogeological domains indicates that defects can vary from widely spaced to closely spaced and are associated with faults. The extents of the major structural features mapped by Newcrest (2015) in the Cadia Hill Pit walls are shown in Figure 3.2.

This shows that major structural features are mostly located within the eastern walls of the pit, and to a lesser extent along the western and southern walls. It should be noted that the image is based on the local mine grid, and has been rotated 32 degrees anticlockwise to return it to true north. Given the generally impermeable nature of the rock matrix, groundwater movement is expected to largely occur through the structural features (where these are permeable).

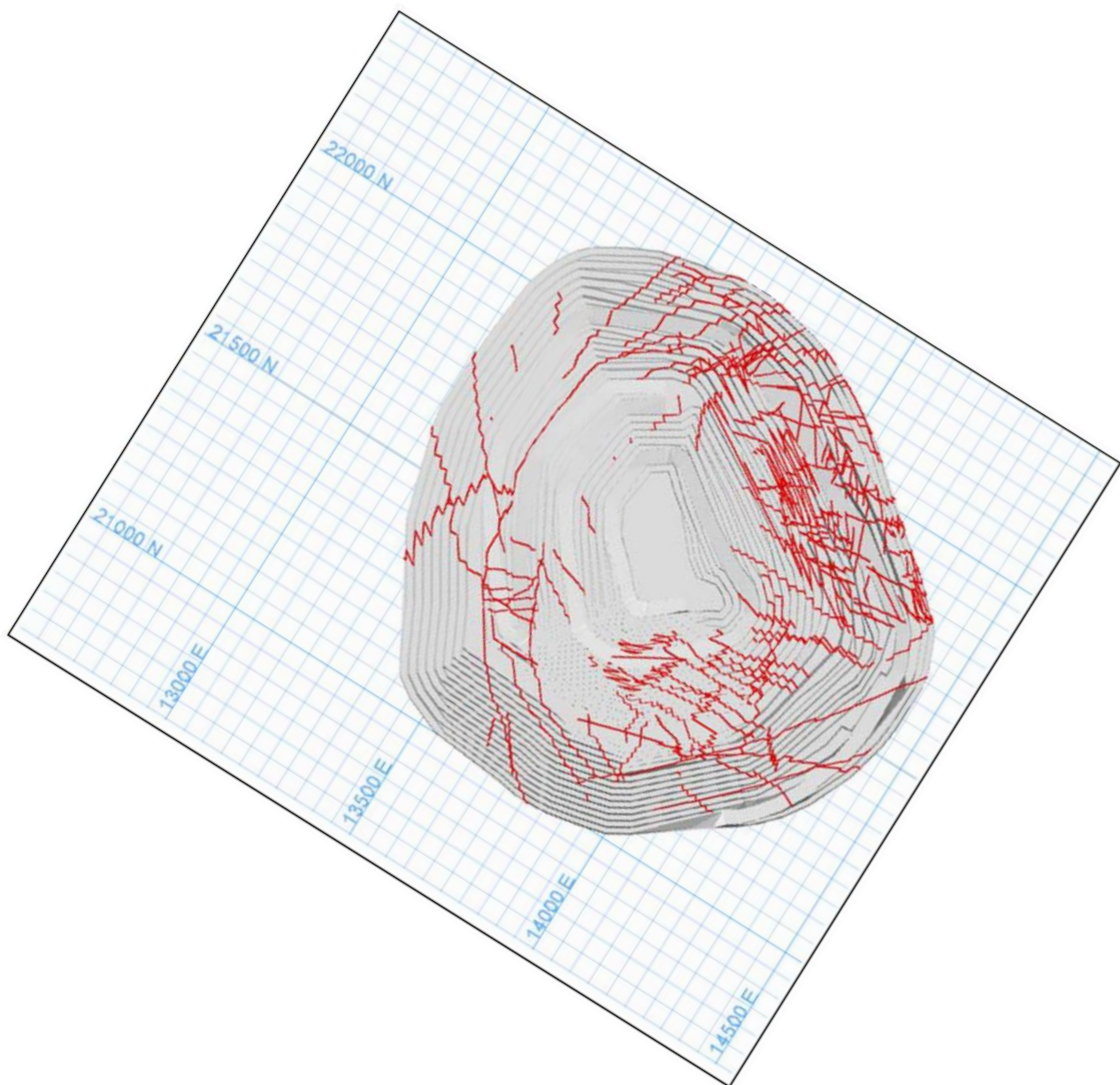


Figure 3.2 Cadia Hill Pit shell and large-scale structural features (faults) (Newcrest 2015)

Geotechnical investigations conducted during mining (Newcrest 2006) noted that Cadia Hill open pit occurs within a low permeability rock mass, and groundwater ingress was generally only evident in localised areas through structures. A number of faults intersect Cadia Hill open pit with visual examinations summarised by AGE (2009), indicating the faults are between 0.5 m and 20 m wide and characterised by milled rock and clay gouge infill with fractured wall rocks. During mining, the faults did not produce problematic (i.e. excessive) volumes of groundwater. This is expected to have been a function of the clay gouge material retarding water movement through the fault planes, and poor interconnectivity and ‘dead end’ fractures preventing full drainage of the fracture network.

During operations, groundwater inflow into Cadia Hill open pit could not be directly measured as it occurred as slow seepages across the pit walls that mixed with runoff, or was readily evaporated, or bound by capillary action to the excavated ore and waste rock. Figure 3.3 below illustrates the rock mass exposed within the Cadia Hill open pit and the localised seepage zones evident as zones of iron staining on the walls. Whilst this photograph shows minor visible seepage, the extent of the iron staining provides an indication of historic seepage from the pit walls.



Figure 3.3 Photo within Cadia Hill Pit showing limited and isolated seep zones (2018)

3.3 Groundwater monitoring network

CHPL has installed a groundwater monitoring network that provides groundwater level and water quality data within and adjacent to the Cadia Hill open pit. Details of these monitoring bores are provided in Table 1 and their locations shown in Figure 3.4. The monitoring network has been gradually built up over time through a series of drilling campaigns as follows:

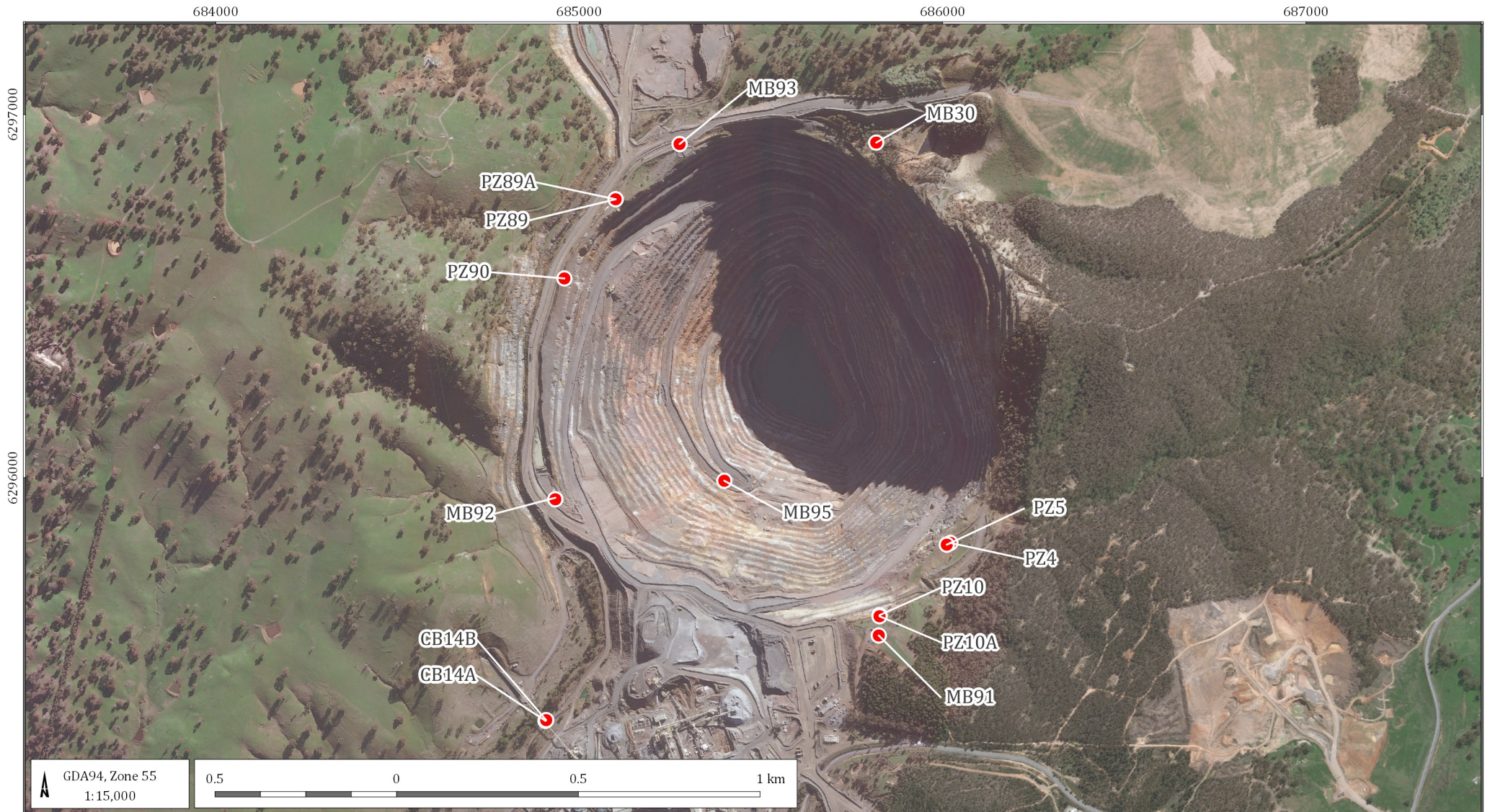
- CB series – installed in 1995 as part of the early investigations prior to mining at Cadia Hill;
- PZ series – installed in 2007 for geotechnical purposes to monitor water pressure behind the Cadia Hill pit walls;
- MB30 series – installed 1997 for groundwater monitoring purposes; and
- MB90 to MB95 – installed in 2018 to monitor impact of tailings deposition in Cadia Hill.

Isometric views of the monitoring bores in relation to the pit shell are shown in Figure 3.5.

Table 1 Cadia Hill Pit groundwater monitoring network

Bore	Easting ¹	Northing ¹	Ground elevation (mAHD ²)	Screen zone	Screen zone (mbgl ³)	Total depth (m)
CB14A	684907	6295331	711.8	Silurian Sediments	ND	12.3
CB14B	684909	6295333	711.8	Silurian Sediments	ND	37.5
PZ4	686021	6295821	749.0	Ordovician Volcanics	36-45	49.85
PZ5	686011	6295816	747.6	Ordovician Volcanics	83-95	100
PZ10	685826	6295622	772.6	Ordovician Volcanics	75-85	94
PZ10A	685826	6295619	772.6	Ordovician Volcanics	30-54	60
PZ89	685100	6296767	732.7	Ordovician Volcanics	138-150	150
PZ89A	685100	6296767	732.7	Ordovician Volcanics	ND	ND
PZ90	684959	6296549	732.0	Ordovician Volcanics	155-170	200
MB30	685817	6296923	758.4	Tertiary Basalt	4-76	100
MB91	685824	6295566	793.0	Ordovician Volcanics	138-150	150
MB92	684934	6295941	721.7	Ordovician Volcanics	102-108; 114-120	120
MB93	685276	6296919	732.7	Ordovician Volcanics	72-78; 84-90; 96-102; 114-120	120
MB95	685399	6295992	476.8	Ordovician Volcanics	200-236	240

Notes: 1 – Coordinates are in GDA94, Zone 55
 2 – Metres Australian Height Datum
 3 – Metres below ground level



LEGEND
● Monitoring bores

Cadia MOD13 Cadia Hill tailings continuation (G1383R)



Cadia Hill Pit groundwater monitoring network

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12/02/2019

FIGURE No:
3.4

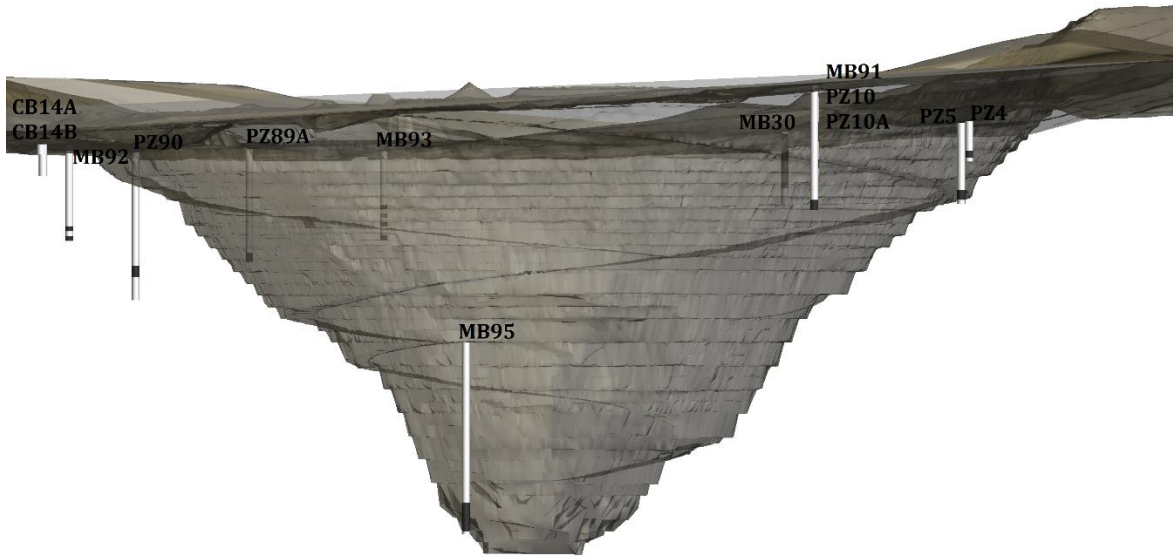
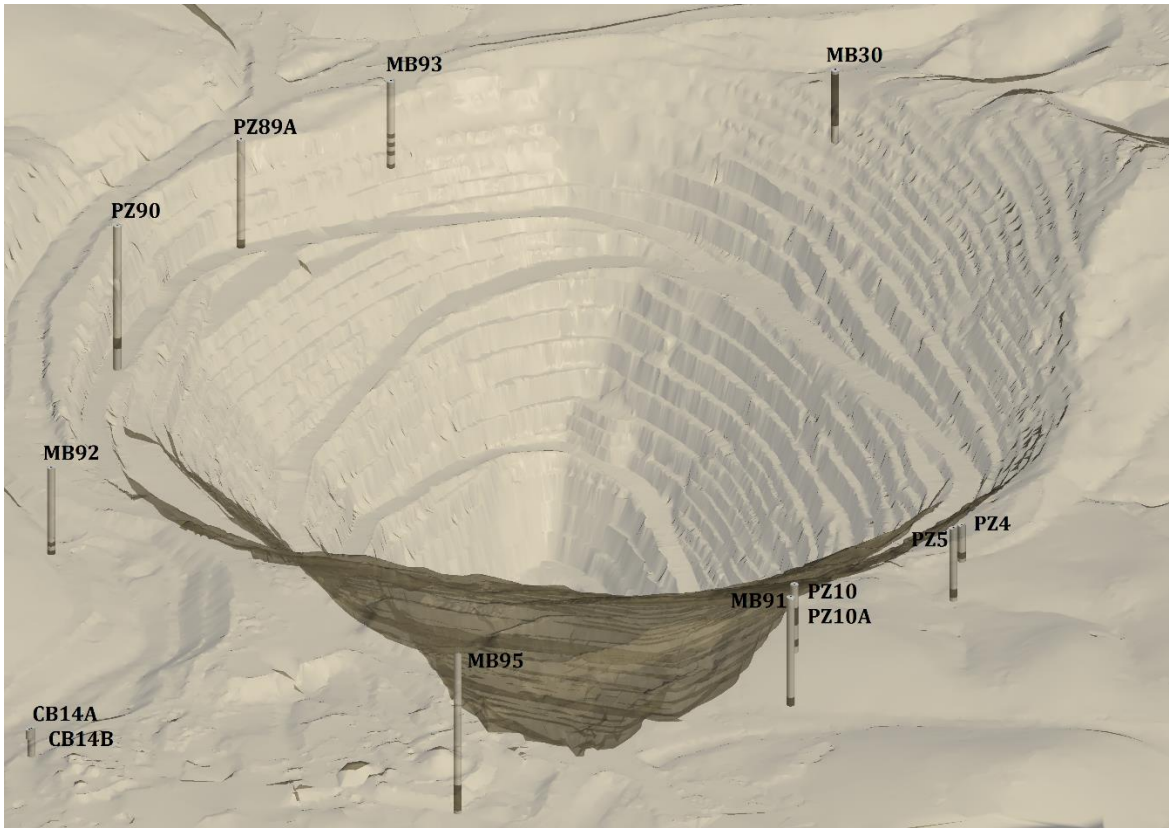
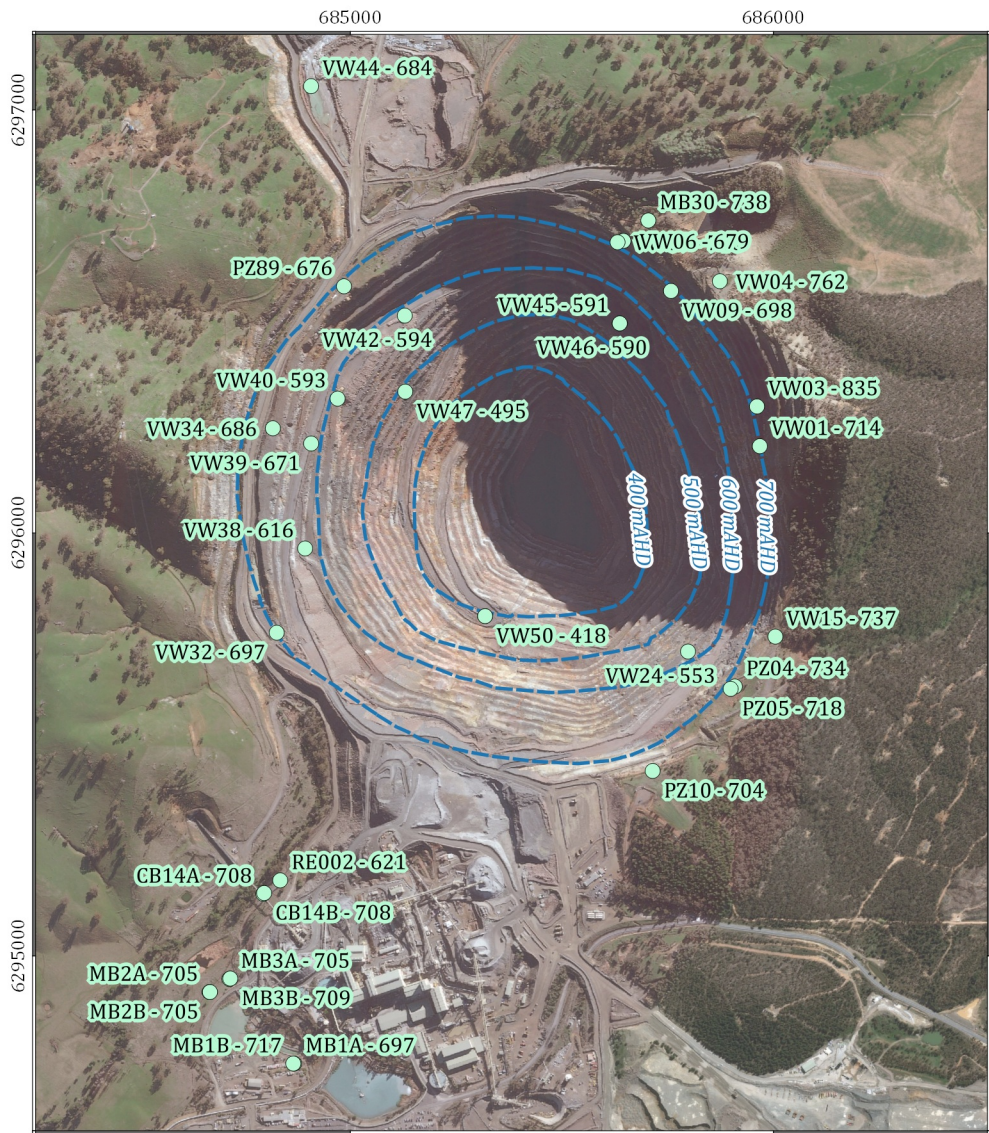


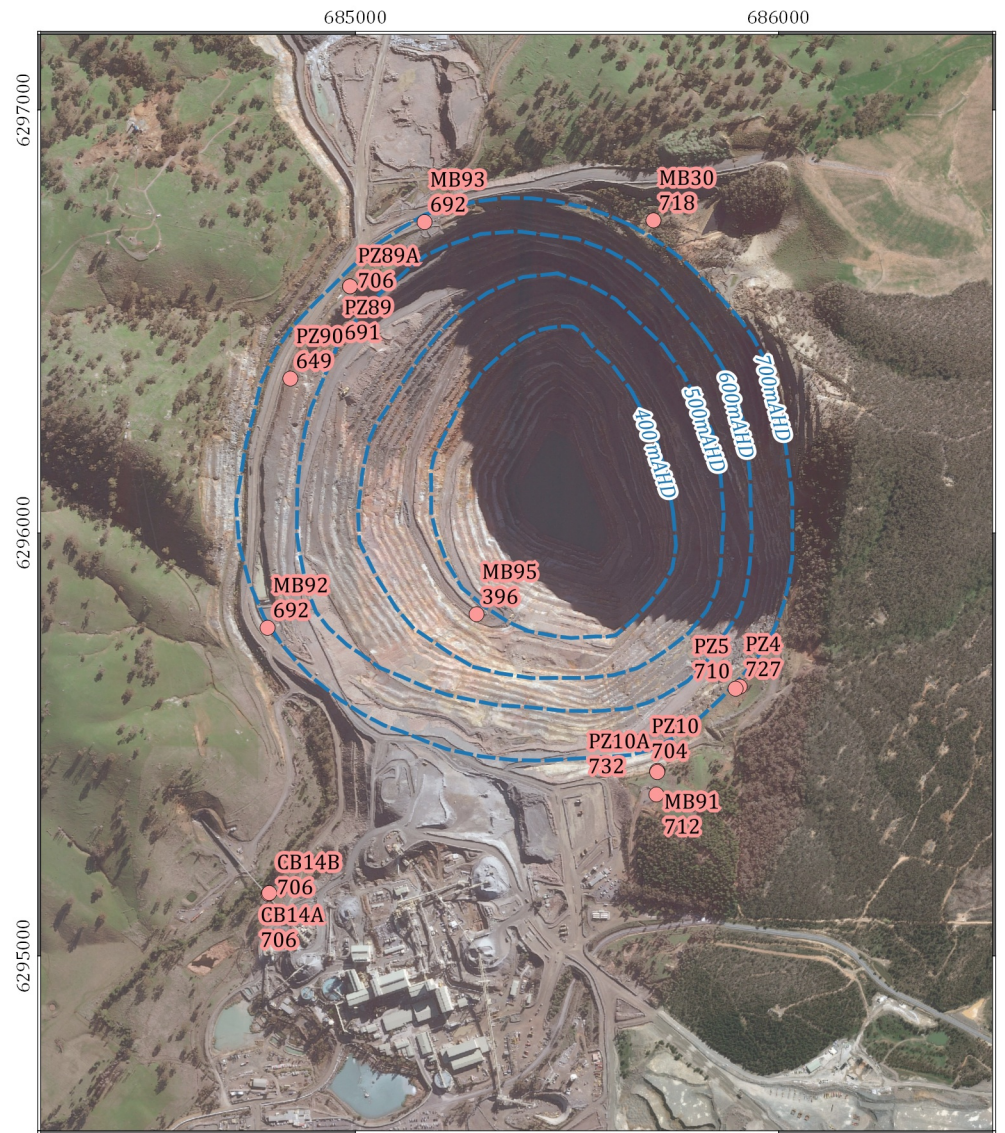
Figure 3.5 Isometric views of monitoring bore network looking north

3.4 Groundwater levels

Prior to mining commencing at Cadia Hill, groundwater levels measured in 1997 ranged from 705 mAHD south and 726 mAHD north of the open pit footprint (AGE, 2009). During mining of Cadia Hill, CVO measured pore pressure within the pit walls using a series of geotechnical piezometers. The observations from Newcrest (2015) within each of the hydrogeological zones indicate variable and localised groundwater drainage from the pit wall. However, the piezometer data after the commencement of mining indicates that a very steep hydraulic gradient remains in place within the rock mass and does not extend far from the pit shell. This is consistent with the description of the hydrogeological regime in Sections 3.1 and 3.2 (i.e. a very low permeability rock mass). Groundwater levels measured from monitoring bores in 2012 (when mining ceased) are presented in Figure 3.6. This figure also displays additional groundwater level data measured between December 2018 and February 2019, which indicates that water levels have only varied a matter of metres over the last 6 to 7 years. Some have increased whilst others have decreased, showing it is clear steep hydraulic gradients driving groundwater towards the pit have remained in place.



Water level - September 2012



Water level - December 2018 to February 2019

- LEGEND**
- Monitoring bore ID and water level - mAH (September 2012)
 - Monitoring bore ID and water level - mAH (December 2018 - February 2019)
 - Inferred groundwater contours (mAH)



Cadia MOD13 Cadia Hill tailings continuation (G1383R)

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07/03/2019

**Groundwater monitoring at Cadia Hill
Pit - 2012 - 2019**

FIGURE No:
3.6

Figure 3.7 below shows groundwater levels recorded from the monitoring bores surrounding Cadia Hill open pit since deposition of tailings commenced. Groundwater levels in the more elevated bores around the crest of the Cadia Hill open pit have generally remained static since tailings emplacement commenced. Monitoring bore MB95 which is installed towards the base of the Cadia Hill open pit and has recorded a gradually rising water level since the tailings level reached the groundwater level in this bore in November 2018. Thereafter, the groundwater level has risen at a similar rate to the pit water level. This indicates a localised hydraulic connection along fractures within the pit wall between the pit water level and the nearby surrounding groundwater level at depth.

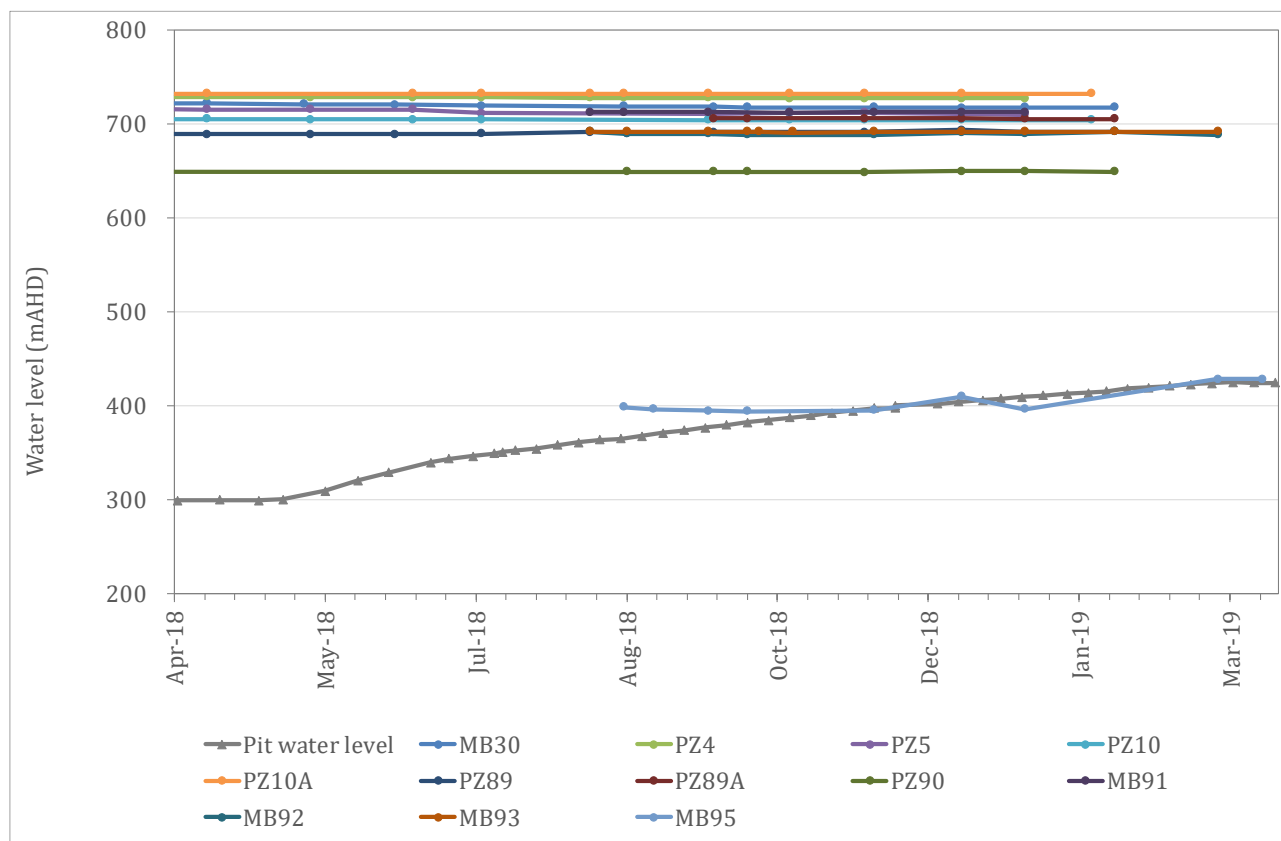


Figure 3.7 Hydrograph showing groundwater response to Cadia Pit water levels

3.5 Groundwater quality

Groundwater quality data collected from the Cadia Hill open pit and from two monitoring bores (PZ4 and PZ5) is summarised in Table 2. The locations of monitoring bores PZ4 and PZ5 are shown on Figure 3.6.

Table 2 Water quality data

Analyte	Units	Pit lake samples (CAWS65)		Groundwater samples			
		31/08/18	08/10/18	PZ4 25/05/18	PZ4 21/06/18	PZ5 20/06/18	PZ5 23/10/2018
pH Value	pH Unit	7.3	7.57	4.2	5.01	7.18	7.18
EC	µS/cm	2,110	2,520	128	114	230	427
TDS	mg/L	1,730	1,540	67	78	165	264
Chloride	mg/L	68	65	5	8	19	8
Sulphate	mg/L	908	966	15	25	24	27
Hydroxide Alkalinity	mg/L	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity	mg/L	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	16	34	<1	<1	49	158
Total Alkalinity	mg/L	16	34	<1	<1	49	158
Calcium	mg/L	144	173	6	8	24	58
Magnesium	mg/L	28	30	1	2	5	8
Sodium	mg/L	228	275	1	6	10	14
Potassium	mg/L	59	70	2	3	3	3
Aluminium	mg/L	0.02	0.02	0.35	0.02	<0.01	<0.01
Antimony	mg/L	<0.001	0.001	0.002	0.002	<0.001	0.002
Arsenic	mg/L	0.002	<0.001	<0.001	<0.001	<0.001	0.002
Cadmium	mg/L	<0.0001	<0.0001	0.0004	0.0003	0.0002	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Cobalt	mg/L	<0.001	<0.001	0.007	0.006	0.002	0.003
Copper	mg/L	<0.001	<0.001	0.4	0.151	0.05	0.023
Lead	mg/L	<0.001	<0.001	0.038	<0.001	<0.001	0.002
Manganese	mg/L	0.02	0.028	0.101	0.117	0.159	0.12
Molybdenum	mg/L	0.304	0.367	<0.001	<0.001	0.002	0.008
Nickel	mg/L	<0.001	<0.001	0.017	0.014	0.004	0.003
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	0.21	-	-	<0.001

Analyte	Units	Pit lake samples (CAWS65)		Groundwater samples			
		31/08/18	08/10/18	PZ4 25/05/18	PZ4 21/06/18	PZ5 20/06/18	PZ5 23/10/2018
Zinc	mg/L	0.018	<0.005	0.21	0.307	0.25	0.035
Iron	mg/L	<0.05	<0.05	0.55	<0.05	<0.05	<0.05
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nitrite	mg/L	<0.01	<0.01	<0.01	0.05	0.03	<0.01
Nitrate	mg/L	<0.01	<0.01	3.52	3.11	4.91	1.9
Nitrite + Nitrate	mg/L	<0.01	<0.01	3.52	3.16	4.94	1.9
Total Kjeldahl Nitrogen	mg/L	0.6	0.6	1.7	1.4	0.6	0.2
Total Nitrogen	mg/L	0.6	0.6	5.2	4.6	5.5	2.1
Total Phosphorus	mg/L	0.06	194	0.18	0.16	0.68	0.52

The water quality data indicates the groundwater quality in the pit lake (since commencement of in-pit tailings deposition in May 2018) is slightly alkaline and brackish. The water quality data for PZ4 (which is approximately 40 m deep) indicates this groundwater is acidic and fresh, whilst the groundwater quality for PZ5 (which is approximately 100 m deep) is neutral and fresh.

The relative proportions of the major ions in the six water samples are presented graphically in the Piper diagram in Figure 3.8.

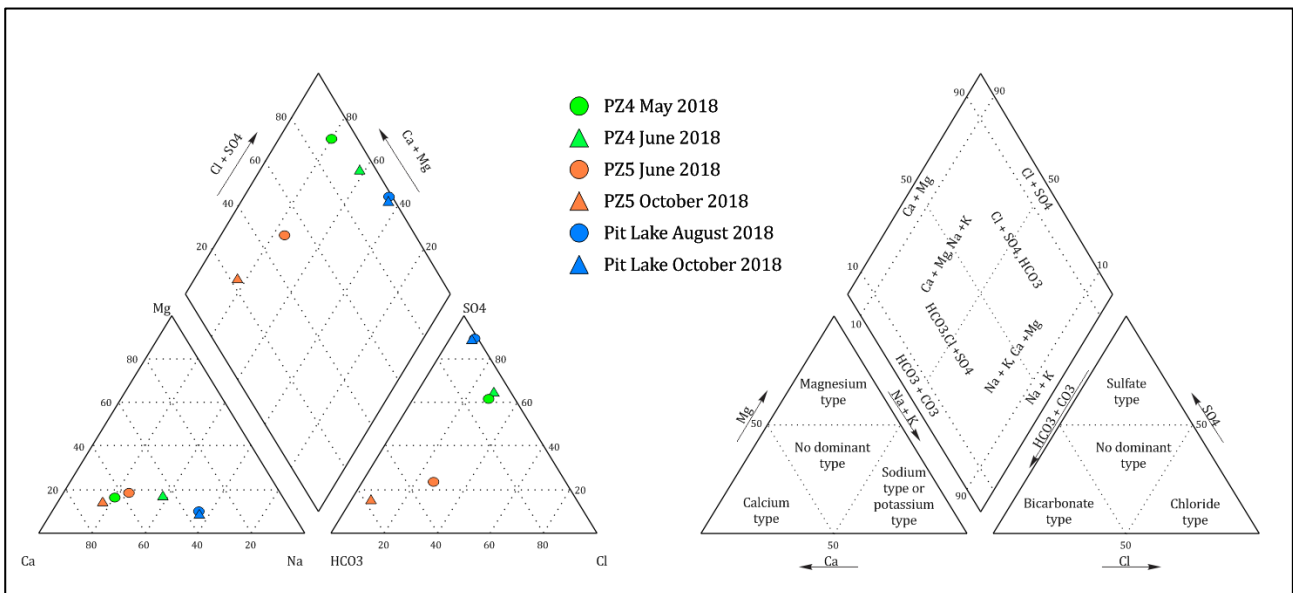


Figure 3.8 Piper diagram – Pit Lake and surrounding groundwater quality

The Piper diagram identifies three different water types as follows:

- pit water shows a sodium/calcium-sulphate dominant water type;
- bore PZ4 groundwater shows a calcium-sulphate dominant water type; and
- bore PZ5 groundwater shows a calcium-bicarbonate dominant water type.

Additional observations regarding the dissolved metals concentrations include detectable levels of:

- aluminium, antimony, arsenic, manganese, molybdenum, and zinc within the pit lake waters;
- aluminium, antimony, cadmium, cobalt, copper, iron, lead, manganese, nickel, silver and zinc in PZ4; and
- antimony, arsenic, cadmium, cobalt, copper, lead, manganese, molybdenum, nickel, and zinc in PZ5.

The data indicates an overall increase in dissolved metals concentrations in the more acidic groundwater (PZ4) compared to that for the more alkaline water in the pit lake.

4 Numerical modelling

The impact of the Cadia Hill open pit, Cadia East underground mine and Ridgeway underground mine on the groundwater regime has been assessed using numerical groundwater flow models. AGE (2009) describes the numerical model developed for the Cadia East Environmental Assessment, which was approved in 2009. The groundwater model has been updated on two occasions since this time in accordance with Schedule 3, Condition 34(d) of PA 06_0295 (AGE 2013, 2016).

As noted previously, due to the very low inherent host rock permeability (Newcrest 2006, 2015), Cadia Hill open pit experienced very low groundwater inflows over its life. AGE (2009) constructed a 3D numerical groundwater flow of CVO that included Cadia Hill open pit. The model was constructed using the MODFLOW-SURFACT software and represented the three key regional hydrostratigraphic units, being the Tertiary basalts, Silurian sediments and Ordovician volcanoclastics.

The model was calibrated to average water level measurements. Calibration was achieved by adopting a horizontal hydraulic conductivity for the Ordovician rock mass of 1×10^{-8} m/sec. Subsequent updates to the numerical model (AGE 2013, 2016) adopted lower hydraulic conductivity values for the Ordovician rock mass to improve the ability of the model to replicate the actual groundwater ingress estimated for Cadia East and the Cadia Hill open pit. The most recent update to the groundwater model adopted a hydraulic conductivity for the Ordovician rock mass of between 5×10^{-12} to 6×10^{-11} m/sec to achieve calibration with estimated and observed groundwater inflows to the mining areas.

The groundwater modelling has consistently predicted a relatively steep cone of depression and limited zone of drawdown within the rock mass around the Cadia Hill pit shell (and the Cadia East underground mine). This has been confirmed by monitoring within geotechnical piezometers installed within the Cadia Hill pit walls that have retained high pore pressures (Section 3.4).

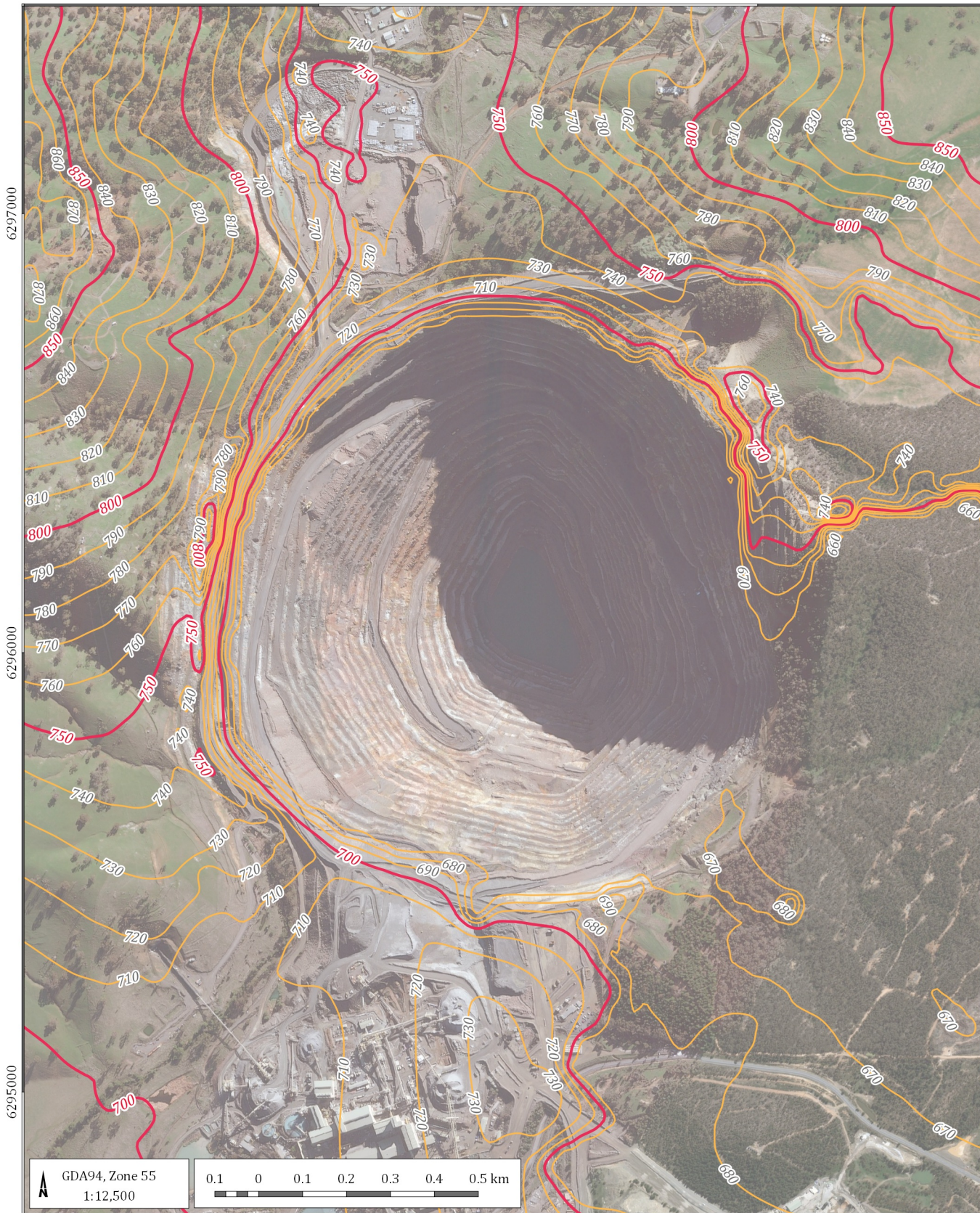
The AGE (2009) numerical model provided an estimate of groundwater inflow rate to the Cadia Hill open pit of 1.5 megalitres per day (ML/day) reducing to 1.3 ML/day when Cadia East mine was developed. As noted, subsequent updates to the groundwater model have reduced the bedrock hydraulic conductivity to achieve a better match to the estimate of actual groundwater inflow to Cadia Hill from the pit water balance of a maximum of 0.7 ML/day (AGE 2016).

Gilbert & Associates (2009) assessed the long-term behaviour of the waterbody that will form in Cadia Hill using a water balance model. Groundwater inflows predicted by AGE (2009) were represented in the model along with surface runoff from the adjacent catchment, incident rainfall and evaporation from the surface of the Cadia Hill open pit and Cadia East subsidence zone combined final void waterbody. The modelling indicated Cadia East would slowly fill over a period of 150 to 160 years before spilling into the Cadia Hill open pit and eventually reaching a combined equilibrium water level of 670 mAHD at around 330 years. The model was subsequently updated using a Cadia Hill open pit groundwater influx of a maximum 0.7 ML/day and Cadia East underground influx of 1.5 ML/day to better represent the estimates of the pit water balance and observed underground inflows. The updates had no effect on the equilibrium level but extended the period to equilibrium to approximately 900 years (Hydro Engineering Consultants [HEC], 2018).

The groundwater modelling conducted for the Cadia East Project (AGE, 2009), included an assessment of the water table that will form around the Cadia Hill void when water levels stabilise at the predicted 670 mAHD. The post-mining equilibrium groundwater levels are reproduced with a 10 m contour interval in Figure 4.1. These show post-mining groundwater levels stabilise at 700 mAHD around the crest of the Cadia Hill open pit, except where the model is hydraulically connected to Cadia East (a scenario which is no longer predicted to occur [Section 1]). The water levels extend higher in excess of 730 mAHD to the north and northeast, and 750 mAHD to the west of the Cadia Hill open pit.

685000

686000



LEGEND

Groundwater level contours:

- 10 m interval
- 50 m interval

Cadia MOD13 Cadia Hill tailings continuation (G1383R)

Post mining simulated groundwater level contours



DATE
12/02/2019

FIGURE No:
4.1

Geotechnical assessments have now indicated that the Cadia East subsidence zone will not extend to the Cadia Hill open pit. This means that instead of a single pit lake forming across the two mining areas, the two pits will remain separated. HEC (2019) updated the water balance model to reflect the changes in the Cadia Hill pit and predicted the water level will rise some 30 m higher than if it was connected with the Cadia East subsidence zone. The modelling indicates the water level will stabilise and fluctuate between 687 mAHD and 699 mAHD, averaging about 694 mAHD as shown in Figure 4.2 below.

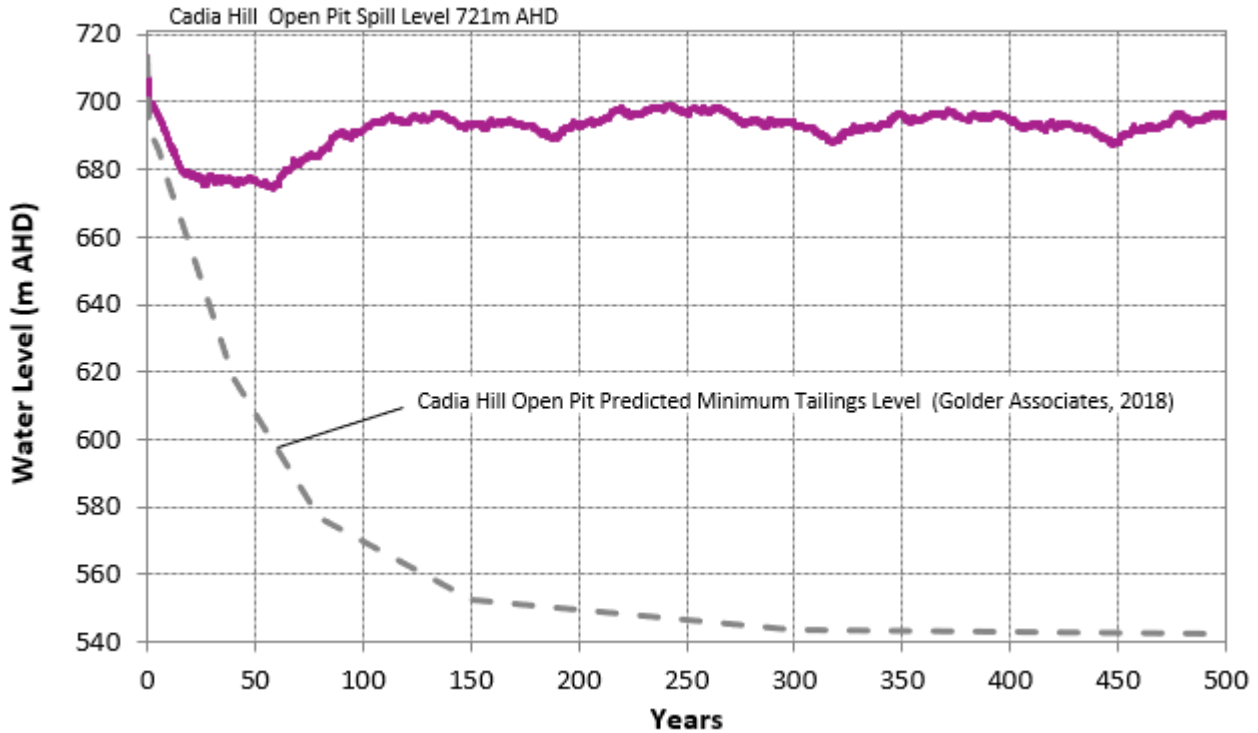


Figure 4.2 Predicted Cadia Hill Water Level (HEC 2019)

CHPL engaged Golder Associates Pty Ltd (Golder) to assess the geotechnical aspects of tailings placement in the Cadia Hill Pit (Golder, 2018a). This included an assessment of tailings settlement following placement within the Cadia Hill Pit. The study concluded the tailings settlement will occur at a rate of around 2 m per year where the tailings are thickest in the centre of the pit. Settlement will take in excess of 100 years to reach 90% consolidation after mine closure. The tailings were assessed to settle approximately 150 m over a period likely to exceed 100 years post-closure. Therefore, whilst tailings slurry will initially be deposited to 713 m AHD, it will slowly settle to 563 m AHD in the middle of the Cadia Hill Pit. This means that within about six to seven years the level of the tailings will fall below 700 m AHD and a lake will form over the settling tailings. As noted, the water balance modelling by HEC (2019) indicates that after mining ceases the water levels within the Cadia Hill Pit will stabilise and fluctuate between 687 m AHD and 699 m AHD, averaging about 694 m AHD.

5 Impact assessment

The impact of depositing tailings within Cadia Hill open pit on the groundwater regime depends on the potential for tailings water to leak from the pit shell into the surrounding rock mass and then to move to receptors such as aquifers or streams. The movement of tailings water into, or out of, the pit shell is controlled by the difference in the water level within the pit shell, and the groundwater level in the rock mass immediately outside the pit shell. Groundwater levels surrounding the pit shell must therefore be above 713 mAHD during operations and up to 699 mAHD post-closure to prevent any outward hydraulic pressures being created within the Cadia Hill pit that could promote loss of pit waters to the surrounding environment. Where outward hydraulic pressures from the final void are formed it is commonly referred to as a 'source', whereas a 'sink' is used to describe a final void with inwards hydraulic pressures. The sections below discuss the potential for the tailings emplacement to form a 'source' or a 'sink' during operations and post-closure.

5.1 Operational impacts

Figure 5.1 presents cross-sections across the Cadiangullong Creek Diversion showing the relationship between the short-term (713 mAHD) and long-term (694 mAHD) pit water levels and the adjacent diversion creek invert levels. The sections show that during operations, the water level within Cadia Hill Pit will rise above the base of Cadiangullong Creek, indicating the potential for transport of pit water into the creek in the short-term during operations. The potential for an outward hydraulic gradient occurs in the southern section of the pit shell where the creek elevation is around 708 mAHD, and is in close proximity (i.e. within 200 m) to the pit shell. In this case the Cadia Hill Pit would form a 'source'.

Seepage modelling by Golder (2018b) included a two-dimensional seepage model aligned north-east/south-west through the Cadia Hill Pit to assess the potential for seepage into and out of the pit. The south-west extents of this seepage assessment coincide with the southerly portion of the pit shell in proximity to Cadiangullong Creek, where the creek bed elevation is around 708 mAHD.

The seepage modelling assumed a maximum pit water elevation of 713 mAHD, thereby creating a hydraulic gradient towards this portion of Cadiangullong Creek. The permeability of the rock mass outside the pit shell was based on the 90th percentile of laboratory core rests to represent a fractured volcanic rock condition. The simulation was run for 150 years to establish equilibrium conditions. In reality, this will not occur due to tailings settlement post-deposition resulting in settlement to approximately 563 mAHD in the middle of the pit.

The modelling indicated that outward seepage from Cadia Hill Pit to the south-west would occur, but the volumes would be very low between 2.9×10^{-8} and 4.2×10^{-6} m/day. This is due to the very low permeability of the surrounding rocks and low hydraulic head differential between the maximum pit water level and adjacent groundwater level south-west of the pit. The total predicted volume of seepage from the entire section of the pit at the end of the simulation (i.e. 150 years) was predicted to be 0.072 m³/yr (72 L/yr). The seepage modelling by Golder is considered to be representative of groundwater flow within the rock matrix and based on permeability data derived from core permeability testing.

However, this seepage assessment may not be representative of permeability created by a widely spaced and open fracture network, which could not have been assessed in the core samples (refer Sections 2.2 and 3.2). That is, there is likely potential for higher seepage rates to occur temporarily during the operational phase if a fracture network created connectivity between the pit shell and the rock mass.

In order to manage this, CHPL proposes to:

- conduct trials to assist in determining and testing the optimal treatment strategy prior to inundation of tailings;
- locate faults and cracks in the south-west corner of the Cadia Hill pit, between 694 mAHD and 713 mAHD, and treat these using, for example, a grout/polyurethane sealant (injected under pressure into fractured networks); and
- implement contingency measures should unforeseen impacts occur (e.g. cease pumping of tailings and supernatant into the pit and commence pumping out of the pit).

In addition, additional groundwater monitoring bores would be installed in the south-west corner of the Cadia Hill open pit (outside of the pit shell) and along Cadiangullong Creek to measure groundwater levels and water quality.

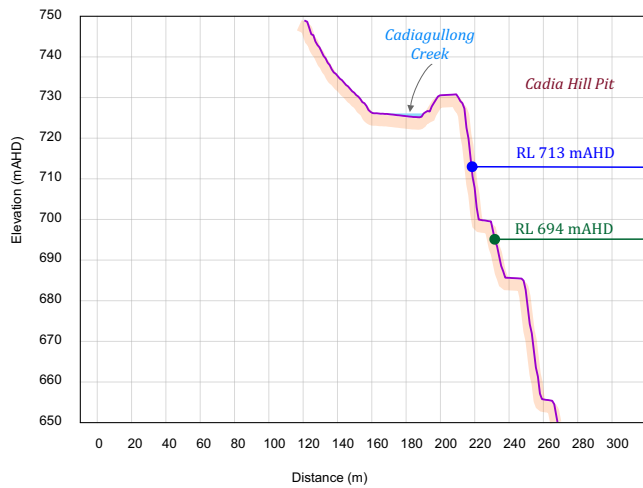
5.2 Post-closure impacts

As noted previously the water balance modelling by HEC (2019) indicates that after mining ceases the water levels within the Cadia Hill Pit will stabilise and fluctuate between 687 mAHD and 699 mAHD, averaging about 694 mAHD. Therefore, for the Cadia Hill Pit to form a 'sink' post-closure the groundwater levels around the pit shell need to remain higher than the maximum pit water level of 699 mAHD.

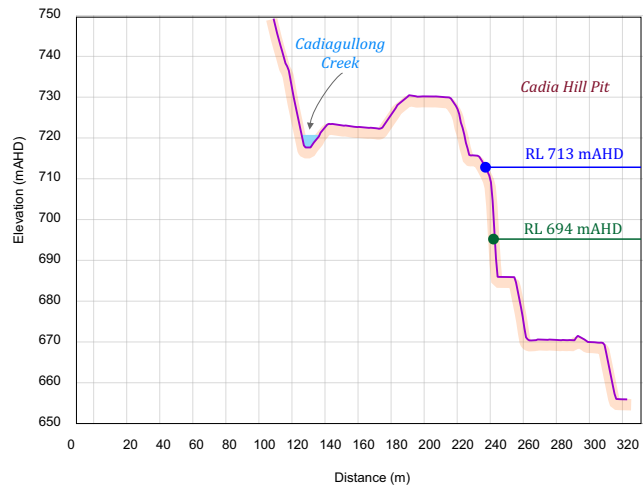
Figure 3.6 shows that groundwater levels measured within the existing monitoring network are above 699 mAHD in the monitoring bores installed on the eastern edge of the Cadia Hill pit. This indicates groundwater will flow into, not out of, the pit in this area. Along the western and south-west walls of the Cadia Hill pit current measurements of groundwater level are commonly less than 699 mAHD. The lower groundwater levels are either a result of depressurisation and resultant lowering of water levels from mining activities or are representative of equilibrium conditions at the point of the bore. To determine the potential for 'source' or a 'sink' to occur in the southern and western areas of the pit shell additional water level measurement points are required further from the pit shell. Whilst there are few bores in these areas to measure groundwater levels it is likely that groundwater levels rise outside the pit shell and would create an inward hydraulic gradient into the pit. This is indicated by the catchment mapping for the Cadia Hill Pit and surrounds, that shows the topography surrounding the southern, eastern and western sides of the pit are higher than the pit crest. Groundwater levels in poorly transmissive fractured rock are commonly a subdued reflection of the terrain which would indicate that groundwater levels rise above 699 mAHD to the west of the pit. Higher groundwater levels in these areas were predicted by groundwater modelling undertaken for the Cadia East Project which is reproduced in Figure 4.1. The modelling shows post-mining groundwater levels in excess of 730 mAHD to 750 mAHD to the north-east to west of the Cadia Hill open pit. The lowest groundwater levels are predicted to be in a small zone at the southern wall of the pit where the Cadiangullong Creek is located. In this area the previous numerical modelling indicates groundwater levels are between 700 mAHD and 710 mAHD.

Figure 5.1 shows the average post-mining pit water levels of 694 mAHD compared to the elevation of the nearby Cadiangullong Creek. This figure indicates that, post-closure, as the pit water level falls and equilibrates, the potential for direct seepage to Cadiangullong Creek will reduce to zero. A post-mining groundwater elevation between 700 mAHD and 710 mAHD in the vicinity of Cadiangullong Creek, indicates there will be an inward hydraulic gradient established south-west of the pit wall resulting in the pit forming a 'sink' long-term.

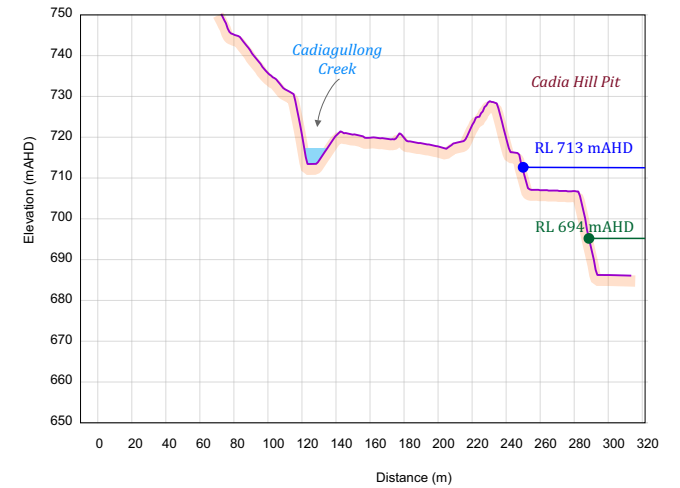
Previous studies also identified that the water quality of the combined Cadia Hill and Cadia East final void will be affected by the long term evapo-concentration of salts and also acidic drainage of potentially acid forming Ordovician host rock affecting pH and dissolved metal concentrations. The continued addition of the tailings solids to the Cadia Hill open pit would not affect the long term water quality of the recovered groundwater table or final void, as the void water quality would continue to be an outcome of evapo-concentration of salts and the geochemistry of the host rock, both of which would be unchanged by the Modification.



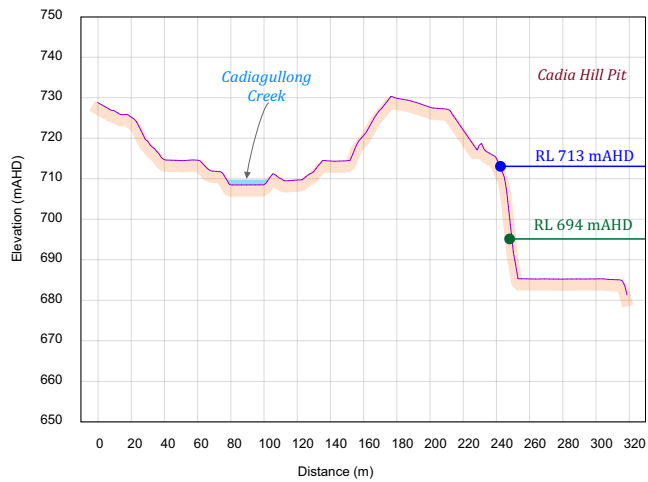
Section A



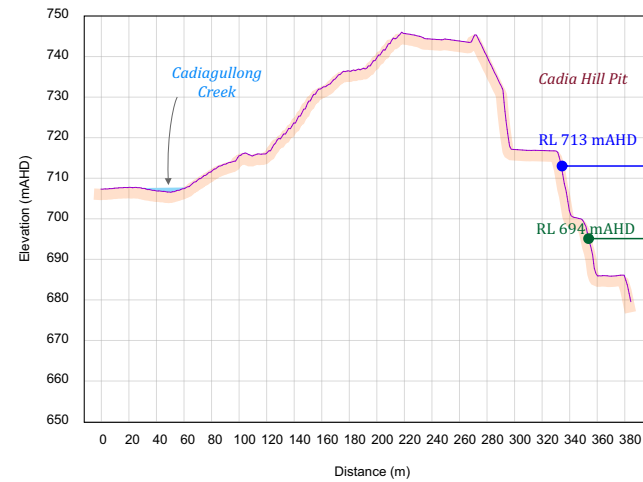
Section B



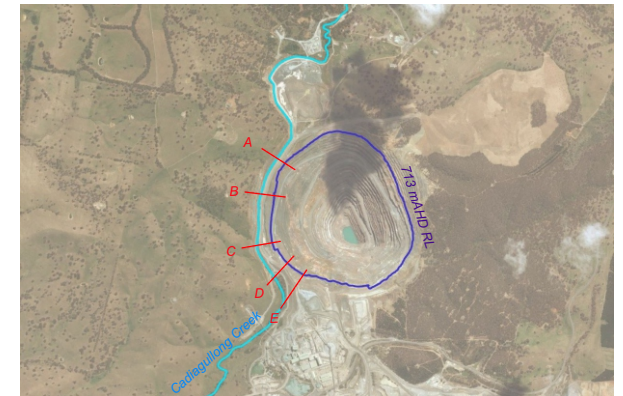
Section C



Section D



Section E



Section Plan

— Operational phase pit water level — Post closure pit water level

Cadia Hill tailings and Cadiagullong Creek invert levels

Figure - 5.1

Cadia MOD13 Cadia Hill tailings (G1383R)



6 Conclusions

This assessment demonstrates that the primary rock mass is of very low permeability, which serves to limit any impact associated with the Modification. Notwithstanding, the potential for seepage through fracture networks in the Cadia Hill pit walls is considered to occur temporarily during the mine's operational phase, when the water level will rise to 713 mAHD. Whilst the existing conditions indicate the magnitude of the seepage is likely to be small, the quality of the seepage could be poorer than the in-situ groundwater and surface water. The assessment indicates that the long-term (post-closure) equilibrium level will average around 694 mAHD and will remain a sink at this level. As described in Section 1, to prevent any outward migration of tailings water during operations, CHPL would seal fractures within the pit wall in the south-west section of the pit that could transmit water outside the pit shell, to ensure there is no degradation in environmental values and beneficial use of surrounding water sources. To achieve this, CHPL would identify, locate and seal defects (for example, using a grout/polyurethane sealant) in the rock mass that could temporarily transmit water outwards during the operational period of tailings disposal. In addition, management plans would allow for contingency measures such as pumping of tailings and supernatant out of the pit down to 694 mAHD, should seepage be identified and shown to be impacting on surrounding water sources.

Further data collection would also be undertaken to better understand the local hydrogeological regime in the southern and western areas of the Cadia Hill pit. To achieve this, additional groundwater monitoring bores suitable for measuring groundwater levels and water quality would be installed outside the pit shell and along Cadiangullong Creek. Drilling and testing would incorporate in-situ packer tests to measure fracture network permeability. In-pit mapping of faulting and fractures (if safe access is available) would focus on hydrogeological domains H1, H3, H5 and H6 (Figure 2.2).

7 References

Australasian Groundwater and Environmental Consultants Pty Ltd (2009) *“Cadia East Project Groundwater Assessment”*, April 2009, Project Number G1383/D.

Australasian Groundwater and Environmental Consultants Pty Ltd (2013) *“Cadia East Mine Update to Groundwater Model”*, June 2013, Project Number G1383A.

Australasian Groundwater and Environmental Consultants Pty Ltd (2016) *“Cadia Mine Update to Groundwater Model”*, August 2016, Project Number G1383C.

Australasian Groundwater and Environmental Consultants Pty Ltd (2018) *“Cadia MOD12 - Cadia Hill Tailings Continuation – Groundwater Assessment”*, August 2018, Project Number G1383P.

Cadia Holdings Pty Limited (2018a) *“Cadia Hill Tailings Modification – Statement of Environmental Effects”*.

Cadia Holdings Pty Limited (2018b) *“Cadia Hill Tailings Continuation Modification – Statement of Environmental Effects”*.

Gilbert Associates (2009) *“Cadia East Project, Surface Water Assessment”*, Prepared for: Cadia Holdings Pty Limited, May 2009.

Golder (2018a) *“Backfilling the Cadia Hill Pit with Tailings, Cadia Gold Mine”*, Prepared by Golder Associates Pty Ltd for Newcrest Mining Limited, March 2018.

Golder (2018b) *“Cadia Pit – Additional Seepage Modelling”*, Prepared by Golder Associates Pty Ltd for Newcrest Mining Limited, December 2018.

Hydro Engineering Consultants (2018) *“Cadia Hill Tailings Continuation: Final Void Water Balance and Water Management”*, Prepared for: Cadia Holdings Pty Limited, June 2018.

Hydro Engineering Consultants (2019) *“Cadia Valley Operations Modification 13 – Cadia Hill Tailings Completion Modification Surface Water Assessment for Statement of Environmental Effects”*, Prepared for: Cadia Holdings Pty Limited, 2019.

Newcrest (2006) *“Cadia Hill Pit Geotechnical Report”*.

Newcrest (2015) *“Cadia Hill Pit Cutback 4 Geotechnical Pre-Feasibility Study”*.

New South Wales Office of Water (2012) *“NSW Aquifer Interference Policy”*.

Appendix A **Response to Aquifer Interference Policy Requirements**

AIP requirement		Response	
		Approved operations	Proposed modification
1	Described the water source (s) the activity will take water from?	<ul style="list-style-type: none"> Lachlan Fold Belt MDB Groundwater Source Orange Basalt Groundwater Source 	No change due to Modification
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	<ul style="list-style-type: none"> Lachlan Fold Belt MDB Groundwater Source – 1024.1 ML/yr¹ Orange Basalt Groundwater Source – 314.6 ML/yr¹ average 	No additional take due to Modification
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	Peak will occur during mining, and reduce post mining	The impact of the evaporative pumping effect from the Cadia Hill subsidence zone final void post mining will be reduced due to the Modification as tailings waters will fill the final void more quickly reducing the inflow of groundwater
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (page 27)	Numerical model used subjected to 3D transient calibration – refer AGE (2016)	Modification will not result in significant change to environmental impacts therefore no additional modelling required
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	<ul style="list-style-type: none"> Lachlan Fold Belt MDB Groundwater Source – 1,024.1 ML/yr¹ Orange Basalt Groundwater Source – 314.6 ML/yr¹ average 	No additional take due to Modification
6	Described how any licence exemptions might apply?	N/A	N/A
7	Described the characteristics of the water requirements?	Yes – refer AGE (2016)	No additional water requirements due to Modification

¹ Note – the licensed quantities shown incorporate a multiplier for the unit share

AIP requirement		Response	
		Approved operations	Proposed modification
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	<p>Yes:</p> <ul style="list-style-type: none"> WAL31072 - Units 408.1 ML¹, Lachlan Fold Belt MDB Groundwater Source WAL36229 - Units 1024.1 ML¹, Lachlan Fold Belt MDB Groundwater Source WAL31062 - Units 314.6 ML¹, Orange Basalt Groundwater Source 	No additional take due to Modification
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	Yes	No change for Modification
10	Determined how it will obtain the required water?	Yes	No additional water required for Modification
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	N/A	N/A
12	Considered actions required both during and post-closure to minimise the risk of inflows to a mine void as a result of flooding?	Post-mining the Cadia Hill and Cadia East subsidence zone combined final void will flood and lakes will form in the subsidence voids	No change due to Modification
13	Developed a strategy to account for any water taken beyond the life of the operation of the Project?	Surrendering of water licences post-mining if required	No change due to Modification
	<p><i>Will uncertainty in the predicted inflows have a significant impact on the environment or other authorized water users?</i></p> <p><i>Items 14-16 must be addressed if so.</i></p>		No - continued tailings emplacement will reduce inflow to Cadia Hill open pit
14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?		No potential to cause or enhance hydraulic connections

AIP requirement		Response	
		Approved operations	Proposed modification
15	Quantified any other uncertainties in the groundwater or surface water impact modelling conducted for the activity?	Yes - sensitivity analysis undertaken by AGE (2016)	Pit water balance updated for proposed tailings emplacement modification – refer HEC (2019)
16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?	Yes - ongoing monitoring and routine updates to groundwater model in accordance with Schedule 3, Condition 34(d) of PA 06_0295	No additional strategies beyond those outlined within the Water Management Plan considered necessary

Determining water predictions in accordance with Section 3.2.3

AIP requirement		Response	
		Approved operations	Proposed modification
1	Addressed the minimum requirements found on page 27 of the AIP for the estimation of water quantities both during and following cessation of the proposed activity?		The impact of the evaporative pumping effect from the Cadia Hill subsidence zone final void post-mining will be reduced due to the Modification as tailings waters will fill the final void more quickly reducing the inflow of groundwater

Other requirements to be reported on under Section 3.2.3

AIP requirement		Response	
		Approved operations	Proposed modification
1	Establishment of baseline groundwater conditions?	Yes - previously provided	Yes known from monitoring – no change from Modification
2	A strategy for complying with any water access rules?	Yes - refer Water Management Plan	Not applicable as no additional water take expected
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	Yes - predictions provided in previous approval documents	During operations there is potential for the Cadia Hill Pit to act as a source – whilst impacts to landholders are considered improbable engineering measures are proposed to prevent any seepage of tailings affected waters into local water sources

AIP requirement		Response	
		Approved operations	Proposed modification
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	Yes - predictions provided in previous approval documents	No additional impacts on licensed water users in connected groundwater and surface water sources predicted
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	Yes - predictions provided in previous approval documents	No additional drawdown impacts predicted
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	Yes - predictions provided in previous approval documents-previous predictions that the Cadia Hill and Cadia East subsidence zone combined final void will form an evaporative sink concentrating salts and may include acid rock drainage (ARD)	No change due to Modification with implementation of proposed engineering measures to prevent seepage from the Cadia Hill pit
7	Potential to cause or enhance hydraulic connection between aquifers?	Yes - predictions provided in previous approval documents	No potential for cause or enhance hydraulic connection between aquifers
8	Potential for river bank instability, or high wall instability or failure to occur?	N/A	N/A
9	Details of the method for disposing of extracted activities (for CSG activities)?	N/A	N/A

Addressing the minimal impact considerations

Aquifer	Fractured rock - Orange Basalt	
Category	Highly productive	
Level 1 minimal impact consideration	Previous assessment	Proposed modification
<p><u>Water table</u> 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: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan. OR A maximum of a 2 m water table decline cumulatively at any water supply work.</p>	<p>Acceptable</p> <ul style="list-style-type: none"> No high priority groundwater dependent ecosystems or culturally significant sites have been identified within the predicted zone of depressurisation. Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m. 	<p>No additional drawdown predicted due to proposed Modification. No change due to Modification.</p>
<p><u>Water pressure</u> A cumulative pressure head decline of not more than a 2 m decline, at any water supply work.</p>	<p>Acceptable</p> <ul style="list-style-type: none"> Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m. 	<p>No change due to Modification.</p>

Aquifer	Fractured rock - Orange Basalt	
Category	Highly productive	
Level 1 minimal impact consideration	Previous assessment	Proposed modification
<p><u>Water quality</u> Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.</p>	<p>Acceptable</p> <ul style="list-style-type: none"> • Groundwater flow is towards Cadia Hill and Cadia East - therefore, there will be no change in the beneficial use category of the basalt. • Post-mining, the Cadia Hill and Cadia East subsidence zone combined final void will remain a permanent sink to groundwater and therefore the flow will be into the void and there will be no change in the beneficial use category of the basalt. • Previous predictions that the Cadia Hill and Cadia East subsidence zone combined final void will form an evaporative sink concentrating salts and may include ARD. • Transfer of tailings supernatant water to the open pit is approved. 	<p>During operations there is some potential for outward hydraulic gradient in the southern section of the pit. This potential should be reduced using engineering measures where feasible</p> <p>Post-mining, a sink is expected (i.e. flow towards the pit).</p>

Aquifer	Porous rock or fractured rock – Silurian and Ordovician Bedrock - Lachlan Fold Belt MDB Groundwater Source	
Category	Less productive	
Level 1 Minimal impact consideration	Previous assessment	Proposed modification
<p><u>Water table</u> 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: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan.</p> <p>OR A maximum of a 2 m water table decline cumulatively at any water supply work.</p>	<p>Acceptable</p> <ul style="list-style-type: none"> No high priority groundwater dependent ecosystems or culturally significant sites have been identified within the predicted zone of depressurisation – Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m – 	<p>No change due to Modification</p> <p>No change due to Modification</p>
<p><u>Water pressure</u> A cumulative pressure head decline of not more than a 2 m decline, at any water supply work.</p>	<p>Acceptable</p> <ul style="list-style-type: none"> Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m – 	<p>No change due to Modification.</p>

Aquifer	Porous rock or fractured rock – Silurian and Ordovician Bedrock - Lachlan Fold Belt MDB Groundwater Source	
Category	Less productive	
Level 1 Minimal impact consideration	Previous assessment	Proposed modification
<p><u>Water quality</u> Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.</p>	<p>Acceptable</p> <ul style="list-style-type: none"> • Groundwater flow is towards Cadia Hill - therefore, there will be no change in the beneficial use category of the water source. • Post-mining the Cadia Hill and Cadia East subsidence zone combined final void will remain a permanent sink to groundwater and therefore the flow will be into the void and there will be no change in the beneficial use category of the water source. • Previous predictions that the Cadia Hill and Cadia East subsidence zone combined final void will form an evaporative sink concentrating salts and may include ARD. • Transfer of tailings and supernatant water to the open pit is approved. 	<p>During operations there is some potential for outward hydraulic gradient in the southern section of the pit which could influence groundwater quality. Engineering measures are proposed to prevent this occurring.</p> <p>Post-mining, a sink is expected (i.e. flow towards the pit).</p>