CADIA EAST SURFACE PRECONDITIONING PROGRAM

ENVIRONMENTAL ASSESSMENT

PREPARED BY
CADIA HOLDINGS PTY LIMITED

FEBRUARY 2014
Project No. NEC-13-79
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1 INTRODUCTION

The Cadia Valley Operations are located approximately 25 kilometres (km) south-west of Orange, in the Central Tablelands of New South Wales (NSW) (Figure 1). Cadia Holdings Pty Limited (CHPL) is the owner and operator of the Cadia Valley Operations and is a wholly owned subsidiary of Newcrest Mining Limited (Newcrest).

Project Approval (PA) for the Cadia East Project was granted by the NSW Minister for Planning under Part 3A of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 6 January 2010 (PA 06_0295). The approval includes all components of the mining operations at Cadia (as described in Schedule 1 of the PA) including the Cadia East underground mine, the Cadia Hill open cut mine, the Ridgeway underground mine, the Concentrate Dewatering Facilities, and ancillary infrastructure. These integrated operations are herein referred to as the Cadia Valley Operations.

1.1 OVERVIEW OF THE EXISTING CADIA VALLEY OPERATIONS

The Cadia Hill open pit, Ridgeway underground mine and Cadia East underground mine are located in the Cadia Valley within Mining Lease (ML) 1405, ML 1472, ML 1481 and ML 1449 (Figure 1). The Concentrate Dewatering Facility is located approximately 25 km to the east of the Cadia Valley in the town of Blayney (Figure 1).

Mining at the Cadia Valley Operations commenced at Cadia Hill in 1998. Ridgeway commenced production using the sub-level caving method in 2002, and Cadia East commenced panel caving in 2013 after a two year construction and underground development phase.

Up to approximately 27 million tonnes per annum (Mtpa) of ore is mined at the Cadia Valley Operations. Mineral concentrate containing gold and copper is pumped approximately 30 km from the Cadia Valley Operations to the nearby town of Blayney, where it is dewatered and then loaded onto trains for transport to Port Kembla on the eastern seaboard.

Operations at the Cadia Hill open pit ceased in 2012, and are currently under care and maintenance. With the Ridgeway Deeps extension, Ridgeway is currently scheduled to cease operations in 2017.

Cadia East involves panel cave mining to extract approximately 450 million tonnes (Mt) of ore over a period of 21 years. The ore contains gold, copper and some molybdenum. Cadia East extends the life of the Cadia Valley Operations to approximately 2030. Figure 2 shows the approved General Arrangement at the end of the currently approved mine life.

Cadia East is described in full in the Cadia East Project Environmental Assessment (the Cadia East EA) (CHPL, 2009).

1.2 OVERVIEW OF THE CADIA EAST PRECONDITIONING PROGRAM MODIFICATION

The proposed Cadia East Surface Preconditioning Program Modification (the proposed Modification) involves the use of approximately ten existing/approved diamond drill holes to conduct a preconditioning program from the surface in to the host rocks above the Cadia East orebody. The preconditioning would involve the use of hydrofracturing to increase the number of cracks and fissures in the host rocks so that subsidence above the orebody occurs in a controlled manner.

A full description of the proposed Modification is provided in Section 2.

1.3 LEGISLATIVE FRAMEWORK

Approval for the proposal is sought as a modification to the Project Approval (PA 06_0295) under section 75W of the EP&A Act. Section 75W of the EP&A Act relevantly provides:

> ***75W Modification of Minister's approval***
>
> *(1) In this section:*
>
> ***Minister's approval** means an approval to carry out a project under this Part, and includes an approval of a concept plan.*
>
> ***modification of approval** means changing the terms of a Minister's approval, including:*
>
> *a) revoking or varying a condition of the approval or imposing an additional condition of the approval, and*
>
> *b) changing the terms of any determination made by the Minister under Division 3 in connection with the approval.*
>
> *(2) The proponent may request the Minister to modify the Minister's approval for a project. The Minister's approval for a modification is not required if the project as modified will be consistent with the existing approval under this Part.*
>
> *(3) The request for the Minister's approval is to be lodged with the Director-General. The Director-General may notify the proponent of environmental assessment requirements with respect to the proposed modification that the proponent must comply with before the matter will be considered by the Minister.*
>
> *(4) The Minister may modify the approval (with or without conditions) or disapprove of the modification.*
>
> *…*

1.4 CONSULTATION FOR THE PROPOSED MODIFICATION

CHPL provided a brief overview of the proposed Modification to the Department of Planning and Infrastructure on 16 December 2013.

In November and December 2013 CHPL consulted with the Division of Resources and Energy (DRE), which is part of the NSW Department of Trade and Investment, regarding the installation of the ten surface diamond holes that would be used to conduct the Cadia East Surface Preconditioning Program. Approval to install the exploration holes was granted by the DRE on 6 December 2013 via a Surface Disturbance Notice (SDN).

1.5 DOCUMENT STRUCTURE

This EA is structured as follows:

Section 1	Provides an introduction to the proposed Modification and the purpose of this EA, describes the structure of this EA and provides a summary of the consultation undertaken.
Section 2	Describes the approved Cadia East Project and the proposed Modification.
Section 3	Details the environmental assessment for the proposed Modification.
Section 4	Provides a conclusion to this EA.
Section 5	Lists documents and reports referenced in this document.

2 PROJECT DESCRIPTION

2.1 OVERVIEW OF THE APPROVED PRECONDITIONING ACTIVITIES

Panel Cave Mining Method

The Cadia East panel caving operation would be conducted in three lifts (i.e. Lifts 0, 1 and 2). The Cadia East EA (CHPL, 2009) describes how the relative elevation of these lifts and all underground infrastructure is expressed in mine height datum which is 5,000 metres (m) above Australian Height Datum (AHD) (i.e. 5,900 m mine Relative Level [RL] is equivalent to 900 m AHD). Lifts 0, 1 and 2 would be approximately 400 m high with their bases located at 5,050 m RL, 4,650 m RL and 4,250 m RL, respectively.

The Cadia East mining method involves inducing caving of the rock mass by undercutting a block of ore. Mining proceeds by progressively advancing an "undercut" level beneath the block of ore. Above the undercut level, the overlying host rocks are pre-conditioned using blasting and/or hydraulic fracturing, resulting in controlled fracturing of the ore block. Figure 3 provides a schematic diagram of the panel caving ore extraction method during the mine life.

Following pre-conditioning of the overlying host rocks, broken ore is removed through an extraction level developed below the undercut level. The extraction level is connected to the undercut level by draw-bells, through which the ore gravitates to draw-points on the extraction level (Figure 3). The ore would then be removed by a load-haul-dump fleet to underground crushing stations.

Preconditioning Methods

Hydraulic Fracturing Technique

The Cadia East EA describes how pre-conditioning using hydraulic fracturing would be conducted at Cadia East to improve the fragmentation and caving characteristics of the ore, prior to panel cave mining being initiated.

Hydraulic fracturing involves isolating sections of ore via drilling and creating a pressurised zone by pumping water into the system until the tensile strength of the rock is reached and a fracture is created. Once the fracture is created it is extended by pumping water at a rate of up to approximately 300 litres (L) per minute.

The Cadia East EA describes that once the planned fracture extension is achieved, the pressure would be released and up to 60 percent (%) of the total water injected would be recovered via the mine dewatering system. Estimated water consumption for hydraulic fracturing would be approximately 0.2 L per tonne of preconditioned ore or up to approximately 5 megalitres (ML) of water per annum. Approximately 3 ML of water per annum would be recovered.

The Cadia East EA did not identify or assess hydraulic fracturing of the host rocks above the Cadia East mineralisation (e.g. weakly mineralised and unmineralised Ordovician porphyritic and vocaniclastic rocks and Silurian shales and sandstones).

Blasting Technique

The Cadia East EA also describes how preconditioning using drilling and blasting may be used instead of or as well as hydraulic fracturing.

The blasting technique would involve the development of long, vertical drill holes from the undercut or extraction levels and controlled and precise detonation of explosives. Estimated consumption of bulk emulsion explosive would be approximately 0.003 kilograms per tonne of preconditioned ore using up to a Maximum Instantaneous Charge of 1,500 kilograms of explosives per delay. Preconditioning of the Cadia East underground mine orebody using this technique would involve use of up to approximately 110 tonnes per annum of emulsion explosive.

2.2 DESCRIPTION OF THE PROPOSED MODIFICATION

Operational experience, exploration, geotechnical drilling and modelling conducted since the Cadia East Mine was approved in 2010 have shown that some the host rocks above the Cadia East mineralisation require preconditioning in order for the caving and subsidence zone to advance within design and safety parameters.

The proposed Modification would involve the use of approximately ten existing/approved diamond drill holes, which are being installed from the surface during the period from January to March 2014. As described in Section 1.4, installation of the diamond drill holes is being conducted in accordance with a SDN issued by the DRE on 6 December 2013. When completed, the holes will have a staggered pattern with a spacing of approximately 90 m. The holes will be approximately 350 to 750 m in length, which places their base directly above the Cadia East underground workings.

The location of the holes on the surface is shown on Figure 4. The existing/approved holes are all situated within the footprint of the approved Cadia East subsidence zone (i.e. the area in which they occur will be destroyed when the Cadia East subsidence zone breaks through to the surface). Access to the holes would be via existing tracks or new tracks and drill pads approved under the SDN issued by the DRE in December 2013 (Section 1.4). Once drilled, half of the diamond drill holes will be filled with a cement-based grout which would remain in place until the preconditioning occurs. The purpose of the grout would be to maintain the integrity of the hole (i.e. prevent collapse or filling by loose rock) and to prevent groundwater loss or contamination. Monitoring equipment may be included within the grout plugs. The remaining holes will be left open to allow monitoring of any air gap formation in the top of the cave. These holes would then be grouted at the commencement of the preconditioning program with a minimum of 28 days curing time before the grout would be reamed out and preconditioning would take place.

The first step in the hydraulic fracturing process would be to drill out the majority of the grout in the drill holes, leaving just a thin film on the wall to stabilise it. Since the cement grout would be softer than rock, up to 200 m per 11 hours can be reamed. The only drilling chemical required for the grout removal is an organic, biodegradable drilling product (i.e. AMC CR-650), which is used to help lift the cuttings from the hole. This product would be collected in the drilling sumps along with the drilling water and grout fines (i.e. drilling mud). Once the grout reaming is completed the drilling mud would be pumped from the sumps and transferred to the Cadia Valley Operations tailings storage facilities for permanent disposal (i.e. mixing with tailings and burial).

Once the holes have been reamed out and prepared, the hydraulic fracturing would be conducted using the same methods described and assessed in the Cadia East EA (i.e. water would be pumped into the hole until the tensile strength of the host rock is reached and a fracture is created that radiates approximately 50 m from the drill hole). Fractures would be installed at vertical intervals of approximately 2 m in the target areas of each hole.

Figure 5 is a schematic diagram showing the approximate locations of the drill holes, the proposed extent of the hydraulic fracturing zone for each hole, and the approved/existing Cadia East underground development and mineralisation areas.

The equipment required on the surface to conduct the Surface Preconditioning Program would consist of a surface drilling rig (e.g. UDR1200) secured to the ground by cables, or an underground rig bolted to a cement pad. The drill rig would be used to pump water into the drill holes and would operate 24 hours a day.

Approximately 12,000 L of water would be used per hydraulic fracture, which would equate to approximately 20 ML of water for the entire Surface Preconditioning Program. No additives would be used for the preconditioning (i.e. only water would be used).

The precondition water would be obtained from the existing approved Cadia Valley Operations water supply network (e.g. Rodds Creek Dam or alternative existing water storage) and would be trucked to the drill pad and temporarily stored in poly tanks on the surface. The water used for the preconditioning would not be pumped back to the surface, rather it is expected to drain downwards and into the Cadia East underground workings where it would be collected and recycled as part of the overall mine water system.

3 ENVIRONMENTAL REVIEW

3.1 WATER RESOURCES

A Groundwater Assessment for the Project was conducted as part of the Cadia East EA by Australian Groundwater and Environmental Consultants Pty Ltd (AGE) (2009) and was peer reviewed by Dr Noel Merrick. The assessment included a comprehensive review of the available hydrogeological information and groundwater monitoring results, and the development and use of regional numerical groundwater model. A summary of the hydrogeology of the Cadia East area is provided below based on the AGE (2009) assessment.

The Cadia East deposit is hosted in Ordovician porphyritic and vocaniclastic rock units, and in parts by 100 to 300 m of Silurian shales and sandstones. A thin Tertiary basalt cap also occurs in the north-eastern section of the Cadia East subsidence zone.

The Ordovician volcaniclastic rock units in the Cadia East area are part of the Forest Reefs Volcanics. The groundwater aquifer within these rock units is relatively low yielding, and in general it has a higher salt content than the groundwater in the Tertiary basalt and Silurian aquifers. Recharge to the Ordovician aquifer occurs via direct rainfall infiltration at the surface and leakage from overlying Tertiary basalt and Silurian aquifers. AGE (2009) suggests that groundwater discharge from the Ordovician volcanics occurs predominantly via baseflow into local creeks (i.e. Swallow Creek, Cadiangullong Creek and the southern section of Flyers Creek).

The hydraulic conductivity of the Silurian groundwater aquifer is typically relatively low, however in areas where fractures are closely spaced hydraulic conductivities can be locally higher (AGE, 2009). Recharge to the Silurian aquifer is believed to occur via direct rainfall infiltration at the surface and leakage from the overlying Tertiary basalt (AGE, 2009). Groundwater discharge occurs predominantly to creeks incised into the Silurian sediments including Copper Gully, Flyers Creek and Rodds Creek. The available water quality data for the Silurian aquifer shows that it has relatively low salinity.

Tertiary basalt in the Orange region originated from Mount Canobolas and covers an extensive area to the north and north-east of the Cadia Valley Operations. The thickness of the basalt varies between a few metres and approximately 150 m (AGE, 2009). The Tertiary basalt contains what is known as the Orange basalt fractured rock aquifer. AGE's review of the NSW registered bore database in 2009 indicated that approximately 960 bores have been drilled in the Orange basalt fractured rock aquifer since 1952. The dominant groundwater use is stock and domestic, with some irrigation undertaken where bore yields are higher. The review also indicated that the median yield is approximately 1.25 litres per second (L/s), with 96% of bores having yields of less than 10 L/s.

In accordance with Condition 34 of Schedule 3 of Project Approval PA 06_0295, CHPL has prepared a Groundwater Monitoring Program which, amongst other things, includes programs to monitor the volume of water seeping into the underground workings, a program to monitor the impacts on the groundwater supply of potentially landowners, and the impacts on springs and groundwater dependent ecosystems. These programs would be sufficient to monitor the effects of the Surface Preconditioning activities, without the need for additional monitoring sites, parameters or changes to the monitoring frequency.

The proposed Modification could potentially impact local groundwater resources through the pumping of additional water into the Ordovician host rocks and aquifer located above the Cadia East mineralisation.

AGE (2014) has conducted a review of the potential impacts of the proposed Modification on the groundwater resources in the Cadia Valley (Attachment 1). The review concluded that the proposed preconditioning would not induce additional fracturing beyond that already accounted for by the regional numerical groundwater modelling of the Cadia Valley Operations.

AGE (2014) identified that the proposed preconditioning would cause some fracturing to the surface approximately two to three years earlier than was represented in the groundwater model. However, the area in which the preconditioning would occur covers a relatively small portion of the total subsidence zone and the available data from monitoring bores indicates that the Silurian sequence is dry and the Tertiary basalt is not present. The Silurian sequence varies in thickness, and therefore some areas of fractured and saturated Silurian may be present, particularly along faults zones within the preconditioning area. Where present, these areas would be the source of most of the seepage from the Silurian sequence within the preconditioned area.

Notwithstanding, AGE (2014) identified that seepage from the Silurian sequence has already been accounted for by the groundwater modelling, and it is only the timing of the seepage that would change due to the preconditioning. AGE (2014) therefore concluded that the preconditioning would have no net additional impact on the groundwater regime beyond that predicted by the numerical modelling (i.e. the predicted location and magnitude of the regional groundwater drawdown would remain unchanged).

The proposed preconditioning would not change the amount of water that would drain to and accumulate in the Cadia East underground workings (i.e. no change to groundwater extraction amounts). As a result, the current mine dewatering licences would not require any changes.

3.2 NOISE

A comprehensive noise and blasting assessment for the Cadia East Project was undertaken by Wilkinson Murray (2009) as part of the Cadia East EA. The Noise and Blasting Assessment included assessment of:

- potential on-site operational noise impacts from the Cadia Valley Operations (including the Cadia East activities);
- potential noise impacts from the Concentrate Dewatering Facility;
- potential blasting impacts from the Cadia Valley Operations (including the Cadia East activities); and
- potential off-site road traffic noise impacts.

An acoustic model was developed and used to simulate the Cadia Valley Operations components and noise source information (i.e. sound levels and locations). The model also considered meteorological effects, surrounding terrain, distance from source to receiver and noise attenuation. The predicted operational and construction noise levels were generally lower than the Project-specific criteria at each assessed receiver location during daytime, evening and night-time operations for all modelled scenarios.

In accordance with Condition 9 of Schedule 3 of Project Approval PA 06_0295, CHPL has prepared a detailed Noise Monitoring Program for the Cadia Valley Operations. The Program describes the unattended and attended monitoring measures that are used, as well as the noise monitoring protocol that has been adopted to evaluate compliance with the noise impact assessment and land acquisition criteria specified in Project Approval PA 06_0295.

The proposed Modification could potentially affect the local acoustic amenity through the use of the surface drill rig to pump water into the holes used for hydrofracturing. Wilkinson Murray (2014) has conducted a review of the potential noise impacts of the proposed Modification (Attachment 2). The review concluded that the predicted noise levels of the pump and drill rig alone are at least 14 decibels (dBA) below the relevant noise criteria at all receivers during the worst case night-time noise emission. At receivers closest to the pre-conditioning location, the noise from the pump and drill rig could increase the overall mine noise level by up to 1 dBA, depending on the location of the preconditioning activities. Wilkinson Murray (2014) concluded that this amount of change in noise levels is generally regarded as being imperceptible by the majority of people.

At no location is the minor increase in noise levels predicted to result in the noise impact assessment and land acquisition criteria specified in Project Approval PA 06_0295 being exceeded.

3.3 OTHER ASPECTS

The proposed Modification would not require any additional land disturbance as it would use a combination of existing drill pads and access tracks, or the new tracks approved under the SDN issued by the DRE in December 2013 (Section 1.4). As indicated previously, the entire area in which the activities would occur are already approved to be disturbed as they fall within the Cadia East subsidence zone. Notwithstanding, CHPL would adopt its existing land management practices when conducting the Surface Preconditioning Program (e.g. fire, weed and pest control measures, land and water contamination controls).

The proposed Modification would not involve any activities that could potentially generate significant quantities of dust or adversely affect air quality.

4 CONCLUSION

The existing Project Approval (PA 06_0295) for the Cadia Valley Operations authorises preconditioning of the Cadia East orebody using hydrofracturing or blasting, however it does not currently allow for preconditioning of the host rocks above the Cadia East orebody.

CHPL wishes to conduct a preconditioning program from the surface at Cadia East using hydrofracturing. The proposed program would involve the use of approximately ten existing/approved diamond drill holes that extend approximately 350 to 750 m from the surface into the weakly mineralised and unmineralised host rocks above the Cadia East orebody. Water would be pumped into the holes and used to create fractures that radiate out approximately 50 m from each drill hole. The area in which the Surface Preconditioning Program would be undertaken is located entirely within the approved Cadia East subsidence zone.

A drill rig located on the surface would be used to pump water into the holes and precondition the host rocks, with the water allowed to drain downwards into the underlying Cadia East development and mining areas (where it would be collected and recycled). The preconditioning program would be conducted 24 hours a day over a period of 3 to 6 months.

Approval for the Cadia East Surface Preconditioning Program is being sought via a modification to Project Approval PA 06_0295 under section 75W of the EP&A Act. An environmental assessment has been conducted and is documented in this report. The assessment includes reviews by AGE (groundwater) and Wilkinson Murray (noise), which both conclude that the proposed program would not result in any significant additional impacts when compared with the Cadia East EA and Project Approval PA 06_0295. No other material impacts on other environmental aspects (e.g. land resources, ecological values, amenity or heritage values) are predicted to occur.

5 REFERENCES

Australasian Groundwater and Environmental Consultants Pty Ltd (2009) *Cadia East Project Groundwater Assessment*. Report prepared for Cadia Holdings Pty Limited.

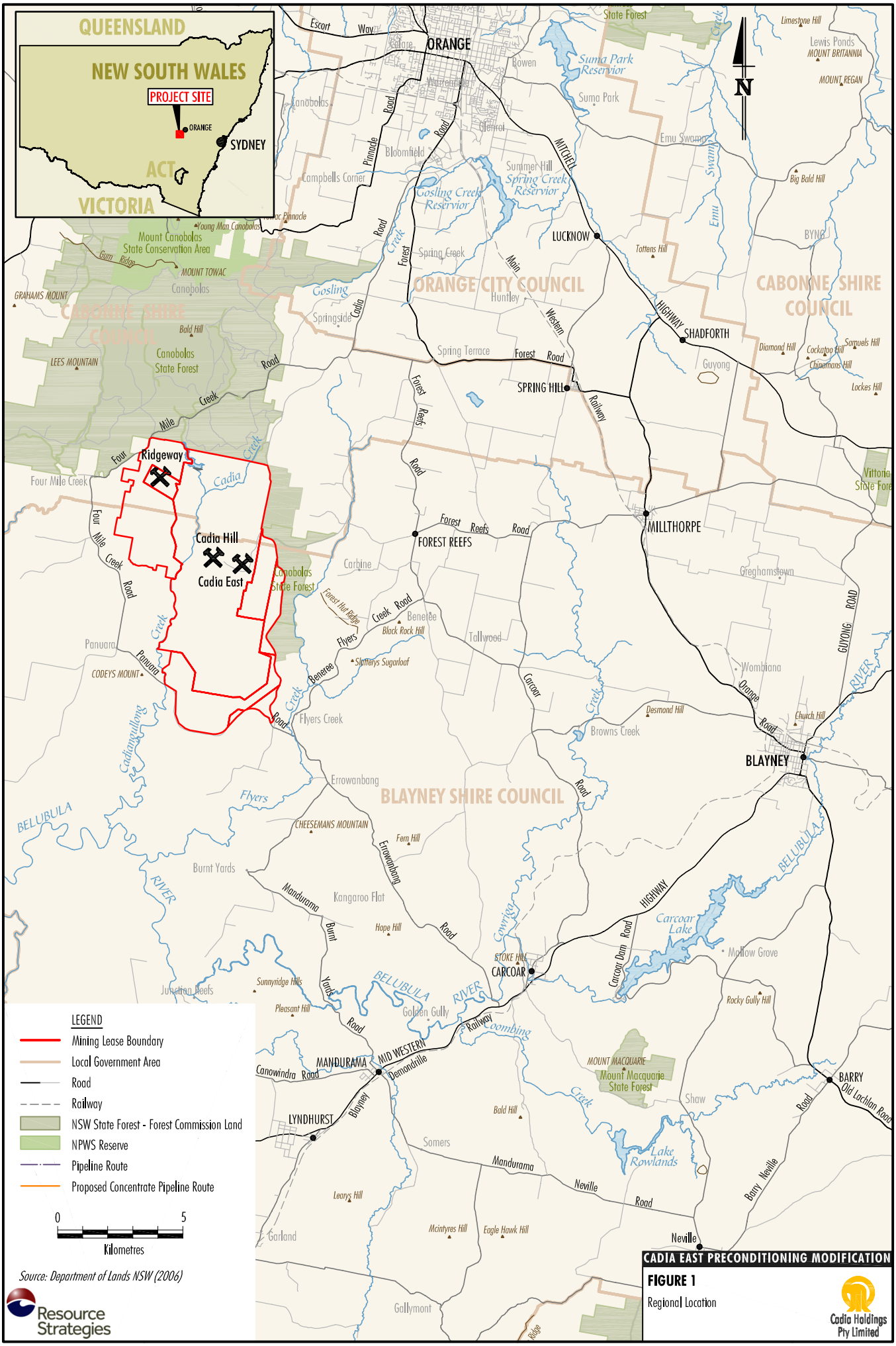
Australasian Groundwater and Environmental Consultants Pty Ltd (2014) *Cadia East Surface Preconditioning Program*. Letter report prepared for Cadia Holdings Pty Limited.

Cadia Holdings Pty Limited (2009) *Cadia East Environmental Assessment.*

Wilkinson Murray Pty Ltd (2009) *Cadia East Project Noise and Blasting Impact Assessment*. Report prepared for Cadia Holdings Pty Limited.

Wilkinson Murray Pty Ltd (2014) *Cadia East Surface Preconditioning Program*. Letter report prepared for Cadia Holdings Pty Limited.

FIGURES



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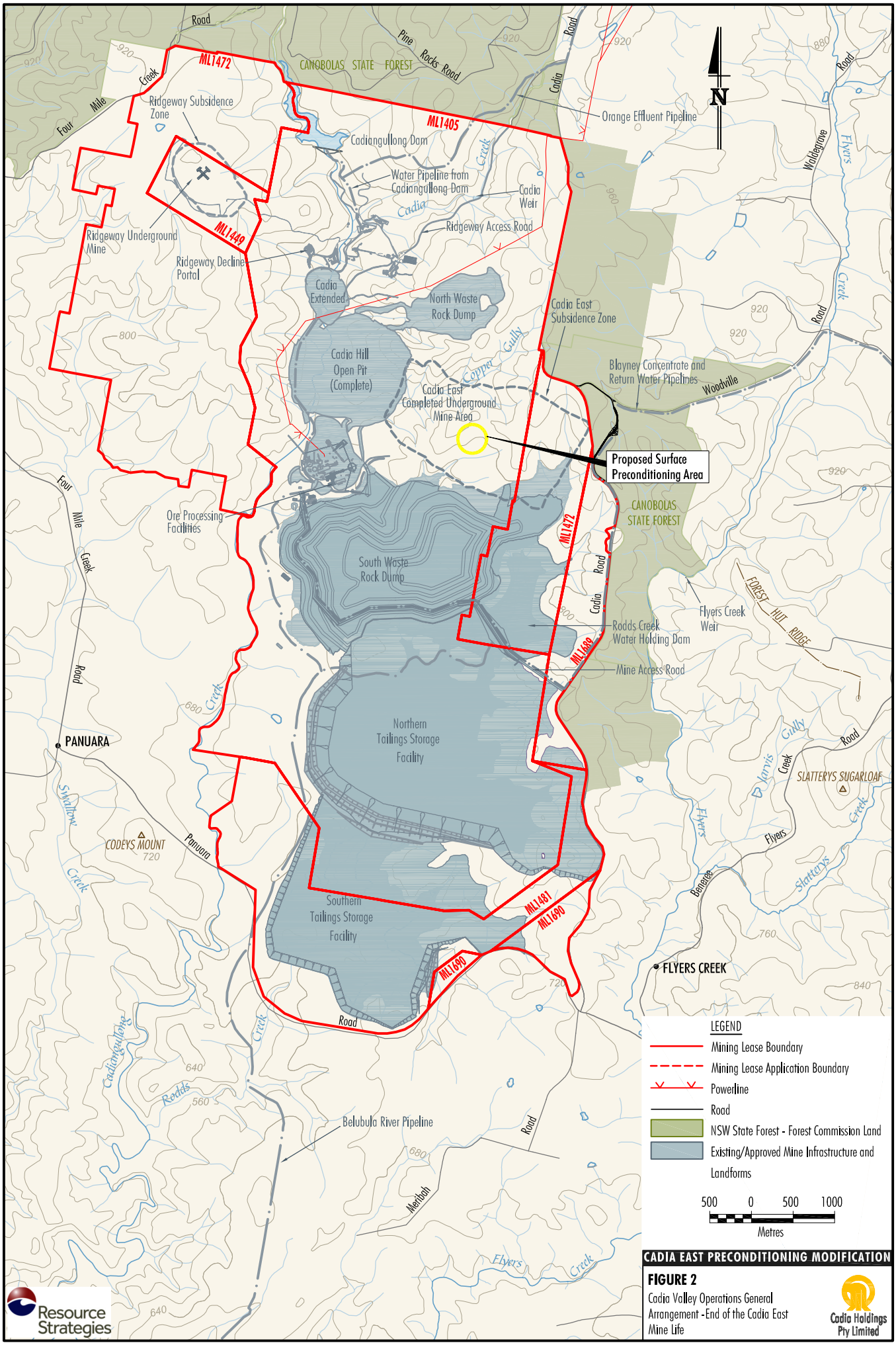


CADIA EAST PRECONDITIONING MODIFICATION

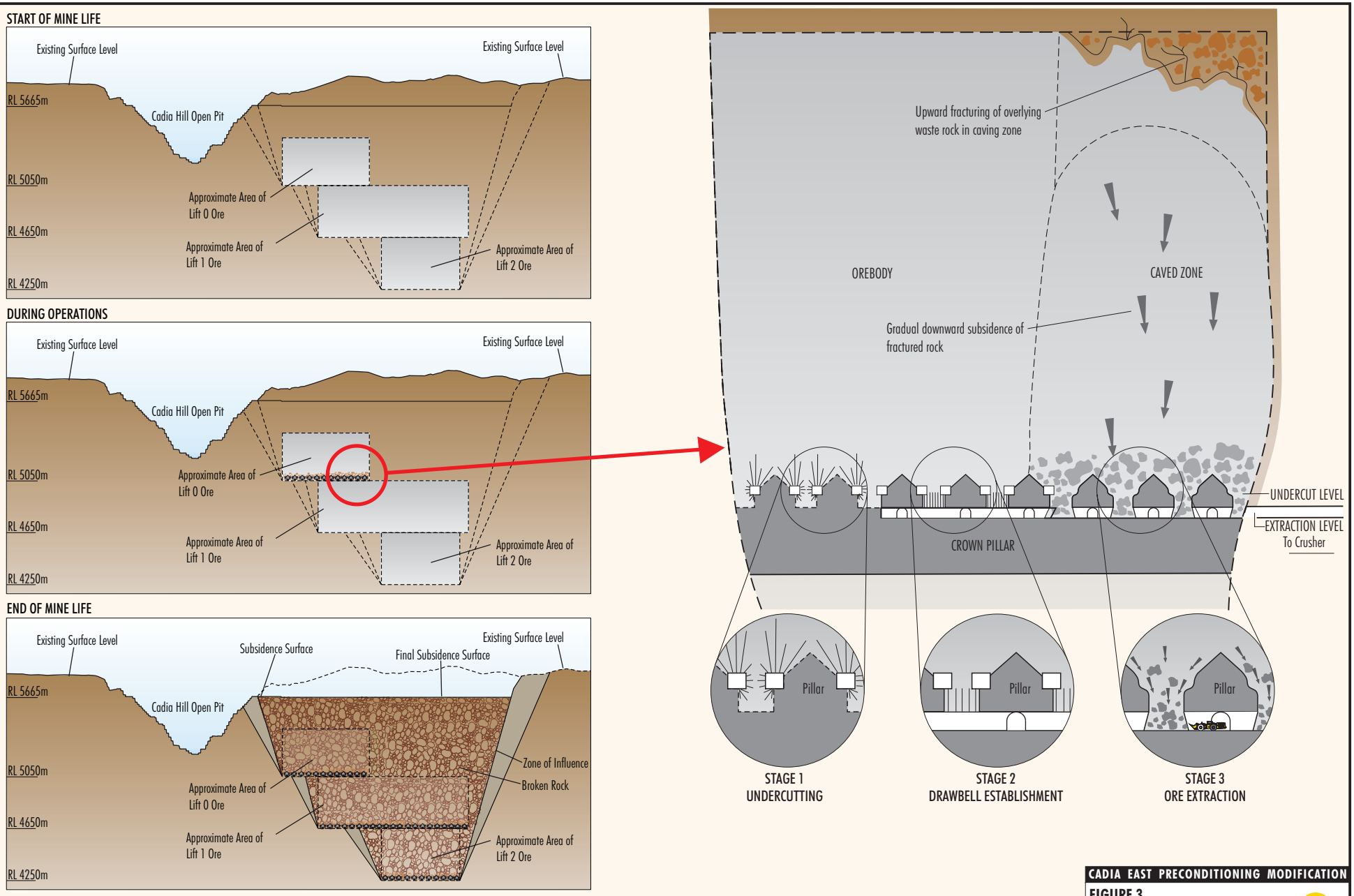
FIGURE 2

Cadia Valley Operations General Arrangement - End of the Cadia East Mine Life

Resource Strategies

Cadia Holdings Pty Limited

NEC-13-79 CEHFP_102C



Resource Strategies

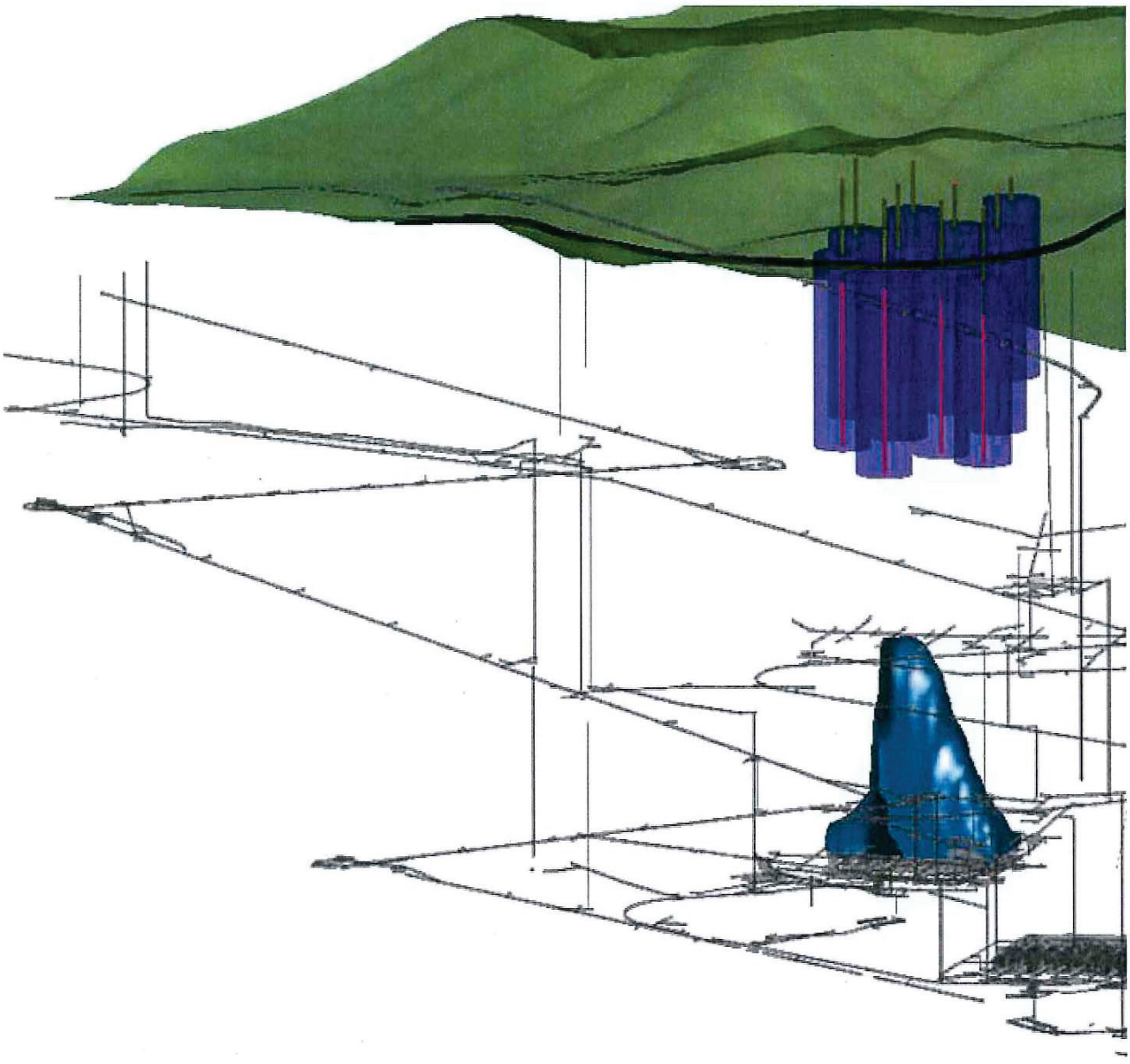
NEC-13-79 CEHFP_001B

CADIA EAST PRECONDITIONING MODIFICATION

FIGURE 3
Panel Caving Mining Method Schematic

Cadia Holdings Pty Limited

NEC-13-79 CEHFP_103A



CADIA EAST PRECONDITIONING MODIFICATION

FIGURE 5
Schematic Diagram Showing the Proposed Hydraulic Fracturing Areas

Resource Strategies

Cadia Holdings Pty Limited

NEC-13-79 CEHFP_002B

ATTACHMENT 1

GROUNDWATER ASSESSMENT

Australasian Groundwater
and Environmental Consultants Pty Ltd
Level 2 / 15 Mallon Street
Bowen Hills, QLD 4006 Australia

ABN 64 080 238 642
T. +61 7 3257 2055
F. +61 7 3257 2088
brisbane@ageconsultants.com.au
www.ageconsultants.com.au

JST/ae (G1383B.Cadia_Mod)
7 February 2014

Mr Andrew Wannan
Manager Environment
Cadia Valley Operations – Newcrest Mining Limited
via email

Dear Andrew,

RE: CADIA EAST PRECONDITIONING – 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 comprise one open cut mine (Cadia Hill), and two underground mines (Ridgeway and Cadia East). Cadia Holdings Pty Limited owns and operates the Cadia Valley Operations and is a wholly owned subsidiary of Newcrest Mining Limited.

The Cadia East mining method induces controlled caving of the rock mass by undercutting a block of ore. Mining proceeds by advancing an "undercut" level beneath the block of ore. Above the undercut level, the overlying host rocks are pre-conditioned by drilling from the underground mine and blasting and/or hydraulic fracturing the ore block.

To improve the controlled caving of the rock mass, Cadia Valley Operations propose to 'precondition', from the surface, the host rocks above the Cadia East orebody. The preconditioning program would consist of ten existing/approved surface diamond drill holes that would be hydro-fractured to increase the number of cracks and fissures in the host rocks so that subsidence above the orebody occurs in a controlled manner. Cadia Valley Operations seeks a modification to the current project approval to conduct the surface preconditioning program.

Cadia Holdings Pty Limited engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to assess the impacts of the proposed preconditioning program on the groundwater regime. This letter reviews the groundwater regime and discusses the impacts of the proposed preconditioning program. The impacts are also compared with the requirements of the Aquifer Interference Policy.

2 GROUNDWATER REGIME

Previous Work

Australasian Groundwater and Environmental Consultants Pty Ltd [AGE] (2009) assessed the impact of the Cadia East Mine on the groundwater regime using a numerical model, which was part of the Environmental Assessment (EA). The NSW Minister for Planning approved the Cadia East Project on 6 January 2010. The conditions of approval required Cadia Valley Operations to install a monitoring bore network within the predicted zone of drawdown and update the numerical model. AGE (2013) subsequently supervised the drilling and installation of the monitoring bore network and updated the groundwater flow model to including a transient calibration. AGE presented the findings of the drilling and updated modelling to the New South Wales Office of Water (NOW) during a meeting in Forbes on 8 August 2013. The sections below draw upon the work described by AGE (2009) and AGE (2013) to describe the groundwater regime and predicted impacts of mining.

Hydrostratigraphic Units

There are three major hydrostratigraphic units within the project site and region:

- Tertiary basalt, which forms a productive aquifer utilised by surrounding properties with varying yields from low to high and consistently fresh water suitable for potable use;
- the underlying Silurian sequence which is more variable but can form a low yield aquifer from fractured sandstone and siltstones, with locally high yields where fractured limestones are present; and
- the Ordovician volcaniclastic basement rocks which have a widely spaced and poorly interconnected fracture network beyond the major fault zones and form an aquitard with very low yields and slightly brackish water quality.

Groundwater Monitoring

CVO commissioned AGE to undertake field investigations to meet the commitments of the Project approval to upgrade the regional monitoring network and to further investigate the Cadia East area. A total of 24 standpipe monitoring bores were drilled and constructed between August 2011 and March 2012 in the Cadia East area and surrounding region. AGE (2013) describes the drilling program in detail, with a summary provided below.

Five bores were drilled into Silurian sediments within the predicted Cadia East subsidence zone to investigate the water bearing potential of the Silurian sequence. A further three bores were installed adjacent to a ventilation shaft (known as Raise Bore VR81) adjacent to the subsidence zone to investigate the potential for seepage from the Silurian into the underground mine when drilling the shaft. Figure 2.1 shows the locations of the monitoring bores, the predicted extent of subsidence and the proposed preconditioning bores. Table 2.1 summarises the construction details and water levels.

Table 2.1: GROUNDWATER MONITORING BORES – CONSTRUCTION DETAILS								
Hole ID	Coordinates*		Screened Horizon	Ground Level*	Gravel Pack mbGL	Static Water Level		
	mE	mN				Month	mbTOC	mAHD
MB50	687,584	6,294,791	Silurian limestone	808.02	Open hole	Apr 2012	196.47	611.55
MB51	687,590	6,294,788	Silurian siltstone	808.15	36 - 57	Aug 2011	34.34	773.81
MB52	687,613	6,294,783	Silurian siltstone	807.29	34 - 57	Aug 2011	34.00	773.29
MB57	687,155	6,295,384	Silurian siltstone	840.52	22.5 - 81	Oct 2011	Dry	<768.04
MB58	687,209	6,295,352	Silurian siltstone/ limestone	843.44	18.6 - 76	Oct 2011	Dry	<769.88
MB60	687,487	6,295,380	Tertiary basalt	901.55	43.3 - 56.8	Nov 2011	43.90	857.65
MB66	687,480	6,295,360	Silurian siltstone	900.02	63 - 96.5	Mar 2012	Dry	<803.7
MB67	687,102	6,295,075	Silurian Siltstone/Sand-stone	828.29	95 - 147.8	Mar 2012	135.43	692.86

Notes: Co-ordinates AGD84, Zone 55
mbGL = metres below ground level
mAHD = metres above Australian height datum
mbTOC = metres below top of casing
* surveyed by CVO staff with survey equipment – sub-meter accuracy

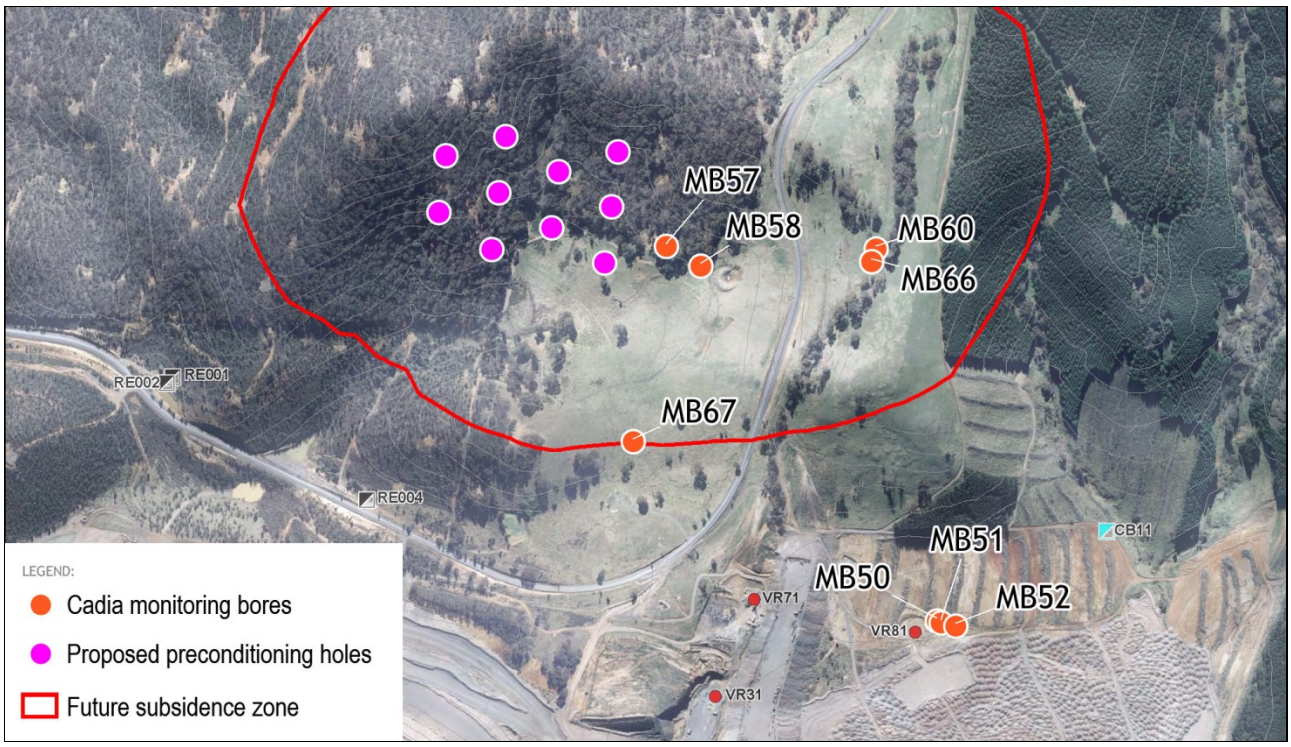


Figure 2.1: New monitoring bores within subsidence zone

Of the new bores, only MB58 intersected the basal limestone unit. No water was intercepted during drilling of MB57, MB58 and MB66, and these bores remained dry after drilling. Bore MB67 subsequently gained water from slow seepage through tight siltstones and sandstones.

The drilling indicated the Silurian sediments and particularly the basal limestone unit is highly heterogeneous and does not occur as a uniform layer across the subsidence zone. The drilling indicated the basal limestone has a poor ability to store and transmit water due to a low primary porosity, except along fault zones where fracturing creates secondary porosity increasing water storage.

Water level measurements in Table 2.1 indicate the raise bores drilled to ventilate the underground mine have induced some drainage of groundwater from the Silurian sequence. However, the shallower bores installed in the upper parts of the Silurian and the overlying Tertiary basalt are yet to show significant declines, indicating a low vertical hydraulic conductivity through the sequence.

Simulation of Mining at Cadia East

The updated numerical model presented by AGE (2013) represented the caving process as predicted by geotechnical modelling. The groundwater model increased the hydraulic conductivity to represent fracturing as a bell shaped zone above the orebody (known as the yield zone) that gradually moved upwards over time. The ground surface in the model also moved downwards and the hydraulic conductivity (vertical and horizontal) increased from the surface to 50 m depth to represent subsidence. The numerical model represented this process over four stages, with the hydraulic conductivity and ground surface updated at each stage:

- Stage 1 occurred at Year 3 representing fracturing/subsidence from years 3 to 5.
- Stage 2 occurred at Year 5 representing fracturing/subsidence from years 5 to 10.
- Stage 3 occurred at Year 10 representing fracturing/subsidence from years 10 to 20.
- Stage 4 occurred at Year 21 representing fracturing/subsidence from years 20 to post mining.

At these stages, the model increased the horizontal/vertical hydraulic conductivity:

- by 5 x the baseline parameters in the 50 m deep halo under the subsidence zone.
- to 1000 m/day and changed storage to 1 in the subsidence zone,
- by 1000 x baseline in the yield zone, i.e. 0.0001 to 0.1 m/day.

Figure 2.2 shows the rate of groundwater seepage predicted by the numerical model for Cadia East.

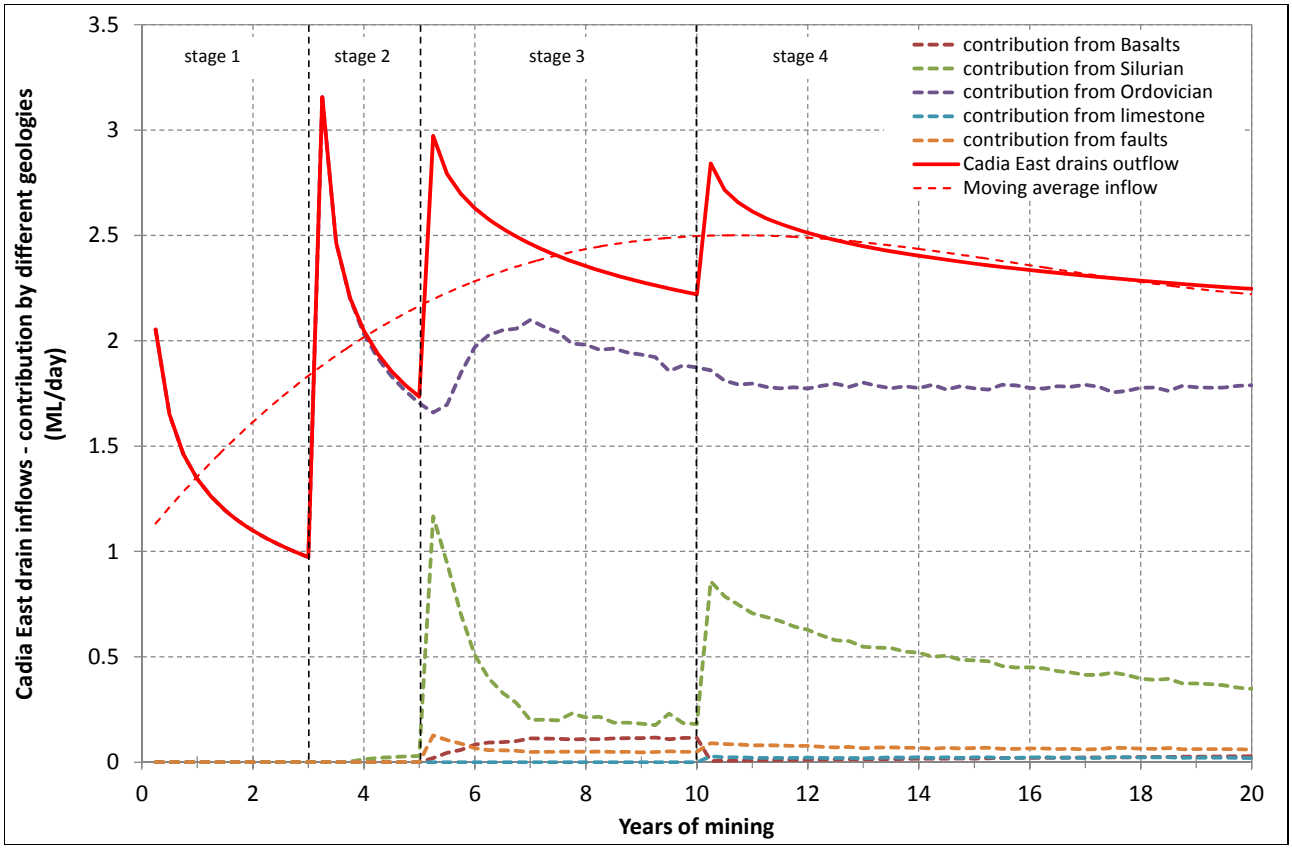


Figure 2.2: Predicted seepage to Cadia East underground mine (AGE 2013)

Figure 2.2 shows a spike in the contribution of seepage from the Tertiary and Silurian cover sequence in Year 5. This is because the model simulates the fracturing from the yield zone breaking through to the surface at this time. A second increase occurs at Year 10 in the model as mining moves to the east and the subsidence zone expands, and again intersects the surface. In reality, the fracturing process will be more gradual than represented by the groundwater model, that applies several years of fracturing in an instant.

3 IMPACT OF PRECONDITIONING

The groundwater model simulated mining at Cadia East from 2013 until the end of mining in 2034, with the fracturing estimated at that time to first break through to the surface in late 2017/early 2018. The preconditioning requires approximately six months to complete. This means that if approved, fracturing in part of the subsidence zone would extend to the surface at the earliest in late 2014, which is about three years earlier than represented in the groundwater model. If Tertiary and/or Silurian rock units are encountered in the drill holes they will be sealed off with PVC casing or equivalent. As a result, any Tertiary and/or Silurian cover material will not be hydro-fractured by the preconditioning process, but will be subsequently subsided by controlled caving into the underground after the preconditioning is completed.

The proposed preconditioning would not induce additional fracturing beyond that already accounted for by groundwater modelling, rather it would cause fracturing to the surface about three years earlier than represented in the model. The area in which the preconditioning would occur covers a relatively small area of the total subsidence zone and available data from monitoring bores to the east indicates that the Silurian sequence is dry and the Tertiary basalt is not present. The Silurian sequence varies in thickness, and therefore some areas of fractured and saturated Silurian may be present, particularly along faults zones within the preconditioning area.

Where present, these areas would be the source of most of the seepage from the Silurian sequence within the preconditioned area. As stated previously, this seepage has already been accounted for by previous modelling, it is only the timing of the seepage that changes slightly due to the preconditioning. It is therefore concluded that the preconditioning would have no net additional impact on the groundwater regime beyond that predicted by numerical modelling (i.e. the predicted location and magnitude of the regional groundwater drawdown would remain unchanged).

The proposed preconditioning would not change the amount of water that would drain to and accumulate in the Cadia East underground workings (i.e. no change to groundwater extraction amounts). As a result, the current mine dewatering licences would not require any changes.

4 AQUIFER INTERFERENCE POLICY

The Cadia East Project was assessed and approved in 2009 prior to the enactment of the NSW Aquifer Interference Policy (NOW, 2012). Groundwater extraction licences have been issued for the Cadia Valley Operations, and as described above no changes to the predicted groundwater take or licenced allocations are required as a result of the modification. Notwithstanding, a comparison of the proposed modification against the NSW Aquifer Interference Policy (NOW, 2012) is provided in the tables below. Much of this is based on the updated modelling presented by AGE (2013), and therefore, describes the impacts of the entire project, not the preconditioning modification alone.

AIP Requirement		Proponent Response
1	Described the water source (s) the activity will take water from?	• Lachlan Fold Belt MDB Groundwater Source • Orange Basalt Groundwater Source
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?	• Lachlan Fold Belt MDB Groundwater Source – 804 ML/yr • Orange Basalt Groundwater Source – 50 ML/yr average • No additional take due to preconditioning 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?	No more than above
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 (2013)
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	• Lachlan Fold Belt MDB Groundwater Source – 804 ML/yr • Orange Basalt Groundwater Source – 50 ML/yr average • No additional take due to preconditioning modification
6	Described how any licence exemptions might apply?	N/A
7	Described the characteristics of the water requirements?	Yes – refer AGE (2013)
8	Determined if there are sufficient water	Yes

AIP Requirement		Proponent Response
	entitlements and water allocations that are able to be obtained for the activity?	• WAL31702 - Units 371ML, Lachlan Fold Belt MDB Groundwater Source • WAL36229 - Units 931ML, Lachlan Fold Belt MDB Groundwater Source • WAL31062 - Units 56ML, Orange Basalt Groundwater Source • No additional take due to preconditioning modification
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	Yes
10	Determined how it will obtain the required water?	Yes
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	N/A
12	Considered actions required both during and post-closure to minimize the risk of inflows to a mine void as a result of flooding?	Yes surge pumping system installed to mitigate risk during mining. Post mining voids will flood and lake will form in the subsidence void No additional flow due to preconditioning modification
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	Surrendering of water licenses post mining if required
	Will uncertainty in the predicted inflows have a significant impact on the environment or other authorized water users? *Items 14-16 must be addressed if so.*	No additional inflow predicted due to preconditioning modification
14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?	Yes detailed subsidence assessment undertaken and additional drilling to characterise any aquifers, particularly limestone overlying the subsidence zone
15	Quantified any other uncertainties in the groundwater or surface water impact modeling conducted for the activity?	Yes sensitivity analysis undertaken by AGE (2013)
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

Determining water predictions in accordance with Section 3.2.3

	AIP Requirement	Proponent response
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?	Yes

Other requirements to be reported on under Section 3.2.3

	AIP Requirement	Proponent response
1	Establishment of baseline groundwater conditions?	Yes
2	A strategy for complying with any water access rules?	Yes
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	Yes
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	Yes
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	N/A
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	N/A
7	Potential to cause or enhance hydraulic connection between aquifers?	Yes
8	Potential for river bank instability, or high wall instability or failure to occur?	N/A
9	Details of the method for disposing of extracted activities (for CSG activities)?	N/A

Addressing the minimal impact considerations

Aquifer	Fractured Rock - Orange Basalt
Category	Highly Productive

Level 1 Minimal Impact Consideration	**Assessment**
Water Table 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.	**Acceptable** • 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
Water pressure A cumulative pressure head decline of not more than a 2m decline, at any water supply work.	**Acceptable** • Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	**Acceptable** • During mining groundwater flow is towards the mine and there will be no change in the beneficial use category of the basalt • Post mining the subsidence void will remain a permanent sink to groundwater and therefore the flow will still be into the void and there will be no change in the beneficial use category of the basalt

Aquifer	Porous rock or fractured rock – Silurian and Ordovician Bedrock - Lachlan Fold Belt MDB Groundwater Source
Category	Less productive

Level 1 Minimal Impact Consideration	**Assessment**
Water Table 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.	**Acceptable** • 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
Water pressure A cumulative pressure head decline of not more than a 2m decline, at any water supply work.	**Acceptable** • Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity.	**Acceptable** • During mining groundwater flow is towards the mine and there will be no change in the beneficial use category • Post mining the subsidence void will remain a permanent sink to groundwater and therefore the flow will still be into the void and there will be no change in the beneficial use category

5 REFERENCES

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

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

New South Wales Office of Water, (2012), *"Aquifer Interference Policy".*

Please contact the undersigned should you have any queries or require clarification.

Yours faithfully,

JAMES S. TOMLIN
Principal Hydrogeologist/Director
Australasian Groundwater and Environmental Consultants Pty Ltd

ATTACHMENT 2

NOISE ASSESSMENT

WILKINSON MURRAY

3 February 2014

WM Project Number: 14060
Our Ref: RS070214 GJ

Mr Andrew Wannan
Manager Environment
Cadia Holdings Pty Limited
via email

Dear Andrew

Re: Cadia East Preconditioning Modification - Noise Assessment

Cadia Holdings Pty Limited (CHPL), a wholly owned subsidiary of Newcrest Mining Limited (Newcrest), owns and operates the Cadia Valley Operations, which are situated some 25 kilometres (km) south-west of Orange, in the Central Tablelands of New South Wales (NSW) (Figure D-1).

Project Approval (PA) for the Cadia East Project was granted by the NSW Minister for Planning under Part 3A of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 6 January 2010 (PA 06_0295). The approval includes all components of the Cadia Valley Operations (as described in Schedule 1 of the PA) including the Cadia East underground mine, the Cadia Hill open cut mine, the Ridgeway underground mine, the Concentrate Dewatering Facilities, and ancillary infrastructure.

A modification to the Project Approval (PA 06_0295) is now sought to allow "pre-conditioning activities". The modification involves hydraulic fracturing of rock above the Cadia East mineralisation. The preconditioning process includes a pump and drill rig at surface level and therefore has the potential to cause noise impacts. This letter provides a noise assessment of the proposed preconditioning activities.

The proposed modification does not affect blasting, traffic noise or noise levels at the Concentrate Dewatering Facility.

SUMMARY OF THE NOISE ASSESSMENT FOR EIS

Wilkinson Murray conducted a Noise and Blasting Assessment of the Cadia East Project in 2009, with the report being included as Appendix D of the Environmental Impact Statement (EIS) of that project.

Noise level criteria were developed in accordance with the procedures of the *NSW Industrial Noise Policy (INP)*.

Noise levels from existing approved and proposed operations at the Cadia Valley Operations were assessed cumulatively with proposed construction activities.

The Wilkinson Murray (2009) Cadia East Noise and Blasting Assessment report concluded that:

- Operational noise impacts would be greatest during the early part of the Project when Cadia Hill and Ridgeway would be still active and construction activities associated with Cadia East would be undertaken (i.e. from 2010 to 2012). Noise levels were expected to increase marginally from 2007 levels (1-2 dBA) at night in Year 1 of the Project (2010). Noise levels would however comply with the project-specific criteria at all but one of the sensitive receivers, which would experience a minor (1 dBA) exceedance. This receiver would be in the noise management zone.
- Noise levels would steadily decrease over the following years as Cadia Hill and Ridgeway are completed. It was anticipated that noise levels in Year 4 would decrease by around 2 dBA on average, relative to the Year 1 noise levels. By Year 17 of the Cadia East mine life a further reduction of 2-3 dBA was predicted during Cadia East only operations.

In summary, the 2009 assessment predicted that while there would be a short-term marginal increase in operational noise during Year 1, noise would subsequently reduce over the life of the Cadia East mine.

NOISE MONITORING

Noise monitoring is conducted on a quarterly basis at the Cadia Valley Operations as required by Project Approval PA 06_0295.

Monitoring undertaken until December 2012 indicates that operational noise levels from the Cadia Hill and Ridgeway Gold Mine (i.e. prior to the commencement of Cadia East) generally complied with Project Approval noise limits for the daytime, evening and night time periods.

Monitoring undertaken in 2013 indicates no exceedances of the Project Approval noise limits were recorded (i.e. following the commencement of underground mining at Cadia East and the completion of open pit mining at Cadia Hill).

NOISE CRITERIA

The noise impact assessment criteria for the Cadia Valley Operations are set out in Condition 2 of Schedule 3 of Project Approval PA 06_0295, and are repeated below.

The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria in Table 2-1 at any residence on privately owned land or on more than 25 per cent of any privately owned land.

Table 2-1 Noise Impact Assessment Criteria – dBA

Location	Operational Noise Criteria, $L_{Aeq,15min}$			Sleep Disturbance Criterion, $L_{A1,1min}$
	Day	Evening	Night	
Mining Operations				
41-CW Knox ('Meribah', 43-CJ Healey ('Triangle Park'), 138-AC & A Bailey ('Mayburies', 45-CC Colman ('Mirrabooka'), 246-CK Channell and KP & DV Donlan ('Eastburn'), 209-JI McLennan ('Northwest'), 171-GA Knox ('South Log')	43	38	38	45
1-GT & JA Christou ('Coorabin'), 137-MP & LA Ellis ('Argyle'), 169-RL & SL Chamberlain ('Weemalla')	43	38	37	45
44-AR Colman ('Triangle Flat'), 105-KA Hughes ('Barton Park'), 133-LC & LR Baker ('Bonnie Glen')	43	38	36	45
Other privately owned land	43	38	35	45

Notes:

- Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.
- The noise limits do not apply if the Proponent has an agreement with the relevant owner/s of these residences/land to generate higher noise levels, and the Proponent has advised the Department in writing of the terms of this agreement.

The $L_{A1,1min}$ sleep disturbance criteria for the various sites apply between 10.00pm-7.00am. Considering that $L_{A1,1min}$ and L_{Amax} descriptors are similar, the L_{Amax} noise levels have been used for the purpose of this assessment.

The Proponent shall implement all reasonable and feasible measures to ensure that the noise generated by the project combined with the noise generated by other mines and industries does not exceed the amenity criteria in Table 2-2 at any residence on privately owned land or on more than 25 per cent of any privately owned land, to the satisfaction of the Director-General.

Table 2-2 Cumulative $L_{Aeq(period)}$ Noise Criteria – dBA

Location	Day	Evening	Night
Mining Operations			
All privately owned land	50	45	40

Note: Cumulative noise is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.

NOISE LEVELS ASSOCIATED WITH THE PROPOSED PRE-CONDITIONING

Source of Noise

The source of noise from the pre-conditioning works would be a pump located on a drill rig which would be bolted to the ground on the surface. The pump and drill rig would be used to pump water underground via existing/approved drill holes to induce the hydraulic fracturing. There are approximately ten drill pad sites where pumping would be carried out; however, only one pump and drill rig would operate at any time. Pumping would be continuous on a 24-hour basis. The drilling of the holes themselves has been approved previously and is therefore not included as part of the proposed modification.

The typical noise level of mud pumps and drilling rigs is SWL 112-115dBA. For purpose of this noise modelling and assessment, a source level of SWL 115dBA was assumed.

Noise Prediction

The noise model used for the Wilkinson Murray (2009) Cadia East Noise and Blasting Assessment was used to predict noise from the proposed pre-conditioning activities. As was the case in the 2009 assessment, the noise model predicts the $L_{Aeq,15min}$ as the 10^{th} percentile exceedance value, based on the probability of occurrence of the meteorological conditions.

As the proposed preconditioning activities would be conducted at various drill pad locations on the surface, the noise was predicted with the noise source at the western-most and eastern-most edges of the drilling area. The worst case noise from those two scenarios was taken as the potential impact at any residence.

The assessment was based on the Cadia Valley Operations night time criteria as these are the lowest, and atmospheric conditions that enhance noise propagation are most prevalent during the night time. Hence compliance at night leads to compliance during daytime and evening periods.

Table 1 shows the predicted noise levels generated by the pump and drill rig during the night time period. The results are given for the receivers where specific noise criteria are conditioned. The predicted levels of the pump and drill rig alone are at least 14dBA below the noise criteria at all receivers during the worst case night time noise emission. At receivers closest to the pre-conditioning location, the noise from the pump and drill rig could increase the overall mine noise level by up to 1dBA, depending on the location of the drilling. This amount of change in noise levels is generally regarded as being imperceptible by the majority of people.

At no location is the minor increase in noise levels predicted to result in non-compliance of the Project Approval noise limits.

Table 1 Predicted Night Time Noise Levels

Location	Worst Case Winter/Autumn Night Time Noise, $L_{Aeq,15min}$	
	Criterion	Predicted Noise Level
41-CW Knox ('Meribah')	38	22
43-CJ Healey ('Triangle Park')		22
138-AC & A Bailey ('Mayburies')		20
45-CC Colman ('Mirrabooka')		20
246-CK Channell and KP & DV Donlan ('Eastburn')		11
209-JI McLennan ('Northwest')		24
171-GA Knox ('South Log')		19
1-GT & JA Christou ('Coorabin')	37	10
137-MP & LA Ellis ('Argyle')		19
169-RL & SL Chamberlain ('Weemalla')		14
44-AR Colman ('Triangle Flat')	36	14
105-KA Hughes ('Barton Park')		8
133-LC & LR Baker ('Bonnie Glen')		18

Cumulative Noise & Sleep Disturbance

Based on the findings of this review the proposed Cadia East preconditioning modification would not lead to non-compliances of the cumulative noise and sleep disturbance criteria at the Cadia Valley Operations.

We trust this information is sufficient. Please contact us if you have any further queries.

Yours faithfully
WILKINSON MURRAY

George Jenner
Associate