Berrima Colliery - Passive Water Treatment Project
Review of Environmental Factors

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Rehabilitation and Final Closure Plan
REVIEW OF ENVIRONMENTAL FACTORS

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ES 1 Background

This Review of Environmental Factors (REF) has been prepared by International Environmental Consultants Pty Limited (IEC) on behalf of Boral Cement Limited (Boral) for a proposed surface water treatment system at the pit top of Berrima Colliery, shown on Plans 1 and 2 (at end of Chapter 6). The purpose of the treatment system is to provide beneficial use of water, reduce pollutant load to the Wingecarribee River, and improve consistency and quality of treatment prior to discharge.

Berrima Colliery has been in the process of final closure since 2014 which followed the cessation of production in late 2013. The primary outstanding issue impacting the final closure of the mine is the management of groundwater. Following previous groundwater modelling, Boral determined that it was not possible to fully seal the underground workings to prevent the release of poor quality water from the mine into the Wingecarribee River. In response to this, Boral determined that the final closure option for the colliery would necessarily involve a permanent passive water treatment facility located at the pit top which would treat water pumped from the mine workings for treatment prior to release back into the Wingecarribee River via the existing licensed discharge point or pumped overland to supply to the Berrima Cement Works. Boral favoured this option because it provided a high degree of certainty that it would successfully resolve the final closure issue of groundwater management but also provide a permanent solution to water security for the cement works.

Since 2014, Boral has investigated possible final mine closure scenarios. Groundwater modelling concluded that it was not feasible to fully seal the mine to prevent groundwater from entering the Wingecarribee River via the existing drainage adit or a new point source. The main reason for this is the highly permeable nature of the overlying Hawkesbury Sandstone which would allow groundwater to bypass over the installed bulkheads irrespective of the number of bulkheads installed within the mine workings or their location. It was also likely given the location of the original mine workings being below the sandstone cliffs of the Wingecarribee River, that installing bulkhead style seals at the adit point of discharge would pressurise the overlying shallow talus slope resulting in a new point source discharge that would cause significant environmental impact and water quality implications for the Wingecarribee River.

The NSW Environment Protection Authority (EPA) has issued a Notice of Variation to the Colliery's Environment Protection Licence (EPL 608) which specifies that the licence holder is to install a passive water treatment plant on the surface of Berrima Colliery to treat groundwater from the closed underground coal mine at Medway and lay a pipeline from Berrima Colliery to Berrima Cement Works to transfer treated water for use in the cement making process. Condition U1.1(3) of EPL 608 also specifies that an environmental assessment be prepared that identifies potential environmental impacts from the construction and operation of the facility and proposes measures to prevent or mitigate these potential impacts. This REF satisfies these conditions.

ES 2 Project Outline

In summary, the proposed groundwater treatment system involves pumping the water from the mine to a purpose built passive treatment system at the current pit top. The treatment system will involve aeration, pH correction and settlement via multi celled ponds. The treated water will be returned to the workings and discharged within the current discharge channel which

ultimately flows into the river via the existing licensed discharge point. A proportion of the treated water could be sent to the Berrima Cement Works via a pipeline located within the existing railway easement between the colliery and the cement plant. This would replace the need for the cement plant to source its water needs from its existing licensed pump-out in the Wingecarribee River upstream of the Berrima township. The project therefore provides a beneficial reuse of the water and an overall reduction in mineral load entering the river.

ES 2 Summary of Impacts

The project will result in the following impacts:

- Increased traffic on Medway Road during the first four months of construction. This will include up to 10 truck movements per day (average 2) delivering plant and equipment, dam construction materials and pipework. Once the earthworks component is complete, the final fit-out and ongoing operation of the facility would result in no additional transport than has occurred since 2014, that is, about 6 light vehicles per day and 1 truck delivering stores per week.
- Increased noise emissions during the first four months of construction when the majority of the earthworks are being undertaken. This will include a dozer for pad development, 20 tonne excavator and front end loader for material movement and backhoe/bobcat for final shaping. Work will be undertaken between 7am and 6pm Mondays to Fridays.
- The pipeline construction will also involve earthmoving equipment consisting of a bobcat/backhoe for clearing and leveling, an excavator to construct the pipe trench a Telehandler used to unload trucks and lay pipes. Pipes and supplies will be provided by smaller trucks suitable to access the easement. A pipe boring unit may also be used to bury the pipeline beneath road crossings. As the pipeline work will be remote from services a generator will be required to power hand tools and pipe welding and portable amenities provided. This equipment will pass close to residential receptors for a period of approximately 5 days with the entire pipeline being completed within 3 months.

The project will result in the following benefits:

- Significant reduction in environmental risks as a result of mine closure.
- Improved water quality within the Wingecarribee River due to more consistent and effective water treatment capability.
- Better reuse of the water resource by eliminating the existing cement plant river pump-out.
- Increase in base water flow between the existing river pump-out upstream of Berrima township to the new discharge point at the colliery.

This REF has determined that the proposed activity provides both positive and negative environmental and social consequences. The main environmental issue identified is water quality. The project will provide significantly greater control over the treatment of mine water which in turn will improve the water quality in the Wingecarribee River particularly during periods of low natural flow.

The potential impacts from the activity are almost exclusively a result of the estimated four month earthmoving component of the 14 month construction program. Once operational, the repurposed site will result in no additional noise or dust generating activity than what the community has experienced since the mine closure.

1. Introduction

1.1 Activity Overview

The purpose of this Review of Environmental Factors (REF) is to provide the EPA and the local community with information on the proposed surface water treatment system and potential environmental implications of the activity.

The project consists of:

- Constructing additional underground bulkheads within the mine workings to create a reservoir where the mine drift intersects the coal seam workings. This area is referred to as "pit bottom" and separates the newer mine workings from the original old workings. The bulkheads will extend from the floor to the roof creating a dam.
- A pump will be installed into the reservoir which will deliver water to the surface facilities area, referred to as the "pit top". Under normal operating conditions, the water level within the workings will be kept at or just below the coal roof of the mine workings to avoid water seeping into the overlying porous sandstone. If this occurs, this seepage will pass over the bulkheads and enter the old workings and discharge untreated into the Wingecarribee River.
- At the pit top, a multi-celled pond will be constructed that will enable water to be separated to undergo several treatment methods. The first will be aeration, followed by pH adjustment and then settlement. As shown on Plan 3 (at the end of Chapter 6) this pond will be located along the existing access road from the office carpark to the end of the helipad.
- Two additional settlement ponds will be constructed. One will be located on the engineering carpark area which will enable a final water testing point prior to delivery of water to the Wingecarribee River via a pipeline. The second pond will be located along the site entrance road. This pond will include a pumping station to pump water along the pipeline to the cement works.
- Construct a pipeline within the existing railway easement from the pit top to the Berrima Cement Works. The pipeline will be pressure rated HDPE with a 200 mm internal diameter and buried.

As the project represents a key component of the final mine closure plan for the colliery, the Resources Regulator has included a number of additional items to be incorporated in the underground workings. These do not require approval as part of this REF but have been discussed in the document for completeness. These items include:

- Testing the assumption that the underground water level should be kept at or below the roof of the mine workings to avoid uncontrolled seepage over the bulkheads. This will be tested by allowing the water to pressurise against the roof for a period of time and monitor seepage volume and quality. Provisions will be made to allow increased treated water to enter the discharge channel should water quality deteriorate.
- Construct additional underground ventilation stoppings to further reduce atmospheric exchange. This will provide additional protection against oxygenating mineralised sections of the workings which may help improve water quality over the long term.
- Provide a monitoring network capable of measuring atmospheric conditions and water quality behind the new bulkheads.

- ❒ Complete the removal/sign over of any remaining mine related equipment on private land. This includes either sealing or sign over of water bores, removal or make safe any remaining subsidence pegs and removal of the two vibrating wire piezometers. This work is currently underway.

The Resources Regulator also required Boral to develop a re-entry plan to enable access to the underground workings should it be deemed necessary. The plan will include dewatering the flooded workings caused by the additional bulkheads around pit bottom. The water will be treated prior to discharge. Further details of the project are provided in Chapter 3.

1.2 Title Holder

The Berrima Colliery Holding consisting of Consolidated Coal Lease 748 held by Boral Limited. Boral is currently the operator of Berrima Colliery and will be responsible for building and operating the passive water treatment system. The lease has been renewed for the purposes of rehabilitation and final closure but no longer includes the ability to extract coal.

1.3 Legislation and Planning

The EPA has a statutory obligation under Part 5, clause 5.5 of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) to "examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment" of an activity, in this case, the approval of the Passive Water Treatment System for Berrima Colliery. This obligation applies where activities have not previously been approved under Part 4 of the EP&A Act, or assessed by another Government agency in accordance with Part 5.

The REF needs to determine the significance of the environmental impacts of constructing and operating the Water Treatment system including the discharge and reuse of water on the receiving environment. This has been prepared in accordance with the Department of Planning and Environment Guidelines for Division 5.1 Assessments (February 2022). Other relevant guidelines for REF assessments include the ESG2 Guideline for Preparation a Review of Environmental Factors (Resources Regulator), and the publication *Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979* (Department of Planning) which provides an assessment methodology for determining the significance of an activity.

A key outcome of the assessment contained in this REF is whether or not the project is likely to have a significant impact on the environment which would necessitate the preparation of an Environmental Impact Statement, a Species Impact Statement or Biodiversity Development Assessment Report. The assessment of significance is contained as Appendix B. This assessment concludes that the potential impacts of the proposed water treatment process will not result in a significant impact and therefore an Environmental Impact Statement is not required.

This REF does not override any other obligations under development control legislation. Table 1.1 describes other State legislation or guidelines which apply to the activity or land subject to the activity. Legislation that is noted as being relevant indicates that either a separate approval, or step in the process is required prior to construction occurring.

Table 1.1 State Legislative Matters

Legislation	Section	Relevant?	Matter
NSW *Protection of the Environment Operations Act 1997* (POEO Act).	s42 and s43.	Yes	An environment protection licence is currently in force for Berrima Colliery and will be progressively modified as necessary during the closure process, inclusive of the Passive water Treatment System. The current monitoring program requires monitoring of the mine discharge once every month and sampling background quality in the Wingecarribee River once every two months. It is Boral's intention to keep EPL 608 for the foreseeable future.
NSW *Biodiversity Conservation Act 2016 and Regulation 2017*	Section 7.8	Yes	This section requires an assessment of significance of the activity. An activity is to be regarded as an activity likely to significantly affect the environment if it is likely to significantly affect threatened species. The activity will not harm of any threatened species, population or ecological community or damage of any critical habitat and habitat of any threatened species, population or ecological community. The project is located wholly within the disturbed footprint of the pit top and railway easement. This assessment has found that by improving the water discharge quality and maintaining the previous baseflow contribution to the Wingecarribee River that the impacts on aquatic ecosystems will be positive.
Protection of the Environment Operations (Clean Air) Regulation 2002	Division 2	Yes	The colliery pit top is licensed and therefore a Scheduled Premises. The issue of dust emissions during the construction and operation of the treatment system have been addressed in this REF.
NSW Industrial Noise Policy 2000	Section 1.4	Yes	Applies to industrial developments including construction and management of industrial premises. A noise assessment has been included in this REF
Roads Act 1993	Section 138	Yes	This section requires approval from a responsible authority when undertaking any activities within a road reserve. This can include Transport for NSW in the case of classified roads, Wingecarribee Shire Council in the case of local roads under their management and Crown Lands for any Crown road reserves and easements. There are several instances where the overland pipeline will cross road reserves and applications for approval under Section 138 will be made to the appropriate authorities prior to construction commencing.
Mining Act 1992	Part 11	Yes	The Berrima Colliery closure process will continue to be conducted in accordance with conditions listed under Part 11 of the Mining Act 1992. This includes several additional approvals covering progressive rehabilitation and relinquishment
Mining Act Regulation 2016	Schedule 8A	Yes	Covers various approval and reporting provisions in relation to the ongoing closure process.
Crown Land Management Act 2016	Various	Yes	Although the vast majority of activities outlined in this REF occur within the confines of Consolidated Coal Lease 748, there is one strip of Crown Land near the colliery entrance which is not covered by any mining titles. This strip will be crossed by the overland pipeline leading to Pond 2B. Any necessary approvals will be separately sought from the DPIH-Crown Lands which may also involve a Crown Land Lease or outright purchase.
NSW *Fisheries Management Act 1994.*	s220ZW(1).	No	A s220ZW licence is not considered necessary as the activity will not alter overall water flow within the Wingecarribee River.
NSW *Heritage Act 1977.*	s57 & s59.	No	An approval under s58 is not required as there are no remaining structures at the Colliery pit top that will be removed or disturbed.
NSW *National Parks and Wildlife Act 1974.*	s90, s70 & s71.	No	A s90 Aboriginal Heritage Impact Permit will not be required as no items or places of Aboriginal heritage significance were identified following surveys carried out as part of the original Part 3A Environmental Assessment. No rehabilitation activities will occur in a wildlife refuge declared under s68. An offence will not be committed under sections 70 or 71 in relation to fauna and flora in the wildlife refuge.
NSW *Rural Fires Act 1997*	s100B(1)	No	A 'bush fire safety authority' is not required for the works as they are not described in s100B(1) of the Act. Berrima Colliery currently has an emergency management plan for the site which includes procedures to be undertaken in the event of bushfire.

Table 1.1 State Legislative Matters

Legislation	Section	Relevant?	Matter
NSW *Water Management Act 2000* and Water Management Regulation 2018	s91(2)	No	A 'controlled activity approval' under s91(2) of the Act is not considered necessary as there will be no additional disturbance within 40 m of 'waterfront land', being the Wingecarribee River. The treated water discharge pipeline will cross the existing bridge and the overland component will not cross any waterways on route to the cement plant. Berrima Colliery holds Water Licence 10BL602621 under the Water Act 1912 which is taken as being a groundwater interference licence under the Water Management Act 2000. This licence allows for the taking of groundwater which will continue under the proposed surface water treatment system.
State and Environmental Planning Policy (Biodiversity and Conservation) 2021(includes the previous State Environmental Planning Policy (Sydney Drinking Water Catchment)	Clause 12	Yes	There is a requirement to address potential impacts on water quantity and quality within the Wingecarribee River and prepare a Neutral or Beneficial Effects Statement. This is contained as Appendix A to this REF.
Contaminated Land Management Act 1997 and State Environmental Planning Policy No 55 (Remediation of Land)	Various	Yes	The final rehabilitation work needs to meet the expectations of this legislation. Specifically, the objectives of the rehabilitation work are to meet the most stringent Residential A contamination criteria which would enable the site to be used for any potential future land use. The Passive Treatment system will not alter any potential final land use.

Commonwealth Matters

It is considered that approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is not required. The Department of Sustainability, Environment, Water, Population and Communities' 'Protected Matters' tool (July 2024) was used to identify any matters of national environmental significance (MNES) including threatened species and communities, wetlands of international importance and national and world heritage areas listed under the EPBC Act that occur within the Berrima Colliery Holdings.

As the project lies within an existing disturbed footprint it is highly unlikely that the activity will have a significant impact on matters of national environmental significance. This assessment has determined that a referral to the Commonwealth Department of Agriculture, Water and the Environment is not required.

1.4 Scope of REF

This REF specifically covers the installation of a passive water treatment plant to be constructed on the surface at the pit top to treat groundwater from the closed underground workings of the Colliery. This is a component of the final rehabilitation and closure activities for Berrima Colliery. The scope of this REF is therefore limited to:

- Installation of three pit top dams including two 1ML catch dams and a 6ML multicellular treatment dam.
- Installation of associated internal plumbing, pipework, pumps, electrical upgrades and control systems.
- The connection of a water supply pipeline to pump groundwater from the workings to the treatment dam along the drift cutting.

- A pipeline will be constructed from the catch dam back into the mine workings for discharge to Wingecarribee River via the existing licensed discharge point.
- Construct an overland pipeline from the third catch dam to the Cement Plant in Berrima using the existing rail easement which is owned by Boral.
- Repurpose the existing buildings to support the ongoing water treatment project and remove any remaining coal handling infrastructure. The existing carpark will be relocated to the rear of the main office/bathhouse building and minor access changes will also be made.
- Removal and/or site disposal of building rubble and debris generated during the construction program.

There are other activities associated with the passive treatment system such as installation of underground bulkheads, additional ventilation stoppings, installation of monitoring equipment and sealing of mine entries however these activities do not require approval from the EPA and are therefore not included in this REF. These activities form part of the final closure activities and will be subject to separate instructions provided by the Resources Regulator.

1.5 Project Justification

The project is justified on the basis that it will provide a more consistent and improved water quality being discharged to the Wingecarribee River. The project also provides reuse opportunities by supplying water to the Berrima Cement Works. These issues are discussed further below.

For over 120 years, Berrima Colliery has discharged collected groundwater from the underground workings into the Wingecarribee River. The mine workings were designed to allow free drainage back to the original mine entry. The naturally occurring groundwater, while low in salts, has elevated minerals such as iron and manganese. While operating, the mine removed these minerals through simple aeration, pH adjustment and settlement providing a relatively consistent water quality discharged to the Wingecarribee River.

Now closed, the mine drainage continues in the direction of the original drain adit and is heavily mineralised. Without treatment, this water has a deleterious effect on the river. At present, the groundwater is partially treated in a small section of underground workings with a component treated on the surface and returned. This process is cumbersome and prone to breakdown due to most of the activities being located within an underground mine environment. By pumping all the collected groundwater to a surface based treatment system will provide a more robust and efficient treatment operation.

Detailed groundwater modelling which has been calibrated with underground bulkhead trials, has determined that it is unlikely that a complete sealing and aquifer re-pressurisation scenario is possible. This is due to a coarse grained, friable, porous layer of Hawkesbury Sandstone which lies immediately above the Wongawilli Seam, the porosity of the seam itself and the extensive fracture network caused by previous coal extraction. Any re-pressurisation of the surrounding strata caused by the construction of bulkheads within the mine workings would simply flow over the bulkhead and back into the workings. The modelling suggests that the seepage rate would ultimately be close to the original discharge volume rending the bulkheads useless as a seal. This means that some level of treatment will be required for the foreseeable future.

Based on investigations to date and discussions with the Resources Regulator, the proposed passive treatment system has been incorporated in the final closure plan for the colliery. The Regulator has advised (reference LETT0008960 dated 5th March 2024) that it does not object to the staged approach as proposed in Boral's response to Direction 4 of Notice NTCE0011762. This approach included the construction of the Passive Treatment System as proposed in this REF but included measures to determine the long term, that is, greater than 30 years of seepage quality through the strata above and around the bulkheads. This involves allowing the water to pressurise against the roof for a period of time and monitor seepage volume and quality. Provisions will be made to allow increased treated water to enter the discharge channel should water quality deteriorate. The Regulator has also required additional measures to reduce ventilation and hence oxidation of the flooded workings.

Although not forming part of the project as described in this REF, the additional information required by the Regulator will be obtained by increasing and decreasing the rate of pumping and treatment over several years. If in time, the quality of the water seeping through the strata is capable of being discharged without further treatment then it may be possible to discontinue the surface passive treatment system. If this occurs sometime in the future, then the requirements of the Regulator that a permanent "in-perpetuity" solution would have been found. Approval would need to be obtained from the EPA for this to occur.

Until this occurs, Boral has determined that the risk of environmental harm caused by mineralised water entering the Wingecarribee River far outweighs the cost of the proposed passive treatment system. In the meantime, the benefits of the ongoing treatment option include the ability to provide a secure source of water for the Berrima Cement Works.

2. The Site and Surrounding Environment

2.1 Background

Located in the Southern Highlands of NSW as shown on Plan 1 and 2 (at the end of Chapter 6). Berrima Colliery is owned and operated by Boral. Berrima Colliery extracted the Wongawilli Seam by underground methods from around 1872 to October 2013. Originally by manual methods employing pick and shovel and drill and blasting, the mine was mechanised in the 1968 with the introduction of a single continuous miner. At the time production ceased, the mine still employed a single continuous miner and shuttle cars feeding a breaker feeder and a conveyor leading to the pit top via a drift and bridge over the Wingecarribee River.

The Colliery Holding is shown on Plan 3 and consists primarily of cleared agricultural land to the west of the township of Berrima. The Wingecarribee River bisects Consolidated Coal Lease 748 and essentially divides a portion of the western half of the coal resource.

Production over the three years prior to cessation averaged around 250,000 tpa which was transported to the Berrima Cement Plant. Coal was crushed only prior to delivery by truck to the cement plant or the Loch Catherine Coal Storage Area. There was no other beneficiation of the coal and therefore no coal waste was produced. Coal was originally sent to the cement plant via a small gauge private rail line, the easement of which is still owned by Boral.

Berrima Colliery has been in the process of final closure since 2014 however the issue of mine water discharge has remained an outstanding issue. The mine closure process has involved several detailed studies including:

- Groundwater modelling.
- Water quality and ANZECC 2000/ANZG 2018 Assessment.
- Aquatic Ecology.
- Ecotoxicology.
- Water treatment investigations including trials.
- Hydrogeochemical and ventilation.
- Engineering studies and design.

The scope of the investigations were determined through both risk assessments and advice from the Resources Regulator. The proposed passive water treatment system has been developed as a result of these investigations.

2.2 Regional Setting

Berrima Colliery is located in the Wingecarribee Local Government Area in the Tablelands Subregion of the Illawarra Region which is referred to as the Southern Highlands. The lease area occupies the southern part of the Woronora-Nattai Plateau which forms the southern section of the Sydney Basin.

2.3 Topography and Landform

The region is characterised by the elevated Woronora-Nattai Plateau which remained relatively flat when uplifted in the late Tertiary Period. The primary topographic features are residual volcanic peaks of Mount Gibraltar, Mount Gingenbullen, Mt Jellore and Mt Misery. These are

products of the more erosion resistant characteristics of the Jurassic and Tertiary basalts and dolerites in comparison with the surrounding sedimentary sandstones and shales.

Mt Misery and Mt Jellore are the prime volcanic feature which resulted in both the basaltic flow which crosses part of the Berrima Colliery mining area and the numerous igneous intrusions which cross the extraction area.

The other main features include the Wingecarribee River and tributaries which cut through the sandstone and in some instances go through the Wongawilli Seam. The Wingecarribee River bisects the lease area primarily in an east west direction while steeply incised valleys of its tributaries cut through in a north south orientation.

2.4 Geology

The Berrima lease is located within the Southern Coalfields of NSW. The Berrima Mine lease contains a significant resource in the Wongawilli Seam. The seam is typically ten metres in thickness, but the economically mineable section occurs towards the base. Traditionally, the working section that has been extracted has ranged from 2.2 m to 2.4 m at a raw ash of 28% to 32%. This is important when considering the construction of bulkheads within the mine, that in all locations, the roof and floor of the workings are located in coal.

The strata generally have a shallow dip to the southeast but also a slight dip to the south towards the original mine entry. Although the main underground roadways run on the strike of the dip, the workings have been designed to always drain to the original mine entry which has the lowest RL within the mine. This is also important in the closure process given the natural flow of water which enters the mine is towards to original drain adit.

The Hawkesbury Sandstone is the main geological unit above the coal seam. The Hawkesbury Sandstone is a flat lying massive quartzose sandstone approximately 150 m thick and often represents the main cliff forming sequence.

It is known from drilling at Berrima Colliery that the Hawkesbury Sandstone consists of two separate bands. The upper band is more mineral rich while the lower band is coarser grained and lower in iron. The lower Hawkesbury Sandstone band has a high permeability which represents is the primary limiting factor in the ability to fully seal the mine. This is also an important aspect of the groundwater modelling as this overlying sandstone provides a flow path for groundwater above the seam.

There are other sources of source of minerals within the mining area. These consist of numerous igneous intrusions which occur throughout the local area and which largely follow localised fault lines. These intrusions extend into the Wongawilli Seam which have resulted in multiple sources of mineral rich water entering the mine workings. These sources still exist and influence the water quality of the now partly flooded mine workings.

Other geological issues relate to areas of full extraction and caving of the overlying sandstone. Full extraction occurred throughout the mine even in the early stages of mine development. This has created a situation where standing underground roadways which are available for the installation of bulkheads are often surrounded by highly permeable but also cracked overlying sandstone.

2.5 Soils

There are limited soil resources remaining at the pit top. The site occurs on a sandstone ridge and any original soil materials have long since been removed. There are small patches of original soils surrounding the pit top. These resources would be utilised in the final rehabilitation works however the importation of soil components and manufactured topdressing material will be required to rehabilitate the outer faces of any new dams or the rehabilitation of hardstand that is not required to support the ongoing passive treatment project.

Soils developed from Hawkesbury Sandstone tend to be shallow, particularly near the edge of escarpments, they are moderately to highly permeable, poorly structured and frequently containing a high gravel fraction. They tend to be acidic (pH 5 to 5.5) and infertile and moderately to highly erodible. Although they can respond to fertiliser treatment, their lack of structure and high permeability reduces their agricultural potential.

In order to manufacture a suitable topdressing medium, some existing sandstone substrate would be necessary. This would be generated on site by ripping the underlying in-situ sandstone followed by an application of mulch to increase organic material and the addition of a general native plant fertiliser such as Patons Native Plant Food. It is anticipated that rehabilitation of any areas disturbed during the construction of the passive treatment system and overland pipeline will utilise existing soil resources with minor additional ameliorants.

2.6 Land Use

The predominant land use is agriculture with the minimum lot size within the majority of the lease area being 40 ha. A few of the properties are significantly larger and represent viable commercial farms. A proportion of the farmland consists of hobby farms, rural lifestyle and equestrian properties. The village of Medway is located adjacent to the pit top which consists of approximately 30 residential dwellings. The pit top and Loch Catherine sites are surrounded by forests and include both private and Crown Land.

The land subject to the proposed passive treatment project is owned by Boral and has been previously disturbed by mining activities.

2.7 Land Ownership

The pit top and Loch Catherine sites are located on land owned by Boral. The underground extraction area is located beneath privately owned agricultural properties. There is Crown Land associated with the Wingecarribee River and areas to the north and south of the surface facilities. All physical works required at the pit top and along the railway easement will occur on land owned by Boral.

There will be two sections of public road to be crossed, these being Liebman Road and Medway Road. Both roads will remain undisturbed as the pipeline from the pit top to the cement plant will be buried.

2.8 Surface Facilities

There are two separate surface facility sites as shown on Plan 2. The main pit top includes the office, bathhouse, coal handling infrastructure, workshop and stores. This site carried the main

infrastructure to support the mine such as power and ventilation facilities as well as coal clearance and men and materials entry.

The second site is located nearby and is referred to as the Loch Catherine Coal Storage Area. This site represents the old Loch Catherine Colliery but is also the site where other earlier mines utilised. The site was used to temporarily store excess coal production which was then reloaded and transported to the Berrima Cement Plant. The Loch Catherine site is not relevant to this REF as the sealing of the mine adits is addressed in the Final Closure Plan RMP.

The passive treatment facility will require the ongoing use of the office and bathhouse, workshop and storage shed. As the main treatment pond will be located in the main carpark area, and an alternative carpark will be established at the rear of the office and bathhouse buildings. Essentially, the entrances will be swapped around so the rear entrance will become the main entrance to the building.

The remaining coal infrastructure or other structures not required to support the ongoing passive treatment facility will be removed in accordance with the Final Closure RMP.

2.9 Water Management

2.9.1 Surface Water Management

The proposed passive water treatment system will be located solely within the existing surface water management system of the Berrima Pit Top. This includes three dirty water catchments which are captured by three dirty water dams. The main pollution control dam is referred to as the Chitter Dam which has a licensed discharge point. This dam controls runoff from the majority of the site including the proposed passive treatment construction area.

The smaller Workshop Dam captures runoff from the workshop and stores area while a separate dam captures runoff from the clean stores area. Water contained in each of these ponds is sequentially pumped into the Chitter Dam. The pit top water management system has not recorded a discharge for over 20 years as the dam capacity far exceeds the 1 in 100 year event. The surface water management system will not require modification or augmentation as a result of the proposed development.

2.9.2 Underground Water Management System

Prior to 2014 the mine managed underground water through a series of underground storages and sumps from which the water was repeatedly pumped, aerated and allowed to settle. The use of limestone dusting on exposed coal throughout the mine provided pH adjustment. Regular water testing was undertaken in the last three sumps and again prior to discharge at a point referred to as the V Notch Weir. From this point, the water flowed down the original mine access roadway to the Drain Adit and into the Wingecarribee River, as shown on Plan 3. The treatment system extended along the main underground roadways known as the 400 Panel Mains. With the closure of the mine, the majority of infrastructure was removed along with all potentially contaminating materials such as pumps, electrical components and sources of oil. The 400 Panel roadways were then allowed to flood removing access to the previous passive treatment system.

Without treatment, groundwater discharged from the mine contains naturally high levels of minerals, particularly Iron and Manganese which can discolour the receiving waters of the

Wingecarribee River. Natural groundwater seeps of similar quality occur along the stretch of the Wingecarribee River as it passes through the Hawkesbury Sandstone geology of the Sydney Basin. However, given that the mine discharge is a point source with a discharge of around 1.5 to 2.5 ML/day, dispersion of minerals only occurs during high flow events in the river. Settled minerals within the mixing zone below the discharge can impact on aquatic and benthic organisms.

The proposed passive treatment system essentially replaces the original underground treatment system. This was attempted as a temporary measure over recent years following the flooding of the mine workings. This used a small section of unflooded roadways which involves aeration from pumping and then passing the water over a limestone lined channel for pH adjustment. This system worked well initially but currently requires additional pH adjustment which is achieved by mixing a component of mine water with hydrated lime at the surface before returning the treated water back to the underground workings.

The primary benefit of pumping all the mine water to the surface for treatment is the ease and simplicity of a surface managed system. There are significant constraints imposed on undertaking any activity within an underground coal mine. These include ventilation, strata stability and general safety considerations.

A surface management system also provides flexibility to expand or change treatment methods in response to water quality. Although the anticipated treatment rate will be around 2.6 ML/day which is slightly less than the historic average, a surface managed system can quickly respond to a significantly greater or lesser amount.

This flexibility will allow the operation to gather the additional information requested by the Resources Regulator as part of the final closure plan. This will involve reducing the treatment rate to allow groundwater to saturate overlying strata above the mine seals and measure the quality and quantity of water seeping through the strata and entering the discharge channel. Should the water quality not be suitable for discharge, the surface treatment system will have the ability to quickly increase treatment capacity and deliver water to the discharge channel underground to counteract any poor quality seepage water.

Further details of the treatment process are provided in Section 3.2.

3. The Proposed Activity

This Chapter details the proposed surface water treatment activities in sufficient detail to allow the potential impacts of the activities to be assessed. An analysis of alternatives is also provided while the results of the assessment and proposed mitigation measures are outlined in Chapters 4 and 6.

3.1 Objectives of the Activity

The objectives of the passive water treatment system are summarised below:

- Pumping sufficient groundwater to the surface and treat to maintain the level of water backed up behind the underground bulkheads;
- Improve the quality of the water in surface treatment dams including the reduction of metals such as iron and manganese and maintaining a neutral pH;
- Provide clean water to the Berrima Cement Plant during periods when onsite captured water is insufficient for operational needs; and
- To return water of equal or higher quality than previously discharged into the Wingecarribee River.

The Final Closure RMP provides details of the proposed measures to achieve the required rehabilitation goals and standards while this REF provides an assessment of the potential environmental issues associated with the water treatment plant project.

3.2 Description of the Activity

There are three elements to the proposed activity, the first involves the construction of a set of bulkheads located within the underground workings. Although this component is integral to the activity, they do not require approval from the EPA as they fall under the provisions of the Mining Act which is administered by the Resources Regulator. The second element is the construction and operation of a passive treatment system at the pit top of Berrima Colliery while the third consists of a pipeline which joins the pit top with the Berrima Cement Works. These two components are surface installations which specifically deal with future water management, pollution control and discharge in accordance with EPL 608 and are therefore covered by Condition U1.1(3) of EPL608. The three components are described below.

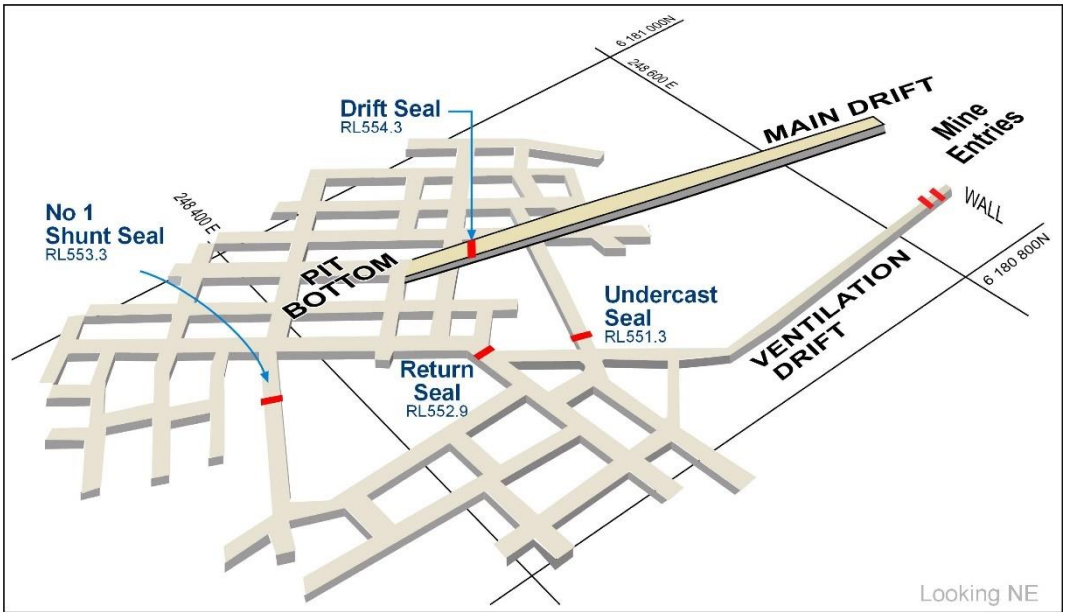
3.2.1 Pit Bottom Bulkhead Seals

The proposed pit bottom seals are:

- Undercast Seal – this seal represents an old roadway which directly links to the drain adit roadway. Its located just north of the V Notch Weir and has an elevation of RL551.3m.
- Return Seal – is located in the main return airway roadway which leads from the Ventilation fan. It has an elevation of RL552.9m.
- No 1 Shunt Seal – is located further to the west at an elevation of RL553.3m.

These three seals will effectively flood the entire pit bottom area. They will be of concrete construction and will include a grout curtain around them to minimise the seepage potential of the surrounding coal material.

The fourth seal will be located in the mine entry drift and is referred to as the Drift Seal. The drift was constructed at a 1 in 8 grade from the surface to the seam and passes over the roadway where the undercast seal is located. The Drift Seal will likely be constructed at or just above the seam level in the Hawkesbury Sandstone. The suggested elevation is RL554.3m but this is subject to further design. The Drift Seal will not be a permanent barrier but rather a safety barrier to prevent access. It will allow pumps and pipework to be installed to enable pumping of the water from the flooded pit bottom area to the surface water treatment area. The relative locations of the seals are shown in the schematic below.



The Resources Regulator has required that a re-entry plan will be needed should access to the workings be required sometime in the future as well as additional ventilation stoppings and monitoring equipment be installed. The development of the re-entry plan will be completed prior to the installation of the bulkheads while the location of the additional ventilation stoppings will be determined separately with the Resources Regulator.

3.2.2 Pit Top Treatment Works

Experience with the underground treatment system has informed the design of the surface treatment system. The pit top treatment works will consist of three dams located at the upper level of the existing pit top. This area consists of the main access road leading into the site, the top carpark and the engineering carpark. The area is currently cleared but includes landscaping.

As shown on Plan 3, The main pond will be a 6 ML multicell structure measuring approximately 90m long by 20 m wide and 3.5 m deep. It will be constructed by a combination of excavation and fill with the surface walls being approximately 2 m high. The slopes of the fill batters will be approximately 1 in 2 (vertical to horizontal) and consist largely of crushed sandstone removed from the excavation.

The main multicell pond will be divided into 6 cells representing two separate treatment circuits. Each circuit will consist of a primary settlement pond followed by a treatment pond and finally polishing pond. Water pumped from the mine will be aerated via venturi style valves within the delivery pipeline which will also be equipped to add alkalis and settlement agents. It is

anticipated that the majority of minerals will be deposited in the first pond which will be accessible for cleanout.

Following primary settlement, overflow water will pass to a second pond for additional forced aeration and further passive treatment using limestone aggregate or similar such as dolomite. The third cell will assist with fine particle settlement and testing.

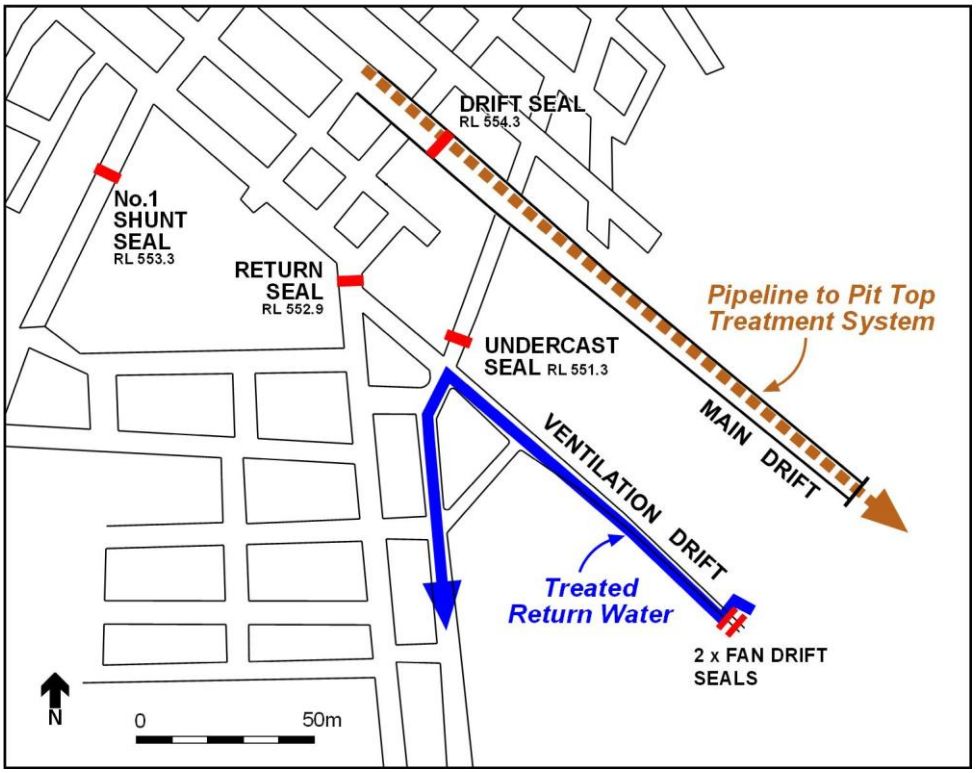
As shown on Plan 4, there are two complete circuits. This allows for one circuit to be isolated for cleaning and maintenance.

The pond will be lined with either clay, sand and cement or geotextile depending on usage and final design criteria. The ponds will be designed to avoid seepage but also allow for regular cleaning. It is expected that approximately 19 tonnes of mineral precipitates will be generated each year, the majority of which will be Iron. The minerals will form a sludge with a moisture content of approximately 70% and would need to be dried in order to load and transport. Dewatering will be achieved by using non-woven geotextile filter bags with filtered water being returned to the treatment ponds or allowed to report to the existing pit top water management system.

As the cement works uses iron as a feed material in the manufacture of clinker, there is the potential to reuse the precipitates from the passive treatment system. If this proves not to be viable, the material will be transported to an approved resource recovery facility.

Treated water will then be pumped or gravity feed to two separate 1 ML pond. These are referred to as Pond 2A and 2B on Plan 3. Pond 2A will be the return water pond which will deliver treated water back into the underground workings via a pipeline down the Ventilation entry and into to the Wingecarribee River. This will also be a monitoring point and allow water to be returned to the treatment pond if necessary.

A schematic showing these arrangements is provided below. It should be noted that these may change following detailed design. The return treated water pipeline will discharge into the drain adit roadway and will ultimately discharge into the Wingecarribee River via the current licensed discharge point.



Pond 2B is located adjacent to the original site entrance road. This pond will be equipped with a pumping station which will feed the overland pipeline to the cement plant.

3.2.3 Treatment Efficiency

In late 2017 and early 2018, a surface treatment trial was undertaken at the Berrima Colliery Pit Top. The trial used aeration and pH adjustment followed by settlement and utilised raw underground water which was passed through a series of limestone lined channels and weir structures. The purpose of the trial was to:

- Determine reaction time to achieve pH 7.5.
- Determine variability in reaction time due flow rate and aggregate size.
- Verify modelled reductions in metal removal, particularly Iron and Manganese.
- Assess alternative use of alkalis and oxidisers should the passive limestone treatment system prove unsatisfactory.

The trial demonstrated that passive treatment was effective at removing almost all of the iron and approximately 25% of other minerals and was subsequently used underground to treat water following the installation of the seven bulkheads. The proposed pit top passive treatment system is based on a combination of the surface trials, the methods used underground while the mine was operating and the current treatment system which utilises some of the elements of both. The main difference will be the additional settlement ponds and the ability to incorporate different alkalis and oxidisers to further improve stripping minerals from solution. These chemicals, such as Sodium Hydroxide and Calcium hypochlorite are common to water treatment but are unsuitable to use in an underground mine.

Based on the trials and process design work to date, an estimate of the removal rate will be:

- Iron – Raw concentration 18.9 mg/L, treated discharge quality 0.1 mg/L.
- Manganese – Raw concentration 8.8 mg/L, treated discharge quality 1.9 mg/L.

- Nickel – Raw concentration 0.22 mg/L, treated discharge quality 0.15 mg/L.
- Zinc – Raw concentration 0.54 mg/L, treated discharge quality 0.25 mg/L.

The raw concentration is the current average water quality contained behind the seven bulkheads and is a Total Concentration value while the treated water objective is a dissolved concentration. Based on an average treatment rate of 2 ML per day, it is anticipated that approximately 19 tonnes of mineral sludge will be produced annually or 52 tonnes each day. The volume of sludge however will be greater as the solids will have a moisture content of around 70%. The sludge will be dewatered using geotextile filter bags. The filter cake will be disposed of in a licensed waste disposal facility or if suitable, used in the manufacture of clinker.

3.2.4 Pit Top Earthworks

The ponds are located within the surface facilities area of the colliery which has historically been defined as a clean catchment. It consists of concrete carparking area, roadways and some landscaping. Beneath the hardstand is a skeletal sandy soil overlying weathered Hawkesbury Sandstone. The activity will require the following earthworks:

- Excavation and levelling for each pond. This will generate some concrete waste which will be disposed in a licensed waste resource recovery facility.
- Pond wall forming. The material used for this will be generated by weathered sandstone base material generated by the excavation.

The ponds will be constructed as a combination of cut and fill with approximately 2 m below ground and 1 m above ground as shown on Plan 4. It is assumed that the surface weathered sandstone will not be suitable for wall construction and would be used for general rehabilitation purposes. The disturbed area for the main pond is approximately 2,000 m^2 of which 1,800 m^2 represents pond excavation. This area will generate approximately 3,600 m^3 of spoil. The two smaller ponds will generate 1,000 m^3 in total. Dam wall construction would use approximately 800 m^3 leaving approximately 3,800 m^3 of crushed sandstone to be used for rehabilitation purposes. This would be used at both the lower clean storage area and at Loch Catherine Coal storage area.

The earthworks component of pit top construction program will take approximately 4 months and will include the following plant and equipment:

- Small dozer (D6 or equivalent). This will be used for the majority of the excavation and the unit will be equipped with a ripper tyne attachment.
- 20 tonne excavator with both bucket and rock breaking attachments. This unit will be used to load excess material into trucks and to break up harder sandstone material.
- Bobcat which would provide shaping of dumped materials and the final trimming of the dam walls.
- Two small rigid dump trucks to transport excess excavated materials to final emplacement areas.

It is possible that some contaminated material or building waste will be encountered during the earthworks phase. This material will be collected and disposed in an approved resource recovery facility, as further discussed in Section 4.5. A Construction Environmental Management Plan (CEMP) will be developed prior to construction. This will include an

unexpected finds protocol with appropriate treatment, handling and disposal of potentially hazardous or contaminating substances.

3.2.5 Fit Out and Installation of Treatment System

The fit out will include pond lining, erection of guards and walkways, pump supports, supply of services and installation of electronic control systems. Some concrete works will be required which will involve a concrete agitator and pump. The passive treatment system will require power for pumping, forced aeration and lighting. This will be provided from the existing power supply. The metal gantries will be required to support pipework and allow for mixing and chemical additions. A general arrangement drawing showing the layout of system is provided as Plan 3 while a schematic of the internal cells is provided in Plan 4.

Once excavated and shaped, the ponds will be lined with either HDPE liner or a compacted industrial sand with 10% cement mix. The internal division baffles will be inert concrete block construction or lined timber. The internal cells will be designed to allow access for cleanout of precipitated sediments and will be lined according to future cleaning procedures. Flow between ponds will be largely by gravity via overflow weirs on top of baffle walls however pumping between cells will also be available.

The existing fire fighting tanks at the pit top may also be utilised in the treatment system. These tanks hold approximately 200,000 litres and are connected by a pumping station to a reticulation line and fire sprinkler system across the pit top.

The existing office and Bathhouse building will be used for the operators of the treatment system as well as during the workforce engaged in bulkhead installation and entry sealing work. The main entrance to the building however will be changed to the current rear entrance and a new carpark will be designated as shown on Plan 3. Minimal internal upgrading of the buildings will be required and existing services, including telecommunications, water, power and sewage are all currently available and adequate to cater for the proposed construction and installation program as well as ongoing operations.

The workshop, stores and sheds will be used to support the ongoing treatment operation. The workshop will store spare parts and general workshop supplies. The workshop has a loading dock and internal drainage systems to direct spillage to a fully contained concrete sump. The sump is also used as part of a washdown bay and is equipped with a multiplate oil separator. The existing storage shed will be used to store chemicals and reagents. The shed is fully bunded and any spillage is contained within the bund and collection point. The capacity of the bunding system exceeds the requirements of Australian Standard AS1940 which requires that bunds must be capable of containing spills and leakages, be chemically and fire-resistant, and have sufficient capacity based on the largest container or total storage.

Any unnecessary coal related infrastructure will be removed from site. This will include any remaining conveyors, the coal crusher and mining related stores and spares. The winder will continue to be used but will eventually be removed once alternative access down the drift is available.

As shown on Plan 3, there will also be two separate ponds, noted as Pond 2A and Pond 2B. These ponds will be used as transfer points for treated water. Pond 2A will be located in the carpack behind the engineers office building. This is a flat bunded area representing an ideal location to transfer treated water back down the drift and into the mine workings. The treated

return water will likely enter via the ventilation shaft to allow discharge within the channel which currently houses the V Notch Weir. This channel represents the licensed discharge point for the mine (the V notch being the point where volume is calculated while the adit associated with this channel represents the current discharge point into the Wingecarribee River.

Pond 2B will be located along the existing vehicle access to the colliery, no closer than 230 m from the nearest residence in Medway Village. The site is already cleared and represents the old mine managers cottage site, although no remains of the building exist. The site is also slightly elevated to the railway easement which makes it a suitable site to transfer water to the cement works. A small lockable shed will be provided to house a 47 kW pump. The shed will be lined and will have acoustically shielded ventilation louvres located at the rear of the shed. The pump will be mounted on a concrete footing but with vibration isolating mounting system such as rubber plating.

The operation of the treatment system will be controlled remotely at the cement works control room. This will include automatic starting and stopping of pumps. Remote sensing control systems will be based on standard telemetry and include water quality sensor data, pond levels, servo activation, system shutdown and camera systems.

3.2.6 Access to Pit Top

The main access to the site will change slightly as the new ponds will remove the existing employee car parking. Both the front entrance and coal haul road will remain open as will the internal roads between the upper and lower levels of the pit top. New signage will be provided as required to designate direction of travel and location of the new carparking area.

3.2.7 Commissioning of Treatment System

The passive treatment system has been designed to allow for easy expansion and modification. During the commissioning phase, in-situ monitoring of pH, conductivity, dissolved oxygen and turbidity will be taken at each cell to allow fine tuning of the treatment system. To cater for this, facilities will be included that will allow for multiple additions as required.

3.2.8 Overland Pipeline Project

The route of the overland pipeline is shown on Plan 5. The route lies within a service corridor between the cement works and the colliery. The land is owned by Boral and does not represent an easement or right of way entitlement on other land titles. Originally constructed in 1881 it was used to transport coal by rail from various mines in the Medway and Loch Catherine area. The last train used the line in June 1978 after which coal was transported by truck. From 1926 to the present, it has been partly used as a service corridor for the 66kV transmission line which runs between the cement works and the colliery. Although the rail tracks and majority of sleepers were removed by 1987, the earth embankment and rail ballast remain.

The pipe will be pressure rated HDPE 200mm internal diameter (ID) and buried within the railway easement. Commencing at the pump station at Pond 2B, the route will follow the existing access road to the railway cutting. From this point it will be wholly contained with the railway easement until it reaches the edge of the Boral Property on the eastern side of the Old Hume Highway. From here, the route will pass through the cement works and linked into the existing raw water system. This system consists of several surface ponds, including the Shale Pit void which are linked by a series of channels and pipelines.

The water supplied to the cement works will offset water that is currently taken from the Wingecarribee River at Berrima Weir. Plan 5 accurately shows the pipeline route within the railway corridor but once the pipeline enters the cement works property, the off take point may vary and will be subject to detailed design. This component of the route is dashed to indicate that further refinement will be required.

There are five road crossings along the 5.2 km route between the pit top and the cement works property boundary. These are described below:

- Pit top access road crossing. The crossing will occur on just south of Pond 2B on Boral owned land. This is a private access road and the pipeline is likely to be trenched through.
- Liebmans Road crossing. This is a dirt road which accesses private properties. The road will be under-bored to avoid traffic implications.
- Medway Road crossing. The railway easement crosses Medway Road at an angle near the entry to the Zen Oasis Restaurant and Function Centre. This entry has been recently upgraded and widened. The pipeline will be under-bored so as not to interfere with passing traffic and intersection performance.
- Hume Motorway crossing. The pipeline will use the existing culvert underpass beneath the Hume Motorway.
- Old Hume Highway crossing. On the eastern end of the pipeline route is the Old Hume Highway crossing. This crossing will be under bored to avoid traffic impacts.

The majority of the pipeline route passes adjacent to cleared agricultural land, however as the pipeline will be laid within an old railway easement, no agricultural land will be impacted. There are however some regrowth native and exotic species which will be cleared as required to construct the pipeline.

As the railway easement is narrow, it is anticipated that the pipe will be buried using a small excavator (8-12 tonne) and/or backhoe with a bobcat used for final shaping. Small trucks (around 5 tonne) will be used to deliver bedding material and to remove any debris. Pipes will be delivered by truck and a telehandler used to unload and place the pipe sections into the trench. A boring machine or equivalent maybe used for road crossings. Other equipment will include a generator, pipe welding (elecro-fusion pipe joints) and hand tools. Portable toilet facilities will be provided which will move daily along the easement.

Any additional spoil generated during the pipeline installation will be spread within the easement in accordance with a Construction Management Plan.

3.2.9 Access Along Pipeline Route

The construction program for the pit top and overland pipeline will be undertaken sequentially with the pit top system being constructed first followed by the overland pipeline. The workforce involved in the pipeline construction will be less than involved in the pit top treatment system and will average approximately 4 people plus transient delivery drivers. The workforce will travel each day to the site in two light vehicles (4WD utilities or similar). Given the lack of width within the easement, most vehicles will travel in one direction only along the easement. There are several existing entry and exit points along the easement, which will be used to access each section of the pipeline construction. The direction of travel will vary depending on location of

physical construction at the time, meaning that an entry point can also serve as an exit point and vice-versa. These include:

- Entry at the pit top access road and exit at Carrada Street Medway. A distance of 490 m. Carrada Street can also be access from Boral land to the north.
- Entry at Carrada Street and exist 550 m east on Boral land near the private trotting track.
- Entry from Boral land and exit on Liebmans Road approximately 900 m further to the east.
- Entry form Liebmans Road and exit on Medway Road approximately 860 me to the east.
- Entry from Medway Road and exist on the Old Hume Highway approximately 2.3 km to the east.
- Entry from the Old Hume Highway and exit within the Berrima Cement Works.

The Construction Management Plan will detail access points for each section of the route as well as provide notification to land owners of the dates that access will occur.

3.3 Project Timing

Work will commence on the project following the approval of activity, internal capital approval by Boral and the installation of the underground bulkheads. At this time the following sequence of events and timing will likely occur:

Component	Timing
Pit Top Passive Treatment Works	
Detailed design and finalisation	1 month
Tender preparation, release and commissioning of earthworks contractor	3 months
Completion of earthworks component	4 months
Fit out	2 months
Commissioning	1 month
Total	11 months
Overland Pipeline to Cement Works	
Survey and Detailed Design	1 month
Pipeline installation	3 months
Commissioning	1 month
Total	5 months

The pit top treatment system and overland pipeline will be treated as two separate projects for construction purposes. The pit top treatment system will be constructed first and maybe completed prior to the commencement of the overland pipeline project.

Not itemised above is the completion of the underground bulkheads. This component will require a separate approval issued by the Resources Regulator. This approval is currently being sought and will be tied to any future conditions imposed on the Final Closure Plan.

The commissioning phase may also be extended as it will be tied to treatment performance. As with the early surface and underground treatment trials, there were several technical issues to resolve which resulted in implementation delays. The commission phase will likely start at a low throughput volume and several hold points will be established to ensure that only suitable quality

water is discharged into the Wingecarribee River. Volume will increase in stages as water quality improves.

3.4 Workforce

There are currently six employees and contractors working at Berrima Colliery. During the installation of the underground bulkheads, this will increase to 12 through the use of additional contractors and equipment operators.

During the construction phase of the passive treatment system, it is anticipated that a maximum of 20 contractors will be employed. These include equipment operators, tradesmen and general laborers. A separate contract will be issued to cover the construction of the overland pipeline which is anticipated to use approximately 4 contractors plus transient truck drivers.

On completion of the work, including the final sealing of the mine entrances and the removal of the need to maintain the underground mine, the workforce will be reduced to approximately 3 full time equivalent personnel. This will consist of several part time and on call personnel to carry out maintenance, inspections and security. As the facility will be fully automated and controlled remotely at the Cement Works, there will be no need for any personnel to be permanently stationed at the pit top.

3.5 Analysis of Alternatives

The consideration of alternatives fall into the following categories:

- Alternative mine closure scenarios;
- Alternative water treatment options;
- Option to do nothing.

Various alternative mine closure scenarios have been investigated since 2014. These have been reported in the previous staged Final Closure Mining Operations Plans which have been widely discussed with government stakeholders and the community. The only outstanding issue is how to deal with the groundwater which will continue to enter the mine. This is discussed in the following sections.

3.5.1 Alternative Mine Closure Scenarios

There are limited options available to deal with the groundwater. These options fall into three categories. The first is to allow the water to free drain from the mine into the Wingecarribee River. The second involves various sealing options to prevent water discharging and in turn repressurise the overlying sandstone aquifer. The third category involves continually treating the discharge in some way. The Resources Regulator has indicated that the final closure plan must consider an in-perpetuity water management solution. It also requires the formulation of a re-entry plan prior to approving any cessation of underground access.

Assessing the free discharge option, the following information is available:

- Over 20 years of discharge water quality and receiving water quality. This data demonstrates that the quality of the underground water is unsuitable for discharge into the Wingecarribee River without treatment.

- Aquatic ecology and ecotoxicological studies indicate that the long term discharge of treated water from the mine does not in itself harm the environment receiving environment so long as mineral content is kept within long term averages and do not build up in the mixing zone sediments.
- A short period following closure when untreated groundwater was discharged from the river which caused a deterioration of river health and resulted in the development of the current underground treatment system.
- Regular high flow events in the Wingecarribee River assists with the removal of untreated groundwater discharged from the mine however they are too infrequent to maintain a healthy mixing zone.

Based on the above, Boral has determined that any option involving untreated water being discharged into the Wingecarribee River is unacceptable.

The second category of options involve attempting to prevent groundwater from being discharged from the mine. This would involve using various combinations of underground pressure seals. The number and location of seals has been variously discussed and assessed in the previous staged Final Closure Mining Operations Plans and subsequent meetings with the Resources Regulator. In assessing these options, the following information is available:

- Geological data including permeability data, historic mining plans and underground survey.
- Underground trials using a series of seven bulkheads.
- Groundwater modelling which has been progressively updated to include additional data and calibration.
- Geochemical assessment of the source of mineralisation.
- Multiple Risk Assessments involving experts in water quality, groundwater, geochemical, mine engineering and ventilation.

This data has demonstrated that the groundwater intercepted by the mine will naturally flow towards the original mine adit, which is also the current drain adit and is the licensed discharge point for the mine. The mine workings were originally designed to drain to this point. This would occur irrespective of the number of pressure seals installed due to the fact that the overlying sandstone strata is highly permeable. Repressuring the overlying strata would simply provide another pathway for groundwater to travel, that is, over the top of the bulkheads and back towards the original mine adit.

Although the groundwater modelling did suggest that a small portion of water would flow elsewhere, the modelled discharge was still above 2 ML/day. The geochemical assessment indicated that the discharge quality would be similar to the untreated discharge although over time it may improve. This timeframe could not be accurately defined and may well be in excess of 20 years and possibly hundreds of years. This would result in unacceptable environmental impacts.

A sub alternative of this scenario involved sealing the actual discharge point in the river. This option would hopefully allow the water to be discharged evenly through the talus slope of the river. Unfortunately, on detailed inspection of the talus slope as well as the examination of the original mine record tracings, it was found that the original mine workings extended beneath unconsolidated material along the talus slope beneath the Wingecarribee River gorge. It was considered highly likely that any attempt to seal the mine at this location would result in failure of

the talus material at some point along the escarpment which would lead to an uncontrolled and polluted discharge. This section of river is inaccessible to earthmoving equipment rending the repair of any blowout extremely difficult and environmentally damaging.

Based on the above information to date, Boral has determined that it is not feasible to fully seal the mine in a manner which would prevent an unacceptable discharge into the Wingecarribee River. It is considered that the only viable and sustainable option is to treat the groundwater prior to discharge. The treatment underground has proved successful, but difficult to maintain over the long term given the constraints imposed by working within an underground coal mine environment. Therefore, the option to treat the water on the surface within the existing pit top footprint is considered the only long term viable solution, particularly given the ability to transfer a proportion of the water to the Berrima Cement Plant to offset water that is pumped from the Wingecarribee River at Berrima Weir.

3.5.2 Alternative Water Treatment Options

Removal of iron from groundwater in the Southern Highlands is commonplace and usually involves pumping bore water into a dam to settle prior to use. Removing manganese is more difficult, and requires oxidation in an alkaline environment. Nickel and zinc and similarly more difficult to remove or to precipitate from solution and often require chemical oxidation. However, the concentration of these minerals in the bore water is relatively low. Alternative treatment systems therefore include:

- Surface irrigation was considered as an option for evaporation of excess groundwater. Four areas for potential irrigation were identified including the existing waste water irrigation area, the old pit pony paddock, Boral owned land to the north of Medway village and at the Loch Catherine site. The key requirements of this option would be to avoid surface runoff causing erosion and soil degradation, minimise the risk of groundwater pollution and maintain healthy vegetation cover. An investigation into this option found that there are opportunities to irrigate mine water, although some pre-treatment of water would still be required to reduce metal concentration and it is not considered possible to dispose of all the water even if additional land area was available. This option failed on the basis that there would be extended intervals during prolonged rainfall when irrigation would not be available which in turn would result in the risk of untreated discharge into the river from overflowing underground bulkheads.
- A chemical treatment plant for the removal of iron and manganese from water is commonly achieved by chemical dosing and flocculation. This treatment option would involve pumping the groundwater to a tank at the pit top for the addition of alkali and oxidiser prior to transfer to a secondary tank for sediment removal. The metal oxide sludge would be settled with the addition of a coagulant and flocculant prior to clarification and pH adjustment of the final discharge water. This option is possible but provided no additional benefits over a passive treatment system and came at a significantly greater cost. The proposed passive treatment system has incorporated the ability to chemical dose if required.
- Reverse Osmosis/ Ultra Filtration Treatment uses high pressure to force small molecules through a fine but high surface area membrane. An advantage of this method is the complete removal of metals, including manganese, zinc and nickel. However disadvantages include high capital and operating costs, energy consumption, the need to pretreat the water to remove solids, and the requirement for disposal of the resultant brine.
- Activated carbon adsorption is commonly used to adsorb organics, but can also be used to adsorb most metals. This method was subject to a separate investigation to see if it was

possible to treat overflows from the bulkheads within the discharge channel in perpetuity. The study found that it may be possible to treat the water to an acceptable standard however ultimately the treatment system would need to be replaced. This option failed as it would not allow the mine to enter final closure.

Active treatment such as Reverse Osmosis or solely chemical treatment are only viable if space were limited, for example if the mine was continuing to operate. As the mine is closed, there are less space constraints, allowing for the construction of large ponds.

Surface irrigation is only viable as an adjunct to pre-treatment and therefore does not offer any benefits over the preferred option of returning treated water to the river to maintain environmental flows and reusing a component of the water in the cement plant.

To date, the underground passive treatment system has proved to be an efficient mechanism for water treatment, with an increase of pH to near neutral, a reduction in mineral concentration approaching historic average and an increase in dissolved oxygen equivalent or higher than the receiving waters. The system has been augmented by mixing hydrated lime on the surface and pumping this mixture into the workings near the V Notch weir to allow mixing before discharge. However, treating the water within the underground mine is difficult and less flexible than a surface operated treatment system. The underground mine workings are also not as safe as working on the surface and requires operating within the required safety provisions of the Mining Act.

Some components of these options have proven useful in the development of the proposed passive treatment system. The current underground system supplemented with addition of lime at the surface with the final discharge point remaining as is has worked well but only fails as a result of being located within the confines of an underground coal mine. Undertaking all activities on the surface provides increased safety and flexibility while keeping the current discharge point reduces environmental impacts on the Wingecarribee River to within historic levels.

The surface irrigation study, although failing in its ability to dispose of all underground water during prolonged rainfall periods led to the proposal to supply water to the Berrima Cement Works thereby maintaining an important reuse consideration.

A key benefit of the proposed passive treatment system is its flexibility in that it can easily be modified or augmented as required. The Resource Regulator requested that the final water management solution be used to test the possibility that long term water quality discharged from the mine may, over an extended time period, improve to a point where no ongoing treatment would be required. The proposed treatment system can be used to test this assumption by varying the volume pumped to the surface for treatment. This option is further discussed in the following section.

3.5.3 Option To Do Nothing

This option is represented by either:

- The free draining option. This is essentially allowing the water to discharge as is without treatment. This would result in pollution of the Wingecarribee River during times of very low flow, however in time there is the potential for the river to adapt to the high mineralised discharge or the discharge itself would naturally improve. This option was considered

untenable to Boral and the EPA as it would result in a period of time, likely decades, where a highly mineralised discharge would be impacting the river.

- The continuation of the existing underground treatment system. This option was rejected by Boral due to safety reasons. The underground system requires the mine to remain open indefinitely. As the mine is already nearly 100 years old, the risk of roof fall and/or pillar collapse within the necessary working area is considered high and untenable to keep open indefinitely.
- Future free draining option. This option represents the possibility that at some time in the future, the level of mineralisation within the mine would reduce to a point where water quality would be acceptable for discharge without any treatment. This option satisfies the Resources Regulator's requirements for an in perpetuity solution that does not require on going human intervention.

A future free draining option has been incorporated into the proposed surface passive treatment system project in order to meet both short term and long term goals for mine closure. The passive treatment system treatment rate can be varied over time. This flexibility will allow the operation to gather the additional information requested by the Resources Regulator as part of the final closure plan. This will involve reducing the treatment rate to allow groundwater to saturate overlying strata above the mine seals and measure the quality and quantity of water seeping through the strata and entering the discharge channel.

Should the water quality not be suitable for discharge, the surface treatment system will have the ability to quickly increase treatment capacity and deliver water to the discharge channel underground to counteract any poor quality seepage water. This process can be done over many years, particularly in high rainfall years when demand from the cement works is low.

3.6 Stakeholder Consultation

There has been significant ongoing consultation with government organisations and the community since Boral notified that it would seek final closure approval. The consultation effort has principally been related to the various options surrounding final closure. Government stakeholder consultation has largely centred on progress meetings and regular reporting. Consultation with the community has been facilitated by the establishment of a Community Working Group (CWG). The CWG met regularly between mid 2018 to mid 2023 with 17 meetings having been held. The CWG meetings have been temporarily paused until the final closure scenario, including the surface passive treatment system has been approved. The CWG meetings were independently chaired and include the following government agencies:

- NSW Resources Regulator.
- NSW Environment Protection Authority.
- Water NSW.
- Wingecarribee Shire Council.

There are six community representatives in the CWG as well as Dr Ian Wright from the University of Western Sydney who has been previously involved in water quality and aquatic ecology studies. Key Boral representatives attended each meeting and provided an update on the closure activities. The meetings covered all aspects of the mine closure process and communication strategies. The role of the local community in the Closure Working Group is to ensure the views of the local community are raised and considered as part of the closure process. The local community representatives provided advice and feedback as members of

the public on the long-term issues that are faced with the options presented for final closure of the mine. The CWG will likely reconvene following final approval of the passive treatment system.

The communications strategy also includes newsletters which are available to the local community, community open days and a dedicated website which hosts up to date information on the closure process, environmental studies and monitoring data as well as the minutes for the CWG meetings. All data and reports, including CWG minutes are hosted on a dedicated Berrima Colliery web page: https://www.boral.com.au/boral-berrima-medway-colliery-and-mine

This site provides detailed information on each action taken in the closure process including the current proposal to undertake passive treatment at the pit top as well as contact details in order for the community to make comments and submissions on the closure process. The web page will be updated with any approval documents and will include a timeframe for the construction program.

There have also been regular meetings with both the Resources Regulator and the EPA in relation to the passive treatment system and other closure matters. Issues raised by the Resources Regulator centre on how the closure activities underground will seek to minimise oxidation of minerals which lead to poor water quality. Although accepting of the passive treatment system as a means to ensure poor quality water is not discharged into the river, it is not viewed as an in perpetuity solution. To alleviate this concern, the final closure plan has incorporated a 30 year program designed to test the assumption that mineralisation will reduce over time following additional ventilation controls to reduce atmospheric exchange with the mine workings.

The EPA raised concerns in relation to the river discharge point and construction related noise issues. As a result of these concerns, the project now proposes to utilise the existing discharge point rather than a new point of discharge into the river. This means that the historic mixing zone downstream of mine discharge will remain unaltered or extended. A construction noise study has also now been undertaken and contained in full as Appendix C.

4. Environmental Issues and Impacts

This Chapter identifies the environmental aspects relevant to the proposed passive treatment system project and provides sufficient environmental impact assessment to enable the EPA to determine the project as required under Part 5 of the Environmental Planning and Assessment Act.

4.1 Environmental Aspects

The key environmental issue associated with closing Berrima Colliery is the longstanding water discharge into the Wingecarribee River. Secondary issues relate to construction impacts, particularly noise and traffic, contamination and ongoing operational impacts. The passive treatment system construction will not result in any additional site disturbance at the pit top and therefore biophysical and cultural impacts are not considered relevant.

There has been a number of environmental studies that have been undertaken over the past 10 years. These studies included several sequential groundwater studies that concluded that it is highly unlikely that any closure arrangement would see the discharge cease. The sections in this Chapter references and summarises the conclusions from these reports rather than repeats the analysis. It has also been found that the Impacts on the Wingecarribee River can be divided into two environmental aspects, the first is flow while the second is water quality. Both aspects can be interrelated, as described in this Chapter.

The overriding premise of the assessment for this project has been that the water discharged from the surface passive treatment system is returned to the mine workings to be discharged from the same licensed discharge point into the Wingecarribee River. It is therefore valid to include historic data on river health, mixing zone impacts and water quality issues in the assessment of the passive treatment system. This data is important as it shows that untreated groundwater contains high levels of minerals which can impact the mixing zone ecology, however the previous treatment by the mine operator to reduce the concentration of these minerals has allowed the river ecology to adapt to the long standing discharge from the colliery.

The foundation of the proposed surface passive treatment system project is to provide a consisted discharge quality, equal to or better than was historically delivered by the operating mine.

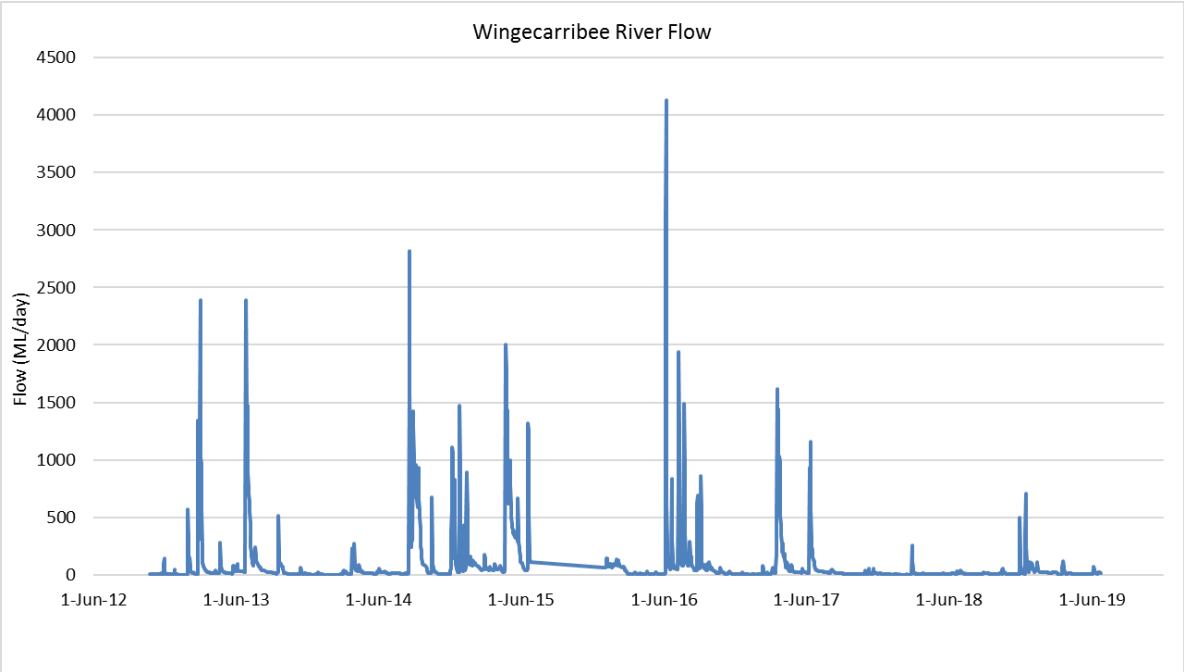
4.2 Water Volume Changes in the Wingecarribee River

As the mine has been discharging groundwater collected within the mine workings for at least 100 years, the environment downstream of the mine has adapted to this small but regular baseflow. Over this time, the volume of water upstream of the mine has been significantly reduced and regulated by water supply dams and numerous farm dams within its immediate catchment. As a result, the water flow upstream of the mine is often reduced to a trickle between shallow stagnant pools. This is demonstrated in Graph 1 below which shows a seven year period of river flow gauging undertaken at Macarthur's Crossing just upstream of the mine.

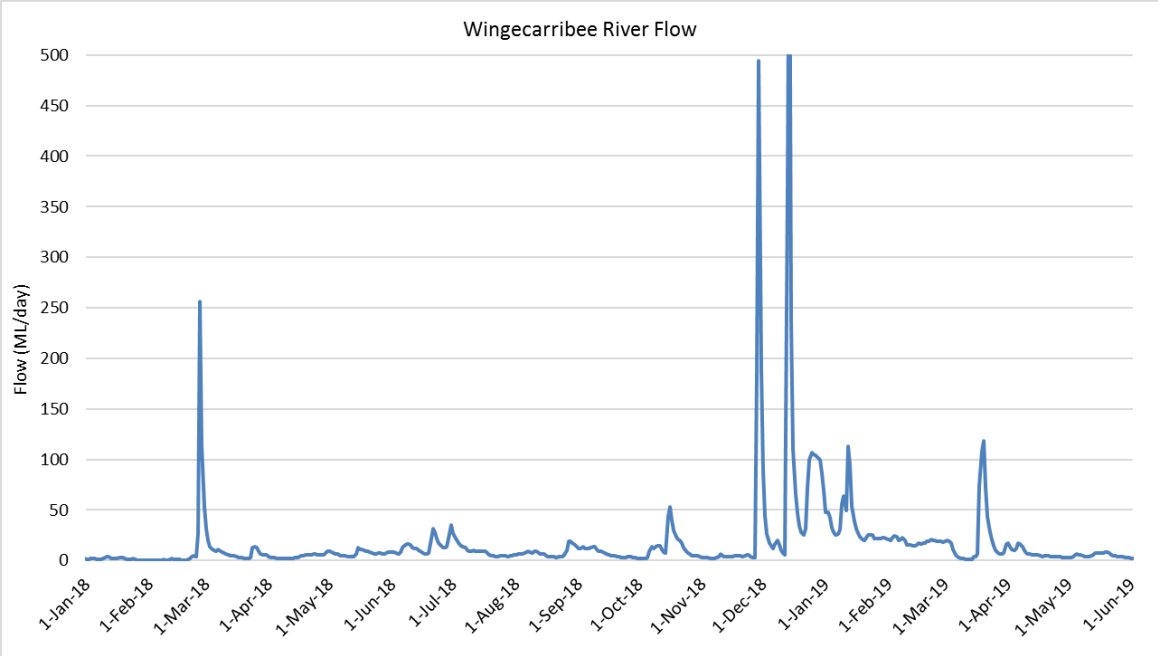
Graph 2 shows the same flow measurements at a larger scale over 18 months of flow monitoring during drought to show the volume of low flows. This can help determine whether there is surface flow connectivity between pools during such drought conditions. Based on the available flow data, there are long periods representing several months at a time when there

was no detected flow. This would result in little if any flow between pools. This lack of flow can cause stagnation and loss of oxygen resulting trapped fish and macro invertebrates to perish which in turn increases eutrophication and associated algal growth.

Flow volume monitoring at Macarthur's Crossing was discontinued in June 2019, however the seven year database is considered representative of current and past flow regimes.



Graph 1 - Flow Record for Wingecarribee River at Macarthur's Crossing



Graph 2 - Flow Record for Wingecarribee River at Macarthur's Crossing during drought

There are regular flushing events caused by extended rainfall, however the volume of rain needed within the catchment to cause a meaningful rise in river flow is much higher than would be required naturally. This is due to need to fill and then overflow the Wingecarribee Reservoir as well as the numerous farm dams within the catchment.

Long term water quality data for the Wingecarribee River has shown that background water quality varies according to flow. In low flow conditions, water quality deteriorates but can also suffer from high nutrient levels during high flow events due to runoff from agricultural properties, urban areas and sewage treatment plant discharges. Under extended moderate flow conditions, water quality improves significantly.

The proposed passive treatment system will have the following implications on the Wingecarribee River:

- Baseflow provided by the discharge will continue, albeit at a reduced rate due to the component supplied to the Berrima Cement Plant. The remaining discharge however will still represent a valuable baseflow for the river which has effectively drought proofed the aquatic ecosystems downstream of the mine discharge.
- The water provided to the Berrima Cement will be offset by a corresponding reduction in water pumped from the river at the Berrima Wier. This will provide baseflow benefits for the stretch of river between Berrima Township and the mine discharge point.
- Water quality discharged to the river will be consistent with historic levels but without the previous spikes in mineral content that regularly occurred when the mine encountered geological features. The consistency in water quality should provide a long term improvement in sediment quality within the mixing zone.

In 2012 when the mine was operating, aquatic ecology and stream health studies undertaken along the Wingecarribee River found that sites downstream of the Berrima Colliery discharge immediately below the mixing zone and the gorge supported a diverse range of macro-invertebrate fauna, with condition indices similar to indices for sites upstream of the mine discharge. The studies, contained within the 2012 Water Management Plan for Berrima Colliery, demonstrated that despite the low flow conditions at the time which extended the mixing zone to at least 500 m below the discharge point, there was little evidence of any impact on downstream stream health or ecology arising from the historic mine water discharge. This was a result of the underground water treatment system which reduced mineral concentrations while the mine was operational.

Later studies showed that water quality within the mixing zone deteriorated when the mine was free draining between 2016 and 2017 but without any water treatment. Although the underground treatment system was installed in 2018, this corresponded with drought conditions which resulted in very low flow within the Wingecarribee River. This resulted in the impacts of the elevated mineral content in the mixing zone extending over a two year period. This episode demonstrated that even a short period of untreated discharge can cause unacceptable impacts on the river.

The proposed surface water treatment system would remove the risk of this happening in the future. It also provides weight to Boral's decision that an attempt at fully sealing the mine which would likely result in a period of high mineralised water entering the river, would be unacceptable.

It is therefore considered that the proposed development would not have a detrimental impact on overall water flow in the Wingecarribee River. It is also considered that water quality issues related to water flow will be unchanged as a result of the proposed development.

4.3 Water Quality Implications for the Wingecarribee River

The water quality implications of the project has been assessed in terms of ANZECC & ARMCANZ (2000) guidelines as updated by the 2018 Water Quality Management Framework (WQMF 2018). The WQMF has ten steps to work through:

Step 1 – Examine current understanding
Step 2 – Define community values and management goals
Step 3 – Define relevant indicators
Step 4 – Determine water/sediment quality guideline values
Step 5 – Define draft water/sediment quality objectives
Step 6 – Assess if draft water/sediment quality objectives are met
Step 7 – Consider additional indicators or refine water/sediment quality objectives
Step 8 – Consider alternative management strategies
Step 9 – Assess if water/sediment quality objectives are achievable
Step 10 – Implement agreed management strategy.

The first five steps are relevant for this assessment as these lead to the establishment of appropriate water quality objectives. However, over time and with input from the EPA, additional water quality objectives may be necessary, or refinements made to those proposed.

The EPA also advised that simple reliance on what the historic discharge quality from the mine was while it was operating may not be appropriate when considering the final closure and future long term discharge.

4.3.1 Examination of Current Understanding

In February 2020, a Scientific Report was produced under the Colliery's EPA licence (EPL 608). This report included a number of components including:

- Surface water quality within the receiving waters of the Wingecarribee River. This included both the mixing zone and nominated reference sites.
- Groundwater quality within the mine workings prior to release into the Wingecarribee River. Although the water is naturally occurring and the discharge longstanding, the recent change in water quality following cessation of mining has created the need to undertake investigations into removing higher mineral content to better match long term discharge quality.
- Aquatic ecology studies within the receiving waters, including the mixing zone and nominated reference sites.
- Ecotoxicological investigations to determine changes in inhibitors within the mixing zone compared to nominated reference sites.
- Sediment analysis along the river to determine rate of transport, effects of geology and the ultimate fate of minerals discharged within the mixing zone.

The above studies were undertaken during calendar years 2018 and 2019, however a similar set of studies were undertaken between 2011 and 2012, while ambient water quality within the Wingecarribee River has been undertaken continuously since 2010. An ANZECC 2000 assessment was completed for Berrima Colliery in February 2013 which included aquatic ecology and ecotoxicology assessments which provided a baseline to compare with studies undertaken in 2018 and 2019.

The assessments found that the mixing zone within the Wingecarribee River during low flow conditions extends from the discharge point downstream for a distance of approximately 6 km but in high flow the mixing zone ranged from less than 100 m to 350 m in length from the discharge point. Below the mixing zone, the Site Specific Trigger Values (SSTVs) as defined using the ANZECC 2000 Guidelines were being met, but only if the groundwater underwent treatment to reduce mineral content prior to discharge. The level of treatment was not specified however data was provided on the required discharge quality needed in order to meet the SSTVs.

Discussing potential changes to untreated water quality within the mine workings is important to the overall assessment of the proposed passive treatment system. When estimating future water quality within the underground, the following parameters have been considered:

- Percentage contribution of water from the overlying strata within the mine;
- Flooding of mineralised zones within the mine causing changes to mineralised seepage;
- Reduced aeration of groundwater caused by lack of oxygen and/or increase in carbon dioxide in the mine atmosphere in the unflooded sections in the mine;
- Regional changes in water table depth increasing or decreasing exposure and subsequent leaching of minerals from the Upper Hawkesbury Sandstone into the mine void;
- Long term pH of the water contained in the workings;
- The flooding of mineralised areas which could lead to potential changes in long term water quality; and
- Trends in water quality obtained since mining ceased.

Groundwater entering the mine represents a mixture of water from the Wongawilli Seam, the Lower Hawkesbury Sandstone and Upper Hawkesbury Sandstone. To understand the potential mix of water leaving the mine, the groundwater model took into account the components of water emanating from the differing strata. The model found that the percentage composition of inflow water into the mine would represent approximately:

- 10% from the Upper Hawkesbury Sandstone;
- 70% from the Lower Hawkesbury Sandstone; and
- 20% from the Wongawilli Coal Seam.

The Upper Hawkesbury Sandstone is known to be more highly mineralised than the lower Hawkesbury Sandstone. The Wongawilli Seam has lower mineralisation with the exception of Manganese but has lower salt concentration than the overlying sandstones.

The previous underground water management system was designed to cater for regular but short duration mineralised water ingress into the workings as the mine passed through igneous intrusions. This water was captured within underground roadways lined with stone dust (powdered limestone) which kept the pH above 7. These roadways led to pumping points which transferred the water to various sumps and allowed to settle. There were 4 major settling sumps within the mine with additional smaller ponds used for water transfer. The pumping process between sumps assisted with aeration of the water. This process was particularly effective with Iron but less effective with Manganese, Zinc and Nickel.

The installation of the seven bulkhead trial resulted in the partial flooding of the lower portion of the mine workings, essentially the main 400 panel roadways and associated extraction panels. As shown in Table 4.1, the water quality within the flooded section of the mine has deteriorated. This could be caused by the absence of aeration in the flooded section of the mine, leaching from workings that were previously dry or mobilisation of sediments within the original sumps.

Sulphate has also increased and pH has fallen which in turn increases the mobilisation of metals in solution. As the mine is no longer extracting, there is no potential to expose new sources of mineralisation such as dykes or faults. This would limit the addition of minerals from exposed of new geological features, however the flooding of sections of the mine which were once dry may lead to potential leaching of salts and minerals into the water.

Data shows that the water quality held behind the underground bulkheads has stabilised but it could be assumed that it could deteriorate further. Given the inflexible nature of the current underground treatment system, which is currently being supplemented by additional pH correction from the surface, the long term ability to successfully maintain acceptable discharge quality must be significantly enhanced. The proposed surface only passive treatment system will provide this certainty.

Average untreated mine water quality is provided in Table 4.1.

Table 4.1 - Quality of Untreated Groundwater Held within Berrima Colliery

Analyte	Units	Average Mine Water Prior to Treatment*
pH	pH units	6.6
Electrical Conductivity	µS/cm	1128
Suspended Solids	mg/L	53
Sulfate as SO_4	mg/L	418
Chloride	mg/L	57
Cobalt	mg/L	0.085
Copper	mg/L	0.001
Manganese	mg/L	8.8
Nickel	mg/L	0.22
Zinc	mg/L	0.54
Iron	mg/L	18.9
Oil and Grease	mg/L	<5
Dissolved Oxygen	mg/L	7.8

* Taken from behind each of the seven underground bulkheads between 2019 and 2023

The Resources Regulator raised the issue of underground aeration of the strata as being an important consideration in long term water quality within the mine workings. Minimising atmospheric exchange during the closure process is considered good practice and part of the closure process will involve the installation of additional ventilation stoppings to further reduce the potential for air ingress.

4.3.2 Define Community Values and Management Goals

Berrima Colliery is located within the water supply catchment of Lake Burragorang (Warragamba Dam). Clause 27 of the Drinking Water Catchments REP No 1, requires that all developments within the catchment must have a neutral or beneficial effect (NorBE) on water quality. Although a NorBE assessment is contained as Appendix A to this REF, the fact that such an assessment is required can be used to define long term management goals. All long term management

goals should adopt the principal of continual improvement, that is, ensure that the health of the receiving environment of the Wingecarribee River improves over time.

According to the NSW Healthy Rivers Commission of Inquiry into the Hawkesbury Nepean Catchment, the Wingecarribee River is considered under stress. The Commission recognised that the Wingecarribee River was stressed due to town water storage, extractions and intervalley transfers, irrigation extractions and effluent discharges. The Wingecarribee River, particularly the upper catchment was a source of Blue-green Algal blooms. Berrima Weir near Medway Dam was sighted.

Nutrient impacts from agricultural properties and septic systems within the Southern Highlands, were noted as severely impacting on the Wingecarribee River. Damage caused by the water transfer from the Shoalhaven River was also noted several times.

The Inquiry found that the ecological health of the river would benefit from the retention within the river of water flows that are, in quantity and quality terms, closer to natural than they are currently. The analysis for the Inquiry investigated three major ways in which flows in the river could be returned to levels and patterns more closely reflecting the 'natural' order. These are:

- revising the rules governing water sharing so that extractions and storage of water are more limited under various circumstances;
- altering the level, quality and timing of releases from water storages; and
- altering the level, quality, and timing of effluent discharges to the river from sewage treatment plants.

Previous studies at Berrima Colliery have also demonstrated the significant stress that the Wingecarribee River is under in periods of low rainfall. The investigation of the river mixing zone between August 2012 and January 2013, highlighted that under low rainfall conditions, flow in the river upstream of the colliery discharge is reduced to a series of small, shallow and often disconnected pools. Conversely, the river was flowing freely below the mine discharge providing significant habitat benefits compared with upstream. Despite the low rainfall, there should have been sufficient runoff to maintain the river in a healthy condition however it was obvious that was not the case. This is due to the large number of public water supply dams as well as numerous private rural dams.

In keeping with these recommendations, the future discharge from Berrima Colliery should be improved beyond the historic discharge quality. Although the proposed passive treatment system will be more efficient than the previous underground system, its main benefit is to allow a more consistent water quality to be discharged. When the mine was operating, discharge quality varied as geological features such as igneous dykes and faulting were mine through. These areas were mineral rich and the underground treatment system could not respond very quickly.

Now that the mine has closed and extraction ceased, underground water quality has become more consistent and the surface treatment system can be purpose built to maximise treatment efficiency. The surface treatment system has also incorporated additional treatment options should water quality change in future. These additional treatment options can be implemented very quickly thereby minimising the risk of poor water quality being discharged.

4.3.3 Relevant Indicators

The relevant indicators have been selected based on historic water quality monitoring which has included full physical and chemical analysis. The key indicators are listed in Table 4.1 and form the basis for the water quality goals discussed in the following section.

4.3.4 Water Quality Goals Post Passive Treatment

This section provides information on appropriate water quality objectives based on toxicant default guideline values from the ANZECC & ARMCANZ (2000) guidelines as updated by the 2018 Water Quality Management Framework (WQMF 2018), National Health and Medical Research Council Guidelines for Managing Risks in Recreational Water 2008 and Site Specific Trigger Values (SSTV) prepared under ANZECC 2000/ANZG2018 guidelines specifically for Berrima Colliery.

Consideration has also been given to the limitations of a passive treatment system to remove certain metals, such as Manganese, Zinc and Nickel. The proposed development does not rely on active chemical treatment or advanced filtration methods, but rather aeration, pH adjustment and settlement. In late 2017 and early 2018, a surface treatment trial was undertaken at the Berrima Colliery Pit Top. The trial used aeration and pH adjustment followed by settlement. The trial demonstrated that passive treatment was effective at removing almost all of the iron and approximately 25% of other minerals. The proposed treatment system is based on a combination of the surface trials, the methods used underground while the mine was operating and the current treatment system which utilises some of the elements of both.

The proposed performance criteria for water discharged from the passive treatment system are provided in Table 4.2. These are based on the expected performance of the surface treatment system and comparison with current guideline values.

Table 4.2 Mine Water Discharge Criteria (mg/L)

Parameter	Avg Discharge while Operating	ANZECC 95% Default / EPA***	Recreation Guidelines ANZG 2018	NHMRC Recreation Guidelines*	Proposed Passive Treatment Output Goals***
pH Value	7.29	6.5 to 8.5	6.5 to 8.5	6.5 – 8.5	6.5 – 8.5
Electrical Conductivity	692	350	1,500	N/A	1,000
Oil and Grease	<5	<10	N/A	N/A	<10
TSS	9	50	<20% of natural	N/A	<20
Sulphate	320	N/A	400	500	400
Aluminium	0.034	0.055	0.2	N/A	0.03
Copper	0.0008	0.0014	1.0	2	0.002
Iron	0.106	N/A	0.3	0.3	0.1
Manganese	2.30	1.9	0.1	0.5	1.9
Nickel	0.15	0.011	0.1	0.02	0.15
Zinc	0.26	0.008	5.0	3	0.25
Dissolved Oxygen	N/A	N/A	N/A	8.0**	8.0

Note: parameter units are listed as per Table 4.1

* The NHMRC guideline values are directly applicable to drinking water quality and should only be regarded as an initial guide to the quality of recreational water. These values are Total Concentration.

** Based on NHMRC 80% saturation level as relevant to Berrima at 600 m AHD and 12^0C

*** ANZECC/ANZG and Passive Treatment Plant Goals are listed as Dissolved Concentration (filtered sample)

Also listed in Table 4.2 are the values achieved while the mine was operating. These values represent the long term discharge from the mine and were relevant at the time of the initial aquatic ecology and ecotoxicological studies. Typical EPA licence limits have also been provided for pH, Oil and Grease and Total Suspended Particulates (TSS) for completeness.

The proposed treatment system goals are based on the anticipated performance of the passive treatment system but also mindful of the current water quality held within the mine workings. This data is provided in Table 4.1. The process of flooding the mine workings has changed the water quality with a general increase in metal concentration and salt content. The increase in salt level has been minor and still within acceptable discharge goals.

The monitoring program will include a continuation of the upstream and downstream sampling within the Wingecarribee River. A summary of the receiving water quality is provided in Appendix A.

The passive treatment system has been designed to facilitate future modifications to cater for any variability in raw water quality. This includes the potential to use more aggressive alkalis, oxidisers and flocculants. This level of flexibility is unavailable if the treatment system remains within the underground workings.

4.3.5 Pit Top Water Management

The existing surface water management system consists of three dams which contain runoff from the pit top and a further set of two dams which control runoff from the Loch Catherine site. The surface water management system will be utilised as part of the passive water treatment system. Initially this will be to contain any dirty runoff from the construction phase. As the project will require the continuation of the workshop and storage sheds, the pollution control dams will simply continue with their current function.

The passive treatment system will produce a mineral rich sludge from the flocculation process. It is estimated that approximately 19 tonnes of minerals will be removed from the mine water annually, however the minerals will be bound in a sludge consisting of up to 70% water, or approximately 27,000 litres per year. It is proposed to use commercially available dewatering bags. These are non-woven geotextile filter bags which are available in various capacity and pore size. Filtered water from the bags will be contained within the existing surface water management system which ultimately reports to the Chitter Dam. The Chitter Dam represents the licensed discharge point for the pit top and will continue this function with the ongoing passive treatment system project.

Dewatered mineral sludge will either be disposed of in an approved waste disposal facility or if found suitable, will be used in the cement plant.

A Construction Environmental Management Plan (CEMP) will be prepared prior to construction commencing. The CEMP will describe proposed soil and water management controls to be implemented during the construction phases of both the surface passive treatment works and the overland pipeline.

4.3.6 Proposed Water Quality Mitigation Measures

Water quality mitigation measures will consist of monitoring and response in a similar fashion as a Trigger Action Response Plan (TARP). Boral proposes to incorporate an extensive monitoring program during the commissioning phase to determine the appropriate level of treatment to achieve the water quality goals. This will include monitoring of input water quality and the quality at each cell within the main treatment pond on a daily basis. Data will be collected using field probes measuring pH, Conductivity, Dissolved Oxygen and turbidity.

Laboratory samples will be taken of the treated water for verification prior to release on a weekly basis during the commission phase. During the commissioning phase, water will be held on site until the laboratory samples have been received and the verified. This will allow adjustments to be made prior to discharge. The commissioning phase may result in modification to the treatment process as considered necessary to meet the discharge goals listed in Table 4.2. This may include:

- Alternative additives used to raise pH.
- The use of forced aeration such blowers and mixers with or without venturis.
- The use of various alternative oxidisers.
- The rate of additives at different steps in the treatment process.
- Variation in settlement time.
- The use of flocculants to assist with settlement.

Once the process has produced a consistent water quality, continuous discharge will occur. This is likely to occur within the first month of the commissioning phase. Continuous probe measurements of pH, Conductivity, Dissolved Oxygen and turbidity will continue while laboratory sampling will continue weekly.

The operation of the treatment system will be controlled remotely at the cement works control room. This will include automatic starting and stopping of pumps. Remote sensing control systems will be based on standard telemetry and include water quality sensor data, dam levels, servo activation, system shutdown and camera systems. This includes the ability to completely shut down the system at the cement plant control room, which is manned 24 hours per day, 7 days per week, should there be a system failure that could potentially result in poor quality water being released from the site.

A key feature of the proposed passive treatment system is the ability to respond to water quality variations that are likely to occur over the medium term, that is, between periods of above average rainfall followed by drought. These periods have tended to result in higher and lower groundwater inflows respectively which result in a corresponding increase and decrease in leached minerals entering the flooded mine workings.

On completion of the commission phase, which is anticipated to be at least three months, a report will be provided to the EPA which summarises the water quality data collected. This report will be published on the Berrima web page.

Once operational, monitoring will revert to a similar regime as at present with monthly discharge samples and bimonthly receiving water samples being taken. Data will be provided on the Berrima web page and the Closure Working Group.

4.4 Threatened Species, Populations and Ecological Communities

Flora and fauna resources within CCL 748 and in particular, surrounding the pit top and Loch Catherine sites have previously been documented by Hayes Environmental (2012) and OzArk EHM (2010).

Section 7.8 of the Biodiversity Conservation Act 2016 (BC Act) states that a proposed that is regarded as an activity that significantly affects threatened species and ecological communities, or their habitats, is taken to also significantly affect the environment. Significance is assessed via the test of significance in Section 7.3 of the BC Act, which may then lead to a Species Impact Statement (SIS) or Biodiversity Development Assessment Report (BDAR) if the proponent elects to provide a BDAR in place of the SIS).

4.4.1 Overview

The surface facilities area is surrounded by Mittagong Sandstone Woodland with a very small area of Wingecarribee Woodland occurring near the pit top area. These communities generally fall under the Vegetation Class South East Dry Sclerophyll Forests and Plant Community Type (PCT) 838 and PCT 1093. None of the communities mapped within or adjacent to the Study Area are listed as threatened under relevant legislation (*Commonwealth Environment Protection & Biodiversity Conservation Act 1999* & *NSW Biodiversity Conservation Act 2016*). The condition of the vegetation is good, with only a few discrete areas of weed invasion close to existing infrastructure. OzArk EHM noted that most of the vegetation surrounding the surface facilities is regrowth from previous clearing associated with historical operation of the colliery.

Vegetation surrounding the surface facilities has a natural structure and good floristic diversity, and would be expected to provide habitat and resources for a wide diversity of native fauna. The majority of the extraction area is privately owned agricultural area however there are numerous remnant woodland stands. The proposed overland pipeline between the pit top and the Berrima Cement works will be located within the old railway easement. The easement is largely bordered by agricultural land however since the cessation of railway activities, there has been some native regrowth.

4.4.2 Mittagong Sandstone Woodland

Mittagong Sandstone Woodland (MSW) occurs on Hawkesbury and Narrabeen Sandstone from Penrose, through Belanglo and onto the southern portion of the Nattai Plateau. It is the dominant vegetation community within the Wingecarribee Shire.

MSW is the dominant community surrounding the Berrima surface facilities and will be the main target community to match during the rehabilitation program. MSW is dominated by *Eucalyptus agglomerata, Eucalyptus punctata, Eucalyptus sieberi, Eucalyptus piperita* and *Allocasuarina littoralis.* The understorey is dominated by *Persoonia linearis, Persoonia levis, Tetratheca thymifolia, Banksia spinulosa, Bossiaea obcordata, Hibbertia empetrifolia* and *Leptospermum trinervium.* The groundcover is variable with common species including *Entolasia stricta, Goodenia hederacea, Patersonia glabrata, Phyllanthus hirtellus, Pomax umbellate, Dampiera purpurea, Billardiera scandens, Lomandra oblique* and *Lomandra cylindrica.*

The proposed passive treatment system will remain within the existing cleared pit top site. rehabilitation program will seek to re-establish this vegetation community over the Pit Top and Loch Catherine sites. The removal of the buildings and structures may involve some minor tree

clearing in order to gain access for mobile plant and cranes. The overall project however will improve the biodiversity of the local area by increasing the available habitat.

4.4.3 Wingecarribee Woodland

Wingecarribee Woodland (WW) occurs on moderately fertile soils derived from low quartz sedimentary geologies on the slopes and ridges throughout the Belanglo, Canyonleigh and Joadja areas. The community occurs in small patches on the slopes from the pit top.

Wingecarribee Woodland is dominated by *Eucalyptus globoidea, Eucalyptus punctata, Eucalyptus mannifera, Allocasuarina littoralis, Acacia longifolia* and *Acacia falciformis*. The understorey is variable, with *Persoonia linearis*, *Hibbertia obtusifolia* and *Olearia viscidula* being the most frequently recorded species. A diverse groundcover plays an important role in the floristic identification of this community, with *Goodenia hederacea, Microlaena stipoides, Billardiera scandens, Dianella revoluta, Lomandra multiflora ssp multiflora* and *Opercularia diphylla* being recorded in high frequencies.

Although this community exists in isolated patches near the pit top and along the railway corridor, it would not have been contiguous with the Mittagong Sandstone Woodland. Although similar to the Mittagong Sandstone Woodland, this community requires a deeper soil depth and a more sheltered aspect. The proposed pipeline to the cement plant comes close to some small patches of this community on the northern boundary of the Medway Village, however no intact stands will be impacted.

4.4.4 Threatened Flora

Although numerous threatened plant species occur within the Consolidated Coal Lease, only two have been identified immediately surrounding the surface facilities area which would need to be considered during the construction program for the passive treatment system and overland pipeline. These are:

- Cambage Kunzea *Kunzea cumbagei* has twice been recorded between the Berrima and Loch Catherine collieries. Although the records are outside of the area of potential disturbance, the area west of Berrima along the Wingecarribee River supports the largest known population of this species. There has also been recorded to the northwest of the Loch Catherine coal storage area.
- Mittagong Geebung *Persoonia glaucescens* has been recorded within 3km of Berrima Colliery, and is fairly common in the western part of the Wingecarribee Shire.

One ROTAP species (Rare or Threatened Australian Plant listed in Briggs & Leigh 1996) - the mallee tree *Eucalyptus apiculata*, occurs around the pit top and Loch Catherine sites. The majority of these individuals, also referred to as Narrow-leaved Mallee Ash, have previously been tagged and will be protected during the rehabilitation program and it is therefore not anticipated that any impacts would occur. One such individual has been identified near the front gate to the pit top. This individual will be protected from disturbance during the construction of the pipeline and Pond 2B.

4.4.5 Threatened Fauna

Four threatened fauna species have been identified (OzArk EHM, 2010) as being of particular relevance to the construction program:

- The Koala (*Phascolarctos cinereus*) is 'frequently' recorded in the region. Although the construction program will not disturbed vegetation that constitutes 'potential koala habitat' on the basis of suitable feed tree species, the locality as a whole is regarded as 'core koala habitat'.
- The Powerful Owl *Ninox strenua* has been recorded near the surface facilities.
- A Spotted-tailed Quoll *Dasyurus maculatus* has been recorded 2km northwest of the Berrima Colliery.
- One threatened microchiropteran bat species (Eastern Bentwing Bat *Miniopterus schreibersii oceanensis*) was recorded by Cumberland Ecology (2009) in adits below the old Loch Catherine colliery (less than 1km from the Loch Catherine Coal Storage area).

The construction program will be undertaken during daylight hours only which will not disturb nocturnal species. The footprint of the passive treatment system remains within the current disturbed footprint of the pit top and no disturbance to vegetation communities outside the existing footprint will occur.

The closure of the colliery will involve sealing of the mine adits however this aspect is not covered by this particular project. The assessment of potential impacts on bat species associated with the adits has been addressed in the Final Closure RMP.

Grant (2006) provides a summary of the platypus surveys that have been undertaken on behalf of Sydney Catchment Authority for the Wingecarribee River. The report noted that platypus have been reported from the Wingecarribee River from at least 1968 onwards and that platypus are known from most of the river length including the pool under the present mine drift and portal. Grant (2009) states that in relation to his sampling sites around the confluence of the river and Black Bobs Creek (at Greenstead): "the lower river represents some of the best platypus habitat in New South Wales and supports a large breeding population." These studies were used by the Sydney Catchment Authority to reduce the high volume drought transfers from the Shoalhaven system which were between 1,000 to 1,600 ML per day, down to seasonal transfer limitations of up to 600 ML per day. The rationale was that Platypus populations would be best protected by sustained baseflow rather than sustained periods of high flow which can cause erosion and loss of habitat. Although the Wingecarribee River experiences naturally high flow events during high rainfall, the water transfers to the Sydney Water Supply System provided unnaturally extended extreme flow periods.

The proposed passive treatment system will result in a similar water flow in the Wingecarribee River and comparable to the long term average from the mine. The potential impact on Platypus is assessed in Section 4.2.6.

The threatened Macquarie Perch has been recorded in waterways nearby but there has been no indication of their existence during the many aquatic ecology studies undertaken by Berrima Colliery.

4.4.6 Threatened Species, Populations and Communities

There are no species listed under the Biodiversity Conservation Act 2016 that will be impacted by the proposed construction program. There are mapped vegetation communities which occur within the Southern Highlands which are listed under the BC Act and EPBC Act. These

communities lie outside the existing disturbed footprint of the colliery and will therefore not be impacted by the construction of the passive treatment system.

There is however a well studied Platypus colony downstream of the mine at Greenstead, generally downstream of the confluence of the Wingecarribee River and Black Bobs Creek but extends up to the mine portals. Platypus have regularly been noted in pools below the mine access bridge which extends across the Wingecarribee River and links the mine drift into the underground workings.

The main breeding population of Platypus occurs downstream of the Black Bobs Creek confluence, approximately 10 km downstream of the discharge point. There are several additional tributaries which enter upstream of this point which contribute to flows within the main Platypus habitat. These streams include Medway Rivulet, Bowmans Creek, Jacky Jacky Creek and Black Bobs Creek. There are also natural groundwater seeps and springs which assist in maintaining a permanent flow within the Wingecarribee River.

This flow however does reduce to almost nothing during extended drought periods upstream of the mine discharge as demonstrated in the river flow gauge at Macarthur's Crossing (Graph 1). Discharges from the Wingecarribee River for environmental flow is generally maintained at 4 ML/day during periods when no water is being transferred from the Shoalhaven system. These environmental flow discharges may not be sufficient on their own to maintain the current Platypus habitat in the vicinity of the mine discharge however the additional water provided by the passive treatment system will continue to mitigate against the artificially low flow from the upstream catchment.

As previously discussed the flow in the Wingecarribee River upstream of the mine discharge ranges from near zero to over 4,000 ML/day. The flow regime is entirely rainfall dependant and there is significant variability. This variability is caused by land use factors and water storages within the catchment which have modified the natural flow of water in the river. The point source discharge from the mine is also an unnatural change but to some extent has replaced water which would have otherwise flowed in the river. With an anticipated similar flow under the proposed passive treatment system, there will be no significant change over the long term situation.

The discharge from the mine has occurred for over 100 years and the river has adapted to this constant flow, particularly within the mixing zone. This was confirmed during the 2012 aquatic ecology studies for Berrima Colliery. During low flow conditions, the mixing zone extends for at least 500 m downstream of the discharge point while in high flow conditions, the mixing zone is less than 10 m in length. Aquatic ecology studies and ecotoxicological testing in the very low flow conditions of 2012 also demonstrated that there was little evidence of any impact on downstream stream health or ecology arising from the historic mine water discharge. This was a result of the underground water treatment system which reduced mineral concentrations while the mine was operational.

The 2023 Groundwater Modelling Report for Berrima Closure also confirmed that groundwater baseflow contribution to the creeks and Wingecarribee River is very small. River flow is therefore dependent on rainfall. Changes in water quality may impact the habitat value within the mixing zone but it is unlikely to extend significantly further downstream particularly given the ability of the proposed passive treatment system to maintain a consistent discharge quality.

The benefits of the long term baseflow from the mine discharge has largely been a result of drought proofing. Providing flowing water in times of drought avoids the situation found further upstream at Macarthur's Crossing which lacks the ability to sustain Platypus in times of very low flow. This area essentially dries out in drought conditions and often just becomes a series of stagnant pools which are not suitable to sustain a viable Platypus population.

The main issue becomes the quality of the mine discharge. Without some basic water treatment to remove elevated Iron and Manganese, there is the potential to smother benthic communities in mineral deposits. This occurred during the period of free draining after mine closure but before the use of underground treatment. This period impacted the aquatic ecology of the river within the mixing zone which would in turn reduce the food available for species such as Platypus. In order to avoid periods of poor water quality entering the river, the following mitigation measures are required:

- Undertake regular discharge testing from the new surface treatment facility.
- Modify treatment system as required to meet required discharge quality goals.
- Cease pumping from the underground workings if goals are not met for greater than 7 days.
- Review treatment process on an annual basis to ensure it is fit for purpose.
- All reviews and monitoring data to be provided to the EPA and Resources Regulator on an annual basis.

Provided the mitigation measures outlined above are implemented, the risk of impacts resulting from the construction and operation of the passive water treatment system on threatened species and communities likely to occur is considered low and a Species Impact Statement is not required.

4.4.7 Key Threatening Processes

The only potential key threatening process (KTP) which may be relevant to the activity is the "alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands". The sealing of the mine will continue the current mine discharge at near, but lower than historic levels. The component of the groundwater that will be transferred to the Berrima Cement Works will be offset by water that is not pumped from the river at the Berrima Weir.

This is not a natural discharge and so technically this KTP does not strictly apply, however it is worth considering that given the length of time the discharge has occurred, the aquatic ecology of the Wingecarribee River below the mine discharge has adapted to this unnatural additional and constant flow. Continuing the status quo in effect does not alter what would be considered a "natural" flow particularly given that the natural flow in the river has been artificially reduced by land use changes upstream of the mine discharge.

4.4.8 Invasive Species

The ongoing operation of the passive treatment system, including the continued use of the railway easement has the potential to introduce and spread weeds, particularly when surfaces are exposed during the burial of the overland pipeline and prior to vegetation establishment. Weed species occur throughout the local area particularly in cleared agricultural land and road reserves. The main area of risk if the old railway easement which is boarded by agricultural land and crosses two road easements.

The *Noxious Weeds Act 1993* (NW Act) provides a framework for the state wide control of noxious weeds. Noxious weeds are listed by the local management authority, in this case Wingecarribee Shire Council. Table 4.3 provides a list of noxious weeds that have been recorded in the local area. These noxious weeds were not recorded as widespread. Some of these weeds are also listed as 'Weeds of National Significance' (WoNS).

Table 4.3 Noxious Weeds Recorded in Local Area

Species	Control class	Weed of National Significance?	Control measures under NW Act	Recommended control techniques
Lantana (Lantana camara).	4	Yes	The plant must not be sold, propagated or knowingly distributed.	Cut stump and apply herbicide. Scrape stem and apply herbicide.
Blackberry (*Rubus fruticosis* species aggregate).	4	Yes	The growth of the plant must be managed in a manner that reduces its numbers, spread, incidence and continuously inhibits its reproduction. The plant must not be sold, propagated or knowingly distributed.	Herbicide spray during flowering/fruiting season (September to April).
Paterson's Curse (*Echium plantagineum*).	4	No	The growth of the plant must be managed in a manner that reduces its numbers, spread, incidence and continuously inhibits its reproduction.	Herbicide spray or hand weeding.
Fireweed (*Senecio madagascariensis*).	4	No	The growth of the plant must be managed in a manner that reduces its numbers, spread, incidence and continuously inhibits its reproduction.	Hand pulling and spot spraying individual plants.
Gorse (*Ulex europaeus*).	3	Yes	The plant must be fully and continuously suppressed and destroyed.	Apply herbicide via foliar spray or cut stump method.
Serrated Tussock (*Nassella trichotoma*).	4	Yes	The growth of the plant must be managed in a manner that reduces its numbers, spread, incidence and continuously inhibits its reproduction. The plant must not be sold, propagated or knowingly distributed.	Herbicide spray or physical removal with hand tools.

Although there are a total of 93 noxious weed species listed within the Wingecarribee Shire, the majority are well controlled in agricultural properties adjacent to the railway easement between the pit top and the cement works and therefore not a significant ongoing risk.

Noxious weeds will continue to be controlled by regular weed spraying. This will include within the railway easement as required.

The Red Fox and the European Rabbit are common agricultural pests throughout New South Wales. Evidence of the presence of rabbits exist within the railway easement. During the burying of the overland water supply pipeline to the cement works, existing rabbit burrows will be destroyed by ripping and filling.

4.4.9 Ecologically Sustainable Development

Ecologically sustainable development (ESD) and its component relating to intergenerational equity has emerged as a primary objective of environmental protection in NSW. ESD is an objective of *the Environmental Planning and Assessment Act, 1979* under Section 1.3 (b).

The overall objectives of ESD are to use, conserve and enhance natural resources. This ensures that ecological processes are maintained facilitating improved quality of life, now and into the future. The natural resource in this instance is the underground water supply.

The Precautionary Principle
The precautionary principle, in summary, holds that where there are threats of serious or irreversible environmental damage, the lack of full scientific certainty should not be used as a reason for postponing measure to prevent environmental degradation.

The passive treatment project will aim to maintain the environmental flows within the Wingecarribee River, even during dry periods. This can be achieved since the total water demand of the cement works is about half the anticipated water treatment process throughput. This will result in at least 1 ML per day of treated water being released back into the Wingecarribee River.

The impacts of this flow were the subject of several scientific studies (Ecowise 2004, The Ecology Lab 2006 and Dr Tom Grant 2006), including water quality, aquatic ecology and river health which concluded that the river had adapted well to the additional baseflow provided by the mine discharge and that this assisted in maintaining viable populations of Platypus downstream of the current mine discharge. The studies were commissioned by the Sydney Catchment Authority as part of the inter-catchment water transfer project (SCA 2010 *Metropolitan Water Plan Groundwater Project Technical Reports 2005 to 2009*) and later confirmed by Dr Grant in 2012 as part of the preparation of the Berrima Colliery Water Management Plan.

Over the past decade Berrima Colliery has amassed a significant database on groundwater conditions and background water quality within the Wingecarribee River. This database has demonstrated that the mine has provided positive benefits to the river environment during the period when the mine was operating and the discharge underwent treatment to reduce the mineral content. These benefits will continue under the proposed ongoing water treatment scenario.

However, it should also be noted that during the period between 2016 and 2017 when no treatment occurred, there was a reduction in macroinvertebrate abundance and taxonomic richness downstream of the discharge point (Niche 2019). This was a result of increased iron deposition in the mixing zone. This data emphasis the need to maintain a treatment system prior to discharge.

Intergenerational Equity
Intergenerational equity is centred on the concept that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

Emphasis has been placed on prevention of potential adverse impacts upon the local environments and surrounding community through mitigation measures and management

strategies to ensure that the physical works associated with the construction and operation of the passive treatment system do not result in long term environmental degradation or harm. The objectives of the water treatment process are to:

- ensure that that the discharge of mine water undergrows sufficient treatment to avoid build up of mineral deposits in the river;
- provide ongoing baseflow contribution to the Wingecarribee River during low flow conditions; and,
- provide an ongoing beneficial reuse of groundwater for the cement works.

Conservation of Biological Diversity and Ecological Integrity

The passive treatment program will not reduce the area of native vegetation but will occupy an area of existing land disturbance. The project will maintain the baseflow into the Wingecarribee River while the existing and proposed additional mine bulkheads will result in some groundwater recharge of the lower Hawkesbury Sandstone.

Improved Valuation, Pricing and Incentive Mechanisms

Polluter Pays

The 'Polluter Pays' principle requires the party responsible for producing pollution to pay for the damage done to the natural environment caused by this pollution.

The impacts of proposed treatment and water management system are minimal, while the proposed continuation of water treatment prior to discharge to the Wingecarribee River will reduce the risks of future pollution events or other environmental consequences.

The potential for a decrease in water quality within the Wingecarribee River comes under the provisions of polluter pays. The proposed passive treatment system significantly reduces the risk of future pollution events however should such an event occur in future, the EPA have the power to impose additional conditions on the Environment Protection Licence.

Full Life Cycle Costs

Boral intends to continue to hold the Environment Protection Licence (EPL) covering the passive treatment operation. The lifecycle of the project, that is, the need to treat the groundwater will likely extend beyond the life of the Berrima Cement Works. As holder of the EPL, Boral will still be responsible for the treatment and discharge of the water irrespective of the existence of the Berrima Cement Works. At the time when water is no longer needed by the cement plant, the holder of the EPL has the option of selling the site and treatment process or to continue to operate the site.

The operation should not be viewed as a liability. Although there are costs associated with the treatment process, the output is a valuable raw water source which could be used as an input into a town water supply or directly into agricultural activities. It is proposed that the operation could be largely automated and will require minimal labour costs. The main operating costs would be pumping from the underground workings, pond maintenance and the supply of additives. There is the potential for the operation to be commercially viable in its own right.

It was also noted in discussions with the Closure Working Group that there could be a future risk to the closure of the colliery if the cement plant ceases to exist and therefore no longer requires a supply of water. This could be postulated for any development, however it can be safely assumed that the production of water would always be in demand in the future. It could also be assumed that environmental controls on development, such as licensing by a government

regulator, would be a constant feature of the future regulatory framework. As such, there is a very low risk that the facility would not operate in the future irrespective of the future of cement manufacture at the Berrima Cement Works.

Environmental Goals

The objectives of the activity are stated in Section 3.1 and include the improvement of water quality entering the Wingecarribee River which in turn will maintain the river health by drought proofing aquatic habitat downstream from the mine. To achieve this, the goal of the passive treatment system is to return water of equal or higher quality than previously discharged into the Wingecarribee River.

4.5 Aboriginal Cultural Heritage

A comprehensive Aboriginal Cultural Heritage assessment was undertaken as part of the Environmental Assessment for Continued Operations by OzArk and reported in EMGA Mitchell McLennan 2011. This assessment included consultation and study participation by the following organisations:

- Illawarra Local Aboriginal Land Council (ILALC);
- Korewal Elouera Jerrungarugh (KEJ);
- Gundungurra Aboriginal Heritage Association;
- Buru Ngunawal Aboriginal Corporation (BNAC).

The study area is located within the eastern limits of the lands occupied by the Gandangara tribe, and appears to have been part of a zone of interaction between the Gandangara, Wodiwodi and Ngunawal tribes. Whilst a number of regional archaeological studies have been undertaken in the Southern Highlands, few have been undertaken within the vicinity of Berrima Colliery. The results of an OEH Aboriginal Heritage Information Management System (AHIMS) database search identified 11 recorded Aboriginal sites located within a 10 x 10 km area centred on the colliery pit top. Of these none are located within the vicinity of the surface facilities. Three sites, including two rock shelters and one open site, are located immediately adjacent to the lease area.

A study by Kelton (2002) as part of the Berrima Colliery SMP application identified three Aboriginal sites, two rock shelters with art and deposit and one open site, in the vicinity of the underground mining area. One rock shelter (MC-S-1) was located on the eastern side of Mandemar Creek, the second rock shelter (MC-S-2) was situated approximately 200 m to the north-west of MC-S-1, and the open site (MC-OS-1) was located on a low hillslope/low ridge crest overlooking an unnamed tributary of Wingecarribee River. The only potential archaeological deposits identified by Kelton were those associated with sites MC-S-1 and MC-S-2. Although these sites are located near the Wingecarribee River, they are well away from the proposed new discharge point from the passive treatment system.

For the EA studies, OzArk found one additional Aboriginal site, referred to as Berrima Colliery Open Site No. 1 (Boral-OS1). The site is located on a vegetated spur in the south-eastern portion (panel 406) of the underground mining area. The site is near an ephemeral watercourse that is a tributary into Mandemar Creek. Only a few small artefacts were recorded at the site. However, it is possible and expected that further artefacts are present below the leaf litter and surface, though deposits are not expected to be deep.

No sites were identified around the surface facilities area despite targeted searches. This was determined to be the result of a lack of close water sources, and the overall steep nature of the landscape. The surface facilities area, whilst not possessing any specific sandstone overhangs potentially suitable as shelter sites within its boundaries, does however exhibit such features within close proximity. This indicates that there is likely to be some additional Aboriginal sites in the surrounding area however none would be impacted by the proposed construction activities associated with the passive treatment system, including the pipeline route.

4.6 European Heritage

A Heritage Study was undertaken by OzArk and contained in Appendix C of the November 2015 Berrima Colliery Closure Plan. The study found that the mine buildings may have local heritage significance but do not represent items worthy of preservation.

The surface facilities have a long history in the area and is itself an 'inheritor' of coal mining activities in the immediate region that began in the nineteenth century. As such, the surface facilities would be regarded as having local heritage values although no single item or structure was identified that is more significant than any other. Further, most items have been substantially altered, primarily in the late 1960s, so that while original fabric is present it is neither contiguous nor in good condition. There are no items of heritage value at the Loch Catherine Stockpile site.

The Heritage Report recommended that the local heritage values of Berrima Colliery be recorded and, where possible retained, for future study and interpretation. This has been completed with the preparation of an archival photographic record and documentation library. The proposed passive treatment system will repurpose most of the existing buildings however the remaining coal handling infrastructure will be removed.

4.7 Site Contamination

A Phase 1 and 2 (PSI and DSI equivalent) Site Contamination Assessment was undertaken by DLA Environmental covering the pit top and Loch Catherine Coal Stockpile Area which is contained in full as Appendix B of the 2015 Final Closure Plan. A total of 60 surface and subsurface soil samples were taken at targeted locations. The analysis included:

- ❒ Naphthalene and Volatile Total Recoverable Hydrocarbons;
- ❒ Semi-volatile Total Recoverable Hydrocarbons;
- ❒ Polycyclic Aromatic Hydrocarbons;
- ❒ Pesticides;
- ❒ Polychlorinated Biphenyls;
- ❒ Heavy Metals; and
- ❒ Asbestos.

Although the current and proposed future land use is industrial, the assessment took into account potential future land uses by adopting the most conservative Health Investigation Levels (Residential A criteria). By achieving these criteria in the remediation work eliminates site contamination as an issue in any potential future land use for the site. This is particularly relevant to the Loch Catherine site and Boral owned land around the pit top as these holdings are not required for the ongoing passive treatment system and may be prepared for private sale but not relevant to the pit top activities as it is proposed to continue the industrial land use.

The results of the assessment found that there was some hydrocarbon contamination in between the workshop and storage shed and around the apron of the diesel tank. These areas were targeted as there was visual evidence of previous minor spillages of fuel and oil. The test results showed only one result exceeding the Commercial/Industrial D criteria and a further 4 locations exceeding the Residential A criteria. This area has since been cleaned up as part of the mine closure program. The remaining sample sites met the more stringent Residential A criteria although several sites registered contamination levels above the level of laboratory detection.

The investigation showed that the site is suitable as is to continue as an industrial site. The identified asbestos in the eaves of the office/bathhouse have been removed by licensed contractor and the site declared to be asbestos free. Since 2015, there has also been a general clean-up of the site which has included removal of coal fines and coal handling infrastructure and removal of oil contaminated soils.

The results of the contamination assessment and clean up to date has confirmed that the site is suitable for ongoing industrial use, which includes the passive treatment system.

4.8 Noise Assessment and Management

The potential noise impacts of the construction and operation of the passive treatment system has been assessed by SLR Consulting and their report is contained as Appendix C. The assessment was prepared in accordance with the NSW EPA's Interim Construction Noise Guideline (2009) and the EPA's Noise Policy for Industry (2017). The assessment covered both operational noise and construction noise.

4.8.1 Operational Noise Assessment

The assessment found that when operational, the on site activities including pumping would result in a predicted noise level at the nearest residential receptors of less than 17 dB(A) $_{LAeq(15min)}$ for both the day and evening period. This level is well below the Project Noise Triggers of 40 dB(A) $_{LAeq(15min)}$ daytime and 35 dB(A) $_{LAeq(15min)}$ evening and night time periods. With a predicted level of less than 30 dB(A) it is highly unlikely that any activities during the operational phase will be audible at the nearest residential receptors in Medway Village.

The assessment concluded that no specific noise management will be required for the ongoing operation. However, it was assumed that the 45 kW pump that is located adjacent to Pond 2b which is used to transfer water to the cement works, would be housed in a permanent enclosure. This pump is located near the colliery entrance and approximately 280 m from the nearest residence in Medway Village. Although the enclosure does not necessarily require acoustic treatments, the noise assessment has set an overall sound power level of 84 dB(A) $_{LAeq(15min}$ measured at 1 m from the enclosure.

4.8.2 Construction Noise Assessment

The noise assessment found that construction phase would exceed the daytime project-specific noise management levels (NMLs) of 45 dB(A) but within the highly noise affected construction noise management level of 75 dB(A). The higher levels will be experienced by residents located along the pipeline route, particularly within Medway village and the section of the easement towards Liebman Road.

Predicted noise levels at the nearest residential receptors in Medway village will experience between 47 to 55 dB(A) $L_{Aeq(15min)}$ from the earthworks component of the pit top treatment construction. At this level, the works will be clearly audible but ranked as low to moderate intrusiveness.

The pipeline construction will pass within 36 m of the nearest residences and these will experience between 54 to 69 dB(A) $L_{Aeq(15min)}$ which is classed as moderately intrusive. These residences will experience this noise level for a proximately 1 day (7am to 6pm) as the excavator completes the trench digging and pipe burial process. The noise level at each impacted residence would build, peak and then diminish as the construction activities pass by. This process will take an estimated 5 days for each impacted residence.

4.8.3 Mitigation Strategies

Based on the results of the noise impact assessment, the following noise management strategies will be incorporated into the project. These strategies will also be included in a Construction Management Plan.

- ❒ All construction activities to be limited to 7 am to 6 pm Monday to Friday and 8 am to 1 pm on Saturdays. No work is to occur on Sundays or public holidays.
- ❒ All affected residents are to be provided with at least 3 months notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule period, any operational noise benefits from the works (where applicable) and contact telephone number.
- ❒ Follow-up notification should be provided at least 7 calendar days prior to the works proceeding and a detailed timing of the works provided.
- ❒ Consultation should include newsletters/letter drops, email and website notifications and Boral contact details provided.
- ❒ All employees and contractors are to receive an environmental induction which covers noise mitigation measures, permissible hours of work and limitations on high noise generating activities.
- ❒ Ensure all equipment is well maintained with effective noise controls such as silencers.
- ❒ The door on the Pond 2b pump station should remain closed at all times other than poeriods of maintenance.
- ❒ Non-tonal reversing alarms should be used wherever feasible.
- ❒ Where practicable, work compounds, parking areas, and equipment and material stockpiles will be positioned away from noise-sensitive locations and take advantage of existing screening from local topography.
- ❒ One way traffic should be promoted along the railway easement and site access points should be selected away from residential receptors if feasible.

Other measures may be developed and included in the Construction Management Plan.

4.9 Dust Management

The earthworks component for the pit top passive treatment system will extend over a 4 month period during which time, dust controls may be implemented during windy conditions. This will

include wetting the excavation area using the existing fire equipment. Given the small size of the excavation area, a water cart would not be practicable. Similarly, water will be available during the burial of the pipeline to the cement plant to control dust in the event of high winds. No additional dust controls are considered necessary.

4.10 Traffic Management

The construction of the passive treatment system will require the delivery of plant and equipment, removal of rubbish and debris and delivery of general stores which will generate truck traffic through the village of Medway for a period of approximately 6 months. When operational, the passive treatment system will generate very little traffic with most functions being automated. This will consist of 1 to 2 light vehicles per day for personnel undertaking inspections and one truck per month for supplies.

No specific traffic management measures will be required.

4.11 Soils and Land Stability

The soils surrounding the surface facilities have been derived from Hawkesbury Sandstone and are shallow, moderately to highly permeable, poorly structured, contain a high gravel fraction and are considered moderately to highly erodible. Erosion and sedimentation controls will be required during the earthworks component in order to reduce the potential for sediment movement into the retained pollution control ponds.

The main control will be maintaining the existing drainage system until the surface works are complete and the land surface stabilised. There may also be the need to install additional controls such as silt stop fencing. The drift will continue to be stabilised with railway ballast as it will continue to be used by light vehicles accessing the bridge and drift seal pump.

No further mitigation measures will be required for the ongoing passive treatment system operation.

4.12 Services, Public Utilities and Infrastructure

Existing services will be maintained at the pit top to support the passive treatment system. The main high voltage line feeding the site comes directly from the Berrima Cement Plant. This line is not connected to any public infrastructure or private residences and will continue to be maintained as part of the project. It is located wholly within the railway easement which will also be used for the overland pipeline.

There is no public sewage or water reticulation systems impacted by the proposed works, however a section of the private water supply line from the mine to the village of Medway will be removed. The mine has not supplied Medway Village with raw water since October 2013 and the pipeline has already been disconnected. The section of pipeline to be removed is where it interacts with the location of the passive treatment ponds.

4.13 Social and Economic Implications

The closure of the colliery has had both direct and indirect impacts on surrounding landholders. For residents of Medway and those who access their properties from Medway Road, these

impacts occurred from 2014 onwards and were largely positive. Although not possible to quantify, there is the potential that properties currently located in Medway Village and along Medway Road have improved in value, in addition to general market conditions, as a result of the closure of Berrima Colliery.

The mine closure activities of the colliery since 2014 have included the use of the winder, mining equipment and stores which although significantly less than the activity when the mine was operational, will be further reduced with the operation of the passive treatment system. The installation of the final bulkheads, the private sale of surplus Boral owned land around the pit top and Loch Catherine sites and the relinquishment of the mining lease over the extraction area will eliminate the potential for further coal mining activities in the future. This may have additional positive implications for the village of Medway.

There have already been negative economic impacts resulting from the closure of Berrima Colliery. These included the loss of jobs both directly and indirectly, and the loss of annual expenditure in the local community. Berrima Colliery had a policy of maximising the use of local business and suppliers where possible. An average of around $15 Million was expended locally per annum while the colliery was in operation.

The economic impacts have already occurred as the mine ceased extraction in October 2013. There has been minimal expenditure since that time and the loss of this once the passive treatment system is completed, will result in negligible economic consequences to the region.

4.14 Bushfire

The current bushfire risk associated with the colliery will remain, although slightly reduced with the corresponding reduction in site activities associated with the passive treatment system. The site has established fire fighting facilities which will remain but modified to suite the new operation on completion of the construction program. The Rural Fire Service existing connection to the main elevated water supply tank will not be available however access will be provided to Pond 2B should it be suitable. This pond is located near the new entrance and may be a more suitable location than the existing one adjacent to the main carpark.

4.15 Community Safety

Public safety aspects have been considered in detail. The closure of the colliery did not affect overall community safety however the construction of surface ponds will require additional safety measures.

Since going into Care and Maintenance in 2013, and subsequently moving to permanent closure in 2014, there has been an increase in trespass and resulting public safety concerns. Potential safety risks associated with unauthorised public access to the site has resulted in increased security and public safety measures around the surface facilities. These include increased fencing, more secure gates, use of a local security company and installation of CTV facilities.

The new passive treatment system will also include additional fencing and warning signs. The water pipeline will be buried and operated under low pressure and therefore of little risk to public safety. Overall, the risk to public safety will be similar to the current security program.

4.16 Visual Impact

The pit top and Loch Catherine sites are not easily visible from the surrounding area. There are elevated areas within the mining area which could see the coal loading bin while the parts of Medway Village can view the elevated gantries and entry signage. The rehabilitation program to date has removed most of these structures and the remaining will be removed as part of the construction of the passive treatment system. This has already improved the visual environment. The new ponds and retained buildings will not be visible from any public vantage point however Pond 2B may be partially visible to passing local traffic at the corner of Medway Road and Railway Parade.

No specific mitigation measures are considered necessary to further reduce visual impacts.

4.17 Cumulative Impacts

The proposed passive treatment system has been designed to exceed the historic discharge quality from Berrima Colliery. This discharge met all required environmental standards and assessment criteria at the time. There was however a period during the closure process when discharge standards were not met. This occurred during the free draining period when no water treatment was carried out. This was corrected with the installation of the passive treatment system located within the underground workings. This system functioned adequately however difficulties were encountered from time to time which resulted in short periods of poorer water quality being released. These difficulties will be alleviated with the construction of a purpose built surface treatment system which can be more easily and effectively controlled and managed.

5. Conclusion

This REF has identified the key environmental issues associated with the proposed construction and operation of a passive water treatment facility at the pit top at Berrima Colliery. The results of this assessment have found that the closure activities will result in the following.

- A surface based water treatment system will provide an overall improvement in water quality within the Wingecarribee River due to more consistent and effective water treatment capability. Overall, the project has been assessed as having a Neutral impact on the receiving environment of the Wingecarribee River (refer Appendix A).
- Better reuse of the water resource by eliminating the existing cement plant river pump-out.
- Maintaining the water flow within the Wingecarribee River with improved quality and reduced variation will provide added drought security for the aquatic habitat downstream of the mine.
- Maintaining the current licensed discharge point to the Wingecarribee River will not change the aquatic composition, health or extent of the existing mixing zone.
- Minor but acceptable levels of noise and dust generated during the earthworks component which would unlikely exceed the current assessment criteria.
- Slightly reduced traffic impacts on the village of Medway overall as a result of transitioning to ongoing surface water treatment.

This REF has also assessed the level of environmental impacts in order to determine if an environmental impact statement is required. The method provided in *Is an EIS required – best practice guidelines for Part 5 of the Environmental Planning and Assessment Act 1979* (DPI 1995) to determine the level of impact from the proposal is summarised in this REF as follows:

- Potential environmental issues are summarised in Table 1 of Appendix B;
- The extent of potential impacts is described in Table 2A of Appendix B;
- The extent of potential adverse impacts in sensitive areas is described in Table 2B of Appendix B;
- The nature of the impacts are described in Table 2C of Appendix B; and
- The significance of the impacts is evaluated in Table 3 of Appendix b.

The conclusion of this REF is that both activity specific and cumulative impacts to environmental aspects will be low to moderate, and that an environmental impact statement is not required.

This REF has determined that the proposed activity provides both positive and negative environmental and social consequences. The main environmental issue identified is water quality. The project will provide significantly greater control over the treatment of mine water which in turn will improve the water quality in the Wingecarribee River particularly during periods of low natural flow.

The potential impacts from the activity are almost exclusively a result of the estimated four month earthmoving component of the 14 month construction program. Once operational, the repurposed site will result in no additional noise or dust generating activity than what the community has experienced since the mine closure.

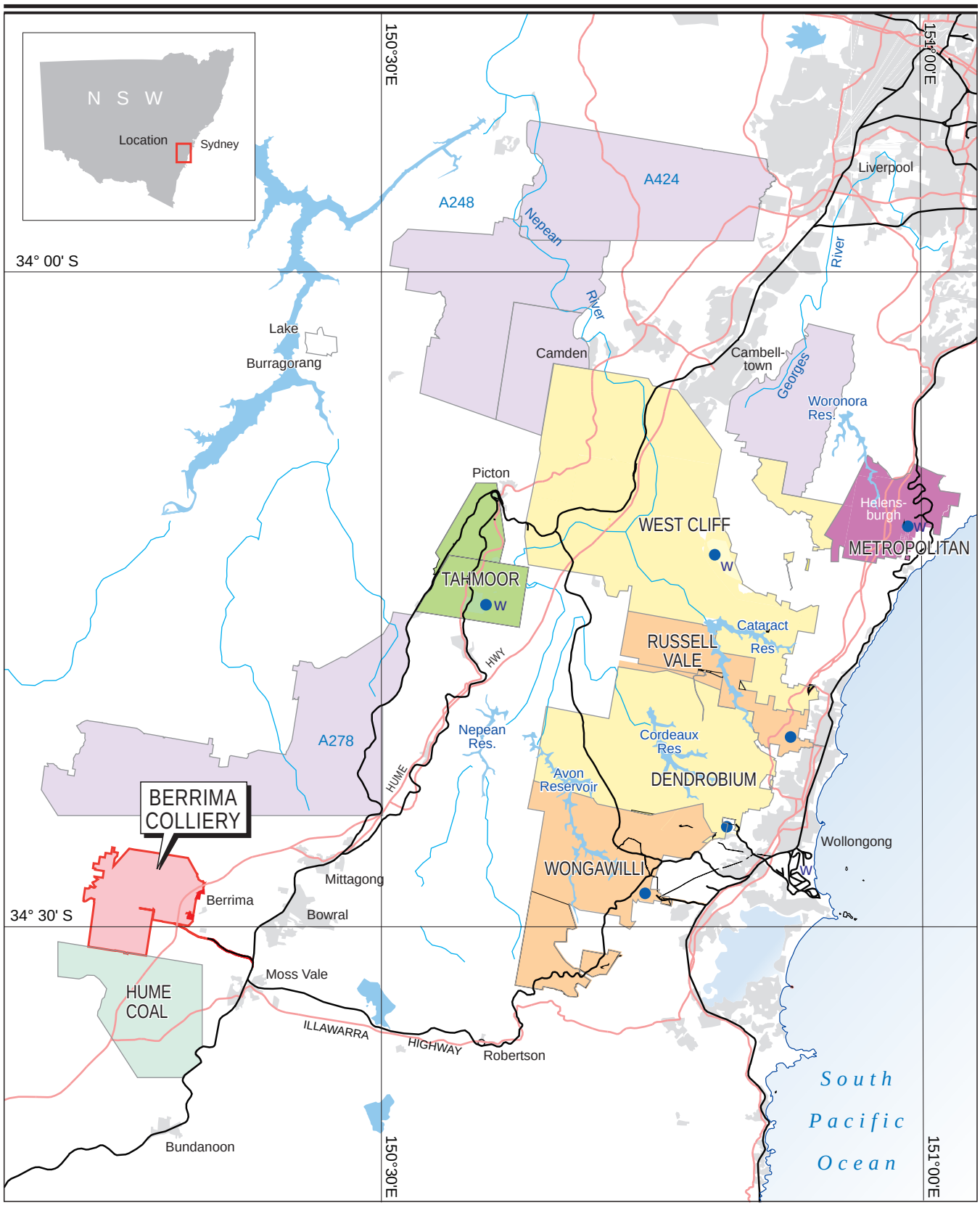
6. Statement of Commitments

A summary of the environmental commitments and strategies contained in this REF is provided in the following table.

Environmental Aspect	Commitment
Water Discharge	Achieve the discharge goals specified in Table 4.2
	Meet all new conditions imposed on the operation's Environment Protection Licence (EPL)
	Continue to monitor discharge quality in accordance with the existing and any future variations to the EPL
	Continue to monitor and assess the health of the Wingecarribee River as may be required by the EPL or government regulators
Noise	Provide a permanent enclosure for the Pond 2b pump. All construction activities to be undertaken between 7a, and 6pm Monday to Friday, 8am to 1pm Saturdays and no work on Sundays or Public Holidays. Ensure construction activities for the pipeline pass each affected residence within 5 working days. Effectively engage with affected residents 3 months prior to planned construction and to provide at least 5 working days notice prior to works commencing.
Surface Water	Maintain existing EPL limits on surface discharge site from the pit top following completion of the passive treatment system.
Sediment and Erosion Controls	A Construction Environmental Management Plan will be prepared and will include details of erosion and sediment controls required during construction. Maintain nil discharge site for surface facilities during construction.
Heritage	Prepare Site History and photographic record of current facilities, Aboriginal unexpected finds procedure will be incorporated into the Construction Environmental Management Plan.
Safety	Ensure the passive treatment system is appropriately secured and maintain security systems during its ongoing operation.
Revegetation	Stabilise exposed areas following the completion of the passive treatment system. This includes construction areas and new dam walls.

With the implementation of the above mitigation measures, the activity of construction and operation of the surface passive water treatment system and the water supply pipeline to the cement works will not result in adverse long term environmental impacts.

Plans



Boral Limited
BHP Billiton
Peabody Coal
SIMEC Coal
Hume Coal
Wollongong Coal
Coal Authorisation
Underground mine
w Washery
Urban areas
Railway
Main Road
Reservoir

Jan 2019

0 20 km

N

PLAN 1a
Berrima Colliery - Regional Location
Southern Coalfield, NSW

6 181 000 N

6 180 000 N

6 179 000 N

248 000 E

249 000 E

250 000 E

Berrima Colliery
Mine Entries

Berrima Colliery
Pit Top

WINGECARRIBEE

RIVER

MEDWAY

MEDWAY RD

Berrima

Loch Catherine
Stockpile

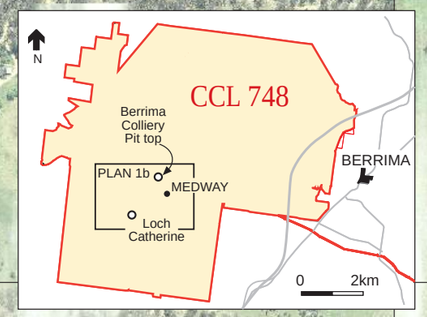
INCLINE

RIVULET

1
2
3
4

Loch Catherine
Colliery
Mine Entries

MEDWAY



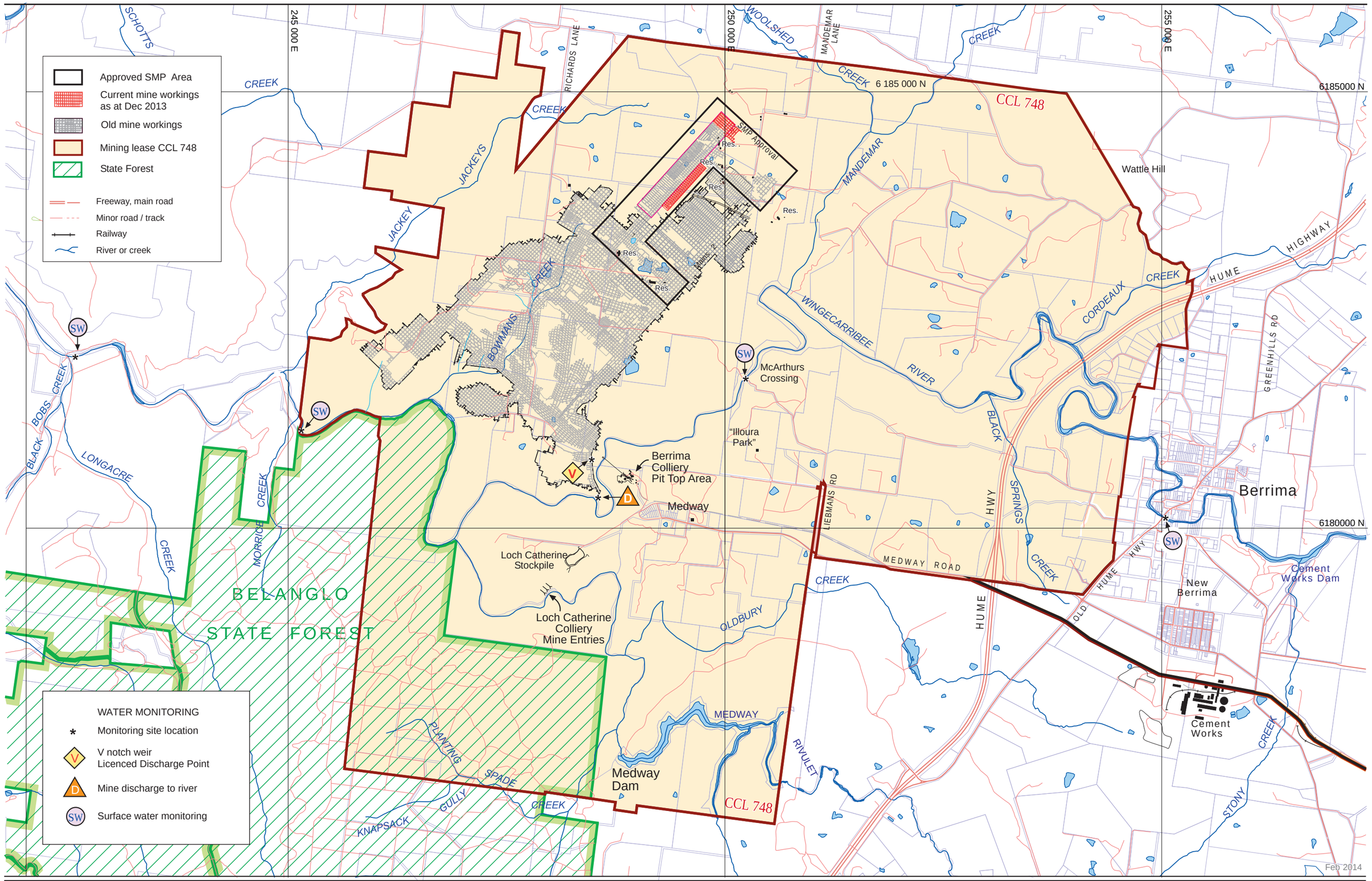
Datum: GDA94 MGA Zone 56

0 125 250 500 m

Cadastral lots (© NSW Lands Department)

N

PLAN 1b
Berrima Colliery - Natural Environment



Map source: © NSW LPMI 2011

0 1000 2000 m

N

PLATE 1c
Berrima Colliery
Lease Plan and Built Environment

NO JOB IS SO IMPORTANT THAT IT CAN'T BE DONE SAFELY!

REV.	DATE	REV-BY APPROVED	REVISION
D	6/05/205	L.P.McIntosh	DRAWING REVISED. CATCHMENT DAM 2B RELOCATED.
C	02/08/2021	L.P.McIntosh	DRAWING REVISED. DAM No.1 DETAIL ADDED.
B	23/04/2021	L.P.McIntosh	DRAWING REVISED. DAM CO-ORDINATES ADDED.
A	10/09/2020	L.P.McIntosh	DRAWING ISSUED FOR COMMENT

DRAWING No | DESCRIPTION | REFERENCE DRAWINGS | REVISIONS

DRAWN: L.P.McIntosh DATE: 10/09/2020
CHECKED: DATE:
ENGINEER: DATE:
APPROVED: DATE:

BORAL Boral Cement
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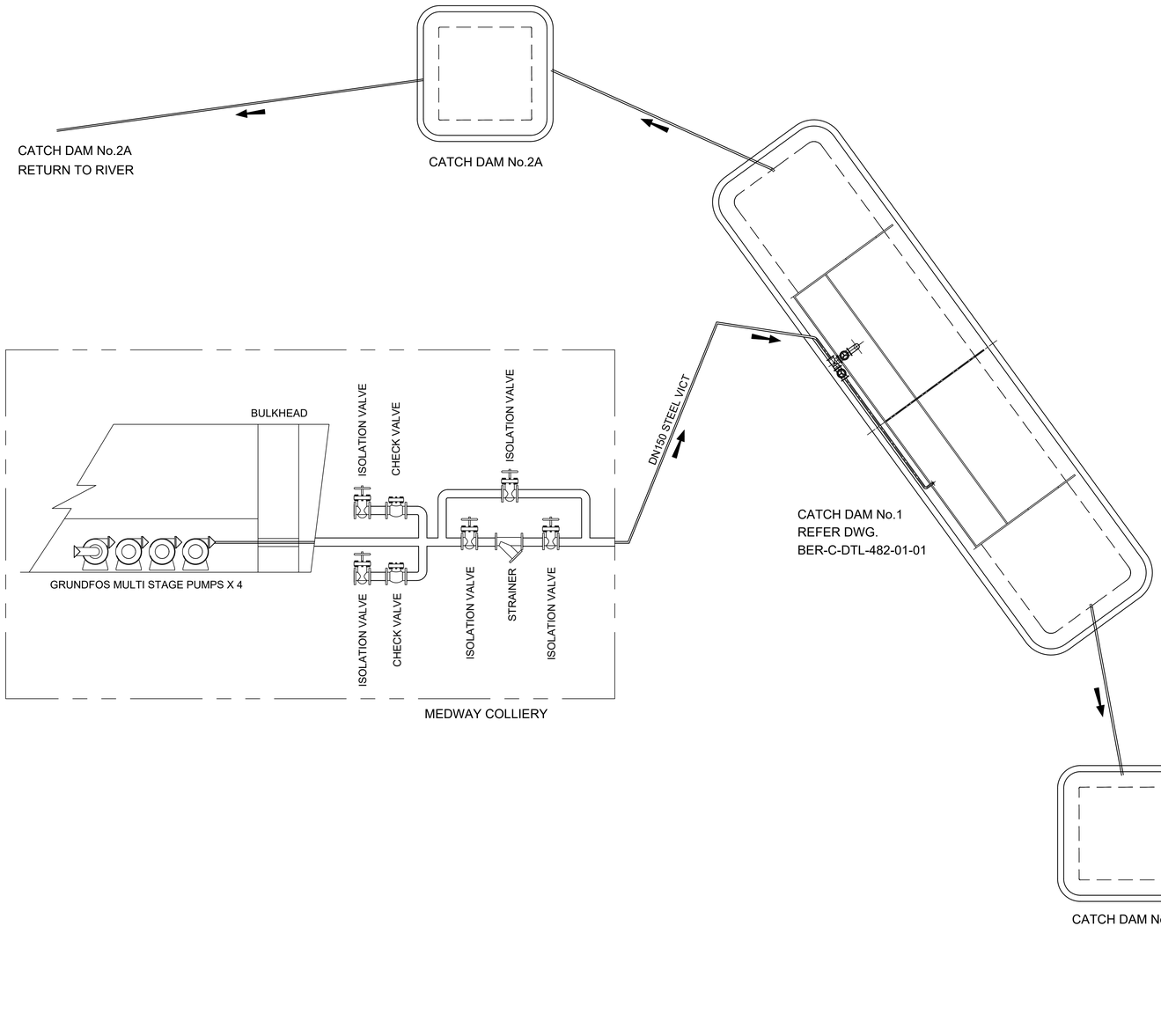
Fax: +61 2 4860 2399

STATUS: PRELIMINARY

ALPHA NUMERIC: | BCES JOB No: GBM482
STOCK NUMBER | SHEET: B1 | SCALE: NTS

PLANT: MEDWAY
PROJECT: BERRIMA COLLIERY CLOSURE
SECTION: MINE
SUB SECTION:
TITLE: PIT TOP WATER TREATMENT - OPTION 6
CLASSIFICATION: SITE LAYOUT

DRAWING No: BER-G-LAY-482-07-01
WORKS No: | REV. D



NO JOB IS SO IMPORTANT THAT IT CAN'T BE DONE SAFELY!

DRAWING No	DESCRIPTION	REV.	DATE	REV-BY APPROVED	REVISION
REFERENCE DRAWINGS		B	02/08/2021	L.P.McIntosh	DRAWING REVISED. DAMS ADDED.
		A	19-3-20	L.P.McIntosh	DRAWING ISSUED FOR COMMENT
		REVISIONS			

DRAWN: L.P.McIntosh DATE: 19-3-20
CHECKED: DATE:
ENGINEER: DATE:
APPROVED: DATE:

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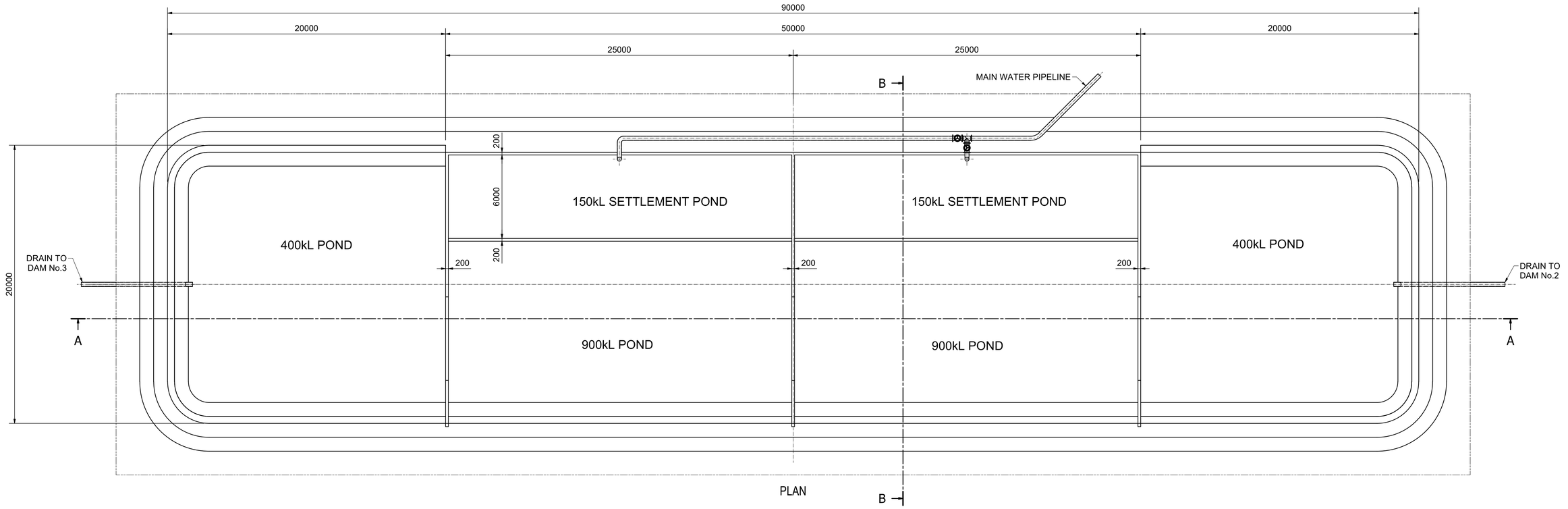
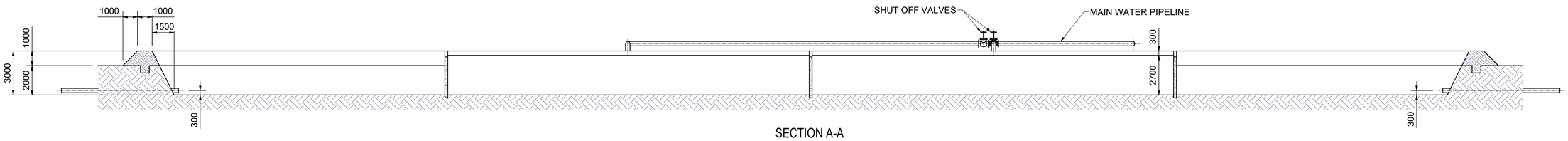
STATUS: PRELIMINARY
ALPHA NUMERIC:
STOCK NUMBER
BCES JOB No: GBM482
SHEET: B1
SCALE: NTS

PLANT: MEDWAY
PROJECT: BERRIMA COLLIERY CLOSURE MINE
SECTION:
SUB SECTION:
TITLE: MEDWAY TO BERRIMA PIPELINE PROCESS FLOW DIAGRAM
CLASSIFICATION:

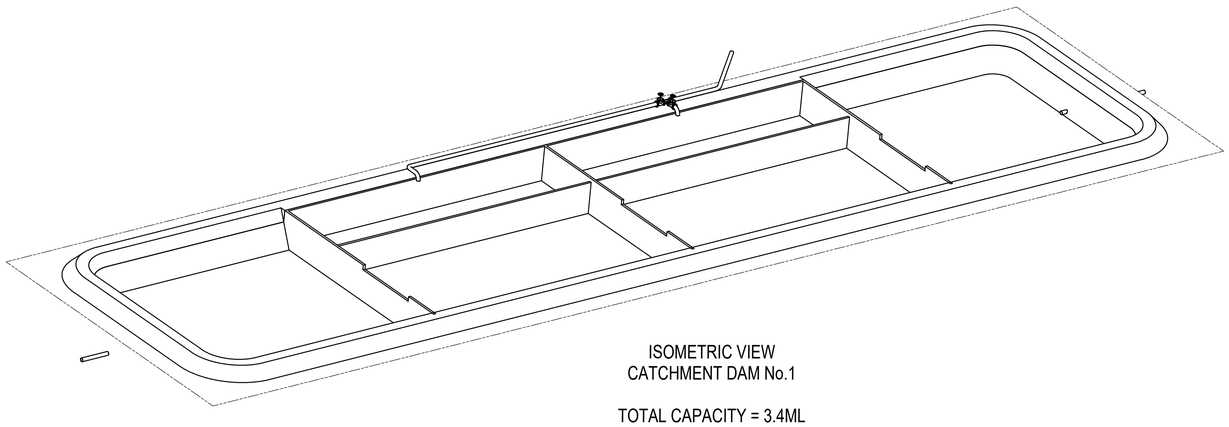
DRAWING No: BER-M-PFD-482-01-01
WORKS No:
REV: B



PLAN

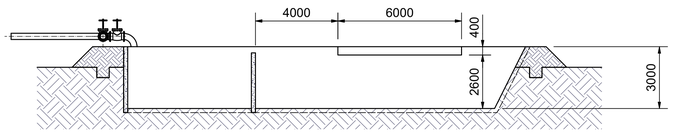


SECTION A-A



ISOMETRIC VIEW
CATCHMENT DAM No.1

TOTAL CAPACITY = 3.4ML



SECTION B-B

REV	DATE	DESIGNER	APPROVED	DESCRIPTION
A	20/04/2021	L.P.McIntosh		DRAWING ISSUED

REVISION HISTORY

DRAWN: L.P.McIntosh	DATE: 20/04/2021	STATUS: REVIEW / APPROVAL	GROUP ENGINEERING No: PLANT BER / DRAWING C-DTL-482-01-01 / SHEET 01
CHECKED:	DATE:	ALPHA NUMERIC:	BCES JOB No: GBM482
ENGINEER:	DATE:	STOCK NUMBER:	SHEET: B1 / SCALE: 1:125
APPROVED:	DATE:	PLANT: MEDWAY	WORKS No: / REV. A
		PROJECT: BERRIMA COLLIERY CLOSURE	
		SECTION: MINE	
		SUB SECTION:	
		TITLE: PIT TOP WATER TRATMENT - DAM No.1 DETAIL	
		CLASSIFICATION:	

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Engineering Services
Locked Bag No. 4 New Berrima N.S.W. 2577 Australia
Telephone - 02-48 602325
Facsimille - 02-48 602399

ZERO HARM

Berrima Colliery
Underground
Workings

Berrima Colliery
Main Entry Drift
and Ventilation entry

Berrima Colliery
Pit Top

Drain Adit

CCL 748

MEDWAY

RAILWAY CORRIDOR

Under Bored
Road Crossing

LIEBMAN RD.

MEDWAY ROAD

Under Bored
Road Crossing

Existing Freeway
Underpass

RAILWAY CORRIDOR

Under Bored
Road Crossing

OLDBURY CREEK

HUME HWY

OLD HUME HWY

WINGECARRIBEE RIVER

WINGECARRIBEE RIVER

MEDWAY RIVULET

BERRIMA

NEW BERRIMA

Berrima
Cement Works

250 000 E

252 500 E

255 000 E

6 180 000 N

6 177 500 N

6 177 000 N

- Proposed pipeline route
- Pipeline route to be determined
- Berrima Colliery CCL748
- Motorway, main road
- Secondary road
- Watercourse , dam
- Cadastral lot

August 2022

Map source: © NSW LPMI 2011 Datum: MGA, GDA94, Zone 56

0 1,000 metres

N

FIGURE 00
Berrima Cement Works
Proposed Water Pipeline Route

References

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Sullivan R., Wright I.A., Renshaw A., Wilks M., (2014). The assessment of impacts from mining wastes on water quality and aquatic ecosystems using freshwater macroinvertebrate communities and novel bio-assay test**s**, in Vietz, G; Rutherfurd, I.D, and Hughes, R. (editors), *Proceedings of the 7th Australian Stream Management Conference*. Townsville, Queensland, Pages 369-376.

Appendix A – Neutral or Beneficial Effects

Environmental Assessment under Clause 27 of the Drinking Water Catchments REP 1

Since the Colliery Holdings are located within the water supply catchment of Lake Burragorang, the assessment for the passive water treatment system needs to address Part 6.5 of State Environmental Planning Policy (Biodiversity and Conservation) 2021, that is, whether or not the activity will have a neutral or beneficial effect (NorBE) on water quality. The assessment provided below is based on the NorBE guidelines and template as provided by WaterNSW.

1. Activity

Key elements of the activity involve the construction and operation of a passive water treatment facility at the pit top of Berrima Colliery (closed). The work will involve:

- Constructing additional underground bulkheads within the mine workings to create a reservoir where the mine drift intersects the coal seam workings. This area is referred to as "pit bottom" and separates the newer mine workings from the original old workings. The bulkheads will extend from the floor to the roof creating a dam.
- A pump will be installed into the reservoir which will deliver water to the surface facilities area, referred to as the "pit top". Under normal operating conditions, the water level within the workings will be kept at or just below the roof of the mine to avoid water seeping into the overlying porous sandstone. If this occurs, this seepage will pass over the bulkheads and enter the old workings and discharge untreated into the Wingecarribee River.
- At the pit top, a multi-celled pond will be constructed that will enable water to be separated to undergo several treatment methods. The first will be aeration, followed by pH adjustment and then settlement. As shown on Plan 3 this pond will be located along the existing access road from the office carpark to the end of the helipad.
- Two additional settlement ponds will be constructed. One will be located on the engineering carpark area which will enable a final water testing point prior to delivery of water to the Wingecarribee River via a pipeline. The second pond will be located along the site entrance road. This pond will include a pumping station to pump water along the pipeline to the cement works.
- Construct a pipeline within the existing railway easement from the pit top to the Berrima Cement Works. The pipeline will be pressure rated HDPE with a 200 mm internal diameter and buried.

Further details of the project are found in Chapter 3 of the main REF document.

2. Name of Catchment/Subcatchment

The site lies within the Wingecarribee River Catchment which forms part of the catchment of Lake Burragorang. The principle water way impacted by the proposed final closure is the Wingecarribee River between the new mine discharge point near the current mine entrance and the Black Bobs Creek confluence.

3. Are there any Identifiable Potential Impacts on Water Quality?

Yes, the mine discharge consists of groundwater collected within the underground workings. The water quality differs from the Wingecarribee River which is assimilated within a mixing zone of approximately 500 m in length. Below the mixing zone, the water quality is essentially the same as the natural water quality of the river.

It is however known that the upstream water quality of the river contains pollutants from farmland, urban areas and sewage treatment discharges. The mine discharge assists in dilution of these pollutants during low flow conditions. This dilution will be the same following completion of the passive treatment system as the mine discharge quality will be similar to historic levels.

Two separate phases ecotoxicological and aquatic ecology testing were undertaken. The first was in 2012 and the second between 2018 and 2019. Both studies were performed in a period of extremely low river flow. The first was in a period when the mine was operational and groundwater discharge was treated within the underground workings prior to release while the second was when the mine was in the process of final closure and no treatment was being undertaken.

The samples for the first phase were taken of the mine discharge water, upstream of the discharge point and within the mixing zone. The results showed that the mine discharge water has a very low toxicity with nil toxicity to freshwater shrimp *Parataya australiensis* and non-biting midge (chironomid) larvae. The more interesting results came from the freshwater water flea cladoceran *Ceriodaphnia* results which showed that the upstream site was in fact more "toxic" than downstream site within the mixing zone.

This data implies that the mine water reduces the toxicity in the river however this is not a correct conclusion. The water within the mixing zone is different than the upstream water quality and some of these differences, such as greater nutrient content upstream or higher aluminium levels upstream, may be affecting the toxicity results. The use of water fleas is a test of total toxicity as it is using the most fragile of organisms which don't naturally reside in the Wingecarribee River.

The overall results confirmed that while the mine was operational, the mixing zone was not adversely impacted by the historic mine discharge water. However, in 2016 to 2017, there was a period when untreated water discharged from the mine. This water contained higher mineral content which resulted in a reduction in macroinvertebrate abundance and taxonomic richness downstream of the discharge point. This was detected by the results from the second phase of aquatic testing.

The impact was caused by the increased iron deposition in the mixing zone which in turn increased the turbidity. This data emphasis the need to maintain a treatment system prior to discharge.

4. Identify the likely pollutants of concern during construction and operation

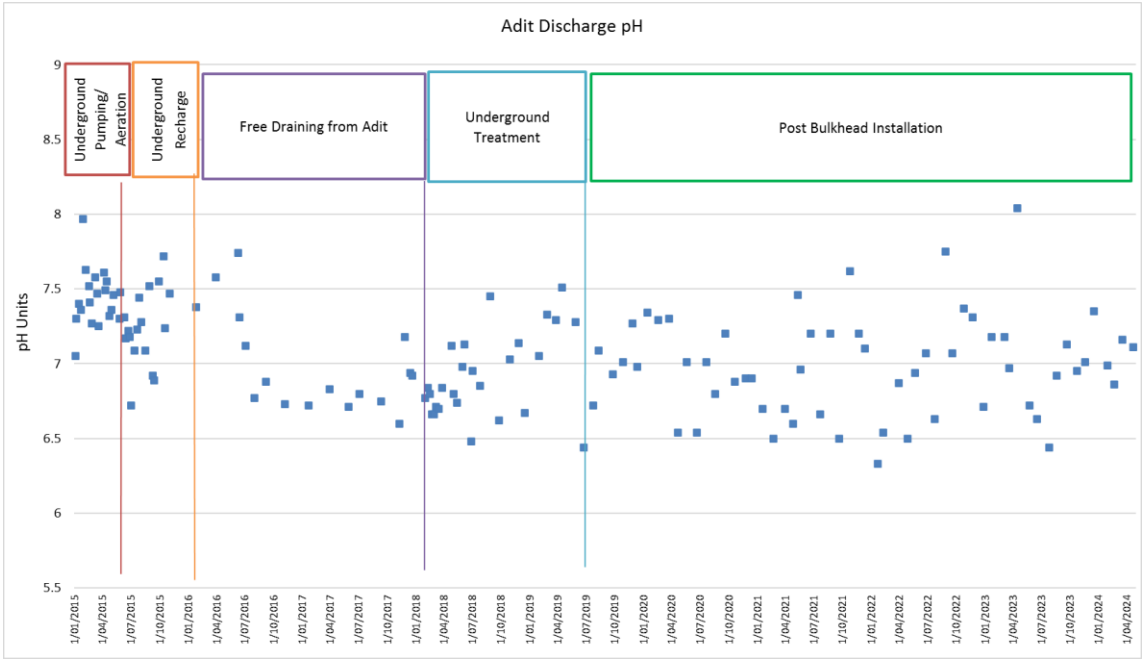
The water represents naturally occurring groundwater that has undergone settling and aeration to remove Iron and Manganese in a similar fashion to agricultural properties which use the same groundwater source. Minerals and physical water quality parameters which are measured and assessed under Site Specific ANZECC derived trigger levels include:

- ❒ pH
- ❒ Conductivity
- ❒ Suspended Solids
- ❒ Manganese
- ❒ Iron
- ❒ Nickel
- ❒ Zinc
- ❒ Copper
- ❒ Aluminium

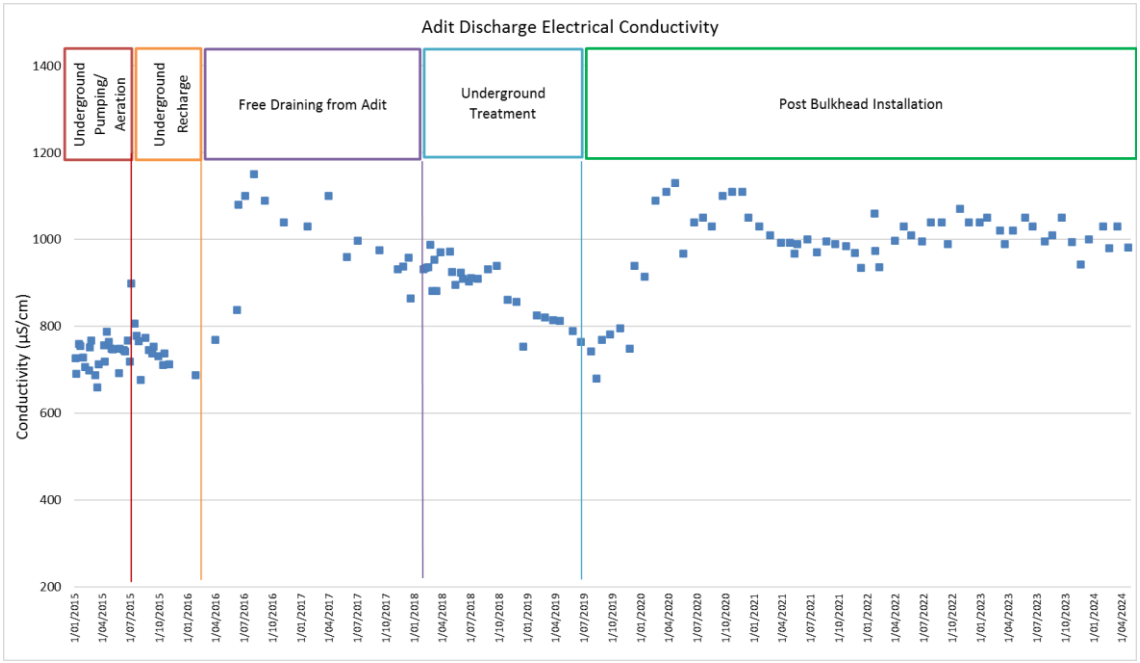
The mine discharge quality has varied during the closure process. The passive treatment system has been designed to treat water to a standard equal to or better than the historic discharge from the mine. It is also designed to reduce the variability that has occurred in the past. This includes the variability while the mine was operating. The surface based system will be more easily managed and have the ability to respond quickly to any variability in water quality.

There will also be the ability to stop pumping water from the mine for several months if problems arise. With the construction of the underground bulkheads there will be a much larger underground storage buffer to enable variations to occur in the pumped/treated volume. This was not possible when the mine was operating as the main imperative was to keep the mine from flooding.

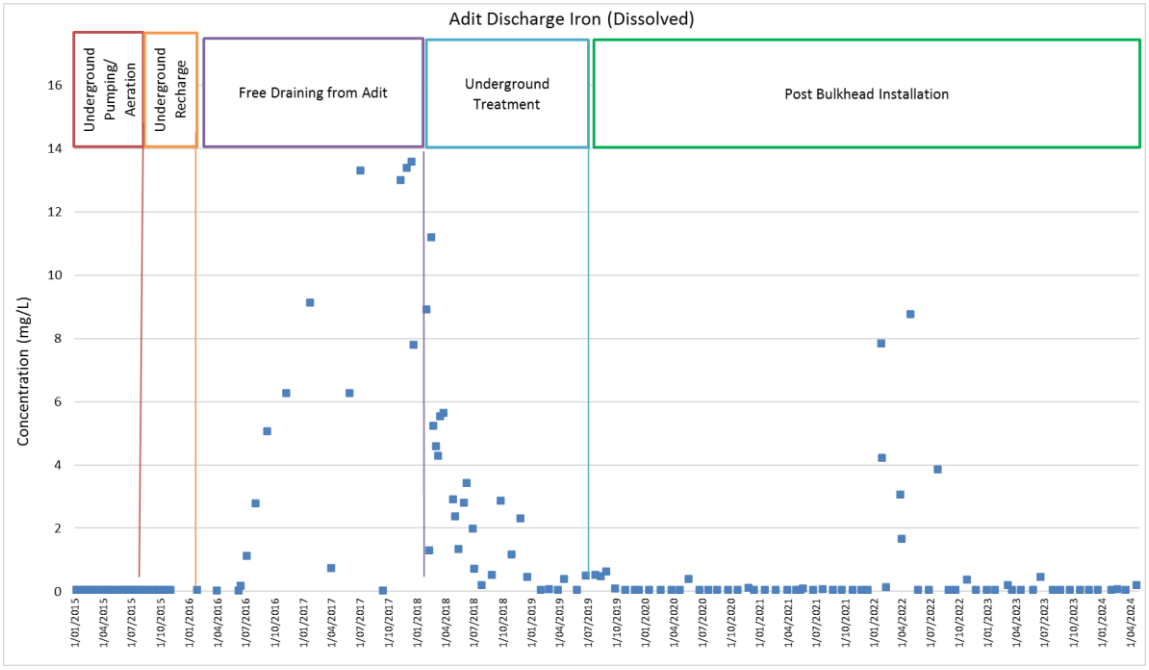
The following graphs show discharge water quality commencing when the mine was operating the underground treatment as it was when mining coal, followed by the removal of the underground equipment allowing the mine to flood, referred to as the underground recharge period. This was followed by a free draining period which had no water treatment and then the implementation of the underground treatment system again. The post bulkhead installation also includes the underground treatment process.



Graph 1 – Adit Discharge pH



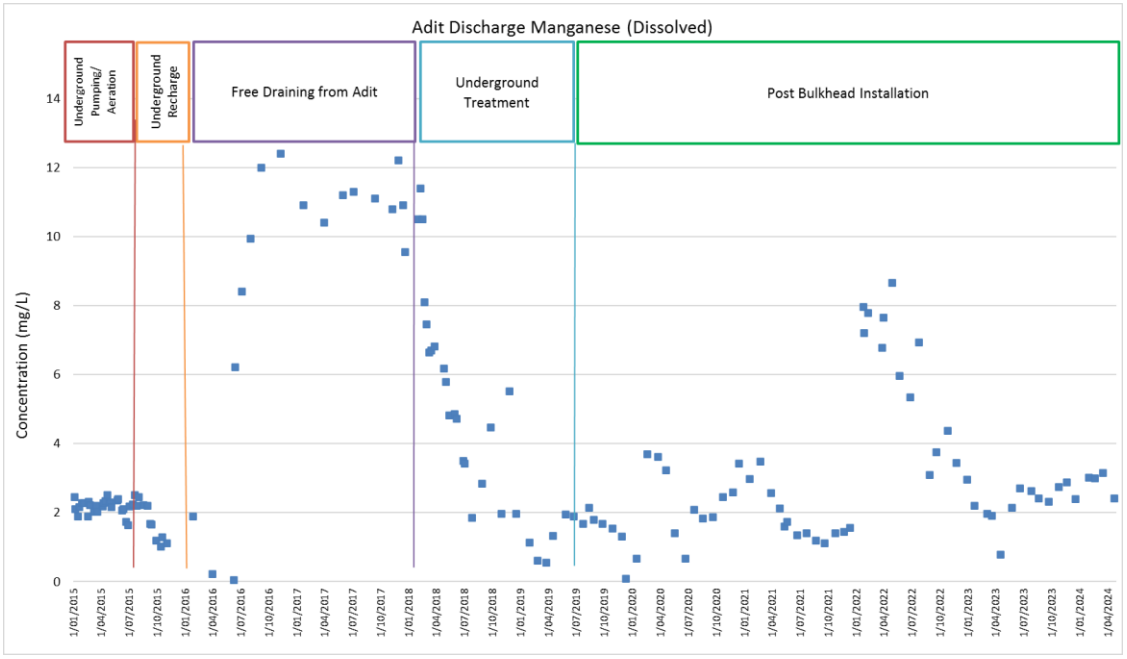
Graph 2 – Adit Discharge Electrical Conductivity



Graph 3 – Adit Discharge Iron Concentration

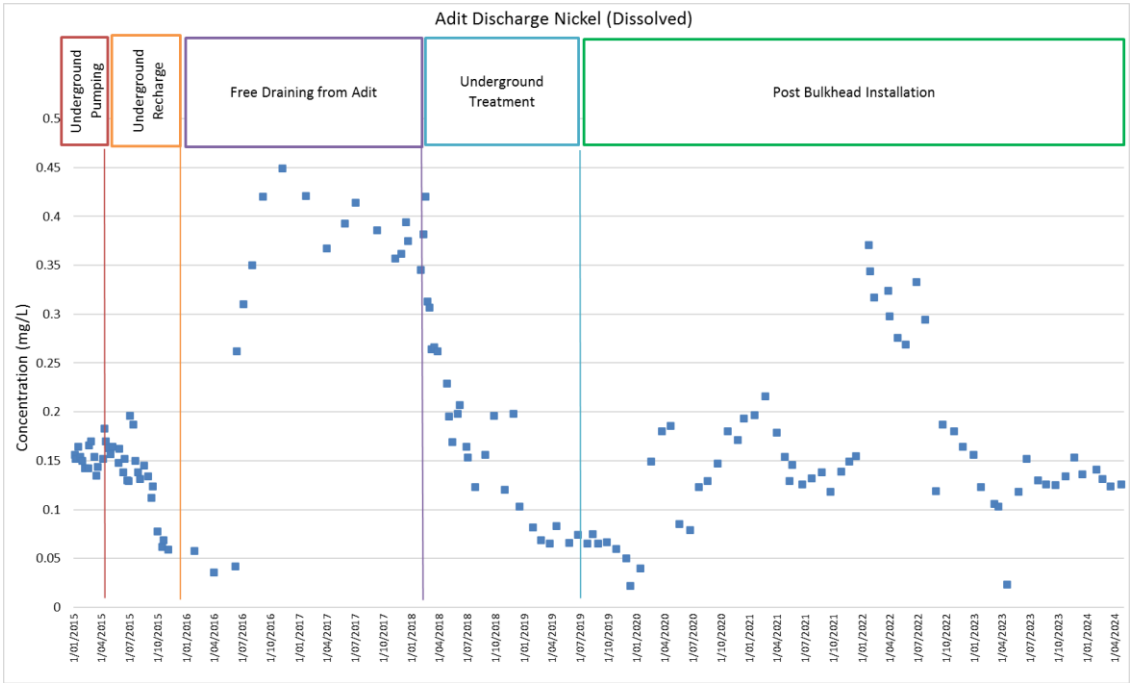
The pH and Electrical Conductivity results show some overall variation in water quality however conductivity (the measure of salt content) has been slightly higher since mine closure. Mineral concentration has seen the most changes over the closure process. Graph 3 above shows that while the mine was operating there was a very low Iron concentration. This was able to be removed by simple aeration and settlement.

The naturally high Iron concentration within the mine water can be seen when the mine commenced to free drain. This period had no treatment prior to discharge. The underground treatment system that was installed quickly removed the Iron concentration however there has still been some variability. This has been caused by the difficulties placed on the current underground treatment system by the very nature of being located within the mine workings.



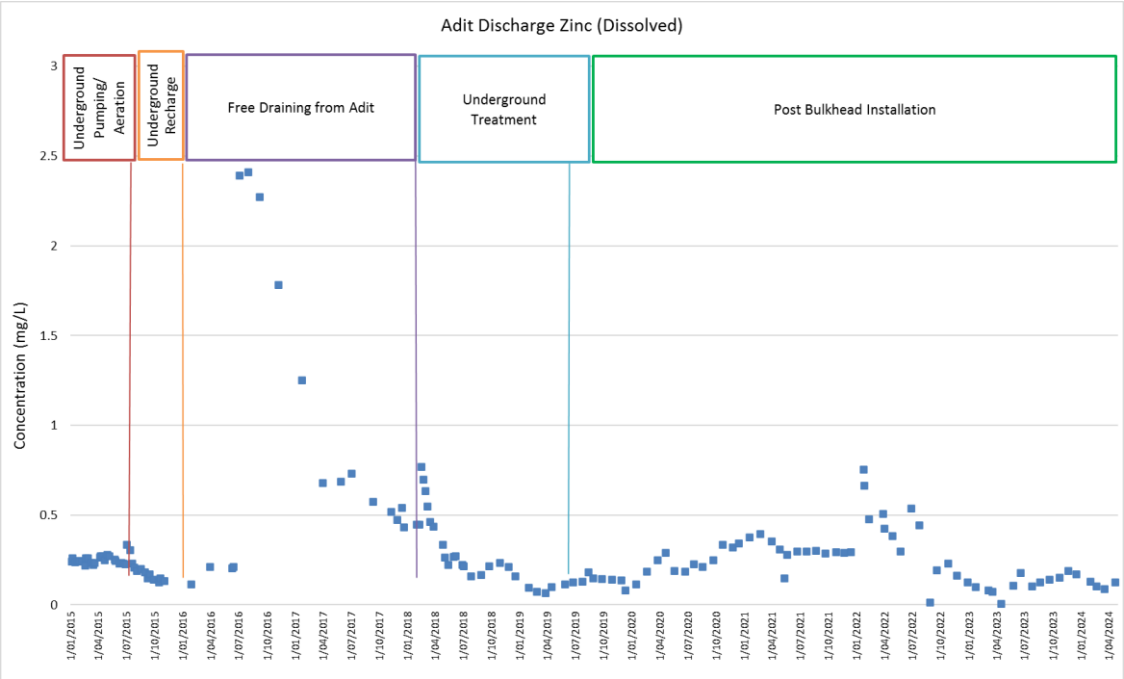
Graph 4 – Adit Discharge Manganese Concentration

A similar patten occurred with other minerals, that is, a significant rise in concentration during the free draining period followed by a reduction but with some variability with the implementation of the underground treatment system. One of the key aims of the proposed surface passive treatment system is to be able to remove the variability in water quality.



Graph 5 – Adit Discharge Nickel Concentration

Nickel and Zinc are more difficult to reduce using simple aeration and settlement processes. The design of the passive treatment system allows for the introduction of additional chemical oxidisers and settlement agents which may improve the removal of these minerals.



Graph 6 – Adit Discharge Zinc Concentration

In late 2017 and early 2018, a surface treatment trial was undertaken at the Berrima Colliery Pit Top. The trial used aeration and pH adjustment followed by settlement. The trial demonstrated that passive treatment was effective at removing almost all of the iron and approximately 25% of other minerals. The proposed treatment system is based on a combination of the surface trials, the methods used underground while the mine was operating and the current treatment system which utilises some of the elements of both.

The proposed discharge quality goals are listed in Table 4.2 of the REF.

5 Have the following been prepared as part of the environmental assessment: Water Cycle Management Study, Stormwater Management Plan and Erosion and Sediment Plan/Soil and Water Management Plan?

The water discharge from Berrima Colliery was the subject of ongoing water quality assessments since 2010. The assessment included long term receiving water quality and specific aquatic ecology assessments as outlined below.

- ❒ Surface water quality within the receiving waters of the Wingecarribee River. This included both the mixing zone and nominated reference sites.
- ❒ Groundwater quality within the mine workings prior to release into the Wingecarribee River. Although the water is naturally occurring and the discharge longstanding, the recent change in water quality following cessation of mining has created the need to undertake investigations into removing higher mineral content to better match long term discharge quality.
- ❒ Aquatic ecology studies within the receiving waters, including the mixing zone and nominated reference sites.
- ❒ Ecotoxicological investigations to determine changes in inhibitors within the mixing zone compared to nominated reference sites.

- ❒ Sediment analysis along the river to determine rate of transport, effects of geology and the ultimate fate of minerals discharged within the mixing zone.

The above studies were undertaken during calendar years 2018 and 2019, however a similar set of studies were undertaken between 2011 and 2012, while ambient water quality within the Wingecarribee River has been undertaken continuously since 2010. An ANZECC 2000 assessment was completed for Berrima Colliery in February 2013 which included aquatic ecology and ecotoxicology assessments which provided a baseline to compare with studies undertaken in 2018 and 2019.

Copies of the reports and data were made available to relevant government stakeholders including the WaterNSW.

The passive treatment system will be located wholly within the existing disturbed footprint of the Berrima Colliery pit top. This site has existing pollution control systems covering surface water management and controls. This includes two pollution control dams and internal pumping systems to transfer water as required. All runoff from the construction of the treatment system at the pit top will be fully contained within existing pollution control structures.

The construction program will be covered by a Construction Environmental Management Plan which will include details of any specific erosion and sedimentation controls required during construction. The main area of additional controls will be along the pipeline route. This is likely to include the erection of temporary silt fencing and revegetation of all disturbed areas following completion.

6. For each pollutant listed in Question 4, list the on-ground water quality protection measures that will be needed during construction along with performance criteria for each.

During the earthworks component of the construction activities, all existing pollution control structures will remain. The pit top site will remain nil discharge during the construction program and therefore the risk of sedimentation impacts off site will be avoided. Any additional erosion and sedimentation controls will be designed to meet the requirements of Landcom's *Managing Urban Stormwater: Soils and Construction* Vol 14th edition (Blue Book).

Once operational, a new discharge licence will be established for the pit top passive treatment system allowing treated water to be returned to the Wingecarribee River. This discharge point will be subject to discharge criteria imposed by the EPA in consultation with other government regulators.

7. For each pollutant listed in Question 4, list the on-ground water quality protection measures that will be needed post construction along with performance criteria designed for each.

The proposed performance criteria for water discharged from the passive treatment system are provided in the table below. These are based on the expected performance of the surface treatment system and comparison with current guideline values.

Mine Water Discharge Criteria (mg/L)

Parameter	Avg Discharge while Operating	ANZECC 95% Default / EPA***	Recreation Guidelines ANZG 2018	NHMRC Recreation Guidelines*	Proposed Passive Treatment Output Goals***
pH Value	7.29	6.5 to 8.5	6.5 to 8.5	6.5 – 8.5	6.5 – 8.5
Electrical Conductivity	692	350	1,500	N/A	1,000
Oil and Grease	<5	<10	N/A	N/A	<10
TSS	9	50	<20% of natural	N/A	<20
Sulphate	320	N/A	400	500	400
Aluminium	0.034	0.055	0.2	N/A	0.03
Copper	0.0008	0.0014	1.0	2	0.002
Iron	0.106	N/A	0.3	0.3	0.1
Manganese	2.30	1.9	0.1	0.5	1.9
Nickel	0.15	0.011	0.1	0.02	0.15
Zinc	0.26	0.008	5.0	3	0.25
Dissolved Oxygen	N/A	N/A	N/A	8.0**	8.0

Note: parameter units are listed as per Table 4.1

* The NHMRC guideline values are directly applicable to drinking water quality and should only be regarded as an initial guide to the quality of recreational water. These values are Total Concentration.

** Based on NHMRC 80% saturation level as relevant to Berrima at 600 m AHD and 12^0C

*** ANZECC/ANZG and Passive Treatment Plant Goals are listed as Dissolved Concentration (filtered sample)

Also listed above are the values achieved while the mine was operating. These values represent the long term discharge from the mine and were relevant at the time of the initial aquatic ecology and ecotoxicological studies. Typical EPA licence limits have also been provided for pH, Oil and Grease and Total Suspended Particulates (TSS) for completeness.

The proposed treatment system goals are based on the anticipated performance of the passive treatment system but also mindful of the current water quality held within the mine workings. This data is provided in Table 4.1 of the REF. The process of flooding the mine workings has changed the water quality with a general increase in metal concentration and salt content. The increase in salt level has been minor and still within acceptable discharge goals.

The monitoring program will include a continuation of the upstream and downstream sampling within the Wingecarribee River. The passive treatment system has been designed to facilitate future modifications to cater for any variability in raw water quality. This includes the potential to use more aggressive alkalis, oxidisers and flocculants. This level of flexibility is unavailable if the treatment system remains within the underground workings.

8. Are the water quality protection measures sustainable for the periods for which they are expected to be in place?

Yes, the site will be governed by an Environment Protection Licence. The lifecycle of the project, that is, the need to treat the groundwater will likely extend beyond the life of the Berrima Cement Works. As holder of the EPL, Boral will still be responsible for the treatment and discharge of the water irrespective of the existence of the Berrima Cement Works. At the time when water is no longer needed by the cement plant, the holder of the EPL has the option of selling the site and treatment process or to continue to operate the site.

9. For each pollutant listed in Question 4, describe the expected load and concentration post-construction/during operation compared with pre-construction levels

The concentration of minerals prior to treatment and post treatment have been discussed in Clauses 4 and 7 above. Although the aim of the project is to treat the water to the same standard as occurred when the mine was operating, it is worth discussing the overall mineral load of the Wingecarribee River. In 2012, Berrima Colliery undertook a fate assessment of the minerals discharged from the mine. This assessment determined the total load of minerals carried by the river as well as the contribution to this from the mine discharge.

The following tables and graphs describe the sediment quality within the Wingecarribee River upstream (Old Hume Highway and Macarthur's Crossing) and downstream of the mine discharge (Biloela Camp and Black Bobs Crossing). This data is relevant if the discharge from the passive treatment system will be the same as historically discharged from the mine.

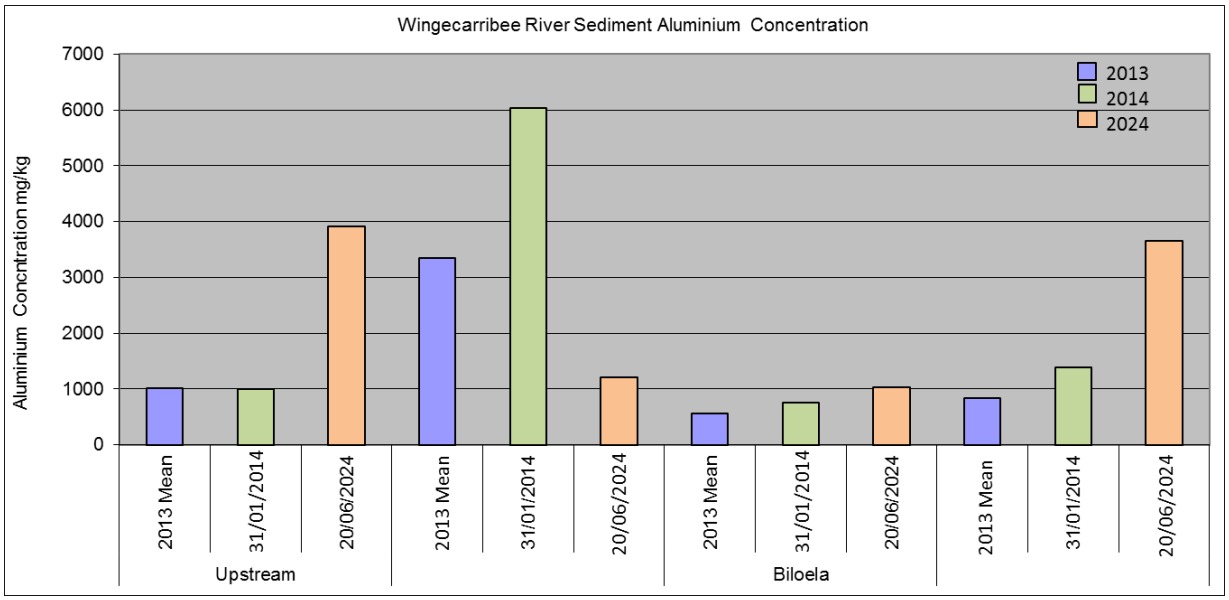
Summary Statistics for Metal Concentrations in River Sediments (2013 to 2024)

Analyte	Old Hume Highway	Macarthurs Crossing	Biloela Camp	Black Bobs Crossing
Aluminium (mg/kg)	1,972	3,531	779	1,960
Copper (mg/kg)	<5	<5		<5
Iron (mg/kg)	11,406	50,000	2,147	9,138
Lead (mg/kg)	5	<5		<5
Manganese (mg/kg)	198	336	84	123
Nickel (mg/kg)	2.6	20.3	3.2	5.4
Zinc (mg/kg)	33.7	25.7	13.8	17.5

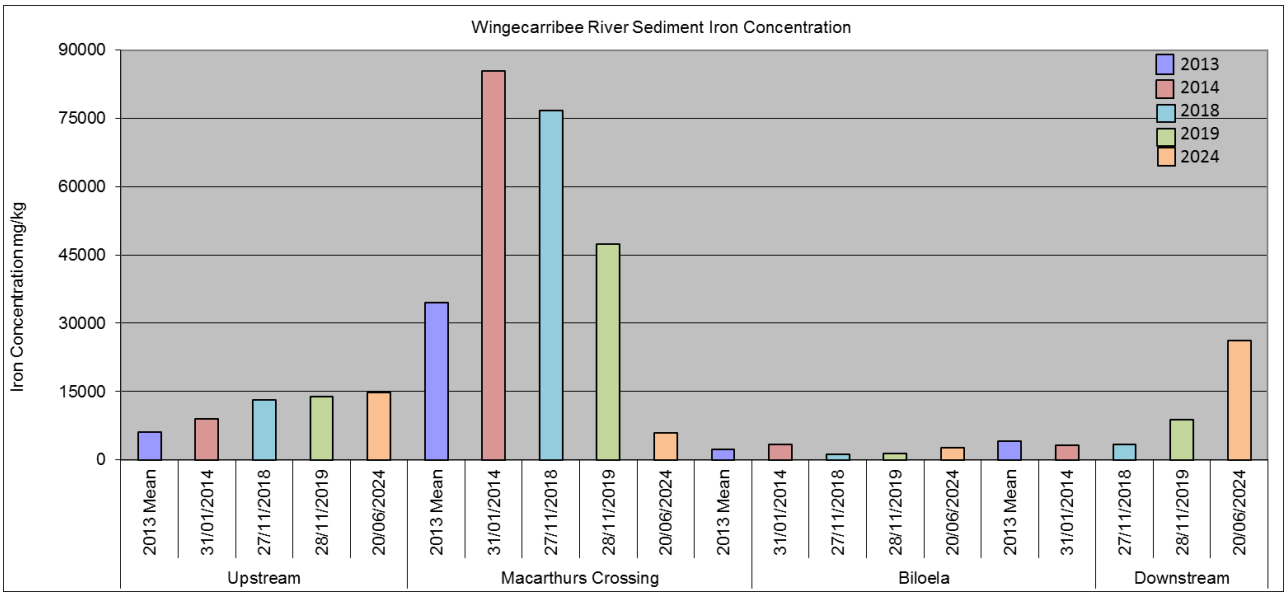
Table above shows the main metals of interest. Other metal species were analysed but found to be at inconsequential concentrations. The data shows that sediments within the Wingecarribee River upstream of the mine are generally higher in mineralisation than the sediments below the mine discharge point. However this does not mean that the mine does not contribute to mineralisation. The above data is the long term averages, while the data is shown graphically in the following graphs provides information on changes over time.

The sampling points are described below:

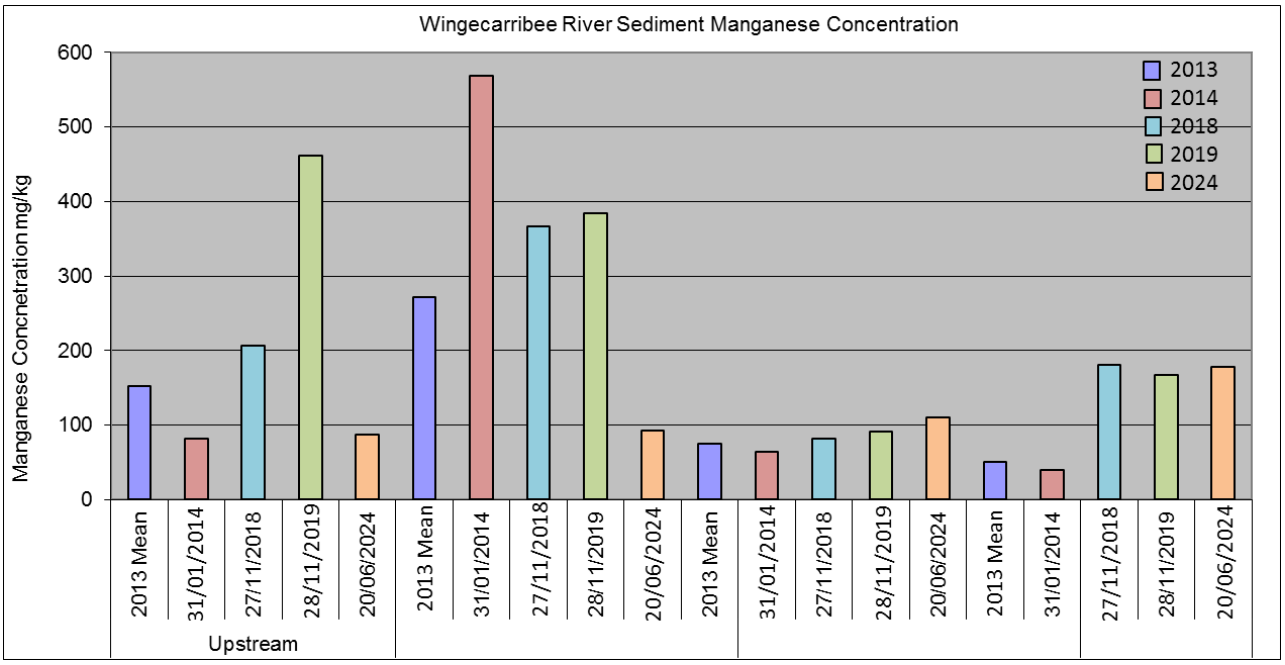
- Upstream - Wingecarribee River upstream of the mine adit discharge at Old Hume Highway Crossing at Berrima. This site is influenced by drainage from the Berrima Township, highway traffic and upstream land uses.
- Macarthur's Crossing - Wingecarribee River upstream of the mine adit discharge at Macarthur's Crossing. This site represents a change in geology where the Wingecaribee River enters Hawkesbury Sandstone.
- Biloela - Wingecarribee River 6 km downstream of the mine adit discharge at Biloela Camp Site. This site represents the first privately owned land downstream of the mine discharge and on the edge of the mining lease.
- Downstream - Wingecarribee River downstream of mine adit discharge at Black Bob's confluence.



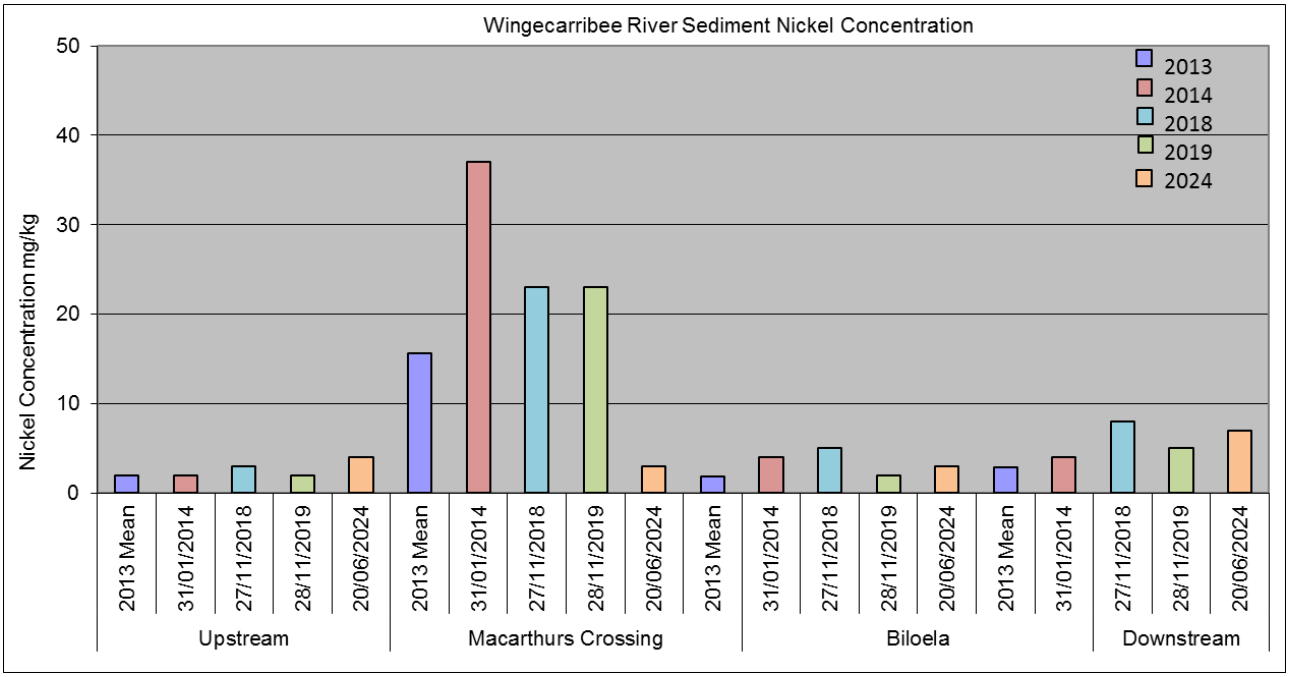
Graph 7 - Concentrations of Aluminium (mg/kg) in River Sediments



Graph 8 - Concentrations of Iron (mg/kg) in River Sediments

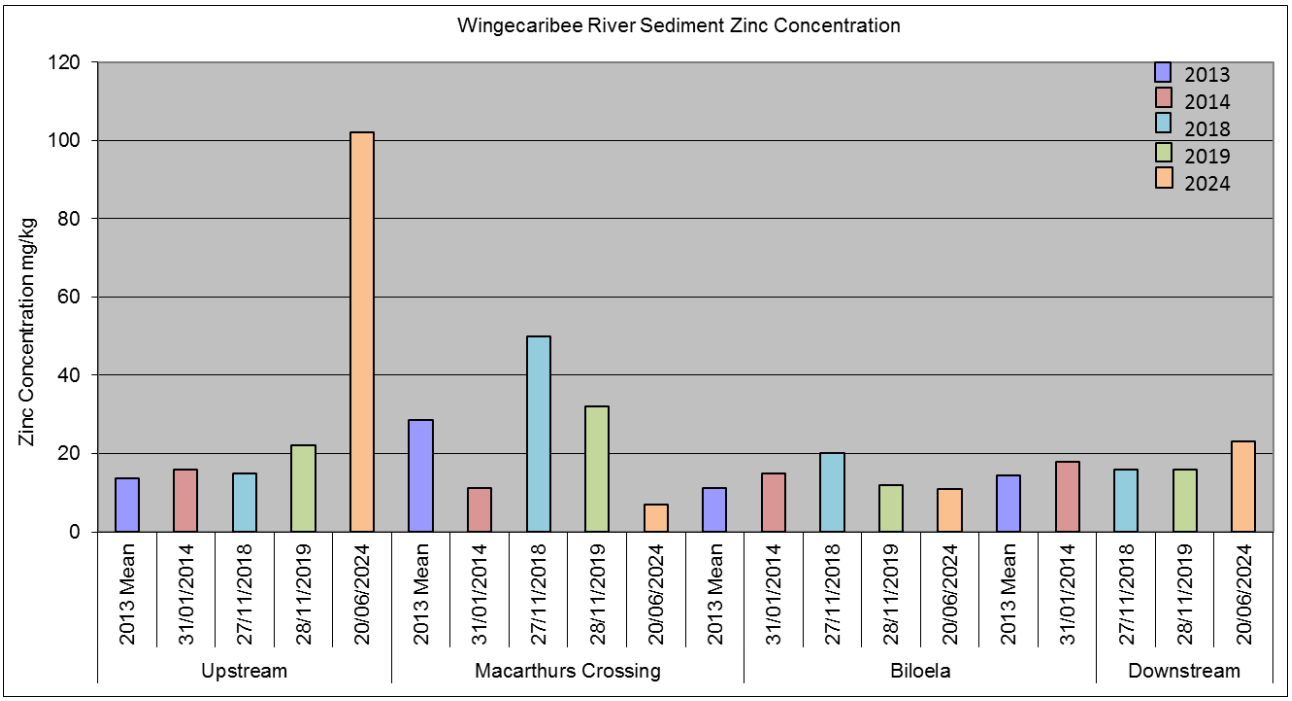


Graph 9 - Concentrations of Manganese (mg/kg) in River Sediments



Graph 10 - Concentrations of Nickel (mg/kg) in River Sediments

The overall results confirm that the discharge has not significantly raised mineral loading in the river, however there was a period between 2016 to 2017 when untreated water discharged from the mine. This water contained higher mineral content which resulted in a slight increase in mineral load in the later 2018 to 2024 results at Biloela and the Downstream sample site. This could be the result of the progressive movement of sediments resulting from the period when no treatment was undertaken prior to discharge. The concentration of minerals within the river sediments were still consistently higher at the Macarthurs Crossing site upstream of the mine discharge.



Graph 11 - Concentrations of Zinc (mg/kg) in River Sediments

In all cases, the higher mineralisation in the river sediments relate more to local geology than in the mine discharge. The Wingecarribee River flows from the agricultural/urban area of Berrima into the Hawkesbury Sandstone gorges of Macarthur's Crossing before passing the mine discharge point and into the wider agricultural valleys downstream.

The anticipated mineral loading within the river as a result of the proposed passive treatment system is therefore not expected to measurably change from historic levels. It is however important to note that without treatment, significantly larger pollutant loads would accumulate within the mixing zone. The proposed passive treatment system has been designed to avoid this in future.

10. Is it likely that a NorBE on water quality will occur?

The proposed passive water treatment facility will seek to ensure that water quality entering the Wingecarribee River will be consistent and at a better overall quality than has historically discharged from Berrima Colliery. This discharge has occurred for nearly 100 years and the river has not only adapted to it but arguably benefited from the additional flow. The principle benefits have arisen following progressive unnatural reductions in river flow caused by water supply dams and numerous agricultural dams that have been built within the catchment and which reduce natural flows.

The project also involves pumping a component of the treated water back to the cement plant however this component will be offset by the cement plant not pumping out of the river at the Berrima Weir. Overall the impact on water flow will be neutral.

Similarly, the impact on water quality, albeit better than in recent years and without the variability which occurred while the mine was operating, will be very similar to the historic average. The aim is to meet the values listed in Table 4.2 of the REF. Therefore, the impact on water quality will be neutral.

11. Neutral of Beneficial Effect Statement

This assessment has been prepared by Mr Robert Byrnes of International Environmental Consultants Pty Limited and concludes that the proposed installation of a passive treatment system at the existing pit top facilities of Berrima Colliery and the connection of the facility to the Berrima Cement Works as described in the attached REF, will have a neutral effect on the catchment of Lake Burragorang over the long term.

Appendix B – Assessment of Activity Significance

Berrima Colliery Final Closure Rehabilitation
Preliminary Environmental Assessment in accordance with
Department of Urban Affairs and Planning *"Is an EIS Required?"*

This report presents the state of existing environmental resources in the study area and assesses the likely potential impacts of the proposed closure and rehabilitation activities on the environment. The methodology provided in the DUAP guideline, "*Is An EIS Required?"* was used to assist in identification of environmental issues of potential relevance to the proposal. As outlined in the guideline:

- ❒ The potential environmental issues associated with the activity are identified in Table 1;
- ❒ The extent of the potential impacts is identified Table 2A;
- ❒ Table 2B analyses the extent of potential adverse impacts in sensitive locations;
- ❒ An analysis of the nature of the impacts is given in Table 2C;
- ❒ An evaluation of the likely significance of the potential impacts on the environment is provided in the final table.

Description of proposed activity	**Berrima Colliery Passive Treatment Facility**
Activity:	Boral proposes to pump groundwater from the mine to a purpose built passive treatment system at the current pit top. The treatment system will involve aeration, pH correction and settlement via multi celled ponds. Treated water can then be discharged back into the Wingecarribee River via a new licensed discharge point. A proportion of the treated water could be sent to the Berrima Cement Works via a pipeline located within the existing railway easement between the colliery and the cement plant. This would remove the need for the cement plant to source its water needs from its existing licensed pump-out in the Wingecarribee River upstream of the Berrima township.
Objectives:	The objectives of the activity are to: ❒ Pump and treat sufficient volume of water from the mine to avoid to maintain the level of water backed up behind the underground bulkheads by pumping groundwater to the surface for treatment. ❒ Improve the quality of the water in surface treatment dams including the reduction of metals such as iron and manganese and maintaining a neutral pH. ❒ Provide clean water to the Berrima Cement Plant during times of drought to ensure continuation of work. ❒ To return water of equal or higher quality than previously discharged into the Wingecarribee River. ❒ Significant reduction in environmental risks as a result of mine closure. ❒ Improved water quality within the Wingecarribee River due to more consistent and effective water treatment capability. ❒ Better reuse of the water resource by eliminating the existing cement plant river pump-out. ❒ Increase in base water flow between the existing river pump-out upstream of Berrima township to the new discharge point at the colliery.
Major elements including any environmental impact mitigation measures:	The project consists of two components, constructing a passive treatment system at the Berrima Colliery Pit Top and the second is the installation of an overland pipeline between the pit top and the Berrima Cement works. The pipeline will be buried within an existing railway easement. Key elements of the activity involve: ❒ Constructing additional underground bulkheads within the mine workings to create a reservoir where the mine drift intersects the coal seam workings. This area is referred to as "pit bottom" and separates the newer mine workings from the original old workings. The bulkheads will extend from the floor to the roof creating a dam. ❒ A pump will be installed into the reservoir which will deliver water to the surface facilities area, referred to as the "pit top". The water level within the workings will be kept at or just below the roof of the mine to avoid water seeping into the overlying porous sandstone. If this occurs, this seepage will pass over the bulkheads and enter the old workings and discharge untreated into the Wingecarribee River. ❒ At the pit top, a multi-celled pond will be constructed that will enable water to be separated to undergo several treatment methods. The first will be aeration, followed by pH adjustment and then settlement. As shown on Plans in the REF this pond will be located along the existing access road from the office carpark to the end of the helipad.

Description of proposed activity	Berrima Colliery Passive Treatment Facility
	❒ Two additional settlement ponds will be constructed. One will be located on the engineering carpark area which will enable a final water testing point prior to delivery of water to the Wingecarribee River via a pipeline. The second pond will be located along the site entrance road. This pond will include a pumping station to pump water along the pipeline to the cement works. ❒ Repurpose the existing buildings to support the ongoing water treatment project and remove any remaining coal handling infrastructure. The existing carpark will be relocated to the rear of the main office/bathhouse building and minor access changes will also be made. The primary mitigation strategy includes: ❒ Achieve the discharge goals specified in Table 4.2 of the REF. ❒ Meet all new conditions imposed on the operation's Environment Protection Licence (EPL). ❒ Continue to monitor discharge quality in accordance with the existing and any future variations to the EPL. ❒ Maintain nil discharge site for surface facilities during construction. ❒ Continue to monitor and assess the health of the Wingecarribee River as may be required by the EPL or government regulators. ❒ Maintain security systems during rehabilitation program. ❒ Ensure the passive treatment system is fully fenced and maintain security systems during its ongoing operation. ❒ Prepare and implement a Construction Environmental Management Plan.
Any ancillary works:	The project consists of three dams located at the upper level of the existing pit top. This area consists of the main access road leading into the site, the top carpark and the engineering carpark. The area is currently cleared but includes landscaping. The area of disturbance corresponds to the previously assessed bushfire asset protection zone and has previously been disturbed by mining activities
Outline of construction methods:	The ponds are located within the surface facilities area of the colliery which has historically been defined as a clean catchment. It consists of concrete carparking area, roadways and some landscaping. Beneath the hardstand is a skeletal sandy soil overlying weathered Hawkesbury Sandstone. The activity will require the following earthworks: ❒ Excavation and levelling for each pond. This will generate some concrete waste which will be disposed in an approved resource recovery facility. ❒ Pond wall forming. The material used for this will be generated by weathered sandstone base material generated by the excavation. ❒ Pipe trenching and burying using. This will involve some leveling of the railway formation using a small dozer followed by an excavator and/or trenching machine for burying the pipeline. A specialised boring machine will be used to bury the pipeline beneath public roads. Any additional spoil generated during the pipeline installation will be spread within the easement.
Outline of operations:	The passive treatment system will utilise aeration and settlement to primarily remove Iron and Manganese and to a lesser extent other minerals that occur in the groundwater which enters the Berrima Colliery underground mine workings.
Location(s):	All activities will occur with the pit top of Berrima Colliery and associated railway easement which links the pit top to the Berrima Cement Works.
Time frame:	The pit top treatment system and overland pipeline will be treated as two separate projects for construction purposes. The pit top treatment system will be constructed first and maybe completed prior to the commencement of the overland pipeline project The passive treatment system will require approximately 11 months to design and construct while the overland pipeline project will take approximately 5 months with the program commencing shortly after receiving approval from the EPA. Once completed, the system will operate permanently.

Table 1 – Identify the Issues

Characteristics of the activity (during construction and operation)	Potential Issues
How is the proposal likely to affect the physical aspects of the environment or introduce pollution or safety risk factors?	
1. Disturbs the topography or above or below ground features including filling, excavation, dredging, tunnelling: eg land forming, site preparation, quarrying, reclamation, creation of islands, water bodies, etc; involves the disposal of large quantities of spoil.	The construction program involves earthworks, removal of some infrastructure and refit of buildings which will require removal of spoil and recyclable materials from the site. Primary issues for this phase are noise and dust generation on the village of Medway. There will be some reforming of the land in order to increase surface stability. Existing drainage provisions will remain post completion of the passive treatment facility. Surface contamination will be removed in the case of hazardous materials or bioremediated to meet Residential A criteria. There will be negligible ongoing (operational) impacts generated from the passive treatment facility.
2. Affects a natural waterbody, wetland or groundwater aquifer or the natural water drainage pattern; affects the quality or quantity of water in the systems.	Potential impacts on the Wingecarribee River will be improved compared to the long term historic mine discharge. Water quality variability while the mine was operating was a result of mining through geological structures. As the mine has now closed, water quality and quantity is anticipated to be more consistent and therefore the passive treatment facility will produce a more consistent water quality discharge.
3. Uses groundwater or surface water from a natural waterbody; stores water in a dam or artificial waterbody.	The permanent closure of the mine has allowed the underground workings to partially flood. Groundwater recharge will occur over time and will be contained by the new bulkheads constructed around pit bottom. Groundwater will be prevented from flowing through overlying strata by pumping to the surface passive water treatment facility. The mine discharge is anticipated to remain at long term averages. The Resources Regulator has requested that the permeability of the overlying strata be tested over time. This will involve allowing the water to saturate overlying strata to determine both permeability and quality.
4. Changes the flood or tidal regimes or is affected by flooding or tides.	None
5. Uses, stores, disposes or transports hazardous substances (flammable, explosive, toxic, radioactive, carcinogenic or mutagenic substances); uses or generates pesticides, herbicides, fertilisers or other chemicals which may build up residues in the environment.	The previous rehabilitation program has included a contamination assessment which has identified minor levels of site contamination requiring remediation. The proposed activities will reduce potential hazardous material in the environment.
6. Generates or disposes of gaseous, liquid or solid waste (industrial, medical or domestic waste, sewage, sludge or effluent, spoil or overburden); generates greenhouse gas emissions or releases chemicals which affect the ozone layer or a precursors to photochemical smog; generates or disposes of hazardous waste.	Minor quantities of waste generated as a result of construction of the passive treatment facility. Includes waste materials, fuel and lubricants. The amounts are significantly less than was used during operations. Once the treatment facility is completed, approximately 19 tonnes of mineral concentrates will be produced per year as sediment in the ponds. These will be removed and disposed of at approved resource recovery facilities or if suitable used in clinker manufacture.
7. Emits dust, odours, noise, vibrations, blasts, electromagnetic fields or radiation in the proximity of residential areas or landuses likely to be affected.	Noise and dust will be emitted from the site during construction and earthworks associated with the passive treatment ponds. It has been assessed that the total noise and dust generation would be lower than that emitted from the mine while in operation and will meet current noise assessment criteria.
8. Any other matters.	Water flow within the Wingecarribee River has also been assessed and that the benefits of the historic discharge from the colliery will continue.

Table 1 – Identify the Issues

Characteristics of the activity (during construction and operation)	Potential Issues
	If no impacts identified this section can be ignored in Tables 2(a) and 2(c)
How is the proposal likely to affect the biological aspects of the environment?	
1. Clears or modifies (including by modifying the drainage) native vegetation (including trees, shrubs, grasses, herbs or aquatic species).	There is the potential for minor disturbance to non native vegetation within the pit top area.
2. Displaces or disturbs fauna (terrestrial or aquatic) or creates a barrier to fauna movement; clears remnant vegetation or wildlife corridors.	The passive treatment system will maintain the mine discharge to current historic levels which will continue the maintenance of an important breeding population of Platypus approximately 10 km downstream of the mine.
3. Introduces noxious weeds, vermin, feral species or disease or releases genetically modified organisms.	Although weeds currently exist on site ongoing weed controls are proposed to minimise the risk of weed infestation in the long term.
4. Undertakes activity that affects revegetation or replenishment of native species following a disturbance.	None, the project resides within an existing disturbed area.
5. Introduces high bushfire risk factors or changes the fire regime.	Bushfire risk currently exists on site and is managed by an established fire fighting system. This system will remain but modified accordingly following the completion of the passive treatment system.
6. Any other issues.	None
	If no impacts identified this section can be ignored in Tables 2(a) and 2(c)
How is the proposal likely to affect natural or community resources?	
1. Uses or results in the use of community services or infrastructure including roads, power, water, drainage, waste management, education, medical or social services.	No negative impact.
2. Uses or results in the use of natural resources including water (ground or surface), fuels, timber, extractive material, minerals, prime agricultural land, etc.	Diesel will be used in the construction phase by external contractors however no new plant or equipment will be purchased for the exclusive use of the project. Therefore diesel usage is not incrementally higher than would otherwise occur. The closure of the mine and the installation of the bulkheads has reduced access to the Wongawilli Seam from the current pit top. Coal remaining in the lease could be accessed from other sites in future.
3. Affects future potential of commercial deposits of minerals or extractive material or areas important for fishing, agriculture or forestry.	The Berrima coal lease has approximately 326 Million tonnes of remaining coal reserves. The resource was previously used in a raw condition for use in cement manufacture but requires some beneficiation for other uses. Access to this resource will be difficult but not impossible from the current pit top once the passive treatment system is completed. The Resources Regulator has requested that a mine re-entry plan be prepared as part of the closure process. Access to the coal resource would also be available from other sites in future.
4. Changes the demographics of an area.	None
5. Changes the transport requirement of an area.	None
6. Creates a new route alignment for the provision of infrastructure (eg rail, roads, power, etc).	None
7. Any other issues.	None
	If no impacts identified in this section can be ignored in Tables 2(a) and 2(c)
How is the proposal likely to affect the community?	
1. Generates population movements including influx or departure of the workforce.	The main impact of the closure has already occurred when the mine went into Care and Maintenance in October 2013. The mine employed 37 people and currently employs 6. This will be further reduced on completion of the passive treatment

Table 1 – Identify the Issues

Characteristics of the activity (during construction and operation)	Potential Issues
	system.
2. Changes the workforce or industry structure of the area/region.	Berrima Colliery also employed a number of local contractors and expended around $15 Million pa within the local economy. The impact has already occurred and is not considered part of the impact of physical closure and ongoing use for passive water treatment which is the subject of this REF.
3. Affects employment opportunities in areas of high population densities or established development patterns.	Nil
4. Affects access to an area, building or items of aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific, recreational, aesthetic or social significance or other special value for present or future generations.	Berrima Colliery has local heritage value despite none of the buildings and structures possessing Heritage Significance. The buildings were originally constructed in 1926 but have been significantly modified over time. A Heritage Assessment has been undertaken and recommended that the history of the colliery be fully documented and a photographic record kept of structures prior to demolition. This has been completed.
5. Affects the visual or scenic landscape (including major cuts/fills, towers, projects on escarpments, etc).	The pit top and Loch Catherine sites are not easily visible from the surrounding area. There are elevated areas within the mining area which could see the coal loading bin while the parts of Medway Village can view the elevated gantries and entry signage. The rehabilitation program to date has removed most of these structures which and the remaining will be removed as part of the construction of the passive treatment system. This has already improved the visual environment.
6. Affects sunlight or views of another property.	No
7. Affects the amenity of publicly owned land (particularly recreational areas, national parks or reserves).	No
8. Changes surrounding land uses as a direct or indirect result of the activity; forms a barrier to movement within the community or access to existing properties; leads to a loss of housing.	No
9. Generates significant volume of traffic (road, rail, air, pedestrian, etc).	Minor additional traffic generated for short periods during the construction program but significantly less than experienced when the mine was operational.
10. Generates nuisance, health or safety risks including air pollution, odour, noise or vibration, blasting, electromagnetic fields or radiation; releases diseases or genetically modified organisms; changes the bush fire regime.	Minor temporary noise and dust impacts during the construction program. Once completed, the passive treatment system will not produce any emissions.
11. Any other issues.	The colliery previously provided raw water to the Medway community. This ceased when the mine went into Care and Maintenance in October 2013 and the impact has already occurred.
	If no impacts identified this section can be ignored in Tables 2(a) and 2(c)
How is the proposal likely to affect areas sensitive because of physical factors?	
1. Coastline and dune fields, alpine areas, deserts, caves or other unique landforms.	None present.
2. Land with high agricultural capability.	No Class I or II lands occur within the current extraction area or near the surface facilities
3. Natural waterbodies, riparian zones, wetlands, drinking water catchments or flood prone areas.	The project will pose no greater impact on the Wingecarribee River than the mine did while operating and is likely to improve water quality within the mixing zone. The ecology of the river has been previously studied and demonstrated to benefit from the low but constant flow of good quality water into the river. The benefit was most pronounced in drought conditions when the river ecology was maintained below the mine discharge. The passive treatment system will provide a more consistent quality of water which should provide some overall benefits to the river health.

Table 1 – Identify the Issues

Characteristics of the activity (during construction and operation)	Potential Issues
4. Groundwater recharge areas or areas with high water table.	The process of flooding the mine behind the new bulkheads around the mine entry will allow some groundwater recharge in the strata above the workings however the amount will be small.
5. Erosion prone area; areas with slopes of greater than 18 degrees.	No significant impact, some steep areas exist around the pit top area but will be stabilised as required. Some retaining walls would need to remain and the external faces of dam walls will need to be actively rehabilitated.
6. Subsidence or slip areas.	Not relevant to this project.
7. Areas with acid sulphate, sodic or highly permeable soils.	No ASS have been identified at Berrima Colliery. Most soils around the pit top and Loch Catherine sites have developed on Hawkesbury Sandstone and are considered highly permeable. These soils do not represent a constraint to rehabilitation and will be replicated on site in order to achieve the desired final vegetation community.
8. Areas with salinity or potential salinity problems.	None present.
9. Areas with degraded air quality.	No.
10. Areas with degraded or contaminated soil area or degraded or contaminated water (ground or surface).	Yes, the pit top and one site at Loch Catherine have identified contamination areas. These areas do not pose a risk to groundwater or surface water and will be remediated to a Residential A Criteria. All potentially contaminating materials within the underground workings have already been removed.
11. Any other sensitive areas.	None identified.
	If no impacts identified this section can be ignored in Tables 2(a) and 2(c)
How is the proposal likely to affect areas sensitive because of biological factors?	
1. Corals and seagrass beds, wetland communities (coastal, peatlands or inland), native forests, urban bushland, arid and semi-arid communities.	Minor impact to non-native vegetation during the construction program.
2. Critical habitats or the habitats of threatened fauna or flora species, populations or ecological communities (within the meaning of the TSC Act).	There will be no additional impact on threatened species or ecological communities listed under current vegetation protection legislation. The proposed project will result in similar discharge volumes compared to the historic average. This includes discharge from the mine combined with the cement plant usage being offset by reduced supply from the river.
3. Habitat of species listed under international agreements including Japan-Australia Migratory Birds Agreement (JAMBA) and China-Australia Migratory Birds Agreement (CAMBA).	No significant impact.
4. Wildlife corridors and remnant vegetation.	The existing native woodland around the pit top and Loch Catherine sites will not be impacted. This area allows for existing wildlife corridors to continue unaffected.
5. Habitat of protected aquatic species (within the meaning of Fisheries Management (General) regulation 1994) or of aquatic species having conservation status under Conference on Australian Threatened Fishes.	Aquatic habitats downstream of the mine discharge will be maintained under the proposed development and likely improved due to more consistent water quality.
6. Fishing grounds and commercial fish breeding or nursery areas.	None present.
7. Bushfire prone areas.	No significant impact.
8. Any other sensitive issues.	None identified.
	If no impacts identified this section can be ignored in Tables 2(a) and 2(c)
How is the proposal likely to affect areas allocated for conservation purposes?	
1. National parks and other areas reserved or dedicated under the NP&W Act.	No impact
2. Land reserved or dedicated within the meaning of the *Crown Lands Act 1989* for preservation or other environmental protection	No impact

Table 1 – Identify the Issues

Characteristics of the activity (during construction and operation)	Potential Issues
purposes.	
3. World heritage areas.	No impact
4. Environmental protection zones in environmental planning instruments or lands protected under SEPP 14 – Coastal Wetlands or SEPP 26 - Littoral Rainforests.	No impact
5. Land identified as wilderness under the *Wilderness Act 1987* or declared as wilderness under the NP&W Act.	No impact
6. Aquatic reserves dedicated under the *Fisheries Management Act 1994*.	No impact
7. Wetlands areas dedicated under the Ramsar Wetlands Convention.	No impact.
8. Heritage items identified on the Register of the National Estate, under the NSW Heritage Act or an environmental planning instrument.	No impacts to known or registered items
9. Community land under the Local Government Act (for which a plan of management has been prepared).	No impact
10. Land subject to a 'conservation agreement' under the NP&W Act.	No impact
11. Any other areas.	None identified
	If no impacts identified this section can be ignored in Tables 2(a) and 2(c)
How is the proposal likely to affect areas sensitive because of community factors?	
1. Aboriginal communities or areas subject to land rights claims.	No impact
2. Communities with a strong sense of identity.	The cessation of water supply to Medway Village caused measurable and significant impacts on this community. This impact occurred in October 2013 and is not part of the current application to construct a passive water treatment facility.
3. Disadvantaged communities (reduced economic, social or cultural indicators).	No impact
4. Areas with degraded amenity from noise, traffic congestion or odour.	Some minor traffic implications during the construction program however this impact would be less than experienced during operations when coal was trucked from the mine to the cement plant. Once completed, the site would no longer generate traffic or emit noise or dust.
5. Areas or items or high anthropological, archaeological, architectural, cultural, heritage, historical, recreational or scientific value.	There is a strong sense of identity felt in the community regarding Berrima Colliery which has operated for over 100 years. Although the site does not have any items of State or National Heritage Significance, nor items listed in the Wingecarribee LEP, Boral has documented the site's history for future reference.
6. Areas or items of high aesthetic or scenic value.	No impact
7. Any other areas	None identified
	If no impacts identified this section can be ignored in Tables 2(a) and 2(c)

Table 2A – Analysis of the extent of the potential impacts

Characteristics of potential impacts (adverse & beneficial)	Type of potential impacts	Evaluation criteria		Ranking of potential significance of extent
		size, scope & intensity	duration	
Physical or pollution impacts (during operation and construction)				
(a) Air impacts				
1. air quality impacts (eg dust, smoke, grit, odours, precursors to photochemical smog, fumes, toxic or radioactive gaseous emissions) with economic, health, ecosystem or amenity considerations	Potential for dust generation	Very minor amounts anticipated to be generated	Short term impacts during construction only.	Low

Table 2A – Analysis of the extent of the potential impacts

Characteristics of potential impacts (adverse & beneficial)	Type of potential impacts	Evaluation criteria		Ranking of potential significance of extent
		size, scope & intensity	duration	
2. air impacts with greenhouse or ozone damage considerations	None			Low
3. any other air impacts	None			Low
(b) Water impacts				
1. impacts from changes in surface or groundwater quantity	Short period of low flow while the mine floods up to the level of the new bulkheads but will be returned to historic levels on completion of the passive treatment system	Long term average discharge will be maintained.	Long term	Low
2. impacts from use of water	Minor usage	Dust suppression during earthworks	Short duration	Low
3. impacts from changes to natural waterbodies, wetlands or runoff patterns	High	Flow reduction in Wingecarribee River short term then returned to historic levels	Long term	Low
4. impacts from changes to flooding or tidal regimes	None			Low
5. impacts from changes in water quality with economic, health, ecosystem or amenity considerations-eg salinity, colour, odour, turbidity, temperature, dissolved oxygen, nutrients, pH factors or pollutants intentional or unintentional releases of oil, fuels, toxins - including heavy metals and anti-foulants, spoil, sediment, sewage or other waste	Flow will be maintained and water quality is anticipated to remain within or better than current long term average	Groundwater discharge quality naturally alters water quality but not significantly. River adapted to previous long term discharge and this adaptation will not be adversely affected	Long term	Moderate
6. any other impacts on water or from the use or storage of water	Surface pollution control dams will remain following rehabilitation	Increase in water storage for habitat value	Long term	Low
(c) Soil and stability impacts				
1. degradation of soil quality including contamination (intentional or unintentional), salinisation or acidification	None			Low
2. loss of soil from wind or water erosion	Minor erosion during earthworks	Minor potential for some erosion during construction	Short term	Low
3. loss of structural integrity of the soil	None			Low
4. increased land instability with high risks from land slides or subsidence	None			Low
5. any other soil impacts	None			Low
(d) Noise and vibration impacts				
1. results in increased noise or vibrations to unacceptable levels for the surrounding communities	Minor	Temporary noise impacts within acceptable criteria	Short term during physical construction works	Low
2. affects sensitive properties (educational, hospitals, residential, heritage)	None			Low

Table 2A – Analysis of the extent of the potential impacts

Characteristics of potential impacts (adverse & beneficial)	Type of potential impacts	Evaluation criteria		Ranking of potential significance of extent
		size, scope & intensity	duration	
3. any other impacts from noise, blasting or vibration	None identified			Low
(e) Any other physical or pollution impacts	None			Low
Accumulation of physical or pollution impacts - Low				
Biological impacts (during operation and construction)				
(a) Fauna impacts				
1. any endangering or displacement of fauna species (including animals, birds, frogs, reptiles, insects, fish or crustaceans)	No significant impact			Low
2. any reduction of critical habitat of any unique, threatened or endangered fauna (within the meaning of the NP&W Act)	No significant impact			Low
3. impacts which create significant barriers to fauna movement	No significant impact			Low
4. any other impacts	None identified			Low
(b) Flora impacts				
1. any endangering of flora species (including trees, shrubs, grasses, herbs or aquatic plants)	No			Low
2. impacts from the clearing or modifying of extensive areas of relatively undisturbed native vegetation or wetlands	Minor disturbance	Small scale	Short term	Low
3. any other impacts	None identified			Low
(c) Ecological impacts				
1. any threat to the biological diversity or ecological integrity of species or communities	Maintenance of base flow in the river during low flow conditions	Locally significant, positive	Long term	Low
2. any barrier to the normal replenishment or revegetation of existing species following disturbance	Enhanced vegetation communities for surface infrastructure sites	Locally positive	Long term	Low
3. impacts from the introduction of noxious weeds, vermin, feral species or diseases or releases of genetically modified organisms	Potential for minor impacts due to weeds	Very low, particularly with implementation of mitigation measures	Medium to long term	Low
4. impacts from the uses of pesticides, herbicides, fertilisers or other chemicals which may build up residues in the environment	None required			Low
5. high bushfire risk impacts	Work which presents potential fire ignition risk when fire weather is hazardous will be avoided	Minor risk, effective reduction measures in place	Short term risk at any one location	Low
6. any other impacts	None identified			
Accumulation of biological impacts - Low				
Resource use impacts (during operation and construction)				
(a) Community resources				
1. any significant increase in the demand for services and infrastructure resources including roads, power, water supply and drainage, waste including sewage management, education, medical and social services	Minor use of water during earthworks component	Water contained on site	Short term	Low

Table 2A – Analysis of the extent of the potential impacts

Characteristics of potential impacts (adverse & beneficial)	Type of potential impacts	Evaluation criteria		Ranking of potential significance of extent
		size, scope & intensity	duration	
2. any significant resource recycling or reuse schemes to reduce resource usage	Wastes recycled where possible	Minor quantities	Short term, well within capacity of local facilities	Low
3. any diversion of resources to the detriment of other communities or natural systems	No			Low
4. any degradation of infrastructure such as roads, bridges	Minor use of existing roads	Minor traffic generation	Short term	Low
5. any other impacts	None identified			
(b) Natural resources				
1. any disruption or destruction of natural resources (eg fish habitat or fish species) with impacts on industries based on these resources	Maintenance of discharge at historic levels	Maintains overall flow in river by supplying treated water to the Berrima cement Works which in turn would not require to pump water from the river. Maintains water flow in river under extreme drought conditions	Long term	Low
2. any disruption of existing activities (or reduction of options for future options) because of the natural resource demands of the proposal	Access to the remaining coal resource would be unavailable from the current mine entries	Remaining resource can be accessed from other sites	Long term	Low
3. any use which results in the wasteful use of large amounts of natural resources	No usage of coal involved in this activity			Low
4. any use which results in the substantial depletion of natural resources	No usage of natural resources			Low
5. any use which results in the degradation of any area reserved for conservation purposes	No			Low
6. any other impacts	No			Low
Accumulation of resource use impacts - Low				
Community impacts (during operation and construction)				
(a) Social factors				
1. any impacts which result in a change in the community's demographic structure	No additional employment generation however loss of the workforce previously experienced	Impacts caused by mine closure occurred in 2013 and no further impact anticipated	Short term	Low
2. any environmental impact that may cause substantial change or disruption to the community (loss of neighbourhood cohesion, access to facilities, links to other communities, community identity or cultural character)	Community division between perceived impacts relating mining and the loss of Berrima Colliery.	Perceived impacts will continue and the loss of measurable benefits has already occurred	Long term	Low
3. any impacts which result in some individuals or communities being significantly disadvantaged	Medway Village lost its long term water supply	This impact occurred in late 2013 and will remain permanently	Long term	Moderate

Table 2A – Analysis of the extent of the potential impacts

Characteristics of potential impacts (adverse & beneficial)	Type of potential impacts	Evaluation criteria		Ranking of potential significance of extent
		size, scope & intensity	duration	
4. any impacts on the health, safety, security, privacy or welfare of individuals or communities because of factors such as: i) air pollution or odour ii) noise, vibration, blasting, electromagnetic fields or radiation iii) release of disease or genetically modified organisms iv) lighting, overshadowing or visual impacts	Minor impacts from noise and dust from earthworks component. Minor traffic and risk of weed infestation	Noise and dust emissions well within acceptable criteria and less than previous operations. Weed controls proposed to reduce risk	Short term	Low
5. any impacts that result in a change in the level of demand for community resources (eg facilities, services and labour force)	Reduced labour demand caused when mine ceased production in October 2013	Impact already registered in the local economy	Short term	Low
6. any other social impacts	None			Low
(b) Economic factors (including impacts on employment, industry and property value)				
1. any impacts which result in a decrease to net economic welfare	None			Low
2. any impacts that result in a direct cost to the community or individuals	The loss of local jobs when the mine closed.	Impact registered in late 2013 and will continue. Impact considered but is not a direct result of the proposed activity	Long term	Moderate
3. any impacts that result in a decrease in the community's economic stability	Loss of local investment and economic activity following closure of the mine	Not specifically relevant to the current activity of constructing a passive treatment system	Medium term	Low
4. any impacts which result in a change to the public sector revenue or expenditure base	None		N/A	Low
5. any other economic impacts	None		N/A	Low
(c) Heritage, aesthetic and cultural impacts				
1. any impacts on a locality, place, building or natural landmark having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific, recreational, scenic or social significance or other special value for present or future generations	No impact on State Significant Heritage however local heritage value of the colliery	History of the mine has been fully documented and some characteristic items of mining interest will be retained	N/A	Low
2. any impacts from new lighting, glare or shadows	None			Low
3. any other heritage, aesthetic or cultural impacts	None			Low
(d) Land use impacts				
1. any major changes in land use	Land use changed from mining related to passive water treatment	Positive impact with reduced activity and water quality benefits	Long term	Moderate
2. any curtailment of other beneficial use	None	N/A	N/A	Low
3. any property value impacts with land use implications	Potential increase in value of land within Medway Village	Positive but very minor impact	Long term	Low
4. any other land use impacts	None	N/A	N/A	Low

Table 2A – Analysis of the extent of the potential impacts

Characteristics of potential impacts (adverse & beneficial)	Type of potential impacts	Evaluation criteria		Ranking of potential significance of extent
		size, scope & intensity	duration	
(e) Transportation Impacts (during construction and operation)				
1. substantial impacts on existing transportation systems (rail, water, road, air or pedestrian – both public and private), altering present patterns of circulation, modal split or movement of people and/or goods	Minor use of existing roads during construction	Minor traffic generation but less than when operational	Short term	Low
2. directly or indirectly encouraging additional traffic: i) during construction ii) during operation	Minor, not significant	Very low	Long term	Low
3. increased demand for parking (off and on street including residential areas)	No	N/A	N/A	Low
4. any other impacts on transport or traffic	No	N/A	N/A	Low
Accumulation of community impacts - Low				

TABLE 2B – ANALYSIS OF THE EXTENT OF THE POTENTIAL ADVERSE IMPACTS IN SENSITIVE LOCATIONS

Characteristics of potential impacts (adverse & beneficial)	Type of potential impacts	Evaluation criteria		Ranking of potential significance of extent
		size, scope & intensity	duration	
On areas sensitive because of physical factors				
1. coastline and dune fields, alpine areas, deserts, caves or other unique landforms	None			Low
2. land with high agricultural capability	None			Low
3. natural waterbodies, riparian zones, wetlands, drinking water catchments or flood prone areas	Maintains discharge to river at historic levels	Positive impacts on the river by maintaining aquatic habitats during low flow conditions	Long term	Low
4. groundwater recharge areas or areas with high water table	Groundwater will continue to enter the mine	A new groundwater equilibrium will be reached after which groundwater reaches the height of the new pit bottom bulkheads. At this point water level will be maintained by pumping to the surface for treatment and then returned to the river.	Long term	Low
5. erosion prone areas; areas with slopes of greater than 18 degrees	None, mitigation measures adequate	N/A	N/A	Low
6. subsidence or slip areas	None	Not relevant to this particular project	N/A	Low
7. areas with acid sulfate, sodic or highly permeable soils	None	N/A	N/A	Low
8. areas with salinity or potential salinity problems	None	N/A	N/A	Low
9. areas with degraded air quality	None	N/A	N/A	Low
10. areas with degraded or contaminated soil area or degraded or contaminated water (ground or surface)	Minor	Mitigation designed to remove to Residential A criteria	Long term	Low

TABLE 2B – ANALYSIS OF THE EXTENT OF THE POTENTIAL ADVERSE IMPACTS IN SENSITIVE LOCATIONS

Characteristics of potential impacts (adverse & beneficial)	Type of potential impacts	Evaluation criteria		Ranking of potential significance of extent
		size, scope & intensity	duration	
11. any other factors	None identified	N/A	N/A	Low
Accumulation of impacts: Low				
On areas sensitive because of biological factors				
1. corals and seagrass beds, wetland communities (coastal, peatlands or inland), native forests, urban bushland, arid and semi-arid communities	None	N/A	N/A	Low
2. habitat of endangered terrestrial or aquatic fauna species and of species listed under international agreements including Japan-Australia Migratory Birds Agreement (JAMBA) and China-Australia Migratory Birds Agreement (CAMBA)	None	N/A	N/A	Low
3. habitat/wildlife corridors and remnant vegetation	None	N/A	N/A	Low
4. protected, rare or threatened plant species or inadequately reserved plant communities	None	N/A	N/A	Low
5. bushfire prone areas	None	N/A	N/A	Low
6. fishing grounds and fish breeding or nursery areas	Reduction in aquatic habitat	Maintains environmental flows within river	Long term	Moderate
Accumulation of impacts - Low				
On areas sensitive because of conservation factors				
1. National Parks and other areas reserved or dedicated under the *National Parks and Wildlife Act 1974*	None	N/A	N/A	Low
2. land reserved or dedicated within the meaning of the *Crown Lands Act 1989* for reservation or other environmental protection purposes	None	N/A	N/A	Low
3. World Heritage areas	None	N/A	N/A	Low
4. environmental protection zones in environmental planning instruments or lands protected under SEPP 14 - *Coastal Wetlands* or SEPP 26 - *Littoral Rainforest*	None	N/A	N/A	Low
5. land identified as wilderness under the *Wilderness Act 1987* or declared as wilderness under the *National Parks and Wildlife Act 1974*	None	N/A	N/A	Low
6. aquatic reserves dedicated under the *Fisheries Management Act 1994*	None	N/A	N/A	Low
7. wetlands areas dedicated under the Ramsar Wetlands Convention	None	N/A	N/A	Low
8. heritage items identified on the Register of the National Estate, under the *Heritage Act 1977* (NSW) or an environmental planning instrument	None	N/A	N/A	Low
9. community land under the *Local Government Act 1993* (for which a plan of management has been prepared)	None	N/A	N/A	Low
10. land subject to a 'conservation agreement' under the *National Parks and Wildlife Act 1974*	None	N/A	N/A	Low
11. any other factors	None identified	N/A	N/A	Low
Accumulation of impacts: Low				
On areas sensitive because of community factors				
1. Aboriginal communities or areas subject to land rights claims	None	N/A	N/A	Low
2. communities with a strong sense of identity	None	N/A	N/A	Low
3. disadvantaged communities (reduced economic, social or cultural indicators)	None	N/A	N/A	Low
4. areas with degraded amenity from noise, traffic congestion or odour	Minor	Temporary and less than operational impacts	Short term	Low
5. areas or items of high anthropological, archaeological, architectural, cultural, heritage, historical,	No State	Adequate mitigation measures in the	Short term	Low

TABLE 2B – ANALYSIS OF THE EXTENT OF THE POTENTIAL ADVERSE IMPACTS IN SENSITIVE LOCATIONS

Characteristics of potential impacts (adverse & beneficial)	Type of potential impacts	Evaluation criteria		Ranking of potential significance of extent
		size, scope & intensity	duration	
recreational or scientific value	Significant Items	form of recording		
6. areas or items of high aesthetic or scenic value	None	N/A	N/A	Low
7. any other factors	None identified	N/A	N/A	Low
Accumulation of impacts: Low				

TABLE 2C - ANALYSIS OF THE NATURE OF THE POTENTIAL IMPACTS

	Evaluation Criteria							
Characteristics of potential impacts (adverse & beneficial)	**What is the confidence in predicting impacts?**	**How resilient is the environment to cope with impacts?**	**Can the impact be reversed?**	**How well can the impacts be mitigated?**	**Do the impacts comply with plans, policies?**	**What is the level of public concern?**	**Are further studies required on impacts or mitigation?**	**Ranking of potential significance**
Physical impacts or pollution impacts (during operation and construction)								
(a) Air impacts								
1. air quality impacts (eg dust, smoke, grit, odours, precursors to photo- chemical smog, fumes, toxic or radioactive gaseous emissions) with economic, health, ecosystem or amenity considerations	High	Highly	Yes	Adequately	Yes	Very low	No	Low
2. air impacts with green- house or ozone damage consideration	High	Highly	Yes	Highly	Yes	Very low	No	Low
3. any other air impacts	None identified							
(b) Water impacts								
1. impacts from changes in surface or ground water quantity	Moderate	Moderately	Yes	Highly	Yes	High	Yes	Low
2. impacts from use of water	High	Sufficiently	Yes	Adequately	Yes	Moderate	No	Low
3. impacts from changes to natural waterbodies, wetlands or runoff patterns	High	Moderately	Yes	Adequately	Yes	High	Yes	Moderate
4. impacts from changes to flooding or tidal regimes	N/a							Low
5. impacts from changes in water quality with economic, health, ecosystem or amenity considerations – eg salinity, colour, odour, turbidity, temperature, dissolved oxygen, nutrients, pH factors or pollutants (intentional or unintentional releases of oil, fuels, toxins including heavy metals, and anti-foulants), spoil, sediment, sewage or other waste	High	Moderately	Yes	Highly	Yes	High	No	Moderate
6. any other impacts on water or from the use or	None Identified							

TABLE 2C - ANALYSIS OF THE NATURE OF THE POTENTIAL IMPACTS

Characteristics of potential impacts (adverse & beneficial)	Evaluation Criteria: What is the confidence in predicting impacts?	How resilient is the environment to cope with impacts?	Can the impact be reversed?	How well can the impacts be mitigated?	Do the impacts comply with plans, policies?	What is the level of public concern?	Are further studies required on impacts or mitigation?	Ranking of potential significance
storage of water								
(c) Soil and stability impacts								
1. degradation of soil quality including contamination (intentional or unintentional), salinisation or acidification	High	Moderately	Yes	Adequately	Yes	High	No	Low
2. loss of soil from wind or water erosion	High	High	Yes	Adequately	Yes	High	No	Low
3. loss of structural integrity of the soil	High	High	Yes	Adequately	Yes	High	No	Low
4. increased land instability with high risks from land slides or subsidence	High	High	Yes	Adequately	Yes	High	No	Low
5. any other soil impacts	N/a							
(d) Noise and vibration impacts								
1. results in increased noise or vibrations to unacceptable levels for the surrounding communities	High	High	Yes	Adequately	Yes	Moderate	No	Low
2. affects sensitive properties (educational, hospitals, residential, heritage)	High	High	Yes	Adequately	Yes	Moderate	No	Low
3. any other impacts from noise, blasting or vibrations	High	High	Yes	Adequately	Yes	Moderate	No	Low
(e) Any other physical or pollution impacts								
Accumulation of physical or pollution impacts - Low								
Biological impacts (during operation and construction)								
(a) Fauna impacts								
1. any endangering or displacement of fauna species (including animals, birds, frogs, reptiles, insects, fish or crustaceans)	High	Moderately	Yes	Well	yes	Moderate	Yes	Moderate
2. any reduction of critical habitat of any unique, threatened or endangered fauna (within the meaning of the NP&W Act)	High	Moderately	Yes	Well	Yes	High	Yes	Moderate
3. impacts which create significant barriers to fauna movement	High	Resilient	Yes	Well	Yes	High	Yes	Low
4. any other impacts	High	Resilient	Yes	Well	Yes	High	Yes	Low
(b) Flora impacts								
1. any endangering of flora species including trees, shrubs, grasses, herbs or aquatic plants	High	Resilient	yes	Well	Yes	High	No	Low
2. impacts from the clearing or modifying of extensive areas of relatively undisturbed native vegetation or wetlands	High	Resilient	Yes	Well	Yes	High	No	Low
3. any other impacts	N/a							

TABLE 2C - ANALYSIS OF THE NATURE OF THE POTENTIAL IMPACTS

	Evaluation Criteria							
Characteristics of potential impacts (adverse & beneficial)	**What is the confidence in predicting impacts?**	**How resilient is the environment to cope with impacts?**	**Can the impact be reversed?**	**How well can the impacts be mitigated?**	**Do the impacts comply with plans, policies?**	**What is the level of public concern?**	**Are further studies required on impacts or mitigation?**	**Ranking of potential significance**
(c) Ecological impacts								
1. any threat to the biological diversity or ecological integrity of species or communities	High	Moderately	Yes	Well	Yes	High	Yes	Moderate
2. any barrier to the normal replenishment or revegetation of existing species following disturbance	High	Resilient	Yes	Well	Yes	High	No	Low
3. impacts from the introduction of noxious weeds, vermin, feral species or diseases or releases of genetically modified organisms	High	Resilient	Yes	Well	Yes	High	No	Low
4. impacts from the uses of pesticides, herbicides, fertilisers or other chemicals which may build up residues in the environment	High	Resilient	Yes	Well	Yes	Moderate	No	Low
5. high bushfire risk impacts	High	Low	Yes	Well	Yes	Moderate	No	Low
6. any other impacts	N/a							Low
Resource use impacts (during operation and construction)								
(a) Community resources								
1. any significant increase in the demand for services and infrastructure resources including roads, power, water supply and drainage, waste (including sewage) management, education, medical and social services	High	Highly	Yes	Well	Yes	High	No	Low
2. any significant resource recycling or reuse schemes to reduce resource usage	High	Highly	Yes	Well	Yes	High	No	Low
3. any diversion of resources to the detriment of other communities or natural systems	High	Highly	Yes	Well	Yes	High	No	Low
4. any degradation of infrastructure such as roads, bridges	High	Highly	Yes	Well	Yes	High	No	Low
5. any other impacts	N/a							
(b) Natural resources								
1. any disruption or destruction of natural resources (eg fish habitat or fish species) with impacts on industries based on these resources	Moderately	Moderately	Yes	Well	Yes	Moderate	Yes	Moderate
2. any disruption of existing activities (or reduction of options for future options) because of the natural resource demands of the proposal	High	Highly	Yes	Well	Yes	High	No	Low
3. any use which results in the wasteful use of	High	Highly	Yes	Well	Yes	High	No	Low

TABLE 2C - ANALYSIS OF THE NATURE OF THE POTENTIAL IMPACTS

Characteristics of potential impacts (adverse & beneficial)	Evaluation Criteria: What is the confidence in predicting impacts?	How resilient is the environment to cope with impacts?	Can the impact be reversed?	How well can the impacts be mitigated?	Do the impacts comply with plans, policies?	What is the level of public concern?	Are further studies required on impacts or mitigation?	Ranking of potential significance
large amounts of natural resources								
4. any use which results in the substantial depletion of natural resources	High	Highly	Yes	Well	Yes	High	No	Low
5. any use that results in the degradation of any area reserved for conservation purposes	High	Highly	Yes	Well	Yes	High	No	Low
Accumulation of resource use impacts: Low								
Community impacts (during operation and construction)								
(a) Social impacts								
1. any impacts which result in a change in the community's demographic structure	High	Highly	Yes	Well	Yes	High	No	Low
2. any environmental impact that may cause substantial change or disruption to the community (loss of neighbour cohesion, access to facilities, links to other communities, community identity or cultural character)	High	Highly	Yes	Well	Yes	High	No	Low
3. any impacts which result in some individuals or communities being significantly disadvantaged	High (community concern)	Moderate	Yes	Moderately	Yes	High	No	Moderate
4. any impacts on the health, safety, security, privacy or welfare of individuals or communities because of factors such as	High	Highly	Yes	Adequately	Yes	High	No	Low
i) air pollution or odour, noise								
ii) vibration, blasting, electro-magnetic fields or radiation								
iii) release of disease or genetically modified organisms								
iv) lighting, overshadowing or visual impacts								
5. any impacts that result in a change in the level of demand for community resources (eg facilities, services and labour force)	High	Highly	Yes	Well	Yes	High	No	Low
6. any other social impacts: Cumulative social and economic impacts	High	High	Yes	Well	Yes	High	No	Low
(b) Economic factors (including impacts on employment, industry and property value)								
1. any impacts which result in a decrease to net economic welfare	High	High	Yes	Well	Yes	High	No	Low
2. any impacts that result in a direct cost to the community or individuals	High	High	Yes	Well	Yes	High	No	Low
3. any impacts that result in a decrease in the	High	High	Yes	Well	Yes	High	No	Low

TABLE 2C - ANALYSIS OF THE NATURE OF THE POTENTIAL IMPACTS

Characteristics of potential impacts (adverse & beneficial)	Evaluation Criteria							
	What is the confidence in predicting impacts?	How resilient is the environment to cope with impacts?	Can the impact be reversed?	How well can the impacts be mitigated?	Do the impacts comply with plans, policies?	What is the level of public concern?	Are further studies required on impacts or mitigation?	Ranking of potential significance
community's economic stability								
4. any impacts which result in a change to the public sector revenue or expenditure base	High	High	Yes	Well	Yes	Low	No	Low
5. any other economic impacts	High	High	Yes	Well	Yes	Low	No	Low
(c) Heritage, aesthetic and cultural impacts								
1. any impacts on a locality, place, building or natural landmark having aesthetic anthropological, archaeological, architectural, cultural, historical, scientific, recreational, scenic or social significance or other special value for present or future generations	High	Low	Yes	Very well	Yes	High	Yes	Moderate
2. any impacts from new lighting, glare or shadows	High	Highly	Yes	Well	Yes	High	No	Low
3. any other heritage, aesthetic, cultural impacts	High	High	no	Very well	yes	low	No	Low
(d) Land use impacts								
1. any major changes in land use	High	Highly	Yes	N/a	Yes	Moderate	No	Low
2. any curtailment of other beneficial uses	N/a							
3. any property value impacts with land use implications	High	Highly	Yes	Well	Yes	Low	No	Low
4. any other land use impacts	N/a							
(e) Transportation impacts)								
1. substantial impacts on existing transportation systems (rail, water, road air or pedestrian – both public and private), altering present patterns of circulation, modal split or movement of people and/or goods	High	Highly	Yes	Adequately	Yes	Low	No	Low
2. directly or indirectly encouraging additional traffic	High	Highly	Yes	Adequately	Yes	Negligible	No	Low
i) during construction								
ii) during operation								
3. increased demand for parking (off and on street including residential areas)	N/a							
4. any other impacts on transportation or traffic	N/a							
Accumulation of community impacts - Low								

TABLE 3 **EVALUATE THE LIKELY SIGNIFICANCE OF POTENTIAL IMPACTS ON THE ENVIRONMENT**

Impacts	Potential significance considering the extent of impacts	Potential significance considering the level of adverse impacts on environmentally sensitive areas	Potential significance considering the nature of the impacts
Physical and pollution			
a) air impacts	Low	Low	Low
b) water impacts	Moderate	Low	Low
c) soil impacts	Low	Low	Low
d) noise and vibration	Low	Low	Low
Biological			
a) fauna	Moderate	Low	Low
b) flora	Low	Low	Low
c) ecological	Low	Low	Low
Resource Use			
a) community resources	Low	Low	Low
b) natural resources	Moderate	Low	Low
Community			
a) social impacts	Moderate	Low	Low
b) economic impacts	Low	Low	Low
c) heritage, aesthetic, cultural impacts	Moderate	Low	Low
d) land use impacts	Low	Low	Low
e) transportation impacts	Low	Low	Low
Activity as a whole	Moderate	Low	Low

This activity is **not likely** to significantly affect the environment. No EIS is required. ☑

or

This activity is **likely** to significantly affect the environment. An EIS is required. ☐

Person responsible for analysing the potential impacts
(eg preparing the REF if necessary)

Robert Byrnes,
Director
International Environmental Consultants Pty Ltd

Signature: R Byrnes

Date: 8 May 2025

Appendix C – Noise Assessment

Boral Colliery Water Treatment and Pipeline

Construction and Operational Noise Assessment

Boral Cement Limited

PO Box 6041
NORTH RYDE NSW 2113

Prepared by:

SLR Consulting Australia

SLR Project No.: 610.03211.00001

Client Reference No.:

8 November 2024

Revision: 1.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	8 November 2024	John Sleeman	Mark Irish	John Sleeman

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Boral Cement Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

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Acronyms and Abbreviations

EPA	Environment Protection Authority
NPfI	Noise Policy for Industry
ICNG	Interim Construction Noise Guideline
RBL	Rating Background Level

1.0 Introduction

Berrima Colliery originally provided coal for the cement works located at New Berrima, with the colliery pit top located approximately 400 m north-west of the village of Medway. The colliery ceased production in 2013, and since 2014 the colliery has been in the process of final closure, with the primary outstanding issue impacting the final closure option the management of groundwater. Boral have determined that the final closure option for the colliery would necessarily involve a permanent passive water treatment facility located at the pit top which would treat water pumped from the mine workings for treatment prior to release back into the Wingecarribee River via the existing licensed discharge point, or pumped overland to supply to the Berrima Cement Works.

This report assesses the construction noise impact of the water treatment facility located at the pit top, and the construction of the pipeline from the pit top to the Berrima Cement Works. The operational noise from the water treatment facility located at the pit top is also assessed.

Specific acoustic terminology is used in this assessment. An explanation of common terms used is included in **Appendix A.**

2.0 Project Description

The project consists of :

- Construction of a multi-celled pond at the pit top that will enable water to be separated to undergo several treatment methods. The first cell will be aeration, followed by pH adjustment and then settlement. Construction of two additional settlement ponds at the pit top. Noise emissions are expected during the first four months of construction when the majority of the earthworks are being undertaken. The equipment would include a dozer for pad development, 20 tonne excavator and front end loader for material movement and backhoe/bobcat for final shaping.
- Construction of a pipeline within the existing railway easement from the pit top to the Berrima Cement Works. The pipeline construction will also involve earthmoving equipment consisting of a bobcat/backhoe for clearing and leveling, an excavator to construct the pipe trench and a telehandler used to unload trucks and lay pipes. Pipes and supplies will be provided by smaller trucks suitable to access the easement. A pipe boring unit may also be used to bury the pipeline beneath road crossings. As the pipeline work will be remote from services a generator will be required to power hand tools and pipe welding and portable amenities provided. This equipment will pass close to residential receptors for a period of approximately 5 days with the entire pipeline being completed within 3 months. The pipeline will be pressure rated HDPE with a 200 mm internal diameter and buried.
- Operational equipment consisting of 4 (four) underground Grundfos multistage pumps, and 2 (two) 45kW pumps in a 100% redundancy configuration located in an enclosure south east of the main pit top area, and approximately 230 m north west of the nearest Medway residences on Railway Parade.

Figure 1 presents the Berrima Colliery pit top and pipeline route, and **Figure 2** the pond(s) and pump station layout at the pit top.

Figure 1 Berrima Colliery Pit Top and Pipeline Route

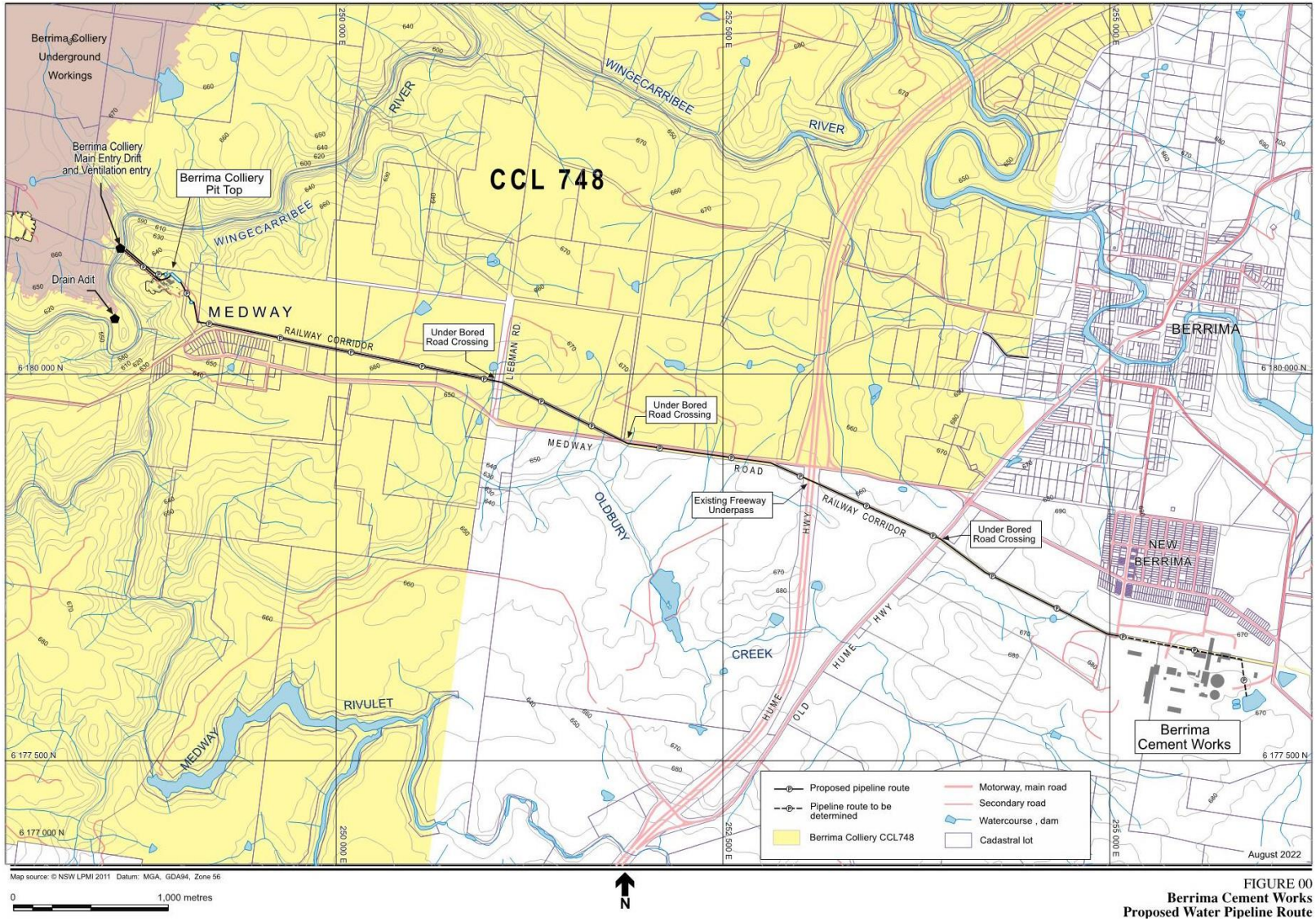


Figure 2 Berrima Colliery Pit Top Layout

3.0 Noise Assessment Criteria

3.1 Construction Noise Assessment Criteria

The NSW EPA's Interim Construction Noise Guideline (ICNG) (EPA, 2009) recommends a construction noise management level (CNML) equivalent to the daytime rated background level (RBL) plus 10 dBA within standard hours (ie daytime) and RBL plus 5 dBA outside standard hours (ie evening and night-time). The ICNG also contains "highly noise affected" daytime CNMLs which are set at 75 dBA $L_{Aeq(15minute)}$.

For this assessment for the residences at Medway, or on Medway Road the minimum RBLs nominated in the EPA's Noise Policy for Industry (NPfI) will be assumed. For residences in New Berrima the measured long term average L_{A90} noise levels provided in the PRP-7 Response Report will be adopted as representative of RBLs for the nearest receivers. Accordingly, for Medway 35 dBA for the daytime, and 30 dBA RBLs for the evening and night-time will be adopted. For New Berrima the measured long term average L_{A90} noise levels at 12 Brisbane Street of 44 dBA for the daytime, and 42 dBA for the evening and night-time will be adopted.

As the Facility construction works would be limited to daytime only, the ICNG construction noise management levels are as presented in **Table 1**.

Table 1 Construction Noise Management Levels

Residences	Daytime CNML (noise affected) RBL plus 10 dBA [1]	Daytime CNML (highly noise affected)
Medway Residences	45	75
New Berrima Residences	54	

Notes: 1. ICNG - Recommended standard working hours: Monday to Friday: 7:00 am to 6:00 pm, Saturday 8:00 am to 1:00, no work on Sundays and Public Holidays.

3.2 Construction Vibration

The nearest residences to pipeline trench construction are typically 36 m, and the on site pond construction works are 460 m distant. Accordingly no vibration impacts are anticipated for the nearest residences.

3.3 Operational Noise Assessment Criteria

Operational noise from pumping operations will potentially impact on the Medway residences. The EPA's NPfI was released in 2017 and sets out the requirements for the assessment and management of operational noise from industry in NSW, and has been adopted. Similarly to the construction noise assessment the minimum RBLs nominated in the NPfI will be assumed for Medway and the surrounding rural areas, being 35 dBA for the daytime, and 30 dBA for the evening and night-time.

3.3.1 Project Intrusiveness and Project Amenity Noise Levels

The NPfI defines how to determine 'trigger levels' for noise emissions from industrial developments. Where a development is likely to exceed the trigger levels at existing noise sensitive receivers, feasible and reasonable noise management measures are required to be considered to reduce the impacts.

There are two types of trigger levels – one to account for 'intrusive' noise impacts and one to protect the 'amenity' of particular land uses:

- The intrusiveness of an industrial noise source is generally considered acceptable if the L_{Aeq} noise level of the source, measured over a period of 15-minutes, does not exceed the representative background noise level by more than 5 dB. Intrusive noise levels are only applied to residential receivers. For other receiver types, only the amenity levels apply.
- To limit continual increases in noise levels from the use of the intrusiveness level alone, the ambient noise level within an area from all industrial sources should remain below the recommended amenity levels specified in the NPfI for that particular land use.

For this assessment, the area surrounding the proposal is considered to be 'Rural' as per the NPfI definitions.

3.3.1.1 Project Noise Trigger Levels

The NPfI recommended amenity noise level and minimum RBLs for a rural area are presented in **Table 2.** The associated trigger levels for industrial noise from the proposal are also summarised in **Table 2**. The Project Noise Trigger Levels (PNTL) are the most stringent of the intrusiveness and amenity trigger level for each period and are highlighted below.

Table 2 Project Noise Trigger Levels

Receiver Type	Period	Amenity Noise Level $L_{Aeq(period)}$ (dBA)	NPfI Minimum RBLs [1] (dBA)	Project Noise Trigger Levels $L_{Aeq(15minute)}$ (dBA)	
				Intrusiveness	Amenity[2,3]
Residential	Daytime	50	35	**40**	48
	Evening	45	30	**35**	43
	Night-time	40	30	**35**	38

Notes: 1. RBL = Rating Background Level.

2: The recommended amenity noise levels have been reduced by 5 dB, where appropriate, to give the project amenity noise levels due to other sources of industrial noise being present in the area.

3: The project amenity noise levels for residences have been converted to a 15-minute level by adding 3 dB, as outlined in the NPfI..

4.0 Construction Noise Assessment

A computer model was developed in order to predict noise emissions from the construction of the proposed pipeline system. The noise modelling was undertaken using SoundPlan v8.2 software developed by Braunstein and Berndt Gmbh in Germany, using the Concawe algorithm for predicting noise. The noise modelling takes into account source sound power level emissions and locations, screening effects, receiver locations, ground topography and noise attenuation due to spherical spreading and atmospheric absorption. The model used 1 m terrain data provided by GIS.

The potential impacts have been determined by comparing the predicted noise levels to the NMLs in a 15-minute assessment period.

4.1 Modelling Scenarios and Sound Power Levels

As outlined in **Section 2.0** construction works would involve civil works for the pond construction at the pit top, and trench construction and road under boring for the pipeline installation. The significant noise generating stages or scenarios are summarised as follows:

- Scenario 1 – Pond Construction and works at the existing pit top. These works will impact on Medway residences;
- Scenario 2 – Pipeline construction between the pit top and the Berrima Cement Works. The pipeline construction will impact on residences along, and near the route; and
- Scenario 3 – Pipeline under road boring construction at Liebman Road, at Medway Road adjacent to the Oasis Function Centre access road, and at the Old Hume Highway.

Construction equipment for these scenarios have been determined and these are presented in **Appendix B** with the associated equipment sound power levels (SWL) used in the modelling. The assessment uses 'realistic worst-case' scenarios to determine the impacts from the noisiest 15-minute period that is likely to occur for each work scenario, as required by the ICNG.

4.1.1 Working Hours

The works would be undertaken during Standard Construction Hours, as outlined in the ICNG. These are:

- 7.00 am to 6.00 pm Monday to Friday
- 8.00 am to 1.00 pm on Saturdays
- No work on Public Holidays or Sundays.

It is not expected that there would be any requirement for works during evening or night-time periods.

4.2 Construction Noise Impact Residential Receivers

The results of construction noise predictions are presented in **Table 4** to **Table 6** , and to assist assessment of construction noise impacts, consideration of subjective classifications of exceedances as presented in **Table 3** is used.

Table 3 Exceedance Bands and Impact Colouring

Exceedance of NML	Subjective Classification	Impact Colouring
No exceedance	**None**	
1 to 5 dB	Noticeable	
6 dB to 15 dB	Clearly Audible	
16 dB to 25 dB	Moderately Intrusive	
>25 dB	Highly Intrusive	

4.2.1 Scenario 1 – Pond Construction

The nearest receivers to the pond construction bulk earthworks are located in Medway on Railway Parade. Predicted noise levels for the nearest residences (10 to 18 Railway Parade), typical residences (32-34 Railway Parade, and 492 to 506 Medway Road), and distant residences (e.g. 477 Medway Road) are presented in **Table 4**.

Table 4 Scenario 1 - Predicted Daytime Construction Intrusive Noise Levels

Receiver	Daytime Project Specific NML	Predicted $L_{Aeq(15minute)}$ Noise Level
Medway Residences: 10 to 18 Railway Parade	45	55
Medway Residences: 32 to 34 Railway Parade; 492 to 506 Medway Road		47 to 51
Medway Residences: 477 Medway Road		45

4.2.2 Scenario 2 – Pipeline Construction

The nearest receivers to the pipeline route are on Railway Parade, with the route adjacent to, and north of Railway Parade. Other Medway receivers are further distant and located on Medway Road. A third group of receivers are located in the rural area between Medway and the Berrima Cement Works, with the nearest typically 50 m from the pipeline route. Receivers in New Berrima are located typically 350m from the pipeline route.

Accordingly noise levels have been predicted at distances normal to the pipeline route for the following grouping:

- Receiver Group 1 – 20 to 40 Railway Parade, typically 38 m from the pipeline;
- Receiver Group 2 – 478 to 502 Medway Road, typically 120 m from the pipeline; and
- Receiver Group 3 – Nearest rural receivers, typically 50 m from the pipeline
- Receiver Group 4 – New Berrima receivers, typically 350 m from the pipeline

Predicted noise levels for these receiver groupings are presented in **Table 5**.

Table 5 Scenario 2 - Predicted Daytime Construction Intrusive Noise Levels

Receiver	Daytime Project Specific NML	Predicted $L_{Aeq(15minute)}$ Noise
Receiver Group 1 Medway 20 to 40 Railway Parade	45	69
Receiver Group 2 Medway Receivers typically 120 m	45	54
Receiver Group 3 Rural Typically 50 m	45	65
Receiver Group 4 New Berrima	54	41

4.2.3 Scenario 3 – Under Road Pipeline Construction

Underground road pipeline construction is proposed at three locations, being Liebman Road, the Oasis Function Centre access road, and at the Old Hume Highway. Residences are located nearby at the Liebman Road, with the nearest being 334 Medway Road at 120 m, and 'Panawanica' 298 Medway Road at 250 m.

Predicted noise levels for these receiver groupings are presented in **Table 6**

Table 6 Scenario 3 - Predicted Daytime Construction Intrusive Noise Levels

Receiver	Daytime Project Specific NML	Predicted $L_{Aeq(15minute)}$ Noise
Receiver 1 334 Medway Road	45	58
Receiver 2 298 Medway Road	45	50

4.2.4 Discussion

Construction noise impacts are summarised as follows:

- Pond construction will result in clearly audible exceedances of the NMLs of up to 10 dB at the nearest Medway residences, and generally lower exceedances of up to 6 dB at the remaining Medway residences.
- Pipeline Construction will result in moderately intrusive noise levels, which exceed the NMLS by up to 24 dB at the nearest receivers which are typically 20 m to 40 m from the pipeline route. These are a direct result of the close proximity to the works. Other receivers at typically 120 m from the pipeline result in clearly audible exceedances of the NMLs of up to 9 dB. These exceedances would be present for up to 5 days as the works pass the residences. No exceedances are expected at New Berrima residences.
- Under road pipeline construction will result in a clearly audible noise level at the nearest receiver, and an audible noise level at other nearby receivers. These exceedances would be present for typically one day as the underground pipeline is bored.

In accordance with the ICNG, whilst the predicted noise levels exceed the NMLs at a number of receivers, they are below the 75 dBA 'highly noise affected' noise level. Accordingly Boral should adopt the Standard Mitigation Measures of **Section 4.4**. These include Boral liaise with impacted residents and provide advanced notice of the impending works, the duration of construction activities, particularly when the pipeline trenching will pass each affected resident.

4.3 Construction Vibration

As outlined in **Section 3.2** the nearest residences to trench construction are typically 36 m, and potential vibration equipment is a 10 tonne excavator, and 12- 15 tonne trucks. Accordingly no vibration impacts would occur from construction activities.

4.4 Standard Mitigation

The standard mitigation measures are provided in **Table 7** and should be applied where feasible and reasonable to minimise the impacts from the works as far as practicable.

Table 7 Recommended Standard Mitigation and Management Measures

Action Required	Applies To	Details
Management Measures		
Provide a Construction Environmental Management Plan (CEMP)	Airborne noise	The CEMP should identify affected residents and document any specific noise management solutions to be incorporated during the construction phase.
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required.
Implement community consultation or notification measures.	Airborne noise	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule period, any operational noise benefits from the works (where applicable) and contact telephone number. Where possible, notifications should be given well in advance of works (3 to 6 months) and should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Website (If required) Contact telephone number for community Email distribution list (if required) Community drop in session (if required by approval conditions).
Site inductions	Airborne noise Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • all project specific and relevant standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Source Controls		
Construction hours and scheduling.	Airborne noise Ground-borne noise & vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Equipment selection.	Airborne noise	Use quieter and less vibration emitting construction methods where feasible and reasonable. Ensure plant including the silencer is well maintained.

Action Required	Applies To	Details
Plant noise levels.	Airborne-noise	Noise generating equipment will be regularly checked and effectively maintained, including checking of hatches/enclosures regularly to ensure that seals are in good condition and doors close properly against seals
Use and siting of plant.	Airborne-noise	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise.	Airborne noise	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible.
Reduced equipment power	Airborne noise	Use only the necessary size and power
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise	Compounds and worksites will be designed to promote one-way traffic and minimise the need for vehicle reversing. Where practicable, work compounds, parking areas, and equipment and material stockpiles will be positioned away from noise-sensitive locations and take advantage of existing screening from local topography. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Path Controls		
Shield stationary noise sources such as generators, pumps, compressors, fans etc.	Airborne noise	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities.	Airborne noise	Where practicable, work compounds, parking areas, and equipment and material stockpiles will be positioned away from noise-sensitive locations and take advantage of existing screening from local topography.

5.0 Operational Noise Assessment

The SoundPlan v8.2 computer model developed for construction activities has been used to predict operational noise. Predictions were based on the CONCAWE method.

The potential impacts have been determined by comparing the predicted noise levels to the PNTLs in a 15-minute assessment period.

5.1 Modelling and Sound Power Levels

As outlined in **Section 2.0**, the above ground noise generating equipment consists of a 45 kW pump housed in an enclosure assumed to be constructed of colourbond steel or equivalent.

Sound power levels of noise producing equipment shown in **Table 8** are typical of currently available equipment. All equipment is assumed to be in operation for the entire period, with 15-minute and period noise data identical.

Table 8 Equipment Sound Power Levels

Qty	Item	Overall Sound Power Level (SWL), L_{Aeq} 15 min, dBA
1	45 kW pump	84

5.2 Weather Conditions

Certain weather conditions can increase noise levels by focusing noise towards receivers. Noise-enhancing weather conditions can occur where wind blows from the source to the receiver, or where temperature inversions occur.

The NPfI defines ‘standard’ and ‘noise-enhancing’ weather conditions as shown in **Table 9**. Noise-enhancing weather should be included in the assessment where they occur for more than 30% of the daytime, evening or night-time period in any season.

Table 9 Standard and Noise-Enhancing Weather Conditions

Weather Conditions	Meteorological Parameters
Standard	Daytime/evening/night-time: stability categories A–D with wind speed up to 0.5 m/s
Noise-enhancing	Daytime/evening: stability categories A–D with light winds up to 3 m/s

The NPfI contains guidance for determining prevailing weather conditions. Based on previous analysis of weather conditions conducted in the southern highlands of NSW noise-enhancing weather conditions are expected to be a feature of the proposal site.

Accordingly to provide a conservative assessment, a source to receiver wind has been adopted for all receivers and it is assumed that a temperature inversion (Stability Class F) condition can also occur during the night time period. Standard and noise enhancing weather conditions have been adopted for the assessment as shown in **Table 9**.

5.3 Predicted Operational Noise Levels

A summary of the predicted operational noise assessment at the nearest Medway receiver(s) to the south-east of the proposal is shown in **Table 10**. These predicted levels are compared to the PNTLs to determine the potential for noise impacts.

Table 10 Industrial Noise Assessment

Receiver	Project Noise Trigger Level $L_{Aeq(15minute)}$ (dBA)			Predicted Noise Level[1] $L_{Aeq(15minute)}$ (dBA)		Compliant?
	Day (D)	Evening (E)	Night (N)	Standard (D/N)	Noise Enhancing (D/N)	
Medway Residences Railway Parade	40	35	35	15 / 15	17 / 17	Y

Notes 1. The same noise levels are predicted for the evening and night-time period.

5.3.1 Discussion

Operational noise from the above ground pump operation clearly complies with the Project Noise Trigger Levels at the nearest receivers.

6.0 Conclusion

SLR has been engaged to assess the potential construction and operational noise emissions from the proposed Boral Colliery Water Treatment and Pipeline.

The report's findings are summarised as follows:

- Construction noise criteria (NMLs) has been set in accordance with the NSW EPA's Interim Construction Noise Guideline. Operational noise criteria (Project Noise Trigger Levels) have been set in accordance with the NSW EPA's Noise Policy for Industry.
- Pond construction will result in clearly audible exceedances of the NMLs of up to 10 dB at the nearest Medway residences, and generally lower exceedances of up to 6 dB at the remaining Medway residences.
- Pipeline Construction will result in moderately intrusive noise levels, which exceed the NMLS by up to 24 dB at the nearest receivers which are typically 20 m to 40 m from the pipeline route. Other receivers at typically 120 m from the pipeline result in clearly audible exceedances of the NMLs of up to 9 dB. As the pipeline construction moves along the route, works will affect nearby residences by typically up to 5 days. No exceedances are expected at New Berrima residences.
- Under road pipeline construction will result in a clearly audible noise level at the nearest receiver, and an audible noise level at other nearby receivers. These exceedances would be present for typically one day as the underground pipeline is bored.
- Operational noise from the above ground pump operations at the colliery pit top complies with the Project Noise Trigger Levels at the nearest Medway receivers.

7.0 Feedback

At SLR, we are committed to delivering professional quality service to our clients. We are constantly looking for ways to improve the quality of our deliverables and our service to our clients. Client feedback is a valuable tool in helping us prioritise services and resources according to our client needs.

To achieve this, your feedback on the team's performance, deliverables and service are valuable and SLR welcome all feedback via https://www.slrconsulting.com/en/feedback. We recognise the value of your time and we will make a $10 donation to our Charity Partner - Lifeline, for every completed form.

Appendix A Acoustic Terminolgy

Boral Colliery Water Treatment and Pipeline

Construction and Operational Noise Assessment

Boral Cement Limited

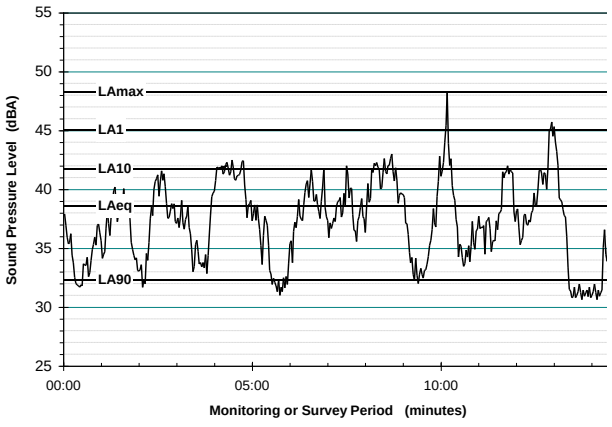
SLR Project No.: 610.03211.00001

8 November 2024

This Report makes repeated reference to certain noise level descriptors, in particular the L_{A10}, L_{A90} and L_{Aeq} and L_{Amax} noise levels.

- The L_{A10} is the A-weighted sound pressure level exceeded 10% of a given measurement period and is utilised normally to characterise typical maximum noise levels.
- The L_{Aeq} is essentially the average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound over the same measurement period. Intrusive noise is assessed over 15 minutes using the $L_{Aeq(15min)}$. The $L_{Aeq(period)}$ is the measurement parameter used to describe the average sound level over the period. For daytime the period is 7 am to 6 pm, for evening 6 pm to 10 pm, and for night-time 10 pm to 7 am. The Sydney Airport curfew is 11 pm to 6 am.
- The L_{A90} noise level is the A-weighted sound pressure level exceeded 90% of a given measurement period and is representative of the average minimum background sound level (in the absence of the source under consideration), or simply the "background" level.
- The L_{Amax} is simply the maximum noise level and is often represented by the $L_{A1(1min)}$, being the level exceeded 1% of 1 minute, ie the noise level exceeded for 0.6 of a second.

Graphical Display of Typical Noise Indices



Typical Noise Levels

The following table presents examples of typical noise levels.

Typical Noise Levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130 120 110	Threshold of pain Heavy rock concert Grinding on steel	Intolerable Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerb side of busy street Loud radio or television	Loud
60 50	Department store General Office	Moderate to Quiet
40 30	Inside private office Inside bedroom	Quiet to Very quiet
20	Unoccupied recording studio	Almost silent

A-Weighting or dBA Noise Levels

The overall level of a sound is usually expressed in terms of dBA, which is measured using the "A-weighting" filter incorporated in sound level meters. These filters have a frequency response corresponding approximately to that of human hearing. People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the "loudness" of that sound. Different sources having the same dBA level generally sound about equally as loud, although the perceived loudness can also be affected by the character of the sound (eg the loudness of human speech and a distant motorbike may be perceived differently, although they are of the same dBA level).

Sensitivity of People to Noise Level Changes

A change of up to 3 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corres`s to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness.

Appendix B Construction Scenarios and Equipment Sound Power Levels

Boral Colliery Water Treatment and Pipeline

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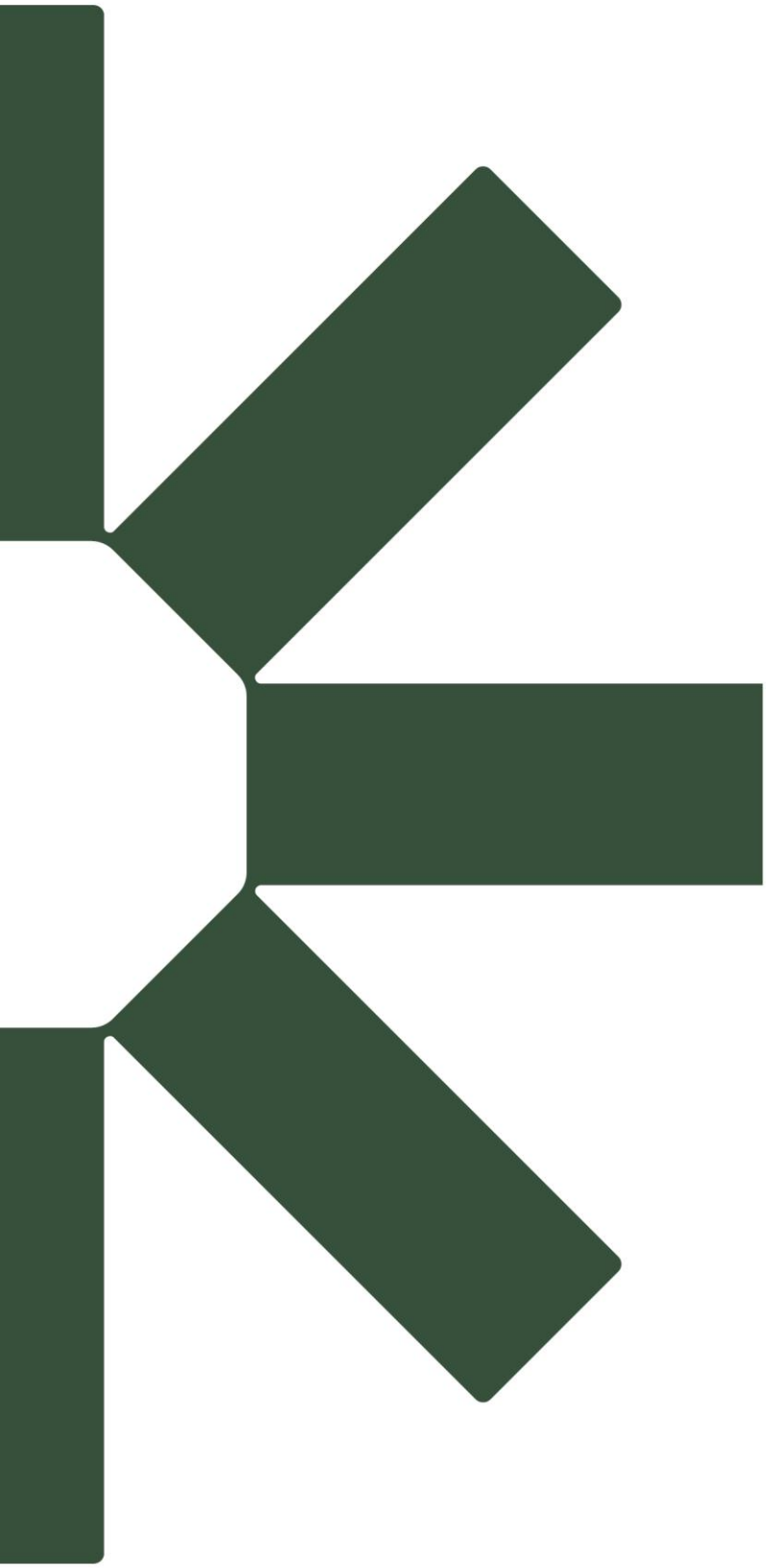
Table A-1: CONSTRUCTION NOISE MODELLING SCENARIOS

Construction Component	Construction Period	Equipment Involved at each Work Site	Number of Items
Pond Construction	Daytime	Dozer 20 tonne excavator FEL Bobcat 12-15t Trucks Concrete trucks Concrete agitator	1 1 1 1 1 1 1
Pipeline Construction	Daytime	10 tonne excavator Bobcat 12-15t truck Telehandler (pipe handling) Generator Hand tools Light vehicle	1 1 1 1 1 2 2
Pipeline road under boring	Daytime	Horizontal air hammer drill 12-15t truck Hand tools	1 1 2

A-2: Equipment Sound Power Levels

Facility Construction Equipment	Overall SWL $L_{Aeq(15minute)}$ (dBA re 1ρW)
Dozer	116
20 tonne excavator	105
10t excavator	100
FEL	112
Bobcat	104
12-15t Trucks	108
Concrete trucks	109
Telehandler (pipe handling)	92
Generator	101
Hand tools	94
Light vehicle	103
Horizontal air hammer drill	111



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