Appendix C

Updated table of proposed mitigation measures

C.1 Updated table of mitigation measures

Table C.1 - Revised environmental management measures

Aspect	Environmental management measure	Revised environmental management measures
Noise	Preliminary mitigation options targeting the main operational noise sources at the site have been considered in a mitigation decision making matrix (Table 9.1 of Appendix E of MOD2). Mitigation strategies have been considered in the following hierarchical approach: • control of noise at the source; • once the feasible and reasonable controls at the source are exhausted, controlling the transmission of noise; and • once source and transmission feasible and reasonable controls are exhausted, considering mitigation measures at the noise sensitive receivers.	
	It is anticipated that all the feasible and reasonable noise mitigation measures identified in the mitigation decision making matrix (Table 9.1 of Appendix E MOD2) will be adopted. These include: • rail load out improvements, which could be in the form of new/improved enclosure, engineering design solutions to reduce noise emissions from coal leaving bin and entering wagons (or a combination of any of these); • noise suppression kit for dozer or new dozer; • noise suppression kit for FEL or new FEL; • improvements to screen/sizer and elevator enclosures; and • extend existing 6 m high rail barrier further north to the rail loadout bin.	Additional reasonable noise mitigation measures have been developed by Wollongong Coal, these include: • relocation of the size/screening equipment underground; and • Extension of the Wongawilli lower pit top noise wall.
	The implementation of all noise mitigation measures proposed will require significant operational planning, engineering design and, in some cases, significant capital investment.	
	WWC will require an appropriate timeline to coordinate and implement all these measures.	
	Based on the results table, the predicted noise levels at each assessment location are estimated to reduce by 3-8 dB at most assessment locations, compared to predicted noise levels from approved operations. Indicative noise contours including mitigation measures are provided in Figure 9.1 and Figure 9.2 of Appendix E. It is noted that noise contours do not include the applicable LFN modifying factor. The residual noise impact categorisations, after the implementation of feasible and reasonable mitigation measures, are displayed spatially in Figure 9.3 of Appendix E, showing a significant reduction in the number of properties predicted to be significantly impacted by the Wongawilli Colliery operational noise compared to approved operations.	

Air quality	The Colliery as approved currently has numerous mitigation and management measures in place to reduce potential air quality impacts.	In consideration of submissions raised in regard to MOD2 Wollongong Coal propose to implement the following mitigation measures, in addition to those proposed in MOD2 and established within the AQGHGMP, to further reduce the relatively minor GHG emissions proposed by MOD2: • Equipment sourced to support the development of MOD2 is to be selected taking into consideration GHG emission production potential. • Source fuels which represent the lowest GHG emission potential. • Investigate the utilisation of renewable energy to support mining activities to reduce GHG emissions associated with electricity consumption of operations. • Tenders to provide equipment and or services to Wollongong Coal will including a weighting in which GHG emissions are to be considered, by means of supplier policy and or proximity to the Wongawilli.
	The Colliery operates under the Air Quality and Greenhouse Gas Management Plan (AQGHGMP) to ensure all personnel undertaking works at the Colliery understand their responsibility to manage air quality.	
	The mitigation and management measures as described within the AQGHGMP would continue to be implemented as part of MOD2.	
Surface water	Water management is currently documented in the Surface Water Management Plan (SWMP) (Wollongong Coal 2019a). Management of wastewater and greywater is documented in the Integrated Wastewater Management Plan (IWMMP) (Wollongong Coal 2019b).	
	The SWMP details the surface water monitoring program and Trigger Action Response Plan (TARPs) necessary to identify and respond to potential surface water impacts associated with the Wongawilli Colliery operations. The water monitoring program and TARPs detailed in the SWMP have been developed to ensure that the Wongawilli Colliery complies with the EPL 1087 LDP conditions.	
	The SWA recommends the following further measures: • the surface water quality monitoring program for the Lake Avon catchment is recommenced and continued for the duration of the colliery's operation; • water quality monitoring is undertaken in the tributary of Robins Creek downstream of the overflow point from the Mine Dam; • field water quality monitoring is undertaken each month and/or following overflow events; • sampling and laboratory water quality analysis is undertaken at least at six-monthly intervals;	Downstream turbidity water quality monitoring will be included as a revised environmental management measure as part of MOD2. The results from the downstream turbidity water quality monitoring will be included into the updated surface water management plan for Wollongong Coal post MOD2 approval.

	• water quality parameters to be monitored should comprise: • pH, EC, DO and temperature during field analysis; and • total alkalinity, total dissolved solids, sulphate, total metals, total phosphorous and total nitrogen via laboratory analysis; • metering of pumped volumes from key water storages is undertaken including transfer from the Mine Dam and Pond C; and • outcomes of the surface water monitoring program to be reported in the Wongawilli Colliery Annual Review reports, in accordance with the SWMP (Wollongong Coal 2019). The above measures will provide an improved understanding of the potential water quality impacts to Robins Creek associated with the Wongawilli Colliery.	•
Subsidence	Fit-for-purpose or low-height machinery such as a suitably designed road-header is recommended to manage variable mining conditions and achieve a satisfactory level of productivity. The use of such machinery is recommended for excavation of the shale material in the mid-steam split of the Bulli Seam over the first approximately 1500 m of the NW Mains, the immediate roof strata of the Bulli Seam and the stone driveages to access the Wongawilli Ventilation Shaft 1.	• Development and implementation of a subsidence monitoring and response program following approval of MOD2. Including the update of any associated TARPs to ensure that the notification of relevant agencies should water inflows significantly increase during operations. • Wollongong Coal will review and update existing operational control plans to address the potential for inrush, prior to developing the roadways beneath the reservoir. The contingency plan will be developed in accordance with the NSW Code of Practice: Inundation and inrush hazard management (NSW Department of Trade and Investment, Regional Infrastructure and Services).
	Drill ahead strategies to confirm the presence of coal on the other side of dykes are recommended to manage the vertical alignment of the belt road in the areas above secondary extraction in the Wongawilli Seam.	
	Some areas above secondary extraction in the Wongawilli Seam will likely require meshing and additional rib support to control roadway width. A program of monitoring and response is recommended to match the support requirements to the strata and stress conditions.	
	Staying above the existing Bulli Seam workings in the area close to the Wongawilli Ventilation Shaft 1, to avoid all the legacy issues associated with mining through old workings. This approach will ensure that: • there would be no need to intersect the existing Bulli Seam workings which are old, low height and relatively poorly supported; • the shaft could be back filled to above the Bulli Seam and sealed to prevent circulation loss into existing workings in the Bulli Seam and Wongawilli Seam; and • waste rock material from the stone driveages could be disposed of into the shaft.	

	A precautionary approach is recommended to manage the potential for inflows from the Avon Lake Reservoir into the proposed four roadways of the NW Mains. The strategy considered most effective to manage the potential for inflows involves being able to drill ahead in the Bulli Seam through the dyke and below the base of Avon Lake Reservoir. This approach would confirm there are no zones of increased hydraulic conductivity that would lead to high potential inflows into the underground roadways from the reservoir.
Biodiversity	The BDAR recommends reducing impacts on biodiversity values within the study area by avoiding and/or minimising the removal of native vegetation and fauna habitat. Steps undertaken to avoid and minimise impacts to biodiversity are broken down into site selection and planning, construction and operation phases of the proposed modification. **Site selection and planning** The location of the proposed conveyor to be installed is necessary to connect the conveyor portal to the existing infrastructure at the Wongawilli Colliery. The reutilisation of infrastructure at the Wongawilli Colliery minimises impacts to native vegetation and flora and fauna habitats present within the broader study area, by avoiding construction of completely new infrastructure. ***Construction*** Mitigation measures recommended to avoid and minimise further indirect impacts to vegetation and habitat during the construction phase of the proposed works include: • installation of appropriate exclusion fencing around trees and vegetation to be retained in the study area; • installation of appropriate signage such as 'No Go Zone' or 'Environmental Protection Area'; • identification of the location of any 'No Go Zones' in site inductions and a Construction Environmental Management Plan (CEMP); • all material stockpiles, vehicle parking and machinery storage will be located within cleared areas or areas proposed for clearing, and not in areas of native vegetation that are to be retained; • prosed hollow-bearing tree to be removed should be placed in the area of retained vegetation to provide additional fauna habitat; • removal of the hollow-bearing tree should be supervised by a qualified ecologist; • where appropriate native vegetation cleared from the subject land should be mulched for re-use on the site, to stabilise bare ground; • wet down areas to reduce dust generation during construction; and • implementation of temporary stormwater controls during construction and to ensure that discharges to the drainage channels are consistent with existing conditions; guidelines, should be maintained throughout the construction period and should be carefully removed following the completion of works.

Table ES1 outlines detailed mitigation measures to be undertaken by Wollongong Coal in order to minimise any impacts to potential threatened microbats utilising the old gantry and tumbler house or the existing mine tunnel entrance, as a result of works associated with the proposed modification.

The following measures are recommended for impacts associated with the construction of coal conveyor adjacent to a potential roosting and breeding structures for threatened microbats:

Table ES1 Impact management and mitigation strategies for the old gantry and tumbler house structures

Impact	Environmental mitigation strategies	Timing	Responsibility
Construction of coal conveyor adjacent to a Potential roosting and breeding structures for threatened microbats	A microbat survey is to be undertaken during the day prior to the commencement of construction of the proposed conveyor. All potential habitat is to be inspected to confirm if microbats are present.	Pre construction	Project Ecologist, Environmental Manager
	A detailed schedule of management, monitoring and mitigation measures specific to the construction phase of the project will be implemented in the CEMP.	Pre construction	Project Ecologist, Environmental Manager
	Appropriate noise barriers are to be installed between the proposed conveyor and the old gantry and tumbler house before the start of construction, ensuring not to impede movement of microbats in and out of the structure.	Pre construction	Environmental Manager, Contractors

It will be ensured that any staff that are required to undertake works within the vicinity of the structure are briefed on the importance of minimising disturbance to the structure and any potential resident microbats.	Pre construction	Environmental Manager, Site Foreman, Contractors
Any necessary lighting required for the proposed works will be directed away from the structures, and designed such that light spill does not occur within retained vegetation.	Construction	Environmental Manager and Contractors
Wollongong Coal will maintain appropriate exclusion zones around the structures, and manage any night works by ensuring noise and light pollution is kept to a minimum, particularly through the breeding and lactation period (October and March) in the vicinity of the identified microbat habitat.	Construction, operation	Environmental Manager, Contractors
If it is identified that bats are present in torpor within the structure, fortnightly winter monitoring should be conducted during any upgrades or maintenance works to ensure that over-wintering	Construction, operation	Project Ecologist

	roosting colonies are not being adversely impacted.		
	Unexpected finds and stop works procedures are to be implemented if microbats are observed exiting the structure during construction.	Construction	Environmental Manager and Site Foreman
	Any permanent lighting required for operation of the proposed conveyor will be designed to be directed away from, and avoid light spill into, the structure and any retained vegetation.	Operation	Environmental Manager
	Permanent noise barriers will be constructed between the conveyor and the microbat structure, to minimise noise or vibration disturbance to resident microbats.	Operation	Environmental Manager
	The structure will be designated as a permanent no-go zone to avoid disturbance to microbats from increased foot traffic in the vicinity.	Operation	Environmental Manager
Reutilisation of the existing mine tunnel entrance that provides potential roosting and breeding habitat for	A pre-clearance survey is to be undertaken during the day in September or October, when individuals from all microbat species concerned would have returned to their breeding habitat prior to the	Pre-construction	Project Ecologist, Environmental Manager

	threatened microbats	breeding season. All areas with the potential to support microbat habitat within the existing mine tunnel entrance will be inspected. **If threatened microbats are not located during preclearance** All potential habitat found not to support microbats during pre-clearance surveys and considered likely to be impacted by the proposed works is to have temporary exclusion measures installed to prevent microbats from moving in before works begin. These measures are to be installed immediately following the pre-clearance survey, to ensure microbats do not move into the habitat overnight. Exclusion measures may include: • thick tape (such as bitumen tape) or plywood installed over habitat; • expanding foam to remove cracks and gaps that may beutilised by microbats; and • sealing of all side entrances that connect the existing tunnel to other inactive sections of the adit system, including the old

	gantry and tumbler house. Sealing off of these entrances will ensure that microbats are able to continue utilising inactive adit structures, without exposure to works within the exiting tunnel entrance. Exclusion measures are to be confirmed sufficient and effective by a qualified ecologist prior to works beginning. Any habitat not considered likely to be impacted by the works, for example permanently unused sections within the adit system are to remain available to any displaced microbats. This will include the installation of bat-friendly gates at any entrances to the system available to microbats. A detailed schedule of management, monitoring and mitigation measures specific to the construction phase of the project will be implemented in the CEMP. **If non-breeding threatened microbats are located during preclearance** If microbats are found to be present in the existing tunnel	

		entrance during the pre-clearance inspection, but are not likely to be utilising the structure as a maternity roost (ie no evidence of pregnant or lactating females) then temporary exclusion measures are to be installed overnight once the bats have left the roost to forage. Planned roost exclusion can only be conducted outside the breeding season (October – March) and over wintering time (mid-May to August) under the supervision of a qualified ecologist to ensure all microbats have vacated the roost. The following safeguards must be considered to minimise potential impacts to displaced bats: • ensure that this procedure is not conducted during an extensive dry period (drought) as this could be detrimental and lead to mortality, if there is no nearby suitable habitat; and • avoid conducting this procedure during windy, fullmoon, cold or rainy nights (ie >20 mm in 24 hours), as there is a low	

likelihood of roost exodus.

The most beneficial timing for planned roost exclusion is in autumn (mid-April – early May) and the start of spring (September). This would avoid both the breeding and overwintering period for microbats. If works and exclusion of roosting bats are required during the overwintering months (mid-May to August), when many culvert roosting bats enter torpor (hibernation state), the following additional safeguards must be adhered to:

- nocturnal monitoring of roost activity is to be undertaken by a qualified ecologist, and bats must be confirmed as leaving the roost to forage on at least two separate occasions prior to installation of exclusion measures.
- if bats are not confirmed as leaving the roost to forage (ie. in winter torpor) additional monitoring is to be undertaken until regular foraging has resumed; and
- works are not to impact upon the tunnel with bats

present in winter torpor.

Additional safeguards that must be considered when exclusion devices are installed include:

- all roost exclusion should be done after dusk, once individuals have emerged to feed and an ecologist is satisfied no microbat individuals remain within the roost; and
- roosting habitat that has been sealed must be regularly monitored to ensure the sealing mechanism remains intact and no microbats are able to utilise the habitat.

If it is suspected that the exclusion mechanism has failed, then an ecologist must re-inspect the habitat before the seal is reapplied.

Alternative roosting habitat should be made or left available wherever possible when undertaking passive roost exclusion.

If breeding threatened microbats are located during preclearance

Although unlikely, if threatened microbats are

	found to be present in the existing tunnel entrance during the preclearance survey and appear to be in breeding condition (ie. pregnant or lactating females, presence of young), any use of the tunnel will be immediately postponed, and appropriately qualified ecologists will be consulted to determine the most appropriate steps to be taken. Appropriate approval authorities would also be notified. Maternity roosts are considered habitat critical to the survival of these species.			
	Reports are to be provided outlining the findings of preclearance assessments and detailing the exclusion measures installed and procedure (if required).	All works	Project Ecologist	
	Unexpected finds and stop works procedure are to be implemented if microbats are observed within the existing tunnel during works	Construction operation	Site Foreman, Environmental Manager and Project Ecologist	
Operations	The following recommendations are made to avoid impacts resulting from 'operation' of the proposed works: any lighting required around the facility should point towards the development and not into surrounding vegetated areas. on-going treatment of exotic species from within retained vegetation should be undertaken to assist vegetation resilience and quality.			Wollongong Coal will review and update the existing operation controls to address the potential for inrush and inundation, prior to developing roadways in the NWMD, beneath the Lake Avon Reservoir.

Historic heritage	The following mitigation measures will be implemented to minimise potential impacts to historic heritage sites associated with the proposed modification. **i) Archival recording** A digital photographic archival recording of the Wongawilli pit top part of the study area will be undertaken prior to any works occurring. This is in accordance with Policy 12 of the CMP. The archival recording will comply with the NSW Heritage Council guidelines *How to Prepare Archival Records of Heritage Items and Photographic Recording of Heritage Items Using Film or Digital Capture 2006.* **ii) Protection of Dumper House (B4)** The existing fencing surrounding the Dumper House will be marked with high visibility bunting to further protect it from any possible damage during the construction of the new conveyor. This is in accordance with Policy 5 of the CMP. **iii) Unexpected finds procedure** Any relics discovered during the construction will trigger the implementation of Wollongong Coals unexpected find procedure. Work in the vicinity of the any unanticipated relic would cease and an archaeologist will be contacted to make a preliminary assessment of the find, including notification to the Heritage Council, if required.	
Aboriginal heritage	The study area has been assessed as being of low potential for identification of any Aboriginal archaeological sites, however, it is recommended in the unlikely event an item or items of Aboriginal historical significance should be discovered during the course of development the following protocols be followed: **Recommendation 1:** No further archaeological assessment is required – No further archaeological work is required in the study area due to the entire study area being assessed as having low archaeological potential. **Recommendation 2:** Discovery of unanticipated Aboriginal objects – All Aboriginal objects and places are protected under the *National Parks and Wildlife Act 1974* (NPW Act). It is an offence to knowingly disturb an Aboriginal site without a consent permit issued by the Heritage NSW, Department of Premier and Cabinet (Heritage NSW). Should any Aboriginal objects be encountered during works associated with this proposal, works must cease in the vicinity and the find should not be moved until assessed by a qualified archaeologist. If the find is determined to be an Aboriginal object the archaeologist will provide further recommendations. These may include notifying the Heritage NSW and Aboriginal stakeholders. **Recommendation 3:** Discovery of Aboriginal ancestral remains – Aboriginal ancestral remains may be found in a variety of landscapes in NSW, including middens and sandy or soft sedimentary soils. If any suspected human remains are discovered during any activity you must: Immediately cease all work at the location and not further move or disturb the remains. Notify the NSW Police and Heritage NSW's Environmental Line on 131 555 as soon as practicable and provide details of the remains and their location.	Develop an AHMP, subject to ongoing consultation with RAPs and Heritage NSW, the following: • Heritage inductions for all employees, contractors and sub-contractors working in the study area. • Procedures to minimise and manage the impacts of the project on heritage items within the study area, such as baseline recording and monitoring. • Procedure to protect Aboriginal heritage sites outside the project disturbance area. • Contingency plan if Aboriginal heritage items outside the approved disturbance area are damaged. • Procedure to follow for conducting further archaeological and heritage assessments in any undisturbed areas where assessment has not been carried out. • Ongoing consultation with Aboriginal stakeholders regarding the management and conservation of Aboriginal cultural heritage throughout the operational life of the proposed development. • Maintaining and managing reasonable access for Aboriginal stakeholders to Aboriginal heritage items located within the study area throughout the operational life of the project.

	Not recommence work at that location unless authorised in writing by Heritage NSW. **Recommendation 4:** The proponent should continue to consult with RAPs about the management of Aboriginal cultural heritage sites within the study area through the life of the project.	• Procedure to follow in the event of the discovery of human remains. • Procedure to follow in the event of chance/unexpected Aboriginal finds. • Procedure to follow in the event of unexpected non-Aboriginal finds.
Groundwater		***Groundwater monitoring and reporting*** Groundwater monitoring and reporting will be undertaken in accordance with the GWMP. The monitoring program will include: • Manual groundwater level monitoring to be conducted for all monitoring bores; • Dataloggers installed within selected bores to gather temporal changes in water levels; • Data downloaded from the existing VWPs, pressure readings recorded and converted to groundwater elevations; and • QA/QC field data and stored within a central database. Groundwater quality sampling will be conducted to detect any changes in groundwater quality during and post mining. Baseline data have been collected from the existing bores, as presented in Appendix D of the SGIA. Sampling will include collection of field analytes of pH and EC on a quarterly basis, as well as annual sampling for laboratory analysis of a full suite of analytes to determine any changes in beneficial groundwater use (i.e. livestock drinking water). The full suite will include: • Physio-chemical indicators – pH, electrical conductivity, total dissolved solids; • Major ions – Na, K, Ca, Mg, Cl, SO4, F; • Total P; • Organics - NO3 and Total N; • Total alkalinity as CaCO3, HCO3, CO3; and • Dissolved metals Ag, Al, As, B, Ba, Cd, Co, Cu, Fe, Hg, Li, Mn, Mo, Ni, P, Pb, Sb, Se, Zn. Yearly reporting of the water level results from the monitoring network will be included in the Annual Review. The Annual Review will also identify if any additional monitoring sites are required,

or if optimisation of the existing monitoring sites should be undertaken.

Within the GWMP, proposed triggers for water level and water quality for the site compliance monitoring network will be documented. This will include establishment of triggers for EC and pH. The observed groundwater levels will also be reviewed against the model predictions on an annual basis. The trends will be reviewed by a suitably qualified and experienced hydrogeologist to determine potential adverse changes. The review will consider the impact of mining, and other factors that could result in declining water levels including climatic conditions and surrounding mining.

Swamp Monitoring

Swamp monitoring and reporting will be undertaken in accordance with the GWMP. Swamp monitoring will be conducted to capture natural water level fluctuations (such as responses to rainfall) and detect any potential water level impacts resulting from the Project.

Monitoring of the soil moisture and water level within swamp deposits will be conducted with a paired soil moisture probe and water level piezometer. The soil moisture probe will be installed to determine the moisture content of the swamp with probes at a 1 m depth with five sensors at 10, 30, 50, 70 and 90 cm below surface. It is recommended that the paired piezometers at the proposed monitoring sites be installed as close to the centre of the swamp, . Table 7 1 of the SGIA includes indicative locations, to be confirmed based on land accessibility and agreement with the regulatory authority.

Geological, Hydraulic and Geotechnical Investigations

The groundwater assessment utilises geological information to understand and characterize the groundwater regime. Over the life of the Project, additional geological data will be collected, including details on lithology, groundwater intersection and intersection of structures (i.e. faults and dykes). This information will be used to routinely update the site geological model. This information will be stored and made available as required for future groundwater investigations and/or updates to the model.

Packer testing will be conducted on the four proposed monitoring bores and VWP.

This will provide further hydraulic properties of the overlying sandstone and the Wongawilli fault and can be used to inform future groundwater investigations and model updates.

Mine Inflows and Groundwater Balance

Monitoring of mine inflow volumes into the Project area within ML1596 area will be undertaken on a monthly basis. Field water quality analysis will also be undertaken on a monthly basis, with full water quality analysis undertaken annually.

The objective of the monitoring is to provide an early indication of any groundwater mixing between the Triassic and Permian strata that might indicate a change in vertical connectivity. The monitoring program will include:

- Volumetric measurement of water pumped from the mining areas using flow meters or equivalent devices;
- Monitoring the quality of water pumped from the mining areas;
- Correlation of rainfall records (and catchments); and
- Monitoring of coal moisture content.

The mine water balance will be reported annually.

Model Updates

Every three years the validity of the model predictions will be assessed by comparing observed groundwater levels and mine inflows. If the comparison between observed and modelled data indicate significant deviation, an update to the groundwater model may be required.

Updates will include consideration of the limitations and recommended improvements as discussed in Section 3.5.4.3 of the SGIA

Private Bores

No impacts to landholder bores are predicted. If potential impacts are identified in future and mitigation measures are not feasible, 'make good' measures with affected land owners would be carried out that may include:

- Ensuring the bore owner has access to a similar quantity and quality of water for the water bore's authorised purpose by:
- Bore enhancement by deepening the bore or improving its pumping capacity;
- Constructing a new water bore; or

		• Providing a supply of an equivalent amount of water of a suitable quality by piping it from an alternative source. • Carry out a plan to monitor the water bore by undertaking periodic bore assessments.
Social	The proposed mitigation and management strategies for potential social impacts identified and outlined in the SIA are summarised below: • traffic and transport: – reduced hours of production on weekends and out of hours to mitigate road delays; – Council upgrades to Wongawilli Road (previously owned by the Colliery) to manage public safety from increased traffic; • historic heritage: – archival recording, high visibility bunting, and unexpected finds procedure to mitigate loss of historic heritage; • air quality: – dust suppression measures outlined in the AQIA to mitigate health impacts from expelled dust; • biodiversity: – actions to avoid or minimise impacts and offsetting one vegetation zone through the transfer and retirement of biodiversity credits or by paying into the BCT Offset Fund, to mitigate the loss of native species' habitats; • noise and vibration – reduce out of hours operation and mitigation measures outlined in noise assessment, to mitigate amenity impacts from noise and vibration.	