Independent Expert Scientific Committee
on Coal Seam Gas and Large Coal Mining Development

Advice to decision maker on Wambo Coal Mine South Bates Extension Modification Project

IESC 2017-085: Wambo Coal Mine South Bates Extension Modification Project (EPBC 2016/7816; State DA 305-7-2003 Mod 17) – Expansion

Requesting agency	The Australian Government Department of the Environment and Energy The New South Wales Department of Planning and Environment
Date of request	9 June 2017
Date request accepted	13 June 2017
Advice stage	Assessment

Summary

The proposed Wambo Coal Mine South Bates Extension Modification Project is located in the New South Wales Hunter Valley, a region with considerable current coal mining activities, and will incorporate nine new longwall panels. The proposed project is likely to cause groundwater drawdown in both the alluvial and Permian aquifers and alter surface water flows and flow regimes in North Wambo Creek. These changes could impact water levels in some private bores – although the exact number of impacted bores is unclear – as well as water availability for ecosystems which utilise groundwater and surface water. These impacts are predicted to occur due to mine dewatering and subsidence.

The environmental assessment provided by the proponent contains limited information about the quality of both surface water and groundwater at the proposed project site and contains no geochemical assessment. Assessment of the occurrence of, and potential impacts to, groundwater dependent ecosystems, and to surface water flow regimes due to fracturing of the streambed, is also limited, with further assessment and interpretation needed.

A full appraisal of the groundwater model was not possible with the data and information provided. The proponent has not adequately explored uncertainty in the groundwater model predictions of drawdown and the depth to the water table. Uncertainty in these predictions needs to be quantified to enable a detailed assessment of the magnitude and likelihood of potential impacts arising from changes to groundwater from the proposed project.

Impacts of the proposed project are likely to be limited in scale given the relatively small size of the proposed project compared to adjacent mining operations. However, the predicted impacts from the proposed project will contribute to the cumulative impacts from mining occurring across the region. Proposed mitigation, monitoring and management approaches are limited and require a number of improvements to minimise the potential risks to water resources. These improvements include:

- the collection of baseline water quality data,
- calculation of appropriate trigger values from reference sites,
- development of appropriate trigger-action-response plans,
- increased frequency of water quality monitoring,
- review of the groundwater model,
- monitoring of groundwater dependent ecosystems, and
- publication of all management plans.

Context

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) was requested by the Australian Government Department of the Environment and Energy and the New South Wales Department of Planning and Environment to provide advice on Wambo Coal Pty Ltd's (WCPL) Wambo Coal Mine South Bates Extension Modification Project in New South Wales.

This advice draws upon aspects of information in the Environmental Assessment (EA), together with the expert deliberations of the IESC. The project documentation and information accessed by the IESC are listed in the source documentation at the end of this advice.

The Wambo Coal Mine South Bates Extension Modification Project (the proposed project) is located approximately 15 km west of Singleton in the NSW Hunter Valley. The proposed project will extend the South Bates Underground Mine through an additional nine longwall panels located to the west of the approved South Bates Underground Mine. The proposed project will extract 18 Mt run-of-mine (ROM) thermal coal from the Whybrow seam, extending the life of the broader Wambo Mine Site by seven years to 2039. Mining at the approved South Wambo Underground Mine will be delayed to accommodate the proposed project with mining to start in 2023 rather than 2019.

The proposed project will utilise some existing infrastructure including the coal handling and preparation plant (CHPP), the water management system, rail facilities and administration facilities. New infrastructure to be constructed for the proposed project includes two ventilation shafts, gas drainage infrastructure and associated roads, and ancillary infrastructure. The proposed project will clear approximately 2 ha of vegetation and cause vertical subsidence of 20 to 1950 mm over approximately 4 km^2.

The proposed project is located in an area with an extensive mining history and a number of active mining projects. Mining has occurred at the Wambo Mine Site since 1969, consisting of both underground and open cut operations.

Key potential impacts

The IESC notes the following key potential impacts are likely to arise due to the proposed project:

- drawdown in the alluvial and Permian aquifers which could affect local groundwater users, surface water flow regimes, stream biota and riparian vegetation, and potentially groundwater dependent ecosystems (GDEs).
- subsidence related impacts to surface water features including changes to the geomorphology and hydrology of North Wambo Creek and the North Wambo Creek diversion such as the loss

of surface water flows to the subsurface due to fracturing of the streambed, the formation of ponds, and increased turbidity due to changes in stream gradient.

Although the magnitude of these potential impacts is likely to be small, relative to the impacts caused by the existing mine and other larger mining operations in the area, it is not clear from the proponent's EA and current management plans how the impacts will be effectively mitigated and/or managed.

Appraisal of data and methodologies

The data provided in the EA and the methodologies applied to predict potential impacts from the proposed project were assessed against the IESC's Information Guidelines (IESC 2015). The EA utilises a range of data from previous studies undertaken at the Wambo Mine Site, which have been supplemented with some additional field-based data collection. There is, however, limited data provided on pre-mining and current water quality conditions for both surface water and groundwater and limited assessment of potential GDEs, including stygofauna. This has restricted the identification and assessment of potential impacts related to these features. Surface water and groundwater quality trigger values for physico-chemical parameters have been calculated erroneously from impacted sites, instead of reference sites, so they are not sufficiently conservative to detect potential impacts.

It is unclear that appropriate modelling methodologies for groundwater, surface water and subsidence have been applied in the EA. The complex history of mining in the area (i.e. a combination of single and multiple seam underground operations plus open cut mining); the limited data supplied on impact monitoring for previous and current mining activities at the site; and the lack of documentation provided on groundwater model revisions prevents a full appraisal of the modelling methodologies. These issues also affect the identification and monitoring of cumulative impacts (see paragraphs 17 to 21). Information and discussion of model construction, parameterisation, calibration, validation, limitations and assumptions are at times limited (and lacking an uncertainty analysis), leading to incomplete assessment of potential impacts and appropriate mitigation measures.

Response to questions

The IESC's advice, in response to the requesting agencies' specific questions is provided below.

Question 1: Do the subsidence, groundwater and surface water assessments, including numerical modelling therein, provide reasonable estimations of the likely impacts to water resources and water dependent ecosystems? Consideration should include but not necessarily be limited to potential changes to water quality, water quantity, aquifer connectivity, flow regimes and cumulative impacts and the underlying predictions of fracture height and the likelihood of connective cracking.

1. The groundwater, surface water and subsidence assessments identify a range of potential impacts and provide some estimates of the magnitude of these potential impacts. There are, however, inadequacies in elements of these assessments as discussed in detail below.

<u>Groundwater</u>

2. The proponent's assessment of potential drawdown impacts on privately owned bores identified three bores where cumulative impacts could cause drawdown to exceed 2 m (EA, App. B, Table 17, p. 50). The data provided in Attachment H of the Groundwater Assessment shows approximately 20 bores with no indication of mine ownership or use and a predicted maximum cumulative drawdown of more than 2 m. Further information and discussion on why these bores are apparently not included in the assessment of drawdown impact on registered bores are needed. Additionally, it is unclear whether all bores located within 5 km of the proposed project have been evaluated. Figure 8 (EA, App. B, p. 70) shows registered bore locations but does not extend to 5 km. Clarification is required to confirm that all potentially impacted private bores have been adequately considered.

3. Groundwater quality data for contaminants such as metals and other ions (e.g. sulfate) was not provided in the EA or in the proponent's environmental reporting (from July 2015 onwards (Peabody Energy 2017)) despite the proponent's groundwater monitoring plan stating that monitoring for these parameters had commenced in July 2015 (Peabody Energy 2015a). The current sampling frequency (i.e. annual) will not provide data that is suitable for use in calculating or applying trigger values. This data should be provided to assist in characterising current groundwater conditions at the Wambo Mine site and to understand potential impacts that may arise from the proposed project such as possible leakage of:

    a. water stored in historic underground workings. The risk posed by leakage from these workings to water resources (e.g. the Hunter River, Wollombi Brook and alluvial groundwater systems) cannot be fully assessed without an understanding of the quality of the stored water and groundwater with which it may interact before discharge.

    b. saline and potentially contaminated water from future void lakes. This leakage could potentially be induced through depressurisation from the proposed project.

4. The proponent has not fully explored and characterised vertical connectivity, both between the Permian strata and alluvial aquifers, and those aquifers and surface water at the Wambo Mine Site. Understanding connectivity, and changes to connectivity that may occur with subsidence, is important for accurately predicting likely impacts to the alluvial aquifers from the proposed project and the potential for groundwater drawdown and depressurisation to affect surface water flows and flow regimes. Further work to improve this understanding could include:

    a. monitoring and analysis of data from nested piezometers (which may necessitate installation of new monitoring bores) located within the alluvial and Permian aquifers and comparison of the hydrographs with surface water hydrographs and rainfall.

    b. collection and analysis of surface and groundwater quality data and suitable stable isotope or tracer data that could provide independent estimates of vertical mixing over time.

    c. monitoring of inflows to mine workings to identify changes in volumes and/or rates. For example, if inflows change rapidly or vary considerably from predicted inflows, this may indicate that the current model is no longer accurately representing the groundwater system and that further investigations and model updates may be required.

5. Based on the data supplied, the proponent currently holds sufficient licences for the maximum predicted groundwater take from the Lower Wollombi Brook Water Source. This take has been calculated on a site-wide basis. A change of only 1.5% would result in an exceedance of the licensed take. The proponent should discuss the practicalities of obtaining additional licences should the actual take exceed the predicted take, and commit to regularly reviewing and recalculating this take to ensure it remains within licensed limits.

6. The drawdown plots provided in the EA are too small to clearly read the contours, particularly in areas with steep gradients. Clearer and larger versions of these plots should be provided to assist in the assessment of the spatial extent of predicted impacts.

7. Some improvements to the groundwater model are required to provide a better understanding of the potential impacts of the proposed project. These include:

    a. sensitivity and uncertainty analysis, as recommended by the *Australian Groundwater Modelling Guidelines* (Barnett *et al.* 2012), of hydraulic parameters, including storativity, hydraulic conductivity and recharge. These analyses are important for understanding how the parameter values applied in the groundwater model may influence predictions of drawdown

and depressurisation. They will also increase confidence in the groundwater model predictions.

b. separate model layers for the alluvium and weathered material/regolith. This is likely to improve the representation of changes in saturation of the alluvium over time and hence the prediction of potential impacts to this important aquifer.

c. a peer review of the model should be provided that is specific to the current version and calibration of the groundwater model.

8. The proponent has not adequately characterised faults within the modelled area and did not include faults in the groundwater model. Faults have been assumed to act as barriers to flow at the proposed project site presumably due to the lack of high hydraulic conductivity strata (with the exception of the alluvium). However, the faults at the project site have displacements of up to 20 m and may be locally significant. Future groundwater modelling investigations at the Wambo Mine Site should consider analysing potential fault impacts on groundwater flow through a sensitivity analysis with the results used to inform future data collection.

Surface Water

9. The surface water assessment provided by the proponent has insufficient discussion of the potential impacts of fracturing on the North Wambo Creek and the North Wambo Creek diversion. Further consideration is needed of:

a. the likely impacts to both these reaches of North Wambo Creek and downstream reaches, such as increases in the number of no-flow days and potential reduction in pool persistence, should fracturing result in the diversion of low and moderate flows to the subsurface.

b. the potential implications on water quality and biota in the creek, and existing and predicted future ponds should less flow occur in the creek.

c. the changes to water quality that may arise from diversion of flows to the subsurface, and potential re-emergence of this diverted water in North Wambo Creek, including changes to iron, salt and dissolved oxygen concentrations.

10. The proponent has reported that North Wambo Creek will experience a small reduction in baseflow of approximately 0.014 ML/day as a result of the proposed project (EA, App. B, p. 43). The predicted depth to the water table prior to the proposed project (EA, App. B, Figure 50, p. 101) shows potential for connectivity between groundwater and North Wambo Creek upstream of the diversion. The predicted water table depths after mining are in excess of 20 m below ground level (EA, App. B, Figure 51, p. 102) making connectivity and hence baseflow contribution highly unlikely. The data suggests that the 'small' reduction in baseflow predicted by the proponent may represent the entire loss of baseflow to North Wambo Creek. This requires clarification. If all, or a considerable portion of baseflow is to be lost, then assessment of the potential implications on ecology, the maintenance of permanent pools within North Wambo Creek and GDEs (e.g. hyporheic fauna) associated with the creek's alluvial sediments is required.

11. Limited water quality data was provided in the EA. Summary data in Table 6 of the existing surface water monitoring plan (Peabody Energy 2015b, p. 17) shows that electrical conductivity (EC) and total suspended solids (TSS) are much higher and the pH lower at the downstream monitoring site (SW05) compared to the upstream site (SW04). Comparisons between these two sites are, however, limited by the lack of data due to the intermittent nature of North Wambo Creek at the upstream site. Further water quality data incorporating the full suite of metals and organics is required since no geochemical assessment has been provided to inform the selection of a site-specific suite. This will:

a. provide an understanding of baseline conditions so that potential mining impacts and variation from natural conditions can be clearly identified.

b. allow the identification and assessment of potential risks posed by discharges, either planned or unplanned, from the water management system, including the potential for toxicity to downstream users. Water quality data should be reported for individual water storages and show the full range of temporal variation.

12. The proponent notes that they currently do not hold sufficient salinity credits under the Hunter River Salinity Trading Scheme (HRSTS) for the predicted discharge from the proposed project and that they will need to approximately double the number of credits held (EA, App. L, p. 8). Information is needed on the availability of salinity credits for the proponent to purchase, particularly given 30 salinity credits currently held by WCPL will expire in 2020; and in the event that they cannot obtain a sufficient number, how they will manage water onsite to comply with their environmental licence conditions.

13. Information should be provided on the water management system showing:

    a. all storages to be used by the proposed project,

    b. the water quality of the storages,

    c. the proposed purpose and management of each storage (e.g. is it a mine water store or a sedimentation dam?), and,

    d. which stores will discharge and/or overflow and where this will go (e.g. the interconnections between components of the water management system).

14. Suggested improvements to the surface water modelling, detailed below, would provide increased confidence in the accuracy of the predictions of this modelling.

    a. Project-specific calculations of discharges and storage water quality/salt loads in addition to the site-wide values should be provided.

    b. Additional discussion of construction, parameterisation, calibration, limitations and assumptions for the suite of models used is needed.

    c. The use of offsite creek flow data should be justified and the related metadata (e.g. location of the creeks used and similarity to the creeks of the Wambo Mine Site) provided.

<u>GDEs</u>

15. The assessment of potential impacts to GDEs from the proposed project is limited as outlined below.

    a. The depth-to-water table maps before and after mining, which are outputs of the groundwater model, are heavily relied upon to support the proponent's assertion that no GDEs will be impacted by the proposed project.

        i. The location of observations used to develop these maps are not clearly identified and outside the alluvium there are few shallow groundwater monitoring bores in the vicinity of proposed project site. This implies that these maps are based on a spatially and possibly temporally limited dataset. As such, uncertainty analysis using the groundwater model is needed to understand the potential variability in water table depth. This would assist in determining if groundwater could be more widely available to vegetation across the proposed project site.

ii. These maps highlight that pre-mining (for the proposed project), groundwater at the proposed project site could provide baseflow to the North Wambo Creek and is likely to be accessible to riparian vegetation. Post-mining conditions, however, show large increases in the depth to the water table which would likely prevent riparian vegetation from utilising groundwater and stop baseflow to North Wambo Creek as discussed in paragraph 10.

b. No stygofauna sampling has been reported yet stygofauna have been recorded by other investigations in the region (e.g. Wollombi Brook and minor tributaries (AGE 2016, p. 55)).

c. Identification of potentially groundwater dependent vegetation appears to have focused on vegetation that the proponent considered likely to require groundwater most of the time. Inadequate consideration was given to vegetation that may periodically or opportunistically utilise groundwater such as riparian vegetation and the EPBC Act-listed Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered Ecological Community (CEEC). The proponent acknowledges that subsidence-induced water ponding may also impact this CEEC (EA, App. D, p. 57).

d. Altered surface flows and flow regimes in the intermittent North Wambo Creek will potentially alter habitat availability for aquatic biota, instream organic matter processing rates and water supplies for riparian zone vegetation and other biota. Changes to channel profile through subsidence may impact sediment regimes within the creek and affect the persistence and geomorphology of pools along the current channel, especially the northeast channel section overlying the proposed longwall panels. These potential impacts and processes have not been adequately considered by the proponent.

Subsidence

16. The subsidence modelling incorporated data from the Hunter, Newcastle and Southern Coalfields, and some site-specific data. This is an appropriate approach; however, as mining has been occurring at the Wambo Mine Site for many years, it is expected that there would be considerable site-specific data. While extraction in parts of the Wambo Mine Site has involved multi-seam operations and the proposed project is single-seam, presentation and discussion of any additional site-specific subsidence data would further increase confidence in the subsidence assessment. Additionally, data and information relating to the successful use of proposed management strategies, and discussion of the potential for interactions between underground and open cut operations to affect subsidence predictions are needed.

Cumulative Impacts

17. The proposed project is close to several other coal mines in the region and therefore its impacts on groundwater and surface water regimes, dependent ecosystems and other water users are likely to be superimposed upon those already occurring or predicted to occur. Although the cumulative groundwater drawdown in various model layers is presented in App B of the EA (Figs 52-57, pp, 103-105) for the various mining operations in the model domain, the figures have been cropped to show only the proposed mine and the source model(s) from which these figures were derived are not clearly stated.

18. The area of direct disturbance of the proposed project (2 ha of grasslands) is considered by the proponent not to contribute to the cumulative loss of native vegetation (EA, App. D, p. 42) but the cumulative effects of indirect impacts on vegetation from subsidence and groundwater drawdown is not quantified in the assessment. As GDEs were not identified by the proponent there has been no assessment of cumulative impacts on them.

19. Figures depicting cumulative drawdown changes due to the proposed project (EA, App. B, Figures 59-63, pp. 106-108) indicate that drawdown will propagate into the Wollemi National Park. Potential hydrological impacts from cumulative drawdown in the Wollemi National Park should be verified.

20. The proponent has provided limited assessment of the cumulative impacts to stream and riparian biota in North Wambo Creek and Wollombi Brook. This includes a lack of analysis of cumulative impacts to water quality and very limited analysis of cumulative impacts to streamflow. Given the progressive accumulation of impacts on North Wambo Creek through the diversion and previously approved undermining of the creek an assessment of these impacts combined with the possible cessation of baseflow as discussed in paragraph 10 is needed.

21. There is limited discussion in regards to the further change to the overall water balance both locally and regionally by this extension. This discussion should include recharge changes, reduction in regional groundwater flow and stream flow reductions.

Question 2: Has WCPL provided reasonable strategies to avoid, mitigate or reduce the likelihood, extent and magnitude of impacts on water resources? Are there further strategies the IESC would recommend to avoid, mitigate or reduce the likelihood, extent and magnitude of impacts on water resources? And if so, why?

22. The strategies suggested by WCPL to reduce the likelihood, extent and magnitude of potential impacts to water resources are mainly management rather than mitigation strategies. The reasonableness of those strategies is discussed in the response to Question 3.

23. There is no clear indication that mitigation options such as altering panel length, width, extraction heights or the mine layout were considered with regards to avoiding, mitigating or reducing potential impacts on water resources, such as fracturing of the North Wambo Creek streambed.

24. The IESC recommends, should the proposed project be approved, that subsidence monitoring data from the early longwall panels should be analysed and used to inform possible changes to the mine layout and panel dimensions to reduce future impacts on water resources of subsequent longwall panels.

25. The IESC also recommends that improvements are made to the risk assessment including consideration of what could occur if mitigation and/or management does not work as anticipated by the proponent. Consideration of these potential impacts in the risk assessment, prior to commencement of any mining activities, would allow the proponent to have suitable contingencies identified and ready to implement should mitigation and/or management unexpectedly fail. This could reduce the environmental impacts of an unexpected failure.

Question 3: In addition to the proposed monitoring and management regime recommendations in the EA, does the IESC recommend additional monitoring and management measures to minimise the risks to water resources?

26. The proposed monitoring and management measures outlined by the proponent in the EA and within the currently approved management plans reviewed by the IESC (see source documentation listed at the end of this advice), are inadequate. The IESC notes that the management plans will require updating if the proposed project is approved. The IESC has a number of recommendations, detailed below, that should be considered for inclusion in management plans to minimise risks to water resources.

Groundwater

27. The current groundwater monitoring network (shown in EA, App. B, Figure 9, p. 71), which the proponent does not propose to expand, does not contain any bores that are able to detect and provide early warning of potential drawdown in private bores located to the north, northwest and west of the proposed project. Additionally, there are no monitoring bores located to the southwest and south of the proposed project; therefore, potential drawdown propagation in the direction of the World Heritage-listed Wollemi National Park will not be monitored. The IESC recommends that monitoring bores be installed in these areas and that the proponent commits to replace or repair any current monitoring bores which are damaged due to the proposed project such as through subsidence.

28. Water quality monitoring (for contaminants such as metals and ions) should be expanded to include the Permian aquifer. Sampling frequency in the Permian aquifer should be at least six-monthly, with frequency increased to a minimum of three-monthly in the alluvial aquifer where higher hydraulic conductivity and connectivity to surface water will cause more rapid changes in water quality parameters. Given the current extent of impact from mining in the area this monitoring will not provide suitable baseline water quality data. Baseline water quality data should be collected from representative reference bores in areas of the aquifers where mining impacts have not occurred.

29. Amendments to groundwater trigger values and associated trigger-action-response plans (TARPs) are needed as outlined below.

    a. The data used to calculate trigger values for both groundwater levels and quality should be provided. The IESC is concerned that data from impacted sites was used to set trigger values (as was clearly the case for surface water). Data and associated metadata (including for reference bores) should be presented to show that only pre-impact data has been used in the calculation of the trigger values.

    b. Trigger values should be calculated using the 20th and 80th percentiles as outlined in the *ANZECC/ARMCANZ Guidelines* (2000), not the less conservative 10th and 90th percentiles used by the proponent.

    c. Trigger values and associated TARPs should be initiated based on a single recorded exceedance of the 20th or 80th percentile values and not multiple exceedances over numerous months. A subsequent consecutive exceedance should initiate another level of the TARP.

    d. When the initiation of a TARP relies on the exceedance of a trigger value, these trigger values must be clearly defined. For example, the current *Surface and Ground Water Response Plan* (Peabody Energy 2015c) has a TARP for impacts to the North Wambo Creek Alluvium that cannot be initiated based on changes to groundwater levels in the alluvium because no trigger values have been defined for the four sites to which the TARP relates.

    e. The initiation of a TARP should not rely on changes being identified at a large number of sites simultaneously. For example, the current TARP for groundwater leakage from Wollombi Brook appears to require the identification of declining head trends in six separate bores concurrently (Peabody Energy 2015c, pp. 18-19). Different levels of this TARP could be initiated based on the number of bores in which the declining head trend is identified. This would be more likely to provide early detection of a potential impact rather than requiring all sites to be impacted before any investigations are undertaken.

f. TARPs need to be made clearer and less repetitive. Actions and responses should be linked to mine operations and should identify and address the causes of the impacts where possible rather than only managing impacts.

g. A commitment is needed by the proponent to compare field data with associated trigger values promptly upon receipt of the field data, and when necessary, to initiate TARPs in a timely manner.

30. The groundwater management plan should include commitments from the proponent to:

    a. undertake a thorough review of the groundwater model given it has been revised over a number of years to accommodate multiple modifications to mining at the Wambo Mine Site. This makes it difficult to identify the calibration and parameterisation history of the model and hence to appraise its ability to accurately predict project-specific and cumulative impacts,

    b. regularly validate the groundwater model predictions,

    c. regularly update the groundwater model as recommended by the *Australian Groundwater Modelling Guidelines (*Barnett *et al.* 2012); and

    d. clearly define the level of variance between groundwater observations and model predictions that will trigger a review of the groundwater model.

31. Improvements to the groundwater model that should be considered were outlined in the response to Question 1 (paragraph 7).

Surface water

32. Current surface water quality monitoring is inadequate for identifying potential mining impacts from either the approved or proposed mining operations at the Wambo Mine Site. Monthly monitoring of metals and ions (including sulfate) is needed to establish a baseline and to develop suitable trigger values. After this period, event-based monitoring (including multiple samples to capture different stages of the hydrograph such as the rising and falling limbs), and regular monitoring at a frequency which captures the natural variability of the system as identified from the baseline data, will need to continue to allow prompt identification and investigation of exceedances of the trigger values.

33. The surface water monitoring program should include monitoring on North Wambo Creek at one or more locations upstream of the proposed project unimpacted by mining (that is upstream of SW04), and at one or more locations immediately downstream of the proposed project. The current downstream monitoring site is too distant from the proposed project and will be impacted by activities other than the proposed project. This suggested distribution of the monitoring sites would also assist in monitoring for potential loss of surface water flows due to streambed and connected fracturing.

34. Water quality monitoring in the upstream reach of North Wambo Creek has historically occurred infrequently (i.e. four samples collected over 13 years) due to the intermittent nature of North Wambo Creek in this reach. Suitable reference sites need to be identified and monitored by the proponent to enable the calculation of appropriate trigger values for incorporation into TARPs. The reference sites must not be impacted by mining. The current trigger values represent water quality which has been impacted by mining, making these unsuitable for identifying potential mining impacts.

35. Water quality triggers and TARPs related to surface water should consider the points raised in paragraph 29 with regards to provision of data used to calculate triggers; appropriateness of

trigger values and trigger initiation; clear definition of trigger values associated with TARPs; clarity of TARPs and commitments to regularly compare data with trigger values.

36. As discussed in the response to Question 1 (paragraph 13), further information regarding the water management system is needed. The water management plan should include this information and an up-to-date version of the water management system schematic.

37. While the proponent has committed to updating the water balance annually it is unclear if this includes a commitment to update any other models that underpin the predictions of the water balance model. These should be regularly reviewed and updated as needed.

38. Commitments for surface and groundwater monitoring should be presented as part of a water monitoring plan and should be consistent with the National Water Quality Management Strategy.

GDEs

39. Monitoring is required to quantify the condition and species composition of riparian vegetation along North Wambo Creek, together with other vegetation GDEs that rely on groundwater for all or part of the time. In particular, this monitoring should focus on areas where there may be potential impacts of subsidence and ponding on the Central Hunter Valley Eucalypt Forest and Woodland CEEC (EA, App. D, p. 57), and GDEs near the Wollemi National Park. This work could include analysis of historical conditions through use of remote sensing data (e.g. Emelyanova *et al.* in press).

40. Stygofauna, an obligate GDE, should be monitored using similar sampling methods to those that have detected stygofauna in Wollombi Brook and its tributaries (AGE 2016). Sampling should include multiple reference sites upstream of the proposed project and in alluvial aquifers where no drawdown is predicted. This data will provide crucial baseline information for comparison with samples from areas where groundwater drawdown and/or subsidence has occurred.

41. Commitments by the proponent for GDE monitoring and development of appropriate mitigation plans should be included as part of a GDE monitoring strategy following recommendations by Serov *et al.* (2012).

Subsidence

42. Unlike the groundwater and surface water management plans the subsidence management plan was not publically available on the proponent's website and thus could not be reviewed by the IESC. This plan should be published on the proponent's website.

43. Notwithstanding this, the subsidence management plan will require revision should the proposed project be approved. The IESC recommends that the following be included in any revision.

    a. Evidence of the successful application of proposed management and rehabilitation measures for subsidence, at the Wambo Mine Site or an equivalent geological setting, should be provided.

    b. Trigger values and TARPs should be developed and described for when it will be necessary to initiate rehabilitation for the various types of subsidence impacts such as slippage and erosion on steep slopes; change in groundwater storage between the surface and caved zone; streambed fracturing and when ponding is considered to be adverse. This should also include a measure for evaluating if "natural" rehabilitation is working or if intervention is required.

c. The subsidence management plan should contain a commitment from the proponent to rehabilitate identified subsidence damage that could impact water resources, both currently and in the future, in accordance with the proposed triggers and TARPs.

d. A monitoring program should be developed for subsidence rehabilitation which includes measures to determine the success of rehabilitation with respect to water flows and storage.

e. The subsidence management plan should outline subsidence monitoring which will be undertaken both on and off site. This should include subsidence survey lines to measure actual movements and a program of visual observation within the Wollemi National Park. Monitoring is needed to better understand potential subsidence impacts at the Wambo Mine Site to verify that impacts to water resources and GDEs are within the estimated limits and have not occurred beyond the predicted impact zone, and to inform future management.

f. The proponent should commit to designing and constructing the Montrose Water Storage giving appropriate consideration to the changed land surface and altered hydraulic properties of the underlying strata to ensure that there are no potential impacts to either surface or groundwater quality. Additionally, the proponent should assess if there is likely to be an impact to the Central Hunter Valley Eucalypt Forest and Woodland CEEC at this location due to the cumulative impacts of subsidence from the proposed project and the dam.

Date of advice	31 July 2017
Source documentation available to the IESC in the formulation of this advice	NSW EPA (New South Wales Environmental Protection Authority) 2015. *Environmental Protection Licence 529.* [Online]. Available: https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Approvals,-Plans-Reports Peabody Energy 2015a. *Wambo Coal Groundwater Monitoring Program. Document No. WA-ENV-MNP-509.1.* [Online]. Available: https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Approvals,-Plans-Reports Peabody Energy 2015b. *Wambo Coal Surface Water Monitoring Program. Document No. WA-ENV-MNP-509.2.* [Online]. Available: https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Approvals,-Plans-Reports Peabody Energy 2015c. *Surface and Ground Water Response Plan. Document No. WA-ENV-MNP-509.4.* [Online]. Available: https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Approvals,-Plans-Reports Resource Strategies 2017. *South Bates Extension Modification Environmental Assessment for the Modification of DA 305-7-2003 (MOD 17) Extension of the approved South Bates Underground Mine.* Prepared for Wambo Coal Pty Ltd. [Online]. Available: http://majorprojects.planning.nsw.gov.au/page/development-categories/mining--petroleum---extractive-industries/mining/?action=view_job&job_id=8124

References cited within the IESC's advice

AGE (Australasian Groundwater and Environmental Consultants Pty Ltd) 2016. *Report on United-Wambo Open Cut Coal Mine Project Groundwater Impact Assessment.* Prepared for Umwelt Australian Pty Ltd. [Online]. Available: http://www.unitedproject.com.au/en/publications/EIS/Appendix-12-Groundwater-Impact-Assessment_Part-1.pdf

ANZECC/ARMCANZ 2000. *Australian Guidelines for Water Quality Monitoring and Reporting. National Water Quality Management Strategy (NWQMS).* Canberra: Australian and New Zealand Environment and Conservation Council and Agriculture and Resources Management Council of Australia and New Zealand.

Barnett B, Townley LR, Post V, Evans RE, Hunt RJ, Peeters L, Richardson S, Werner AD, Knapton A, Boronkay A 2012. *Australian Groundwater Modelling Guidelines.* Waterlines Report, National Water Commission, Canberra.

Emelyanova I, Barron O, Vleeshouwer J, Bridgart R in press. *Application of remote sensing techniques to support delineation and characterisation of groundwater-dependent vegetation: Technical Report.* CSIRO, Australia.

IESC 2015. *Information Guidelines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals* [Online]. Available: http://www.iesc.environment.gov.au/system/files/resources/012fa918-ee79-4131-9c8d-02c9b2de65cf/files/iesc-information-guidelines-oct-2015.pdf.

Peabody Energy 2017. Peabody Wambo Mine Approvals, Plans and Reports Website: https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Approvals,-Plans-Reports

Serov P, Kuginis L, Williams JP 2012. *Risk assessment guidelines for groundwater dependent ecosystems, Volume 1 – The conceptual framework*. NSW Department of Primary Industries, Office of Water, Sydney. [Online]. Available: http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/547682/gde_risk_assessment_guidelines_volume_1_final_accessible.pdf