

Advice to decision maker on coal mining project

IESC 2022-132: Dendrobium Mine Extension Project (EPBC 2021/9115 and State Ref No SSI-33143123) – Expansion

Requesting agency	The Australian Government Department of Agriculture, Water and the Environment The New South Wales Department of Planning and Environment
Date of request	08 April 2022
Date request accepted	11 April 2022
Advice stage	Assessment

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) provides independent, expert, scientific advice to the Australian and state government regulators on the potential impacts of coal seam gas and large coal mining proposals on water resources. The advice is designed to ensure that decisions by regulators on coal seam gas or large coal mining developments are informed by the best available science.

The IESC was requested by the Australian Government Department of Agriculture, Water and the Environment and the New South Wales Department of Planning and Environment to provide advice on Illawarra Coal Holdings Pty Ltd's Dendrobium Mine Extension Project in New South Wales. This document provides the IESC's advice in response to the requesting agencies' questions. These questions are directed at matters specific to the project to be considered during the requesting agencies' assessment process. This advice draws upon the available assessment documentation, data and methodologies, together with the expert deliberations of the IESC, and is assessed against the IESC Information Guidelines (IESC, 2018).

Summary

The Dendrobium Mine Extension Project (the project) is a proposed expansion of the operational Dendrobium Underground Mine located 8 km west of Wollongong in the Southern Coalfield of New South Wales. The project is located in the Metropolitan Special Area, a restricted-access area designed to protect Sydney's drinking water supply catchments. The expansion would allow access to Area 5 to mine coal from the Bulli Seam. Longwall mining would continue at an approximate rate of 5.2 million tonnes of run-of-mine coal per annum, with Area 5 to be mined until approximately 2035.

The project will increase the area affected by subsidence, including undermining sixteen Coastal Upland Swamps of the Sydney Basin Bioregion (listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) and numerous first- and second-order streams. This will considerably

change surface water flows and water regimes within the impacted stream reaches and swamps. The project will also contribute to groundwater drawdown in the Hawkesbury Sandstone aquifers which could impact groundwater-dependent ecosystems (GDEs) connected with the regional water table.

Existing infrastructure such as coal handling, water management and train-loading facilities will be utilised with some minor additions required to the water management system. Discharges of mine-affected water are likely to increase; however, these will continue to be managed under the mine's existing environment protection licence EPL 3421 (EPA 2018) during operations with discharges occurring to Allans Creek below the Illawarra Escarpment.

Key potential impacts from this project are:

- surface effects from ground movements related to subsidence, including vertical subsidence, cracking and fracturing of streambeds and swamp bases, and diversion of surface water underground;
- permanent changes to the flow regimes of numerous first-, second- and third-order stream reaches that will substantially decrease streamflows and increase the number of low- and no-flow days under all rainfall scenarios;
- major changes to water regimes and increases in drying severity in swamps. Sixteen EPBC Act-listed swamps will be directly undermined and impacted by subsidence, with an additional six potentially impacted because they are located partially or wholly within 600 m of planned longwall panels;
- increased vulnerability of swamps and their surrounding vegetation to irreversible damage or loss following extreme bushfires in a drier landscape;
- irreversible loss of near-pristine swamps, instream and riparian habitats, and their water-dependent processes, flora and fauna, such as the EPBC Act-listed Giant Burrowing Frog (*Heleioporus australiacus*) and Littlejohn's tree frog (*Litoria littlejohni*), resulting from the above-mentioned changes to flows and water regimes in streams and swamps;
- reduced water quality and inflows to Sydney's drinking water storage;
- unquantified long-term alterations to groundwater levels and water quality post-mining; and,
- increased mine water outflows through portal(s) after mine closure and groundwater level recovery when controlled by bulkheads within the mine. For discharge of mine water to surface waters below the Illawarra Escarpment, water treatment will be required in perpetuity.

These key potential impacts on near-pristine water resources in the restricted catchment of Sydney's drinking water supply are highly likely and will be severe, long-lasting and irreversible. Ample evidence is provided from previous longwall mining in the area, supported by the proponent's modelling and assessments of the predicted impacts of subsidence and drawdown.

Although the proponent has substantially reduced the footprint of the proposed project compared with the previous proposal submitted to the IESC in 2019, the IESC remains extremely concerned about the

severity and persistence of the predicted environmental impacts in this Metropolitan Special Area. Options for remediation are limited and largely unproven.

Offset strategies will not compensate for the loss of EPBC-Act listed species and upland swamp ecosystems in their current landscape context. The risks and impacts of longwall mining methods cannot be mitigated in this environment.

In general, the proponent has adequately described the severity of the potential impacts of the project on surface waters and groundwater-dependent ecosystems and acknowledged that remediation options are limited and unlikely to succeed. Although some additional work is desirable, the IESC believes that doing this will not materially change the conclusions that the project's impacts will be severe, irreversible and persistent, and that longwall mining methods are not appropriate in this context.

Context

The Dendrobium Mine Extension (the project) is a proposed expansion of the currently operational Dendrobium Underground Mine located 8 km west of Wollongong in the Southern Coalfield of New South Wales. The project is located in the Metropolitan Special Area, a restricted-access area designed to protect Sydney's drinking water supply catchments. The expansion would allow access to a new underground mining area (Area 5) to mine coal from the Bulli Seam. Longwall mining would continue at an approximate rate of 5.2 million tonnes per annum run-of-mine coal (already approved under existing operations). Area 5 would be mined until approximately 2035 with this expansion extending the working life of the Dendrobium mine until 2041.

The project will increase the area affected by subsidence by at least 792 ha, including undermining sixteen Coastal Upland Swamps of the Sydney Basin Bioregion (listed as a Threatened Ecological Community (TEC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) and numerous first- and second-order streams. This will result in considerable, and probably irreversible, changes to surface water flows and water regimes within the impacted stream reaches and swamps. Impacts to EPBC Act-listed species, such as the Giant Burrowing Frog and Littlejohn's tree frog, that rely on these water resources are also probable. There are also likely to be impacts on water-dependent species listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) such as the Red-Crowned Toadlet (*Pseudophryne australis*).

Response to questions

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

Question 1: Does the IESC consider that the decision maker can have confidence in the predictions provided by the model(s) in regard to 'surface-to-seam' cracking or fracturing of strata above the proposed longwalls and near-surface ground movements.

1. The IESC considers that the possibility of 'surface-to-seam' cracking or fracturing, and drainage of the strata is understated because of evidence from the observations in Area 3B and the predictions for proposed Area 5 on the basis of revised conceptual models. Both these Areas are sandstone-dominated landscapes with varying elevation, implying that ground movements will be similar for the proposed longwall mine design.
2. Observed impacts to surface and flow regimes for longwalls 11 to 17 in Area 3B are summarised in Table 16 (HEC 2022). Mining-related effects include reductions in total discharge on tributaries to Donalds Castle Creek, the upper reaches of Wongawilli Creek and tributaries of Lake Avon. Monitored data from 25 of 26 piezometers in upland swamps overlying longwall panels within Area 2, 3A and 3B indicated an impact to water level and/or recession rate while monitored data from 11 of

12 piezometers in upland swamps located within 1 to 60 m from the longwall edge indicated an impact (HEC 2022, p. 55).

3. Conceptual models for fracturing and near-surface cracking (Watershed 2022, Figures 3-5 and 4-8) in the proposed Area 5 are based on multiple lines of evidence including observations and investigations of Areas 3A and 3B. The fracturing of strata above extracted longwalls in Areas 3A and 3B was investigated by drilling to depths between 280 and 300 m and comparison with tests in pre-mining drillholes at the same sites (Watershed 2022, p. 74), and there is also a database of tritium to trace groundwater seepage from the surface to the coal seam. The main findings in relation to cracking and/or fracturing of strata above these longwalls are listed below.
 - a. Mining-induced fracturing, including high-angle ($> 20^\circ$) fracturing, is highly variable and appears to extend above the goaf to the near-surface (Watershed 2022, Figure 3-3) and includes brittle failure of the Bald Hill Claystone (Watershed 2022, Figure 3-5). The response of the claystone to deformation, the lack of self-sealing, and hydraulic test data show that there is no effective aquitard below the Hawkesbury Sandstone in these areas.
 - b. A significant increase in fracture frequency was noted in the near-surface layer (~30 m) compared with underlying strata in Areas 3A and 3B. Generally, the surface cracking zone (SCZ) is defined as a depth below ground equivalent of ten to twelve times (Watershed 2022, Table 3-2) the height of longwall cutting. Cracking will occur to a depth of 30 – 35 m below the ground surface in the proposed Area 5 longwall footprint, based on a proposed cutting height average of 2.9 m.
 - c. Mine water inflow and shallow groundwater drawdown are largely influenced by the intersection of the fracture zone(s) with saturated Hawkesbury Sandstone which has both higher permeability and drainable storage (S_y) than underlying units. The 'height of complete drainage' above some of extracted longwall panels likely intersects with the surface cracking zone (Watershed 2022, Figure 4-8).
 - d. Based on observations of groundwater pressure in Area 3B (Watershed 2022, Figure 2-19), there is evidence for drainage of the strata from surface to seam, leaving remnant spots of saturation. The modern water (<70 years) content of mine inflow waters indicates that there are tortuous pathways through fractured strata for downwards seepage (Watershed 2022, Figure 3-5).

Question 2: Are the assumptions, calibrations and uncertainty analysis applied in the groundwater modelling reasonable and is there sufficient data within the model to provide meaningful predictions, including worst-case impacts on groundwater resources?

4. The calibration and uncertainty analysis applied in the groundwater modelling is reasonable under the assumption of equivalent porous media (EPM) conditions. However, an EPM model is not able to explicitly simulate the impacts of surface cracking and fracturing of deeper strata. The IESC does not believe that an EPM-based groundwater model can adequately address the main impact pathways or worst-case scenarios.
5. Evidence for this includes the observation that some groundwater level calibration data show mismatches of over 100 m of observed versus modelled values (Watershed 2022, Figures 5-2 to 5-12, pp. 126 – 131). Also, the groundwater model predicts drawdown of up to 40 m in multiple areas within Area 5 (Watershed 2022, Figure 6-7A). The modelled drawdown predictions are similar to the maximum predicted for Areas 3A and 3B, although the observations of groundwater pressures (Watershed 2022, Figure 2-19) indicate residual pockets of saturation in strata after undermining (Area 3B). These observations highlight the importance of fracture flow pathways on predicted 'height of complete drainage' and uncertainty regarding the vertical separation with the SCZ (Watershed 2022, Figures D3 and D4 for Area 5).

Question 3: To what extent can decision makers have confidence in the predictions of potential impacts on surface water resources provided in the EIS, including in regard to potential losses to water supply volumes within the Metropolitan Special Area of Sydney's drinking water catchment, stream flow losses, water quality, changes to stream geomorphology and impacts on upland swamps.

6. The IESC considers that the decision makers can have confidence that the predictions of potential impacts on surface water resources would be severe. Potential losses to water supply volumes within the Metropolitan Special Area of Sydney's drinking water catchment are predicted as a result of reduced stream flows. There would also be long-term deterioration in water quality. Changes to stream geomorphology include potential cracking of rock bars and streambeds that will impact on aquatic biota (HEC 2022, p. 73) and instream processes. Irreversible impacts on undermined upland swamps and low-order streams would be severe. All of these predictions are supported by several lines of evidence from nearby mining (Areas 3A and 3B) and the proponent's conceptual and numerical models.
7. Alterations to catchment hydrology will have a major impact on undermined streams and swamps and their flora, fauna and ecological processes. Loss of surface waters on the catchment plateau will impact ecological processes and water quality at the landscape scale. These will, in turn, influence catchment-scale processes such as contaminant loading, erosion and sediment transmission. The potential to impact catchment-scale processes, water quality and aquatic biota has not been assessed.

Question 4: Are the setbacks proposed from surface water features (such as named watercourses, reservoirs, and 3rd order and greater streams) reasonable and likely to avoid significant impacts on these features?

8. The proposed setbacks are beyond the maximum distance of historically observed impacts of subsidence and are likely to avoid most direct subsidence-related impacts to third- and higher-order streams. However, approximately 15% of the stream-controlling features (e.g., rock bars and steps) located within 400 m of the proposed longwalls could be impacted via minor fracturing causing reduced standing water levels. Additionally, due to the possibility of unexpected impacts such as anomalous subsidence movements, which are inherently unpredictable near geological structures such as faults (Murray and Power, 2022), the risk of anomalous and non-conventional subsidence-related impacts to streams within the project area cannot be eliminated.
9. The proposed setbacks will not mitigate non-subsidence-related impacts. In particular, the IESC notes that impacts to higher-order streams such as LA13 and Donalds Castle Creek (DC8) are still possible from altered geomorphology and reduced streamflow contributions from impacted first- and second-order tributaries. As these streams occur at lower elevations, connectivity between these streams and the water table is also plausible. Mining-induced drawdown could reduce baseflow contributions and alter water regimes in LA13 and DC8 regardless of setback distances. Collectively, these impacts could still result in significant impacts, particularly to LA13 which remains surrounded by proposed longwalls.

Question 5: Are the assumptions and calibration used in the modelling reasonable and is there sufficient data within the model to provide meaningful predictions, including worst-case impacts on surface water resources?

10. The appropriateness of the assumptions and calibration for the groundwater model used to infer reductions in baseflow is addressed in the response to Question 2 (refer to Paragraphs 4 – 5).
11. The assumptions used to simulate mine water management are reasonable although the AWBM model used to simulate rainfall-runoff processes was not calibrated. The VADOSE/W model used to simulate seepage from the swamps relies on EPM assumptions; while these have the same

limitations as discussed in Paragraph 4, some confidence can be given to the model predictions as the model was calibrated using local observations (HEC 2022, Figures 19 and 20). Estimates of seepage have considered a suitable range of climatic conditions although the associated model predictions have not considered worst-case impacts arising from uncertainty in model structure and parameterisation. There are sufficient data to provide meaningful predictions.

Question 6: Have the impacts of the project on surface water and groundwater dependent ecosystems (ie upland swamps) been adequately described and assessed?

12. In general, the potential impacts of the project on surface waters and groundwater-dependent ecosystems have been adequately described and assessed. These impacts are portrayed clearly in the proponent's conceptual models and risks pathways (e.g., Watershed 2022, Figures 3-5 and 3-10) and are well-supported by evidence from previous mining in the area. Although there are some areas of deficiency in the assessment (e.g., lack of baseline ecological data from swamps and low-order streams that will be undermined, applicability of some of the models), the IESC believes that addressing these will not materially change the conclusions that the project's impacts will be severe, irreversible and persistent, and that longwall mining methods are not appropriate in this context.

Question 7: Are there any additional mitigation, monitoring, management or offsetting measures that should be considered by decision makers to address the residual impacts of the project on water resources, particularly to inform adaptive management to address areas of scientific uncertainty.

13. The IESC considers that mitigation and remediation options for the severe residual impacts of this project on water resources are very limited and largely unproven.
14. The IESC believes that no offsetting measure can appropriately compensate for the predicted loss of EPBC-Act listed species and TECs (Shale Sandstone Transition Forest, Coastal Upland Swamps of the Sydney Basin Bioregion) in their current landscape context. These species, TECs and surrounding matrix of vegetation and water-associated assets are in near-pristine condition because of their historical protection within the catchment of Sydney's drinking water storage. Collectively, these aspects occur nowhere else in such good condition outside already-protected areas which means that suitable equivalent offset areas do not exist.
15. The following measures are required to monitor the inevitable severe impacts and irreversible decline in physical and ecological condition of the affected water resources:
- a. Collect baseline data on geomorphology, hydrology (e.g., water- or flow-regimes, groundwater-surface water interactions), water quality and the composition and condition of aquatic biota and fringing vegetation for at least two years pre-mining for each swamp and lower-order stream that is to be undermined, along with concurrently collected data from multiple comparable control sites well outside the predicted zone of subsidence and drawdown. Each lower-order stream should be mapped in sufficient detail to identify all relevant habitat features that may be affected by subsidence and/or drawdown.
 - b. Sample stygofauna (using methods described in Doody et al. 2019) in the project area, especially where drawdown is predicted (including the Hawkesbury sandstone aquifers) and where saturated sediments (e.g., near swamps, permanent pools) occur. The project will probably impact stygofauna (Cardno 2022, pp. 37 – 38) that likely perform important ecosystem functions that maintain good water quality (Saccò et al., 2019).
 - c. Field-assess the groundwater-dependence of riparian vegetation, including Shale Sandstone Transition Forest (a critically endangered TEC), using methods outlined in Doody et al. (2019) so that site-specific impacts of drawdown on this habitat and its associated biota can be assessed.

- d. Field-assess temporal variation (over at least two years pre-mining) in groundwater-dependence and hydrogeological connectivity of each swamp in the project area (including within buffer zones). Permanent monitoring sites and equipment to measure seepage, inflows and outflows should be established that will not compromise the swamp's ecological values but is sufficiently replicated to capture relevant swamp-scale spatial variability and detect impacts after mining commences.
 - e. Metal loads and other possible water quality contaminants are not considered for the reservoirs downstream of the project area. A water quality program for the affected tributaries should be developed that provides information about potential contaminant loads and ambient water physico-chemistry to assess risks.
 - f. Long-term groundwater quality impacts are predicted, with upwellings and discharges expected to occur within the Metropolitan Special Area for unspecified periods. This groundwater discharge may degrade water quality in swamps and streams and may occur decades after mining completion. Depending on this duration and any potential build-up of contaminants, impacts to aquatic biota and riparian vegetation (including protected species and TECs) may be significant and difficult to mitigate. The proponent should outline how these long-term ecohydrological impacts will be addressed.
 - g. Groundwater pressure profiles through strata from surface to seam, including multi-level monitoring sites in the centre and edge of key longwalls are required. Several open monitoring bores and groundwater pressure depth profiles are needed to verify the SCZ, depth of depressurisation and depth of complete drainage.
16. The IESC does not believe that an adaptive management strategy is feasible in this context to address areas of scientific uncertainty. There is little uncertainty that the project will have severe impacts on water-dependent EPBC-Act listed species, TECs and associated water resources in the area to be undermined. Existing mining by the proponent has already left undesirable and long-term environmental legacies (e.g., contaminated mine-water discharge into perpetuity, swamps and streams whose ecological values have been permanently lost through subsidence-induced drying). Adaptive management will not resolve these irreversible impacts nor materially increase understanding of their risk.

Date of advice	09 Jun 2022
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Source documentation provided to the IESC for the formulation of this advice	<p>Cardno 2022. <i>Dendrobium Mine Extension Project - Aquatic Ecology Assessment</i>. Cardno (NSW/ACT) Pty Ltd, 2022.</p> <p>HEC 2022. <i>Dendrobium Mine Extension Project Surface Water Assessment</i>. Hydro Engineering & Consulting Pty. Ltd.</p> <p>Jacobs 2022. <i>Dendrobium Groundwater Model Review</i>. Jacobs Group (Australia) Pty, Ltd.</p> <p>Watershed 2022. <i>Dendrobium Mine Extension Project (DMEP) Groundwater Assessment</i>. Watershed HGEO Pty Ltd.</p>
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