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

Advice to decision maker on coal mining project

IESC 2021-128: Newstan Mine Extension Project (EPBC 2019/8528 and SSD-10333) – Expansion

Requesting agency	The Australian Government Department of Agriculture, Water and the Environment and the New South Wales Department of Planning, Industry and Environment
Date of request	29 September 2021
Date request accepted	29 September 2021
Advice stage	Referral

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, Industry and Environment to provide advice on Centennial Newstan Pty Limited's Newstan Mine Extension Project in NSW. 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 Newstan Mine Extension Project (the project) is an extension to the existing underground Newstan coal mine (under care and maintenance since 2014). The project is located in the south-western part of the Newcastle Coalfield, which occupies the north-eastern portion of the Sydney Basin, and targets the West Borehole Seam of the Newcastle Coal Measures. The extension of the mining area would directly undermine the Eraring Power Station and the Eraring Ash Dam and previous mine workings in the Awaba and Great Northern Coal seams, resulting in a mined multi-seam environment.

The project area has already been affected by historical mining and experienced subsidence-related impacts. The project will result in further subsidence with impacts focused under the existing mine workings (multi-seam environment) and the Eraring Ash Dam. The project will potentially result in seepage from the Eraring Ash Dam to the proposed Newstan extension via the existing Awaba underground workings and groundwater. Seepage from the Eraring Ash Dam ultimately exits the groundwater system into surface watercourses.

There are several streams and an *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Offset area which are predicted to experience subsidence-related impacts, such as surface fracturing, ponding, plug failures and sinkholes. The proposed project operations will also lead to mine-affected water being discharged from the site and entering LT Creek, Stony Creek and Muddy Lake. These impacts will alter surface water quality and lead to potential impacts downstream, including on Lake Macquarie. Lake Macquarie, Muddy Lake and Whiteheads Lagoon are mapped as potential aquatic groundwater-dependent ecosystems (GDEs) within the project area and are located within the predicted zone of groundwater drawdown.

Collectively, these potential impacts will contribute to the cumulative effects of mining, urban development and other human activities on water resources within and near the project area, including catchments of the Awaba Biodiversity Conservation Area, Lake Macquarie and other valued natural assets. However, considerable uncertainty surrounds the current modelling and predictions of project-specific impacts on GDEs and freshwater and estuarine ecosystems, many of which support EPBC Act-listed species and other wildlife in an already impacted region where the conservation of the few near-natural ecosystems are increasingly important.

Key potential impacts from this project are:

- changes to groundwater flow between the Eraring Ash Dam, surrounding aquifers, the Awaba Underground Void and surface expressions of groundwater, including via continuous and discontinuous fracturing above the mined seam;
- contribution to groundwater and surface water contamination as a result of increased contaminant seepage from the Eraring Ash Dam into the underground workings and, ultimately, surface waters;
- mining-induced failure of the Eraring Ash Dam that, although very unlikely, would have severe consequences on impacted water-dependent ecosystems;
- subsidence leading to stream-bed fracturing, ponding and long-term water quality issues post closure (including ongoing erosion where subsidence-induced ground deformation occurs);
- subsidence causing surface fracturing, ponding, plug failures and sinkholes in the catchment of the Awaba Biodiversity Conservation Area that may compromise its role as an environmental offset;
- declines in surface water quality associated with an increase in the frequency and magnitude of discharge of mine-affected water discharges into LT Creek and Stony Creek, and from discharges from the Awaba Pollution Control Dam into Stony Creek;
- long-term changes, post-mining, to water resources due to contaminated water discharges from underground voids, seepages and surface water storages;
- loss and decline in aquatic and terrestrial GDEs, some of which provide critical habitat for EPBC Act-listed species and migratory birds, as a result of cumulative alluvial drawdown, subsidence-related impacts and discharges of mine-affected water into streams in the project area;
- increased Awaba seepage into potential aquatic GDEs (e.g., Muddy Lake), estuarine ecosystems and Lake Macquarie; and

- contribution to cumulative impacts on surface water resources (including estuaries entering Lake Macquarie), GDEs (e.g., Muddy Lake, Whiteheads Lagoon, groundwater-dependent vegetation) and associated terrestrial ecosystems, which may provide habitat for EPBC Act-listed species and migratory birds.

The IESC has identified key areas in which additional work is required to address the key potential impacts, as detailed in this advice. These are summarised below.

- Update and integrate the results of the groundwater, subsidence and hydrogeotechnical impact assessment reports, including the potential impacts of the proposed changes to the mine plan.

- The representation of the groundwater system in the conceptual and numerical groundwater models requires improvements to better characterise potential groundwater impacts. These improvements should specify how paleochannels, faults and leakage into the Newstan workings contribute to drawdown and groundwater flow-paths.

- An improved understanding and conceptualisation of the interactions and pathways for the seepage from the Eraring Ash Dam to enter the groundwater, and hence the Awaba Colliery void which then discharges into Muddy Lake and ultimately Lake Macquarie. This improved understanding and conceptualisation should include investigating:

    - how the proposed Eraring Ash Dam augmentation will affect these pathways; and

    - the potential interactions between the Awaba Underground Void, Eraring Ash Dam and groundwater.

- Further assessment of how ground movement (including subsidence, cracking, fracturing, ponding, sink holes and plug failures) will impact on spatial patterns of catchment runoff, streamflow regimes, groundwaters and associated water-dependent biota and ecosystems, especially those in the catchment of the biodiversity offset area (Awaba Biodiversity Conservation Area).

- Further information and assessment of how controlled and uncontrolled discharges, particularly from the Pollution Control Dam associated with the Awaba LDP009 discharge point, may alter ecologically important components of the flow regime and water quality (locally and downstream).

- Subterranean, aquatic and terrestrial GDEs should be ground-truthed to more accurately assess impacts to potential GDEs and associated ecological communities.

- Further field surveys of freshwater and estuarine ecological communities and habitats are needed to provide more recent baseline data and improve the proponent's understanding of the project's potential impacts on the EPBC Act-listed species, other biota and their habitats.

- An ecohydrological conceptual model is required to improve understanding of the connections and interactions between groundwater, surface water and water-dependent ecosystems. This model will identify potential impact pathways as a result of these connections and indicate where monitoring and mitigation measures are needed.

- A cumulative impact assessment is needed which considers the likely effects of historical, current and future mining activity and built features (e.g., Eraring Ash Dam) on water resources and other natural assets, including Lake Macquarie.

- Suitable mitigation, management and monitoring plans for all relevant water resources and related assets should be provided. These plans should be developed following the completion of the additional work outlined in the above bullet points and be informed by the advice below.

Context

Mining operations at Newstan Colliery began in 1887, with extraction occurring in the upper coal seams (Great Northern and Fassifern seams) and lower coal seams (West Borehole, Borehole and Young Wallsend and Yard seams). The previous mining methods have used a combination of bord and pillar and longwall mining. Neighbouring coal mines include Cooranbong Mine, Mandalong Mine, Myuna Colliery and the proposed Wallarah 2 Coal Project.

The proposed project will target the West Borehole Seam and extract up to 25.9 million tonnes (Mt) of run-of-mine (ROM) thermal and coking coal over a fifteen-year period. The depth of cover within the extension of mining area ranges from 140 m in the north-west to 320 m in the east. The target seam is overlain by the previous Awaba Colliery mine workings in parts of the mining extension area with the interburden between the two seams ranging from 100 m to 210 m.

Bord and pillar mining is proposed using the flexible conveyor train mining system that will include areas of first workings, partial extraction and full extraction. The development of first workings only will occur beneath certain features in both single and multi-seam conditions, including under second and third order streams, the Main Northern Railway, a 132-kV substation, the Eraring Power Station and the Eraring Ash Dam wall. Degasification will also be required due to the high volumes of gas within the West Borehole Seam and overlying seams. The proposed underground mining will be supported by operation of existing surface facilities at Newstan Colliery, and the augmentation and operation of surface facilities at the nearby Awaba Colliery (another existing Centennial Newstan underground mining operation, currently under care and maintenance).

The project area is located within the catchment of Lake Macquarie, with several streams traversing the project area including LT Creek, Kilaben Creek, Stockyard Creek, Palmers Creek, Stony Creek, Lords Creek and Crooked Creek. There is also a number of potential aquatic groundwater-dependent ecosystems (GDEs) to the east and south of the project area, including Lake Macquarie, Whiteheads Lagoon and Muddy Lake.

Mine-affected water from the proposed project activities will be discharged into LT Creek from the Newstan Colliery Surface Site and into Stony Creek from the Awaba Colliery Surface Site. Both creeks flow downstream into Fennell Bay, Lake Macquarie. Stony Creek also receives discharge from the Fassifern Underground Storage at Newstan Colliery. Seepage from the Awaba Underground Void flows into an unnamed tributary, which also receives discharge from the Cooranbong Entry Site (the underground mining areas of the neighbouring Mandalong mine are dewatered via an underground storage which is then discharged to Cooranbong Entry Site to the unnamed tributary). The unnamed tributary ultimately flows into Lake Macquarie downstream.

The project area in the north is partly overlain by a biodiversity offset area owned by Lake Macquarie City Council. The site, known as the Awaba Biodiversity Conservation Area, is managed for biodiversity conservation in perpetuity in accordance with the terms of an agreement established under the EPBC Act.

The project area already experiences the cumulative effects of past and current mining, urban development and other human activities on its water resources, including catchments of the Awaba Biodiversity Conservation Area and Lake Macquarie. However, considerable uncertainty surrounds the current modelling and predictions of project-specific changes to surface water and groundwater dynamics and water quality. These uncertainties propagate to limit understanding of how these changes may impact freshwater and estuarine ecosystems, many of which support EPBC Act-listed species and other wildlife. This region is already heavily impacted, and its near-natural ecosystems are increasingly important and may be approaching ecological tipping points that are irreversible.

Response to questions

1. The proponent has outlined changes to the mine plan in the Environmental Impact Statement (GHD 2020, p. 128) based on the potential impacts described in the Subsidence Assessment (GHD 2020, App. H) and the Hydrogeotechnical Report (GHD 2020, App. I). In particular, these changes are to mitigate the potential impacts in the areas between the Eraring Ash Dam, Awaba Colliery and the West Borehole Seam. As only limited details of these changes have been provided and they have not been considered in the Subsidence Assessment or the Hydrogeotechnical Report, the IESC is unable to comment on the adequacy of these as mitigation methods. Therefore, the following advice does not consider these changes in the IESC's responses to the questions below.

Groundwater

Question 1: Are the assumptions and data used to develop the groundwater model appropriate to assess the impacts from the project? What refinements, if any, does the IESC recommend to improve the current modelling?

2. The assumptions and data used to develop the conceptual and numerical groundwater models are not sufficient to assess the impacts from the project. These models should be revised based on the following recommendations (Paragraphs 3 – 8, 10 – 12).

3. The conceptual hydrogeological model and hydrogeological cross-sections highlight the relevant aquifers as well as inputs, outputs and exchanges between the groundwater and surface water (GHD 2020, App. J, App. B, pp. 43 – 45). However, some changes should be made to improve understanding of the groundwater system.

    a. The proponent should clarify where the cross-sections are located.

    b. The cross-sections should make clear how groundwater moves between the aquifers, and should include the Awaba Underground Void, Eraring Ash Dam and any associated groundwater movements.

    c. The arrows on the conceptual model illustrate groundwater and surface water movements but the key pathways need to be specified.

    d. The proponent should clarify which fault is shown in the conceptual model. The proponent should also identify other relevant paleochannels and faults in the project area in the conceptual model and discuss any impacts these features may have on groundwater flow.

    e. As noted in Paragraph 6, the conceptual model and/or cross-sections should also clarify the relationship between the Eraring Ash Dam, the groundwater and the surface water.

4. The numerical groundwater model did not predict drawdown in the alluvium or increased leakage from the Eraring Ash Dam and Awaba Underground Void during mine operation. However, the model predictions are in doubt due to deficiencies with the model, including those identified below (Paragraphs 5-8).

5. The independent peer review identified that the numerical model did not predict drawdown in the alluvium due to model deficiencies that include the set-up of rivers in the model, an incorrect assumed height of continuous fracturing (Paragraph 18a), and issues with model parameterisation such as specific storage in the West Borehole Seam which is poorly justified. The IESC agrees with the independent peer reviewer's concerns and recommends that the proponent adopts them, especially the following.

a. The initial conditions used in the groundwater model should be presented, explained and justified, to show how the current groundwater regime was included in the model.

b. The general head boundary conditions and use of constant heads (GHD 2020, App. J, App. B, App. G, p. 15) for the Awaba Colliery should be reconsidered, as these may be buffering potential impacts. The IESC recommends this could be considered within an uncertainty and sensitivity framework.

c. The potential influence of paleochannels (particularly in the interburden and coal seams) and faults on the groundwater system should be addressed in the model.

d. A model should be developed that presents results at a number of time intervals post-closure to illustrate potential future groundwater conditions.

6. Some components of the conceptual model were considered outside the scope of the numerical model and so were not included. These were catchment runoff, operational transfers from the Newstan Colliery Surface Site and Awaba Colliery Surface Site, inputs and outputs to and from the Fassifern underground storage and Awaba workings other than groundwater inflows and outflows, and potential flows from the Eraring Ash Dam to the Awaba Underground Void via sinkholes (GHD 2020, App. J, App. B, p. 39). The proponent does not provide a justification for excluding these components from the numerical model. Components such as potential flows from the Eraring Ash Dam to the Awaba Underground Void via sinkholes (GHD 2020, App. I, p. 15) and outputs such as pumping from the Fassifern Underground Storage and Awaba workings are likely to be important in understanding the range of potential impacts. These components should be included in a revised groundwater model if the proponent cannot provide a compelling justification for excluding them.

7. A revised groundwater model should include:

   a. clearer quantification of groundwater leakage into, through and out of existing and proposed Newstan Colliery workings prior, during and post project;

   b. the influence of the paleochannels within the coal seams and interburden and of the porous conglomerate rocks known in the project area, including around the paleochannels; and

   c. potential interactions between the existing underground workings, other structural features (e.g., faults, sills, the West Borehole Seam split), and subsidence-related surface fracturing.

8. Post-closure impacts to the alluvium are required after the other limitations of the model have been addressed. Climate change should also be considered in the groundwater model, to allow for better assessment of potential impacts including the recovery of groundwater levels following the end of mining (GHD 2020, App. J, App. B, pp. 70 – 71).

Question 2: Does the IESC consider that the decision maker can have confidence in the predictions provided by the model(s), particularly in regard to:

a. groundwater and groundwater-surface water interactions;

b. groundwater-dependent ecosystems;

c. groundwater inflows;

d. potential impacts on the Eraring Ash Dam and previous overlying mine workings groundwater storage;

e. potential impacts on private bores; and

f. any impacts on the nearby water body of Lake Macquarie through groundwater depressurisation, connective cracking, geological structures and/or changes in the storage of underlying strata.

9. The IESC does not consider that the decision maker can have confidence in current model predictions for all six points listed in Question 2 for the following reasons.

a. Groundwater and groundwater-surface water interactions.

10. The proponent has not adequately discussed the interactions between groundwater and surface water, specifically the hydraulic connectivity between watercourses, their alluvium and the underlying mine-impacted hydrogeological units. Given the project area is impacted by previous mining activities the proponent should clearly define and address the potential additional and cumulative impacts from the proposed extension.

11. The Subsidence Assessment (GHD 2020, App. H) sufficiently assesses the predictions of the subsidence impacts to surface water; however, the impacts to groundwater were not assessed. Subsidence-related changes in hydrogeological properties and, in turn, changes in groundwater behaviour are a coupled process. Mining-induced changes as a result of subsidence have not been quantified by the proponent. The proponent should pay particular attention to areas that are likely to experience greater subsidence impacts (e.g., multi-seam conditions) and to the possibility of non-conventional or anomalous subsidence. Furthermore, the potential interactions with, and resulting changes to, the paleochannels in the West Borehole Seam are not well described and should be assessed (Paragraph 20).

12. Due to deficiencies in the numerical model (Paragraphs 5 to 8), the IESC does not have confidence in the proponent's prediction that there will be no drawdown in the alluvium during mining. Furthermore, the proponent does not present the groundwater model's predictions of post-closure drawdown in the alluvium or regolith due to the project (GHD 2020, App. J, App. B, p. 77; GHD 2020, App. J, App. B, App. E, Figure E-5). Limited discussion about cumulative impacts is provided (GHD 2020, App. J, App. B, pp. 49 – 51). If the revised groundwater modelling shows that there are likely to be impacts, an assessment of possible short and long-term impacts to water quality, including contributions to cumulative impacts, should be provided.

    a. Water quality changes are of particular concern for the likely connection between the Eraring Ash Dam and the surface water. Muddy Lake leads to Lake Macquarie and its associated habitats and fauna may be affected by changes to water quality.

    b. Groundwater water quality changes may also affect stygofauna in the project area, although the presence of stygofauna cannot be confirmed given the lack of surveys in the project area (Paragraph 56).

b. Groundwater-dependent ecosystems

13. Moderate- and high-potential aquatic and terrestrial GDEs have been identified within, and in the vicinity of, the project area using the Bureau of Meteorology GDE Atlas (GHD 2020, App M, App A, p. 60). The identification of GDEs has been limited to desktop surveys only and the proponent has not undertaken any ground-truthing field surveys. These field surveys should be done (Paragraph 55,) so that the proponent can adequately identify and assess the potential impacts of the project on GDEs, including Muddy Lake, Whiteheads Lagoon and Lake Macquarie, and the EPBC Act-listed species that they may support. These species could include the Green and Golden Bell Frog (*Litoria aurea),* the Regent Honeyeater (*Anthochaera phrygia*) and the Koala (*Phascolarctos cinereus*).

14. The proponent considers that subsidence poses a potential risk to GDEs (GHD 2020, App A, App M, p. 61). However, an assessment of how subsidence-induced changes will impact GDEs is not provided and potentially affected GDEs have not been field-truthed (Paragraph 13). Further field

studies and an ecohydrological model are required for an accurate assessment of the potential impacts to ecological communities (including aquatic GDEs) (Paragraph 55-59). These impacts should be based on the findings from a revised groundwater model (Paragraph 7).

15. The proponent has not adequately considered the potential impacts of groundwater contamination on GDEs, especially surface waterbodies receiving groundwater inputs. The IESC has low confidence in the proponent's modelling of leakage from the Eraring Ash Dam into the underground workings (Paragraphs 16 – 17). The project could increase leakage from the Eraring Ash Dam that could ultimately flow into Muddy Lake and Lake Macquarie. Similarly, the proponent has not adequately considered the surface water discharge impacts on aquatic GDEs.

c. Groundwater inflows

16. As highlighted in Paragraph 11, the proponent has not adequately considered the subsidence impacts to groundwater and the underlying mine-impacted hydrogeological units. Changes to groundwater flow and connectivity (in particular, vertical connectivity) as a result of subsidence impacts should be considered. Furthermore, the proponent's groundwater model does not quantify the potential for additional leakage from the Eraring Ash Dam due to the project. Groundwater inflows to the Awaba Underground Void are modelled to slightly decrease due to project-related drawdown. Inflows to the Fassifern Underground Storage are predicted to remain the same (GHD 2020, App. J, App. B, pp. 78 – 80). Given the reduced confidence in the proponent's groundwater model (Paragraphs 3 – 8), the proponent's predictions of potential changes to groundwater leakage and inflows are uncertain.

17. A plausible range of groundwater flow rates between the Eraring Ash Dam, Awaba Underground workings, Newstan workings and the Awaba seepage should be assessed and presented.

18. The proponent disputes the Hydrogeotechnical Report's predicted inflows from the Eraring Ash Dam and Awaba Underground Void to the Newstan workings.

    a. The proponent should justify the values for hydraulic conductivity and the height of continuous fracturing based on site-specific observations and investigation.

    b. Noting that the groundwater inflow predictions are likely to be different if the proponent alters the mine plan to reduce predicted impacts, including the likelihood of fracturing occurring as a result of mining under the Eraring Ash Dam (Paragraph 1), the new mine plan and an updated assessment should be provided with revised inflow predictions based on the mining methods.

    c. The proponent also considers that the Awaba Underground Void does not provide inflow to the Newstan Colliery, based on differences in water chemistry and that inflow is likely coming from the porous and fractured rock aquifer (GHD 2020, App. J, App. B, pp. 41 – 42). Further investigation by the proponent is required to provide confidence in the significance of this flow and mixing (Paragraph 44).

In-seam gas drainage

19. In-seam gas drainage is proposed within the underground workings as a means to control gas levels within the coal measures (GHD 2020, p. 19). The information provided by the proponent on the method is limited. In particular, the proponent has not provided any assessment of potential impacts on water resources and related assets.

d. Potential impacts on the Eraring Ash Dam and previous overlying mine workings groundwater storage

20. The proponent has not clearly evaluated potential scenarios for additional groundwater interactions and pathways for the Eraring Ash Dam seepage. The Hydrogeotechnical Report considers that

discontinuous fractures caused by the proposed mining activity could extend from the seam up to the surface (GHD 2020, App. H, p. 100). These fractures could provide additional pathways for seepage from the Eraring Ash Dam to the Awaba Underground workings, to the West Borehole Seam and ultimately to surface waters via various geological structures. Even after the proposed partial filling of the Awaba Underground Void workings near the Eraring Ash Dam (GHD 2020, App. I, pp. 24 – 26), there could be additional pathways for seepage from the Eraring Ash Dam to mine workings that discharge to surface waters. For example, changes in the groundwater storage balance in the Awaba underground workings since 2013 have resulted in the Awaba seepage that discharges from mine workings to unnamed tributaries of Muddy Lake via a series of pre-existing faults (GHD 2020, App. J, App. B, p. 36). There are also other potential pathways for seepage via the paleochannels in Permian interburden and the West Borehole Seam split (GHD 2020, App. H, App. E, MSEC1042-12). Further work is required to integrate subsidence, hydrogeotechnical and groundwater impact assessments (GHD 2020, Appendices H, I, J) to evaluate potential scenarios for seepage pathways from the Eraring Ash Dam to surface waters including Whiteheads Lagoon, a potential GDE.

21. The proponent's documentation provided to the IESC has not presented the potential for mining-induced failure of the Eraring Ash Dam. It is recommended by SCT (GHD 2020, App. I, p. 5) that Dam Safety NSW is consulted and a risk assessment completed to confirm that the earth embankment is protected from mining subsidence in relation to the proposed underground workings for the Newstan project extension.

Other subsidence-related impacts

22. Subsidence-related impacts on the main water and fuel storage tanks, the recycled water dam and the oil retention dam could destabilise the integrity of the tank structures and fracture the bases of the dams and dam walls. Cracking of the base may occur in the recycled water dam (located above proposed panel 207), and there may be fracturing of the bedrock and cracking in the bases and walls of the water storage dams (located above proposed panels 213 to 217) (GHD 2020, App. H, p. 70 & 93). Potential impacts could include leakages and spillages, releasing contaminants into the receiving environment. Although the IESC notes that this infrastructure is the responsibility of the Eraring Power Station, potential impacts resulting from leakage and spillages should be considered in the proposed Built Features Management Plan (GHD 2020, App. H, p. 106).

<u>e. Potential impacts on private bores</u>

23. Project-related groundwater drawdown will contribute to existing drawdown in private bores (irrigation, stock watering, water supply) targeting the West Borehole Seam. Up to 0.6 m of project-related drawdown is predicted in the private bores, although these predictions and associated impacts are uncertain due to deficiencies in the groundwater model (Paragraphs 3 – 8). Existing drawdown is large in some of the private bores, with one bore experiencing drawdown of 44 m (GHD 2020, App. B, pp. 51 – 53). The IESC recommends that the proponent reviews these potential impacts on private bores when the numerical model has been revised (Paragraph 5 – 8).

<u>f. Lake Macquarie</u>

24. The IESC has low confidence in the current model predictions of the project's impacts on Lake Macquarie. Following suitable revision of the hydrogeological models (Paragraphs 3 – 8), the proponent should use these and appropriate field data to assess potential impacts on hydrology and water quality of Lake Macquarie and associated estuarine ecosystems that may arise from groundwater depressurisation, Eraring Ash Dam failure, connective cracking, influences of paleochannels and faults and/or changes in the storage of underlying strata. These impacts are likely to be indirect ones whose effects are propagated via feeder streams and subsurface groundwater discharge into Lake Macquarie. In addition, the proponent should assess potential project-specific and cumulative impacts on water quality (Paragraph 65 – 66a) of the Lake Macquarie's coastal

wetlands and estuaries that are fed by streams draining the project area because of the potential incorporation of metals and other contaminants into near-shore foodwebs that may include migratory birds and EPBC Act-listed species.

Question 3: Does the IESC consider that the predicted impacts on surface water resources and dependent ecosystems have been appropriately modelled and assessed in the EIS? What refinements, if any, does the IESC recommend to improve the current modelling?

Surface water

25. The impacts on surface water resources arise from both mine water management and subsidence. The IESC has reasonable confidence in the modelling undertaken to assess the frequency, magnitude and quality of discharges from mine water operations, but not on the impacts of these discharges on downstream receiving waters. While the general modelling approach used to assess impacts on frequent and rare floods is reasonable, these estimates are heavily dependent on the defensibility of the predicted changes to overland and in-stream flow pathways resulting from subsidence. As the predicted impacts of subsidence on the terrain are subject to considerable uncertainty, the IESC has low confidence in the predicted impacts on surface water resources, which includes surface water flows, flood impacts, and the fate of seepage flows. Further details on these issues are described below.

Mine-affected discharges

26. The proposed project has the potential to increase the frequency and magnitude of discharges from the Newstan Colliery Surface Site to LT Creek via Newstan LDP001 (from 11 ML/day to 14 ML/day) and Stony Creek via Newstan LDP017. An increase in the salt load is predicted to occur with the additional discharge volumes. The increased salt loads associated with the increased discharge volumes from Newstan LDP001 and LDP017 are stated by the proponent to have a negligible impact on water quality in the receiving environment of Lake Macquarie (GHD 2020, App. K, p. 99). However, the proponent has not considered the potential impacts that the increased salt loads will have on LT and Stony creeks or the cumulative impacts on the receiving environment of Lake Macquarie. These impacts should be considered, especially those on riparian vegetation, aquatic and estuarine macroinvertebrates and associated foodwebs.

27. The proponent states that uncontrolled discharges at LDP009 from the Awaba Pollution Control Dam into Stony Creek will occur every five days or if rainfall exceeds the design capacity of the storages of dirty surface water (GHD 2020, App. K, p. 99). The proponent has not considered the potential impacts on the water quality of Stony Creek, Fennell Bay and Lake Macquarie from controlled and uncontrolled discharges from the Awaba Pollution Control Dam. The proponent should consider what impacts controlled and uncontrolled discharges from the Awaba Pollution Control Dam may have on the water quality, biota and aquatic ecosystems of Stony Creek, Fennell Bay and Lake Macquarie.

Surface water quality data

28. The current 2019 dataset used for the hydrologic models should also include 2020 rainfall intensity and temporal pattern data to better reflect the most recent rainfall events and other climatic conditions.

Awaba seepage

29. The proposed project has the potential to result in enhanced infiltration of water from the Eraring Ash Dam to the Awaba Underground Void. This water would migrate through the Awaba seepage, mix with discharge from Cooranbong Entry Site and flow into Muddy Lake via an unnamed tributary. It is noted in the Hydrogeotechnical Assessment (GHD 2020, App. I, p. 3) that the long-term impacts of the project could result in the Awaba seepage being diverted to the Newstan overflow point. The

proponent has not assessed the changes in flow from the Awaba seepage caused by the new underground workings or how such changes in flow may affect the water quality flowing into Muddy Lake.

30. Metal sulfide oxidation and acid generation was previously observed in 2014 within the Awaba Underground Void (GHD 2020, App. K, App. C, p. 21). This resulted in a spatially limited impact on the unnamed tributary of Muddy Lake, where metals precipitated before entering the lake. The water released during this event had a low pH, elevated electrical conductivity (EC), and elevated concentrations of potentially ecotoxic metals, such as nickel and zinc. The proponent should assess the potential ecological and surface water quality impacts to Muddy Lake and the unnamed tributary if metal sulfide oxidation and acid generation were to occur in the Awaba Underground Void again.

Subsidence-related impacts

31. The project area is predicted to experience vertical subsidence which could increase ponding areas and low-level valley-related upsidence (GHD 2020, App. H). These impacts could result in changes and decreases of flow in Kilaben Creek (that drains into the Awaba Biodiversity Conservation Area), Stony Creek, Stockyard Creek and Crooked Creek as well as a number of unnamed water courses in the project area. The proponent should investigate any potential surface hydrology impacts associated with the predicted subsidence, regardless of relative size. Alterations such as ponding, enhanced surface-groundwater interactions, increased erosion and sediment transport, changes to lateral sub-surface and surface flow pathways due to subsidence and off-channel ponding in the catchment, and impaired water quality should be considered. Furthermore, changes to ecologically relevant components of streamflow (e.g., duration of low- and zero-flow periods) are likely to affect the aquatic and riparian biota of these ephemeral streams (reviewed in Datry et al. 2017) and should be assessed by the proponent. These impacts should also consider the cumulative impacts from the historical Newstan activities, in particular, predicted subsidence that will occur regardless of the proposed project (e.g., increasing sinkhole diameter).

32. The proponent has not considered the potential impacts associated with fracturing that may occur in the bedrock beneath Kilaben Creek, Stony Creek, Stockyard Creeks and Crooked Creek and unnamed water courses due to predicted subsidence. The exposure of unweathered rock could increase chemical reaction rates within the rock mass and mobilise significant amounts of cations and anions along fractures and bedding planes to surface waterways and aquatic systems. The proponent should investigate the potential impacts associated with additional fracturing and the development of cracks in watercourses that could mobilise leachates from exposed unweathered rock to the downstream aquatic environment. Moreover, the proponent should assess how weathering products (e.g., iron and magnesium, dissolution of carbonate minerals) produced from the exposure of unweathered rock may impact water quality.

33. The mean concentration of ammonia in the Awaba Waste Management Facility leachate is stated to be 100 times greater than the ANZG (2018) default guideline values (DGVs) for ammonia as a toxicant (GHD 2020, App. K, p. 88). Elevated concentrations of aluminium, arsenic, boron, chromium, cobalt, copper, iron, nickel and zinc that exceed (at the 95th percentile) the relevant DGVs, have also been observed downstream of Awaba Waste Management Facility (WMP32 monitoring site) in an unnamed creek that flows into Lake Macquarie. If the environmental performance of the Awaba Waste Management Facility is impacted due to subsidence, the high concentrations of ammonia and dissolved metals present in the Awaba Waste Management Facility leachate have the potential to impact the receiving aquatic environment. Although the proponent expects no cumulative impacts to occur to the Awaba Waste Management Facility from predicted subsidence, potential cumulative impacts of the Facility's leachate on the water quality of downstream ecosystems, including Lake Macquarie, should be considered.

Water-dependent ecosystems

34. As highlighted in Paragraphs 13-14, the proponent has not conducted adequate ground-truthing and field surveys of the water-dependent ecosystems in and near the project area. Impacts on water-dependent ecosystems are likely to arise from the controlled and uncontrolled releases in the three discharge points (Awaba LDP009, Newstan LDP017 and Newstan LDP001), which discharge into Stony Creek and LT Creek. The proponent undertook direct toxicity assessment of the LDP001 discharge from 2015-2019 and found some toxicity to micro-algal growth (GHD 2020, App. N, Figure 4-9, p. 68), but did no further investigation. Furthermore, the proponent considers that increased total suspended solids and flow rates are likely impact pathways to aquatic biota as a result of these releases (GHD 2020, App N, pp. 69 – 70). However, the water quality impacts from the discharge points may contribute to a decrease in the overall condition in the creeks and downstream environments (e.g., estuarine wetlands, Lake Macquarie). In particular, noting that there are exceedances of some metals (cadmium, lead and zinc), the IESC considers that further work is required to improve confidence in the proponent's predicted impacts and these are detailed below.

35. To assess the potential impacts of releases and concomitant changes to water quality on aquatic biota and food chains in the receiving waters, the proponent should undertake additional field surveys (Paragraph 57).

36. First-flush events may transport pulses of contaminated sediments into the downstream environment (Lake Macquarie) and potentially have acute ecological impacts, particularly for sensitive biota. The proponent provided limited and sometimes illogical evidence based on 2019 sediment monitoring data to suggest the project is unlikely to contribute to ecological impacts from increased metals and bioaccumulation (GHD 2020, App N, p. 52-53). Despite only a small number of analytes from a few sites exceeding sediment quality guideline values (GHD 2020, App N, Tables 4-15 – 4-20), the proponent should consider the cumulative impact that the proposed discharges may have on sediment quality and potential bioaccumulation of metals. Further analysis and evidence is required to understand how discharge events may alter sediment quality and how this may impact local and downstream aquatic biota, especially if bioaccumulation occurs.

37. The composition and condition of riparian vegetation along LT Creek may be impacted by increased flows as the volume of water discharged from Newstan LDP001 increases. The proponent recorded the EPBC Act-listed Small-flower Grevillea *Grevillea parviflora* var. *parviflora* and Black-eyed Susan *Tetratheca juncea* in the riparian zone of streams in the project area (GHD 2020, App M, App A, p. 69). The proponent should survey the composition and condition of riparian vegetation along LT Creek, determine whether EPBC Act-listed species are present locally, or downstream, and assess likely impacts of increases in flow (e.g., on recruitment) on these and other riparian species.

38. Seepages into Muddy Lake, Whitehaven Lagoon and Lake Macquarie from the underground workings may occur and act as a contaminant transport pathway. These potential GDEs may support EPBC Act-listed threatened species and migratory birds that use these wetlands and estuaries as habitat or to breed, forage and feed, and also support aquatic biota and fringing vegetation. The proponent should assess the potential for these seepages to impact on these wetland and estuarine values, especially in the long term.

39. The proponent should consider the cumulative impact of discharges on water-dependent biota and ecosystems, especially as water quality currently exceeds DGVs and site-specific Guideline Values for numerous analytes at most monitoring sites (GHD 2020, App. N, p. 70). This may indicate an already stressed environment, potentially nearing ecological tipping points and associated irreversible change.

40. The proponent considers that subsidence is likely to have a moderate impact on aquatic biota, identifying reduced and fragmented habitat, altered water and sediment quality, and changes in flow

and velocity (GHD 2020, App N, pp. 71 – 73) as the potential impacts. However, potential impacts to riparian vegetation were not assessed adequately by the proponent (see response to Question 4).

41. Acknowledging subsidence as the most likely impact pathway to EPBC Act-listed species that potentially, or are known, to occur in the project area (GHD 2020, App M, App A, App D), the proponent suggests further monitoring is required to better understand how these species will be impacted (GHD 2020, App M, App A, App D). The IESC agrees that this further monitoring and assessment should be undertaken. This should include identifying likely habitats used by EPBC Act-listed species and the potential impacts to these locations from subsidence. This is discussed further in response to Question 4.

42. The proponent notes that EPBC Act-listed frog species (Green and Golden Bell Frog *Litoria aurea*, Giant Barred Frog *Mixophyes iteratus* and Littlejohn's Tree Frog *Litoria littlejohni*) are known to be impacted by changes in water quality and hydrology (GHD 2020, App M, App A, App D). As highlighted in Paragraphs 26 – 27 and 31 – 33, it is highly likely that surface water hydrology and quality will change, due to subsidence and the controlled and uncontrolled discharges. Additional impacts may also occur to these species if their habitat is found to depend on groundwater. The proponent should assess potential collective impacts on these species and, if appropriate, apply suitable avoidance and mitigation measures.

Question 4: Does the EIS provide reasonable strategies to effectively avoid, mitigate or reduce the likelihood, extent and significance of impacts (including cumulative impacts with the existing Newstan mine) to water-related resources? If not, what additional measures does the IESC consider are required to monitor, mitigate and manage impacts to water resources?

Groundwater

43. The proposed monitoring of groundwater levels and groundwater quality for the project area and the Awaba Conservation Area (GHD 2020, App. J, pp. 31, 55 – 57) needs further consideration.

    a. Groundwater levels are currently monitored at multiple locations, but only one vibrating wire piezometer monitors multiple depths in the project area. Additional multi-level piezometers are recommended to confirm the height of fracturing above extraction associated with proposed mining between the Earing Ash Dam, the Awaba seepage and surface waters (Paragraph 20). At least one additional multi-level piezometer should be located in this area and should be designed to monitor groundwater drawdown at multiple depths between the Munmorah Conglomerate and West Borehole seam. This multi-level piezometer should enable water sampling for environmental tracers and downhole geophysical logging, including downhole camera inspection.

    b. The proponent proposes two additional monitoring bores for alluvial aquifers within the Awaba Conservation Area. IESC supports this proposal, along with continuous groundwater level monitoring in these alluvial aquifers using pressure transducer loggers.

    c. Additional groundwater quality monitoring locations, sampling frequency and parameters are recommended. Currently, multiple monitoring bores are monitored twice a year for only groundwater level, pH and EC. An expanded program of quarterly groundwater quality monitoring that includes field parameters (e.g., pH, EC), major ions, dissolved and total metals and nutrients is recommended that adequately spans spatial variability and changes in groundwater quality over time. This expanded program should also apply to the additional bores proposed for the Awaba Conservation Area (Paragraph 43b. above)

44. The proponent recommended that the existing groundwater flow monitoring program at the Newstan Colliery and Awaba Colliery (GHD 2020, App. J, pp. 34 – 38) should continue, including monitoring of water levels in the Awaba Underground Void and of groundwater inflows and outflows in the project

area (GHD 2020, App. J, p. 55). The IESC agrees; however, further details about the flow monitoring program (e.g., a conceptual model or summary of the program, maps of monitoring locations) should be provided to allow assessment of the adequacy of the program.

45. The IESC recommends that the proponent investigate and monitor leakage from the Eraring Ash Dam, taking into consideration the recommendations provided in the Hydrogeotechnical Report (GHD 2020, App. I, pp.1 – 2, 5 – 6). Leakage pathways from the Eraring Ash Dam to surface waters (Paragraph 20) should be identified. The IESC recommends the use of environmental tracers (OWS 2020) and multi-level monitoring (see Paragraph 43a above).

46. After the project is approved, the proponent intends to combine the site-specific water management plans for the Newstan Colliery and Awaba Colliery and update this new plan for the proposed extension. The proponent notes that Trigger Action Response Plans (TARPs) are provided in the existing water management plans but does not clarify what the current TARPs are or how they may be updated (GHD 2020, App. J, pp. 56). Developing triggers based on relevant guidelines (e.g., ANZG 2018) at the assessment stage of the project would allow for more rigorous assessment of project monitoring and mitigation measures. The water-management plans should be based on the revised groundwater model and should consider the recommendations of the Hydrogeotechnical Report (GHD 2020, App. I, pp. 5 – 6).

Subsidence

47. The IESC cannot comment on the adequacy of mitigation, management and monitoring measures without a Subsidence Monitoring Plan, TARPs and adaptive management measures documentation being provided. The IESC recommends that the proponent provides a Subsidence Monitoring Plan which includes the following components.

    a. A monitoring program should be undertaken to measure the seismic energy released during and after mining operations. The monitoring data should be used to confirm that mine-induced seismicity is less than natural seismic background levels.

    b. Suitable drone- or satellite-based remote sensing should be used to confirm predicted subsidence and detect any movement of the Eraring Ash Dam. The resolution of the monitoring should be sufficient to identify localised anomalous subsidence.

    c. Regular subsidence observations collected from the monitoring site locations should be used to inform TARPs. The TARPs should specify practical options for changes to the mine plan and cease-to-work triggers.

    d. An extraction plan should be provided on a panel-by-panel basis during extraction. Each extraction plan should review all subsidence monitoring data from previous sections to confirm that no ground movements have occurred from the project before the next section is commenced. The review should also assess pillar stability nearby, including in the overlying historic workings.

    e. As highlighted by the Hydrogeotechnical Report, the inflow rates should be monitored on a panel-by-panel basis during extraction of the initial panels within the West Borehole Seam to better estimate the likely inflow rates below the Eraring Ash Dam.

    f. Intended adaptive management practices and their likely effectiveness should be specified.

    g. A program of field measurements should be undertaken in consultation with the operators of the Eraring Power Station during and after the void filling program, as suggested by the Hydrogeotechnical Report, to confirm the effectiveness of void filling as a barrier to flow from the Eraring Ash Dam into Awaba Colliery. This will also provide a baseline against which to assess further impacts from mining within the West Borehole Seam.

Eraring Ash Dam

48. A detailed monitoring program should be developed for the Eraring Ash Dam wall, which could include far-field survey marks, long-bay survey marks and extensometers and drone-based monitoring of mining-induced movement (Paragraph 47b). The monitoring program should also include the recommendations by a specialist dam engineer as highlighted in the Subsidence Assessment (GHD 2020, App. H, p. 102)

49. The proponent should provide details of their planned response in case of subsidence-related failure of the Eraring Ash Dam (e.g., a TARP) and options for remediating impacted water-dependent ecosystems. Furthermore, a suitable qualified soil mechanics specialist should be engaged to confirm that the material properties of the fly ash and the fill geometries being considered are capable of dissipating pore pressure in the timeframe of subsidence.

Other infrastructure

50. The proponent should provide management plans for the potential subsidence-related impacts to the infrastructure highlighted in Paragraph 22. These structures should be monitored and have TARPs in the event of impact. Preventative measures should then be developed to protect the integrity of the structures. For example, reinforcing the existing lining of the dams to ensure any cracking of the base will not result in the loss of stored liquids, such as oil.

<u>Surface water</u>

Mine-affected discharges

51. The proponent should provide a surface water monitoring framework for the mine-affected discharges (Paragraphs 26 – 27).

    a. The proponent should continue monitoring for a broad range of physiochemical parameters, including metals, major ions, nutrients and other contaminants such as oil/grease for discharges from the Awaba Pollution Control Dam. Results should be compared with the ANZG Guidelines (2018) for aquatic ecosystem protection.

    b. The proponent should characterise water quality in the current Awaba Pollution Control Dam. In-dam monitoring should include TSS, total nitrogen, phosphorus, dissolved metals and other contaminants (such as oil/grease).

    c. Given that there are already exceedances of several water quality guidelines, to better assess the potential impacts of these exceedances, the IESC recommends assessing labile metals and/or undertaking direct toxicity assessment of the discharges prior to release at Awaba LDP009 and Newstan LDP017.

    d. Given the likely elevated concentrations of contaminants in the Awaba Pollution Control Dam, the proponent should specify the handling, storage and disposal methods for the sediment removed from the dam.

    e. The proponent should include the Awaba seepage in the monitoring framework (Paragraphs 29 – 30).

    f. Water quality and visual monitoring in all streams within the current and proposed project area should be undertaken to identify any potential impacts to surface and groundwater quality from fracturing in the stream beds. Sites should be selected based on the Subsidence Assessment's predictions for the streams in the project area and include sites that either receive mine-affected discharges (GHD 2020, App. H, p. 46 – 47), seepage or both.

Subsidence-related impacts

52. As outlined in the Hydrogeotechnical Report (GHD 2020, App. H), the proponent should develop an effective water treatment management plan for the site which accommodates the potential interaction between the Awaba Colliery, Newstan Colliery and the Eraring Ash Dam. The plan should detail the range of possible flow rates and constituent concentrations to estimate the loads and volumes that would require treatment. This should be developed for long-term management and mine closure (Paragraphs 62-64).

53. The proponent has not provided a subsidence management plan. This plan should recommend monitoring and management for the streams in the project area. The proponent should outline feasible remediation methods that could be undertaken on larger surface cracking and erosion protection measures to stabilise the slopes and banks in the longer term. The IESC recommends the following management for streams in the project area.

    a. Periodic visual monitoring to be carried out along Stony, Kilaben, Stockyard and Crooked creeks during and after undermining.

    b. Ground monitoring to confirm and verify the subsidence and ground movements across these streams. This monitoring should be used to inform the extraction plan (Paragraph 43d) and be also used to suggest modifications to the mine layout as an avoidance measure.

    c. A management plan should be developed that includes impact monitoring (impacts outlined in Paragraphs 31 – 33) and management provisions for the streams.

Awaba seepage – modelling

54. As discussed in Paragraph 30, metal sulfide oxidation and acid generation occurred within the Awaba Underground Void producing acidic seepage that impacted the unnamed tributary of Muddy Lake (GHD 2020, App. K, App. C, p. 21). The released water had a low pH, elevated EC, and elevated concentrations of potentially ecotoxic metals, including nickel and zinc. Although the proponent expects no acid production to reoccur in the Awaba Underground Void (GHD 2020, App. K, App. C, p. 12), more information regarding the previous and potential future risks of metal sulfide oxidation and acid generation in the Awaba Underground Void should be provided to better assess the potential impacts of future outflows from the Awaba seepage on the water quality of Muddy Lake. The proponent should provide any mitigation or management measures to prevent acidic water from the Awaba Underground Void from impacting the receiving environment should this reoccur.

<u>Water-dependent ecosystems</u>

55. No monitoring, mitigation or management plans have been provided for surface-expression GDEs, including groundwater-dependent vegetation. These plans should be developed following ground-truthing field studies using techniques recommended by Doody et al (2019). Where GDEs are mapped within the zone of predicted drawdown (GHD 2020, Fig. E-1 in App. E in App. J), baseline data on groundwater use by GDEs should be collected to inform monitoring, mitigation and management plans.

56. Stygofauna sampling has not been done to determine their presence in the project area. The EC of the groundwater for most bores is suitable for stygofauna (<2000 µS/cm (GHD 2020, App J, App C, Figure C-2 and C-61)) and there are aquifers within the project area that could support stygofauna (e.g., sediments within paleochannels). The proponent should conduct suitable field surveys (using methods described in Doody et al. 2019) in aquifers where drawdown is predicted and/or groundwater water quality may be altered. If stygofauna are found, appropriate mitigation, management and monitoring plans should be developed.

57. The proposed aquatic ecology monitoring plan is inadequate to assess potential impacts to freshwater and estuarine biota. Surveys should include a greater range of taxa (e.g., fish) and target potentially occurring EPBC Act-listed species, and their habitat as identified by the Department of Agriculture, Water and Environment's Protected Matters Search Tool. These surveys should be undertaken for at least two years to provide up-to-date baseline data and inform monitoring, mitigation and management plans. The potential sensitivity of freshwater and estuarine biota to predicted changes in flow and water quality (Paragraphs 34 – 42) should be considered when developing these plans.

58. Mitigation, management and monitoring information provided for terrestrial EPBC Act-listed species was limited. A Biodiversity Management Plan that includes TARPs is intended (GHD 2020, App M, App A, p. 61) and will identify the potential impacts to listed species (GHD 2020, App M, App A, p.78). As this plan was not provided, the IESC cannot comment on its adequacy for application to water-dependent biota and ecosystems. The current documentation of habitats and associated EPBC Act-listed species in GDEs, streams, coastal wetlands and estuaries in the project area is not sufficient to adequately inform mitigation, monitoring and management plans. Further field surveys are needed that should include the identification and mapping of potential habitat for EPBC Act-listed species that may or do occur within or near the project area. These mapping data can then be assessed against field data (Paragraph 13, 55) to evaluate potential impacts of the project on EPBC Act-listed species associated with water-dependent ecosystems, and guide relevant mitigation, management and monitoring plans.

59. Following the recommended field studies of GDEs and other water-dependent ecosystems (Paragraphs 13 –14, 55 – 58), an ecohydrological conceptual model should be developed. This model should identify the connections and interactions between water-dependent ecosystems, surface water and groundwater. Potential impact pathways to water-dependent ecosystems can be identified through this model to better target monitoring, mitigation, and management strategies.

60. The proponent has not provided information on how subsidence-related impacts on water-dependent biota and ecosystems will be mitigated. These mitigation plans should be developed following further field surveys and the development of an ecohydrological conceptual model (Paragraph 59) and should include suitable TARPs, including for Awaba LDP009.

61. An assessment is needed of how subsidence may impact the paleochannel situated underneath the mine workings and Whiteheads Lagoon, a potential GDE. This lagoon may support EPBC Act-listed species that use wetlands and estuaries as habitat (e.g., Australasian Bittern *Botaurus poiciloptilus* and White-bellied Sea-Eagle *Haliaeetus leucogaster*). It is also likely to be important for migratory birds and other wildlife.

Restoration and long-term impacts

62. The proponent presented a very high-level strategy for the restoration and closure of the site outlining that the site will be restored to its current land uses and for potential future re-development. Given the historical mining activities in the project area, there may be long-term water quality issues relating to the underground voids, underground water storage, discharges and seepages. For example, contaminated seepage occurred soon after the Awaba Colliery Mine ceased operation (Paragraph 20). The proponent has not presented a restoration strategy (including post-closure monitoring of groundwater, surface water and ground movements) which considers unavoidable long-term water quality issues and hydrological changes likely to occur for decades after mining ceases.

63. As part of the restoration strategy, the proponent should identify any long-term impacts resulting from discharges from the surface facilities and the underground storage areas. Restoration, mitigation and management strategies for the water resources in the project area should be provided in a discharge water management plan. The plan should include a water balance model which considers water

storage and discharge under worst-case climate change scenarios. The proponent should include timelines for the discharges, whether there will be any discharge and beneficial reuse during and after mining operations, and avoidance, mitigation and monitoring measures to reduce potentially adverse impacts. This should also include the seepages from Muddy Lake and any long-term impacts to the receiving environment, Lake Macquarie.

64. This restoration strategy should also specify potential long-term effects on the Awaba Biodiversity Conservation Area, which is required to be managed in perpetuity for biodiversity conservation in accordance with the terms of an agreement established under the EPBC Act.

Cumulative impacts

65. There are cumulative impacts associated with the historical mining operations, and neighbouring coal mines including Mandalong Mine and Myuna Colliery. However, the proponent has not modelled or discussed potential cumulative influences of discharge from the underground storages, flows and groundwater seepages on water quality. Discussion of the project's contributions to cumulative drawdown is also limited. Cumulative impacts from the historical mining operations and the proposed project on Lake Macquarie and the Awaba Waste Management Facility have not been modelled (Paragraphs 24 & 33). The proponent should assess the project's contributions to the potential cumulative impacts, suggest strategies to reduce these contributions, and monitor their effectiveness during and for a suitable time after operations for all potentially impacted water resources.

66. A cumulative impact assessment on water-dependent ecological communities and biota, especially EPBC Act-listed species, should be provided. This assessment should include potential impacts from other mining projects (past, current and future), the Eraring Ash Dam, and the Eraring Power Station. The IESC considers this is critical because:

    a. watercourses potentially impacted by the project already exceed DGVs for numerous analytes (e.g., dissolved metals), at most sites (GHD 2020, App K, pp.73 – 98). This potentially indicates a stressed environment in which communities (especially those in downstream receiving environments such as coastal wetlands and estuaries along the edge of Lake Macquarie) may be nearing ecological tipping points and associated irreversible change; and

    b. mining impacts and ground movements are already occurring within the vicinity of the project. The cumulative impact assessment should consider the potential for EPBC Act-listed species habitat to have already been fragmented or reduced and how this project may further contribute to this.

67. The limited assessment of the cumulative and long-term impacts of the project should be further strengthened through a comprehensive risk assessment. Where possible, this risk assessment should draw on reliable baseline data against which to judge the effectiveness of mitigation and management plans in addressing cumulative and long-term impacts.

Date of advice	15 November 2021
Source documentation provided to, and used by, the IESC for the formulation of this advice	GHD 2020. *Centennial Newstan Pty Ltd. Newstan Mine Extension Project Environmental Impact Statement.* September 2020. GHD (2020, App. H). Appendix H: *Subsidence predictions and impact assessments. Mine Subsidence Engineering Consultants (MSEC) 2020. Newstan Colliery: Mine Extension Project. Subsidence Predictions and Impact Assessments for Natural and Built Features due to the proposed 201 to 218 Panels in Support of the Environmental Impact Statements*. Report number MSEC1042, February 2020.

GHD (2020, App. I). Appendix I: *Hydrogeotechnical impact assessment. Strata Control Technology (SCT) 2019. Centennial Coal Company Limited. Newstan Mine Extension Project: EIS Assessment of Interaction with Eraring Ash Dam*. NST4976 Gateway Application.

GHD (2020, App. J) Appendix J: *Groundwater impact assessment. GHD 2020. Centennial Newstan Pty Ltd. Newstan Mine Extension Project. Groundwater Impact Assessment*. June 2020.

GHD (2020, App. K) Appendix K: *Surface water impact assessment. GHD 2020. Centennial Newstan Pty Ltd. Newstan Mine Extension Project. Surface Water Impact Assessment*. March 2020.

GHD (2020, App. M) Appendix M: *Terrestrial ecology impact assessment. RPS 2020. Newstan Mine Extension Project*. Biodiversity Development Assessment Report Document # 141842. 22 March 2020.

GHD (2020, App. N) Appendix N: *Aquatic ecology impact assessment. GHD 2020. Centennial Newstan Pty Ltd. Newstan Mine Extension Project. Aquatic Ecology Impact Assessment*. January 2020.

References cited within the IESC's advice

ANZG, 2018. *Australian and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand Governments and Australian state and territory governments*, Canberra ACT. Available online: https://www.waterquality.gov.au/anz-guidelines.

Datry T, Bonada N and Boulton AJ (Eds.) 2017. *Intermittent Rivers and Ephemeral Streams: Ecology and Management*. Amsterdam: Elsevier.

Doody, TM, Hancock PJ and Pritchard JL, 2019. *Information Guideline Explanatory Note: Assessing Groundwater-dependent ecosystems*, Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of Environment and Energy, Commonwealth of Australia 2019.

IESC, 2018. *Information Guidelines for proponents preparing 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-may-2018.pdf.

OWS 2020. *Fact Sheet - Environmental water tracers in environmental impact assessments for coal seam gas and large coal mining developments*. Office of Water Science, 2020. Prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development. [Online]. Available: https://iesc.environment.gov.au/system/files/resources/269a12ba-09a5-424f-bda3-d5f9679317c7/files/environment-water-tracers-factsheet.pdf