



Advice to decision maker on coal mining project

IESC 2024-148: Baralaba South Project (EPBC 2012/6547) – New Development

Requesting agencies	The Australian Government Department of Climate Change, Energy, the Environment and Water The Queensland Department of Environment, Science and Innovation
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Advice stage	Assessment

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

The IESC was requested by the Australian Government Department of Climate Change, Energy, the Environment and Water and the Queensland Department of Environment, Science and Innovation to provide advice on the Baralaba South Pty Ltd's Baralaba South Project in Queensland. 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 2024).

Summary

The Baralaba South Project (the 'project') is a greenfield open-cut metallurgical coal mine located in the lower Bowen Basin region of Queensland, approximately 8 km south of the town of Baralaba and 115 km west of Rockhampton (AARC 2023a, Chapter 2, p. 2-1). The project will disturb up to 1,211 ha of land within Mine Lease Application 700057 (the MLA) and produce up to 2.5 million tonnes per annum of run-of-mine coal over the 23-year life of mine (AARC 2023a, Chapter 2, p. 2-1).

The project includes the excavation of an open-cut pit, construction of a coal handling and preparation plant, on-site disposal of waste material in waste rock emplacements, and construction of supporting infrastructure (including electricity transmission lines, roads and operational facilities). The open-cut pit

will be mined from north to south, with progressive backfilling and staged rehabilitation works as mining advances (AARC 2023a, Chapter 2, Figure 2.31, p. 2-64). Proposed rehabilitation of the project area will include stabilisation and reseeded of the waste rock emplacements and retention of the final void as a pit lake (AARC 2023a, Chapter 3, p. 3-5).

As part of operations, the proponent plans to release mine-affected water (MAW) into the Dawson River when the mine water system is at capacity during wet periods (AARC 2023a, Chapter 4, p. 4-63), and when Dawson River flows are greater than 100 m³/s (AARC 2023a, Chapter 4, p. 4-60). The proponent also plans to take raw water from the river under existing licences (Engeny 2023a, p. 65).

The proponent's ecological surveys reported diverse water resources within and near the project area, including a High Ecological Significance (HES) wetland and other wetlands, multiple watercourses, stygofauna and other groundwater-dependent ecosystems (GDEs). Terrestrial GDEs extend along the Dawson River, its anabranch and Banana Creek, and are considered to be mainly using groundwater in sandy lenses perched above and disconnected from the regional groundwater table (3D Environmental 2023, p. 3). Stygofauna were collected from the Dawson River's alluvium (Stygoecologia 2019, Table 1, p. 10). Threatened Ecological Communities (TECs) listed by the *Environment Protection Biodiversity and Conservation Act 1999* (EPBC Act) in and near the project area include Brigalow (*Acacia harpophylla* dominant and co-dominant) and Coolibah Black Box Woodlands of the Darling Riverine Plains, along with at least nine species listed as Matters of National Ecological Significance (MNES) under the EPBC Act.

Key potential impacts from this project are:

- clearing of habitat and riparian corridors important for flora and fauna in a landscape already largely cleared for agriculture;
- permanent impacts to 2.33 ha of ground-truthed waterways considered to provide fish passage;
- decreases in surface water quality from controlled discharge of mine-affected water and uncontrolled overflow from sediment dams releasing contaminated water and sediments downstream, impacting downstream users and the receiving environment;
- impacts to tributary streams within the MLA, including loss of first- and second-order streams, from the mine development footprint, stream diversions and reduction or loss of catchment areas, with repercussions for Shirley's Gully, the downstream receiving stream reach which has been identified as having moderate to high values for fish, turtles and other aquatic species (ESP 2023, p. 44);
- groundwater drawdown within the alluvial system impacting stygofauna and other groundwater-dependent ecosystems (GDEs);
- impacts to fish and turtle movements and habitat downstream due to stream diversions limiting passage and increasing sediment loads to the downstream environment;
- changes to flood levels and velocities from the mine disturbance area and final landform, potentially exacerbated by climate change; and
- cumulative impacts of the proposed project, such as groundwater drawdown, loss of habitat corridors and loss or changes to tributary streams, combining with those from current and proposed activities in the catchment (e.g. Baralaba North Mine and Dawson Mine).

The IESC has identified additional work to address the key potential impacts as detailed in this advice. This work is required to convincingly demonstrate that the potential impacts identified above will either not occur or can be adequately mitigated, and is summarised below.

- Site-specific water quality and streamflow data are needed, including from Shirley's Gully and watercourses within the MLA, to develop site-specific water quality objectives and flow regimes and inform water balance and flood modelling.
- Further information is needed regarding the potential for flood-overtopping of sediment dams and the associated potential impacts to water quality and infrastructure.
- An assessment is needed of the potential water quality of mine-affected water (MAW) beyond just electrical conductivity (EC) to be able to fully assess potential impacts of controlled releases of MAW into the Dawson River on downstream users and the environment, as well as inform monitoring and management plans.
- More recent (post-2020) field surveys are needed of the ecological values of surface waters within and downstream of the project area (e.g. Shirley's Gully) and of aquatic and terrestrial GDEs that may be affected by drawdown and other project-related activities.
- Clearer explanation is needed of planned rehabilitation strategies, such as revegetation of the stream diversion along Tributary 8 to remediate loss of riparian corridors and reduce impacts to EPBC Act-listed species.
- Further assessment is needed of the HES wetland's and other wetlands' potential dependence on groundwater to properly identify potential impacts from groundwater drawdown. This information will inform monitoring plans, including which ecological values need to be monitored.
- Detailed management plans should be developed to describe monitoring, mitigation and management measures to address all potential residual impacts on water resources during and after the project.

Context

The project is a proposed greenfield open-cut metallurgical coal mine and associated infrastructure to be located on existing grazing land in the Bowen Basin, 8 km south of Baralaba and 11 km south of the existing Baralaba North Mine (AARC 2023a, Chapter 2, Figure 2.2, p. 2-8). Other mining operations in the vicinity of the project include the Dawson Mine 25 km to the south-east, the Meridian Coal Seam Gas Project 28 km to the south and the Mungi North proposed gas field 5 km to the south (AARC 2023a, Chapter 2, p. 2-7).

The MLA covers approximately 2,214 ha with a mine disturbance area of approximately 1,211 ha (AARC 2023a, Chapter 2, p. 2-1). Mining activity in the open-cut pit targets eight seams of the Baralaba coal measures (AARC 2023, Chapter 2, p. 2-39) and will be undertaken from north to south, with progressive backfilling and staged rehabilitation works as mining advances (AARC 2023a, Chapter 2, Figure 2.31, p. 2-64). In addition to the pit, disturbance will include the development of associated infrastructure, including an electricity transmission line (16 ha), access easement for the pumping station and water-release pipeline (1 ha) and a realignment of the Baralaba-Moura Road (14 ha) (AARC 2023a, Chapter 2, p. 2-1). Other on-site infrastructure will include a coal handling and preparation plant, waste-rock emplacements for disposal of reject material, mine water and sediment dams, and operational infrastructure such as offices, warehouses, a vehicle wash-down bay and a refuelling facility (AARC 2023a, Chapter 2, p. 2-1). To facilitate construction, approximately 200.6 ha of vegetation will be cleared.

The project area is located to the west of Mount Ramsay (AARC 2023a, Chapter 2, p. 2-37) and is on the floodplain of the Dawson River, within the Lower Dawson sub-catchment of the Fitzroy Basin (AARC 2023a, Chapter 2, p. 2-7). This river is a perennial eighth-order stream that is subject to seasonal flooding during the wet season (November to April), and has a floodplain 1.5 – 3 km wide on either side (AARC

2023a, Chapter 2, p. 2-37). The MLA boundary is within 700 m of the river and within 400 m of an anabranch (Engeny 2023a, p. 17). The proponent has developed the mine disturbance area to be outside of the 10% AEP flood extent (Engeny 2023b, p. 71), but some areas, specifically in the northwest, are predicted to progressively reduce the extent of floodplain inundation with increasing event severity. Banana Creek, a fifth-order tributary, joins the Dawson River 1 km to the west of the project area (AARC 2023a, Chapter 2, Figure 2.18, p. 2-38). Within the disturbance area, multiple unnamed first- and second-order drainage lines feed Tributary 8, a third-order stream colloquially named Shirley's Gully and rated as having moderate to high aquatic values (ESP 2023, p. 44), which in turn feeds into an anabranch of the Dawson River (AARC 2023a, Chapter 2, p. 2-39).

These watercourses support riparian vegetation that acts as habitat and corridors for several species listed by the *Environment Protection Biodiversity and Conservation Act 1999* (EPBC Act) as MNES (Table 11, ECOSM 2023, p. 106), including the Ornamental Snake (*Denisonia maculata*), Koala (*Phascolarctos cinereus*), Squatter Pigeon (*Geophaps scripta scripta*), Australian Painted Snipe (*Rostratula australis*), Greater Glider (central) (*Petauroides volans*), Yellow-bellied Glider (south-eastern) (*Petaurus australis australis*), and the White-throated Needletail (*Hirundapus caudacutus*), as well as the Queensland Nature Conservation Act 1992 (NC Act)-listed Short-beaked Echidna (*Tachyglossus aculeatus*). Two other EPBC Act-listed species, the Fitzroy River Turtle (*Rheodytes leukops*) and White-throated Snapping Turtle (*Elseya albagula*), are known to occur in the Dawson River downstream and could potentially use watercourses (e.g. Shirley's Gully) within and directly downstream of the project area. In addition to listed species, two Threatened Ecological Communities (TECs) are known to occur within the project area: the Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC and the Coolibah Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions TEC (ECOSM 2023, p. 24). An HES wetland occurs in the south-western area of the mining lease outside of the area of disturbance. An HES wetland is a State significant wetland that is within the Queensland Wetland Protection Area and has been determined to have high ecological value.

The Dawson River adjacent to the project area is a regulated reach, with six weirs and a network of channels along the river upstream and downstream of the project area (AARC 2023a, p. 2-35). These channels and weirs are part of the Dawson Valley Water Supply Scheme, which supplies water for agriculture, industry, town water and recreational use. The closest weir to the project area is the Neville Hewitt Weir (NHW) at Baralaba, 8 km downstream, which supplies water to these users, including town water for Baralaba and water for the Woorabinda Aboriginal Shire Council (AARC 2023a, Chapter 4, p. 4-37). During flood events, NHW forms the Baralaba Weir Pool that extends upstream past the project area (WRM 2023, p. 14).

The project area is located outside the Great Artesian Basin and Other Regional Aquifers (GABORA) water plan and any other declared Groundwater Management Areas (AARC 2023a, Chapter 2, p. 2-7). There are two main hydrogeological units in the project area: 1) the Quaternary alluvial and colluvial sediments associated with the Dawson River and its tributaries, and 2) the Permian strata, specifically the Baralaba Coal Measures, as well as the overlying Rewan Formation and underlying Gylanda Formation (Watershed 2023, p. 103).

Two types of groundwater-dependent ecosystems (GDEs) have been identified in the project area. The first is terrestrial GDEs that are associated with overland flow paths where ponded water infiltrates into subsurface sandy lenses supporting shallow high-quality groundwater perched above and disconnected from the regional groundwater table (3D Environmental 2023, p. 3). The second is stygofauna, collected from the Dawson River alluvium and wholly reliant on groundwater (Stygoecologia 2019, p. iii). Groundwater-dependence of wetlands in and near the project area is less clear and requires further field assessment.

Response to questions

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

Water resources and assets

Question 1: Advice is sought on whether the proponent has adequately characterised surface and groundwater resources to allow for an adequate assessment of the proposed Project's impacts on surface and groundwater resources, and water-related assets, including the residual void and diversion channel.

Groundwater

1. Much detailed information on groundwater resources has been provided for the project area; however, the following limitations should be addressed:
 - a. Interaction between groundwater, wetlands and streams depends on the depth to water, which is estimated from potentiometric head observations and topography. There is an adequate observation network at Baralaba South (Watershed 2023, p. 45), although it could be improved (Paragraph 34). However, depth-to-water estimates would be better supported if project area data were combined with regional observations (i.e. outside the project area and Baralaba North Mine), if any exist.
 - b. It is not clear in the reports where the watertable lies in the alluvium and colluvium, and where those units are dry or perched. The cross-sections of Figures 3-13 and 3-14 (Watershed 2023, p. 74 – 75) should be supplemented with maps showing the estimated unconfined and dry extents of surface units.
 - c. A 3D regional geological model was developed but its layering is not presented. Elevation maps of the stratigraphic units should be provided.
 - d. The proponent states that recharge into the alluvium associated with the Dawson River is anticipated to occur during high-flow periods, following significant rainfall events, although insufficient data are available to quantify the recharge. The proponent stated that recharge from the alluvium into the underlying units may also occur (Watershed 2023, p. 87). To understand the connectivity between the alluvium and the underlying units, the flux over time between these layers should be provided from the groundwater model.
2. Two main datasets have been used to characterise the quality of the groundwater systems in the project area. Physico-chemical parameters and major ion hydrochemistry data from the alluvium and Permian coal measures were obtained in 2012. Additionally, water quality data for both the shallow (alluvium and colluvium) and deep (Permo-Triassic strata) groundwater were obtained from December 2017 to March 2020 (Watershed 2023, pp. 91 – 96).
 - a. The characterisation of the groundwater systems has an adequate temporal scale; however, due to climatic events that occurred after 2020, more recent groundwater quality data should be obtained from the shallow groundwater system as recharge of these surficial sediments is predominantly from direct rainfall and infiltration from streams (Watershed 2023, p. 104).
3. The proponent states that, based on vegetation mapping, surveys and groundwater level monitoring that shows the depth of the water table is approximately 15 m below the HES wetland (Watershed 2023, p. 73), the HES wetland is considered to be a 'perched' system (i.e. disconnected from the regional groundwater system) and reliant on direct rainfall, runoff and floodwaters, which are held near the surface by the shallow clays (Watershed 2023, p. 73). The proponent states that an assessment of groundwater dependence by 3D Environmental (2023) confirmed the HES wetland is not a GDE. However, in Figure 16 (3D Environmental 2023, p. 48), there was one GDE found to have 'moderate' groundwater availability and further investigations should be considered, as discussed in Paragraph 18.

Surface Water

4. The proponent has made reasonable attempts to collate available data to adequately characterise surface water resources to allow for reliable assessment of the project's impacts. However, limited information is provided for Banana Creek adjacent to the project area, and almost no information is provided regarding the hydrology, flow regimes and water quality of the watercourses within and downstream of the project (especially Tributary 8 and the reach colloquially named Shirley's Gully whose upstream drainage network will be reduced by mining, see Paragraph 17). The collection of additional site-specific data (Paragraph 35) would provide increased confidence in their assessment, as outlined below.
 - a. Minimal baseline site-specific water quality data have been collected for the Dawson River and Banana Creek adjacent to the project area. No water quality data have been collected from Shirley's Gully or watercourses within the MLA. These watercourses will be directly impacted by clearing and mining, will be diverted around the mine landform, and/or will be the drainage lines receiving overflow from the sediment dams (Engeny 2023a, p. 87). Baseline data (including concurrent data from reference sites unlikely to be affected by the project) are needed to characterise these systems, to better assess the potential impacts from the project.
 - b. Baseline streamflow data should be collected for Banana Creek, Shirley's Gully and watercourses within the MLA. Monitoring of these watercourses should begin at least two years prior to operations to inform and validate the streamflow assessment and water balance and flood models, and to characterise ecologically important components (e.g. durations of low- and zero-flow periods) of the flow regime.
5. There is limited information about the three proposed diversions, including the 0.39-km diversion of Tributary 8, a third-order stream with sections classified as being at a high risk of adverse impacts to fish movements (ESP 2023, p. 12, 53). Information is needed on how these diversion channels will be designed, and how stream functions, including fish passage and other ecological processes will be retained or re-established (White et al. 2014).
6. Limited consideration is given to the water quality of MAW and the potential impacts due to the proposed controlled release of MAW. The proponent uses electrical conductivity (EC) as a water quality indicator but does not discuss the potential for other parameters of concern, such as Al, As, Be, Mo, Se and V, as highlighted in the geochemistry results (Terrenus 2023, p. 17 and Table C4). The following is recommended:
 - a. A more thorough assessment of available water quality data focusing on the proposed water quality indicators (Engeny 2023a, p. 26) is needed to understand any risks related to controlled release of MAW to the receiving environment.
 - b. The proponent has assessed changes in EC at Beckers gauging station as a result of MAW releases, which shows a potential change in EC of 80 $\mu\text{S}/\text{cm}$ 16 km downstream of the project area (Engeny 2023a, pp. 109-110). An assessment is needed closer to the project area to better assess changes in EC (and other water quality parameters) directly downstream of the project area and also closer to NHW, to properly inform the impact assessment of these receiving waters.
 - c. Water quality data from other mines in the area, such as Baralaba North, should be considered, especially when assessing potential cumulative downstream impacts of released MAW.
7. The proponent briefly discusses the mixing zone directly downstream of the controlled release location (Engeny 2023a, p. 69), and states that while "small areas of elevated EC concentrations are expected in the localised vicinity", average salinity in the river will be below receiving waterway limits due to the high dilution rate (1:200) of the proposed release conditions. However, a full assessment is

not presented and no parameters other than EC are discussed. Potential contaminants in the MAW may require greater dilution factors to meet WQOs (as per ANZG 2018) and limit impacts to water or sediments. A more thorough assessment with other water quality parameters of this zone should be undertaken to be able to assess potential impacts to aquatic ecology and riparian vegetation to this reach of the Dawson River.

Ecology

8. The proponent has provided a characterisation of the aquatic biota of the project area. However, the data provided are at least four years old, based on field surveys concluded in 2018, with only a supplementary inspection done in 2023 (ESP 2023, p. 7). Additional detailed surveys of aquatic biota, specifically addressing seasonal variability because many of the watercourses are ephemeral, are needed to collect up-to-date field data to supplement the information from the 2017 and 2018 studies and provide a more reliable baseline characterisation of biota, instream habitat quality and ecological condition of the watercourses within and near the project area.
9. Although the proponent has characterised the GDEs within and near the project area, the data are 3 to 7 years old, with the most recent field surveys done in 2020 after an especially dry year. To provide a better baseline against which to assess potential impacts, further surveys are needed of stygofauna (sampled in 2017-18, Watershed 2023, p. 11) and of terrestrial GDEs to collect up-to-date data to confirm the earlier survey results and more reliably characterise groundwater use, community composition and ecological condition of these ecosystems within and surrounding the project area.

Question 2: Advice is sought on whether the EIS has identified and assessed all the key risks and potential impacts to water resources and related assets as a result of the proposed project, including to:

- a. groundwater and surface water, including drinking water supplies downstream and other water supplies used for purposes such as irrigation and industrial supply, particularly those found in the Neville Hewitt Weir at Baralaba.
- b. groundwater-surface water interactions
- c. water-dependent ecosystems, aquatic ecosystems and associated threatened species habitat
- d. any consequential impacts of changes of the project to surface and groundwater resources on, and risks to, aquatic ecosystems and water-dependent ecosystems
- i. does the IESC consider that the potential impacts and risks to aquatic ecosystems have been adequately identified and described in the EIS?
- ii. if not, what additional measures does the IESC consider are required to adequately monitor, mitigate and manage potential impacts to water resources?

10. The EIS's identification and assessment of the project's risks to water resources should include one or more impact pathway diagrams (IPDs), derived from a suitable evidence-based ecohydrological conceptualisation, to illustrate all the potential direct and indirect impact pathways and their interactions during and after mining. As project-related drawdown, controlled and uncontrolled releases, raw water take and external events such as flooding will occur concurrently, the combined effects of these on water resources and water-dependent Commonwealth- and State-listed species should be assessed. Drawing up the IPDs using appropriate methods (e.g. Commonwealth of Australia 2024) will also better integrate the different sections of the EIS, illustrate interacting impact pathways and help identify and justify where further data, monitoring and mitigation measures are required (see response to Questions 5 and 6).

Groundwater

11. Further investigation is required regarding the degree of connectivity between the Permian coal measures, the surficial deposits (colluvium and alluvium) and surface water to understand some of the potential impacts to groundwater levels identified by the proponent.
 - a. The groundwater model should be used to provide plots of critical water balance components over time, including both historical and predictive periods. This should include groundwater-surface water fluxes (Dawson River and Banana Creek), and groundwater exchange between alluvium/colluvium and underlying units in and around the project area.
 - b. The issues raised in Paragraph 1b must be resolved and the model results discussed in terms of that conceptualisation, as the current model results show saturated areas in locations described as dry. For example, the predicted 8-m maximum drawdown for the 50th percentile within the colluvium just to the west or south-west of the open-cut pit, which also shows that this cone of depression could extend west to Banana Creek (Watershed 2023, p. 165), is not consistent with the conceptualisation that the colluvium is typically dry and only recharged by direct rainfall (Watershed 2023, p. 104).
 - c. The proponent should provide maximum predicted saturated groundwater drawdown in the alluvium and colluvium as a result of the project for the 95th percentile and discuss potential impacts to the alluvium and colluvium so that the largest potential impact to groundwater-dependent assets can be assessed.

Surface Water

12. Without appropriate characterisation of MAW water quality and prediction of its likely effects on the water quality of receiving waters, it is not possible to fully assess the potential impacts to water resources in the Dawson River downstream of the project area and upstream and within NHW. As discussed in Paragraph 6, current consideration of water quality impacts is limited to EC in the Dawson River, and most changes are presented for Beckers gauging station downstream of the weir. Site-specific data are needed to confirm that the EC-flow relationships at Beckers gauging station are justified to inform release conditions at the release point. Site-specific data, for both baseline water quality and predicted MAW water quality, are also needed to understand the potential impacts immediately downstream of the mine and upstream of NHW to properly assess the risks to the downstream environment and water supplies used for town water supply, irrigation and industry, which are predominantly sourced from NHW.
13. The proponent should clarify release conditions in the proposed draft Environmental Authority (EA) and what streamflow data will inform release opportunities. The draft EA states that release opportunities will be informed by streamflow at Beckers gauging station (AARC 2023a, Chapter 19, p. 19-15); however, it is also stated that streamflow at the Dawson River Confluence monitoring point, directly downstream of the project area, will inform release opportunities during operations (Engeny 2023a, p. 133). In addition, the proponent should clarify that releases can only occur when flows exceed 100 m³/s, and not just start at these flow conditions, to ensure that dilution factors are maintained and impacts to the receiving environment are limited over the release period.
14. Flood modelling indicates minor changes to flood depths, velocity and bed shear stress as a result of the mine landform for 2% AEP (Annual Exceedance Probability) and 1% AEP flood events (AARC 2023a, Chapter 6, pp. 6-19 – 6-31); however, these are centred along the northwest edge of the Waste Rock Embankment (WRE) where the Tributary 8 stream diversion is proposed. The occurrence of sodic soils in the MLA (AARC 2023a, Chapter 4, p. 4-67), and the lack of information regarding the diversion design, erosion management strategies and vegetation reestablishment, means that there are potential risks of additional erosion and scour in this area that cannot be assessed with the information provided. The proponent should address these information gaps and

justify predictions of changes to flood regimes and erosion arising from the project, including the final landform.

15. There is a risk of sediment dams overtopping during flood events and releasing water and sediment into the system. Several sediment dams may be inundated in flood events rarer than the 10% AEP event (Engeny 2023b, p. 85). Sediment dams and clean water dams within the 0.1% AEP flood extent will be of mostly excavated construction to reduce the risk of dam break (Engeny 2023b, p. 80). The proponent should present information about which sediment dams may flood, and the likely overflow volumes and potential impacts associated with such an event, to properly assess potential impacts to surface waters.
16. There are inconsistencies in the information presented regarding seepage from the WRE reporting to the pit and mine water system (AARC 2023a, Chapter 4, p. 4-68) or reporting to the sediment dams and the sediment containment system (Engeny 2023a, p. 112). Seepage from the WRE may be enriched in some metals, such as Al, As, Mo and Se (AARC 2023a, Chapter 4, p. 4-68). Clarification is needed of seepage flow directions and volumes to assess impacts of this WRE seepage with possible metal enrichment leaching to sediment dams that may then overflow to the tributaries in the MLA and impact receiving waters.
17. Several surface water drainage tributaries that cross the proposed mine disturbance area will be removed or diverted as a result of the project. This will result in a loss of catchment area of 33% to Tributary 8 and Shirley's Gully (Engeny 2023a, p. 108). Further baseline information on water quality, flow regimes and instream and riparian habitat should be collected, as discussed in Paragraphs 4, 20, 21 and 35, and the proponent should assess the potential geomorphological, hydrological and ecological impacts of this loss of catchment area on these tributaries, especially Shirley's Gully which has been identified as having moderate to high values for fish, turtles and other aquatic species (ESP 2023, p. 44).

Ecology

18. The proponent discusses potential groundwater drawdown impacts to GDEs but has not considered how drawdown may impact wetlands in and near the project area. This seems to be due to the conceptualisation that the wetlands are reliant on overland flows (3D Environmental 2023, p. 3), despite Figure 16 (3D Environmental 2023, p. 48) showing that there was one GDE surveyed in Area 4, described as 'HES Wetland habitat RE11.3.3 on an upper terrace of the Dawson River flood plain' (3D Environmental 2023, p. 44), that was rated as 'moderate' for groundwater availability. The IESC recommends that the proponent conduct further surveys of these wetlands' groundwater-dependence that encompass different seasons as some of these wetlands could be facultative GDEs that use groundwater opportunistically and may be affected by drawdown associated with the project.
19. The proponent reported stygofauna within the alluvium along the Dawson River (Stygoecologia 2019, p. iii). However, the proponent has not provided detailed information about potential impacts on stygofauna from groundwater drawdown in the alluvium nor discussed the potential for stygofaunal recovery of dewatered sediments. The proponent should address these information gaps and consider using molecular methods (e.g. Korb et al. 2024a,b) to test the prediction that the surveyed taxa 'have a very high potential to be short range endemic, relictual and rare species' (Stygoecologia 2019, p. 21).
20. Several surface water drainage tributaries will be removed for the project (Paragraph 17), thus removing riparian vegetation that probably provides habitat and corridors for movements of EPBC Act- and NC Act-listed species across an already largely cleared landscape. The IESC suggests that the proponent evaluate the potential impacts of the project on riparian habitat and corridor use by these listed species, especially in terms of maintaining their local metapopulations and genetic

diversity. It would also be useful to explain how riparian vegetation to be established along the diverted channels (Paragraph 21b) will fulfil these roles and how long this might take.

21. As an alternative to redesigning the spoil dump to avoid impacts to Tributary 8 (ESP 2023, p. iv), the proponent plans to provide a 0.39-km stream diversion (ESP 2023, p. 136). There are also two clean-water diversions planned for drainages entering the project area. In designing the diversion of Tributary 8, the proponent's focus is on maintaining fish passage and instream habitat (ESP 2023, p. 136).
 - a. Given the complexity of creating a stream diversion that supports ecological processes, including faunal passage, the proponent should confirm that this diversion is essential and that changes cannot be made to the WRE.
 - b. The proponent should also specify how the restoration of vegetation along the stream diversions will occur, which species will be used, how the restored vegetation will be maintained, and what monitoring will be done to confirm the success of the riparian restoration.
 - c. The proponent will create drainage lines along the eastern side of the project area to enable water from the tributaries to drain into Tributary 8, and is planning to only revegetate these with grazing grasses (AARC 2023b, p. 112). However, the IESC suggests that the proponent consider including riparian trees and shrubs to restore corridors that would be lost due to the project and provide habitat and passage for EPBC- and NC Act-listed species (Paragraph 42).
 - d. The proponent has not provided information on how they will ensure that instream habitat is restored in the stream diversion on Tributary 8 or presented evidence that the diverted channel will support fish and turtle passage. The proponent should specify what types of instream habitat will be provided for fish and turtles expected to use Tributary 8 for passage, how this will be installed and maintained, and what monitoring will be done to confirm the success of the instream restoration.
 - e. The proponent has not provided information about potential increases in sedimentation and erosion instream due to the 0.39-km diversion of Tributary 8 (ESP 2023, p. 136). As geochemical studies indicated that the soils in and surrounding the project area are sodic (Terrenus 2023, p. iv), the exposure of sodic soils that are usually contained could increase erosion which would potentially impact instream habitats and downstream ecosystems. The IESC suggests that the proponent assess these potential impacts to instream habitats and downstream ecosystems from sedimentation and erosion, and describe how such impacts will be mitigated.
22. The proponent will release MAW into the Dawson River upstream of NHW where the EPBC Act-listed species Fitzroy River Turtle was found during surveys (ESP 2023, p. 106). As discussed in Paragraphs 6 and 12, the proponent has not discussed potential changes in water quality from these MAW releases to the receiving environment aside from EC. If there may be changes in other water quality parameters, the proponent should assess their potential impacts on aquatic biota, including listed species such as the Fitzroy River Turtle, in receiving waters downstream.

Question 3: Advice is sought on whether the numerical and conceptual modelling provided is adequate for a project of this type and at this stage of development to assess the project's potential impacts, including:

- a. What refinements does the IESC recommend to improve the current modelling, if any?
- b. Has the hydrologic/flood modelling considered all stages of mine development and final landform, specifically the interactions with Banana Creek and Dawson River when significant flood events are occurring within the Dawson River that will create backwater and changes to flow patterns within Banana Creek?

Groundwater

23. See Paragraph 1 regarding the adequacy of the groundwater conceptualisation.
24. The numerical groundwater model may be adequate for this stage, provided that documentation is improved and is sufficiently supported by evidence:
 - a. Regional boundary conditions are fully described.
 - b. Details of the PESTPP-IES settings are described, including the objective function and covariance matrices, and optional features such as regularisation and auto-adaptive localisation.
 - c. Water balances for both historical and predictive periods are provided as time-series plots.
 - d. Hydrograph predictions should be provided for key monitoring wells, including the range from realisations.
 - e. Results from the climate change simulation should be provided for all quantities of interest rather than just the mine inflow.
25. The calibration for wells at Baralaba South could be improved. Once sufficient additional monitoring data are acquired (an additional year or two), the model should be re-calibrated using an objective function that is weighted towards the wells at or near the project site.
26. Further consideration should be given to some of the key parameters controlling the exchange of groundwater between the mine and the alluvial/colluvial aquifers. Other than the horizontal conductivity obtained from Hawkins (1998) applied to the spoil, it is unclear what the source and applicability of the other hydraulic properties selected are, for example, the storage values (see Table 7-2, Watershed 2023, p. 157). The values of horizontal hydraulic conductivity for the Weathered Permian, Weathered Rewan, Weathered Gylanda, and colluvium are all tending towards upper bounds and possibly higher than what is typically observed in the field, probably due to the automated calibration process varying them to extreme values to explore the space to make them sensitive (AGE 2023, p. 4). Further testing of the weathered strata would be useful to improve accuracy of these hydraulic conductivity values.

Surface Water

27. Appropriate models have been selected for estimating baseline flood impacts, and efforts have been made to ensure consistency with regional empirical information, and between the hydrologic and hydraulic model simulations. Indeed, the effort made to ensure the modelled flood risks are consistent with the available empirical information is commendable, noting that:
 - a. The flood modelling has only considered the final landform, as this landform is the largest and is assumed to have the greatest potential impact on flood flows (Engeny 2023b, p. 73). The IESC considers this approach to be appropriate.
 - b. A climate-change sensitivity analysis has been undertaken as part of the flood modelling. The proponent has assessed the 2070 climate-change horizon for 1% AEP and 0.1% AEP flood events, using the Representative Concentration Pathway 6 (RCP6) (Engeny 2023b, p. 83). Given the potential for increased intensity of storm rainfall events in Queensland due to climate change (CSIRO, BoM and Climate Change in Australia 2024), the length of mine operations and the permanence of the final void pit lake, the proponent should do a sensitivity analysis using RCP8.5 and extend predictions past 2070 following approaches that are consistent with current national guidelines (Ball et al. 2019). Additionally, draft revised guidelines for assessing the impact of climate change are now available (DCCEE, 2023) and could be considered as an additional sensitivity analysis.

- c. The probable maximum flood (PMF) has been modelled for baseline conditions (Engeny 2023b, p. 71) but has not been modelled in the climate-change sensitivity analysis. A final landform bund is proposed to protect the final void from the PMF (Engeny 2023b, p. 83); however, limited information is provided on the design of the bund and the proposed freeboard level. Climate change should be incorporated into modelling of the PMF, using current climate change guidelines (as discussed in Paragraph 27b), and specific information about the final void bund should be provided to understand the potential risk of flood waters interacting with the final void pit lake.
 - d. The approach used to assess the interaction between Banana Creek and Dawson River during extreme flood events (Engeny 2023b, p. 72) is simple, but given the large difference in contributing catchment areas, the IESC considers that the implicit assumptions made concerning the independence of the flood drivers are adequate.
28. A streamflow assessment was undertaken to predict mine-related changes to Dawson River streamflow which were then compared against Environmental Flow Objectives (EFOs) of the EFO node at Beckers gauging station (Engeny 2023a, p. 103). This assessment showed minimal changes to streamflow, and EFOs remained within range (Tables 7.3 – 7.5, Engeny 2023a, pp. 106 – 107). In this assessment, catchment reduction and potential changes in baseflow were assessed together. However, the assessment did not include raw water that is proposed to be taken from the river when site inventory does not meet demand (estimated to be 600 – 700 ML/yr, Engeny 2023a, p. 90). Raw water take is proposed to be well within current licences that the proponent holds, and therefore would not impact other users of water (Engeny 2023a, p. 65). However, raw water take is more likely to be needed during dry climate periods, when streamflows are lower and water is more in demand. An uncertainty analysis should be undertaken that includes all impact pathways that could change streamflows for a range of climate scenarios, to assess all possible impacts to flow regimes and EFOs during mine operations.

Cumulative impacts

Question 4: Advice is sought on whether the EIS has sufficiently addressed the potential cumulative impacts on water resources and related assets associated with other mining activities and coal seam gas production in the project area and whether the conclusions on cumulative impacts are appropriately supported.

Groundwater

29. Cumulative impacts considering the Baralaba North Mine operations have been adequately examined in the groundwater model. However, the assessment of potential cumulative impacts to groundwaters should be revised if the required items outlined in Paragraphs 1 and 2 warrant significant changes to the model. If future model predictions show greater drawdowns, then drawdown plots should be provided to show how drawdown changes over time.

Surface Water

30. Two other mines, Baralaba North Mine and Dawson Mine, have approved EAs to release MAW to the Dawson River (Engeny 2023a, p. 114). An assessment was undertaken to determine “worst-case” cumulative changes to water quality in the Dawson River if these two mines plus the project released water at the same time. Modelled scenarios were for a range of flows and EC values, and results showed increases in EC that were still below the receiving waters’ EC limits in the Baralaba North mine EA (Engeny 2023a, p. 116). This assessment is appropriate for cumulative impacts relating to the EC of receiving waters. The proponent should include other water quality indicators (Paragraph 6) and integrate this information with an assessment of cumulative changes in surface water quality.

31. The IESC agrees with the proponent that there will not be significant long-term cumulative impacts to the Dawson River's streamflow from catchment reductions due to Baralaba North mine and the project. It is also unlikely that impacts to other surface water users and water resources will occur, as the proposed raw water take is predicted to be less than the existing water licences held by the proponent (a peak of 880 ML in year 3 (Engeny 2023a, p. 90), compared to a combined licence volume of approximately 1.7 GL/yr (Engeny 2023a, p. 65)). However, an uncertainty analysis should be undertaken to assess all possible impacts, as discussed in Paragraph 28.

Ecology

32. The proponent discusses the potential cumulative impacts to water resources and their ecology with other mining activities and coal seam gas production (AARC 2023a, Chapter 7, p. 7-97). However, the cumulative impacts from the combined effects of concurrent impact pathways of the project alone are not discussed. The IESC suggests that the proponent assess the potential cumulative impacts on GDEs and other water resources within and surrounding the project area that may arise from multiple concurrent stressors such as groundwater drawdown, clearing of native vegetation and stream diversions.

Mitigation and management

Question 5: Advice is sought on whether the proposed monitoring, mitigation and management measures are specific enough to adequately identify, mitigate and manage potential impacts from the proposed project on water resources and related assets.

Question 6: Does the IESC consider that any additional measures are needed to adequately reduce risks and projected levels of impact to water resources and related assets?

33. The proponent's descriptions of the monitoring, mitigation and management measures are not specific enough to adequately identify, mitigate and manage potential impacts from the proposed project to water resources and related assets, and more information is required as discussed in the responses to Questions 1 to 4. Below, the IESC has identified additional measures to adequately reduce risks and projected levels of impact to water resources and related assets.

34. The proponent has proposed the installation of three additional shallow alluvial bores to improve the spatial coverage of the groundwater monitoring network. The proposed bores would be located near monitoring bore P-OB1, the HES wetland and south or south-east of the project area near Banana Creek (i.e. along the strike of the coal measures). In addition, a fourth bore targeting the Permian coal measures will be drilled to 200 m depth to understand geology (faulting) and permeability (via packer testing) and may be used as a monitoring bore depending on the testing/analysis (Watershed 2023, p. 185).

- a. The IESC agrees with the purposes and proposed locations of the proposed additional monitoring bores and the analytes recommended for future groundwater quality monitoring (see Watershed 2023, p. 185). However, the frequency of the samples being analysed by a NATA-accredited laboratory should be increased to at least quarterly from the current proposed annual basis, especially for the monitoring bores in the vicinity of in- and out-of-pit spoil sumps, to allow for early detection of potential groundwater contamination. These monitoring bores, especially in the alluvium, should also be used to monitor stygofauna to confirm the absence of significant project-related impacts on this GDE.
- b. If the seasonal assessment of groundwater-dependence of wetlands (recommended in Paragraph 18) indicates that they are facultative GDEs, the proponent should install monitoring bores in and around the wetlands to be able to monitor groundwater drawdown and ensure that

the proponent can trigger timely mitigation measures to minimise impacts to the wetlands that surround the project area.

35. The proponent should collect additional site-specific baseline data for water quality and water level/streamflow for the Dawson River adjacent to the project area, Banana Creek, Shirley's Gully and tributaries within the MLA before operations commence (Paragraph 4).
 - a. Monitoring of water quality indicators identified for the project (Table 2.3, Engeny 2023a, p. 26) should be undertaken to develop site-specific WQOs based on Queensland Water Quality Guidelines (DEHP 2009) and National Water Quality Management Strategy Guidelines (ANZG 2018).
 - b. Monitoring of water level/streamflow should be undertaken to better characterise the hydrological regime (especially ecologically relevant components such as durations and timing of zero and low-flow periods) of the ephemeral streams in and adjacent to the project area, and the receiving waters of Shirley's Gully. Streamflow data collected from Banana Creek can be used to further calibrate the flood models and inform the streamflow impact assessment.
36. Quarterly water quality monitoring of MAW storages is proposed for pH, EC, total suspended solids and turbidity (AARC 2023a, Chapter 4, p. 4-93). Other water quality indicators such as metals and metalloids should also be monitored. Such data can be used to understand the potential parameters of concern to inform and update monitoring plans and release conditions as part of adaptive management strategies.
37. The proponent plans to monitor end-of-pipe EC and pH daily during controlled releases of MAW (Engeny 2023a, p. 67). Pre-release monitoring should include the full suite of metals and metalloids listed as water quality indicators (Table 2.3, Engeny 2023a, p. 26), and during releases, monitoring of this full suite should be weekly. Trigger values for these parameters should be developed as part of release conditions, and be informed by water quality assessment of MAW and flow conditions (Paragraphs 6 and 7).
38. Sediment dams will be monitored quarterly to validate expected water quality of runoff from disturbed areas (AARC 2023a, Chapter 4, p. 4-93). Monitoring of the receiving environment will also be undertaken after any uncontrolled releases from the sediment dams (Engeny 2023a, p. 131). The proponent should monitor other water quality indicators such as metals and metalloids in the sediment dams and receiving waters, and specify the proposed trigger values needed to limit impacts from any uncontrolled releases.
39. The default WQOs presented for the receiving environment downstream of the project are appropriate (Table 3.1, Engeny 2023a, pp. 42 – 44), except for:
 - a. Beryllium, which should be the 'moderately disturbed aquatic ecosystems' value for 95% species protection' of 0.13 ug/L and not the 'irrigation' WQO value of 500 ug/L (ANZG 2018).
 - b. Cobalt, which should be the conservative 'aquatic ecosystems' value for 95% species protection' of 1.4 ug/L (ANZG 2018) as adopted in the EA conditions for Baralaba North Mine (Engeny 2023a, p. 43).
40. The proponent states that a Water Management Plan should be developed for the project (if approved) (Watershed 2023, p. 185). Groundwater quality trigger levels are proposed to be established in consideration of the Water Plan (Fitzroy Basin) 2011 WQOs and ANZECC (2000) guidelines. As the ANZECC (2000) guidelines have been superseded by the revised Water Quality Guidelines (ANZG 2018), the proponent should use the updated version of the water quality guidelines to develop trigger levels for each of the hydrogeological units potentially impacted by the project.

41. The proponent has not provided information about any continued instream monitoring, including any monitoring around the stream diversion on Tributary 8 (Paragraph 21). The proponent should provide a detailed monitoring plan that justifies the choices of parameters, sampling sites (including reference sites that are not predicted to be impacted by the project), sampling frequency and approaches to interpreting and displaying the data. In particular, this plan should outline the monitoring of fish passage and instream and benthic habitats in the new section of channel being created in Tributary 8 to demonstrate that it is being restored effectively and achieving its desired ecological goals. Given the moderate to high aquatic values identified for Shirley's Gully and that its drainage network will be substantially altered by the project, the detailed monitoring plan should also include at least two sites along this watercourse.
42. As discussed in Paragraph 21c, the proponent should consider restoring riparian shrubs and trees as well as or instead of grazing grasses along the drainage channels to the east of the project area to provide corridors for passage of EPBC Act- and NC Act-listed species across the largely cleared landscape.
43. The proponent plans to develop several monitoring and management plans (e.g. Water Management Plan, Erosion and Sediment Control Plan, Receiving Environment Monitoring Program, Progressive Rehabilitation and Closure Plan, Species Management Program) based on adaptive management. In addition to these plans, a trigger action response plan that implements timely action to prevent further impacts when a WQO is exceeded should be developed, using current data and information along with results of the additional work recommended in this advice.

Date of advice	16 April 2024
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Source documentation provided to the IESC for the formulation of this advice	AARC Environmental Solutions (AARC) 2023a. <i>Baralaba South Project: Environmental Impact Statement</i> , prepared for Baralaba South Pty Ltd. 19 December 2023. Available [online]: https://www.baralabacoal.com.au/baralaba-south-eis/
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