Advice to decision maker on coal mining project

IESC 2017-091: Central Queensland Coal Project (EPBC 2016/7851) – New Development

Requesting agency	The Australian Government Department of the Environment and Energy and The Queensland Department of Environment and Heritage Protection
Date of request	1 November 2017
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Advice stage	Assessment

Summary

The proposed Central Queensland Coal Mine is an open-cut coal mine to be located 130 km northwest of Rockhampton. The project is targeting a maximum extraction of up to 10 million tonnes per annum (Mtpa) with a project life of 20 years.

The proposed mine presents significant risks to areas of high ecological value, including, the Great Barrier Reef World Heritage Area and Marine Park, the Broad Sound Fish Habitat Area, the Styx River Estuary, two state-listed wetlands and the riparian habitat of Tooloombah Creek and Deep Creek. These risks require further investigation, management and mitigation. Located approximately 10 km upstream of Broad Sound, part of the Great Barrier Reef World Heritage Area, this project will:

- be the first coal mine in the Styx Basin, targeting a coal resource that is unproven for open cut extraction and not well-characterised in terms of potential hydrogeological and geochemical risks;
- be located close to a number of high-value environmental assets, with the nature and extent of many potential impacts uncertain as this is a greenfield development with limited available baseline environmental data;
- remove a significant wetland (as identified by the Queensland Government);
- impact the natural flow regime of Tooloombah Creek, Deep Creek and possibly further downstream;
- discharge mine-affected waters directly upstream of the Styx River estuary which is considered to be of high environmental value; and,
- disturb areas likely to contain acid sulfate soils, potentially leading to releases of acidic water and mobilisation of metals.

The proponent has collected information and data to inform the Environmental Impact Statement for this project. The IESC considers that a greater level of detail in the information and analysis is required to determine the full range of potential impacts to water resources. Information to support the proposal must have finer geographical resolution and be collected more frequently to improve confidence in predictions. There is not enough information to assess risks or to determine whether risk mitigation measures are likely to be effective. Furthermore, existing land use such as grazing and cropping must be considered to understand the baseline condition of the Styx River Catchment before development.

There is uncertainty in the assessment of surface water and groundwater impacts as the mine design has not been finalised and may be varied from that presented in the current Environmental Impact Statement. It is not possible to assess, from the information provided, whether alternative mine layouts would result in lower impacts and risks to the receiving environment, much of which is of high environmental value. More detailed information is required to fully assess the relationship between mine design and potential impacts and to inform a comprehensive risk assessment.

Context

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) was requested by the Australian Government Department of the Environment and Energy and the Queensland Department of Environment and Heritage Protection to provide advice on the Central Queensland Coal Pty Ltd and Fairway Coal Pty Ltd's Central Queensland Coal Project in Queensland.

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

The Project is a proposed greenfield open-cut coal mine to be located 130 km northwest of Rockhampton in the Styx River Catchment. The proposed project will target production of up to 10 Mtpa of thermal and semi-soft coking coal from the Styx Coal Measures within the Styx Basin for a project life of 20 years. There are no current operating coal mines targeting the Styx Basin, although some small-scale historic mining occurred up until the 1960s. The basin has also had limited petroleum exploration.

The proposed mine layout includes three open-cut pits, two overburden dumps, two coal handling and preparation plants (CHPP), a train loadout facility (TLF), and mine water infrastructure including 11 water storages. The total mine disturbance area will cover approximately 12 km^2 of the 3,013-km^2 Styx River Catchment. The proposed mine pits are located between Tooloombah Creek and Deep Creek. The two creeks merge just to the north of the mine, forming the Styx River. The proposed layout is divided by the Bruce Highway, which separates the north and south of the site. A coal conveyor is proposed to pass under the highway at Deep Creek Bridge and three causeways will be built for haul roads to cross Deep Creek.

The proposed project area is predominantly used for low-intensity grazing on native or improved pastures. The site contains several existing farm dams, drainage bunds to capture runoff and two wetlands listed as matters of state environmental significance. The adjacent riparian habitats are potentially groundwater dependent and are of high environmental value.

Key Potential Impacts

Key potential impacts on water resources and water-related assets are outlined below.

- Surface water quality could be diminished by controlled and uncontrolled discharges. This includes potential spills from the mine water storages and flooding of the proposed coal conveyor. Impacts could occur on-site and as far downstream as the GBRWHA and may adversely affect high-value ecosystems.

- Groundwater drawdown from the proposed project will extend beyond the project site and will impact groundwater-dependent ecosystems (GDEs). It could also result in extensive disconnection of surface water and groundwater. This will cause changes to baseflow volumes, flow regime, water quality, and aquatic habitat availability and could result in further fragmentation or loss of riparian vegetation.

- Groundwater drawdown may also affect GDEs through reduced groundwater availability and groundwater quality. These could arise because of a lowering of the water table or through seawater intrusion and inundation causing changes in groundwater salinity.

- Groundwater drawdown may increase the tidal-affected stream length which could impact fish breeding, particularly in Tooloombah Creek, and cause the loss of riparian vegetation if it is not tolerant of brackish conditions.

- Groundwater drawdown could also affect groundwater discharges into the coastal marine environment potentially impacting on coastal vegetation and marine GDEs.

- Project construction, operation and long-term management has the potential to expose highly sodic soils, and potentially acid-forming (PAF) material and mobilise metals through the development of acid sulfate soils (ASS). These materials require appropriate handling and management to prevent erosion and adverse water quality impacts from occurring. These impacts could occur on-site and as far downstream as the GBRWHA. Increased erosion could result in sedimentation of the high ecological value riparian areas and increased sediment loads further downstream. Sediment, sediment-bound contaminants, acidification and metals mobilised in the surface water could all impact ecosystem health downstream.

Response to questions

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

Question 1: Advice is sought on whether the information provided in the EIS documentation (including baseline and modelled data), and the conclusions drawn by the proponent, is adequate to assess the project's impacts. If not, what additional information should be provided to identify and assess impacts on water resources?

1. The proponent identifies potential impacts to water resources within the EIS documentation provided. However, the consequences, management and mitigation measures have not been comprehensively explored. Baseline data is generally inadequate as it does not characterise seasonal variability and is insufficient to fully calibrate and validate models. This limits confidence in the predicted impacts. The responses to questions 1 and 2 discuss these issues in further detail.

<u>Groundwater</u>

2. Available baseline data for both groundwater quality and head is limited in its coverage of depth, location and time. The proponent is currently expanding their groundwater monitoring network to improve the spatial deficiencies, although additional bores will be needed to target aquifers other than the alluvial aquifer. When these bores are installed, testing should be undertaken to determine the range of hydraulic parameters across the project area. Monthly monitoring of groundwater quality and head over a period of two years, as outlined in ANZECC/ARMCANZ (2000), will be needed to address the temporal data limitations given the highly seasonal climate

at the project site. This monitoring should be completed before any mining commences in order to characterise pre-impact condition, and the following issues should be considered.

a. Monitoring should include bores in all potential aquifers in the area, with nested bores used to determine the general groundwater behaviour and connectivity between aquifers. This information is needed to refine the hydrogeological conceptualisation and update the groundwater model.

b. The data collected will provide important information on pre-impact conditions and seasonal variability. This information is needed to improve hydrogeological conceptualisation, validate the groundwater model, and derive trigger values for both groundwater quality and head for management plans.

c. Baseline groundwater quality monitoring should include physicochemical parameters, nutrients, metals and hydrocarbons.

d. Monitoring should also include environmental tracers (such as stable isotopes of water and bromide) to investigate groundwater-surface water connectivity and potential mixing with sea-water. This monitoring could occur seasonally. Additional studies are needed to characterise groundwater-surface water connectivity and its temporal variability as discussed in paragraphs 7, 37 and 49.

3. The proponent acknowledges the limited confidence in the groundwater model and its predicted impacts. The groundwater model requires further development including improved conceptualisation and parameterisation. The proponent should complete the work outlined below.

a. Collect site-specific data on a range of hydraulic parameters such as hydraulic conductivity, storativity and recharge to assist with model characterisation and parameterisation.

b. Undertake a thorough review of the underlying geological and hydrogeological conceptualisations. There is still uncertainty in these conceptual models which should be addressed through collection of additional site-specific geological and hydrogeological data.

c. Update the groundwater model to fully incorporate a range of possible configurations and dimensions of the final voids so the range of impacts on groundwater can be assessed (discussed further in paragraph 29).

d. Implement an additional modelling approach which allows investigation of potential seawater intrusion and seawater inundation (groundwater recharge by saline tidal waters). This will require the use of a variable density groundwater flow and solute simulator such as SEAWAT (USGS 2016).

e. Undertake further testing and validation of the groundwater model when suitable data becomes available with predictions regularly checked against ongoing groundwater head observations. A robust criterion should be developed to identify when re-calibration and potentially re-conceptualisation is needed.

f. Obtain a peer-review of the groundwater model as recommended in the *Australian Groundwater Modelling Guidelines* (Barnett *et al.* 2012).

4. Sensitivity and uncertainty analysis should be used to examine different model parameterisations, model boundary conditions, the effects of applying recharge uniformly versus a more realistic episodic recharge regime, and the likelihood of various impact scenarios. This would assist in understanding and assessing the potential range of changes to the groundwater system and the

possible associated ecological impacts. The outputs of these analyses would also be useful to inform management and mitigation options.

5. The timing of maximum groundwater drawdown and the extent and timing of recovery are unclear from the EIS documentation. This information is needed to assess potential long-term impacts and the ability of the system to recover.

Surface water

6. The available baseline hydrological data is limited. While some surface water quality sampling has occurred sporadically in 2011 and 2017, further sampling is needed to establish the inter- and intra-annual variability in both water quality and flow regimes.

   a. Monthly water quality sampling should be undertaken over two years, as outlined in ANZECC/ARMCANZ (2000), and include physicochemical parameters, nutrients, metals and hydrocarbons. This should be done at sites on Tooloombah Creek, Deep Creek, Styx River and in Broad Sound, and occur before mining commences to ensure pre-impact conditions are characterised.

   b. Flow monitoring data is needed for Tooloombah Creek and Deep Creek. This data should be collected more frequently than monthly using suitable data loggers.

   c. The data collected in these baseline studies is needed to characterise seasonal variability, to identify all potential impacts, to derive site-specific trigger values and management plans, and to determine appropriate discharge regimes for releases of mine-affected water.

7. Detailed information on stream morphology and flow regime is lacking. Further studies, including field studies, are required to determine the location of refugial pools; areas of groundwater-surface water connectivity and their exchange dynamics; the upstream extent of the tidal influence in both Tooloombah Creek and Deep Creek; creek substrate and associated aquatic habitats; and to identify exposed geological features.

8. Further modelling should be undertaken to fully assess the potential impacts of the project as detailed below.

   a. A hydrodynamic model incorporating all reaches of Tooloombah Creek and Deep Creek which can be tidally impacted and downstream into Broad Sound should be developed. The hydrodynamic model will require collection of data on the tidal regime of the Styx River and Broad Sound. This model should be coupled with water quality modelling to identify how the tidal regime affects flushing and dilution of project discharges. This modelling is needed to:

      i. ensure that there are no adverse impacts to the ecologically high-value environments downstream;

      ii. confirm the proponent’s assumption that sufficient dilution will occur to meet the varying downstream water quality objectives;

      iii. determine that adequate flushing occurs throughout the surface water system with no areas of contaminants, suspended or dissolved, in the water column or deposited in sediments; and

      iv. identify if tidal movements and storm surge can cause contaminated water to be pushed up into parts of Tooloombah Creek and Deep Creek that may become isolated when surface water levels fall.

b. Uncertainty and sensitivity analysis of the flood modelling to examine possible climate conditions beyond the historical climate records should be undertaken. This is needed to understand how climate change and variability could affect legacy management.

c. Separate water balances for the CHPPs and the TLF are required to identify the volume and frequency of any discharges or extraction requirements. The updated modelling should include uncertainty and sensitivity analysis for water use and availability. The modelling should also include peak water demand at maximum CHPP processing capacity.

d. Salt balances should be calculated for the CHPPs given the large recycled water component. These are needed to determine likely water quality of dam water and the maximum frequency of discharge needed.

<u>Water-dependent Ecosystems</u>

9. The assessment of wetland, riparian and terrestrial GDEs is based on desktop studies and limited field studies. Further work is needed to identify and characterise GDEs in the area potentially impacted by the project. This is particularly important given the proposal to use supplementary surface water flows to manage potential impacts to some GDEs. The further work required is discussed in the response to question 3.

10. The assessment of potential impacts arising from groundwater drawdown to wetlands was not always sufficient. The proponent often assumed that these features were supported by surface water inputs only. The Wetland Protection Area (WPA) located near the western boundary of the project is an example. For this wetland, the assumption was based on two field observations and groundwater levels at an unspecified bore possibly several hundred metres from the wetland. This information is insufficient for concluding that the WPA is not a GDE. Further work is needed at all wetland sites to determine groundwater dependency. This work could include the installation and monitoring of bores located at the edge of the wetland area, development of reference sites, the use of satellite and aerial imagery to identify potential groundwater use (e.g. Eamus et al. 2015), hydrogeochemical sampling and development of criteria to determine groundwater connectivity and dependency.

11. Two aquatic ecology surveys were undertaken for this project, both under sub-optimal climatic conditions (i.e. water temperatures were cold or weather conditions were described as very hot and dry). Further site-specific reference surveys are needed to assess the baseline conditions and were suggested by the proponent's consultant (EIS, App. 9e, p. 49). These surveys should focus on areas both onsite and off-site that may be impacted by the project. The surveys should be conducted under favourable conditions such as when water temperatures are likely to result in faunal activity. The proponent notes the likely occurrence of aquatic EPBC-listed taxa including the Estuarine Crocodile (*Crocodylus porosus*).

12. Stygofauna sampling has been undertaken at several sites with some sites sampled twice; however, additional stygofauna sampling is needed. This sampling should target the alluvial aquifers of Tooloombah Creek and Deep Creek which may be affected by groundwater drawdown and where limited sampling has occurred thus far. Stygofauna sampling should be repeated annually during operational and closure phases of the project, as suggested by the proponent's consultant (EIS, App. 9f, p. 30).

13. There is limited consideration in the EIS of the potential for fresh groundwater from the Styx River catchment to discharge into the marine environments of Broad Sound and Shoalwater Bay. Discharge of fresh groundwater into these saline environments could be ecologically important to coastal vegetation, such as mangroves. Further work is needed to identify if the Styx River

catchment could be a source of fresh groundwater discharges and, if so, what impacts could result from any groundwater drawdown associated with the project.

14. No attempt to determine the location and movements of the seawater intrusion interface in aquifers is reported in the EIS. Groundwater drawdown from the project could allow the seawater intrusion interface to move inland which would affect groundwater quality and may impact groundwater accessibility (due to increased salinity) for GDEs. Further work is required to characterise this potential impact as outlined in the responses to questions 1 and 2. It is noted that determining the location and complexity of the seawater intrusion interface may be a difficult task as the location, shape and thickness of the interface may vary between aquifers.

Geochemistry

15. The potential impacts from ASS have not been assessed in detail. Given that the project is located within 10 km of an estuary, potential ASS could be present. Groundwater drawdown from the project could cause ASS impacts to properties within and outside the project site. Further field studies are needed to identify the potential for ASS and, if present, assess possible impacts.

16. Geochemical analyses, although limited in their application, have identified a small volume of PAF material. Further work is needed, as outlined below to assess the potential impacts of this material.

    a. Further geochemical analysis such as additional kinetic testing should be undertaken. Leach tests should be conducted on a more representative selection of samples that includes some with properties similar to the expected tailings and for longer periods to identify any potential legacy management issues.

    b. The assessment of potential impacts from reactive materials, such as PAF material, should consider the characteristics of more extreme samples and not just the median values. While the median values are representative of the bulk of the material sampled, the characteristics of the extreme samples indicate that these materials are likely to require more specialised management.

    c. Additional work should be completed to determine potential correlations between geology and reactive materials as this may assist in refining estimates of the volumes of material requiring additional management.

17. The proponent is considering the use of chemical dust suppressants. No information is provided in the EIS documentation on the nature of the dust suppressants or the circumstances under which they will be used. This information should be provided along with a risk assessment for water resources.

18. Hydrogeochemical analysis to characterise potential groundwater-surface water connectivity and mixing with ocean water, as was outlined in paragraph 2d should be undertaken.

Final Landforms

19. Proposed final landforms and final voids will significantly modify drainage across the floodplain. Structures such as bunds, levees and drains are proposed to be left in place and elevations in some areas of the floodplain will be raised from 30m AHD to 90m AHD, although the stated rehabilitation goals include a landform that blends with the surrounding landscape (EIS, Ch. 11, p.16). Further information and assessment is needed as outlined below.

a. Hydrodynamic modelling of drainage under the proposed final landform should be undertaken. This should include an assessment of drainage and isolation of the floodplain, and changes to groundwater recharge.

b. Information on the depth to groundwater in the final landforms is needed to determine risks related to saline intrusion and perched water tables.

c. Modelling should include all foreseeable scenarios where the proposed permanent dams become full and then overflow. This is of concern if water quality within a dam is compromised (such as by contact with PAF material).

Question 2: What does the Committee consider are the key risks and impacts of the project to water resources and water-related assets? In this regard comment is sought on the following matters identified by the Queensland Government: a. The potential impacts to surface and groundwater quality from open pit mining, waste rock dumps, dams, the disposal of waste products, the train load out facility, and the proposal to leave two residual voids within the floodplain. b. The potential impact to Deep Creek and downstream environmental values from the flooding of the proposed conveyor (transporting raw coal product between Open Cut 1 and the Mine Infrastructure Area) located underneath the Deep Creek Bridge. c. The potential impacts from the release of controlled and uncontrolled mine-affected water on surface water quality and aquatic ecosystem health including downstream impacts to the GBRWHA. d. The potential for aquifer disruption and mobilisation of the saltwater-groundwater interface near the coast, including impact on the GBRWHA. e. The potential impact of dewatering on groundwater/surface water interactions and GDEs. f. Location of the raw water dam within an existing watercourse and the mine pit dewatering dam within a State significant wetland.

20. The IESC agrees that the issues identified in this question include the key risks and impacts of the proposed project. The response to this question addresses the specific issues raised in the sub-questions. Further commentary on other key potential risks and impacts is provided within the responses to questions 1 and 3.

Question 2a

Mining impacts

21. The project will cause groundwater drawdown both at the project site and in the wider area based on the predictions of the current groundwater model. This will result in key potential impacts as outlined below.

a. Groundwater drawdown is likely to affect riparian vegetation, surface water connectivity, aquatic ecosystems (especially permanent waterholes), stygofauna, wetlands which could be GDEs and surface water quality. Many of these potential impacts have not been fully assessed (see the response to question 1) and proposed management and mitigation measures are limited (see the response to question 3).

b. The likely reduction in surface water flows from the Styx River due to groundwater drawdown could increase the length of waterways with a tidal influence and allow increased recharge to the alluvial aquifers by saline and brackish water associated with tidal flows. The area over which this could occur cannot be determined until connectivity between surface water and groundwater has been more fully characterised.

c. Drawdown could impact an unspecified number of landholder bores. The proponent proposes to manage these impacts through deepening bores, moving pumping infrastructure, constructing new bores or providing alternative water supplies.

22. The project plans indicate the modification of riparian habitat (including instream modifications) for a conveyor passing under Deep Creek Bridge (discussed in paragraphs 31-32) and three causeways across Deep Creek. This will cause fragmentation of riparian habitat and potentially induce impacts to surface water quality from dust generated from the roadway. Floods may mobilise coal dust deposited in riparian areas as discussed in the response to question 2b.

<u>Waste Rock Dumps</u>

23. The proponent states that weathered material will be put at the base of the waste rock dumps along with tailings (EIS, Ch. 8, pp. 8-34 to 8-36). This material will be covered with unweathered material to reduce the erosion risk associated with the high sodicity of the weathered material. However, this produces a water quality risk. Rainfall is likely to infiltrate the broken rock (unweathered material) rapidly but then be retained above finer-grained weathered material which could also have water-repellent properties due to its high sodicity. This could cause a perched aquifer containing potentially contaminated water to develop. The perched aquifer could enhance leaching of contaminants from the weathered material and the tailings if these are saturated. The perched aquifer could also result in lateral groundwater flow and potentially contaminated discharge at the edges of the waste rock dumps. In the out-of-pit waste rock dumps, it is unclear if this could affect the stability of the waste rock dump.

24. The proponent identifies the potential for waste rock dumps to affect groundwater flow by creating a barrier through hydraulic loading (EIS, Ch. 10, p. 10-45). It is suggested that this could affect groundwater discharges to creeks. There is also the potential for this to affect groundwater flows into the final voids particularly given the position of the waste rock dumps adjacent to the open cut pits. Further information is needed about this potential impact and an assessment should be undertaken to determine if this can affect the functioning of the final voids as groundwater sinks.

<u>Dams</u>

25. No clear commitments are provided in the EIS documentation to line any of the proposed dams. As a result, it is likely that there will be some leakage from the dams, particularly those located in existing watercourses and wetlands where groundwater-surface water connectivity may already exist. Groundwater modelling shows that Dam 2 especially is likely to have a large amount of groundwater mounding beneath it, implying it will leak (EIS, App. 6, Figure 19). This dam will contain mine-affected water, thus leakage could affect groundwater quality. Some leakage will also enter the adjacent open cut pits and thus will have to be managed within the mine water management system, meaning it will be pumped back to Dam 2, possibly with a lower water quality than when it leaked out of Dam 2.

<u>Waste Product Disposal</u>

26. It is possible that waste streams from the water treatment facility and the wastewater treatment plant (if constructed as part of the proposed accommodation camp which is not included in the current project proposal) will be disposed of in-pit. Although the proponent states that these waste streams will be adequately treated, no details of the proposed treatment are provided. If these waste streams were disposed of in this manner, they could leach and enter the surface water or groundwater – a scenario not considered by the proponent. These waste streams should be disposed of through a suitably licenced waste contractor.

Train Loadout Facility

27. Coal will be stockpiled at the TLF and will be transferred onto trains via a front-end loader (EIS, Ch. 3, p. 3-46).

    a. The facility is located next to a drainage line and riparian habitat, so it is likely that coal dust will be deposited in this area.

    b. The dam supplying the TLF will contain runoff from the stockpiles and surrounding areas. Insufficient information on water reuse, treatment or requirement to discharge from this dam was provided.

Residual Final Voids

28. The EIS provided considers the situation of two final voids but notes that this could be reduced to one. No discussion is provided of how this alternative scenario would affect the groundwater and surface water modelling results or the impact assessment. The number, location, depth, surface area and shape of the proposed final voids need to be confirmed so that they can be accurately depicted in modelling to enable a full impact assessment.

29. Currently it is unclear whether the final void or voids will be permanent or temporary groundwater sinks. In order to determine this and hence the potential impacts arising from the final voids, they must be incorporated into the groundwater model fully and the following information provided.

    a. The number, location, depth, surface area and shape (level-volume) of the proposed final void or voids.

    b. The expected range of water levels in the final void or voids over time. This should be determined by considering not only inflows from rainfall and outflows to evaporation but inflows and potential outflows to groundwater.

    c. The modelled salinity of the final void or voids. To achieve this, any potential saline aquifer inflows need to be identified. Saline aquifer inflows could cause the water quality within the final void or voids to deteriorate.

    d. The timing and extent of groundwater recovery around the final void or voids and the potential for interaction depending on relative hydraulic gradients and permeability of void walls.

30. If the final void or voids overtop during rainfall events, they may contribute to changes in flood behaviour, through reservoir outflow, potentially modifying flood timing and extent. This should be incorporated into the flood modelling.

Question 2b

31. Potential impacts to Deep Creek from flooding of the conveyor and the conveyor corridor (which is likely to contain accumulated coal dust) are likely to include an increase in the suspended sediment load and potentially higher dissolved metal concentrations. The distance downstream over which these impacts may be experienced was not assessed by the proponent, and will depend on the volume of the flood (e.g. its dilution capacity) and the amount of accumulated coal dust. Overtime, and with successive floods there is a risk that dissolved and sediment-bound contaminants may travel down the Styx River to the GBRWHA.

32. Alternative design options for the coal conveyor have not been adequately considered. These options should include a flyover of the Bruce Highway and locating the conveyor outside of the riparian corridor. The coal conveyor will flood as it is located adjacent to Deep Creek. The

proposed management options will not stop flooding of the conveyor corridor and may not be practical (i.e. conveyor removal prior to large rain events) given the project's location in the catchment headwaters which may mean that there is minimal warning of flooding. Additionally, riparian vegetation and the aquatic environment are likely to be affected by coal dust during normal operation of the conveyor (e.g. dust deposition) and during minor rain events (e.g. coal dust entrained in overland flow).

Question 2c

33. The proponent does not assess the potential for releases to impact the GBRWHA. Impacts from releases, both controlled and uncontrolled, could occur in the water column, within the sediments, or both.

    a. Within the water column, contaminants could accumulate if insufficient dilution occurs due to releases being too large a proportion of total flows. Additionally, accumulation could occur in parts of the waterways where flushing does not occur frequently or where disconnection from the main waterway happens. This would result in diminished water quality which could adversely affect flora and fauna that utilise the water.

    b. Accumulation of metals within the sediment is also a possibility, particularly in the estuarine and marine parts of the system. This is because the pH of ocean water is generally higher than that of fresh water and at higher pH values many metals have decreased solubilities and begin to precipitate. This would affect benthic organisms, and potentially enter the food chain to fish and birds in the GBRWHA.

34. The assessment of potential impacts from releases is further limited by the lack of information provided about the mine water management system. The proponent should:

    a. specify the water source for each water storage.

    b. clearly identify the likely water quality of each water storage and the worst possible water quality that could occur under extreme climate conditions.

    c. identify all receiving environments for all water storages. This includes where uncontrolled discharges will flow to and other dams if water can be transferred.

    d. identify the flood and extreme rainfall events that each water storage is designed to contain before an uncontrolled release occurs.

    e. identify the amount of freeboard that will be maintained.

35. Water which has been in contact with coal and overburden stockpiles and the mine industrial areas (mine-affected water) may be collected in dams where the only treatment is settlement for 48 hours before release to the environment. Best-practice mine water management requires the complete separation of runoff diverted from disturbed areas (generally treated with short-term settlement) and mine-affected water. Mine-affected water requires additional treatment such as longer residence times for increased sediment removal and potentially treatment to remove dissolved contaminants. Improved clarity is needed around the functions of the proposed dams and mine-affected water should be separated from other water streams to ensure this water is appropriately managed to reduce potential impacts to surface water quality and aquatic ecosystem health.

Question 2d

36. Although the proponent states that groundwater drawdown from the project could result in seawater intrusion, no further discussion is provided. The following investigations should be undertaken and information provided to allow a full analysis of potential impacts.

   a. Field studies are required to identify where the seawater intrusion interface is currently located. These investigations need to examine all significant aquifers near the coast, not only the alluvial aquifer.

   b. Potential seawater intrusion and inundation (e.g. during king tides or cyclones) should be modelled using a new variable density groundwater flow and solute transport model developed to compliment the updated groundwater model (as discussed in paragraph 3d).

   c. Information on the location of the seawater intrusion interface needs to be incorporated into the variable density flow and solute transport model. Further model calibration and validation are likely to be needed at this time.

   d. The variable density groundwater flow and solute transport model should be run to determine the maximum possible inland extent of seawater intrusion. The potential for the seawater intrusion interface to interact with the final void or voids must be assessed. If the seawater intrusion interface were to reach a final void this would create additional water quality management issues.

   e. Use the new modelling results to support an analysis and discussion of the potential ecological impacts. This needs to consider the direct impacts of seawater intrusion or inundation on ecosystems plus indirect effects that could arise such as changes to water quality if riparian vegetation is lost.

   f. An analysis and discussion should be provided detailing how any predicted changes in the location of the seawater intrusion interface could affect the extent of the tidal influence and hence surface water flows and quality. Potential impacts on estuarine and marine ecosystems, including those of the GBRWHA, should be specified and mitigation strategies should be proposed.

Question 2e

37. The proponent states that groundwater drawdown is likely to impact groundwater-surface water connectivity. They predict up to 15 km of stream length may be affected (EIS, Ch. 10. p. 10-64). These predictions are based on the results of the groundwater model. As discussed in the response to question 1, confidence in these results is limited and considerable work is required to improve confidence. It is possible that a larger stream length could be disconnected from groundwater. The following improvements, in addition to those outlined in paragraph 3 relating to the groundwater modelling, should be made to enable a full assessment of the potential extent and nature of impacts to surface water-groundwater connectivity and GDEs.

   a. Stream sections that are permanently or occasionally connected to groundwater need to be identified. Further fieldwork needs to be undertaken to characterise the nature of the connection and to provide baseline information.

   b. Sensitivity and uncertainty analysis of the groundwater model should be undertaken to examine the full potential range of drawdown scenarios and their likelihood (also refer to paragraph 4). These results should be compared to the stream connectivity information to identify all possible stream sections that could be impacted.

c. Further ecological surveying of connected stream sections (e.g. permanent pools, riparian vegetation) should be conducted so that the nature of groundwater dependency can be determined and hence potential impacts on GDEs from groundwater drawdown and possible disconnection assessed.

d. Potential surface water and groundwater quality impacts should be assessed. If groundwater discharge decreases, water quality in permanent pools and during low flows is likely to deteriorate. Conversely, if groundwater recharge from surface water flows decreases, groundwater quality could deteriorate. Either of these may have impacts on riparian vegetation and other GDEs.

e. An assessment is needed of the potential combined effects of groundwater drawdown and reduced surface water flows on aquatic and riparian environments, especially those with some reliance on groundwater.

Question 2f

38. The location of the pit dewatering dam should be reconsidered. The proposed location will destroy a wetland identified as a matter of state environmental significance by the Queensland Government. The proposal to destroy this wetland is incompatible with the objectives of the *Draft Reef 2050 Water Quality Improvement Plan 2017-2022* (The State of Queensland 2017). This plan, if approved and finalised, includes a wetland target of "no loss of natural wetlands". The currently operating plan (Commonwealth of Australia 2015) has a target of "no net loss". Additionally, based on the groundwater modelling results, this dam may also provide a source of contaminated (mine-affected water) groundwater recharge.

39. The raw water dam is proposed to be located within an existing watercourse to the north of the site. The watercourse is an unnamed, ephemeral, 2nd order tributary of Deep Creek, in an area where vegetation is identified as modified pasture or remnant vegetation of least concern (EIS, Ch. 14, Fig. 14-1). If possible, the dam should be sized to reduce the need for surface water extraction from Tooloombah Creek and appropriately control erosion and flood risk downstream from overflowing.

Question 3: Advice is sought on whether the measures and commitments proposed in the EIS are appropriate to mitigate and manage impacts to water resources and water-related assets. In particular, the proposed use of supplementary water to maintain refuge pools for aquatic species and GDEs. Advice is sought on whether the monitoring framework proposed in the EIS is adequate to identify the risks and impacts of the project and to trigger management measures to avoid and minimise impacts.

40. The proponent provides limited information regarding proposed mitigation and management actions in the EIS documentation. Management plans cannot be finalised because the location and design of all infrastructure have not been finalised. A full impact assessment has not been completed and baseline environmental data and current modelling is insufficient, meaning suitable management and mitigation measures, including impact management trigger values cannot be derived.

Groundwater

41. The management of potential groundwater impacts is not discussed in detail in the EIS documentation. There appears to be a reliance on the final void or voids operating as groundwater sinks. There is currently considerable uncertainty around this as discussed in the responses for questions 1 and 2. The proponent needs to undertake the additional work and provide further information about the final void or voids as previously discussed to confirm that the

final voids will act as long-term groundwater sinks and hence restrict potential groundwater quality impacts to the mine site.

42. The proposed groundwater monitoring network as shown in Figure 10-27 (EIS, Ch. 10, p. 10-74) provides a reasonable spatial coverage close to the project site. However:

    a. it is unclear that groundwater level and quality will be monitored at these bores as the proponent's proposed environmental authority conditions (see EIS, Ch. 23) use different bore identifiers for proposed groundwater level monitoring bores.

    b. at least some of the proposed monitoring bores would need to be nested installations to ensure that all aquifers are being monitored.

    c. the groundwater modelling results suggest that most of the monitoring bores are likely to be impacted by drawdown by the end of the mine life (approximately 20 years). Additional monitoring bores are required near and beyond the spatial limit of predicted impact to ensure the full extent of impacts is captured and that reference bores outside the area of impact persist to provide a baseline for comparison after mining.

    d. the bores near the Styx River downstream of the site should be monitored for electrical conductivity (EC) regularly (up to monthly) to identify potential seawater intrusion or inundation.

    e. the proponent indicates that some bores may be equipped with water-level loggers to provide higher-frequency observations. The bores identified as MB-6 to MB-14 in Figure 10-27 (EIS, Ch. 10, p. 10-74) should be equipped in this manner. These loggers should be downloaded frequently (at least every three months) or telemetered to provide enhanced early warning capabilities.

    f. groundwater quality monitoring may need to occur more frequently than currently proposed. The frequency of monitoring should be informed by the results of baseline monitoring. The range of analytes monitored should be informed by the results of the further geochemical analysis suggested in this advice.

    g. given that groundwater mounding has been predicted beneath the dams, a monitoring bore to the northeast of the TLF should be considered.

43. When the groundwater management plan is developed, groundwater level and quality trigger values will need to be derived. To do this, the proponent will need to collect baseline data as outlined in the response to question 1. Derivation of suitable trigger values should be based on the process outlined in ANZECC/ARMCANZ (2000). The management responses associated with these trigger values should be clearly articulated and allow a rapid response to implement the needed changes to prevent or limit potential impacts. Additionally, the plan should include a commitment to regularly update the groundwater model (e.g. on a five-yearly basis).

<u>Surface water</u>

44. The management of potential surface water quality changes from mine discharges is reliant on dilution. However, appropriate hydrodynamic and water quality modelling has not been undertaken to confirm that the discharge regime proposed in the proponent's draft environmental authority will achieve sufficient dilution to meet the applicable catchment water quality objectives (see EHP 2014). As the proposed discharge conditions are linked to flow in the receiving creeks, gauging stations will need to be installed on both Tooloombah Creek and Deep Creek. Discharge should not be permitted at low creek flows (as is currently proposed) as this may not allow sufficient dilution.

45. The proponent's draft environmental authority (EIS, Ch. 23) is overly complex and quite unclear. This document needs considerable revision and should:

a. clearly identify water quality objectives and water quality management trigger values for both discharge and non-discharge conditions (i.e. for routine monitoring). Water quality trigger values should be based on the results of the baseline monitoring that is discussed in the response to question 1, or relevant local water quality objectives and the ANZECC/ARMCANZ (2000) guideline values. If other trigger values are suggested, the reasons for using those values should be clearly explained.

b. clearly identify when and where monitoring will occur for the discharge and routine scenarios.

i. Monitoring of physicochemical parameters such as pH, electrical conductivity, dissolved oxygen and turbidity or total suspended solids can be done continuously with multi-parameter probes. During discharges, these parameters should be monitored at least daily.

ii. Routine monitoring during non-discharge periods should occur at least monthly in order to allow detection of potential leakages which can impact water quality. This monitoring should occur at the upstream and downstream monitoring sites and within all water storages.

c. include commitments to monitor sediments due to the potential for metal accumulation to occur as discussed in the response to question 2.

46. The proposed upstream and downstream monitoring sites on both Tooloombah Creek and Deep Creek need to be moved. The upstream sites must be moved further upstream to ensure that there is no potential for impacts from the project. The downstream sites should be moved further downstream to ensure that all runoff from the project site has entered the creeks, but should be located before other tributaries enter the creeks.

47. When the surface water management plan is developed, water quality trigger values will need to be derived. The process outlined in paragraph 43 for groundwater trigger values should be followed.

48. The proponent does not provide a clear commitment to monitor seepage from all dams. This commitment is needed to ensure that this potential impact is appropriately monitored and managed.

Groundwater-dependent Ecosystems

49. Insufficient information is provided in the EIS documentation to determine whether supplementary flows are likely to be a successful management and mitigation option to reduce the impacts of groundwater drawdown on aquatic and riparian ecosystems. The proponent recognises that further work is required. This work should include:

a. mapping of the permanent pools and riparian vegetation that could require the use of supplementary flows. The results of this mapping should also be used to inform the selection of suitable monitoring points (discussed further in paragraph 49f).

b. studies to determine the current dynamics of the groundwater-surface water connectivity at potentially impacted sites; the proportions of groundwater and surface water utilised and the seasonality of use by the ecosystems; any source preferences; and the current quality of the water used by different ecosystems. These studies should include field-based work and could incorporate analysis of satellite and aerial imagery (e.g. Eamus et al. 2015).

c. an analysis of whether the project will have water available at the times when it will be needed for supplementary flows, and whether this water will be of a suitable quality or will require mixing with fresher water that may need to be imported to the project site. If water will need to be brought onto the site, then an assessment is required of availability and potential sources.

d. an assessment of how the supplementary flows which are expected to be primarily sourced from groundwater could affect the quality of the alluvial aquifer. While the proponent does commit to treating the water to meet the relevant water quality objectives, the resulting quality could be lower than natural recharge water.

e. studies to determine the volumes and discharge rates of the supplementary flows required to achieve sufficient recharge to the alluvial aquifer to maintain or improve the condition of affected ecosystems. These studies will need to consider that once drawdown commences, recharge dynamics will change so the flows required could increase considerably.

f. investigations to identify appropriate monitoring variables in order to trigger supplementary flows and to measure their effectiveness. Ecological measures of vegetation health should be monitored; however, response in these can be lagged. Therefore, variables that respond more rapidly to change such as the water table in the alluvial aquifer and soil moisture may also be useful. Consideration should also be given to the use of reference sites.

50. Once the above suggested work has been completed, a more detailed assessment of the likelihood of success of the proposed supplementary flows scheme can be made. This assessment needs to occur prior to the project commencing as other mitigation and management options may need to be considered. Prior ecological work at the project site has highlighted the good condition of the aquatic and riparian ecosystems, the likely occurrence of listed aquatic taxa (e.g. the Estuarine Crocodile) and that there may not be suitable offsets available in the area (EIS, App. 9e, pp. 49-51). Additionally, the riparian vegetation is important for maintaining surface water quality and for habitat connectivity. Therefore, loss of these ecosystems should be avoided.

51. The proponent notes that groundwater drawdown is likely to impact some stygofauna. However, no mitigation or management options are discussed. Further consideration of mitigation and management options is needed as is continued monitoring of stygofauna to confirm the success of mitigation.

52. Adaptive management is proposed, although no details of what this could include are provided. An assessment of the effectiveness of proposed adaptive management measures is therefore not possible at this time.

<u>Geochemistry</u>

53. No details are provided in the EIS about how ASS would be managed. There is the potential for these to occur at the project site, and for groundwater drawdown to contribute to the generation of impacts. The proponent needs to further investigate the likely occurrence through soil profile testing and mapping of ASS, and provide details of proposed management options.

54. Limited information has been provided in the EIS documentation as to how PAF material and sodic material will be managed. Further sampling and analysis are needed as discussed in the response to question 1. Development of an appropriate management plan for these materials needs to consider:

a. that sodic soils are highly dispersive and prone to erosion when disturbed. Increased sediment loads will impact high-value ecosystems downstream.

b. the total possible volume of these materials and the uncertainty in these calculations.

c. whether encapsulation of some material may be needed. If this is the case, then the location of the encapsulated material within the waste dumps will need to be carefully considered as will the amount and source of material with which to encapsulate.

d. contingencies in case more of these materials are identified than currently predicted.

55. There is a lack of clarity in the EIS documentation around the total volume of waste rock predicted to be produced. Successful management of this material necessitates accurate estimates of produced volumes.

56. While the proponent suggests that some monitoring of leachate, tailings and waste rock dumps will be undertaken, very little detail is provided. Without details as to the location and frequency of monitoring and variables to be monitored, the adequacy of proposed monitoring cannot be assessed.

Final Landforms

57. The mine areas are proposed to be returned to grazing with a similar extent as prior to mining. Baseline ecosystem condition assessments are proposed as a way to compare rehabilitation to pre-disturbance condition. Mine closure and rehabilitation management plans are not available. Baseline assessments, mine closure plans and rehabilitation plans are required to establish detailed triggers for management measures and minimise impacts.

58. The information provided regarding the monitoring and management of water held in the final voids is inadequate to determine potential impacts to water resources from the site. This is primarily due to the uncertainty in the predicted volume and quality of water, and the characteristics of the final void or voids as discussed in paragraph 29.

Date of advice	15 December 2017
Source documentation available to the IESC in the formulation of this advice	CDM Smith 2017. *Central Queensland Coal Project Environmental Impact Statement.*
References cited within the IESC's advice	ANZECC/ARMCANZ 2000. Australian Guidelines for Water Quality Monitoring and Reporting. *National Water Quality Management Strategy (NWQMS).* Canberra: Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Eamus D, Zolfaghar S, Villalobos-Vega R, Cleverly J, Huete A 2015. Groundwater-dependent ecosystems: recent insights from satellite and field-based studies. *Hydrology and Earth System Science*, **19**, 4229-4256. EHP 2014. Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives. Basins 127, 128 and 129, including all waters of the Styx River, Shoalwater Creek and Water Park basins and adjacent coastal water. https://www.ehp.qld.gov.au/water/policy/pdf/styx-shoalwater-waterpark-evs-wqos.pdf

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The State of Queensland 2017. *Draft Reef 2050 Water Quality Improvement Plan 2017-2022*. http://www.reefplan.qld.gov.au/about/assets/reef-2050-water-quality-improvement-plan-2017-draft.pdf

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