Appendix E Checklists & Cross Reference Tables

Appendix E1	PD Cross Reference Table – IESC Advice and Response
Appendix E2	List of Contributing Persons
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Appendix E4	IESC Checklist

Appendix E1 PD Cross Reference Table – IESC Advice and Response

Table E1 Response to IESC 2019-103: Jellinbah Coal Mine – Central North Extension (EPBC 2018/8139) – Expansion

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1	The current assessment documentation, while providing information on the proposed project, does not provide sufficient information to assess potential impacts on other surface water and groundwater resources particularly the Mackenzie River and alluvium outside of the project area. The documentation does not contain sufficient baseline data or justification of the proponent's conclusions to allow the IESC to assess all potential impacts of the project on water resources. The project is an extension of an existing mine and the proponent should have site-specific baseline data that can be used to indicate potential impacts of the extension and to provide reference data against which to assess the effectiveness of mitigation strategies. The IESC has highlighted, in response to Question 2, the additional documentation and information required to assist in the assessment of the project's potential impacts to the surface water and groundwater resources, including the Mackenzie River and associated alluvium, GDEs and cumulative impacts.	The revised Preliminary Documentation incorporated sufficient information to assess potential impacts on surface water and groundwater resources. A receiving environment monitoring program (REMP) has been in place at Jellinbah Mines. The site water management plan (SWMP) for the CNE will integrate the existing REMP, together with a trigger actions response plan (TARP) and a real-time in-stream gauging program, to ensure the water quality objectives (WQOs) are continuously met. The revised SWMP is provided in **Appendix C6** (Engeny 2019a), and the Jellinbah REMP Design Report (with a TARP incorporated) is provided in **Appendix D3** (AARC 2019b). A substantial site-specific baseline dataset, which includes water and sediment quality and macro-invertebrates survey results are provided in **Tables 23-25** and **Appendix D4** (with impacted and reference sites). Real-time gauged data from the downstream of Mackenzie River is presented in **Figure 10**. The additional documentation and information provided would assist the IESC to assess the project's potential impacts on the surface water groundwater resources.
Groundwater		
2	a) At the existing Jellinbah CN mine, the proponent notes that no dewatering has been required to mine the Pollux seam to a depth of 125 m. Based on this experience, the proponent does not plan to install dewatering bores at the project site. This would reduce the likelihood of the project impacting groundwater levels and adding to cumulative groundwater impacts in the region. However, operational	a) The proposed mining at the CNE extends to the eastern edge of the lease - it is not possible to drill monitoring bores to the east of the CNE due to land ownership and access constraints. Three additional groundwater monitoring bores will be installed within ML 700011 in accordance with recommendations of the Queensland Department of Natural Resources, Mines and Energy. The bores will provide information on the presence/absence of water and the rate of water level decline as a result of mining

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	changes to mines in the surrounding area may lead to future groundwater level rebound, and so the IESC suggests that the proponent install appropriate monitoring bores to track future water level changes. b) The proponent considers that impacts to the alluvial aquifers are not likely to occur. This is because of a hypothesised disconnection between the alluvial and Permian aquifers. The proponent should provide further information, including hydrogeologic data, to validate the apparent lack of connectivity between the Permian strata (target coal strata), shallow alluvial aquifers and Twelve Mile Creek. If this disconnection is confirmed, then the IESC notes that additional drawdown of deeper groundwater may not produce any additional impact in the shallow alluvium or overlying watercourses. Conversely, if the strata are saturated and connected, then additional drawdown may increase losses from the shallow alluvium resulting in potential impacts on riparian vegetation, stygofauna, and hyporheic processes (e.g. Burrows et al. 2017). There may also be reductions in the persistence of pools along creek beds after flow ceases, reducing habitat availability for aquatic biota.	activity occurring at Central North. Any bore located within the mining footprint will be decommissioned as the mine progresses. The final void will act as a permanent groundwater sink (i.e., a cone of depression will remain around the final void); therefore, the only means of potential impacts via the groundwater system is interpreted to be if the final void water level rises to a level where outflow via unconsolidated sediments at the base of Tertiary is possible. The post-mining final void lake equilibrium level is assessed to be a maximum of 45.3 mAHD (Engeny 2019), and in the area of the CNE the base of Tertiary is interpreted to be in the order of 120 mAHD. Therefore, it is concluded that there is no possibility of outflow via the base of Tertiary. This assessment is discussed further in **Section 7.4**. b) The regional groundwater level beneath Twelve Mile Creek is interpreted to be in the order of 60 m below ground level (mbgl) and is therefore interpreted to be disconnected from the base of shallow alluvium and at too great a depth to be accessible to groundwater dependent ecosystems (GDE's). Predicted groundwater level drawdown from the CNE project does not extend to the limits of the Mackenzie River alluvium, and the 2 m drawdown contour at post-mining equilibrium is predicted to be approximately 4.8 km south of the Mackenzie River. The above responses are discussed in further detail in **Section 7.4** and **Section 8.0**.
3 a-e	The proponent has used a 2-dimensional (2D) model, SEEP/W, to predict groundwater drawdown. The proponent should justify why this model is better suited for the purpose of predicting drawdown than a 3-dimensional (3D) model.	The justification for the selection of the Seep/W model is presented in **Section 7.4.2 – 7.4.4**.

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	a. The IESC notes that drawdown impacts predicted by 2D models such as SEEP/W are likely to differ from the predictions of a 3D model and the likely nature of these differences should be established and documented. The proponent does not provide evidence to show these differences or discuss this as part of their modelling strategy nor have they provided information normally expected in a modelling report (e.g. model calibration data). b. If there is evidence for a hydraulic connection between the groundwater and surface water systems (particularly in Twelve Mile Creek), then a model should be developed to investigate the spatial variation and magnitude of likely impacts on surface water systems. Understanding connectivity between surface water, the alluvium and deeper strata is critical to determining whether drawdown in the Permian could impact other aquifers, potential GDEs and surface-expressed aquatic ecosystems. c. It is not clear whether the proponent has calibrated the model using site-specific field data. The proponent should compare model hydraulic head predictions against historical data to assess the performance of the model. d. The proponent has used a recharge value of 1% of average annual rainfall, which is assumed to be constant over space and time. Given the predicted greater variability in the magnitude and sequencing of wet and dry periods, this constant recharge value should be justified and compared to results obtained from other methods for estimating recharge, such as the chloride mass balance	a) It is not argued that a 2D (SEEP/W) model is inherently better than a 3D (e.g. MODFLOW) model for predicting drawdown, rather that the 2D model is appropriate to the assessment of impacts due to the CNE, for the following reasons: • The CNE represents a minor expansion of an existing mine (Central Pit) and already approved operation at Central North (CN); • The CNE occurs to the east of the CN mining area, therefore the main area for drawdown assessment is a distinct area to the east of the CNE, and it is judged that a 2D model is an appropriate tool for assessment of groundwater drawdown impacts along a west-east flow line (i.e., in the direction where assessment of potential impacts is most critical) • A SEEP/W model is able to accurately represent the seepage face conditions that occur at an open pit face and to represent the transition from unconfined conditions (at and near the pit face) to confined conditions (at a distance from the pit face). In this important respect, a 2D SEEP/W model is judged to be able to more accurately represent the seepage conditions and the prediction of drawdown along a west-east flow line than a 3D model such as MODFLOW, where mining tends to be represented via more simplistic approaches, such as the use of drain cells at the pit floor. b) It is assessed that there is no hydraulic connection between the regional groundwater system and Twelve Mile Creek. Refer response to **2a** above as well as **Section 7.4**. c) The hydraulic conductivity values in the model have been altered to be consistent with values from a calibrated 3-dimensional model that was developed for the Mackenzie North Environmental Management Plan, and which covers the area of the CNE (refer **Section 7.4.2**)

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	approach or the water table fluctuation method. The impact of rainfall and recharge variability should be elucidated. e. The proponent has undertaken uncertainty analysis using a factor of two for each parameter. Further analysis is required where sensitive hydraulic parameters – most importantly, hydraulic conductivity, storage and recharge – are varied by factors that reflect the measured bounds of natural variability to quantify uncertainty in predictions. For hydraulic conductivity and storage parameters, this is typically an order of magnitude or more. This would be consistent with leading practice and would improve understanding of the range of potential impacts. The proponent should also provide maps showing the 1-m drawdown contours as these will improve assessment of potential impacts on GDEs associated with the shallow alluvium.	It has also been observed at the adjacent Central Pit that the mine is dry (i.e. no observable groundwater inflow) at pit depths of 100-120 m. This is not to say that no groundwater inflow from the coal measures is occurring; rather, it is interpreted to indicate that groundwater inflow occurs at a rate that is less than evaporation. This observation provides valuable information for model calibration as the predicted rate of inflow to the pit, with the mine at similar depths, should at least be less than the rate of evaporation, to be consistent with observations from mining. During the modelling process, a check was made of the modelled rate of inflow to establish whether the inflow rate was occurring at a rate that could be removed by evaporation. This is discussed further in **Section 7.4.4**. d) Chloride concentration data from groundwater monitoring bores within the Mackenzie River alluvium, and the coal measures within the Mackenzie North lease area have been utilised to provide an estimate of recharge via the chloride mass balance (CMB) method (**Section 7.4.3**). Recharge to the model has been amended to 0.5% of annual average rainfall for the Tertiary sediments (which subsequently recharges the underlying coal measures) and 1% of annual average rainfall for areas of Quaternary alluvium. e) The section on uncertainty analysis has been updated, with parameters such as horizontal and vertical hydraulic conductivity and storage coefficient increased by one order of magnitude. Uncertainty analysis is discussed in **Section 7.4.5.3**.
Surface Water		
4	The proponent has not provided information on the project's potential impacts to the ephemeral surface water systems of Twelve Mile Creek, Five Mile Lagoon and Three Mile Lagoon. The IESC notes that there is a potential release point located at Five Mile Lagoon and water released here may have high concentrations of aluminium, arsenic, cobalt, copper, lead and zinc compared to 80th	There are no mine-affected water release points proposed for the Central North Extension mining area. Catchment boundaries for CNE have been shown in **Figure 16**. The CNE catchments flow to unnamed tributaries immediately downstream via sediment control devices.

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	percentile (for highly disturbed aquatic ecosystems) ANZG (2018) guideline values. Further consideration of potential impacts should be provided, including those from sediment-bound contaminants deposited downstream or on the floodplain.	These unnamed tributaries flow to the Mackenzie River and do not interact with 12 Mile Creek. The waste characterisation assessment (EGI 2013) indicates that overburden/interburden materials represented by the samples tested are NAF (Non-Acid Forming) and unlikely to release significant concentrations of salt or metals/metalloids. Any mine-affected water generated as a result of the CNE operations will be contained within and managed by the existing Jellinbah mine water management system. Sediment and erosion control structures are proposed to capture disturbed areas not classified as mine-affected water. Ongoing surface water monitoring and adaptive management strategies will identify whether surface water runoff characteristics change and/or do not align with current assessments. Modifications to the surface water management controls should be made accordingly to ensure water quality guideline values are achieved.
5	In response to flooding during the wet season of 2010/11, a levee was constructed to the north of the Jellinbah Plains open pit site to protect the operations from flooding in the Mackenzie River (UDP 145 2016, p. 14). The proponent has stated that the levee has been designed and constructed in accordance with engineering design requirements and flood modelling (AARC 2019, p. 73). Further information on the levee construction and location, along with design assumptions regarding estimated flood risk, should be provided so an assessment can be made of the levee's ability to minimise environmental impacts during flooding events from the Mackenzie River.	A report drawing on previous investigations was prepared by WRM and appended (**Appendix D6**) to help address the additional information requests. The following reports are included for reference as appendices in this report: Appendix A: Jellinbah Plains Stage 3 Levee Design Flood Levels Report (WRM, 2015) Appendix B: Mackenzie North Project Flood Impact Assessment Report (WRM, 2013) Information on levee design, construction, and location and design assumptions regarding flood risk have been provided in these previous investigations, and no change is proposed in the CNE. A diagram shows the extent of the existing Jellinbah levees is included in **Figure 4** (**Section 2.4.1** and **Appendix D7**).

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6	The proponent has not provided historical data on flood events for the region around the project area and no information has been provided on the methods used to define the extent of the 1:1000 Annual Exceedance Probability (AEP) (or other) design flood risks. Further information on flood extents would assist the assessment of the appropriateness of the levee's location in relation to the Central and Central North Site. The levee is aligned with the Mackenzie River meaning floodwaters from Blackwater Creek have the potential to flow into the project area from the western side of the project area. No quantitative assessment appears to have been undertaken to estimate flood behaviour in these two creeks. The IESC recommends the proponent provides models of the surface water regime and floods for both the Mackenzie River and Blackwater Creek. These models should identify: a. peak flows and water depths as a function of AEP; b. volume, duration, frequency and seasonality of inflows; c. wetting and drying cycles over multiple years (to span the responses to different climatic conditions); and d. the interaction between the pits/final voids and the flood extent of the Mackenzie River and Blackwater Creek.	A 'flood assessment' report (**Appendix D6**) was undertaken by WRM (2019) to identify the potential impact of flooding, specifically on the CNE. A description of the design of 1:1000 AEP flood levels at Jellinbah is detailed in **Section 2.1** of **Appendix D6**. Additional modelling work has been included to address the potential for Twelve Mile Creek flooding to impact the CNE (**Section 6.1.3**). Flood models for the Mackenzie River and Blackwater Creek were produced in previous investigations (WRM, 2010, 2013, 2015, 2018). Details include: • Peak flows and water depths for a range of AEPs to the PMF. • Description of the frequency of flooding and the volume and duration of design and historical flood hydrographs. • The pit/final void location – which is outside the extent of the PMF for the Mackenzie River and Blackwater Creek. The extent of Twelve Mile Creek flooding is also indicated in **Section 6.1.3**. Multi-year wetting and drying cycles are not relevant to the design of the flood protection system for large floods. Details from the above are addressed in **Section 6.1.3**.
7	Surface waters within the project area and nearby include the perennial Mackenzie River, ephemeral creeks including Blackwater Creek and Twelve Mile Creek, floodplain wetlands such as Three Mile Lagoon and Five Mile Lagoon, and palustrine wetlands associated with gilgai (much of	Catchment boundaries for CNE have been developed and are shown in **Figure 16**. Run-off from non-mine affected catchments within the CNE area report to unnamed tributaries immediately downstream via sediment control devices. These unnamed tributaries flow to the Mackenzie River and do not interact with Twelve Mile Creek.

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	which lies in the Brigalow TEC which is to be cleared). Although many of these surface waters are ephemeral, they play crucial ecological roles when inundated because they provide habitat, water and food resources for diverse biota and are the sites of ecological processes such as organic matter breakdown and nutrient cycling (Boulton et al. 2014). Changes to their water regimes are likely to be caused by alteration of catchment areas and topography, vegetation clearance and altered surface runoff due to open-cut mining and sediment dams. In turn, these altered water regimes will affect water depth and pool persistence in many surface waters. The proponent has not presented any information on the biota of these flowing and standing surface waters or their fringing vegetation at different stages of inundation which makes it difficult to judge likely impacts of altered water regimes (and altered water quality, see Paragraphs 20 and 24). Without such baseline data against which to assess changes after mining commences, it is impossible for the proponent to demonstrate the success of management and mitigation plans designed to minimise impacts on the flora, fauna and ecological processes in surface waters. The IESC recommends that the proponent survey water quality, riparian vegetation and aquatic biota of Blackwater Creek and Twelve Mile Creek at several times (e.g. during flow and when disconnected pools form) to obtain baseline water quality and biological data to guide predictions of potential impacts and against which to assess the effectiveness of mitigation strategies.	Baseline data, including water and sediment quality and macroinvertebrates from 7 monitoring points (MPs), are presented in **Table 23-25** and **Appendix D4**. The data included impacted and reference sites from Mackenzie River, Blackwater Creek, Five Mile Lagoon and Three Mile Lagoon.
Question 3 re Surface Water		

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19a-d	According to the proponent, the Surface Water Management System will ensure the project maintains compliance with Environmental Authority conditions pertaining to release and receiving water quality, which will ensure regional Water Quality Objectives (WQOs) are achieved. However, the IESC recommends that the proponent should demonstrate how the existing water management system will ensure that these WQOs continue to be achieved. An adaptive monitoring and management framework needs to be appropriately targeted for future stages in the proposed extension, including: a. establishing an appropriate baseline for impact assessment, including potential downstream impacts; b. an ecohydrological conceptual model that illustrates potential pathways and mechanisms of the effects of altered surface flows on groundwater and alluvial recharge, in-stream water quality, and surface and groundwater ecosystems. This conceptual model would help the proponent justify strategies proposed to mitigate and manage potential impacts. The conceptual model could be informed by the use of Water Observations from Space (WOfS) (http://www.ga.gov.au/scientific-topics/earth-obs/case-studies/water-observations-from-space) to quantify where seasonal or ephemeral water bodies are present in the landscape; c. regular and event-based (e.g. during spates) water quality testing of the discharge water, upstream water and water immediately downstream of the licenced discharge	Water balance modelling results indicate no change in the release of mine-affected water and non-mine water for the CNE, as discussed in **Section 6.3**. Recommendations on adaptive monitoring and management framework are provided in **Section 11**. a) A substantial baseline dataset (with impacted and reference sites) is presented in **Table 23-25** and **Appendix D4** (AARC 2019a). In addition, continuous site monitoring is conducted in conjunction with the site water management plan using real-time gauges. Water quality gauged data from the downstream of the Mackenzie River is presented in **Figure 10**. b) Catchment analysis was undertaken by Engeny (2019a) using the Australian Water Balance Model (AWBM) to predict stream flows from Blackwater Creek. Catchment areas associated with the CNE and the resulted area increase of mining catchment are quantified and discussed in **Section 6.2**. c) and d) Water quality sampling has been undertaken during each releasing event at the discharge points. **Section 6.3** discusses further the discharge water quality and **Section 11.3** discusses commitments and mitigation measures on release controls to continuously meeting the WQOs. Since no additional release or monitoring, points are proposed in the CNE and all modelling results from surface and groundwater show that the CNE is unlikely to result in significant change to current water quality, existing EA conditions for receiving/release water contaminant trigger levels will continue to apply.

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	points to determine when individual contaminants consistently exceed water quality guidelines; and, d. commitments for surface water and groundwater monitoring should be presented as part of the relevant water monitoring plans and should be consistent with the Water Quality Objectives for the Fitzroy River (State of Queensland 2013).	
20	The IESC recommends the proponent implements a water quality monitoring program which incorporates reference and impacted sites. This is needed as water quality at the reference sites exceeds multiple water quality parameters when compared to the ANZG (2018) guidelines for aquatic ecosystem protection and the regional WQOs. Data from this program should be used to set site-specific guideline values (Huynh and Hobbs 2019).	This is answered in Q7 and Q19a above. A REMP has been in place at Jellinbah mines, and a substantial site-specific baseline dataset is provided in **Table 23-25** and **Appendix D4** (with reference and impacted sites).
21a-b	The IESC recommends the proponent develop a Receiving Environment Management Plan (REMP) that specifies actions to ensure that the downstream environment is not adversely affected by discharges or storage overflows from the proposed mine. Collectively, these plans should: a. provide a trigger-action response plan (TARP), in line with ANZG (2018) guidelines, and which uses site-specific data from reference and impact sites; and b. integrate with the existing Surface Water Management Plan (SWMP) so that the mitigation and management	A REMP has been in place at Jellinbah Mine, and the CNE will be integrated into the current program (refer response to Q7, Q19a, and Q20 above). a) A TARP has been developed in line with ANZG guidelines using site-specific data that are available from the REMP results. The TARP table is incorporated into the REMP Design Report and presented in **Appendix D3** (AARC 2019b) b) The SWMP developed by Engeny (2019a) has integrated the CNE Water Management Plan with the existing one at Jellinbah Mines and is discussed in **Section 11.3**.

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	measures will adequately protect environmental values within and downstream of the project area.	
22	Using baseline data on water quality, riparian zone vegetation and aquatic biota (see Paragraph 7), the proponent should propose appropriate mitigation and management strategies to minimise potential impacts of altered flow regimes and/or water quality on aquatic biota in Blackwater Creek and Twelve Mile Creek as a result of the proposed project. A suitable monitoring strategy should be outlined that allows the proponent to demonstrate the effectiveness of these mitigation strategies in protecting the ecological integrity of the ephemeral streams and the Mackenzie River into which they flow.	Water quality data for Blackwater Creek are included in **Table 23-24** and **Appendix D4,** and additional baseline biota (macro-invertebrate) analysis results from all monitoring sites (including Blackwater Creek) are provided in **Table 25**. Flood and groundwater modelling (**Section 6.3.1** and **Section 7.4**) results suggest that no significant impacts on aquatic biota of Blackwater Creek and Twelve Mile Creek will occur as a result of the CNE, as addressed in **Section 6.3.1**. Mitigation and management strategies to minimise potential impacts of any altered flow regimes (along with catchment analysis) and water quality are proposed in **Section 6.2** and **Appendix C6** (Engeny 2019a). A suitable monitoring strategy, including the REMP and TARP is discussed in **Section 11.3** and **Appendix D3** (AARC 2019b).
	Site Water Management	
8	Although the proponent provided a water balance, it has not accounted for the quantity of mine-affected water discharge and 'clean' water discharge in the calculations. Quantification of the amounts of water discharged by the proponent into Blackwater Creek and the Mackenzie River for both 'clean' and mine-affected water is required. The water balance does not consider cyclones or high rainfall events which could produce high quantities of runoff and erosion (relevant for transport of sediment-bound contaminants, see Paragraph 4). The proponent has also not provided evidence of how the drainage, designed runoff and sediment traps will withstand extreme rainfall and weather events. The proponent should provide an updated water balance considering the above matters. The IESC	Water balance modelling results indicate no additional accumulation of mine-affected water as a result of the proposed CNE (refer **Section 6.3**). There are no mine-affected water release points proposed for the Central North Extension mining area. While the IESC recommends using the Water Accounting Framework (WAF) to quantify the volumes of mine-affected water and clean water releases discharge, we consider the proposed daily water balance using GoldSIM is a more accurate methodology than the WAF due to its ability to simulate the containment performance of individual storages, including daily fluctuations storage levels, water transfers, controlled and uncontrolled release. The WAF was developed by MCA as a mechanism by which industry can report water consumption in standardised units to comply with industry reporting requirements (**Table 7** and **Table 28**) and was not developed with the intention

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	suggests using the Minerals Council of Australia Water Accounting Framework (Minerals Council of Australia 2014) to do this.	of use to assess and/or quantify the performance of mine water management systems in terms of managing the impacts to the environmental values.
9	The IESC recommends the proponent undertakes a sensitivity analysis on the water balance model to investigate and report on the uncertainties in model parameterisation and future hydro-meteorological assumptions. The current analysis is based on a “looping” of the past 100 years of climate (Paragraph 3(d)), and no consideration, even in the form of a sensitivity analysis, has been given to the likely impacts of magnitude (and hence variability) of rainfalls over the next 100 years. This could be informed through the use of the Climate Futures Framework and Tools (Whetton et al. 2012) (https://www.climatechangeinaustralia.gov.au/en/climate-projections/climate-futures-tool/projections/) which allows for various climate regimes to be simulated.	Climate change scenarios for the CNE have been considered, as described in **Section 6.3.1**. The sensitivity analysis indicates no significant change to the mine water inventory or increased risk of mine affected water releases for CNE.
	Mine-affected Water Discharge	
10	The proponent has provided little information on the quality of the mine-affected water and the predicted quality of the discharge water. Additionally, it is unclear as to the duration of potential discharges because no historical data on the releases were provided by the proponent. Given the proponent noted the water quality in 2016 exceeded the Water Quality Objective values and ANZECC 2000 guidelines for a range of parameters including sulfate, aluminium, copper, arsenic, cobalt, lead, nickel, EC and pH, this information should be provided, together with an assessment of the likely impacts. Any change as a result of	No changes are expected to the existing discharging water quality as the water balance modelling results show minimal changes in volume with the CNE (see **Table 28**). The occurrence and volume of uncontrolled mine water releases are lower as a result of the CNE due to slightly lower stored mine water inventory volumes (**Appendix C6**, Engeny 2019a). Due to the proximity of the CN and CNE mining areas to the Jellinbah Central site facilities, CNE will utilise much of the same infrastructure. Sediment dams and sediment traps are proposed to collect and treat sediment runoff prior to discharging into receiving waterways.

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	the proposed project in the frequency and duration of controlled or uncontrolled mine-affected water discharges should be determined (for example, after high rainfall events). Water discharge quality and timing is particularly important as turtle species within the Mackenzie River, including the critically endangered White-throated Snapping Turtle (Elseya albagula), are susceptible to changes in water quality, flow regime and habitat characteristics (GHD, 2015, pp. 25-26). Discharge information as well as more recent monitoring data should be used to confirm the quality of the water.	In addition to the REMP, continuous monitoring gauge downstream on the Mackenzie River and Blackwater Creek has been implemented to meeting the enhanced release conditions required in the EA Amendment (refer **Section 11.3** for detail).
11	The proponent proposes to use multiple sediment dams to intercept runoff, and it is anticipated that there will be overflow from the sediment dams to the off-site receiving environment. It is also stated that geochemical characterisation of the overburden material indicates that runoff from spoil dumps draining to sediment dams would have concentrations of dissolved salts and metals below guideline values. However, no geochemical assessment was provided for the project area to support this conclusion, which is important if design changes for the spoil dumps and associated infrastructure can be made to preserve the Brigalow TEC in ML 700012.	A waste characterisation assessment was undertaken for Jellinbah Mine (EGI, 2013) and reported low levels of salt and dissolved metals. CNE has the same geological sequence as the CN and as such, it is expected these results are representative of waste material associated with CNE.
12	The IESC notes that there are no water treatment systems in place, but rather the proponent states that they 'recycle' as much water as possible. The quality of the water once it has been 'recycled' and used for site activities has not been provided by the proponent. The tailings dams' water is used at the wash plant and is pumped into water trucks at the Jellinbah Plains site. It is not clear if this water is used for	The tailings decant water is re-cycled through the wash plant circuit and used for dust suppression within the mining void catchment areas. This strategy eliminates the risk of tailings decant water being released to the receiving waterway. CNE will not result in changes to the existing operational activities associated with using tailings water for dust suppression.

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	dust suppression. Given that the water quality data provided by the proponent for the Tailings Dam (KW14) from 2016 show elevated levels of sulfate, arsenic and nickel, further information is needed on the exact use of this water and its potential impacts on and risks to the receiving environment.	
Question 3 re Mine-affected water discharge		
23	The IESC recommends that the proponent undertakes flood modelling (as outlined in response to Question 2) and determines the risks of uncontrolled releases from water dams, sediment traps, storage ponds and other associated infrastructure during extreme weather events, such as cyclones and extended wet seasons to assist in developing monitoring and mitigation plans. Images from WOfS may add value in calibrating this modelling (e.g. Mueller et al. 2016). The information gathered from the flood modelling can be used to inform the SWMP as well as the REMP (e.g. risk of overtopping hypersaline final voids).	A flood assessment report was undertaken by WRM and included as **Appendix D6**, and critical information is updated in **Section 6.1.3** and **Section 6.5.2** in relation to flood risk. No additional mine-affected water dams have been proposed as part of the CNE project. The risk of uncontrolled release from structures associated with Jellinbah Mine was assessed. The water balance modelling, including extreme weather events (e.g. 2011 flood event), indicates that the proposed CNE does not increase the likelihood or volume of mine water releases (refer **Section 6.3**).
24	The IESC considers that prior to disturbance by the proposed project, site-specific water quality guideline values should be derived from 24 contiguous monthly samples as outlined in the ANZG (2018) guidelines. Site-specific guideline values are needed for all parameters where the default ANZG (2018) guideline values are not met. This includes aluminium, cobalt and arsenic in particular where elevated concentrations have been regularly observed. The proponent may need to consider	Existing EA conditions for Jellinbah Mine are suitable as no additional release point, or substantial change to water quality and management is proposed from the CNE. The WQOs' key parameters are stated in **Table 23** & **Appendix D4**. Continuous gauged data from downstream of the Mackenzie River is presented in **Figure 10**. The REMP and TARP are integrated to ensure the WQOs are continuously met. Mitigation and management strategies are discussed in **Section 11.3** with detail.

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	the treatment of water prior to discharge in order to meet the site-specific guideline values.	
	Final Void	
13	The proposed mine plan will result in an extension of an existing approved void (the Central North void) in the project area whose water is predicted to continue to increase in salinity until saturation is reached and salts precipitate. This void will pose multiple and ongoing risks to the environment. It will also not support fringing vegetation or aquatic biota typical of natural freshwater floodplain wetlands. Consideration should also be given to how this higher density saline water may affect groundwater flow (i.e. the void may no longer behave as a groundwater sink due to the density contrast between void water and underlying groundwater) and quality. The IESC suggests modelling of final void water quality should also be conducted with consideration of future climatic regimes as discussed in Paragraph 9.	The estimated water levels in the Central North final void, including the proposed extension and the interconnected Central final void, will be significantly lower than the spill level to receiving environment for all scenarios investigated, including the climate change scenarios. In addition, while the final voids water quality (i.e., salinity) is expected to increase due to lower predicted water levels in the climate change scenarios, the estimated final void water level is significantly lower than the spill level to receiving environment (i.e., final voids will act as sinks) (refer **Section 9.0**).
	Groundwater-dependent Efcosystems	
14	The proponent has used desktop searches and a single field survey to identify GDEs but only within the project area. The IESC suggests that after the proponent has provided groundwater drawdown contours at a finer scale than 5 m, as discussed in Paragraph 3e, desktop and additional field surveys for GDEs should be done in this larger area of potential drawdown to verify whether there are any GDEs at risk of losing some or all access to	The additional desktop analysis was undertaken to include the 2 m drawdown contour from the CNE operations. The location of drawdown contours with respect to potential GDE has been presented in **Figure 32**. Refer to response to Q2 above as well as **Section 8.0** for detail.

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	groundwater. Methods for conducting field surveys and risk assessments of GDEs are reviewed in Doody et al. (2019).	
15	There is potential for terrestrial and aquatic GDEs to occur in areas of saturated alluvium along watercourses (BOM 2017), particularly in the receiving environment downstream of the project. If GDEs are present downstream of the project they could be impacted by controlled and uncontrolled releases of mine-affected water. Field studies of the flora and fauna of these potential GDEs are required to provide baseline data against which to assess potential impacts of altered water quality and/or altered groundwater access.	Refer response to Q2 above and **Section 8.0** for Groundwater and GDEs. Based on the information presented, it is not expected that the CNE will impact on any GDEs within the vicinity of the Project. For the potential risks of mine-affected water discharge, further discussion is included in **Section 6.3** and **Section 11.3**.
Question 3 re Groundwater-dependent ecosystems		
25	The proponent has not proposed any mitigation or management measures for GDEs because it is assumed that few, if any, GDEs occur in the project area (assumed because depth to groundwater exceeds 40 m) and that no impacts on GDEs are expected from the project. However, the proponent's assessment does not consider any GDEs that potentially occur in the area where groundwater drawdown is predicted to be less than 5 m (see Paragraphs 3 and 14). It also does not include GDEs that may occur in downstream receiving environments whose groundwater quality might be affected by controlled or uncontrolled discharges or final void overflows. Further, there may be GDEs that rely on shallow perched groundwaters (e.g., gilgai in the Brigalow TEC) that are not included in the groundwater modelling. Depending on the outcome of the GDE surveys recommended in response to Question 2	Additional analysis was undertaken by JBT (2019) to consider GDEs that potentially occur in the area where groundwater drawdown is predicted to be 2 m. The conclusion stated that it is not expected that the CNE will impact on any GDEs within the vicinity of the Project (refer details presented in **Section 8.0**). It is possible that the GDEs to be affected by uncontrolled surface water releases. Mitigation and management strategies, as well as water quality monitoring programs, have been in place to ensure the WQOs are continuously to meet (refer response to Q7, 19a, 20, 21, 22, and 24).

No.	IESC Advice	Response
	(see Paragraphs 14 and 15), the proponent may need to develop specific management and mitigation plans to avoid or reduce impacts of the proposed project on GDEs in the area surrounding and/or downstream of the project area.	
26	The proponent should provide a map of the estimated saturated zones/depth to the water table (in metres below ground level) and overlay this with a map of potential GDEs. This map would indicate which GDEs may be at risk of drawdown and therefore deserve particular mitigation or management (Doody et al. 2019).	A map of the estimated saturated depth to the water table overlaying with a map of potential GDE is presented in **Figure 30-31** (refer **Section 8.0** for detail).
Cumulative Impacts and Final Voids		
16	Given the proximity and number of mining operations near the project area, cumulative impacts are highly likely. These cumulative impacts may include: a. pulses of potentially hypersaline water from one or more final voids that may be released to the floodplain or groundwater systems during a large flood event; b. additive effects of uncontrolled discharges that may alter downstream water quality and flow regimes, affecting aquatic and riparian ecosystems; and c. enhanced groundwater drawdown through interference of drawdown from various mines, that may affect floodplain and alluvial GDEs if connectivity between deeper groundwater and the shallow alluvium occurs	a) Flood modelling work was undertaken by WRM (**Appendix D6**) and the results indicate that the final voids are located outside the 1:1000 AEP flood extent (detailed in **Section 6.1.3**). While the estimated water quality in final Central North final void including the proposed extension and Central North final void will be hypersaline, the current assessment indicated that the final voids will remain as a sink, and equilibrium water level in these voids will be significantly lower than the spill level to the receiving environment (refer **Section 9.0**). b) Additional catchment analysis was undertaken by Engeny (2019a) to assess whether there is an altered flow regime with the CNE. Mitigation and management strategies are proposed to minimise the risks of uncontrolled discharges, as discussed in the site water management plan (Engeny 2019a) (**Appendix C6**). c) The modelling work conducted by JBT (2019) shows the groundwater below Twelve Mile Creek is disconnected from the base of the shallow alluvium and that at 60 mbgl it is beyond the depth that is accessible by vegetation.

No.	IESC Advice	Response
17	The IESC notes that Twelve Mile Creek runs through additional mine sites downstream and impacts arising from those sites may limit the value of any mitigation undertaken for the Jellinbah CNE (see response to Question 3). Baseline data on water quality and biota (see Paragraph 7) should be collected to guide the prediction of these cumulative impacts and provide reference data for assessing the effectiveness of mitigation strategies.	Catchment boundaries for CNE have been shown in **Figure 16**. The CNE catchments flow to unnamed tributaries immediately downstream via sediment control devices. These unnamed tributaries flow to the Mackenzie River and do not interact with Twelve Mile Creek.
18	Although the proponent acknowledges the likelihood of some of these cumulative effects (e.g. interference of drawdown), the likely collective impacts on aquatic and terrestrial ecosystems in the expanded areas of potential drawdown have not been assessed. Similarly, the additive effects of altered water quality caused by cumulative uncontrolled discharges (including of hypersaline water from final voids during large floods) have not been estimated nor have their possible impacts on aquatic, riparian and floodplain biota and ecological processes downstream been assessed. A risk assessment of these cumulative impacts is needed, along with reliable baseline data against which to judge the effectiveness of proposed mitigation and management plans.	Groundwater modelling predicts that a permanent cone of depression will develop that will direct groundwater flow towards the final void. End of mine closure studies for the Jellinbah Coal Mine predict that post mining, voids will remain a groundwater sink (refer **Section 7.5.2**). The final voids will remain as saline water containments below the natural ground surface in perpetuity (as model results indicated in **Section 7.4**). Upon closure, measures will be taken to ensure the cumulative impacts of multiple saline voids are minimised. Provision has been made in the financial assurance to reshape final voids and construct safety bunds/walls from competent rock to limit human and livestock/animal access to final voids. Fencing will also be installed (where required) along the void highwalls to restrict human and livestock/animal access. Combined, these measures will minimise the cumulative impacts of final voids. (refer **Section 10.0**)
Question 3 re Cumulative impacts and final voids		
27	The cumulative impact assessment undertaken by the proponent does not consider all adjacent mines and other existing tenements. While the current project may make only a small contribution towards cumulative impacts, the overall cumulative impact of these operations should be considered. Monitoring and mitigation plans to address	The existing surface water release conditions and final void water management are discussed in **Section 6.1, Section 9.3,** and **Section 11.3.** Monitoring and mitigation plans to address cumulative impacts have been considered. Cumulative impacts on surface water values will continue to be assessed and managed via the Jellinbah REMP and associated TARP (**Appendix D3**, AARC 2019b), which is

No.	IESC Advice	Response
	cumulative impacts should be developed in collaboration with the operators of the Curragh and Yarrabee mines.	integrated into the site water management plan (SWMP) (refer **Section 11.3** and **Appendix C6**, Engeny 2019a).
28	The remnant Brigalow TEC in ML 700012 should be retained, which could be achieved by redesigning the project to avoid clearing the TEC for spoil deposition and infrastructure. This refugial patch is a potential source for subsequent colonization of rehabilitated vegetation after cessation of mining.	Brigalow patches located within ML 700011 overlie the coal resource, and as a result, avoidance is not possible should the Project be approved. Brigalow, with ML 700012 overlies an area designated for spoil dumping and topsoil stockpiling. Jellinbah has reviewed alternate options for disposal. However, the limitations of the mining tenure mean that land within an economic haul distance is otherwise utilised or required for other essential purposes. As a result, avoidance of the stand-alone patch of Brigalow within ML 700012 was not achievable in the Project design (refer **Section 4.4**).
29	The IESC notes that while the proposed project will result in the modification of a single approved void in the Jellinbah Central mine, the other mines in the broader Jellinbah operation will result in a further six final voids. All seven of these voids will have a lasting cumulative impact. The final voids pose long-term risks to biota from deteriorating water quality, especially increasing salinity. The proponent should work collaboratively with other operators to provide a mitigation plan for minimising impacts on wildlife, and outline how these strategies will be monitored to assess their success.	The current assessment indicated that the estimated water levels at Central North void with proposed extension and Central North final voids would be significantly lower than the spill level to the receiving environment. The other final voids in Jellinbah Mine have been assessed previously (Engeny, 2018). Modelling results indicated that all final voids would remain well below the spill level and do not pose a risk of uncontrolled overflow to the receiving environment. In addition, none of the final voids in Jellinbah Mine will present a seepage risk to the groundwater system, as discussed in Jellinbah Final Void Hydrology Study (Engeny 2018).
30	The IESC recommends that various options for backfilling voids should be investigated. If final voids are not to be backfilled, justification should be provided for why complete backfilling is not achievable and/or results in adverse environmental outcomes. The design of the final landform should consider the impacts to water resources. Appropriate mitigation, monitoring and management measures should ensure that these impacts are minimised.	The final void and final landform proposed within the CNE area has been assessed and approved by DES (as indicated in Table G2 of the EA). More details are included in **Section 2.3.2** – Rehabilitation and Final Landforms, and the final landform of the CNE area is presented in **Figure 3**.

No.	IESC Advice	Response
31	Both the Mackenzie North and Plains voids were modelled, with the results showing that final void water will be below the base of the alluvium (AARC 2018, p. 8). The modelling, however, does not examine the effects of extreme events nor the changes in contributing catchment areas arising from mining activities. It may be possible for water levels in both the Mackenzie North and Jellinbah Plains voids to rise above the base of the alluvium providing a connection between the void and the surrounding environment. The saline void water could then discharge into aquifers or the surrounding surface environment via the alluvium. Given the proponent has stated the final voids will be a contaminated saline water sink, this has the potential to impact on the receiving environments and downstream ecosystems. The proponent should examine the effects of successive high-rainfall years on void water levels to ensure that discharge from final voids to the environment cannot occur through the alluvium.	Both Mackenzie North and Plains' final void assessment were undertaken previously by Engeny (2018). These two final voids are not related to proposed actions for Central North Extension. The Central North void, including the proposed extension, is located 10 km south of Mackenzie River. The final void assessment (Engeny 2018) indicates that all final voids in Jellinbah Mine will remain as sink to groundwater and will not spill to the receiving environment. The impacts of climate change have been assessed in **Section 9.2.1**, which show no overflow to receiving environment from Central North, including the proposed extension and Central final voids. It should be noted that the proposed extension to the Central North final void will cause a small increase in void equilibrium water level (~0.14m) and negligible change in water quality (i.e., salinity).

Appendix E2 List of Contributing Persons

Organisation	Name	Title	Involvement in Preparation of Preliminary Documentation
AARC Environmental Solutions	Caitlin Phillips	Senior Environmental Scientist	Preparation of Preliminary Documentation.
	Eliot Gibbs	Environmental Scientist	Preparation of Preliminary Documentation.
	Gareth Bramston	Director Principal Environmental Scientist	AARC Project Manager for Central North Extension. Review of Preliminary Documentation.
JBT Consulting	John Bradley	Principal Hydrogeologist	Preparation of 2019 Conceptual and Numerical Groundwater Modelling.
Engeny	Aaron Halgarth	Principal	Preparation of Surface Water Assessment 2019 and Final Void Hydrology Study 2019
Jellinbah	Ian Cooper	General Manager	Review of Preliminary Documentation.
	Carl Pritchard	General Manager – Technical Services	Jellinbah Project Manager for Central North Extension. Authorisation of Preliminary Documentation.

Appendix E3 List of People and Agencies Consulted

Agency	Name	Title	Details of Consultation
DoEE	Karina Richards & Sheryl Sibley	Assessment Officer, Environment Standards Division	10/10/2017 Pre-Referral Meeting
DoEE	Karina Richards & Stewart Page	Assessment Officers, Environment Standards Division	25/06/2018 Site visit by DoEE & meeting to provide additional context to the EPBC Referral assessment.
DoEE	Karina Richards & Kynan Gowland	Assessment Officer, Environment Standards Division	29/11/2018 Meeting to discuss submission of Preliminary Documentation. The meeting provided context to the request for further information provided by DoEE.
DoEE	Stewart Page,Karina Richards & Peter Blackwell	Assessment Officer, Environment Standards Division	01/02/2019 Meeting to discuss proposed assessment methodology with Jellinbah representatives and the Office of Water Science
Office of Water Science	Peter Baker		01/02/2019 The purpose of the meeting was to discuss the modelling approach and software package to be used in the groundwater assessment. The suitability of the proposed approach was confirmed by Peter. Discussion also addressed: Potential impacts on GDEs to the east of the Project. Inclusion of uncertainty analysis in the impact assessment. Inclusion of a solid conceptualisation to support the modelling.
DoEE & Office of Water Science	Peter Baker, Stewart Page, Damian Oconnor, Mia Coonan		25/07/2019 The prupose of this meeting was to discuss the IESC findings and confirm the approach to addressing queries.

Description of the proposal	
☐ Provide a regional overview of the proposed project area including a description of the geological basin; coal resource; surface water catchments; groundwater systems; water-dependent assets; and past, present and reasonably foreseeable coal mining and CSG developments.	Section 6.1 Section 7.1 Section 8.0 Section 2.6
☐ Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies or regulations.	Section 3.0
☐ Describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Section 2.0 Figure 2
☐ Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Section 2.4 Section 6.3 Appendix A1 Appendix C6 (WMP)
Final landform and voids – coal mines	
☐ Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion, sedimentation and habitat fragmentation of water-dependent species and communities.	Appendix C Section 8.0
☐ Assess the adequacy of modelling, including surface water and groundwater quantity and quality, lake behaviour, timeframes and calibration.	Section 7.0 Section 7.4.5.3
☐ Provide an evaluation of stability of void slopes where failure during extreme events or over the long term (for example due to aquifer recovery causing geological heave and landform failure) may have implications for water quality.	Appendix C3
☐ Evaluate mitigating inflows of saline groundwater by planning for partial backfilling of final voids.	Appendix A1 Appendix C3
☐ Assess the probability of overtopping of final voids with variable climate extremes, and management mitigations.	Appendix C6 (WMP)
☐ Provide an assessment of the long-term impacts to water resources and water-dependent assets posed by various options for the final landform design, including complete or partial backfilling of mining voids. Assessment of the final landform for which approval is being sought should consider: – groundwater behaviour – sink or lateral flow from void. – water level recovery – rate, depth, and stabilisation point (e.g. timeframe and level in relation to existing groundwater level, surface elevation). – seepage – geochemistry and potential impacts. – long-term water quality, including salinity, pH, metals and toxicity. – measures to prevent migration of void water off-site. ☐ For other final landform options considered sufficient detail of potential impacts should be provided to clearly justify the proposed option.	Appendix C3
Acid-forming materials and other contaminants of concern	
☐ Identify the presence and potential exposure of acid-sulphate soils (including oxidation from groundwater drawdown).	Non-acid forming material on site Appendix C3
☐ Describe handling and storage plans for acid-forming material (co-disposal, tailings dam, and encapsulation.	N/A

☐ Identify the presence and volume of potentially acid-forming waste rock, fine-grained amorphous sulphide minerals and coal reject/tailings material and exposure pathways.	NA Product Handling: Section 2.3.1
☐ Assess the potential impact to water-dependent assets, taking into account dilution factors, and including solute transport modelling where relevant, representative and statistically valid sampling, and appropriate analytical techniques.	Section 8.0
☐ Identify other sources of contaminants, such as high metal concentrations in groundwater, leachate generation potential and seepage paths.	Section 7.0
☐ Describe proposed measures to prevent/minimise impacts on water resources, water users and water-dependent ecosystems and species.	Section 11.3
CSG well construction and operation	
☐ Describe the scale of fracturing (number of wells, number of fracturing events per well), types of wells to be stimulated (vertical versus horizontal), and other forms of well stimulation (cavitation, acid flushing).	No CSG wells proposed.
☐ List the chemicals proposed for use in drilling and hydraulic stimulation including: – names of the companies producing fracturing fluids and associated products – proprietary names (trade names) of compounds (fracturing fluid additives) being produced – chemical names of each additive used in each of the fluids – Chemical Abstract Service (CAS) numbers of each of the chemical components used in each of the fluids – general purpose and function of each of the chemicals used – mass or volume proposed for use – maximum concentration (mg/L or g/kg) of the chemicals used – chemical half-life data, partitioning data, and volatilisation data – ecotoxicology, and ☐ any material safety data sheets for the chemicals or chemical products used.	N/A
☐ Describe proposed measuring and monitoring of fracture propagation.	N/A
☐ Identify water source for drilling and hydraulic stimulation and outline the volume of fluid and mass balance (quantities/volumes).	N/A
☐ Describe the rules (e.g. water sharing plans) covering access to each water source used for drilling and hydraulic stimulation and how the project proposes to comply with them.	N/A
☐ Quantify and describe the quality and toxicity of flowback and produced water and how it will be treated and managed.	N/A
☐ Assess the potential for inter-aquifer leakage or contamination.	N/A
☐ The use of drilling and hydraulic fracturing chemicals should be informed by appropriately tiered deterministic and/or probabilistic hazard and risk assessments, based on ecotoxicological testing consistent with Australian Government testing guidelines (see CoA 2012; MRMMC-EPHC-NHMRC 2009).	N/A
☐ Chemicals for use in drilling and hydraulic fracturing must be identified as being approved for import, manufacture or use in Australia (that is, confirmed by NICNAS as being listed in the Australian Inventory of Chemical Substances (see CoA 2017b).	N/A
☐ Propose waste management measures (including salt and brines) during both operations and legacy after closure.	N/A
Subsidence – underground coal mines and coal seam gas	

☐ Provide predictions of subsidence impact on surface topography, water-dependent assets, groundwater (including enhanced connectivity between aquifers) and the movement of water across the landscape (See CoA 2014b; CoA 2014c). Consider multiple methods of predictions and apply the most appropriate method. Consider the limitations of each method including the adequacy of empirical data and site-specific geological conditions and justify the selected method.	N/A
☐ Describe subsidence monitoring methods, including the use of remote or on-ground techniques and explain the predicted accuracy of such techniques.	N/A
☐ Provide an assessment of both conventional and unconventional subsidence. For project expansions, an evaluation of past or current effects of geological structures on subsidence and implications for water resources and water-dependent assets should be provided.	N/A
☐ Consider geological strata and their properties (strength/hardness/fracture propagation) in the subsidence analysis and/or modelling. Anomalous and near-surface ground movements with implications for water resources and compaction of unconsolidated sediment should also be considered.	N/A
Risk Assessment	
☐ Identify and assess all potential environmental risks to water resources and water-related assets, and their possible impacts. In selecting a risk assessment approach consideration should be given to the complexity of the project, and the probability and potential consequences of risks.	Section 11.3
☐ Assess risks following the implementation of any proposed mitigation and management options to determine if these will reduce risks to an acceptable level based on the identified environmental objectives.	Section 11.3
☐ Incorporate causal mechanisms and pathways identified in the risk assessment in conceptual and numerical modelling. Use the results of these models to update the risk assessment.	Section 11.3 Section 7.3 Section 7.4
☐ The risk assessment should include an assessment of: – all potential cumulative impacts which could affect water resources and water-related assets, and ☐ mitigation and management options which the proponent could implement to reduce these impacts.	Section 11.3

Surface water	
Context and conceptualisation	
☐ Describe the hydrological regime of all watercourses, standing waters and springs across the site including: – geomorphology, including drainage patterns, sediment regime and floodplain features – spatial, temporal and seasonal trends in streamflow and/or standing water levels – spatial, temporal and seasonal trends in water quality data (such as turbidity, acidity, salinity, relevant organic chemicals, metals, metalloids and radionuclides), and – current stressors on watercourses, including impacts from any currently approved projects.	Section 6.1
☐ Describe the existing flood regime, including flood volume, depth, duration, extent and velocity for a range of annual exceedance probabilities. Provide	Section 6.4

Surface water	
flood hydrographs and maps identifying peak flood extent, depth and velocity. This assessment should be informed by topographic data that has been acquired using lidar or other reliable survey methods with accuracy stated.	
☐ Provide an assessment of the frequency, volume, seasonal variability and direction of interactions between water resources, including surface water/ groundwater connectivity and connectivity with sea water.	Section 7.3 Section 7.4
Analytical and numerical modelling	
☐ Provide conceptual models at an appropriate scale, including water quality, stores, flows and use of water by ecosystems.	Section 2.4 Section 6.3
☐ Use methods in accordance with the most recent publication of *Australian Rainfall and Runoff* (Ball et al. 2016).	N/A
☐ Develop and describe a program for review and update of the models as more data and information becomes available.	N/A
☐ Describe and justify model assumptions and limitations and calibrate with appropriate surface water monitoring data.	N/A
☐ Provide an assessment of the risks and uncertainty inherent in the data used in the modelling, particularly with respect to predicted scenarios.	N/A
☐ Provide a detailed description of any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	N/A

Surface water	
Impacts to water resources and water-dependent assets	
☐ Describe all potential impacts of the proposed project on surface waters. Include a clear description of the impact to the resource, the resultant impact to any assets dependent on the resource (including water-dependent ecosystems such as riparian zones and floodplains), and the consequence or significance of the impact. Consider: – impacts on streamflow under the full range of flow conditions. – impacts associated with surface water diversions. – impacts to water quality, including consideration of mixing zones. – the quality, quantity and ecotoxicological effects of operational discharges of water (including saline water), including potential emergency discharges, and the likely impacts on water resources and water-dependent assets. – landscape modifications such as subsidence, voids, post rehabilitation landform collapses, on-site earthworks (including disturbance of acid-forming or sodic soils, roadway and pipeline networks) and how these could affect surface water flow, surface water quality, erosion, sedimentation and habitat fragmentation of water-dependent species and communities.	Section 6.5 Section 8.0

Surface water	
☐ Provide an assessment of the risks of flooding (including channel form and stability, water level, depth, extent, velocity, shear stress and stream power), and impacts to ecosystems, project infrastructure and the final project landform.	Section 6.5
☐ Discuss existing water quality guidelines, environmental flow objectives and requirements for the surface water catchment(s) within which the development proposal is based.	Section 6.1
☐ Identify processes to determine surface water quality guidelines and quantity thresholds which incorporate seasonal variation but provide early indication of potential impacts to assets.	Appendix C6 (WMP)
☐ Propose mitigation actions for each identified significant impact.	N/A
☐ Describe the adequacy of proposed measures to prevent or minimise impacts on water resources and water-dependent assets.	Section 11.3
☐ Describe the cumulative impact of the proposal on surface water resources and water-dependent assets when all developments (past, present and reasonably foreseeable) are considered in combination.	Section 10.1
Data and monitoring	
☐ Identify monitoring sites representative of the diversity of potentially affected water-dependent assets and the nature and scale of potential impacts, and match with suitable replicated control and reference sites (BACI design) to enable detection and monitoring of potential impacts.	NA
☐ Develop and describe a surface water monitoring program that will collect sufficient data to detect and identify the cause of any changes from established baseline conditions and assess the effectiveness of mitigation and management measures. The program will: – include baseline monitoring data for physico-chemical parameters, as well as contaminants (e.g. metals) – comparison of physico-chemical data to national/regional guidelines or to site-specific guidelines derived from reference condition monitoring if available, and ☐ identify baseline contaminant concentrations and compare these to national guidelines, allowing for local background correction if required.	Appendix D3 REMP Section 6.1
☐ Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZG 2018) and relevant legislated state protocols (e.g. QLD Government 2013).	Appendix D3 REMP
☐ Describe the rationale for selected monitoring parameters, duration, frequency and methods, including the use of satellite or aerial imagery to identify and monitor large-scale impacts.	Appendix D3 REMP
☐ Develop and describe a plan for ongoing ecotoxicological monitoring, including direct toxicity assessment of discharges to surface waters where appropriate.	N/A
☐ Identify data sources, including streamflow data, proximity to rainfall stations, data record duration and describe data methods, including	N/A

Surface water	
whether missing data have been patched.	
☐ Identify dedicated sites to monitor hydrology, water quality, and channel and floodplain geomorphology throughout the life of the proposed project and beyond.	Appendix D3 REMP

Groundwater	
Context and conceptualisation	
☐ Describe and map geology at an appropriate level of horizontal and vertical resolution including: – definition of the geological sequence(s) in the area, with names and descriptions of the formations and accompanying surface geology, cross-sections and any relevant field data. – geological maps appropriately annotated with symbols that denote fault type, throw and the parts of sequences the faults intersect or displace.	Section 7.1 Appendix D7
☐ Define and describe or characterise significant geological structures (e.g. faults, folds, intrusives) and associated fracturing in the area and their influence on groundwater – particularly groundwater flow, discharge or recharge. – Site-specific studies (e.g. geophysical, coring/wireline logging etc.) should give consideration to characterising and detailing the local stress regime and fault structure (e.g. damage zone size, open/closed along fault plane, presence of clay/shale smear, fault jogs or splays). – Discussion on how this fits into the fault's potential influence on regional-scale groundwater conditions should also be included.	Section 7.0 Appendix D7
☐ Provide site-specific values for hydraulic parameters (e.g. vertical and horizontal hydraulic conductivity and specific yield or specific storage characteristics including the data from which these parameters were derived) for each relevant hydrogeological unit. In situ observations of these parameters should be sufficient to characterise the heterogeneity of these properties for modelling.	Section 7.4 Appendix D7
☐ Provide time series level and water quality data representative of seasonal and climatic cycles.	N/A
☐ Provide data to demonstrate the varying depths to the hydrogeological units and associated standing water levels or potentiometric heads, including direction of groundwater flow, contour maps, and hydrographs. All boreholes used to provide this data should have been surveyed.	Section 7.0 Appendix D7
☐ Provide hydrochemical (e.g. acidity/alkalinity, electrical conductivity, metals, and major ions) and environmental tracer (e.g. stable isotopes of water, tritium, helium, strontium isotopes, etc.) characterisation to identify sources of water, recharge rates, transit times in aquifers, connectivity between geological units and groundwater discharge locations.	Section 7.0 Appendix D7
☐ Describe the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	Section 7.0 Appendix D7
☐ Assess the frequency (and time lags if any), location, volume and direction	Section 7.0

Groundwater		
	of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water.	Appendix D7
Analytical and numerical modelling		
☐	Provide a detailed description of all analytical and/or numerical models used, and any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	Section 7.4 Appendix D7
☐	Undertaken groundwater modelling in accordance with the *Australian Groundwater Modelling Guidelines* (Barnett et al. 2012), including independent peer review.	Section 7.4 Appendix D7
☐	Calibrate models with adequate monitoring data, ideally with calibration targets related to model prediction (e.g. use baseflow calibration targets where predicting changes to baseflow).	Section 7.4 Appendix D7
☐	Describe each hydrogeological unit as incorporated in the groundwater model, including the thickness, storage and hydraulic characteristics, and linkages between units, if any.	Section 7.1 Appendix D7
☐	Describe the existing recharge/discharge pathways of the units and the changes that are predicted to occur upon commencement, throughout, and after completion of the proposed project.	Section 7.2 Section 7.3 Section 7.4 Appendix D7
☐	Describe the various stages of the proposed project (construction, operation and rehabilitation) and their incorporation into the groundwater model. Provide predictions of water level and/or pressure declines and recovery in each hydrogeological unit for the life of the project and beyond, including surface contour maps for all hydrogeological units.	Section 7.0 Appendix D7
☐	Identify the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	Section 7.4 Appendix D7
☐	Undertake model verification with past and/or existing site monitoring data.	Section 7.4.5.3 Appendix D7
☐	Provide an explanation of the model conceptualisation of the hydrogeological system or systems, including multiple conceptual models if appropriate. Key assumptions and model limitations and any consequences should also be described.	Section 7.3 Section 7.4 Appendix D7
☐	Consider a variety of boundary conditions across the model domain, including constant head or general head boundaries, river cells and drains, to enable a comparison of groundwater model outputs to seasonal field observations.	Section 7.4 Appendix D7
☐	Undertake sensitivity analysis and uncertainty analysis of boundary conditions and hydraulic and storage parameters, and justify the conditions applied in the final groundwater model (see Middlemis and Peeters [in press]).	Section 7.4.5.3 Appendix D7
☐	Provide an assessment of the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling,	Section 7.4.5.3 Appendix D7

Groundwater	
particularly with respect to predicted potential impact scenarios.	
☐ Undertake an uncertainty analysis of model construction, data, conceptualisation and predictions (see Middlemis and Peeters [in press]).	Section 7.4.5.3 Appendix D7
☐ Provide a program for review and update of models as more data and information become available, including reporting requirements.	Section 11.3
☐ Provide information on the magnitude and time for maximum drawdown and post-development drawdown equilibrium to be reached.	Section 7.4 Appendix D7
Impacts to water resources and water-dependent assets	
☐ Provide an assessment of the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts. Consider and describe: – any hydrogeological units that will be directly or indirectly dewatered or depressurised, including the extent of impact on hydrological interactions between water resources, surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water. – the effects of dewatering and depressurisation (including lateral effects) on water resources, water-dependent assets, groundwater, flow direction and surface topography, including resultant impacts on the groundwater balance. – the potential impacts on hydraulic and storage properties of hydrogeological units, including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units. – the possible fracturing of and other damage to confining layers. – For each relevant hydrogeological unit, the proportional increase in groundwater use and impacts as a consequence of the proposed project, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal.	Section 7.5 Appendix D7
☐ Describe the water resources and water-dependent assets that will be directly impacted by mining or CSG operations, including hydrogeological units that will be exposed/partially removed by open cut mining and/or underground mining.	Section 7.0 Section 8.0 Appendix D7
☐ For each potentially impacted water resource, provide a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact.	Section 7.0 Section 8.0 Appendix D7
☐ Describe existing water quality guidelines, environmental flow objectives and other requirements (e.g. water planning rules) for the groundwater basin(s) within which the development proposal is based.	Section 7.0 Appendix D7
☐ Provide an assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Section 10.0 Appendix D7
☐ Describe proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset	Section 11.3

Groundwater	
measures for long-term impacts post mining.	
☐ Provide a description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	Section 11.3
Data and monitoring	
☐ Provide sufficient data on physical aquifer parameters and hydrogeochemistry to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes.	Section 7.0 Appendix D7
☐ Develop and describe a robust groundwater monitoring program using dedicated groundwater monitoring wells – including nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing an understanding of the groundwater regime, recharge and discharge processes and identifying changes over time.	Section 11.3
☐ Develop and describe proposed targeted field programs to address key areas of uncertainty, such as the hydraulic connectivity between geological formations, the sources of groundwater sustaining GDEs, the hydraulic properties of significant faults, fracture networks and aquitards in the impacted system, etc., where appropriate.	N/A
☐ Provide long-term groundwater monitoring data, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	Section 7.0 Appendix D7
☐ Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZG 2018) and relevant legislated state protocols (e.g. QLD Government 2013).	Section 7.0 Appendix D7

Water-dependent assets	
Context and conceptualisation	
☐ Estimate the ecological water requirements of identified GDEs and other water-dependent assets (see Doody et al. [in press]).	N/A
☐ Identify water-dependent assets, including: – water-dependent fauna and flora and provide surveys of habitat, flora and fauna (including stygofauna) (see Doody et al. [in press]). – public health, recreation, amenity, Indigenous, tourism or agricultural values for each water resource.	Section 8.0
☐ Identify the hydrogeological units on which any identified GDEs are dependent (see Doody et al. [in press]).	N/A
☐ Identify GDEs in accordance with the method outlined by Eamus et al. (2006). Information from the GDE Toolbox (Richardson et al. 2011) and GDE Atlas (CoA 2017a) may assist in identification of GDEs (see Doody et al. [in press]).	Section 8.0

Water-dependent assets	
☐ Provide an outline of the water-dependent assets and associated environmental objectives and the modelling approach to assess impacts to the assets.	Section 8.0
☐ Describe the conceptualisation and rationale for likely water-dependence, impact pathways, tolerance and resilience of water-dependent assets. Examples of ecological conceptual models can be found in Commonwealth of Australia (2015).	N/A
☐ Describe the process employed to determine water quality and quantity triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur).	Section 8.0
Impacts, risk assessment and management of risks	
☐ Provide an assessment of direct and indirect impacts on water-dependent assets, including ecological assets such as flora and fauna dependent on surface water and groundwater, springs and other GDEs (see Doody et al. [in press]).	Section 8.0
☐ Provide estimates of the volume, beneficial uses and impact of operational discharges of water (particularly saline water), including potential emergency discharges due to unusual events, on water-dependent assets and ecological processes.	N/A
☐ Describe the potential range of drawdown at each affected bore, and clearly articulate of the scale of impacts to other water users.	Section 7.4 Section 7.5
☐ Assess the overall level of risk to water-dependent assets through combining probability of occurrence with severity of impact.	Section 8.0
☐ Indicate the vulnerability to contamination (e.g. from salt production and salinity) and the likely impacts of contamination on the identified water-dependent assets and ecological processes.	N/A
☐ Identify the proposed acceptable level of impact for each water-dependent asset based on leading-practice science and site-specific data, and ideally developed in conjunction with stakeholders	N/A
☐ Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion and habitat fragmentation of water-dependent species and communities.	N/A
☐ Propose mitigation actions for each identified impact, including a description of the adequacy of the proposed measures and how these will be assessed.	N/A
Data and monitoring	
☐ Identify an appropriate sampling frequency and spatial coverage of monitoring sites to establish pre-development (baseline) conditions and test potential responses to impacts of the proposal (see Doody et al. [in press]).	N/A

Water-dependent assets	
☐ Develop and describe a monitoring program that identifies impacts, evaluates the effectiveness of impact prevention or mitigation strategies, measures trends in ecological responses and detects whether ecological responses are within identified thresholds of acceptable change (see Doody et al. [in press]).	N/A
☐ Describe the proposed process for regular reporting, review and revisions to the monitoring program.	N/A
☐ Consider concurrent baseline monitoring from unimpacted control and reference sites to distinguish impacts from background variation in the region (e.g. BACI design, see Doody et al. [in press]).	N/A
☐ Ensure ecological monitoring complies with relevant state or national monitoring guidelines (e.g. the DSITI guideline for sampling stygofauna (QLD Government 2015)).	N/A

Water and salt balance, and water quality	
☐ Provide a quantitative site water balance model describing the total water supply and demand under a range of rainfall conditions and allocation of water for mining activities (e.g. dust suppression, coal washing etc.), including all sources and uses.	Section 2.4 Section 6.3 Appendix C6 (WMP)
☐ Provide estimates of the quality and quantity of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events and the likely impacts on water-dependent assets.	Section 2.4 Section 6.3 Appendix C6 (WMP)
☐ Provide salt balance modelling that includes stores and the movement of salt between stores and takes into account seasonal and long-term variation.	Section 2.4 Section 6.3 Appendix C6 (WMP)
☐ Describe the water requirements and on-site water management infrastructure, including modelling to demonstrate adequacy under a range of potential climatic conditions.	Section 2.4 Section 6.3 Appendix C6 (WMP)
Cumulative Impacts	
Context and conceptualisation	
☐ Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts.	Section 10.0
☐ Consider all past, present and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern in the cumulative impact analysis. Where a proposed project is located within the area of a bioregional assessment consider the results of the bioregional assessment.	Section 2.6 Section 10.0
Impacts	

☐ Provide an assessment of the condition of affected water resources which includes: – identification of all water resources likely to be cumulatively impacted by the proposed development – a description of the current condition and quality of water resources and information on condition trends – identification of ecological characteristics, processes, conditions, trends and values of water resources – adequate water and salt balances, and – identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).	Section 10.0
☐ Assess the cumulative impacts to water resources considering: – the full extent of potential impacts from the proposed project, (including whether there are alternative options for infrastructure and mine configurations which could reduce impacts), and encompassing all linkages, including both direct and indirect links, operating upstream, downstream, vertically and laterally – all stages of the development, including exploration, operations and post closure/decommissioning – appropriately robust, repeatable and transparent methods – the likely spatial magnitude and timeframe over which impacts will occur, and significance of cumulative impacts, and ☐ opportunities to work with other water users to avoid, minimise or mitigate potential cumulative impacts.	Section 10.0
Mitigation, monitoring and management	
☐ Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts. Evidence of the likely success of these measures (e.g. case studies) should be provided.	Section 11.3
☐ Identify cumulative impact environmental objectives.	Section 10.0 Section 11.3
☐ Identify measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies.	Section 11.3
☐ Describe appropriate reporting mechanisms.	Section 11.3
☐ Propose adaptive management measures and management responses.	Section 11.3