# Attachment 3

## Response to IESC Advice

# WINCHESTER SOUTH PROJECT

## Environmental Impact Statement

## Additional Information

WHITEHAVEN COAL

Resource Strategies

### Table A3-1

### Reconciliation of Comments from the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development

| Recommendation/Comment | Response |
|---|---|
| ***Question 1*** | |
| 1. Multiple areas have been identified within the draft EIS where further information and evidence from the proponent are required to assess and identify the potential risks and impacts to groundwater and surface water resources and water-related assets. These are discussed in the responses below. | Responses to specific Independent Expert Scientific Committee on Coal Gas and Large Coal Mining Development (IESC) comments are provided below. |
| ***Question 1: Groundwater*** | |
| 2. Although the groundwater drawdown model appears to be generally adequate, better conceptualisation of the groundwater system and improvements to the groundwater model are recommended to enhance the assessment of potential impacts (Paragraphs 13-15). These impacts cannot be adequately assessed without ground-truthing potential aquatic and terrestrial GDEs in the area (Paragraph 28). | A numerical groundwater model was developed for the Groundwater Assessment for the optimised Project (SLR Consulting Australia Pty Ltd [SLR Consulting], 2022) (Attachment 5 of the Additional Information). The numerical groundwater model was adapted from the numerical groundwater model developed for the approved Olive Downs Project (HydroSimulations, 2018) as updated for the Moorvale South Project (SLR Consulting, 2019).<br>Dr Noel Merrick completed a peer review of the Groundwater Assessment (including the groundwater model) (Document #2) and concluded (Attachment 3 of the Draft Environmental Impact Statement [Draft EIS]):<br>*The reviewer concurs with the entire modelling methodology described in Document #2 and recognises it as "state-of-art".*<br>The Draft EIS for the Project included an Integrated Assessment of Impacts on Groundwater Dependent Ecosystems (GDE Assessment) (Appendix F of the Draft EIS). The GDE Assessment was prepared in accordance with *Assessing Groundwater Dependent Ecosystems: IESC Information Guidelines Explanatory Note* [Consultation Draft] (Doody, Hancock and Pritchard, 2019). The GDE Assessment draws on information and assessments in the following technical reports prepared for the Project:<br>• Terrestrial Ecology Assessment (E2M Pty Ltd [E2M], 2021) for the Draft EIS;<br>• Groundwater Assessment (SLR Consulting, 2021) for the Draft EIS;<br>• Surface Water and Flooding Assessment (WRM Water & Environment Pty Ltd [WRM], 2021) for the Draft EIS;<br>• Aquatic Ecology and Stygofauna Assessment (Ecological Service Professionals Pty Ltd [ESP], 2021) for the Draft EIS;<br>• Geochemistry Assessment (Terrenus Earth Sciences, 2020) for the Draft EIS; and<br>• Geomorphology Technical Study (Fluvial Systems Pty Ltd [Fluvial Systems], 2020) for the Draft EIS.<br>Notwithstanding, responses to specific IESC comments are provided below. |

| Recommendation/Comment | Response |
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| 3. The contribution of the project to cumulative groundwater impacts, including geochemical changes and groundwater drawdown, has not been adequately assessed and must be discussed in greater detail, particularly in relation to impacts to potential terrestrial and aquatic GDEs (Paragraphs 13-16, 51). | In particular to GDEs, information presented within the following studies undertaken for the Draft EIS Project contributed to the overall conclusion that the Draft EIS Project is not predicted to have any material impacts on potential or actual GDEs due to changes in groundwater quality or resources. These assessments can be re-provided if required and their conclusions would remain consistent with the optimised Project:<br>• Groundwater Assessment (SLR Consulting, 2021).<br>• Surface Water and Flooding Assessment (WRM, 2021).<br>• Soil and Land Suitability Assessment (GT Environmental Pty Ltd [GT Environmental], 2021)<br>• TEM Survey (Groundwater Imaging, 2019).<br>• Terrestrial Ecology Assessment, including extensive field surveys (E2M, 2021).<br>• Aquatic Ecology and Stygofauna Assessment, including extensive field surveys (ESP, 2021).<br>• GDE Assessment (Whitehaven WS, 2021). |
| 4. The proponent's modelling of residual voids addresses predicted equilibrated water levels and an increase in salinity for a period of 250 years post mine closure. However, the proponent has not considered how increasingly hypersaline water may affect groundwater flow within the system, especially the potential for variable-density groundwater flow (Paragraph 16). | Additional modelling was undertaken by WRM and is presented in the Surface Water and Flooding Assessment (Attachment 6 of the Additional Information) for the optimised final landform. Each residual void lake is predicted to equilibrate at different levels.<br>Salt occurring naturally in the Project groundwater systems and surface water runoff would also enter the residual voids. Evaporation from the residual void water bodies would lead to the accumulation of salt over time, except when water is pumped out of the voids for use.<br>To assess whether the saline water in the residual voids has potential to migrate away from the residual void water body due to density differential; the water in the residual void is converted to an equivalent freshwater head. The calculated equivalent freshwater head can be compared to elevations in the receiving environment to determine if there is a gradient away from the residual void water body and the potential for migration. The equation to calculate the equivalent freshwater head is presented below (Kuniansky, 2018):<br>$$H_f = \frac{\rho}{\rho_f} H$$<br>Where '$H_f$' is the equivalent head of freshwater, '$\rho_f$' is the density of freshwater, '$\rho$' is the density of the water within the residual void and 'H' is the head of the water within the residual void. The density of the residual void water is dependent on the amount of salt dissolved in the water stated above in terms of electrical conductivity (EC) represented in units 'µS/cm'. Calculating the density of the water in the residual void ($\rho$) requires conversion of the predicted EC to a density through Total Dissolved Solids (TDS), using the standard conversion factor of 0.67 (ANZECC, 2000). |

<table>
<tr><th>Recommendation/Comment</th><th>Response</th></tr>
<tr><td></td><td>The modelled equivalent freshwater heads have been estimated in the table below. The adopted methodology is highly conservative as it applies both the maximum salinity and maximum modelled water level for each void. In practice, the higher observed salinities occur when the water levels in the voids are lower.<br><b>Final Void Density-driven Flow Calculations</b>
<table>
<tr><th>Void</th><th>Modelled Maximum Void Water Level*</th><th>Maximum Void Salinity*</th><th>Void Waterbody Head^</th><th>Equivalent Freshwater Head</th></tr>
<tr><td>North-west Void</td><td>131 mAHD</td><td>18,000 μS/cm</td><td>17 m</td><td>17.15 m</td></tr>
<tr><td>West Void</td><td>109 mAHD</td><td>8,500 μS/cm</td><td>27 m</td><td>27.11 m</td></tr>
<tr><td>Main Void</td><td>149 mAHD</td><td>6,500 μS/cm</td><td>75 m</td><td>75.25 m</td></tr>
</table>
* Source: Section 8.7 of WRM (2022); ^Calculated by subtracting the maximum void water level from the base of the void.<br>In all cases, the equivalent freshwater head is less than 0.25 m above the modelled head in the void waterbodies. The resultant water levels remain well below the post-mining water level in the Isaac River alluvium (170 mAHD; Section 6.6.1 of SLR Consulting, 2022 [Attachment 5 of the Additional Information]).</td></tr>
<tr><td colspan="2"><b><i>Question 1: Surface Water</i></b></td></tr>
<tr><td>5. The proponent should assess how diversion and loss of approximately 16 kilometres (km) of several ephemeral creeks will alter ecologically important flow components (e.g., numbers of zero- and low-flow days) along their lower reaches down to their confluence with the Isaac River.</td><td>Potential impacts on aquatic ecology were assessed by ESP (2021) in the Aquatic Ecology and Stygofauna Assessment for the Draft EIS, and were updated based on the revised mine plan (Attachment 10 of the Additional Information) (ESP, 2022).<br>Supplementary surveys of ephemeral creeks were undertaken for ESP (2022). Several unnamed tributaries of the Isaac River are located within the Project area. Poor to fair aquatic habitat conditions were observed in the minor waterways (i.e. unnamed ephemeral waterways) with limited in-stream features, evidence of siltation, limited bankside vegetation and high levels of disturbance to the bed and bank, likely from cattle access and land clearing (ESP, 2022).<br>Better aquatic habitat conditions were observed in the Isaac River (ESP, 2022). WRM (2022) (Attachment 6 of the Additional Information) determined the maximum catchment area excised by the optimised Project would represent approximately 1 percent of the Isaac River catchment to the confluence with Ripstone Creek. WRM (2022) concluded that the loss of catchment flows in the Isaac River during the optimised Project would be indiscernible. Based on these findings, ESP (2022) determined that impacts to aquatic ecosystems downstream of the Project area, or aquatic ecological values of the receiving environment, are not expected.</td></tr>
<tr><td>6. The IESC agrees with the peer reviewer’s (Whitehaven Coal 2021, Att. 3, pp. 14-15) recommendation that baseline water quality monitoring and analysis should continue (Paragraph 39).</td><td>Noted. Whitehaven WS has committed to continued surface water quality monitoring and analysis in accordance with the monitoring program described in Section 10.7 of Appendix B of the Draft EIS.</td></tr>
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| Recommendation/Comment | Response |
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| 7. Further information is required on the potential downstream impacts of discharges from the sediment dams on the lower reaches of unnamed tributary 2, and the releases from these dams (currently determined according to Isaac River flows) should instead be determined by the flow regime in the receiving stream. | Water release conditions have been developed for releases to the Isaac River based on the *Model Mining Conditions* (Department of Environment and Science [DES], 2017). The proposed controlled release conditions have been based on those recently approved for the neighbouring Olive Downs Project.<br>Potential impacts of the proposed controlled releases on the downstream tributaries were assessed in the Geomorphology Technical Study (Fluvial Systems, 2020) for the Draft EIS. The Geomorphology Technical Study was prepared by Dr Christopher Gippel and included a comprehensive review of the geomorphology of the tributaries downstream of the proposed controlled discharge points.<br>The Geomorphology Technical Study for the Draft EIS described the proposed monitoring and management strategy for the tributaries, which would be undertaken using objective, scientifically sound methods, following a BACI (Before/After/Control/Intervention) design. Visual inspections would be undertaken following each controlled release event. A topographic survey (using LiDAR) would be undertaken if either of the following are observed:<br>• a channel exceeding 0.2 m deep for a length of 10 m or more; or<br>• initiation of a knickpoint higher than 0.3 m.<br>Appropriate mitigation measures would be applied in response to any observed geomorphic impacts. The appropriate mitigation would be assessed at the time and would range from doing nothing (self-sealing), to assisted recovery (e.g. plant vegetation and soft engineering such as coir matting and stakes), to hard-engineering (e.g. rock rip-rap) (Fluvial Systems, 2020). |
| 8. Moreover, the proponent has not provided any plans for monitoring residual void water quality or modelled the final geochemical characteristics of pit water excepting salinity) for total dissolved metals, water hardness, pH, major ions and toxicants. Poor water quality in the residual voids may impact biota in the surrounding area, especially mobile fauna such as birds and aerial insects that may access the residual voids. | The optimised post-mining final landform would include three residual voids made up of a pit lake and low wall and highwall components.<br>The residual voids for the optimised final landform have been designed to operate as groundwater sinks, preventing any water that accumulates in the residual voids from migrating into the surrounding aquifers. The revised Groundwater Assessment (SLR Consulting, 2022) (Attachment 5 of the Additional Information) included groundwater fate modelling undertaken for the optimised final landform, which supported that the residual voids and backfill spoil in the optimised final landform would behave as groundwater sinks, in perpetuity.<br>Consistent with the outcomes of the Geochemical Assessment (Terrenus Earth Sciences, 2020) for the Draft EIS, Whitehaven WS would monitor surface water run-off and seepage from waste rock emplacements for various water quality parameters including, but not limited to, pH, EC, major anions (sulfate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids, which may inform the water quality of the residual void water bodies.<br>For the optimised final landform, an opportunity was identified to beneficially reuse the water from the residual voids for agricultural or other purposes (e.g. water for cattle consumption). Given the predicted water quality, the reuse of residual void water would slow down the accumulation of salt in the residual voids, which may allow for a sustained final land use without potential impacts to the surrounding environment. Progressing this reuse opportunity would be subject to further feasibility assessment and design, in addition to identification, negotiation and agreement with the final water user/s. |

| Recommendation/Comment | Response |
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| ***Question 1: Water-dependent ecosystems*** | |
| 9. Without field assessment of groundwater-dependence (Paragraphs 28 and 29) of vegetation and ground-truthing of aquatic and terrestrial GDEs in the predicted area of drawdown, the full extent of potential impacts on water-dependent ecosystems is unknown, particularly if drawdown is greater than predicted. Some of the potentially affected terrestrial GDEs within vicinity of the project are likely to provide habitat for species such as Koalas and Greater Gliders (*Petauroides volans*) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Further assessment is needed of the risks and impacts to these species and associated biota from disruption of riparian connectivity (including along the ephemeral streams that are to be removed or diverted) and impaired condition of terrestrial GDEs and other water-dependent vegetation downstream of these ephemeral streams. | See response to Items 2, 28 and 29. Extensive field validation surveys of vegetation across the Project area and surrounds has been undertaken for the Terrestrial Ecological Assessment (E2M, 2021) for the Draft EIS, in particular in areas of predicted drawdown for the Project in the regolith that are outside the extent of surface disturbance for the Project (see Figure 14 of the GDE Assessment [Appendix F of the Draft EIS]).<br>There are various patches of woodland in the vicinity of the Project that are mapped as likely to provide habitat for species such as the Koala (*Phascolarctos cinereus*), Greater Glider (*Petauroides volans*) listed under the EPBC Act (see Figures 5-11 and 5-12 of Section 5 of the Draft EIS).<br>One of these patches of woodland is within the northern portion of the Project Area and consists of mostly regional ecosystems (RE) 11.5.3, but also with RE 11.3.2 and RE 11.3.4. These REs comprise of mainly *Eucalyptus populnea* (which may be a facultative user of groundwater in some locations), however, the depth to groundwater beneath these patches ranges from 12 m to 23 m as the shallowest aquifer is associated with the regolith (SLR Consulting, 2022) (Attachment 5 of the Additional Information). Water within the regolith material is generally highly saline, but can be brackish to moderately saline with an average TDS of 10,510 mg/L, ranging between 1,460 mg/L and 18,600 mg/L (SLR Consulting, 2022). As shown on Figure 13 of the GDE Assessment (Appendix F of the Draft EIS), RE 11.5.3 occurs elsewhere where the depth to groundwater is in excess of 40 m (SLR Consulting, 2022) and too deep for the trees to access.<br>It is concluded that these woodland patches have a low potential to meet the definition of a terrestrial GDE, and any dependency on groundwater in the regolith is likely to be facultative, during dry times (if at all). It is unlikely that these REs would be dependent on the groundwater due to the poor quality (high salinity) of the groundwater source (E2M, 2021). As such, the predicted drawdown within the regolith is unlikely to impact on various patches of woodland in the vicinity of the Project Area that are mapped as likely to provide habitat for species such as Koalas and Greater Gliders (*Petauroides volans*), and therefore, there would be no impacts to these species associated with drawdown in the regolith.<br>It should be noted that there is no predicted drawdown in the Isaac River alluvium for the Project (SLR Consulting, 2022), and therefore, there would be no mechanism for impact to any potential GDEs (or associated fauna that may use these GDEs as habitat), irrespective of the presence in these areas.<br>GDEs are not predicted to be impacted as a result of the Project, notwithstanding, SLR Consulting (2022) has prepared a conceptual ecohydrological model cross-section that shows the disconnection between the groundwater systems, surface water systems and the potential ecological sites. |
| 10. If GDEs are confirmed in the area, an ecohydrological model conceptualising relationships between water-dependent ecosystems and the predicted changes in surface water and groundwater regimes and water quality should be provided to enable a more accurate and integrated assessment of key risks and impacts (Paragraph 19). | |

| Recommendation/Comment | Response |
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| 11. The proponent has not provided sufficient information on how the diversion and loss of approximately 16 km of several ephemeral creeks in the project area will alter alluvial groundwater recharge, surface water flow regimes and inundation patterns of local floodplains in their lower reaches down to their confluence with the Isaac River, and the consequent impacts on the biodiversity and ecological condition of their instream, riparian and floodplain ecosystems (Paragraphs 14, 19, 25, 32-33, 48). | The total catchment areas of the Isaac River and Ripstone Creek immediately downstream their confluence are approximately 5,166 square kilometres (km$^2$) and 286 km$^2$, respectively.<br>During mining operations, the water management system would capture runoff from areas that would have previously flowed to the receiving waters of the Isaac River and Ripstone Creek. The estimated maximum captured catchment areas during the optimised Project operations would be 76 km$^2$ for runoff that would have reported to the Isaac River and 16 km$^2$ for runoff that would have reported to Ripstone Creek. The maximum catchment areas excised by the optimised Project represent:<br>• up to approximately 1% of the Isaac River catchment (to the confluence with Ripstone Creek); and<br>• up to approximately 4.5% of the Ripstone Creek catchment (to the confluence with the Isaac River).<br>On this basis, the loss of catchment flows in the Isaac River and Ripstone Creek would be indiscernible. Therefore, the potential impact on water quantity in the Isaac River and Ripstone Creek due to the excision of catchment is considered negligible (WRM, 2022) (Attachment 6 of the Additional Information).<br>At the completion of mining, surface runoff from rehabilitated in-pit and out-of-pit waste rock emplacement areas would flow to the receiving environment.<br>An area of approximately 13.7 km$^2$ would report to the residual voids at the completion of mining. The changed topography following completion of the Project would have the following impacts on catchment areas:<br>• The catchment draining to the Isaac River (to the confluence of the Isaac River and Ripstone Creek) would reduce by approximately 13.7 km$^2$ (compared to pre-mining conditions), a decrease of less than 0.3%.<br>• The catchment draining to Ripstone Creek would reduce by around 4.3 km$^2$ (compared to pre-mining conditions), a decrease of less than 1.5%.<br>The loss of catchment flows in the Isaac River and Ripstone Creek would be indiscernible, and as such the potential impact on water quantity in Isaac River and Ripstone Creek due to the final landform is considered negligible (WRM, 2022). Therefore, the optimised Project would be unlikely to affect the alluvial groundwater recharge, and limited impacts to instream, riparian and floodplain ecosystems would occur. The Aquatic Ecology and Stygofauna Assessment for the Project (ESP, 2022) (Attachment 10 of the Additional Information) concluded:<br>*The Project area represents less than 0.05% and 0.3% of the overall catchment areas for the Fitzroy River basin and the Isaac-Connors sub-basin, respectively. The changed topography as a result of the Project final landform would reduce the catchment area draining to the Isaac River compared to pre-mining conditions; however, the decrease in catchment area is expected to be less than 1.5% (WRM 2022). No measurable impacts to surface water quantity are likely to occur as a result of the Project (WRM 2022). Therefore, the loss of catchment area is minor in a regional context.*<br>*Regardless of this change to the captured catchment area, no measurable impacts to surface water quantity are likely to occur as a result of the Project (WRM 2022). … Therefore, impacts to surface flows and subsequently aquatic ecosystems downstream of the Project area are not expected.* |

| Recommendation/Comment | Response |
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| ***Question 2*** | |
| ***Question 2: Groundwater*** | |
| 12. The IESC suggests the following improvements to the conceptual and numerical groundwater modelling. | Noted – responses to specific IESC suggestions and comments are provided below. |
| 13. The proponent has used multiple lines of evidence to characterise the groundwater units (Whitehaven Coal 2021, App. A, pp. 45-60), including characterising their hydraulic conductivity (Whitehaven Coal 2021, App. A, App. B, pp. 68-71). The IESC particularly commends the use of geophysical surveys at the project site and surrounding area to ground-truth the extent of the alluvium against geological mapping (Whitehaven Coal 2021, App. A, pp. 48-49). However, the vertical and horizontal groundwater flow between the units is not clear from the documentation. Improvement of the conceptual model (Whitehaven Coal 2021, App. A, pp. 106-111) would allow for a better understanding of connectivity (e.g., between the regolith and alluvium) and any potential impacts to GDEs. For example, there is some predicted incremental drawdown in the regolith adjacent to the Isaac River and its riparian vegetation (1-2 m) (Whitehaven Coal 2021, App. A, p. 116). A better understanding of how this unit interacts with the alluvium would help to characterise potential impacts on groundwater-dependent riparian and other vegetation. | Noted. The updated conceptual groundwater models for pre-mining, during mining and post-mining have been included in the revised Groundwater Assessment prepared by SLR Consulting (2022) (Attachment 5 of the Additional Information) for the optimised Project, as well as detailed discussion of the vertical and horizontal groundwater flow between the hydrogeological units, as summarised below.<br>The Isaac River alluvium comprises of a heterogeneous distribution of fine to coarse grained sands interspersed with lenses of clays and gravels. The hydraulic properties of the Isaac River alluvium vary due to the variable lithologic composition, with field tests from the Moorvale South Project and Olive Downs Project groundwater assessments indicating horizontal hydraulic conductivity can range between 1.4 x $10^{-2}$ metres per day (m/day) and 8.7 m/day. Groundwater occurs within the alluvium at depths of around 11 metres below ground level (mbgl) to 17 mbgl and is approximately 8 m below the base of the Isaac River at the closest monitoring point.<br>Regionally, groundwater flow within the Isaac River alluvium is a subdued reflection of topography, with groundwater flowing in a south-east direction consistent with the alignment of the Isaac River. However, local groundwater levels within the alluvium are highest near the Isaac River, indicating a potential local flow direction away from the Isaac River and losing conditions from the Isaac River to the underlying alluvium during flow periods. Spatially, the alluvium is variably saturated, with the two Project monitoring bores showing saturation in proximity to the Isaac River, and two alluvial bores (Olive Downs Project bores GW04 and GW08s, west of the optimised Project) being recorded as dry since July 2017. Localised perched water tables are also evident where waterbodies continue to hold water throughout the dry period (e.g. pools in the Isaac River and wetlands) occurring where clay layers slow the percolation of surface water, as well as limit the interaction with the underlying groundwater system (e.g. vegetation within these areas not GDEs).<br>Recharge to the Isaac River alluvium is considered to be mostly from stream flow or flooding (losing streams), with direct infiltration of rainfall also occurring rapidly where there are no substantial clay barriers in the shallow sub-surface. On a regional scale, discharge is via evapotranspiration from vegetation growing along creek beds and minor short duration baseflow events after significant rainfall/flooding. Infiltration to underlying formations is limited to areas with relatively high hydraulic conductivity units (e.g. coal seams). General downwards recharge to deeper units is limited by the low hydraulic conductivity (confining) Rewan Group and coal measure interburden sequences.<br>Water quality data for the alluvium indicates it can be fresh to saline and highly spatially and temporally variable. The alluvium is mostly suitable for stock water supply and irrigation but is not suitable for human drinking water and freshwater aquatic ecosystems. Alluvial bores within the optimised Project monitoring network were found to be on average, not be suitable for long-term irrigation, with concentrations of iron, chromium, and manganese exceeding guideline levels. |

| Recommendation/Comment | Response |
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| | Desktop review and two bore censuses indicate the Isaac River alluvium is used by local landholders, predominantly for stock water supply. It should be noted that there is no Isaac River alluvium mapped within the extent of the optimised Project and there is no direct interception of the Isaac River alluvium by the proposed open cut pits.<br>Tertiary-Quaternary aged sediments (regolith) present in the vicinity of the optimised Project form the base of the unconfined shallow groundwater system. The groundwater flow processes are similar to those of the Isaac River alluvium; however, the fluxes are expected to be significantly lower due to the dominance of clay within the tertiary sediments. Within the Study Area, near the Isaac River and creeks (i.e. Ripstone Creek), water has been detected within the regolith material at depths of around 8 mbgl to 19 mbgl. Outside of these areas the regolith material was found to be largely unsaturated. Water quality data for the regolith indicates it is generally highly saline but can be brackish to moderately saline. Water within the regolith is generally of poor quality and not considered suitable for stock, irrigation, aquatic ecosystems or drinking water, and therefore is unlikely to support any potential GDEs.<br>In the Permian strata, groundwater is encountered in the coal seams and in the sandstone/siltstone units of lower hydraulic conductivity. As with the rest of the Bowen Basin, the coal seams are the main groundwater bearing units within the Permian sequences, with low hydraulic conductivity interburden generally confining the individual seams. The coal seams are dual porosity in nature with a primary matrix porosity and a secondary (dominant) porosity provided by fractures (joints and cleats). Hydraulic conductivity of the coal decreases with depth due to increasing overburden pressure reducing the aperture of fractures. Vertical movement of groundwater (including recharge) is limited by the confining interburden layers, meaning that groundwater flow is primarily horizontal through the seams with recharge only occurring at subcrop. Review of fault behaviour within the Study Area and from external studies has identified that faults can increase vertical hydraulic conductivity parallel to the fault trace and reduce it perpendicular to the fault trace. However, any increases in vertical hydraulic conductivity is limited to small vertical horizons (<20 m) and is variable between faults dependent on localised hydrothermal activity and mineralisation in-filling pore spaces. Hydraulic testing of faults for the optimised Project indicate that faulting zones intercepted are not pathways for preferential flow.<br>Regionally, groundwater within the Permian coal measures flows in a south-east direction. Review of water quality data indicates water within the Permian coal measures is generally saline but can range between fresh to highly saline. Groundwater within the coal measures targeted for the optimised Project is only considered suitable for some stock, with the type of stock dependent on the TDS concentration (i.e. beef cattle or sheep). |
| 14. The groundwater modelling appears to be generally adequate, and the proponent has considered the Australian Groundwater Modelling Guidelines (Barnett *et al*. 2012). However, some changes are recommended to improve confidence in the model predictions. | Noted – responses to specific groundwater modelling recommendations are provided below. |

| Recommendation/Comment | Response |
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| a. The sensitivity and uncertainty analysis should be extended to encompass a plausible range of hydrogeologic parameters and to ensure that the likely range of drawdown is captured (Whitehaven Coal 2021, App. A, App. B, pp. 70-73). If drawdown in the regolith is greater than predicted (5 m), then drawdown in the alluvium may be significantly greater than the predicted 0.3 m and may impact terrestrial GDEs. | A comprehensive Type 3 Monte Carlo uncertainty analysis was undertaken in accordance with the methodology recommended by the IESC in *Uncertainty analysis—Guidance for groundwater modelling within a risk management framework* (Middlemis and Peeters, 2018). Dr Noel Merrick in the peer review of the Groundwater Assessment (Attachment 3 of the Draft EIS) (Document #1) reviewed the outcomes of the uncertainty analysis and concluded:<br>*A comprehensive IESC-compliant Type-3 uncertainty analysis has been undertaken by means of a monte carlo technique, using 257 alternative calibrated realisations out of a trial set of 1,400 selections. The parameters subject to variation were horizontal hydraulic conductivity, hydraulic conductivity anisotropy, specific yield, specific storage and diffuse recharge.*<br>*…*<br>*The groundwater modelling has been conducted to a very high standard and a rigorous monte carlo uncertainty analysis offsets much of the uncertainty that is inherent in a groundwater model, as noted in the Limitations Section 9 of Document #1.* |
| b. It appears that the proponent did not include all the projects in the model domain area in the modelling (e.g., Isaac Downs Mine, Poitrel Mine), and excluded some projects close to the model boundary (e.g., the Millennium Mine) (see Whitehaven Coal 2021, App. A, App. B, p. 3; Whitehaven Coal 2021, App. A, pp. 14-15). Including these projects would allow for more rigorous modelling of potential cumulative impacts. | The groundwater model did include the Poitrel Mine in the cumulative impact assessment (refer Sections 3.3 and 6.5 of Attachment 5 of the Additional Information [SLR Consulting, 2022]), noting that the numerical groundwater model was expanded to the north-west for the Project to limit any potential edge effects.<br>The Isaac Downs Mine and Millennium Mine were not included in the groundwater model on the basis that these mines are too distant for cumulative drawdown impacts to occur. It is also relevant to note that optimised Project is separated from the Isaac Downs and Millennium Mines by the Poitrel and Daunia Mines, which were both included in the groundwater model. |
| c. The proponent provided a sensitivity analysis from the Olive Downs project showing the impact of the Bowen Gas project on groundwater drawdown. It was found that the cumulative impacts were sensitive to the inclusion of this project (Whitehaven Coal 2021, App. A, pp. 120, 125). Based on this, the proponent should include the Bowen Gas project in their modelling. | The Bowen Gas Project proposes to extract approximately 270 gigalitres of associated water over a period of 55 years from 6,000+ extraction wells covering an area of 9,500 km$^2$.<br>Conservative assessment of potential cumulative impacts associated with the approved Bowen Gas Project indicates coal seam gas (CSG) extraction would result in drawdown extents in the Rangal Coal Measures extending further east across the model domain (SLR Consulting, 2022) (Attachment 5 of the Additional Information). |

| Recommendation/Comment | Response |
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| d. Major regional- and local-scale faults were included in the groundwater model, using site-specific data that were obtained by testing of boreholes and core to partially characterise faultzone hydrogeology. However, the relative importance of faults to groundwater flux remains uncertain and the model assumes no fault penetration or subcropping to alluvial groundwater (Layer 1). It is recommended that future modeling quantifies the range of plausible fault-related groundwater drawdown with mining-induced stresses, particularly for fault zones that may directly or indirectly influence alluvial aquifers, and associated implications for GDEs. | An extensive geological and hydrogeological data set has been used to identify and characterise faulting in the Project Area. Faults have been included in the numerical groundwater model, with appropriate model parameters determined through extensive hydraulic testwork and calibration. The following groundwater model zones were included to specifically address faulting:<br>• Zone 8: Layer 3 – Rewan Group Fault;<br>• Zone 10: Layer 4 – Rangal Coal Measures Overburden Fault;<br>• Zone 12: Layer 5 – Leichhardt Seam Fault;<br>• Zone 14: Layer 6 – Rangal Coal Measures Interburden Fault;<br>• Zone 16: Layer 7 – Vermont Seam Fault;<br>• Zone 18: Layer 8 – Rangal Coal Measures Underburden Fault;<br>• Zone 20: Layer 9 – Fort Cooper Coal Measures Overburden Fault;<br>• Zone 22: Layer 10 – Fort Cooper Coal Measures Seam Fault;<br>• Zone 24: Layer 11 – Fort Cooper Coal Measures Underburden Fault;<br>• Zone 26: Layer 12 – Moranbah Coal Measures Overburden Fault;<br>• Zone 28: Layer 13 – Moranbah Coal Measures Seam Fault; and<br>• Zone 30: Layer 14 – Moranbah Coal Measures Underburden Fault.<br>The sensitivity of model results to faulting has been tested through the comprehensive IESC guideline-compliant uncertainty analysis, which has investigated how a wide range of different hydraulic parameters applied to faults may affect the groundwater modelling results. |
| e. It would be useful to model how the loss or diversion of 16 km of the ephemeral creeks might influence drawdown in the alluvium due to decreased recharge from the creek flows. The proponent should assess how this potentially decreased recharge might affect saturation of the alluvium down to the confluence of the creeks with the Isaac River to increase certainty in the drawdown predictions on, for example, the High Ecological Significance (HES) wetland in the vicinity. | As discussed in the response to Item 5, the catchment excised by the optimised Project would represent approximately 1% of the Isaac River catchment to the confluence with Ripstone Creek. WRM (2022) (Attachment 6 of the Additional Information) concluded that the loss of catchment flows in the Isaac River during the Project operations would be indiscernible.<br>The potential impacts of the Project on the Isaac River alluvium have been modelled as part of the Groundwater Assessment (SLR Consulting, 2022) (Attachment 5 of the Additional information). The numerical groundwater modelling results indicate there would be negligible drawdown within the Isaac River alluvium due to the Project (SLR Consulting, 2022). Furthermore, the groundwater modelling has shown that the optimised Project would result in negligible increased leakage from surface flows of the Isaac River to the underlying alluvium. The change in flows as a result of the increased hydraulic gradient between the alluvium and the Isaac River would be a negligible reduction in average flow when the Isaac River flows; therefore, impacts to surface flows and subsequently aquatic ecosystems downstream of the Project area are not expected (e.g. no impacts to High Ecological Significance [HES] wetlands). |

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| 15. Two hundred and fifty years after mining finishes, groundwater levels in the alluvium and the regolith next to the backfilled mining pits are predicted to have recovered to pre-mining elevations. Groundwater levels in the Leichhardt and Vermont seams are predicted to be below pre-mining elevations, and flow will move toward the mined area (Whitehaven Coal 2021, App. A, p. 127). It is not clear from the documentation if these post-mining elevations were predicted based on a cumulative or project-only scenario. Providing information from a cumulative scenario would improve understanding of the long-term impacts of the project. Further, modelling a range of recovery periods and considering potential uncertainties in the modelling (e.g., climate change) is necessary to understand long-term impacts. | Since lodgement of the Draft EIS, Whitehaven has reviewed the mine plan and proposed an optimised final landform that results in three residual voids (e.g. backfill of Railway Pit and South Pit). Pit lake equilibrium levels in the residual voids for the optimised final landform were determined by WRM (2022) (Attachment 6 of the Additional Information) based on direct rainfall to the residual void water body, catchment runoff and groundwater inflows and less evaporation losses.<br>The historical rainfall and evaporation sequences (131 years) were repeated five times to create a long-term climate record. No overflows from any of the three residual voids were simulated, with the maximum modelled water level reaching (WRM, 2022):<br>• 78 m below the North-west Void overflow level;<br>• 87 m below the West Void overflow level; and<br>• 59 m below the Main Void overflow level.<br>WRM has undertaken further analysis regarding the potential impact of climate change on the predicted water levels in the voids and concludes:<br>*Potential climate change impacts to the residual void water balance were assessed by simulating the 'best' case, 'maximum consensus case' and 'worst' case climate scenarios for the Year 2090 climate changes projection.*<br>*…*<br>*Under all three modelled climate changes scenarios, the water balance modelling results show that the residual voids water levels will be lower than under baseline climatic conditions.*<br>SLR Consulting (2022) (Attachment 5 of the Additional Information) evaluated the potential impacts of the Project optimised on groundwater resources using a numerical regional groundwater model. Groundwater modelling included predictive modelling over the life of the optimised Project as well as recovery modelling for a 2,000-year period post-mining. SLR Consulting (2022) concluded the following:<br>*The predicted equilibrated final void water levels are between approximately 24 m and 71 m below the pre-mining groundwater levels, which means the final voids would act as sinks to groundwater flow.* |

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| 16. An increase in salinity due to evaporation will result in hypersaline conditions in the residual voids and thus denser void water. Modelling shows that the residual voids will generally act as a groundwater sink as the water levels of the residual void lakes are predicted to sit below pre-mining groundwater levels (Whitehaven Coal 2021, App. B, pp. 104-105). However, a significant density differential may increase the probability for downgradient movement into the groundwater system beneath the residual void floor or allow the spread against the flow gradient via diffusion. This is likely to contaminate the surrounding groundwater system. To better understand the long-term cumulative impacts of hypersaline void water, the proponent should develop a variable-density transport model (e.g., SEAWAT- MODFLOW/MT3DMS) to simulate variable-density groundwater flow to examine the potential for saline plume migration (Langevin 2021) and consequences for GDEs and other users. | Refer to response to Item 4. |
| 17. It has been proposed to partially backfill the residual voids; however, it is not clear whether the proposed depth of the residual voids will reduce possible saline aquifer inflows. More information (e.g., modelling of fully backfilled residual voids and their associated groundwater interactions, geochemical and groundwater flow impacts) should be provided. | Since lodgement of the Draft EIS, Whitehaven WS has reviewed the mine plan and proposed an optimised final landform. The optimised final landform would incorporate the following design commitments from the Draft EIS as well as the additional commitments as part of the optimised Project:<br>• progressive rehabilitation of land as it becomes available, where practicable;<br>• no residual voids located within the 0.1% Annual Exceedance Probability (AEP) Isaac River floodplain;<br>• complete backfilling of the Railway Pit and South Pit mine void;<br>• provide a post-mining land use for the residual voids (e.g. no non-use management areas); and<br>• safe, geotechnically stable and non-polluting (residual voids would be groundwater sinks in perpetuity, preventing the migration of saline water into adjacent aquifers).<br>Additional modelling was undertaken by WRM and is presented in the Surface Water and Flooding Assessment for the optimised final landform (WRM, 2022) (Attachment 6 of the Additional information). Each residual void lake is predicted to equilibrate at different levels. Maximum long-term equilibrated water levels are predicted to be up to approximately (WRM, 2022): |

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| | - 131 m AHD in North-West Void (78 m below the level at which overflows would reach the receiving environment);<br>- 109 m AHD in West Void (87 m below the level at which overflows would reach the receiving environment); and<br>- 149 m AHD in Main Void (59 m below the level at which overflows would reach the receiving environment).<br>Salt occurring naturally in the Project groundwater systems and surface water runoff would also enter the residual voids. Evaporation from the residual void water bodies would lead to the accumulation of salt over time, however, water balance modelling predicts the following salinity levels for the residual void water bodies would generally range between (WRM, 2022):<br>- approximately 2,000 to 6,000 µS/cm for North-West Void (up to 18,000 µS/cm when the stored water volume is low);<br>- approximately 2,000 to 6,000 µS/cm for West Void (up to 8,500 µS/cm when the stored water volume is low); and<br>- approximately 1,000 to 4,000 µS/cm for Main Void (up to 6,500 µS/cm when the stored water volume is low).<br>Alternative final landform scenarios have been considered as part of the Additional Information. The analysis undertaken by SLR Consulting (2022) and WRM (2022) concluded that (Enclosure 1):<br>- The full backfill final landform scenario would allow for limited catchment excision in perpetuity, however, the recovered water levels within the spoil of the final landform scenario is predicted to allow water from the backfilled open cut pits to report off-site (potentially to the tertiary sediments and alluvial groundwater systems) through the groundwater system as supported by the groundwater fate modelling undertaken by SLR Consulting (i.e. final landform behaves as a groundwater source, not a groundwater sink), resulting in potentially adverse environmental outcomes.<br>- The partial backfill above the pre-mining groundwater table final landform scenario would result in the forming of hypersaline water bodies up to 510,000 µS/cm (the maximum solubility of salt in water at 25 degrees Celsius). The reduction in hydraulic gradient towards the backfilled final voids would also result in groundwater flowing from parts of the final landform (e.g. out of pit waste emplacements) to the surrounding groundwater system.<br>- Similar to the optimised final landform, the covered coal seams scenario would contain the groundwater in the residual void water body and backfilled spoil, however, no significant benefit is likely to be observed.<br>Given the results of the comprehensive analysis undertaken for the optimised final landform and the requested alternative final landform scenarios, the optimised final landform is the preferred final landform as it would not pose an environmental risk to the surrounding environment. |
| ***Question 2:Surface water*** | |
| 18. Overall, the standard of surface water modelling, associated water balance and flood analyses, and fluvial geomorphological investigations are well suited to this assessment. | Noted. |

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| ***Question 2: Water-dependent ecosystems*** | |
| 19. An ecohydrological conceptual model is needed to illustrate how the predicted changes in surface water and groundwater regimes and water quality may impact water-dependent ecosystems within and downstream of the project area. This model should be developed following field surveys assessing groundwater-dependence of GDEs and ground-truthing them (Paragraph 19). It should also include potential pathways of ecological impacts arising from changes to surface water and groundwater regimes due to removal and diversion of approximately 16 km of the channels of ephemeral creeks within the direct disturbance area (Paragraphs 22, 25, 32-33 and 48). Particular attention should be paid to conceptually modelling the potential effects of mine-affected water releases and stream flow alterations on water-dependent ecosystems within and near the lower reaches of the unnamed tributary 2 up to its confluence with the Isaac River. | See response to Item 13 regarding a description of connectivity between the surface water and groundwater regimes. Notwithstanding, the Groundwater Assessment for the optimised Project (SLR Consulting, 2022) (Attachment 5 of the Additional Information) includes an ecohydrological conceptual model to demonstrate connectivity between the groundwater regimes, surface water regimes and any potential water-dependent ecosystems.<br>The Aquatic Ecology and Stygofauna Assessment, Terrestrial Ecology Assessment and GDE Assessments for the Draft EIS (Appendix D, E and F of the Draft EIS) were prepared in consideration of the results from the Groundwater Assessment and Surface Water and Flooding Assessment (Appendix A and B of the Draft EIS) and assess potential impacts to water-dependent ecosystems which included ground-truthing field validation. In summary, the Draft EIS and hence the optimised Project, is not predicted to have any material impacts on potential or actual water-dependent assets due to changes in groundwater quality or resources. |
| ***Question 3*** | |
| 20. Consequential impacts may occur due to the project. Several have not adequately been assessed in the EIS and are detailed below. Some of these potential impacts and risks are discussed more fully in Paragraphs 9 and 11, and are not repeated below. The magnitude and spatial extent of groundwater drawdown, which may be much greater than predicted by the proponent, has potentially severe consequences for surface and underground GDEs. | Noted - responses to specific IESC comments are provided in Items 9 and 10 above. |

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| ***Question 3: Groundwater*** | |
| 21. The proponent provides only limited details on the surface water-groundwater interactions of the tributaries to the Isaac River (Cherwell Creek, Ripstone Creek, unnamed ephemeral tributaries) within and near the project area. The proponent considers that Cherwell Creek is a losing system and that the wetlands are likely not GDEs due to the depth to groundwater (Whitehaven Coal 2021, App. A, pp. 103, 132). There seems to have been sufficient assessment of likely groundwater-dependence of the wetlands (Whitehaven Coal 2021, App. A, p. 103). However, further information is needed for the creeks intersecting the zone of predicted drawdown.<br>a. Field measurements and analyses (e.g., hydraulic testing) of reach-scale and temporal patterns of groundwater recharge and discharge of Cherwell Creek, Ripstone Creek and the ephemeral creeks intersecting the zone of predicted drawdown would help justify the proponent's assessment that these creeks are losing and indicate whether potential losses due to seepage could lead to increases in numbers of zero- or low-flow days (which are ecologically important to the instream and riparian biota of these creeks, Paragraph 33). | Noted. However, the predicted drawdown for the optimised Project only, as well as cumulatively, would not intersect with Cherwell Creek and Ripstone Creek, as provided in the Groundwater Assessment of the optimised Project (SLR Consulting, 2022) (Attachment 5 of the Additional Information), and therefore no further field measurements and analysis is considered appropriate as the existing data available is sufficient.<br>Drawdown that intersects with ephemeral unnamed drainage features is generally limited to those that would be disturbed as part of the mining activities and therefore the loss already been accounted for as part of the surface disturbance in the Terrestrial Ecology Assessment (E2M, 2021). |
| b. If these creeks are found to be groundwater-dependent (even transiently), discussion of how groundwater drawdown might affect their flows would be useful because they contribute to the flow of the Isaac River and support riparian habitat for listed threatened species (see maps in Whitehaven Coal 2021, App. D, pp. 96-111). | Based on field measurements and analysis undertaken to inform the Groundwater Assessment, Aquatic Ecology and Stygofauna Assessment and GDE Assessment, the Isaac River and Cherwell Creek are largely losing systems (i.e. not fed by groundwater) resulting in the water draining through the alluvial sediments to the underlying, local groundwater table (SLR Consulting, 2022) (Attachment 5 of the Additional Information).<br>SLR Consulting (2022) describes that occasional periods of baseflow to the Isaac River from the underlying alluvium may occur after prolonged rainfall events or following flood events. Under these conditions, recharged alluvial sediments would drain to the Isaac River as the hydraulic gradient reverses and sustains stream-flow for a short period after the rainfall event (SLR Consulting, 2022). |

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| | The aquatic in-stream ecosystems associated with the Isaac River and Cherwell Creek are largely not dependent on the surface-expression of groundwater, but may be for a short period after rainfall events.<br>Modelling has shown that the optimised Project would result in negligible increased leakage from surface flows of the Isaac River to the underlying alluvium. The change in flows as a result of the increased hydraulic gradient between the alluvium and the Isaac River would be a negligible reduction in average flow when the Isaac River flows, therefore, impacts to surface flows and subsequently aquatic ecosystems downstream of the Project Area are not expected. The optimised Project is likely to result in fewer impacts (proportionally) on baseflow contributions to New Chum Creek, North Creek or Cherwell Creek given the distance of these waterways from the optimised Project (SLR Consulting, 2022). Further to this, there is limited interaction between drawdown in the Layer 1 (Alluvium) and Layer 2 (Regolith) and Isaac River, Cherwell Creek, Ripstone Creek, unnamed ephemeral tributaries. |
| 22. The documentation does not clearly explain how diverting and removing 16 km of ephemeral creek channels may alter groundwater recharge and discharge in the project area, the creeks' lower reaches down to their confluence with the Isaac River and the adjacent alluvial sediments. This information is needed to identify how the project may impact on these processes and their likely consequences for water-dependent ecosystems such as terrestrial GDEs and the HES wetland. | The total catchment areas of the Isaac River and Ripstone Creek immediately downstream their confluence are approximately 5,166 km$^2$ and 286 km$^2$, respectively.<br>During mining operations, the water management system would capture runoff from areas that would have previously flowed to the receiving waters of the Isaac River and Ripstone Creek. The estimated maximum captured catchment areas during the Project would be 76 km$^2$ for runoff that would have reported to the Isaac River and 16 km$^2$ for runoff that would have reported to Ripstone Creek. The maximum catchment areas excised by the Project represent:<br>• up to approximately 1% of the Isaac River catchment (to the confluence with Ripstone Creek); and<br>• up to approximately 4.5% of the Ripstone Creek catchment (to the confluence with the Isaac River).<br>On this basis, the loss of catchment flows in the Isaac River and Ripstone Creek would be indiscernible. Therefore, the potential impact on water quantity in the Isaac River and Ripstone Creek due to the excision of catchment is considered negligible (WRM, 2022) (Attachment 6 of the Additional Information).<br>At the completion of mining, surface runoff from rehabilitated in-pit and out-of-pit waste rock emplacement areas would flow to the receiving environment.<br>An area of approximately 13.7 km$^2$ would report to the residual voids at the completion of mining. The changed topography following completion of the Project would have the following impacts on catchment areas:<br>• The catchment draining to the Isaac River (to the confluence of the Isaac River and Ripstone Creek) would reduce by approximately 13.7 km$^2$ (compared to pre-mining conditions), a decrease of less than 0.3%.<br>• The catchment draining to Ripstone Creek would reduce by approximately 4.3 km$^2$ (compared to pre-mining conditions), a decrease of less than 1.5%. |

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| | The loss of catchment flows in the Isaac River and Ripstone Creek would be indiscernible, and as such the potential impact on water quantity in Isaac River and Ripstone Creek due to the final landform is considered negligible (WRM, 2022). Therefore, unlikely to affect the alluvial groundwater recharge. As such there will be no impact to instream, riparian and floodplain eco-systems.<br>The Aquatic Ecology and Stygofauna Assessment for the optimised Project (ESP, 2022) (Attachment 10 of the Additional Information) concluded:<br>*The Project area represents less than 0.05% and 0.3% of the overall catchment areas for the Fitzroy River basin and the Isaac-Connors sub-basin, respectively. The changed topography as a result of the Project final landform would reduce the catchment area draining to the Isaac River compared to pre-mining conditions; however, the decrease in catchment area is expected to be less than 1.5% (WRM 2022). No measurable impacts to surface water quantity are likely to occur as a result of the Project (WRM 2022). Therefore, the loss of catchment area is minor in a regional context.*<br>*Regardless of this change to the captured catchment area, no measurable impacts to surface water quantity are likely to occur as a result of the Project (WRM 2022). … Therefore, impacts to surface flows and subsequently aquatic ecosystems downstream of the Project area are not expected.* |
| 23. The proposed final landform will result in four partially backfilled residual voids, located near the existing floodplain of the Isaac River (Whitehaven Coal 2021, Section 3, pp. 3-8-3-9). Residual voids are expected to act as a terminal groundwater sink. This proposed landform has a number of potential risks summarised below.<br>a. Water quality will decline in the residual voids as evaporation increases contaminant concentrations. The total sulfur concentration of coal rejects is often above the median crustal abundance (potentially as reactive sulfide) and may contain comparatively high concentrations of metals/metalloids and sulfate salts (Whitehaven Coal 2021, App. M, p. 5). Results of the proponent's geochemical assessment indicate some uncertainty surrounding the acid-forming and metalliferous drainage potential of reject coal samples (Whitehaven Coal 2021, App. M, pp. 20-21). | See Items 4 and 17 for specific discussion regarding the optimised final landform and associated water quality (e.g. salinity) of the residual voids water bodies. The optimised Project has been designed to retain three residual voids, of which all are located well outside the extent of the Isaac River floodplain as defined by the Queensland Floodplain Assessment Overlay (Department of Natural Resources, Mines and Energy, 2022).<br>The residual voids for the optimised final landform have been designed to operate as groundwater sinks, preventing any water that accumulates in the residual voids from migrating into the surrounding aquifers. This is supported by the groundwater fate modelling undertaken for the revised Groundwater Assessment prepared by SLR Consulting (2022) (Attachment 5 of the Additional Information).<br>A Geochemical Assessment prepared by Terrenus Earth Sciences (2020) for the Draft EIS that included leachate analysis of weathered overburden (e.g. clay), overburden (e.g. sandstone and siltstone), and interburden (e.g. claystone, sandstone, coal with some claystone, mudstone, and siltstone) that would be representative of waste rock material and carbonaceous claystone and siltstone (e.g. coal seam roof and floor) representative of potential rejects material, as well as composite samples representing coarse rejects, and built upon previous geochemical studies (EGi, 2012). The analysis found that waste rock material is generally non-acid forming, with the leachate generally averaging an EC of 601 µS/cm (i.e. generally fresh) and low in sulfur content (<0.1%). The generally low sulfur (and, therefore, sulfide) concentrations of most coal reject (as a bulk material) indicates that the sulfate concentration that could be generated by this material if available sulfide were to completely oxidise is also expected to be very low. It is important to note that the results presented in Geochemical Assessment for the Draft EIS (Terrenus Earth Sciences, 2020) represent an 'assumed worst case' scenario as the samples analysed had a long equilibration period or had a very high surface area compared to likely materials in the field. As such, the total sulfur concentration within the residual void water bodies is unlikely to pose a risk to the surrounding groundwater regime, and furthermore, the residual voids would remain as groundwater sinks in perpetuity. |

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| | Notwithstanding, Whitehaven WS has committed to undertake validation geochemical test-work for coal rejects from the coal handling and preparation plant (CHPP) during development of the Project, particularly during the first two years of CHPP operation and whenever new seams/plys are being processed. |
| b. Leachate from residual voids backfilled with waste rock may contain elevated concentrations of aluminium, arsenic, copper, selenium, and zinc (Whitehaven Coal 2021, App. A, App. A3). Further geochemical characterisation of overburden samples during various stages of the project is recommended to better represent potential leachate concentrations of contaminants across the site. | Consistent with the outcomes of the Geochemical Assessment for the Draft EIS (Terrenus Earth Sciences, 2020), Whitehaven WS would undertake surface water run-off and seepage from waste rock emplacements monitor for various water quality parameters including, but not limited to, pH, EC, major anions (sulfate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids. Whitehaven WS would also undertake validation geochemical test-work for coal reject from the CHPP during development of the optimised Project, particularly during the first two years of CHPP operation and whenever new seams/plys are being processed. Test-work would comprise a broad suite of environmental geochemical parameters, including total and soluble metals/metalloids. |
| c. The deterioration in water quality in the residual voids represents a long-term legacy that may have impacts on mobile fauna (e.g., birds and aerial insects). These risks should be assessed by the proponent, especially the potential for aquatic-terrestrial transfer of bioaccumulated contaminants from the residual voids to predators in the foodwebs of the surrounding environment. | Additional modelling was undertaken by WRM and is presented in the Surface Water and Flooding Assessment for the optimised final landform (WRM, 2022) (Attachment 6 of the Additional Information).<br>Salt occurring naturally in the Project groundwater systems and surface water runoff would also enter the residual voids. Evaporation from the residual void water bodies would lead to the accumulation of salt over time, however, water balance modelling predicts the following salinity levels for the residual void water bodies would generally range between (WRM, 2022):<br>• approximately 2,000 to 6,000 µS/cm for North-West Void (up to 18,000 µS/cm when the stored water volume is low);<br>• approximately 2,000 to 6,000 µS/cm for West Void (up to 8,500 µS/cm when the stored water volume is low); and<br>• approximately 1,000 to 4,000 µS/cm for Main Void (up to 6,500 µS/cm when the stored water volume is low).<br>For the optimised final landform, an opportunity was identified to beneficially reuse the water from the residual voids for agricultural or other purposes (e.g. water for cattle consumption). Given the predicted water quality, the reuse of residual void water would slow down the accumulation of salt in the residual voids, which may allow for a sustained final land use without potential impacts to the surrounding environment.<br>Progressing this reuse opportunity would be subject to further feasibility assessment and design, in addition to identification, negotiation and agreement with the final water user/s.<br>Given the above, it is not expected that there would be any potential ecological consequences due to the salinity of the residual void water bodies and the rehabilitated optimised final landform would be able to support the proposed final land uses (e.g. pasture and woodland). |

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| 24. The proponent has only performed static geochemical tests (Whitehaven Coal 2021, App. M, pp. 6, 9), providing information on bulk geochemical characteristics of waste materials at a single point in time. While this provides a good indication of the physical, chemical and mineralogical composition of the potential overburden and coal reject waste material, static testing does not provide information on the reaction rates of chemical processes or the rates at which weathering products are released when exposed to the environment over long periods of time. To better understand the cumulative effects of waste rock and coal reject backfill on groundwater resources, the proponent should perform kinetic tests on overburden and coal reject samples assessing how water quality is affected when backfilled waste material interacts with water over prolonged periods of time. These kinetic tests are more appropriate than static ones for indicating potential long-term and cumulative impacts on, for example, GDEs. | Noted. It is important to note that the results presented in the Geochemical Assessment of the Draft EIS (Terrenus Earth Sciences, 2020) represent an 'assumed worst case' scenario as the samples analysed had a long equilibration period or had a very high surface area compared to likely materials in the field. |
| ***Question 3: Surface water*** | |
| 25. Details on the erosion risk and mitigation measures should be provided for the ephemeral streams' diversions and the discharge points on site to improve assessment of potential impacts on water-dependent ecosystems and their biota. This includes detail of the proposed form, alignment and treatment of the diversion channels, and what monitoring plans are in place. | With respect to sediment-laden water, a 'best practice' approach would be adopted for the design of erosion and sediment controls that is consistent with the International Erosion Control Association (IECA) recommendations. The following broad principles would apply:<br>• minimise the area of disturbance;<br>• apply local temporary erosion control measures, where practical;<br>• intercept runoff from undisturbed areas and divert around disturbed areas; and<br>• where temporary measures are unlikely to be effective, divert runoff from disturbed areas to sedimentation basins prior to release from the site.<br>In rainfall events below the design standard of the sediment dams, runoff from disturbed areas would be intercepted and treated by sediment dams. In larger events that exceed the design standards, these dams would overflow. |
| 26. The proponent provides few details about the construction of roads and infrastructure (including the pipeline and electricity transmission line) and what risks they may pose to water quality and water-dependent ecosystems. | |

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| As a new access road will be required in the northwest of the site in addition to the pits being constructed in the path of the unnamed tributaries (compare Whitehaven Coal 2021, App. B, p. 32 to Whitehaven Coal 2021, Section 2, p. 2-2), a risk management plan should be produced for this activity that describes the monitoring and mitigation of any risks to water-dependent ecosystems downstream.<br>27. The proponent plans to allow the sediment dams to overflow in uncontrolled releases (Whitehaven Coal 2021, App. B, pp. 95-97). Further information is required on the water quality of these dams and whether releases might have any impacts on downstream aquatic and riparian ecosystems and their biota in the lower reaches of unnamed tributary 2 (Paragraph 22). | Temporary storage within the sediment dams prior to overflow would reduce suspended sediment concentrations through settlement of sediment particles (WRM, 2022) (Attachment 6 of the Additional Information).<br>Available geochemical information indicates that the runoff draining to the sediment dams would have low to moderate salinity. Overflows would only occur during significant rainfall events which would also generate large volumes of runoff from surrounding undisturbed catchments. Therefore, it is unlikely that sediment dam overflows would have a measurable impact on receiving water quality or environmental values (WRM, 2022), and therefore there would be no associated impacts on the relevant aquatic and riparian ecosystems.<br>The Surface Water and Flooding Assessment for the optimised Project (WRM, 2022) included a comprehensive assessment of the potential impacts of sediment dam overflows, including modelling of the salinity of the sediment dam overflows and receiving Isaac River. WRM (2022) concluded the following:<br>*The sediment dam overflow would have a negligible impact on the Isaac River quality with predicted increases of less than 3%.*<br>Notwithstanding the above, an Erosion and Sediment Control Plan and Water Management Plan would be developed and implemented throughout construction and operation of the Project. If implemented effectively, environmental risks from disturbed area runoff (i.e. sediment-laden runoff) are expected to be low (WRM, 2022). |
| ***Question 3: Water-dependent ecosystems*** | |
| 28. The proponent uses groundwater depth as a line of evidence to suggest a lack of groundwater-dependent ecosystems or to suggest their facultative nature (Whitehaven Coal 2021, App. D, p. 77-78; Whitehaven Coal 2021, App. F, pp. 36-37). However, the IESC considers this to be insufficient. Instead, direct field measurements of groundwater-dependence are needed (e.g., leaf water potential, soil water potential and the use of stable isotope analysis; Doody *et al*. 2019). These data are essential for ground-truthing predicted GDEs, assessing how much and when they might rely on groundwater, and identifying potential impacts of groundwater drawdown. Currently, the proponent infers that drawdown will be limited and will have minimal impacts on GDEs in the predicted drawdown zone (Whitehaven Coal 2021, Section 4, p. 87). | Refer to Item 14 with regard to groundwater modelling adequacy.<br>With regard to the IESC's concerns surrounding potential GDEs within the Project Area, Whitehaven WS prepared a GDE Assessment consistent with the *Information guidelines for proponents preparing coal seam gas and large coal mining development proposals* (IESC, 2018) and *Information Guidelines Explanatory Note: Assessing Groundwater-dependent Ecosystems* (Doody *et al*., 2019) which consolidated the key outcomes of the specialist's assessments prepared for the project and to provide a comprehensive assessment of potential inputs of the Project on GDEs.<br>Information presented within the following studies undertaken for the Project contributed to the overall conclusion that the Project is not predicted to have any material impacts on potential or actual GDEs due to changes in water quality or resources:<br>• Groundwater Assessment (SLR Consulting, 2021).<br>• Surface Water and Flooding Assessment (WRM, 2021).<br>• Soil and Land Suitability Assessment (GTE, 2021).<br>• TEM Survey (Groundwater Imaging, 2019).<br>• Terrestrial Ecology Assessment, including extensive field surveys (E2M, 2021). |

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| However, without reliable field data on groundwater dependency of these potential GDEs, the IESC has low confidence in these inferences, especially given the concerns surrounding groundwater modelling (Paragraph 14). | • Aquatic Ecology and Stygofauna Assessment, including extensive field surveys (ESP, 2021).<br>• GDE Assessment (Whitehaven WS, 2021).<br>A short summary of the key conclusions from the above studies is provided below.<br>Additionally, a series of further investigations have been undertaken including a literature review of Brigalow Communities in Queensland which further support the outcomes and conclusions of the Draft EIS.<br>**Literature Review**<br>***Field investigation of potential terrestrial groundwater-dependent ecosystems within Australia's Great Artesian Basin (Jones et al. 2019)***<br>Consistent with *Information Guidelines Explanatory Note: Assessing Groundwater-dependent Ecosystems* (Doody *et al*., 2019), Jones *et al*. (2019) conducted quantitative field methods to refine eco-hydrological conceptual models of terrestrial groundwater dependent ecosystems in the Great Artesian Basin, Queensland, Australia. Methodologies included in the study were soil coring to observe root depth, soil moisture and leaf water potential, and analysis of naturally occurring stable isotopes. Jones *et al*. (2019) concluded that at three of the four survey sites mapped as conceptual GDEs (i.e. 75%), tree species rooting depths were consistently much shallower than commonly reported in literature and were predominantly utilising shallow sources of soil moisture located above the regional water-table aquifer.<br>The Draft EIS Project Groundwater Assessment concludes that depth to groundwater within the Project Area is typically greater than 30 to 40 m, with isolated areas of shallower groundwater (10 to 20 m) associated with ephemeral tributaries.<br>***Conceptual Model Case Study Series 'Gilgai wetlands' (The State of Queensland 2011 [updated 2013])***<br>The *Conceptual Model Case Study Series 'Gilgai wetlands'* (The State of Queensland, 2011) identifies that within Queensland, Gilgai (melon hole microrelief) are most commonly found in association with the Brigalow community (*acacia harpophylla)*. The conceptual model case study also describes that due to the nature of the cracking clay soils (present in gilgai environments), on average, 20 centimetres (cm) of water may lie in the gilgai depressions for three months during wetter years.<br>As described in Section 4 of the Draft EIS, the Project was intentionally designed to avoid impacts to the identified Brigalow Threatened Ecological Community (*acacia harpophylla dominant and co-dominant)* located adjacent to the north-eastern boundary of the surface disturbance associated with the Project.<br>The Terrestrial Ecology Assessment (E2M, 2021) identified a patch of RE 11.4.8 (*Eucalyptus cambageana* and *Acacia harpophylla* woodlands (to 18 m) on gently undulating clay plains) conforming to the threshold criteria requirements for Brigalow TEC. Field notes from the Terrestrial Ecology Assessment noted that the TEC was located on gently undulating clay plains (E2M, 2021).<br>The Soil and Land Suitability Assessment (GT Environmental, 2021) conducted soil sampling within close proximity to the identified Brigalow TEC (Site 19 and C14). The soil assessment Site 19 identified that at a depth of 0.7 to 1.0 m a sandy clay loam layer was present. |
| 29. The IESC notes a patch of Brigalow TEC (*Acacia harpophylla dominant and co-dominant*) is present within the mining lease just outside the direct disturbance area (Whitehaven Coal 2021, App. D, p. 64). As Brigalow may be groundwater-dependent, the proponent should assess whether trees in this patch are accessing groundwater and whether drawdown poses potential risks to this TEC. Furthermore, Brigalow TEC is known to provide habitat for EPBC Act-listed species. The patch of Brigalow TEC identified adjacent to the direct disturbance area is mapped in the same location where the proponent has identified potential Ornamental Snake, Koala, Greater Glider and Squatter Pigeon (*Geophaps scripta scripta*) habitat (compare Whitehaven Coal 2021, App. D, p. 64 to Whitehaven Coal 2021, App. D, pp. 97, 101, 103, 105). If this TEC is found to be groundwater-dependent, the proponent must assess the implications of predicted drawdown on its suitability as potential habitat for EPBC Act-listed and other species in the area. | |

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| | Site C14 located slightly closer to the identified Brigalow TEC indicated a boundary of soil mapping unit S1 (i.e. Brown texture contrast loamy soils on gently undulating plains) and soil mapping unit C1-BR (i.e. Moderate to deep brown clay soils on flat plains with melon hole microrelief [gilgai]) was present.<br>The conceptual model case study series 'Gilgai wetlands' demonstrates consistencies with observations and conclusions drawn by the technical assessments for the Project, indicating that the area of Brigalow TEC identified is likely accessing water held within the clay-rich gilgai depressions for extended periods of time following rainfall events. Further to this point, Johnson (1964) describes that Brigalow has a well-developed lateral (horizontal) root system, and plants are often joined together by these roots which form colonies. Considering that depth to groundwater within the Project area is typically greater than 30 to 40 m, it is unlikely that the Brigalow TEC is accessing groundwater at such a depth.<br>***Queensland Government Pre-clearance Regional Ecosystem Mapping***<br>Pre-clearance regional ecosystem mapping indicates that regional ecosystems known to be associated with Brigalow TEC (DAWE, 2021) occurred extensively across the Project Area prior to clearing. The extent of the associated regional ecosystems coincides with both the location of the identified Brigalow TEC and the extent of Gilgai soils mapped by the Soils and Land Suitability Assessment for the Draft EIS. To this end, it is likely that clearing for agricultural land use practices, rather than groundwater reliance has resulted in the decline in potential Brigalow extent over the Project Area.<br>**TEM Surveys**<br>TEM Surveys were undertaken across representative wetland and potential GDE areas within the Study Area. Consistent with the findings of Johnson (1964), and Jones (2019), TEM surveys within the Study Area indicated that wetlands and potential GDE's were underlain by a clay layer. These clay-rich layers create a perched aquifer within the geological profile, located well above the water table, and are disconnected from the surrounding groundwater regime.<br>**Conclusion**<br>The above studies and additional investigations continue to justify the position that further studies of potential groundwater dependency are considered unnecessary on the basis that the outcomes of comprehensive assessments undertaken for the Project preclude vegetation communities within the Project area from forming GDEs, or, otherwise where there is potential for GDEs to occur, conclude that the Project is unlikely to facilitate material impacts due to changes in groundwater quality or resource.<br>In view of the above, further field studies of potential GDEs are considered unnecessary as the likelihood of groundwater dependency has been concluded. |

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| 30. The proponent has undertaken pilot stygofauna surveys which did not identify any stygofauna. However, only three bores within the alluvium (the most likely habitat for groundwater-dependent stygofauna in the project area) were sampled and no bores within the regolith were surveyed (compare Whitehaven Coal 2021, App. E, p. 45 to Whitehaven Coal 2021, App. A, p. 66). As this sample size is very low and facultative stygofauna have been identified at neighbouring mines (Olive Downs Project and Vulcan Complex Project) (Whitehaven Coal 2021, App. E, p. 105), the IESC recommends that the proponent undertake further sampling, especially within the alluvium and regolith. If stygofauna are found, an assessment will be required of the potential impacts of the project on this obligate GDE. | The stygofauna pilot study for the Draft EIS (ESP, 2021) was designed to detect stygofauna if present in the Project Area or surrounds in accordance with the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DES, 2015). No stygofauna were recorded during the pilot study for the Draft EIS (ESP, 2021). The highly saline and largely unsaturated regolith throughout the broader region suggested that the groundwater environment within the Project Area was not ideal for stygofauna (ESP, 2021). However, stygofauna were considered likely to occur in the alluvium associated with the Isaac River (DPM Envirosciences 2018, ESP 2021).<br>Supplementary stygofauna sampling was completed by ESP in February 2022, targeting bores in the regolith and Isaac River alluvium (ESP, 2022) (Attachment 10 of the Additional Information). During the supplementary survey, stygofauna taxa were recorded from one bore targeting the Isaac River alluvium (i.e. bore IF3839P):<br>• Ostracods from family Candonidae (2 specimens); and<br>• Syncarida from family Bathynellidae (10 specimens).<br>Both of these families are obligate inhabitants of groundwater ecosystems (i.e. stygobites). Bathynellidae are widespread and occur in most alluvial aquifers across Australia. The taxonomy of the family Bathynellidae is relatively unresolved, with only a few genera described (ESP, 2022). All are obligate groundwater dwellers that rely on groundwater habitats for their entire lifecycle.<br>Candonidae includes both surface water and groundwater dwelling ostracod species. Although it was not possible to identify the specimens recorded during the current survey to species level, examination of key features determined that they were likely obligate stygofauna species (ESP, 2022).<br>Notwithstanding, there would be no impacts to stygofauna taxa recorded during the supplementary survey within the Isaac River alluvium, as the numerical groundwater modelling results indicate there would be negligible drawdown within the Isaac River alluvium due to the Project (SLR Consulting, 2022) (Attachment 5 of the Additional Information). |
| 31. Any changes in groundwater quality (e.g., as a result of contamination from the residual voids as discussed in Paragraph 16) may impact on GDEs within vicinity of the project. This risk should be more fully assessed. | Refer to Item 4 and Item 23c. |
| 32. The removal and diversion of streams within the disturbance area will remove or alter existing corridors of riparian vegetation and ecological connectivity. | The total catchment areas of the Isaac River and Ripstone Creek immediately downstream their confluence are approximately 5,166 km$^2$ and 286 km$^2$, respectively.<br>During mining operations, the water management system would capture runoff from areas that would have previously flowed to the receiving waters of the Isaac River and Ripstone Creek. |

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| The potential impacts of this loss and alteration of riparian connectivity should be assessed in more detail, especially for arboreal fauna because much of the surrounding landscape has been cleared and so these riparian corridors are disproportionately important. Furthermore, the potential changes that stream diversions and removal may have on flood regimes and how these may impact on gilgai and eucalypt woodland, which are likely providing habitat for EPBC Act-listed species (Ornamental Snake, Greater Glider, Koala, Squatter Pigeon), should also be considered in this assessment. | The estimated maximum captured catchment areas during the Project would be 76 km$^2$ for runoff that would have reported to the Isaac River and 16 km$^2$ for runoff that would have reported to Ripstone Creek. The maximum catchment areas excised by the Project represent:<br>• up to approximately 1% of the Isaac River catchment (to the confluence with Ripstone Creek); and<br>• up to approximately 4.5% of the Ripstone Creek catchment (to the confluence with the Isaac River).<br>On this basis, the loss of catchment flows in the Isaac River and Ripstone Creek would be indiscernible. Therefore, the potential impact on water quantity in the Isaac River and Ripstone Creek due to the excision of catchment is considered negligible (WRM, 2022) (Attachment 6 of the Additional Information).<br>At the completion of mining, surface runoff from rehabilitated in-pit and out-of-pit waste rock emplacement areas would flow to the receiving environment.<br>An area of approximately 13.7 km$^2$ would report to the residual voids at the completion of mining. The changed topography following completion of the Project would have the following impacts on catchment areas:<br>• The catchment draining to the Isaac River (to the confluence of the Isaac River and Ripstone Creek) would reduce by approximately 13.7 km$^2$ (compared to pre-mining conditions), a decrease of less than 0.3%.<br>• The catchment draining to Ripstone Creek would reduce by approximately 4.3 km$^2$ (compared to pre-mining conditions), a decrease of less than 1.5%.<br>The loss of catchment flows in the Isaac River and Ripstone Creek would be indiscernible, and as such the potential impact on water quantity in Isaac River and Ripstone Creek due to the final landform is considered negligible (WRM, 2022) (Attachment 6 of the Additional Information). Therefore, unlikely to affect the alluvial groundwater recharge. As such there will be no impact to instream, riparian and floodplain eco-systems.<br>The Aquatic Ecology and Stygofauna Assessment for the optimised Project (ESP, 2022) (Attachment 10 of the Additional Information) concluded:<br>*The Project area represents less than 0.05% and 0.3% of the overall catchment areas for the Fitzroy River basin and the Isaac-Connors sub-basin, respectively. The changed topography as a result of the Project final landform would reduce the catchment area draining to the Isaac River compared to pre-mining conditions; however, the decrease in catchment area is expected to be less than 1.5% (WRM 2022). No measurable impacts to surface water quantity are likely to occur as a result of the Project (WRM 2022). Therefore, the loss of catchment area is minor in a regional context.*<br>*Regardless of this change to the captured catchment area, no measurable impacts to surface water quantity are likely to occur as a result of the Project (WRM 2022). … Therefore, impacts to surface flows and subsequently aquatic ecosystems downstream of the Project area are not expected.*<br>Modelling has shown that the optimised Project would result in negligible increased leakage from surface flows of the Isaac River to the underlying alluvium. |
| 33. Removal and diversion of some 16 km of ephemeral creeks in the project area will also alter stream flow regimes, especially ecologically important flow components such as the numbers of zero- and low-flow days, along the lower reaches of these streams down to where they join the Isaac River. Changes in flow regimes in ephemeral creeks have major repercussions for the biodiversity and composition of their aquatic and riparian communities (Datry *et al*. 2017) but these potential impacts are not discussed by the proponent, The reduced flows in the lower reaches may also reduce recharge of local alluvial groundwater, potentially affecting the condition of groundwater-dependent vegetation in the riparian zone and nearby floodplain and detracting from habitat values for arboreal wildlife such as Koalas and Greater Gliders. Reduced alluvial recharge may also have impacts on stygofauna and other GDEs in the local area. The proponent should fully assess these potential impacts on water-dependent assets, especially those impacts that will persist after mining finishes. | |

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| | The change in flows as a result of the increased hydraulic gradient between the alluvium and the Isaac River would be a negligible reduction in average flow when the Isaac River flows; therefore, impacts to surface flows and subsequently aquatic ecosystems downstream of the Project area are not expected. The optimised Project is likely to result in fewer impacts (proportionally) on baseflow contributions to New Chum Creek, North Creek or Cherwell Creek given the distance of these waterways from the Project (SLR Consulting, 2022) (Attachment 5 of the Additional Information). Further to this, there is limited interaction between drawdown in the Layer 1 (Alluvium) and Layer 2 (Regolith) and Isaac River, Cherwell Creek, Ripstone Creek, unnamed ephemeral tributaries. |
| 34. The IESC notes that there is an area of highly erosive and dispersive soils to the northeast of the mining lease by the railway pit release point (compare Whitehaven Coal 2021, App. B, App. F, p. 36 to Whitehaven Coal 2021, App. B, p. 144). The proponent does not appear to have discussed the potential risks of impacts on aquatic ecosystems such as Cherwell Creek that may receive runoff from this area. Additional field surveys of aquatic biota are recommended in this area to identify any potential risks and serve as baseline data for future surveillance monitoring. | Cherwell Creek is upstream (and majority is upland) for the Railway Pit, and the proposed controlled release point, and therefore there would be no mechanism to receive run-off from these areas or release point.<br>Notwithstanding, controlled releases would only be required when river flow is more than 400 times larger than the controlled release flow. As such, the minimum dilution ratio (the daily volume of the Isaac River flow divided by the daily volume of controlled releases to the Isaac River) required for a controlled release into the Isaac River is 407. |
| 35. The potential ecological consequences that may arise from the increasing salinity and elevated concentrations of total dissolved metals of pit lakes (e.g., to mobile fauna such as birds and aerial insects) within the residual voids should be considered by the proponent (Paragraphs 8, 16 and 23). The proponent intends to rehabilitate the final landform back to a mixture of woodland and pasture (Whitehaven Coal 2021, Section 6, p. 6-16), which may be impacted in the long-term due to the predicted hypersalinity of the water within the residual voids. The proponent should discuss these potential risks. | Refer to Item 4 and Item 23c.<br>For the optimised final landform, an opportunity was identified to beneficially re-use the water from the residual voids for agricultural or other purposes (e.g. water for cattle consumption). Given the predicted water quality, the re-use of residual void water would slow down the accumulation of salt in the residual voids, which may allow for a sustained final land use without potential impacts to the surrounding environment. Progressing this re-use opportunity would be subject to further feasibility assessment and design, in addition to identification, negotiation and agreement with the final water user/s.<br>Given the above, it is not expected that there would be any potential ecological consequences due to the salinity of the residual void water bodies and the rehabilitated optimised final landform would be able to support the proposed final land uses (e.g. pasture and woodland). |

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| ***Question 4*** | |
| ***Question 4: Groundwater*** | |
| 36. The proponent has committed to developing and implementing a groundwater monitoring program (sampling quarterly) that will continue throughout the life of the project and include adjacent tenure holders (e.g., Olive Downs, Eagle Downs Mine, and the Moorvale South Project). Monitoring will primarily detect changes to groundwater levels and water quality within the alluvium and Rangal Coal measures (Whitehaven Coal 2021, App. A, pp. 136-139). The proponent has committed to developing a database of the monitoring results. Suggested refinements are presented below.<br>a. Monitoring of the regolith does not appear to be planned (Whitehaven Coal 2021, App. A, pp. 138-139). Water quality and groundwater levels in the regolith should be monitored to better understand potential propagation of impacts during and after the project. | A number of existing monitoring bores screened within the regolith have been used from groundwater monitoring networks for surrounding operations (e.g. Olive Downs Project).<br>Notwithstanding, SLR Consulting (2022) (Attachment 5 of the Additional Information) recommended the addition of a Project monitoring bore in the regolith which would allow for groundwater quality and level be monitored during the Project. |
| b. Use of multi-level monitoring bores that target multiple groundwater units is strongly recommended to obtain information on vertical hydraulic gradients, allowing for a better understanding of potential impacts to groundwater flow within the system. | Noted. The optimised Project groundwater monitoring network contains multi-level monitoring sites (e.g. VWP1, VWP2) which would continue for the Project. Also, the groundwater monitoring network for surrounding development includes monitoring at a range of multilevel monitoring sites (e.g. GW01d, GW06D, MS0231, etc.) which would continue to be used on an as required basis, where possible, under the existing data sharing agreement. |
| c. The groundwater monitoring plan proposed by the proponent should derive site-specific guideline values for groundwater quality and include the following analytes: total dissolved solids, major ions, water hardness, ionic balance, total alkalinity, total dissolved metals, nutrients, and organics | Consistent with the standard conditions of an Environmental Authority a Groundwater Monitoring Program would be established for the optimised Project, as part of the Water Management Plan. Site-specific trigger levels values for groundwater quality (including the range of analytes) would be provided in the Environmental Authority should the optimised Project be approved. Groundwater quality triggers would be established to monitor predicted impacts on both environmental values and predicted changes in groundwater quality. |

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| (e.g., volatile and semi volatile organics, benzene, toluene, ethylbenzene and xylene). This plan should outline effective mitigation actions that will be performed once there is a suspected exceedance of a guideline value. Given that some dissolved metal concentrations (i.e., arsenic, aluminium, cobalt, selenium, copper, lead, nickel and zinc) exceed aquatic ecosystem protection guidelines at a 99% protection level and 80% protection level for aluminium, copper, lead and zinc (Whitehaven Coal 2021, App. A, App. A3, pp. 1-94), site-specific guideline values for groundwater quality for these metals should also be considered. | |
| 37. The proponent has committed to reviewing the validity of the groundwater model predictions using data from the monitoring network and updating the model if needed. This will be undertaken every 5 years (Whitehaven Coal 2021, Section 7, p. 7-5). More frequent reviews may be required. The length of time that these updates will continue should be specified. Updates should ideally continue following mine closure, with groundwater level data being compared to the model predictions of long-term groundwater recovery. | Noted. The Water Management Plan for the Project, that would include a Groundwater Monitoring Program, would specify the interval (and would include following mine closure) for which the validity of the groundwater model predictions would be assessed. |
| 38. Noting that some of the monitoring bores sit in the zone of predicted drawdown (compare Whitehaven Coal 2021, App. A, p. 66 to Whitehaven Coal 2021, App. A, pp. 116-124), the groundwater monitoring program should include information about updating the monitoring network with additional bores over time. | Noted. Notwithstanding, the extensive baseline groundwater monitoring would continue to be implemented by Whitehaven WS during the optimised Project. Monitoring of groundwater levels from existing monitoring bores and vibrating wire piezometers (VWPs) would continue and would enable natural groundwater level fluctuations (such as responses to rainfall) to be distinguished from potential groundwater level impacts due to depressurisation resulting from proposed mining activities. Several bores within the extent of proposed mining operations would continue to be monitored until they are no longer available due to mine progression. Whitehaven WS would investigate potential replacements for the bores over the life of the Project. |

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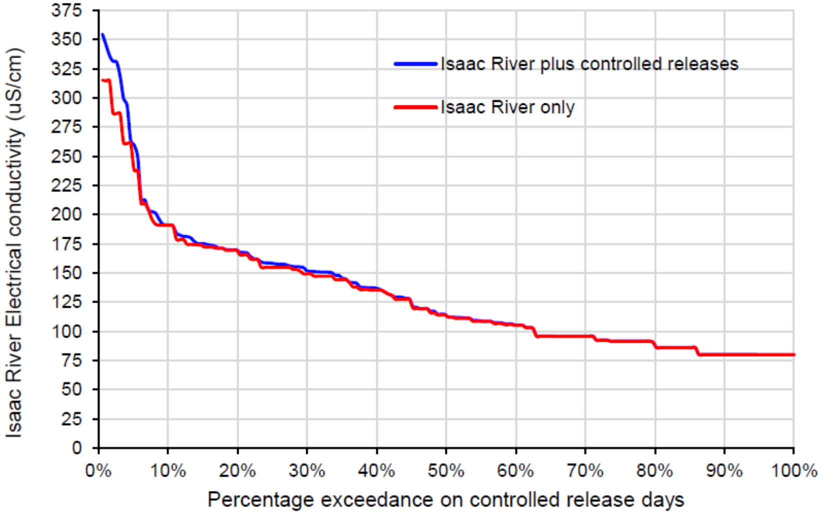
| ***Question 4: Surface water*** | |
| 39. The proponent asserts that there will be negligible impacts to surface water quality due to the project (Whitehaven Coal 2021, App. B, p. 136). However, the potential combined impacts from erosion, sedimentation and releases of mine-affected water on downstream ecosystems and their biota have not been adequately considered by the proponent. The proponent should analyse and present ongoing data from the project from monitoring of the surface waters of all potentially impacted creeks to confirm that water quality and erosion management measures are effective. | Controlled releases from the mine water management system would occur rarely and only when the water quality and flows of the Isaac River meet the proposed release trigger levels. Therefore, it is expected that these controlled releases would have negligible impacts on the Isaac River water quality (WRM, 2022) (Attachment 6 of the Additional Information). Figure 1 shows a ranked plot of modelled Isaac River salinity during controlled release events and provides, on controlled release days the controlled releases will have a negligible impact on the Isaac River salinity (WRM, 2022).<br> <br>**Figure 1 – Ranked Plot of Isaac River Salinity during Controlled Releases**<br>The assessment indicated the receiving river flow is more than 400 times larger than the controlled release flow for all model iterations. Therefore, controlled releases would have a negligible impact on Isaac River water quality (WRM, 2022) (Attachment 6 of the Additional Information). To minimise the potential for mine-affected water releases, the optimised Project would utilise the Railway Pit and Main Pit as in-pit water storages when available.<br>As discussed in Item 25, with respect to sediment-laden water, a 'best practice' approach would be adopted for the design of erosion and sediment controls that is consistent with the IECA recommendations.<br>In rainfall events below the design standard of the sediment dams, runoff from disturbed areas would be intercepted and treated by sediment dams. In larger events that exceed the design standards, these dams would overflow. |

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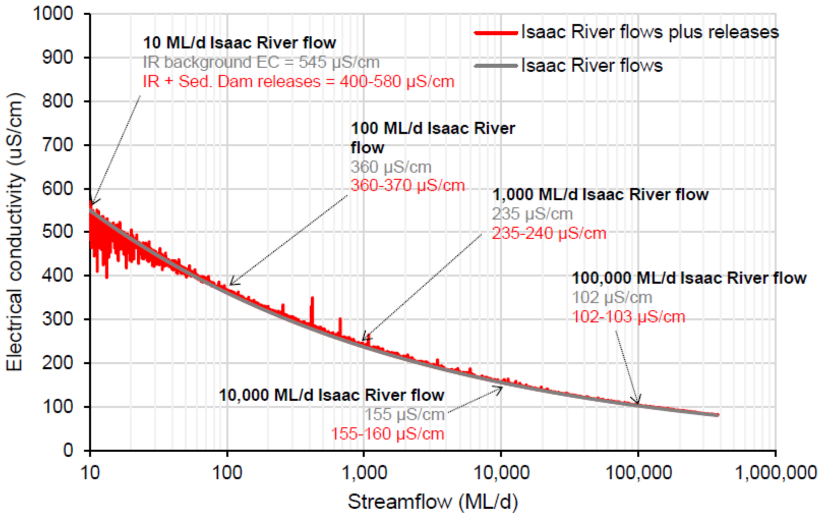
|  | Temporary storage within the sediment dams prior to overflow would reduce suspended sediment concentrations through settlement of sediment particles (WRM, 2022).<br>Available geochemical information indicates that the runoff draining to the sediment dams would have low to moderate salinity. Overflows would only occur during significant rainfall events which would also generate large volumes of runoff from surrounding undisturbed catchments. Therefore, it is unlikely that sediment dam overflows would have a measurable impact on receiving water quality or environmental values (WRM, 2022).<br>The Surface Water and Flooding Assessment for the optimised Project (WRM, 2022) included a comprehensive assessment of the potential impacts of sediment dam overflows, including modelling of the salinity of the sediment dam overflows and receiving Isaac River. WRM (2022) concluded the following which is represented in Figure 2 below:<br>*The sediment dam overflow would have a negligible impact on the Isaac River quality with predicted increases of less than 7%.*<br> <br>**Figure 2 – Impact of Sediment Dam Overflows on Isaac River Water Quality**<br>Potential impacts of the proposed releases on the downstream tributaries were assessed in the Geomorphology Technical Study (Appendix F of Appendix B of the Draft EIS). The Geomorphology Technical Study was prepared by Dr Christopher Gippel and included a comprehensive review of the geomorphology of the tributaries downstream of the proposed discharge points.<br>The Geomorphology Technical Study describes the proposed monitoring and management strategy for the tributaries, which would be undertaken using objective, scientifically sound methods, following a BACI design. |

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| | Visual inspections and would be undertaken following each controlled release event. A topographic survey (using LiDAR) would be undertaken if either of the following are observed:<br>• a channel exceeding 0.2 m deep for a length of 10 m or more; or<br>• initiation of a knickpoint higher than 0.3 m.<br>Appropriate mitigation measures would be applied in response to any observed geomorphic impacts. The appropriate mitigation would be assessed at the time and would range from doing nothing (self-healing), to assisted recovery (e.g. plant vegetation and soft engineering such as coir matting and stakes), to hard-engineering (e.g. rock rip-rap) (Fluvial Systems, 2020).<br>Notwithstanding the above, an Erosion and Sediment Control Plan and Water Management Plan would be developed and implemented throughout construction and operation of the Project. If implemented effectively, environmental risks from disturbed area runoff (i.e. sediment-laden runoff) are expected to be low (WRM, 2022). The Water Management Plan for the Project would also include a program for monitoring and review of the effectiveness of the Water Management Plan. |
| 40. The locations and number of the monitoring sites (Whitehaven Coal 2021, App. B, pp. 143-144) and the suite of analytes to be monitored (Whitehaven Coal 2021, App. B, pp. 145-147) are generally adequate. Sampling during runoff events will be useful for identifying potential impacts. Although sampling of the runoff from reject material is intended (Whitehaven Coal 2021, App. B, p. 132), a detailed monitoring program, with site-specific guidelines that if exceeded, will trigger remedial action should be provided with the analytes, locations and frequency of sampling as this runoff may pose a significant risk. | It should be noted that the Environmental Authority for the Project (if approved) would include conditions to address monitoring requirements and the suite of analytes, and a Water Management Plan would be prepared prior to construction of the optimised Project, which would include the monitoring program. |
| 41. Little information regarding the mitigation and management of erosion around the project area is provided, although the proponent has committed to develop an erosion and sediment control plan (Whitehaven Coal 2021, Section 7, p. 7-2). Details of this plan should be provided and mitigation and management for erosion should be undertaken to reduce potential impacts. | It should be noted that the Environmental Authority for the Project (if approved) would include conditions that require a Water Management Plan which would include an Erosion and Sediment Control Plan, and would be prepared prior to construction of the Project. As described in Items 25 to 27, sediment dams would be designed using a 'best practice' approach for erosion and sediment controls consistent with IECA recommendations |

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| ***Question 4: Water-dependent ecosystems*** | |
| 42. Discussion of mitigation, management and monitoring plans for water-dependent ecosystems is limited which hampers assessment of the adequacy of the suggested measures. | See responses to Items 2, 3, 9, 10, 21, 28, 29 and Items 31 to 35 for assessment of potential impacts on water-dependent assets. Notwithstanding, information presented within the following studies undertaken for the Project contributed to the overall conclusion that the optimised Project is not predicted to have any material impacts on potential or actual GDEs due to changes in groundwater quality or resources:<br>• Groundwater Assessment (SLR Consulting, 2022).<br>• Surface Water and Flooding Assessment (WRM, 2022).<br>• Soil and Land Suitability Assessment (GTE, 2022).<br>• TEM Survey (Groundwater Imaging, 2019).<br>• Terrestrial Ecology Assessment, including extensive field surveys (E2M, 2021).<br>• Aquatic Ecology and Stygofauna Assessment, including extensive field surveys (ESP, 2021).<br>• GDE Assessment (Whitehaven WS, 2021).<br>Supplementary, stygofauna sampling was completed by ESP in 2022 at six bores distributed within the regolith and alluvium. Each bore was established at least six months prior to stygofauna sampling and contained groundwater. In-situ water quality measurements for EC and pH were also taken at each bore, to aid in the interpretation of results.<br>Two stygofauna taxa were recorded from a single bore targeting the Isaac River alluvium. However, there would be no impacts to stygofauna taxa within the Isaac River alluvium, as the numerical groundwater modelling results indicate there would be negligible drawdown within the Isaac River alluvium due to the optimised Project (SLR Consulting, 2022). |
| 43. The proponent does not intend to monitor GDEs (Whitehaven Coal 2021, App. F, p. 44). If the recommended additional sampling of stygofauna (Paragraph 30) and the assessment of groundwater use by potential terrestrial GDEs (Paragraph 28 and 29) indicate that GDEs are actually more prevalent than predicted, suitable mitigation, management and monitoring plans will be needed. These should include appropriate monitoring (using approaches suggested in Doody *et al*. 2019) to obtain adequate baseline data and assess the efficiency of mitigation and management strategies. Measures to feasibly mitigate impacts (e.g. drawdown) on GDEs should be described as part of a suitable trigger action response plan (TARP). | |
| 44. Monitoring plans for water-related assets, including riparian zone condition and GDEs, should be able to detect relevant changes in water quality of groundwater and surface water during and after the project and identify how these changes might impact water-dependent ecosystems. Risk mitigation measures should include thresholds for assessing declining water quality which may compromise GDEs and other water-dependent ecosystems, and incorporate these thresholds into appropriate TARPs. | |

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| 45. If trees in the Brigalow TEC (Paragraph 29) are shown to be accessing groundwater, the proponent should consider how potential impacts of groundwater drawdown on this TEC will be monitored and mitigated. This TEC has not been included in the proponent's environmental offset strategy. If it is found to be groundwater-dependent and mitigation of drawdown impacts is not feasible, the proponent may need to include it in their offset strategy. | Noted, however, responses to Items 28 and 29 provide relevant information to Brigalow TEC that confirms the ecological community is unlikely to access groundwater at the depth observed in the vicinity of the optimised Project (including within the extents of predicted groundwater drawdown). Therefore, no impacts due to the optimised Project and no associated offsets would be required. |
| 46. Monitoring, management and mitigation plans may be required to address potential risks of releases from the railway pit and runoff from the highly dispersive/erosive soils (Paragraph 34) situated nearby. While the IESC commends the intention to implement an erosion and sediment control plan, the details of this plan are insufficient (Paragraph 41) and further aquatic ecology surveys are suggested to elucidate the potential risks from sedimentation and other stressors. Depending on the survey results, the proponent may need to implement appropriate monitoring, management and mitigation measures, including suitable water quality triggers. | As discussed in response to Item 7, water release conditions have been developed for releases to the Isaac River based on the *Model Mining Conditions* (DES, 2017). The proposed controlled release conditions have been based on those recently approved for the neighbouring Olive Downs Project.<br>Potential impacts of the proposed controlled releases on the downstream tributaries were assessed in the Geomorphology Technical Study (Fluvial Systems, 2020). The Geomorphology Technical Study was prepared by Dr Christopher Gippel and included a comprehensive review of the geomorphology of the tributaries downstream of the proposed controlled discharge points.<br>Appropriate mitigation measures would be applied in response to any observed geomorphic impacts. The appropriate mitigation would be assessed at the time and would range from doing nothing (self-healing), to assisted recovery (e.g. plant vegetation and soft engineering such as coir matting and stakes), to hard-engineering (e.g. rock rip-rap) (Fluvial Systems, 2020). |
| ***Question 5*** | |
| 47. The draft EIS does not give adequate consideration to the project's contribution to cumulative impacts associated with other extraction projects in the area. Cumulative impacts are considered in some technical assessments (e.g., the groundwater model) but are not discussed in relation to potential impacts on water-dependent assets. | The Groundwater Assessment (SLR Consulting, 2022) (Attachment 5 of the Additional Information) provided consideration of cumulative impacts associated with developments near the Project including: the Olive Downs Project, Moorvale South Project, Poitrel Mine, Daunia Mine, Peak Downs Mine, Caval Ridge Mine, Lake Vermont Coal Mine, Eagle Downs Mine, Saraji Mine and Saraji East Project. In consideration of the maximum cumulative drawdowns associated with the Project, it is unlikely that there would be material impacts on potential or actual GDEs due to changes in groundwater quality or resources.<br>The Surface Water and Flooding Assessment for the optimised Project (WRM, 2022) (Attachment 6 of the Additional Information) also considered cumulative impacts with the development of the proposed release strategy to the Isaac River based on the existing release conditions for nearby operating coal mines developed by the regulators within an overarching strategic framework for the management of the cumulative impacts of water releases mining activities. |

| Recommendation/Comment | Response |
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| | Therefore, the controlled releases associated with the optimised Project are expected to have negligible cumulative impact on surface water quality and associated environmental values. Notwithstanding, the site water management system has been designed such that controlled releases from the Project are only required rarely, and any such releases would have a negligible impact on receiving water quality.<br>A comparison of the captured catchment areas of the existing mining projects considered in the cumulative impact assessment with the Isaac River catchment to the Isaac River/Stephens Creek confluence is assessed in the Surface Water and Flooding Assessment for the optimised Project (WRM, 2022) (Attachment 6 of the Additional Information), which indicates the following:<br>• The combined total catchment area of the existing mines (including the Project) represents around 9.5% of the total catchment area of the Isaac River to the Isaac River/Stephens Creek confluence.<br>• The combined mine affected catchment area (estimated) represents less than 2.9% of the total Isaac River catchment area to the Isaac River/ Stephens Creek confluence.<br>As such, when taking into account potential discharges from the operating mines in accordance with their current release rules, the overall loss of catchment area and associated stream flow is relatively small (WRM, 2022).<br>See responses to Items 2, 3, 9, 10, 21, 28, 29 and Items 31 to 35 for assessment of potential impacts on water-dependent assets. |
| ***Question 5: Groundwater*** | |
| 48. The proponent has modelled cumulative drawdown, although it is noted that some of the projects (e.g., Poitrel Mine, Isaac Downs Mine) surrounding the project have not been included in the modelling. A brief discussion of the modelled cumulative impacts is provided (Whitehaven Coal 2021, App. A, pp. 119-120), but this does not discuss potential impacts. More details about how the project will contribute to the impacts of cumulative drawdown are required, especially in areas where recharge from ephemeral streams may be altered because of the loss or diversion of their channels and alienation from their catchments by the project. | The groundwater model did include the Poitrel Mine in the cumulative impact assessment (refer Sections 3.3 and 6.5 of Attachment 5 of the Additional Information [SLR Consulting, 2022]), noting that the numerical groundwater model was expanded to the north-west for the Project to limit any potential edge effects.<br>The Isaac Downs Mine and Millennium Mine were not included in the groundwater model on the basis that these mines are too distant for cumulative drawdown impacts to occur. It is also relevant to note that the Project is separated from the Isaac Downs and Millennium Mines by the Poitrel and Daunia Mines, which were both included in the groundwater model.<br>Discussion regarding the cumulative drawdown associated with the Project and surrounding developments is provided in Sections 6.5 and 7.2 of the Groundwater Assessment for the optimised Project (SLR Consulting, 2022). In summary, the optimised Project (including the associated cumulative interactions) is not predicted to have any material impacts on potential or actual GDEs due to changes in groundwater quality or resources (SLR Consulting, 2022). |

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| 49. The proponent has not considered the potential cumulative impacts of the void water on the surrounding groundwater system. These impacts should be considered with reference to the concerns raised in Paragraphs 19-22 and 30. | The optimised final landform for the Project would include three residual voids made up of a pit lake and low wall and highwall components. The residual voids are predicted to behave as groundwater sinks, preventing any water that accumulates in the residual voids from migrating into the surrounding aquifers which is supported by groundwater fate modelling provided in the Section 6.6 of the Groundwater Assessment for the optimised Project (SLR Consulting, 2022). Therefore, there would be no potential cumulative impacts on the surrounding groundwater system from the water within the residual voids. |
| ***Question 5: Water-dependent ecosystems*** | |
| 50. Assessing the project's contribution to cumulative impacts on aquatic habitats and terrestrial GDEs is important given that the landscape is already heavily modified and habitats such as ephemeral streams, riparian corridors and patches of remnant vegetation in the area are likely to be particularly important. Furthermore, there are many mines along the Isaac River and their collective impacts on floodplain wetlands, ephemeral streams, riparian vegetation and other habitats must be considered at landscape and catchment scales, especially for listed threatened species (e.g., Koala, Ornamental Snake) and other species (e.g., fish, turtles) in and near the project area. | Cumulative impacts on listed terrestrial threatened species (e.g. Koala, Ornamental Snake) were considered in the Terrestrial Ecology Assessment (E2M, 2021) for the Draft EIS. The change in potential cumulative impacts on threatened species and communities arising from the Project is considered to be minimal because of the localised nature of the Project compared to the wider distribution of the species and associated habitats and communities in the surrounding landscapes and subregions (E2M, 2021) and impacts would be offset as part of the Project. As such, based on the surface disturbance for the Project, approved disturbance from nearby developments and the available habitat/area in the region, the Project is predicted to have negligible cumulative impacts on terrestrial flora and fauna (E2M, 2021).<br>Fish communities recorded at sites in the vicinity of the Project were typical of those inhabiting ephemeral systems in central Queensland (ESP, 2022) (Attachment 10 of the Additional Information). All taxa recorded during numerous field surveys were common in the broader region, and no listed threatened species known from the catchment (or potential habitat for these species) were identified, and therefore there would be no impacts to threatened aquatic species (e.g. fish, turtles). |

| Recommendation/Comment | Response |
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| 51. Discussion of the cumulative impacts of the project by the proponent is limited, and largely focuses on impacts from land clearing. The proponent should assess the collective hydrogeological and hydrological impacts on ephemeral streams and floodplain habitats and their biota, especially flanking the lower reaches of the tributaries whose upper reaches are to be lost or diverted. The cumulative impacts of lost riparian connectivity across the project area should also be assessed. If GDEs are more prevalent than predicted within the zone of cumulative predicted drawdown (including beyond the boundaries of the project area), these impacts should also be assessed collectively. Finally, the potential cumulative impacts of the residual voids and their long-term legacy of declining water quality should be assessed. | The Project area represents less than 0.05% and 0.3% of the overall catchment areas (e.g. loss and diversion of water flows in the lower reaches of the tributaries) for the Fitzroy River basin and the Isaac-Connors sub-basin, respectively. The changed topography as a result of the optimised Project would reduce the catchment area draining to the Isaac River compared to pre-mining conditions; however, the decrease in catchment area is expected to be less than 1% (WRM, 2022) (Attachment 6 of the Additional Information). No measurable impacts to surface water quantity are likely to occur as a result of the Project and the loss of catchment area is minor in a regional context (WRM 2022), therefore it is unlikely there would be any associated cumulative impacts.<br>As described above in previous responses, the comprehensive assessments undertaken for the optimised Project preclude vegetation communities within the Study Area for the optimised Project from forming GDEs, or, otherwise where there is potential for GDEs to occur, conclude that the optimised Project is unlikely to facilitate material impacts due to changes in groundwater quality or resource (including cumulatively impacts).<br>The Surface Water and Flooding Assessment for the optimised Project (WRM, 2022) and Groundwater Assessment for the Optimised Project (SLR Consulting, 2022) (Attachment 5 of the Additional Information) provide an assessment of the water quality of the water bodies in the residual voids, including the potential for impacts to the surrounding groundwater and surface water systems. The residual voids are predicted to behave as groundwater sinks, preventing any water that accumulates in the residual voids from migrating into the surrounding aquifers, as well as any spills to the surrounding surface water system. Therefore, there would be no potential cumulative impacts on the surrounding groundwater system from the water within the residual voids.<br>For the optimised final landform, an opportunity was identified to beneficially reuse the water from the residual voids for agricultural or other purposes (e.g. water for cattle consumption). Given the predicted water quality, the reuse of residual void water would slow down the accumulation of salt in the residual voids, which may allow for a sustained final land use without potential impacts to the surrounding environment.<br>Progressing this re-use opportunity would be subject to further feasibility assessment and design, in addition to identification, negotiation and agreement with the final water user/s.<br>Given the above, it is not expected that there would be any potential ecological consequences due to the salinity of the residual void water bodies and the rehabilitated optimised final landform would be able to support the proposed final land uses (e.g. pasture and woodland). |

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