

Advice to decision maker on coal mining project

IESC 2019-104: Glendell Continued Operations Project (GA-10005) – Expansion

Requesting agency	The New South Wales Mining and Petroleum Gateway Panel
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Advice stage	Gateway Application

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

The IESC was requested by the New South Wales Mining and Petroleum Gateway Panel to provide advice on Glendell Tenements Pty Ltd's Glendell Continued Operations Project in New South Wales (NSW). This document provides the IESC's advice in response to the requesting agency's questions. These questions are directed at matters specific to the project to be considered during the requesting agency's assessment process. This advice draws upon the available assessment documentation, data and methodologies, together with the expert deliberations of the IESC, and is assessed against the IESC Information Guidelines (IESC 2018).

Summary

The Glendell Continued Operations Project is a proposed expansion of the existing Glendell Mine located approximately 20 km northwest of Singleton in the New South Wales Hunter Valley. The expansion would include extending the current open cut Glendell Pit to the northwest to allow mining of approximately 135 Mt run-of-mine (ROM) coal. The project will increase the mine disturbance area, divert Yorks Creek, increase groundwater drawdown in the alluvium, contribute to cumulative impacts, alter catchment areas and flows of several creeks, and require the demolition of the existing Glendell mine infrastructure area (MIA) and construction of a new one. Existing coal handling facilities, including the coal handling and preparation plant and train loadout areas, will be used. The proposal would extend the life of the mine through to 2044.

Key potential impacts from this project are:

- diversion of Yorks Creek into Bowmans Creek which will disconnect Yorks Creek from its alluvium and riparian corridor, and potentially alter sediment and flow regimes, bed structure and in-stream habitat availability in both Yorks and Bowmans Creeks;
- changes to catchment areas and runoff patterns that could impact sediment and flow regimes and aquatic ecosystems within Yorks, Bettys, Bowmans, Swamp and Main Creeks;
- groundwater drawdown within the alluvial aquifers, with potential impacts on groundwater-dependent ecosystems (GDEs) such as saturated alluvial sediments (including stygofauna) and groundwater-dependent vegetation;
- the presence of a final void in the rehabilitated landscape which could impact long-term surface water and groundwater quality (particularly salinity); and
- the further contribution to cumulative impacts on groundwater (possibly until 2200), surface water and native flora and fauna in the wider Hunter Region.

The IESC strongly encourages the proponent to capitalise on their previous experience of rehabilitation in the area and their control of the mines in the GRAWTS to describe in the environmental impact statement (EIS) how they (1) will use the existing data and information to assess potential cumulative impacts of the project and (2) plan for appropriate rehabilitation strategies that will protect riparian corridors, current offset areas and other refuge habitats as source areas for plant and animal colonists in a changing climate. The IESC has identified key areas in which additional work will be required when the proponent prepares the detailed EIS for the project. These key areas are detailed in this advice and summarised below.

- Provide further information on the baseline conditions of both groundwater and surface water resources including water quality, flow regimes and hydrological connectivity.
- After completion of the proposed field mapping of alluvial aquifers in the project area, provide estimation of groundwater drawdown and the likely effects on surface flows (especially low flows and ecologically important flow components) in associated creeks.
- Update the groundwater model, including a sensitivity and uncertainty analysis and quantification of surface water-groundwater connectivity.
- Flood modelling that incorporates infrastructure changes, the Yorks Creek diversion and the final landform to assess flood risks to mine pits and detention storages and changed floodplain behaviour.
- A detailed site water balance that specifies uncertainties in inputs and performance under future climatic conditions.
- A geochemistry study specific to the project area which assesses all waste rock material.
- Further information on the salt balance of the site and salt sources and stores within the final landform, including salt derived from the alluvial aquifer.
- Provide a general ecohydrological conceptual model showing potential impact-effect pathways on water-related ecological assets, including GDEs and aquatic biota. An additional ecohydrological model specifically addressing the proposed Yorks Creek diversion and its confluence with Bowmans Creek may be needed to further understand potential impacts from changes to flows, bank and bed stability and hyporheic conditions in Bowmans Creek.

- Provide detail on the proposed diversion of Yorks Creek and how the diversion will be built and managed to preserve ecological functions (including those occurring in hyporheic and riparian corridors) currently supported by Yorks Creek.
- Ecological studies to determine the baseline condition of the aquatic ecosystems including permanent and semi-permanent pools (e.g. surface water flora and fauna), riparian vegetation and alluvial sediments (e.g. stygofauna, hyporheos) in all creeks potentially affected by the project.
- Explicit consideration and assessment of project-specific risks, and their materiality at different stages of the project, including during rehabilitation. This is required to inform the selection of appropriate mitigation options and development of management plans.
- Assessment of potential cumulative impacts on groundwater and surface water quality, dynamics (e.g. flow regimes, groundwater flux) and biota (e.g. riparian vegetation, fish).

Context

The proposed project is within the Mount Owen Complex which incorporates the existing Glendell Mine, Mount Owen Mine (North Pit) and Ravensworth East Mine (Bayswater North Pit). A number of operational and historic coal mines, two power stations and two quarries occur in the wider area. The Ravensworth State Forest lies northeast of the project, along with several biodiversity offset areas. One of these is immediately east of the current Glendell Pit and partially within the Bettys Creek riparian corridor. The riparian corridors generally contain the oldest vegetation in the area and are likely to be important habitats for native fauna and flora. Maintaining these corridors will help reduce impacts to *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)-listed species and allow dispersal of flora and fauna into the rehabilitated landscape.

The existing Glendell Mine is part of the Greater Ravensworth Area Water and Tailings Scheme (GRAWTS). It is proposed that the project will be incorporated into this scheme with some additional water management infrastructure constructed, although details are currently limited. The GRAWTS allows Glencore, who controls all the mines within the scheme through subsidiaries or joint ventures, to transfer water and tailings between mines to optimise management, facilitate water reuse and minimise discharges. The members of the GRAWTS are Mount Owen Complex mines, Liddell Coal Operations, Integra Underground Mine and Ravensworth Operations but only Liddell Coal Operations and Ravensworth Operations have licenced water discharge points. Therefore, when water needs to be discharged within the GRAWTS, it must be transferred to either Liddell Coal Operations or Ravensworth Operations.

Response to questions

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

Question 1: Could the IESC advise on the:

- potential likelihood and significance of any impacts of the proposal on water resources
- appropriateness of the proposed mitigation measures
- further studies that should be undertaken.

1. The IESC notes that the documentation provided with the advice request for this project is associated with a Gateway Application. The focus of the Gateway process is on potential impacts to Biophysical Strategic Agricultural Land (BSAL) (NSW Government 2013). As the Gateway process occurs at an early stage of the project assessment process, the information provided is limited in detail with many

impact assessment studies still underway or yet to commence. This means that potential impacts and their likelihood and significance are not yet clear. As a result, mitigation and management measures are high-level and conceptual with minimal detail. These factors hamper the IESC's use of information in the documentation to answer the requesting agency's first two points. The following paragraphs describe information and additional studies needed to identify the likelihood and significance of potential impacts with greater certainty, and to guide appropriate mitigation and management strategies.

2. The IESC recognises that the proponent:
 - a. has requested a conditional Gateway approval which identifies the issues that they should assess in detail in the EIS being prepared for the project (Umwelt 2019a, p. 7);
 - b. will consider the IESC Information Guidelines and Explanatory Notes when preparing their EIS; and
 - c. has committed to undertaking further studies to address knowledge gaps for the project EIS.

Groundwater

3. The IESC notes that the nature and extent of potential impacts to hard rock aquifers from this project will be limited. This is because extensive depressurisation of this aquifer has already occurred in the project area from adjacent approved coal mines. However, potential impacts to the alluvial aquifers are likely and require further investigation. The proponent states they are investigating the thickness and extent of the alluvial aquifers to ensure these aquifers are appropriately represented in the groundwater modelling to assess the likelihood and significance of potential impacts. This investigation should incorporate all alluvial aquifers that may be impacted by the project, including alluvial aquifers beyond the project area.
4. As identified in Paragraph 3, there is a need for an improved understanding of the alluvial aquifers near the project area. Further discussion and analysis are required in the EIS about the issues outlined below.
 - a. It is not clear whether a direct hydraulic connection, and hence a potential impact pathway exists, between the hard rock aquifer and the alluvium. The proponent has stated that the coal seam/hard rock aquifers do not sub-crop beneath the alluvium of Bowmans Creek (Umwelt 2019a, p. 46). The IESC notes that this could reduce the likelihood of potential drawdown in the alluvial aquifer; however, the proponent has not provided evidence to support this geological conceptualisation.
 - i. Further investigations including field studies and modelling should be undertaken and described in the EIS to support conclusions on potential impacts to the alluvium, particularly in Bowmans Creek because this aquifer has been identified as a highly productive aquifer under the New South Wales *Aquifer Interference Policy*.
 - ii. Data obtained from the recently installed alluvial monitoring bores which have been paired with hard rock monitoring bores (Umwelt 2019a, p. 46) should be provided in the EIS. These data will increase the understanding of inter-aquifer connectivity at the site and may support the current geological conceptualisation.
 - b. Additional investigations including conceptualisation and modelling of the alluvial aquifers associated with Yorks, Swamp and Bettys Creeks are required. These investigations will improve the understanding of the ecohydrology of these systems which is needed to determine the nature, extent and likelihood of potential impacts (discussed further in Paragraphs 14d, 14e, 22 and 23).

5. It is noted that the groundwater model will be updated (Umwelt 2019a, p. 47). The IESC suggests the following be incorporated:
 - a. a sensitivity and uncertainty analysis with consideration given to the IESC Explanatory Note: Uncertainty analysis – Guidance for groundwater modelling within a risk framework (Middlemis and Peeters 2018); and
 - b. a coupled surface water-groundwater model be developed at a spatial and temporal scale sufficient to quantify the interaction between surface water and groundwater (Rassam et al. 2008, 2011).
6. In the provided documentation, discussion of potential impacts to groundwater quality is limited. The IESC notes that in the EPBC Act Referral (2019, p. 26) for the project, the proponent has committed to providing a more comprehensive analysis within the EIS that will consider the results of a geochemical analysis. The results of this analysis are needed to inform the development of mitigation, monitoring and management strategies. The analysis should consider:
 - a. including existing monitoring data to support any conclusions on the likelihood of potential impacts;
 - b. all potential pathways for impacts to groundwater quality. This should include uncontrolled releases from water storages, seepage from voids and dams, and infiltration of water from waste rock stockpiles into the groundwater system; and
 - c. the suite of analytes to be monitored in the future, with justification for each analyte in the current suite and any proposed changes.
7. Further discussion and analysis of potential changes to, and implications of, hydraulic conductivity and connectivity between aquifers is required in the EIS. The proponent has noted that backfilling will potentially change aquifer characteristics (Umwelt 2019a, p. 52). The updated groundwater model should include these changes where appropriate. The changes should also be captured as potential impact-effect pathways in the ecohydrological model.
8. Analysis of the temporal variability in electrical conductivity (EC) data for the alluvial sediments of Bowmans, Yorks and Swamp Creeks is needed. An understanding of this temporal variability would inform the conceptualisation of surface water-groundwater connectivity.
9. The proponent has stated they have extensive groundwater monitoring data acquired over approximately 13 years at the Mount Owen Complex (Umwelt 2019a, p. 50). The IESC suggests these data:
 - a. be provided in full in a graphical time-series format with statistical analysis and spatial representation of changes (as an appendix or electronically), and summarised within the EIS report to support the discussion of baseline conditions. Spatial and temporal variation in baseline conditions for both groundwater level and quality must be established so that changes relating to impacts from the project can be identified if they occur; and
 - b. also be used to support the proponent's conclusions on the likelihood, extent and magnitude of potential seepage occurring into the groundwater system from water and waste rock storages. This is important given the proponent has observed that water level changes at monitoring bore NPZ9 are related to continual filling of the nearby tailings emplacement area (Glencore 2019a, p. 21) which could imply seepage from the tailings emplacement facility into the groundwater system.

10. Proposed monitoring and management measures must be fully described and updated in the EIS, specifically including:
 - a. the monitoring network map which requires updating to clearly identify within which aquifers monitoring bores are located. This will allow an assessment of the adequacy of the spatial coverage of the network;
 - b. a summary of the monitoring program with discussion of any proposed additions or changes to the network and suite of analytes to measure potential impacts of the project, and the effectiveness of mitigation measures;
 - c. provision of the full suite of monitoring data collected in the existing monitoring program. These data are needed to support the proponent's assessments about the likelihood and significance of impacts of the project;
 - d. the future monitoring program which should be expanded to include a range of organic parameters such as polycyclic aromatic hydrocarbons (PAHs);
 - e. the results of analyses of waste rock geochemistry which should be explicitly used to inform and justify the selected monitoring suite of analytes; and
 - f. the trigger-action response plans (TARPs) updated to include specifics on the implementation of proposed responses, management options available and timeframes for actions and responses so that the likely success of the TARPs can be assessed. Currently, timeframes are only provided for reporting to regulatory authorities.
11. Detailed information is needed on the volume of groundwater available under current licences specifically for the project. The proponent has provided information on the total licenced volumes held but it is unclear how much of this volume is already utilised by approved operations at the Mount Owen Complex. The proponent should also outline in the EIS any additional licences that will be needed based on the results of the detailed water balance (see Paragraph 19) and a plan to obtain these.
12. The search for registered bores in the vicinity of the project appears to have been done in 2014 (Glencore 2019a, p. 14), and should be updated. Additionally, if groundwater modelling results indicate that drawdown from the project could extend beyond the current search radius, the search radius should be increased accordingly and include a buffer that allows for uncertainty in drawdown predictions (see Paragraph 5).

Surface waters

13. At this stage of the approvals process, the lack of quantitative information provided on streamflows and runoff prevents reliable assessment of the likelihood and significance of surface water impacts. While the surface water systems are ephemeral in the project area, the importance of ephemeral systems is now recognised (Datry et al. 2018). Useful information could be obtained from a variety of techniques including observations of flows made during the water quality monitoring, from water level recording of on-site water storages and stream pools, and from images from Water Observations from Space (WOfS) (Mueller et al. 2016). Information used in the "detailed analysis and calibration" of the site water balance modelling (Glencore, 2018) would also be useful in this regard. The quantitative analysis of such information would allow the impacts of altered catchment areas and other mining-related activities on surface water resources to be assessed.
14. More information on the proposed diversion of Yorks Creek will be needed in the EIS. This information should demonstrate how the proposed diversion plans to address the guidelines developed by White et al. (2014) and should also address the following issues.

- a. Detailed design specifications and a geotechnical and geomorphological assessment of the proposed diversion are required. This information will be essential for determining the suitability of the proposed diversion and its likely long-term stability.
 - b. The proposed diversion appears to be shorter and straighter than the current path of Yorks Creek and will enter Bowmans Creek some four river-kilometres upstream of the current confluence. This is likely to change sediment transport processes (including erosion and deposition) within Yorks Creek and the section of Bowmans Creek immediately downstream of the new confluence. The proponent should consider lengthening the hydraulic path and incorporating meanders in the diversion to more closely replicate hydraulic environments and flow velocities of the current creek. The proponent also needs to assess how the altered location of the confluence will impact flow and sediment processes, flow volumes and fish habitat in Bowmans Creek, especially immediately downstream.
 - c. A shorter stream length will also reduce available aquatic habitat and may affect the formation of instream habitats such as pools and riffles. Aquatic biota (including fish) in Yorks Creek should be sampled during periods of flow and in refugial pools to provide baseline data against which to compare changes in community composition resulting from altered habitat in the diverted section. The EIS should explain how the diversion will affect the ecological function of Yorks Creek and propose mitigation and management measures to ensure the establishment and maintenance of ecological function in the new channel (e.g. White et al. 2014).
 - d. Diversion of Yorks Creek is likely to result in disconnection from its alluvium, with repercussions for associated GDEs (see Paragraphs 22 and 23) and in-stream ecological function supported by exchanges of surface water and groundwater from the alluvium. To reduce these impacts, the proponent should consider including alluvial material below and along the diversion to help establish a new alluvial corridor along the diversion.
 - e. Similarly, ecological continuity along the riparian corridor of Yorks Creek will be disrupted by the diversion. The riparian corridors present at the project site are likely to provide important habitat and refuges for native flora and fauna that would be valuable during rehabilitation as a source of plant and animal colonists. To minimise impacts, riparian vegetation should be established as rapidly as possible along the diversion and should be connected with existing riparian zone vegetation upstream and downstream to enhance ecological connectivity along the corridor and improve the other contributions of riparian zone vegetation to ecological function in the diverted channel.
 - f. Information on current shear stresses and rates, volumes and timings of flows in Yorks Creek and those expected in the diverted channel are required for assessment of likely changes. Previous diversions at the Mount Owen Complex may have resulted in large changes to these characteristics (Glencore 2019b, pp. 18-19) but the impacts of these are unclear.
15. Flood modelling for the project is needed in the EIS. This modelling should:
- a. explicitly consider the proposed Glendell void over a range of flood exceedance probabilities up to and including the Probable Maximum Flood (PMF) as previous flood modelling has not done this (Glencore 2019a, p. 18). This is needed to understand potential impacts posed by the final void to both flooding characteristics and water quality;
 - b. include the proposed diversion so that changes in flood levels and velocities that occur as a result of the diversion can be assessed;
 - c. determine the likelihood of uncontrolled discharges from each water storage and identify if controlled discharge will be required from any of them under any of the examined rainfall and flood runoff scenarios. If any potential discharge is identified, then the receiving environment and

- potential impacts should be described, along with appropriate management and mitigation measures; and
- d. include the realignment of Hebden Road and the proposed MIA to assess how these may be impacted by flooding and how these structures may alter flood behaviour.
16. An assessment of the potential changes to flow regimes of all creeks that may be impacted by the project is needed in the EIS. This assessment should include data on the baseline flow regime and analysis of how these will be altered due to the project. This analysis needs to be undertaken using data collected at a suitable temporal scale to understand the seasonality of ecologically important flow components (e.g. low flows, durations of zero-flow periods). These data are needed to inform selection of mitigation options and development of monitoring and management plans. These data should also be used by the proponent to support conclusions on the likelihood and significance of potential impacts.
 17. The proponent needs to provide a comprehensive assessment of surface water quality that incorporates all existing monitoring data. These data are needed to establish the baseline condition of creeks that could be impacted by the project, to inform selection of mitigation options and to assist development of monitoring and management plans.
 18. Updated schematics for the water management system (WMS) are required. These schematics should clearly show how the project and any additional water management infrastructure associated with the project will be integrated into the WMS and the GRAWTS. The benefits of the GRAWTS for water and waste management should be presented in more detail. Quantitative information on flows and storage under various management scenarios is needed for the scheme.
 19. A comprehensive water balance is needed for the project. The IESC notes that the proponent has committed to undertake this work in the EIS (Umwelt 2018, p. 89). The proponent should consider using:
 - a. the Minerals Council of Australia – Water Accounting Framework (2014) to identify the uncertainties in the water balance inputs; and
 - b. the water balance as evidence to support their conclusion that no changes to current discharge arrangements will be needed to accommodate the project (Umwelt 2019a, p. 52).
 20. More information on potential North Pit Void water storage is needed to understand potential risks and impacts associated with this storage under current and future climatic conditions. Information provided in the EIS should include a long-term quantitative assessment of:
 - a. the likely water quality in the void and changes over time while it is used as a storage;
 - b. groundwater inflows to the storage and whether the storage will be a sink; and
 - c. the volume of water that may be stored within the North Pit Void.
 21. The proposed monitoring and management program should be detailed in the EIS to enable an assessment of its likely effectiveness. The proponent should:
 - a. provide a summary of any changes or additions to the monitoring network that would be required due to the project;
 - b. determine site-specific guideline values for all water quality analytes (see Huynh and Hobbs 2019). Currently, guideline values have only been determined for pH, EC and total suspended solids (TSS); and

- c. update TARPs to include specifics on the implementation of proposed responses, management options available and timeframes for action and response. Currently, timeframes are only provided for reporting to regulatory authorities.

Groundwater-dependent ecosystems (GDEs)

22. To assess the likelihood and significance of potential impacts of the project on GDEs, the EIS should survey all likely GDEs in the project area. Where groundwater drawdown is predicted, the proponent should assess condition and groundwater dependency of each GDE, use ecohydrological conceptual models to illustrate potential pathways of impacts, describe how GDEs will be monitored to detect impacts and propose appropriate mitigation measures (described in Doody et al. 2019). In particular, the EIS requires a detailed:

- a. assessment of the aquatic biota (e.g. fish, surface and hyporheic invertebrates) in creeks draining the project area due to the high potential for impacts to flow regimes (especially during low flows) caused by groundwater drawdown in the alluvial sediments;
- b. study to identify the locations, basin features and habitat value of semi-permanent and permanent pools that occur in the ephemeral creeks potentially impacted by the project. Aquatic biota (e.g. fish, amphibians and aquatic invertebrates) using the pools should be surveyed to provide a baseline against which to assess effects on pool persistence caused by groundwater drawdown;
- c. assessment of whether platypus (*Ornithorhynchus anatinus*) and EPBC Act-listed species (e.g. green and gold bell frog (*Litoria aurea*), koala (*Phascolactos cinereus*) and spotted-tailed quoll (*Dasyurus maculatus maculatus*)) are using GDEs such as groundwater-dependent vegetation and groundwater-fed pools for habitat and/or food resources. Currently, assessment of potential impacts to EPBC Act-listed species focuses on direct clearing of habitat whereas other impact-pathways may also be relevant;
- d. assessment of the baseline condition of alluvial and riparian vegetation and its dependence on groundwater. Riparian zones are likely to be key wildlife corridors (see Paragraphs 14d and 14e) providing organic matter and shading to the creeks, crucial habitat and dispersal pathways for terrestrial fauna, and sources of seeds and detritus;
- e. hyporheos and stygofauna assessment. Stygofauna and hyporheic invertebrates (hyporheos) are reported by the proponent to have been previously found in the Yorks Creek alluvium (EPBC Act Referral 2019, p. 27). This alluvium will be disconnected from Yorks Creek when it is diverted, with some of the alluvium removed due to the pit expansion. There may also be groundwater drawdown in the alluvial corridors of other creeks where stygofauna have also been recorded (e.g. Swamp and Glennies Creek (Referral 2019, p. 27)). Baseline data on hyporheos and stygofauna community composition in all potentially affected creeks in the project area are required to determine the significance of these impacts and to inform the development of potential mitigation and management options; and
- f. analysis that clearly identifies and maps the locations of potential terrestrial GDEs overlain with contour-maps showing predicted changes in depths to groundwater. It would also be useful to map areas of potential terrestrial GDEs that may be impacted by the project as well as those impacted by already approved projects.

23. Proposed monitoring and management measures for GDEs need to be outlined in the EIS. These measures and plans should include:

- a. TARPs which incorporate specific details of the implementation of proposed responses, management options available, their likely effectiveness, timeframes for action and response; and

- b. additional creek diversion performance criteria (e.g. White et al. 2014) that specifically consider establishment and success of local native species and inclusion of alluvial sediments along and below the diverted channel to simulate current hyporheic corridors and subsurface flowpaths.

Geochemistry

24. In the EIS, the proponent should undertake and provide data for a geochemical assessment specific to the Glendell Pit area to confirm their current claims that waste rock will not require specific management (Glencore 2019b, p. 21). The geochemical assessment should also include an assessment of the salinity of waste material and consider potentially acid sulfate soils. If either of these are identified at the project site, then a management plan would be needed.
25. Further evidence is needed to support the current conclusions that there is sufficient existing capacity for the additional waste rock, tailings and rejects that will be generated due to the project (Umwelt 2019a, p. 29).
26. Monitoring and management plans should be updated to explicitly incorporate the project. During these updates, consideration is needed of whether the existing monitoring bore network will require changes (e.g. to integrate any changes that may arise to the location of waste material storages).

Final void and landforms

27. The EIS needs to include analysis of the evolution of salinity and water level in the pit void lake. This information is key for understanding the potential risks posed by the void should it spill or leach. The analysis should use relevant predictions from the project's surface water and groundwater modelling. It should also consider how the multiple voids that will remain across the Mount Owen Complex are likely to interact, especially through groundwater flowpaths (including in the alluvial sediments).
28. The EIS needs to include further details on the proposed final landform and planned rehabilitation. When developing options for the project area, consideration of the limitations of site soils is required. Sodosols are the most common soil type at the project site, and the proponent notes that these Sodosols can have high sodicity and a tendency for dispersion/erosion (Umwelt 2019a, App. A, p. 16). These soil properties have implications for erosion, stability and revegetation potential for the final landforms, and should be discussed in detail.
29. As progressive rehabilitation is occurring at the Mount Owen Complex, the IESC suggests that the proponent provides monitoring data collected from already rehabilitated areas to support proposed plans. These data can be used as evidence of the likelihood of success.

Cumulative impacts

30. Given the parent company of the proponent, Glencore, controls a number of the adjacent mines through subsidiaries and joint venture arrangements, there is considerable scope for broad-scale management as has been shown by the GRAWTS. There is an opportunity for this collective management to address cumulative impacts on surface water hydrology, water quality and aquatic and riparian biota, not just groundwater. The IESC suggests that a comprehensive assessment of cumulative impacts be undertaken at the regional level to inform the development of mitigation options and management plans at an appropriate broad (landscape) scale. This would ensure, for example, that existing offsets such as the one adjacent to Bettys Creek are managed to minimise impacts from subsequent changes to mining operations in the region.
31. The IESC notes that the proponent has committed to investigating potential cumulative impacts further in the EIS through the groundwater model (EPBC Act Referral 2019, p. 26). This assessment should consider the rate of recovery of groundwater levels and saturation of alluvial material in addition to impacts from groundwater drawdown and the interactions of multiple final voids as this will

provide information on the persistence of impacts. The potential sensitivity of these results to operational changes at other nearby mines should also be reported.

Risk assessment

32. The current risk assessment for the project is noted to be a preliminary assessment. When this assessment is updated for the EIS, the IESC suggests:
- a. the assessment includes a greater level of specificity and prioritises the materiality of the risks. The currently assessed risks are general and include multiple risks or pathways. Each individual risk and pathway should be assessed and justified with reference to conceptual models or supporting data, and associated with corresponding mitigation and management options; and
 - b. where possible, the risk assessment should be quantitative and include analyses of likely local short-term and regional long-term cumulative impacts and their planned mitigation (considering the potential for shared data and collective rehabilitation strategies across the mining operations in the region see Paragraph 30).

Date of advice	24 June 2019
Source documentation provided to the IESC for the formulation of this advice	Umwelt 2019a. <i>Gateway Application – Glendell Continued Operations Project</i> . Final April 2019.
References cited within the IESC’s advice	<p>Datry T, Boulton AJ, Bonada N, Fritz K, Leigh C, Sauquet E, Tockner K, Hugueny B and Dahm CN 2018. Flow intermittence and ecosystem services in rivers of the Anthropocene. <i>Journal of Applied Ecology</i> 55(1): 353-364.</p> <p>Department of Natural Resources and Mines (DNRM) 2014. <i>Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000</i>. State of Queensland. Available [online]: https://www.dnrme.qld.gov.au/?a=109113:policy_registry/watercourse-diversions-water-act.pdf&ver=2.00 accessed June 2019.</p> <p>Doody TM, Hancock PJ, Pritchard JL 2019. Information Guidelines explanatory note: Assessing groundwater-dependent ecosystems. Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia.</p> <p>EPBC Act Referral 2019. <i>Glendell Continued Operations Project EPBC Act Referral. Submission #3982</i>. Available [online]: http://epbcnotices.environment.gov.au/referralslist/ (referral number 2019/8409) accessed June 2019.</p> <p>Glencore 2018. <i>Water Management Plan</i>. Version 9.1 effective 22/11/2018. Available [online]: http://www.mtowncomplex.com.au/en/environment/Pages/plans-programs.aspx accessed June 2019.</p> <p>Glencore 2019a. <i>Groundwater monitoring and management plan</i>. Version 2.0 effective 01/03/2019. Available [online]: http://www.mtowncomplex.com.au/en/environment/Pages/plans-programs.aspx accessed June 2019.</p> <p>Glencore 2019b. <i>Surface water monitoring and management plan</i>. Version 2.0 effective 01/03/2019. Available [online]: http://www.mtowncomplex.com.au/en/environment/Pages/plans-programs.aspx accessed June 2019.</p>

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