

Advice to decision maker on coal mining project

IESC 2023-146: Vulcan Coal Mine – Matilda Pit and Ancillary Infrastructure Project (EPBC 2022/09361) – Expansion

Requesting agency	The Australian Government Department of Climate Change, Energy, the Environment and Water
Date of request	3 November 2023
Date request accepted	6 November 2023
Advice stage	Assessment

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 Australian Government Department of Climate Change, Energy, the Environment and Water to provide advice on the Queensland Coking Coal Pty Ltd's Vulcan Coal Mine – Matilda Pit and Ancillary Infrastructure Project in Queensland. 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 Vulcan Coal Mine Matilda Pit and Ancillary Infrastructure Project (the 'project') is a proposed expansion of the Vulcan Coal Mine Complex located in the Bowen Basin in Queensland. The project includes development of a new open-cut pit (Matilda Pit), construction of a coal handling and preparation plant (CHPP), a rail loop and a train loadout facility, on-site disposal of waste rock and tailings, alteration of the existing water management system and clearing of 93.3 ha of vegetation (METserve 2023, Table 2-1, pp. 2-3).

The Matilda Pit is to be approximately 900 m long, 550 m wide and up to 40 m deep (METserve 2023, Figure 2-2, p. 6 and 8) and will be mined until the end of 2025 (METserve 2023, p. 7). The project lies in

an area of substantial coal mining activity, next to the Saraji and Peak Downs coal mines. Coal mining has been occurring in this area since the 1970s (hydrogeologist.com.au 2022, p. 20). Considerable drawdown of groundwater, clearing of vegetation and impacts to surface waters through diversions and releases of mine-affected water (MAW) are presumed to have already occurred within the region.

The extent and magnitude of the impacts arising from this project, including contributions to cumulative impacts, cannot be clearly identified from the documentation provided. Although the proponent has compiled a detailed review of existing impact assessments for other mines operating in the region, the documentation lacks current, ground-truthed, site-specific data on many components of the existing environment (as outlined in the responses to the regulator's questions in this advice). The lack of such data means that relevant modelling and conclusions derived from the impact assessment are not adequately supported to justify the proponent's assertion that impacts arising from the project will be limited and require little to no management.

Potential impacts from this project are:

- clearing of vegetation, reducing remaining biodiversity and habitat availability in an already largely cleared landscape;
- groundwater drawdown from mining operations that may affect groundwater-dependent ecosystems (GDEs) and other third-party users;
- changes to surface water quality due to discharges from sediment dams or overtopping of MAW storages;
- diversion of headwater streams that may reduce aquatic habitat, change sediment regimes and movement, disrupt riparian continuity and possibly alter local flooding regimes; and
- legacy effects from waste rock dumps and the final landform on water resources, such as localised erosion of sodic soils.

Due to the limited baseline and field-verified data provided, the IESC has identified additional work needed to provide sufficient context and inform modelling to assess key potential impacts. This work is required to convincingly demonstrate that the potential impacts identified above will either not occur or can be adequately mitigated.

- Collection of additional, up-to-date, site-specific field data that will enable clear identification of potential impact pathways and which receptors in and near the project area may be affected. This should include:
 - measuring groundwater levels and water quality to enable improved characterisation of the groundwater system, particularly in riparian zones and low-lying parts of the landscape;
 - surveying and mapping of riparian vegetation occurrence, condition and dependence on groundwater;
 - field-sampling of potential subsurface GDEs, especially in areas where mining-related changes in groundwater levels and water quality are predicted; and
 - using the data to develop an ecohydrological conceptual model to derive one or more impact pathway diagrams to illustrate how and where the project may impact water resources, help validate proposed monitoring programs and support development of management plans.

- Provision of further information on the groundwater modelling and impact assessment, including:
 - discussion of the groundwater model (e.g., its design, parameterisation and calibration), including details of representation of the project area;
 - validation of the groundwater model with recent monitoring data for groundwater levels and mine inflows in and close to the project area;
 - potential updating of the model; and
 - uncertainty analysis.
- Provision of information on the layout, form and design principles for the proposed headwater stream and drainage diversions.
- Provision of further information on the water balance modelling to verify the proponent's assumptions and conclusions on impacts.
- Clarification of how water quality objectives for both surface and ground waters have been derived and how they will be applied.
- Clarification of the final landform to understand and assess risks (e.g., erosion).
- Provision and justification of detailed monitoring and management plans, which should be developed where appropriate once the additional baseline data have been obtained and the impact assessment refined.
- Provision of evidence and modelling to better estimate the cumulative impacts of this project and adjacent mining on groundwater, surface water (including water quality) and ecological receptors in the project area and downstream.

Context

Queensland Coking Coal Pty Ltd's Vulcan Coal Mine Matilda Pit and Ancillary Infrastructure Project (the 'project') is located approximately 35 km south-south-east of Moranbah and 35 km north-north-west of Dysart in central Queensland. The project will expand mining at the Vulcan Coal Mine Complex through development of the Matilda Pit, allowing extraction of additional coking and thermal coal. The volume of coal to be extracted from the proposed Matilda Pit, and overall from the Vulcan Coal Mine Complex, is not clearly quantified in the project documentation.

The project will include the development of significant additional infrastructure in the project area, including the CHPP, rail loop and train loadout facilities. Coal processing will now occur on-site, meaning that tailings material will be disposed of on-site. The presence of this material will create an additional potential source of contaminants, which could enter the groundwater or surface waters, that was not part of the previous approval (EPBC 2020/8676). While there will be no residual final voids, the project will result in an additional waste rock dump when the Matilda Pit is backfilled.

The project is located within the headwaters of Boomerang Creek, a tributary of the Isaac River, part of the Fitzroy Catchment. Watercourses in the project area are ephemeral with no alluvium mapped in the project area (hydrogeologist.com.au, Figure 2.1, p. 8). The project will seemingly require diversion of approximately 3 river-km of three different watercourses (WRM 2022b, Figure 4.3, p. 36 and p. 37 and 57), although these diversions were poorly described in the documentation. Additionally, there will be some alterations of existing diversions and water management infrastructure (METserve 2023, Table 2-1, pp. 2-3) but detailed plans of these were not provided. Many of the watercourses downstream of the

project area have already been diverted by neighbouring mines and receive MAW discharges under various Queensland Environmental Authorities.

Six *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)-listed species have been identified in the project area (METserve 2022, p. 68): Koala (*Phascolarctos cinereus*), Greater Glider (*Petauroides volans*), Squatter Pigeon (*Geophaps scripta scripta*), White-throated Needletail (*Hirundapus caudacutus*), Glossy Black-cockatoo (*Calyptorhynchus lathami*) and Rufous Fantail (*Rhipidura rufifrons*). The Koala and Greater Glider are likely to use remnant riparian vegetation in the project area. However, details on this vegetation, its extent, condition, potential groundwater dependence and the amount to be cleared were not provided.

Response to questions

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

Question 1: Can the Committee provide comment on whether the information provided in the PD, particularly the baseline and modelled data, and the conclusions drawn by the proponent, are sufficient to assess the proposed action's impacts to surface and ground water resources, GDEs and other third party users, and cumulative impacts with other proposed and existing projects?

Question 2: Can the Committee identify and discuss what additional information is required to enable the assessment of impacts on surface and ground water resources?

1. Responses to Questions 1 and 2 have been combined to reduce repetition. The following paragraphs comment on the adequacy of the Preliminary Documentation's (PD's) information to assess the proposed action's individual and cumulative impacts to surface and ground water resources, and describe additional information and data required to address relevant knowledge gaps.
2. The impact assessments in the PD relied primarily on desktop analyses, summaries of previous impact assessments for other projects in the region, and remote data gathering approaches. Although these analyses and approaches are important components of an impact assessment, they need to be supplemented with site-specific fieldwork to enable adequate baseline characterisation and validation of modelling to ensure conclusions are evidence-based. Such fieldwork also needs to be recently undertaken so that the baseline data reliably represent current conditions. The lack of current, ground-truthed, site-specific data means that the impact assessments and conclusions in the PD are inadequately supported, hindering reliable determination of the extent and magnitude of specific and cumulative impacts of the project. Specific issues with the impact assessment and the additional information required to address these are discussed further in Paragraphs 3-19 below.

Groundwater

3. Limited baseline data for groundwater levels and quality have been collected for the project, partly because many of the bores located within the project area are dry. Further data, including from unimpacted reference sites, are needed to characterise the baseline conditions of the groundwater system in the project area prior to mining commencing. Without these data, it will be difficult during operations to identify impacts and determine whether they exceed natural variability. The proponent should also consider developing a data-sharing arrangement with nearby landholders (hydrogeologist.com.au 2022, p. 78) to increase the data available to calibrate groundwater modelling and verify groundwater impact predictions.
4. The PD does not provide suitable information about the hydrogeology of the site such as interburden properties, faulting and the occurrence of paleochannels (hydrogeologist.com.au 2022, p. 26) which could influence groundwater flow. Therefore, further information based on field investigations is needed to more fully characterise the hydrogeology of the project area.

5. The groundwater model used to predict impacts from the project is not fully described in the PD. The existing model used for the previous Vulcan Coal Mine Complex referral was updated to include the project and a summary of the model was provided (hydrogeologist.com.au 2022, p. 62). The provided summary and groundwater modelling are insufficient because:
 - a. while the conceptualisation of the groundwater system is discussed (hydrogeologist.com.au 2022, pp. 37-44), it is unclear if the construction of the numerical groundwater model is consistent with this conceptualisation. Consequently, it cannot be determined if the numerical groundwater model adequately represents the groundwater system in the project area, and hence if the impact predictions are valid.
 - b. parameterisation of the existing model was not clearly discussed, so it is uncertain if key parameters such as hydraulic conductivity, storage parameters and conductance applied to river cells are representative of the project area, and hence if impact predictions are reasonable.
 - c. calibration of the existing model was not fully discussed, with no hydrographs of observed versus modelled groundwater levels provided, and no analysis of spatial trends in calibration residuals supplied. This means that the adequacy of the model calibration is unclear, further limiting confidence in impact predictions, particularly when limited uncertainty analysis was undertaken.
 - d. the calibration documentation provided does not demonstrate that the model adequately simulates cumulative impacts. The proponent should provide modelled and calibrated outputs for both regional and project-specific drawdown so that potential ecological impacts can be more reliably inferred.
 - e. no validation of the existing groundwater model was discussed. Given the existing groundwater model does not appear to have been recalibrated following the changes to implement the project, validation of the impact predictions from this model, using monitoring data collected since its last calibration for both groundwater levels and mine inflows, should have occurred to increase confidence in the model predictions.
 - f. there is no discussion of how the existing model was updated to incorporate the project, including excavation of the Matilda Pit, changes to waste rock dumps and changes to the existing Jupiter Pit. Without this information, there is limited confidence in the proponent's conclusions on the extent and magnitude of predicted impacts.
 - g. proposed model updates and validation of modelled predictions with monitoring data will not occur during the life of Matilda Pit as these are to happen once every two to three years (hydrogeologist.com.au 2022, pp. 77-78).
 - h. a peer review of the groundwater model should be undertaken following the *Australian Groundwater Modelling Guidelines* (Barnett et al. 2012).
6. A scenario analysis with subjective probability (Peeters and Middlemis 2023) was provided, examining hydraulic conductivity (plus one order of magnitude) and storage parameters (minus one order of magnitude) in isolation (hydrogeologist.com.au 2022, p. 70). This should be expanded into more rigorous sensitivity and uncertainty analyses once potentially impacted receptors have been identified and Paragraphs 3, 4 and 5a to 5f have been addressed. This will clarify understanding of likely project-specific impacts.
7. A single map of predicted drawdown was provided (hydrogeologist.com.au 2022, Figure 6-5, p. 69), with the proponent assuming that maximum drawdown would occur at the maximum extent of mining (METserve 2023, Table 4-6, p. 79).

- a. The assumption of the timing of maximum drawdown was not supported. As groundwater drawdown typically lags behind its cause, predictive groundwater modelling should be conducted for a period beyond the end of mining to identify when maximum drawdown will occur and when recovery of groundwater levels will reach quasi-equilibrium. This modelling is needed to understand the potential long-term impacts of the project and if, and how, the groundwater system will recover.
 - b. Post-mining modelling is also required to support the conclusion that any contaminant release by the waste rock will ultimately be captured in the void lakes of Saraji and/or Peak Downs mines. This modelling will require the back-filled pits (in-pit waste rock dumps) to be implemented in the model and appropriately parameterised.
 - c. The groundwater impact assessment provided no results for cumulative impacts. Given that there are likely extensive impacts that have occurred and continue to occur in the region, modelling is needed to understand the contribution of the project to these cumulative impacts and to explore whether the project-specific impacts may be causing thresholds in natural systems to be exceeded (e.g., whether the project's contribution to groundwater drawdown in a specific area means that the water table becomes too deep for terrestrial GDEs to access).
8. The Water Quality Objectives (WQOs) proposed are not clearly discussed for either groundwater or surface water. The proponent needs to clearly identify the sources of the proposed guideline values, how they were derived, and the reference site data used to derive the site-specific guideline values.

Surface water

9. It is stated that Drainage Line 1 (WRM 2022b, p. 37) and two other headwater streams will be diverted as part of the project to allow access to the underlying coal. No information is provided on the proposed general arrangement and impacts of these diversions nor on the hydraulic and ecohydrological principles that will be used in their design. This information is needed to assess the impacts on surface water resources.
10. The water balance indicates a negative deficit and that operations will require an external water source (WRM 2022b, p. 78). The proponent states that one source of water will be wastewater from the nearby Peak Downs Mine (WRM 2022b, Table 6.4, p. 67), but the potential impacts and necessary management measures for transfer and handling of this water are not discussed. The proponent should provide this information for this water source as well as any others that are likely to be used.
11. Although the Australian Water Balance Model (AWBM) used has been calibrated to Phillips Creek (WRM 2022b, p. 66), information on the efficacy of this calibration should be provided.
12. Additional site-specific field data and information are needed to assess and quantify impacts on water resources, including:
- a. water quality monitoring of unimpacted reference sites, as the proposed water quality baseline is currently derived from only seven sampling events across a two-year period (WRM 2022b, p. 48). This is not sufficient to characterise the natural variability of the background surface water system.
 - b. discussion of the water quality of any potential controlled or uncontrolled releases from the 16 proposed sediment dams or 6 MAW dams. Potential release water quality and the likely water quality in these storage dams requires discussion and ongoing characterisation to ensure that any potential impacts are understood and mitigated.

Ecology

13. The PD's assessment of potential impacts to GDEs included minimal field validation of their occurrence and condition. Although aquatic GDEs are unlikely given the ephemeral nature of the surface water systems in the project area, there are likely to be subsurface and terrestrial GDEs that may be affected by changes in groundwater levels and water quality associated with the individual and cumulative effects of the project.
 - a. The proponent does not appear to have sampled stygofauna in the area of predicted drawdown and nearby reference sites. Although stygofauna biodiversity typically declines with increasing electrical conductivity (EC), groundwater invertebrates have been collected from Queensland groundwaters (Glanville *et al.* 2016) within the range of EC (ca. 3000-23,000 $\mu\text{S}/\text{cm}$, Table 5-11, hydrogeologist.com.au 2022, p. 53) reported from bores in the project area. As recommended in the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITI 2015), the proponent should conduct a pilot study to ascertain whether stygofauna occur in the project area and, if so, what impacts might arise from the project and how might they be prevented or mitigated.
 - b. Assessment of potential terrestrial GDEs was primarily completed through a desktop analysis comparing estimated depth to the water table with field-verified regional ecosystem mapping (hydrogeologist.com.au 2022, pp. 47-48). The data used to generate the map of estimated water table depth were spatially and temporally limited. There is no evidence that the mapping has been validated, especially in low-lying parts of the landscape where GDEs are more likely to occur. As such, the proponent's conclusions that there are no valid terrestrial GDEs within the maximum drawdown zone and that impacts on GDEs are highly unlikely (hydrogeologist.com.au 2022, p. 72) are not supported with sufficient evidence. Further field work to verify the depth to groundwater is needed, particularly in areas where the mapping suggests this could be less than 10 m from the surface such as the existing riparian corridors to the north and west of Matilda Pit (see Figure 5.9, hydrogeologist.com.au 2022, p. 51). The proponent should assess potential groundwater-dependence (e.g., with methods described in Doody *et al.* 2019) of vegetation overlying these areas where depth to groundwater is less than 10 m from the surface, especially where drawdown is predicted.
14. Ecological surveys were conducted during 2018 and 2019 (METserve 2022, p. 7 and 9) prior to referral of the approved Vulcan Coal Mine Complex. These surveys are now 4 to 5 years old, and information about vegetation structure may not represent current conditions. The proponent should update the field surveys, particularly in relation to vegetation condition and structure, focusing on regional ecosystems that are endangered or of concern, and riparian vegetation and other potential GDEs. These baseline data on riparian vegetation and any terrestrial GDEs (Paragraph 13b) should be used to assess potential impacts of project-related activities (e.g., channel diversions, groundwater drawdown, habitat fragmentation through clearing) so that suitable avoidance and mitigation strategies can be developed.
15. The proponent plans to clear 93.3 ha (METserve 2022, Table 5-4, p. 82) for the project. Habitat suitability for EPBC Act-listed species may have changed since the last surveys (described in Paragraph 14) were completed. Further field surveys are required to fully assess the impact of vegetation clearance on the habitat of EPBC Act-listed species (i.e., Koala, Greater Glider, Squatter Pigeon, White-throated Needle-tail, Glossy Black-cockatoo and Rufous Fantail). These would also allow potential impacts to be put in the context of ongoing changes occurring from the approved Vulcan Coal Mine Complex.
16. These baseline hydrological and ecological field data (Paragraphs 3-4 and 13-15) should be incorporated into an evidence-based ecohydrological conceptual model to derive one or more potential impact pathway diagrams for the project area. These diagrams can be used to support

conclusions about potential impacts and the likely responses of water resources and other receptors. They also help guide development of targeted monitoring, mitigation and management plans to detect and reduce any potential impacts.

Geochemistry

17. The geochemical assessment identified some potential issues with waste rock material that require further discussion, including the following.
- a. Testing of coal reject material has indicated a potential for leaching of aluminium, arsenic, cadmium, copper, manganese, nickel and zinc (RGS 2022, p. 32). It does not appear that current surface water and groundwater quality monitoring is sampling all these potential contaminants, or that proposed receiving water trigger values will be derived for all these contaminants (e.g., WRM 2022b, Table 4.5, p. 52). Baseline data and continued monitoring are needed for these contaminants to ensure the natural variability is adequately characterised prior to potential impacts occurring. In addition, as the potential bioavailability of any metal contaminants will depend on their chemical speciation and water chemistry, both total and dissolved metals, as well as water hardness, alkalinity and dissolved organic carbon, should be included in the monitoring suite.
 - b. Two coal samples were analysed providing differing results, with one of these samples possibly a Potentially Acid-Forming (PAF) material (RGS 2022, Table 3-4, p. 29). Further analysis of coal samples should be undertaken to determine what portion of the tailings material is likely to be PAF. Additionally, the potential volume of coal reject material, which has also been identified as containing PAF, should be quantified. It is important to have a clear understanding of the volumes of PAF material requiring management to fully assess potential impacts.

Final landform

18. Detailed plans for the rehabilitated landscape have not been developed (WRM 2022a, p. 8). The project will result in additional waste rock material and tailings requiring long-term disposal on-site. Further information about the final landform is needed to ensure that risks are adequately assessed.
- a. Analysis of soils occurring in the project area identified that the Limpopo soil management unit (SMU) was widespread (AARC 2021, Figure 3, p. 24) and is likely to be the main source of material for rehabilitation of the landscape. Potentially severe limitations on the use of the Limpopo SMU subsoil were identified as this material is sodic and dispersive which could result in susceptibility to erosion and sedimentation of the surface water system (AARC 2021, p. 83). More specific information is required to understand how much of this subsoil may be used, if it will be handled appropriately and what measures will be in place to prevent or rectify adverse impacts arising from its exposure.
 - b. The proponent is commended for undertaking landform evolution modelling which was used to identify the erosion risk of the potential final landform under a range of cover scenarios. This work provided generalised results indicating that 30% rock mulching and at least 70% vegetation cover would be required to ensure long-term stability (WRM 2022a, Table 3.1, p. 16). Establishment of 70% vegetation cover will require time and continued management, and it was noted that there would be some time initially where the risk of erosion would be considerably greater (WRM 2022a, p. 26). To understand the full potential for impacts, further information is needed on the expected timeframe during which the erosion risk will be heightened and how this risk will be managed and minimised.
 - c. Active management (e.g., water and sediment management) of the final landform will need to continue for many years after the proposed end date of this project (31 December 2025), and potentially beyond the end of the current approval for the Vulcan Coal Mine Complex

(31 December 2045) to ensure that the final landform is stable and non-polluting. Further detailed information is required on monitoring and management of the final landform and potential receptors for contaminants (such as surface water and groundwater systems) to enable assessment of potential impacts from the proposed final landform. This information needs to include post-closure groundwater modelling as discussed in Paragraph 7.

19. Given that rainfall intensities likely to cause erosion are projected to increase by around 15% per degree Celsius of global warming (Wasko *et al.* 2023), any assessment of erosion of the final landform must acknowledge how these changes will affect its performance over the long term.

Question 3: Can the Committee provide comment on the adequacy of the proposed mitigation, management and monitoring measures? Does the Committee consider that any additional measures are needed to remain within the projected levels of impact or sufficiently reduce the risks to surface and ground water resources, GDEs and other third party users considering project impacts alone as well as cumulative impacts with other proposed and existing projects?

20. The proponent has not provided monitoring, mitigation and management plans in sufficient detail as they have generally concluded that the project will have few impacts to water resources (e.g., METserve 2023, p. 75). As outlined in this advice, those conclusions are based on limited data, information and modelling and hence are not adequately supported. The proponent has also not clearly identified potential impacts or proposed likely impact pathways. Without this information, the IESC cannot comment on the adequacy of proposed mitigation, management and monitoring plans. When the information gaps identified in this advice are addressed, monitoring, mitigation and management will require further detailed consideration and suitable plans developed.

Date of advice	14 December 2023
Source documentation provided to the IESC for the formulation of this advice	METserve 2023. <i>Preliminary documentation. EPBC 2022/09361 for Vitrinite Pty Ltd. 01/11/2023.</i> (Including appendices A-L).
References cited within the IESC's advice	<p>AARC 2021. <i>Vulcan Complex Project. Soil and land suitability assessment. Prepared for METSERVE Pty Ltd. April 2021.</i> (Appendix J of PD).</p> <p>Barnett B, Towley LR, Post V, Evans RE, Hunt RJ, Peeters L, Richardson S, Werner AD, Knapton A and Boronkay A 2012. <i>Australian groundwater modelling guidelines. June 2012.</i> Available [online]: Groundwater Modelling Guideline (katalyst.com.au) Accessed 14 December 2023.</p> <p>Doody TM, Hancock PJ, Pritchard JL 2019. <i>Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems.</i> 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 2019. Available [online]: Information Guidelines Explanatory Note - Assessing groundwater-dependent ecosystems iesc Accessed 14 December 2023.</p> <p>DSITI 2015. <i>Guideline for the environmental assessment of subterranean aquatic fauna.</i> Department of Science, Information Technology and Innovation, Queensland Government. Available [online]:</p>

<https://www.publications.qld.gov.au/dataset/subterranean-aquatic-fauna/resource/ba880910-5117-433a-b90d-2c131874a8e6> Accessed 14 December 2023.

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Wasko C, Westra S, Nathan R, Pepler A, Raupach T, Dowdy A, Johnson F, Ho M, McInnes K, Jakob D, Evans J, Villarini G, and Fowler H 2023. A systematic review of climate change science relevant to Australian design flood estimation. *Hydrology and Earth Systems Sciences Discussions* [preprint], <https://doi.org/10.5194/hess-2023-232>, in review.

WRM 2022a. *Vulcan Coal Mine. Landform evolution modelling study. Vitrinite Pty Ltd. 1571-21-B2, 2 December 2022*. (Appendix C of PD).

WRM 2022b. *Vulcan Coal Mine. EA amendment. Surface water assessment. Vitrinite Pty Ltd. 1571-22-B3, 19 September 2022*. (Appendix I of PD).
