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Valhalla Gas Exploration and Appraisal Program
Select RFI Responses by INTERA Geosciences Pty Ltd

Original items are in blue; responses are in black.

17) The Information Guidelines developed by the IESC, outline the information considered necessary to enable the IESC to provide robust scientific advice to government regulators on the water-related impacts of unconventional gas and large coal mining development proposals. Demonstrate how the information provided in the referral and associated documentation is consistent with the following documents:

a) Information guidelines for proponents preparing coal seam gas and large coal mining development proposals (Information guidelines for proponents preparing coal seam gas and large coal mining development proposals)

A cross-reference of the IESC Guidelines against Proposal documentation has been completed to assist both DCCEEW and the IESC in identifying where and how BNR has addressed the guideline requirements (refer to Attachment A Valhalla IESC Guidelines Cross-Reference Table). BNR recommends that this table be reviewed by the IESC alongside the Preliminary Documentation.

b) Information Guidelines Explanatory Note: Uncertainty analysis for groundwater modelling (Information Guidelines Explanatory Note - Uncertainty analysis for groundwater modelling | iesc)

The Information Guidelines for applying uncertainty analysis (UA) to groundwater modelling, as referenced under item 17(b), specifically address groundwater modelling related to the development of coal seam gas (CSG) and large coal mining (LCM) development projects. The subject of the DCCEEW RFI (i.e., the Valhalla Gas Exploration and Appraisal Program) is a proposal for an unconventional gas development rather than a CSG or LCM development; therefore, these information guidelines are not directly applicable to the responses presented here. BNR does acknowledge, however, that a general UA approach is applicable to the type of modelling presented in the Valhalla Gas Exploration and Appraisal Program Environmental Review Document (ERD). BNR has therefore developed a quantitative evaluation of the uncertainty associated with the groundwater modelling presented in Appendix L of the Valhalla Gas Exploration and Appraisal Program ERD (the "original model report").

The original model report include predictive simulations that provide a conservative estimate of the potential impacts to aquifer water levels from water abstraction via rig supply bores. The model assumes that each of the proposed 10 exploratory drilling locations (**Figure 17-1**) will contain a single water supply bore that will produce 33.4 ML of water over a 6-month (182 day) period, which equates to a constant pumping rate of 183.52 m^3/d. Drawdowns were evaluated based on a modelled drawdown limit of 0.1 m as this value is much less than the overall ranges of water level variations from shallow bores in the area as presented in Appendix J of the Valhalla ERD.

A summary of relevant aspects of the models presented in the original model report is as follows:

- The modelling presented in the original model report included separate models for the surficial Liveringa aquifer and underlying confined Grant-Poole aquifer system. Since the publication of the original modelling report, Bennett Resources Pty Ltd (BNR, proponent) has pledged to not pursue any water abstraction from the Grant-Poole aquifer system and will instead only pursue abstraction from the Liveringa. As a result, the uncertainty analysis (UA) presented here only evaluates potential impacts to the Liveringa aquifer.

- The pumping stresses from all 10 bore locations were applied simultaneously throughout the same 6-month period. This is an extremely conservative approach as BNR would not reasonably be able to develop more than two exploratory natural gas bores at a time and would therefore not be expected to operate any more than two water abstraction bores at any given time.
- Simulated Liveringa drawdowns presented in the original model indicated very localized drawdowns with a 0.1 m drawdown contour about 400 meters from each individual bore (see **Figure 17-2**). As indicated by Figure 5-3(a) in the original model report, model-calculated drawdowns are less than 1 mm at 700 m from each abstraction bore location. Given that data from bores in the study area as presented in Appendix J of the Valhalla ERD show variations of greater than a meter over the period of record, a modelled variation of 1 mm is a negligible value, which in turn indicates that modelled drawdowns are essentially zero outside of 500-600 m from each bore.
- The implication of the original model results is that with all ten water supply bores pumping at the same time any drawdown to the Liveringa greater than 0.1 m is restricted to a radius of 400 m from each bore. The nearest known GDE (Mount Hardman Creek) to any of the BNR proposed bore sites is approximately 1 km from the Muspelheim site and is therefore well out of the modelled zone of drawdown influence (**Figure 17-3**).
- A sensitivity analysis developed to evaluate the ranges of model outputs associated with variations in the model input parameters (abstraction rate/volume [Q], hydraulic conductivity [K], and specific yield [Sy]) indicates that drawdowns at each individual abstraction bore will be high for high Q and lower values of K and Sy and some variations of those parameters may result in pumping rates that are not sustainable. Modelled drawdowns at existing bores and GDEs for all scenarios are still less than 0.1 m for all scenarios simulated.

To address the requirements of Item 17(b) a stochastic uncertainty analysis was undertaken for the Liveringa model. The uncertainty analysis propagates prior uncertainty of model parameters through the numerical model to provide a prior definition of model output (e.g. drawdown) uncertainty. Parameter uncertainty was expressed at each of 5,412 geostatistically correlated pilot points with 2 km spacing and reflecting the following prior parameter ranges:

- Hydraulic conductivity (K) values for the Liveringa Group formations as presented in Taylor et al. (2021) range from 3.25×10^{-5} to 0.0913 m/d.
- Specific storage (Ss) from 1×10^{-6} to 1×10^{-4} m^{-1}.
- Specific yield (Sy) range from 0.01 to 0.3 representing a typical range of values for unconfined aquifer systems. These compare favourably to the assumed representative total porosity of 0.05 as presented in Taylor et al. (2021).

Figure 17-4 shows the distribution of pilot points relative to the model grid. For each parameter type (K, Ss, Sy), 200 realisations of pilot point parameter values were drawn using Monte Carlo sampling from multivariate Gaussian distributions with the above ranges assumed to represent four standard deviations (in $\log_{10}$-space) and with spatial correlations described by an exponential variogram with an effective range of 18 km. Pilot points were interpolated to provide 200 realisations of model input parameter fields for K, Ss, and Sy. Each parameter realisation was simulated using the numerical model to produce 200 realisations of drawdown. From these, exceedance probability maps were calculated. The map showing the exceedance probability distribution for 0.1 m of drawdown at the end of the 6-month pumping period is shown in **Figure 17-5**. As indicated by Figure 17-5, the areas of the model domain with a non-zero probability of drawdowns exceeding 0.1 m are constrained to within a radius of about 500 m around each of the proposed abstraction bores. **Figure 17-6** shows that radius compared to the modelled drawdowns from the original model as shown in Figures 17-2 and 17-3. As expected, the UA with 200 realizations that incorporate the full prior parameter ranges results in a radius for the 0.1 m drawdown contour that is greater than the contour using a single "average" or "typical" value; however, the radius indicates that the area with a non-zero probability of exceeding 0.1 m is at least 1 km from the nearest GDE.

The prior parameter ranges evaluated in the UA are similar to those evaluated in the sensitivity analysis (SA) presented in the original model report. The results from the UA are consistent with the results presented in the original model report. The SA in the original model report indicated that, for all scenarios, the modelled drawdowns at the GDEs and all known and proposed pastoral bores would be less than 0.1 m. The results of the uncertainty analysis are a negligibly small (essentially zero) probability of any GDE or pastoral bore experiencing greater than 0.1 m of drawdown from the proposed abstraction bores. The SA and UA both indicate that there are scenarios within the prior parameter range that could result in the wells being incapable of sustaining the modelled pumping rates for the simulated 6-month period. This condition did not result in a greater area with a non-zero probability of exceeding 0.1 m of drawdown. This implies that, while this condition could affect BNR's ability to develop their exploration natural gas bores, it would not result in drawdowns that would affect any GDEs or pastoral bores within the project area.

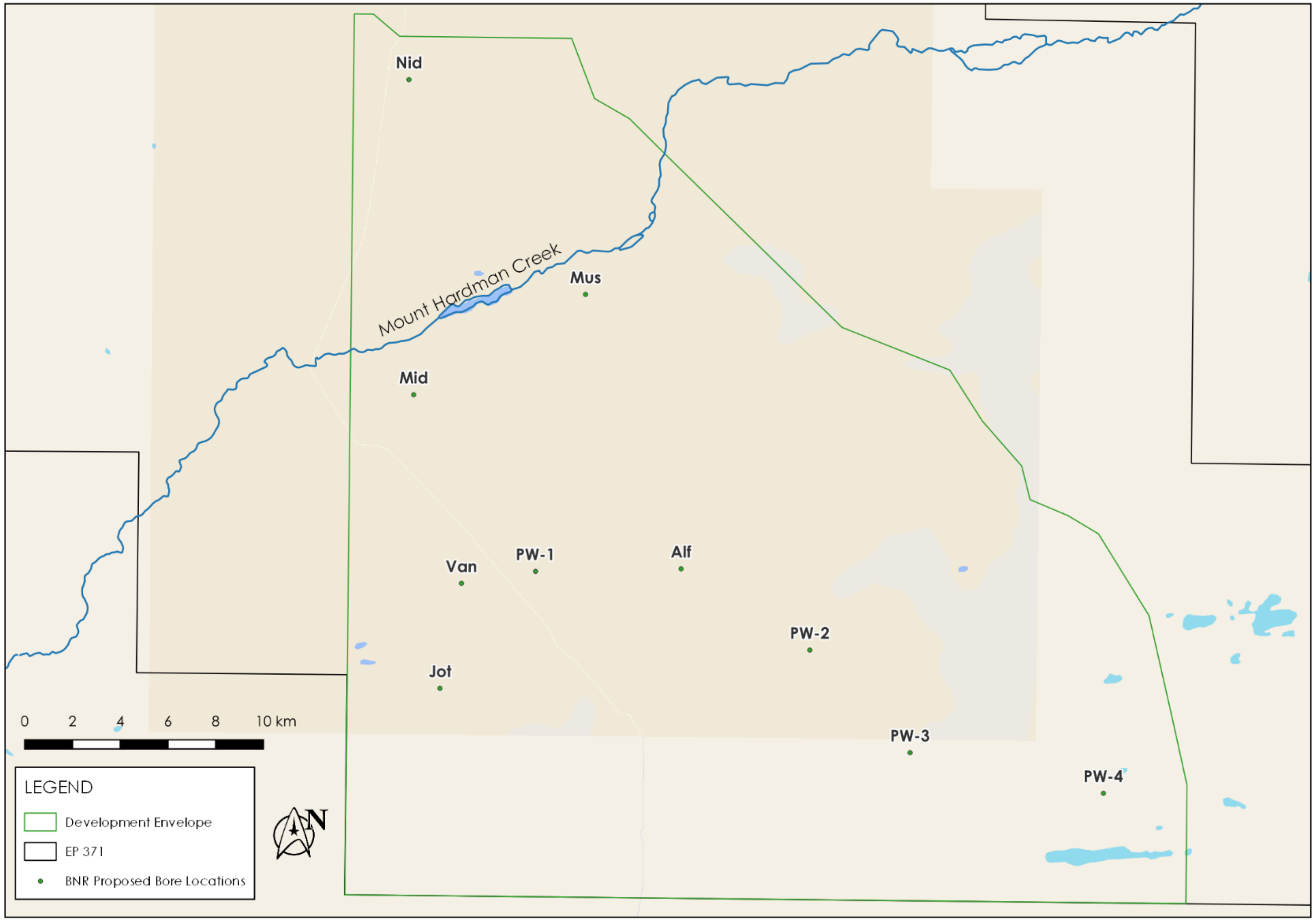

Figure 17-1. Locations of proposed abstraction bores within the development envelope

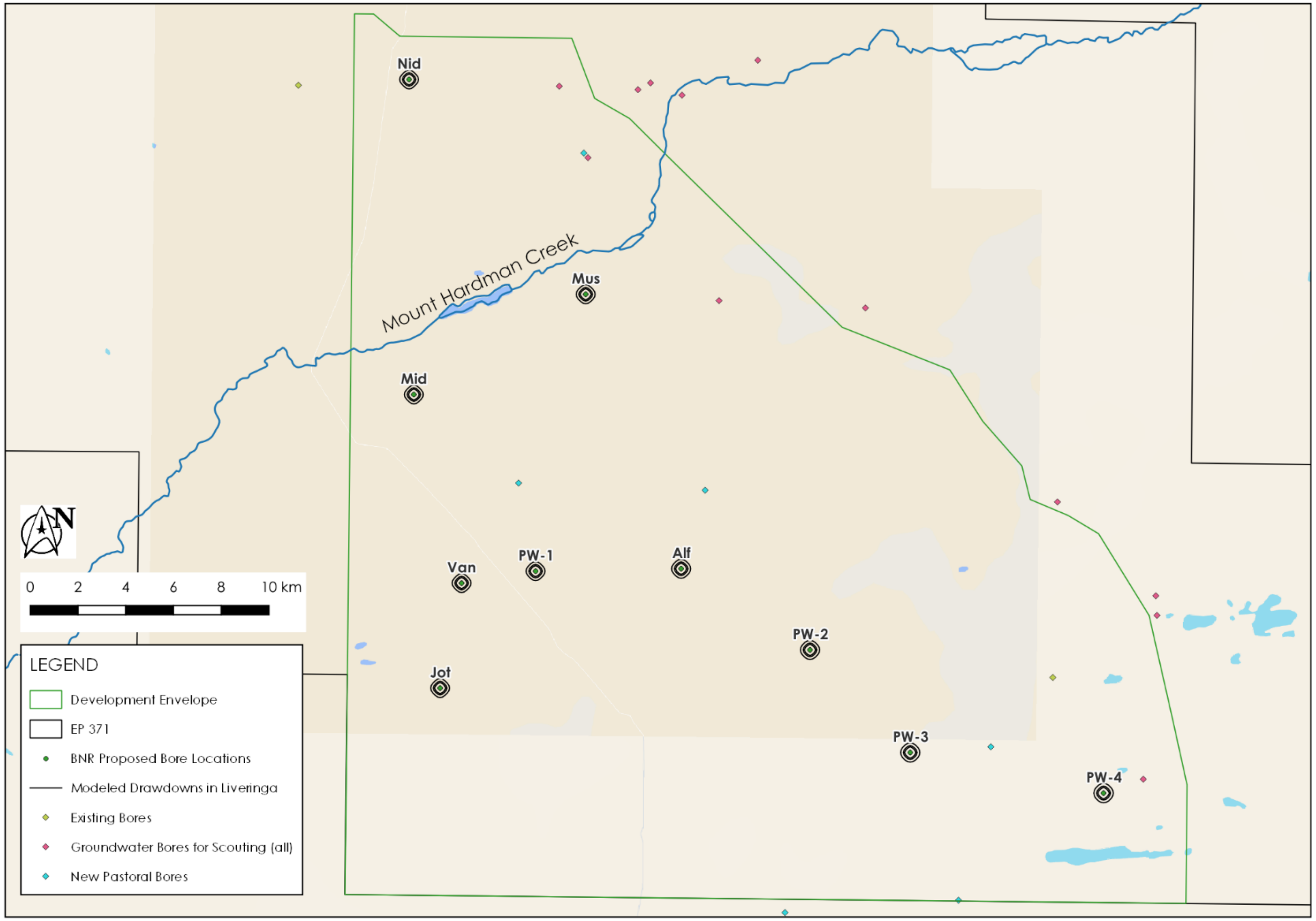

Figure 17-2. Modelled drawdowns for the Liveringa as presented in the original model report. The drawdown contours with the greatest radius around each bore is 0.1 m. A closeup of the area around the "Mus" (Muspelheim) bore is shown in Figure 17-3

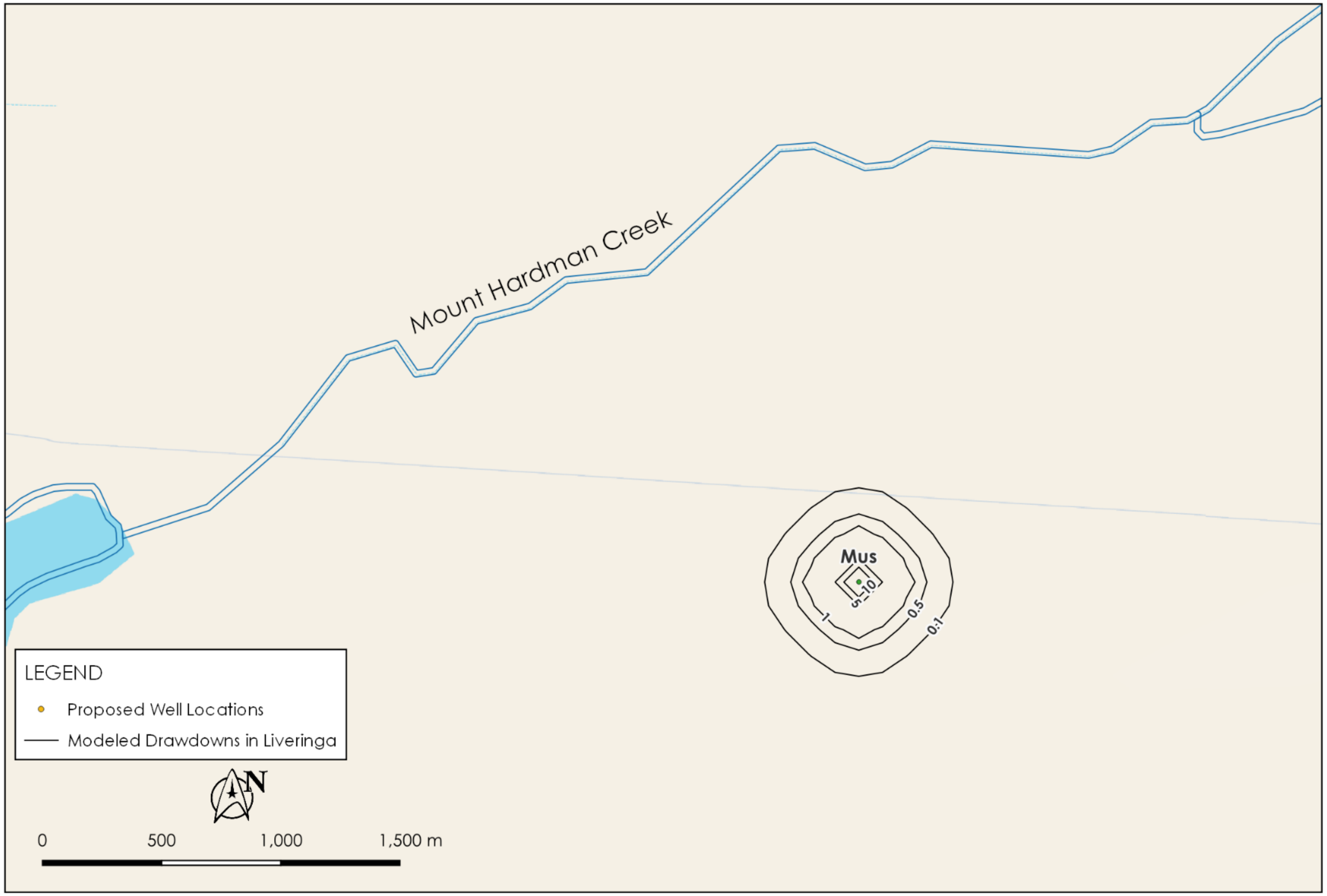

Figure 17-3. Modelled Liveringa Aquifer drawdowns at the proposed Muspelheim abstraction bore as presented in the original model report. Modelled drawdowns are in meters.

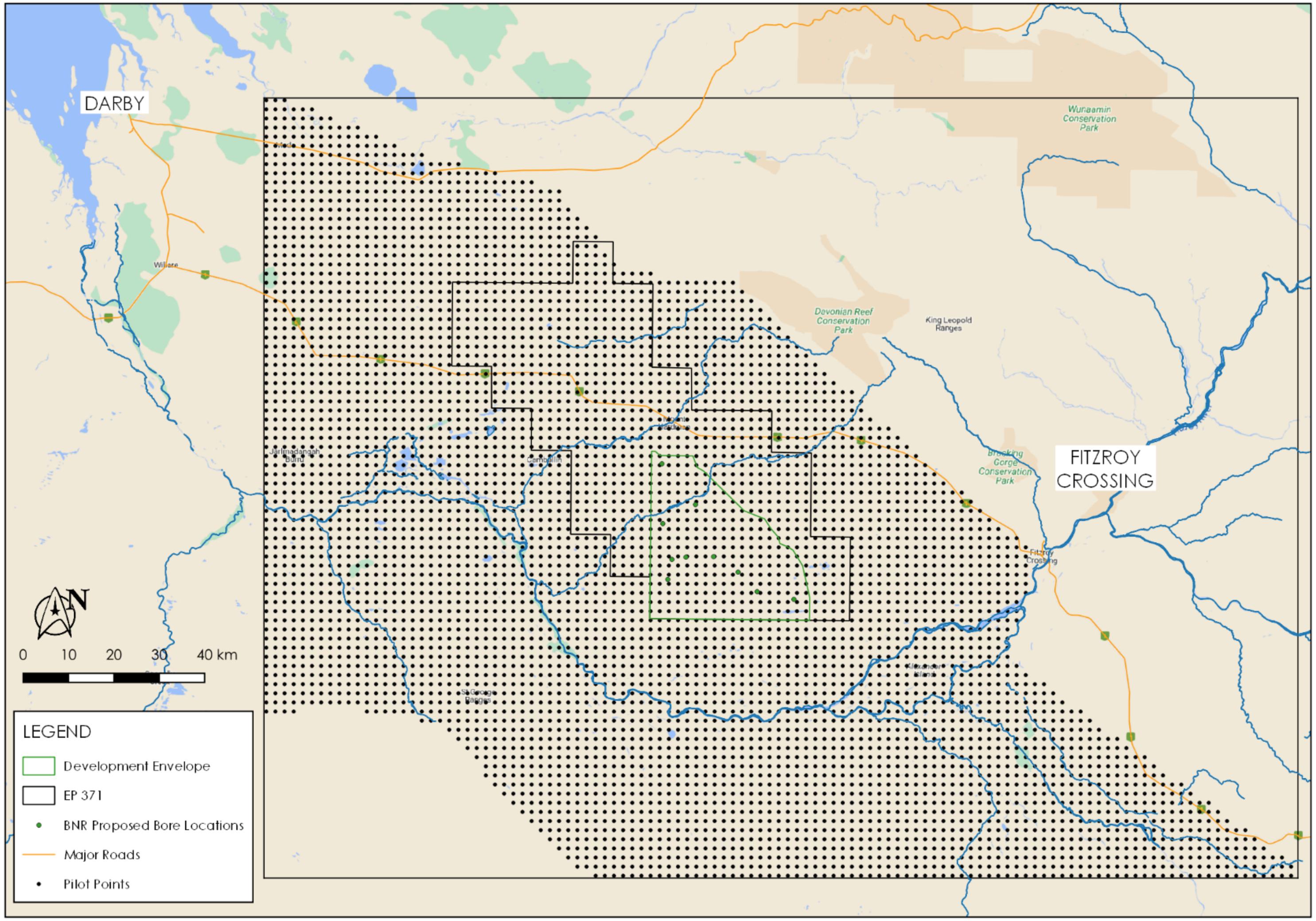

Figure 17-4. Locations of pilot points used in the UA for the Liveringa Aquifer drawdown model.

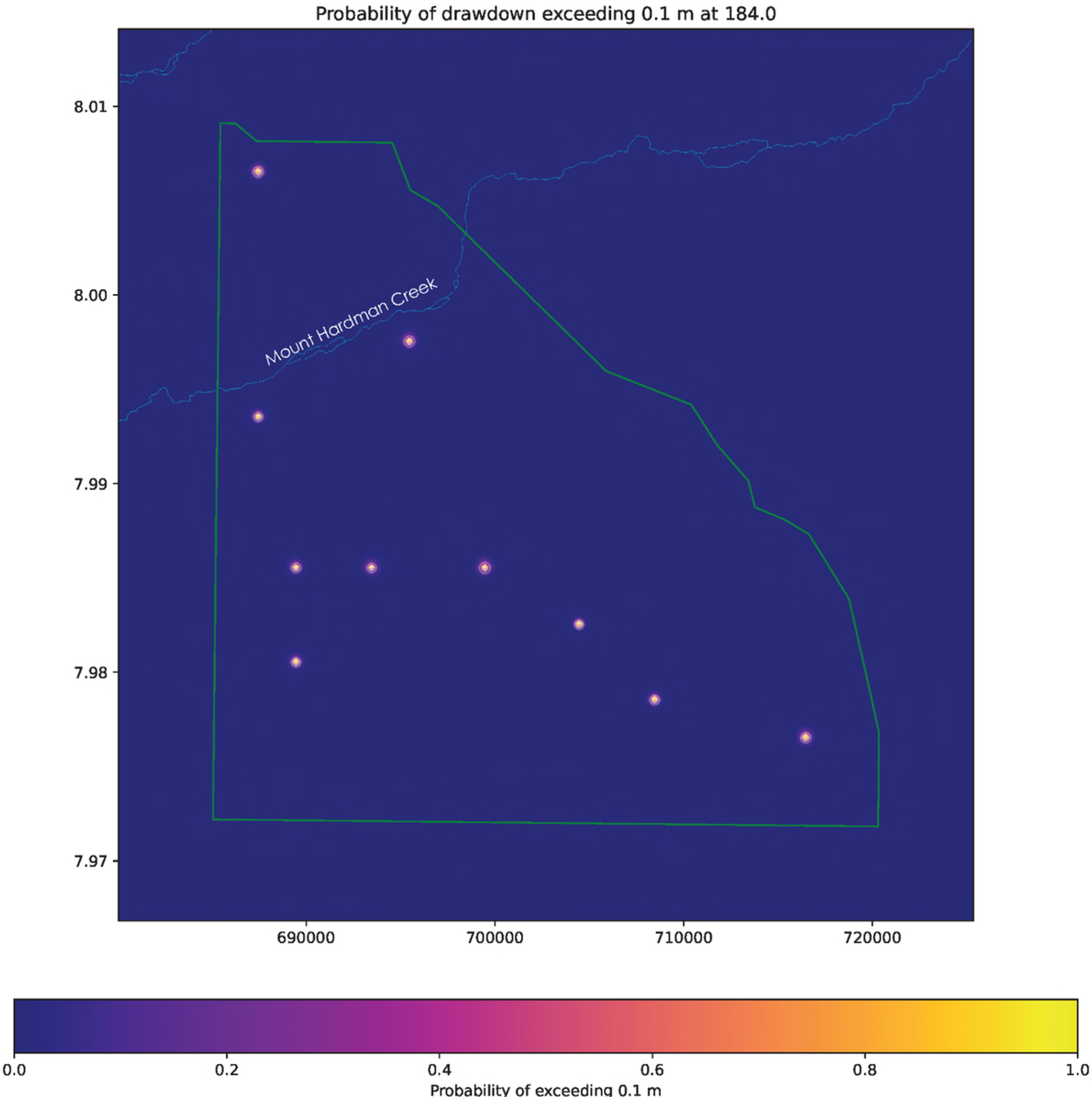

Figure 17-5. Map showing the distribution of probabilities that drawdowns will exceed 0.1 m at the end of the 6-month abstraction period.

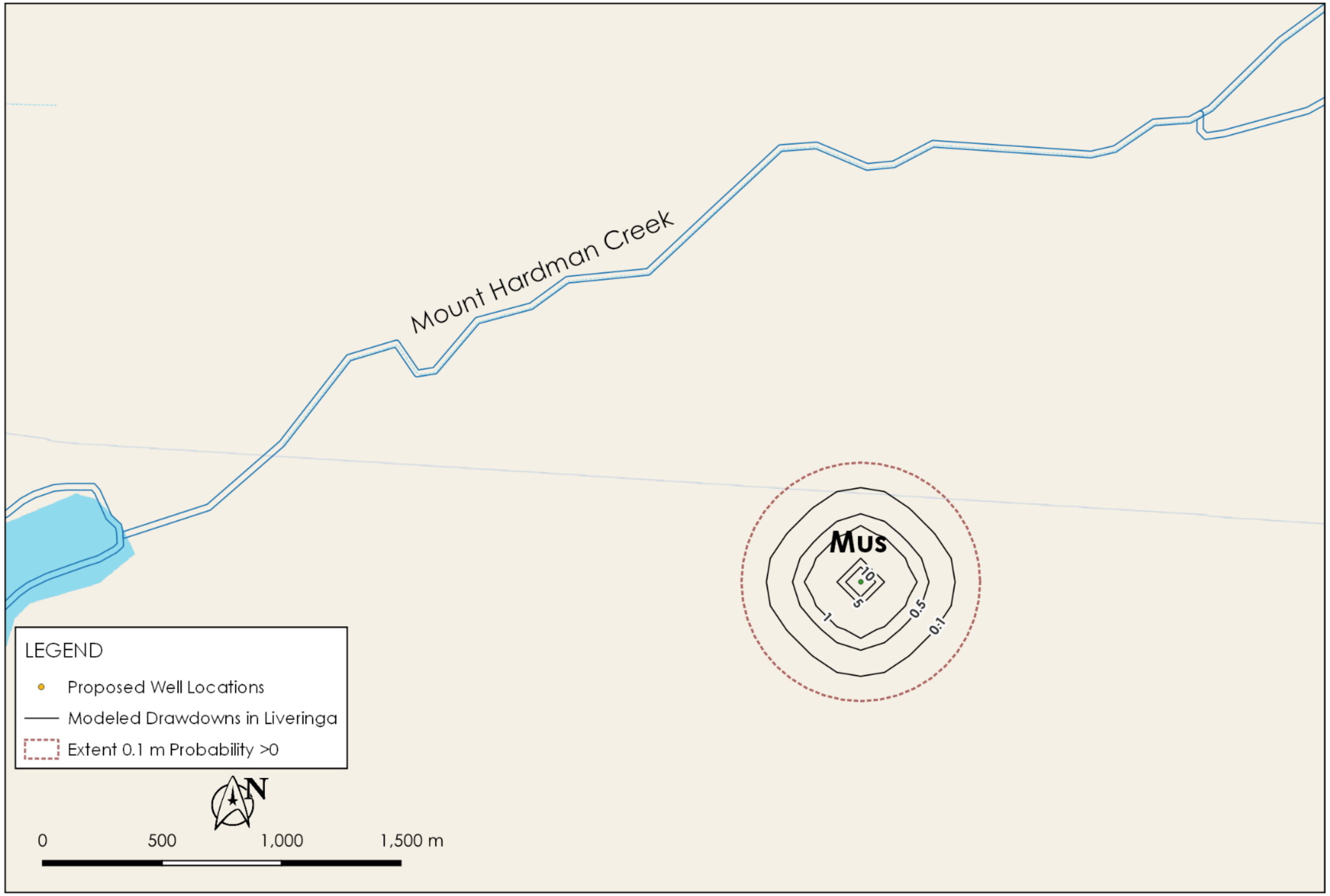

Figure 17-6. Modelled Liveringa Aquifer drawdowns at the proposed Muspelheim abstraction bore as presented in the original model report compared to the radius of the zone with a non-zero probability of drawdowns exceeding 0.1 m. Modelled drawdowns are in meters.

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c) Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems (Information Guidelines Explanatory Note - Assessing groundwater-dependent ecosystems | iesc)

The Information Guidelines Explanatory Note for assessing groundwater-dependent ecosystems (GDEs), as referenced under item 17(c), specifically address impacts to GDEs that are related to development of coal seam gas (CSG) and large coal mining (LCM) development projects. The subject of the DCCEEW RFI (i.e., the Valhalla Gas Exploration and Appraisal Program) is a proposal for an unconventional gas development rather than a CSG or LCM development; therefore, these information guidelines are not directly applicable to the responses presented here.

As discussed in the response to Item 17(b) above, a rigorous UA-based approach was applied to the groundwater models used to evaluate potential drawdowns throughout the shallow aquifer under very conservative and unrealistically high abstraction conditions. The UA was used to develop maps showing the distribution of probabilities of the aquifer experiencing drawdowns greater than 0.1 m, which is far smaller than the actual water level variations observed in existing bores throughout the project area (see Appendix J of the Valhalla ERD). As presented in the response to Item 17(b), the model results show a vanishingly small probability of impact to any of the GDEs in the project area – including the Mount Hardman Creek GDE – associated with water abstraction from the proposed bores. The lack of any reasonable probability of abstraction-related drawdowns at the GDEs in the project area indicates that BNR is not required to assess and evaluate any specific GDEs within the project area.

18) To support the proponent's conclusion of no, or not significant, impacts from the proposed action to a Water Resource and the other protected matters listed above, the Department considers further investigation is required to determine the hydraulic connectivity between aquifers and surface water expressions, the extent of the alluvium and the presence of groundwater across the site.
    a) Provide site-specific data, or use of another scientifically-robust methodology that is appropriate for purpose, including a description of the methodology used and justification of why the methodology was selected, to demonstrate:
        i) hydraulic connectivity (or disconnect) between aquifers and surface water expressions;

Item 18(a)(i) is requesting a scientifically robust methodology to demonstrate hydraulic connectivity or lack of connectivity between "aquifers and surface water expressions". This RFI item does not specify which aquifers and which surface water expressions that should be considered. BNR assumes that this question is requesting a demonstration that involves specific and relevant aquifer(s) and surface water expressions rather than just a discussion of groundwater – surface water interactions in general. Since the relevant aquifers and surface water expressions are not specified in the RFI item, BNR assumes that the "aquifers" refers to the geologic formations from which BNR intends to produce water and the resulting areas that could potentially be impacted by groundwater abstraction, and that the "surface water expressions" refers to any GDEs that occur within the areas that could potentially experience impact from the proposed groundwater abstraction.

As discussed in the response to Item 17(b), BNR produced a set of groundwater models with a rigorous, scientifically robust uncertainty analysis that follows the standards presented in the requirements for applying UA to models supporting proposed CSG or LCM developments. This methodology indicates that the areas within the project area with a probability of impact from the abstraction bores is limited to a restricted zone around each proposed abstraction bore. The results of the UA modelling also indicate that the nearest surface water expression to any of the proposed abstraction bores is at least 1 km from the edge of the modelled zone with a non-zero probability of experiencing a drawdown greater than 0.1 m. Based on the modelling and associated UA, there is no GDE within the study area that will experience any impact from the proposed pumping; therefore, there are no "surface water expressions" that satisfy the assumed definitions presented above. BNR therefore presents the UA modelling described in the response to Item 17(b) as a scientifically robust methodology that is appropriate for the requested evaluation.

ii) the extent of the alluvium;

RFI Item 18(a)(ii) does not specify which alluvium requires a demonstration of extent and does not define what specifically is required. It is therefore not possible to discuss the extent of alluvium without a clearer definition of the alluvium in question.

iv) characterisation of recharge and discharge zones.

Aquifer recharge was intentionally not considered nor included in the groundwater modelling evaluation presented in the original report and in the more recent UA in order to determine a more conservative potential impact from abstraction. Applying recharge to a drawdown model would offset and reduce abstraction-related impacts to the aquifer; therefore, not applying recharge to the models is a conservative approach that should result in over-estimation of abstraction-related drawdowns. BNR does not believe that there is value in attempting to characterize and quantify recharge to the relevant aquifer as doing so would only reduce the predicted impact and would not provide any additional confidence to model results.

Discharge "zones" in the study area include the flow of groundwater into surface waters and abstraction from pastoral bores. Discharge rates into surface waters is directly a function of the difference between the hydraulic head in the aquifer directly adjacent to the surface water body and the elevation of standing water in the surface water body. Any decrease in the hydraulic head in the aquifer adjacent to the surface water body would result in a reduction in discharge to the surface water, and vice versa. As indicated in the response to Item 17(b), the UA modelling indicates that the probability of any abstraction-induced measurable drawdown at any of the surface waters in the study area is vanishingly small; therefore, the proposed abstraction bores are not expected to have any impact on discharge to any surface waters in the project area. Similarly, the probability of any abstraction-induced measurable drawdown at any of the pastoral bores within the project area is so small that there is no anticipated impact to production from those bores.

b) Provide justification, with supporting evidence, for the assessment of limited impacts to the Mount Hardman creek, a groundwater dependent ecosystem.

The response to Item 17(b) provides a UA-based modelling evaluation that follows the standards presented in the requirements for applying UA to models supporting proposed CSG or LCM developments. The modelling results provide a distribution of probabilities which show that the areas within the project area with a probability of impact from the abstraction bores is limited to a restricted zone around each proposed abstraction bore. The results of the UA modelling also indicate that Mount Hardman Creek at its nearest location is at least 1 km from the edge of the modelled zone with a non-zero probability of experiencing a drawdown greater than 0.1 m (see Figure 17-6).

The UA also indicates that some of the model realizations with lower K values near the production well can result in a scenario where the well is not capable of maintaining the modelled abstraction rates throughout the 6-month period. For these scenarios, the extents of modelled 0.1 m drawdown contours are still greater than 1 km from the Mount Hardman Creek GDE. This indicates that conditions not favourable to producing the requires amounts of water will still not result in any impacts to the Mount Hardman Creek GDE.

19) Provide justification as to why site-specific investigations into the nature of the surface and groundwater connectivity and the presence of subterranean or terrestrial groundwater dependent ecosystems (GDEs) have not been undertaken.
Can you provide any justification on why subterranean fauna are unlikely to be present?

As discussed in the response to Item 17(b), BNR produced a set of groundwater models with a rigorous, scientifically robust UA that follows the standards presented in the requirements for applying UA to models supporting proposed CSG or LCM developments. This methodology indicates that the areas within the project area with a non-zero probability of impact from the abstraction bores is limited to a restricted zone around each proposed abstraction bore. The results of the UA modelling also indicate that the nearest surface water expression to any of the proposed abstraction bores is at least 1 km from the edge of the modelled zone with a non-zero probability of experiencing a drawdown greater than 0.1 m. Based on the modelling and associated UA, there are no reasonable scenarios that indicate any probability of impact to terrestrial GDEs in the project area. Since the modelling indicates no probability of impact to terrestrial GDEs, there is no reason to devote time and resources to performing site-specific studies, nor is there any value in the results of those studies.

BNR is not alleging that subterranean fauna are unlikely to be present within the project area. In fact, Appendix S of the Valhalla ERD states that it is likely that subterranean fauna do exist within the study area. Appendix S also states that the expected drawdowns associated with the project will be restricted to the area at the abstraction bores and will likely be too small to result in any impact that could be damaging to subterranean fauna. The UA modelling presented above supports this as modelled drawdowns for a wide range of K and Sy values result in a restricted extent of aquifer impacts.

It should be noted here that the proposed abstractions from the rig supply bores have finite lifespans, and those bores will not be used after the exploratory wells are complete; therefore, the long-term impacts of those wells will be negligible compared to the impacts of existing and future pastoral bores that have been and will potentially be pumped for decades. Since pastoral bores, which have a much greater cumulative impact than the proposed bores, are not required to evaluate impacts to subterranean fauna, it is not reasonable to expect that BNR should be required to do so.

20) Provide justification as to why the individual one-layer models utilised for the groundwater modelling is fit for purpose.

As stated in the response to Item 17(b), the Grant-Poole aquifer system is no longer under consideration for development of abstraction bores. The model for the Grant-Poole aquifer system presented in the original model report is therefore not considered in this response.

The use of a single layer model for simulation of the Liveringa aquifer is appropriate and fit for purpose for the following reasons:

- The models were developed using the latest version of the MODFLOW modelling software, which is the industry standard for developing aquifer models to evaluate drawdowns in response to abstraction from freshwater bores.
- The aquifer is unconfined and is not receiving any recharge or support from any overlying aquifer, therefore there is no reason to apply an overlying layer. As previously stated, applying recharge to the model of the target aquifer – either as distributed recharge simulating infiltration of rainfall or leakage from an overlying formation – would result in a reduction in the simulated drawdowns (i.e., less impact to the target aquifer) that would not be conservative.
- Including an underlying aquifer with any connection to the Liveringa would potentially result in additional water being drawn in under abstraction. This would be similar to applying recharge to the model, as it would result in some reduction to modelled drawdowns. Not including an underlying aquifer layer is therefore a conservative approach that is appropriate for modelling potential impacts from the abstraction bores.

This document identifies how Bennet Resources (BNR) have met each of the IESC Guideline requirements.

This table has been developed by BNR to assist DCCEEW and IESC to locate the documentation that BNR beleives provides information on how each of the the guideline requirements are met. The documentation refered to include:
- Preliminary Documentation (PD)
- Environmental Review Document (ERD)
- Environmental Protection Biodiversity and Conservation Act Referral (EPBC)
- Groundwater Management Plan

IESC CSG-LCM GUIDELINES	BNR RESPONSES
Description of the proposed project	
General	
Provide a regional overview of the proposed project area, including a description of the geological basin, coal resource, surface water catchments, groundwater systems, water-dependent assets (including terrestrial and aquatic GDEs), and past, present and reasonably foreseeable coal mining and CSG developments.	PD Section 2 - Description of the Action Section 4.2 - Current Land Use, Topography, Surface and Groundwater Bodies, Waterways and Vegetation Communities Attachment 1 - Valhalla Flora and Fauna Survey EPBC referral Section 3 - Existing Environment ERD Appendix B - Geotechnical Risk Assessment No public information of future coal mining and CSG developments in the region. No current coal mining and CSG developments in the region.
Describe the proposal's location, purpose, scale, duration and disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	PD Section 2 - Description of the action Section 4.2 - Current Land Use, Topography, Surface and Groundwater Bodies, Waterways and Vegetation Communities Section 5.3 - Water Resources That Relate to Unconventional Gas Development and Large Coal Mining Development Section 6.2 - Water Resources (Consequential cumulative impacts) EPBC referral Section 2 - Location Section 3.4 - Hydrology

Assess the frequency (and time lags, if any), location, volume and direction of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water.	PD Section 2 - Description of the action Section 2.6 - Location and Boundaries Section 5.3 - Water Resources That Relate to Unconventional Gas Development and Large Coal Mining Development EPBC referral Section 3.4 - Hydrology Section 4.1.9 - Water resource in relation to large coal mining development or coal seam gas Connectivity with sea water - No connectivity with sea water
Regulatory context	
Describe the statutory context, including information on the proposal’s status within the regulatory assessment process and any applicable water management policies or regulations.	PD Section 1.3 Project Approval Background EPBC referral Section 1.2.6 - What Commonwealth or state legislation, planning frameworks or policy documents are relevant to the Proposed Action, and how are they relevant? ERD Section 1.4 - Legislative Context **Commonwealth** The Proposed Action was referred on 16 September 2024 for potential impacts to MNES (EPBC No. 2024/10006). On 28 July 2025, the delegate of the Minister for the Environment determined the Proposed Action to be a ‘controlled action’ under the EPBC Act requiring assessment by Preliminary Documentation (PD) likely to have significant impact on the following matters protected under Part 3 of the EPBC Act: Listed threatened species and communities - Greater Bilby (Macrotis lagotis) – Vulnerable - Northern Blue-Tongued Skink (Tiliqua scincoides intermedia) – Critically Endangered - Largetooth Sawfish (Pristis pristis) – Vulnerable Listed migratory species - Largetooth Sawfish (Pristis pristis) National Heritage Places - The West Kimberley Water resources (that relate to unconventional gas development and large coal mining development - Fitzroy River and catchment, river tributaries
Describe how potentially impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	**State** *Environmental Protection Act 1986* *Environmental Key Factor Guideline – Inland Waters (EPA 2018)* *Petroleum and Geothermal Energy Resources Act 1967* *Petroleum and Geothermal Energy Resources (Environment) Regulations 2012* *Petroleum and Geothermal Energy Resources (Resource Management and Administration) Regulations 2015* *Rights in Water and Irrigation Act 1914* DMPR. (2002). Guidelines for the protection of surface and groundwater resources during exploration drilling. Government of Western Australia, Department of Mineral and Petroleum Resources. **Commonwealth** *Environment Protection and Biodiversity Conservation Act 1999* / ESC 2024 Information guidelines for proponents preparing coal seam gas and large coal mining development proposals Health values: Australian Drinking Water Guidelines 6, Version 3.5 (NHMRC and NRMMC, 2011 (updated March 2021))

Describe existing water quality guidelines, environmental flow objectives and other requirements (e.g., water planning rules) for the surface water catchments and groundwater basins within which the development proposal is based.	**PD** Section 14.3 - *Rights and Water Regulation Act 1914* **Canning Basin Specific** Jonasson, K. (2001). Western Australia Atlas of Petroleum Fields, Onshore Canning Basin, Volume 2, Part 1. Petroleum Division, Department of Mineral and Petroleum Resources, Western Australia. Pavey, C., & Vanderduys, E. (2021). Baseline assessment of the biodiversity of the Canning Basin. Western Australia: CSIRO Government of Western Australia, Broome Water Reserve drinking water source protection plan - WRP 100 https://www.wa.gov.au/government/publications/broome-water-reserve-drinking-water-source-protection-plan-wrp-100 Government of Western Australia, HG16 - Hydrogeological assessment of the Fitzroy Alluvium https://www.wa.gov.au/government/publications/hg16-hydrogeological-assessment-of-the-fitzroy-alluvium Lower Fitzroy River Groundwater Review. A report prepared by Innovative Groundwater Solutions DoW. (2008). Fitzroy Crossing Water Reserve drinking water source protection plan. Fitzroy Crossing town water supply. Western Australia: Government of Western Australia. Retrieved from https://www.water.wa.gov.au/__data/assets/pdf_file/0013/5035/80756.pdf **Water Quality Guidelines** ANZECC and ARMCANZ. 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1 The Guidelines. National Water Quality Management Strategy No. 4., Australian & New Zealand Environment & Conservation Council and the Agriculture & Resource Management Council of Australia & New Zealand.
Describe public health, recreation, amenity, Indigenous, tourism and/or agricultural values for each water resource, and the plans relevant to their management and protection.	In addition to pastoral activities, the Traditional Owners (TOs) of the land and members of the Yungngora Community, including some Warlangurru People residing at the Jimbalakudunj Community, use the land within and surrounding the Development Envelope for cultural practices, such as hunting and gathering of traditional foods, initiations and education. The land in this region is also used for recreational purposes such as swimming and fishing. FitzCAM—a community group comprising representatives from the key Traditional Owner groups of the Fitzroy River Catchment, pastoralists, irrigators, recreational fishers and catchment residents—developed a draft table of assets known to be water-dependent features (Harrington & Harrington, 2015). These assets included: - Lake Gladstone, the largest permanent freshwater wetland in the Central Kimberley bioregion, providing a refuge for vulnerable species. - Freshwater springs such as Udialla Springs and Honeymoon Springs. - Mallallah Swamp and Sandhill Swamp, which are potentially important waterbird habitats. The Human Health Risk Assessment (HHRA) (Appendix N) includes contamination of surface from surface spills. Contamination of surface water may occur from a large unplanned surface spill event such as loss of containment from the most northern produced water pond. Standard construction, petroleum storage, and petroleum use mitigation measures (ERD Table 5-11) will be applied to this activity; therefore, the likelihood of such a spill event occurring is extremely low. Containment and recovery measures will ensure that any impact would be minimised and exposure to Mount Hardman Creek (~1 km away) avoided and therefore is not considered to have the potential to result in a significant impact. Mount Hardman Creek is a non-perennial water body and only flows during the
Groundwater context	

Describe and map the geology at an appropriate level of horizontal and vertical resolution, including:	ERD The relevant geology is described in: Appendix L - INTERA 2024 Appendix I - Rockwater, 2016.
– definition of the geological sequence(s) in the area, with names and descriptions of the formations and accompanying surface geology, cross-sections and any relevant field data	ERD The relevant geologic formations are described in Appendix L - Section 2 in INTERA 2024. Additional details about the local geology and geologic sequence are described in: Appendix I - Sections 2, 3, and 4 of Rockwater, 2016. To supplement this, a surficial geology map was produced at a scale more appropriate to the Development Envelope; see "Supplemental Geology Map" (Stewart et al., 2020).
– identification of hydrogeological sequences and characteristics.	ERD Appendix L - Section 2 in INTERA 2024.
Define and describe or characterise significant geological structures (e.g., faults, folds, intrusives) and associated fracturing in the area and their influence on groundwater – particularly groundwater flow, discharge or recharge.	ERD The relevant geologic formations are described in Appendix L - Section 2 and 3 in INTERA 2024.
– Provide geological maps appropriately annotated with symbols that denote fault type, throw and the parts of sequences the faults intersect or displace (e.g., Murray and Power 2021).	ERD Appendix L - See figures 2-1 through 2-3 in INTERA 2024 To supplement this, a surficial geology map was produced at a scale more appropriate to the Development Envelope; see "Supplemental Geology Map" (Stewart et al., 2020).
– Include discussion of how the faults potentially influence regional-scale groundwater conditions.	ERD Appendix L - Section 2 in INTERA 2024. As indicated by this section, the regional faults are likely forming the lateral boundary conditions for the Liveringa formation as implemented in the model.
Describe the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	ERD Appendix L - Section 2 in INTERA 2024.
– Identify current stressors, including impacts from any currently approved projects.	PD Section 4.2.1 - Current land use ERD Section 5.5.3.2 - Surrounding land use
Describe the existing water quality of all aquifers in the project area.	
– Where groundwater is to be used for a given purpose such as irrigation, compare the data with relevant guideline values (ANZG 2018) and regional and local water quality objectives.	Groundwater Management Plan Details baseline data to be collected. PD Section 4.2.3 - Groundwater bodies - Localised Context
Surface water context	
Describe the watercourses, standing waters and springs across the site, including:	
– drainage patterns and key surface water and floodplain features	PD Section 4.1.1.4 - Surface Water and Waterways (Including Mount Hardman Creek) Section 4.2.3 - Groundwater bodies - Regional Context EPBC referral Section 3.4 - Hydrology Section 4.1.9 - Water resource in relation to large coal mining development or coal seam
– hydrological regimes (especially ecologically relevant components such as durations, timing and frequency of periods when no surface water is present)	PD Section 4.1.1.4 - Surface Water and Waterways (Including Mount Hardman Creek) Section 4.2.3 - Groundwater bodies - Regional Context EPBC referral Section 3.4 - Hydrology Section 4.1.9 - Water resource in relation to large coal mining development or coal seam

– current stressors, including impacts from any currently approved projects.	PD Section 4.2.1 - Current land use EPBC referral Section 3.1.2 - Describe any existing or proposed uses for the Project Area ERD Section 5.5.3.1 - Social context Section 5.5.3.2 - Surrounding land uses
Describe the existing water quality of surface waters potentially impacted by the proposed development.	PD Attachment 13 - Human Health Risk Assessment ERD Section 5.8.3 Receiving environment (Human Health)
– Include comparison to relevant default guideline values (ANZG 2018) and regional and local (or site-specific) water quality objectives.	PD Section 5.3.2.3 - Potential contamination of surficial aquifers from an accidental release at the surface of drilling fluids, HFS chemicals, liquid hydrocarbons, or produced formation water Attachment 13 - Human Health Risk Assessment ERD Section 5.8.3 - Receiving environment (Human Health)
Ecological context	
Describe the ecological water-dependent assets in and near the proposed development area, including:	
– water-dependent fauna and flora and their habitats, including GDEs (see Doody et al. 2019)	Mt Hardman Creek and claypans are present adjacent to the Disturbance Footprint of Muspelheim. The alluvium plains in this area broad sandy areas covered with thick pindan scrub, grassland wooded with a sparse layer of trees 5 to 15 m in height and a dense thicket of acacia (DoW 2006). https://www.wa.gov.au/system/files/2022-04/Hydrogeological-assessment-of-the-Fitzroy-Alluviam.pdf eco logical Australia undertook a Detailed and Targeted Flora and vegetation Survey and a Basic Fauna Fauna Survey in 2021 of Project Area, which consists of access tracks, camp locations of proposed well pads (the Disturbance Footprint; 112.46 hectares), and an additional 15.69 hectares of alternative tracks (Additional Survey Area; 128.15 hectares total) (PD Attachment 1). Mount Hardman Creek, crosses the Development Envelope, but the proposed disturbance footprint has been designed to avoid the creek, as such Mount Hardman Creek was not included in the scope of the survey however survey results within the Disturbance Footprint are consistent with that described by DoW (2006). PD Section Attachment 1 Section 4.2.8 Vegetation condition Section 5.1 - Threatened and Migratory Species Attachment 4 - ecologia DCCEEW Responses – Greater Bilby (Macrotis lagotis) Attachment 5 - ecologia DCCEEW Responses – Northern Blue-Tongued Skink (Tiliqua intermedia) Attachment 6 - ecologia DCCEEW Responses – Largetooth Sawfish (Pristis pristis) Section 5.2.5.1 - Groundwater Dependent Ecosystems (GDEs) EPBC Referral Section 3.1.1 - Describe the current condition of the Project Area's environment Section 3.2 - Flora and Fauna

– their current condition and environmental values	Mt Hardman Creek and claypans are present adjacent to the Disturbance Footprint of Muspelheim. The alluvium plains in this area broad sandy areas covered with thick pindan scrub, grassland wooded with a sparse layer of trees 5 to 15 m in height and a dense thicket of acacia (DoW 2006). https://www.wa.gov.au/system/files/2022-04/Hydrogeological-assessment-of-the-Fitzroy-Alluviam.pdf eco logical Australia undertook a Detailed and Targeted Flora and vegetation Survey and a Basic Fauna Fauna Survey in 2021 of Project Area, which consists of access tracks, camp locations of proposed well pads (the Disturbance Footprint; 112.46 hectares), and an additional 15.69 hectares of alternative tracks (Additional Survey Area; 128.15 hectares total) (PD Attachment 1). Mount Hardman Creek, crosses the Development Envelope, but the proposed disturbance footprint has been designed to avoid the creek, as such Mount Hardman Creek was not included in the scope of the survey however survey results within the Disturbance Footprint are consistent with that described by DoW (2006). PD Section Attachment 1 Section 4.2.8 Vegetation condition Section 5.1 - Threatened and Migratory Species Attachment 4 - ecologia DCCEEW Responses – Greater Bilby (Macrotis lagotis) Attachment 5 - ecologia DCCEEW Responses – Northern Blue-Tongued Skink (Tiliqua intermedia) Attachment 6 - ecologia DCCEEW Responses – Largetooth Sawfish (Pristis pristis) Section 5.2.5.1 - Groundwater Dependent Ecosystems (GDEs) EPBC Referral Section 3.1.1 - Describe the current condition of the Project Area's environment Section 3.2 - Flora and Fauna
– stressors that currently affect each ecological water-dependent asset, including stressors that alter the quantity and/or quality of water required by each asset in and near the proposed development area.	PD Section 4.2 - Current Land Use, Topography, Surface and Groundwater Bodies, Waterways and Vegetation Communities Attachment 13 - Human Health Risk Assessment Section 2.1.1 EPBC referral Local and regional use Within the broader Canning–Kimberley area, the Grant Group comprises ~13.6 GL (67.4%) of the total water allocation within the proclaimed groundwater area (>300,000 ML/year (DoW, 2014). Although there are multiple licenses to take water from within the Grant Group (including from the Poole Sandstone), these are associated with other oil and gas operators, mining operators, Main Roads, communities, and the local shire. Some water extraction within the broader region is unlicensed for uses such as livestock and domestic bores (pastoral activities), tourist activities and Aboriginal community bores (Harrington & Harrington, 2015). Locally, there are three known users of groundwater from the Poole Sandstone, near the Project Area —the Yungngora Community, and the towns of Camballin and Fitzroy Crossing.
Environmental impact assessment	
General	
Describe the intensity, duration, magnitude, timing and geographic extent of each potential impact, specifying the impact's significance and consequences, especially on the environmental condition and human values of each water resource.	ERD Appendix L - Section 1 INTERA 2024 The potential impacts are associated with abstraction from rig supply bores. As described in Section 1 of INTERA 2024 the rig supply wells are expected to operate for about 6 months each, with 1 to 2 wells operating at any given time during the project.
For proposed expansions or modifications, distinguish potential impacts from those of the existing project, and include the likely contribution of the proposed expansion to potential cumulative impacts.	N/A - new project

Assess the significance of each impact with reference to the range of system behaviour found under pre-development conditions and natural environmental and climatic variability.	PD Attachment 3 - INTERA 2024 and RFI Response 17 As indicated by the Appendix J GW Data, overall ranges of water levels observed in the monitor bores are generally greater than 1 meter. The observed ranges of values are much greater than those expected from the modelling presented in INTERA 2024 and RFI Response 17. ERD Appendix J - Local Groundwater Characterisation Results Appendix L - Groundwater Modelling
Risk-based assessment	
Identify and assess all potential environmental risks to water resources and water-related assets, and their possible impacts. In selecting a risk-assessment approach, consideration should be given to the complexity of the project and the probability and potential consequences of the project's impacts.	PD Section 5.3 - Water Resources That Relate to Unconventional Gas Development and Large Coal Mining Development Section 6.2 - Water Resources (Consequential Cumulative Impacts) Attachment 3 - Intera DCCEEW response (modelling) Attachment 13 Ground Water Management Plan EPBC referral Section 4.1.9 - Water resource in relation to large coal mining development or coal seam
Describe the consultation with relevant stakeholders and regulators about the likely risks to water resources and water-related assets. This initial engagement should include agreement about the nature of the action, which assets (including water resources) may be impacted, and the likely sources of impacts and the receptors that may be affected.	PD Section 3 - Stakeholder Engagement (most up to date)
The risk assessment should include a systematic and evidence-based assessment of:	
– the sources of environmental impacts in the project area	[See previous comment]
– the exposure pathways by which impacts may be transferred from these sources to water resources (receptors), presented as one or more IPDs based on ecohydrological conceptualisation (see Box 2)	[Incorporate the existing IPD into the groundwater modelling results]
– the likely response of each receptor, especially when the impact(s) may be severe and likely to cause irreversible damage (posing a high risk)	
– 'hot spots', or areas in the project area (e.g., where vulnerable receptors occur close to impact sources) where risks are especially high	
– 'hot moments', or periods during and after the project (e.g., when activities are likely to generate major impact) when risks are especially high.	
Specify where and how each risk can be avoided or mitigated (or, as a last resort, requires appropriate offsets and/or a conservation payment), and:	PD Section 7 - Avoidance and Mitigation Measures Attachment 10 - Table of Mitigation measures (Flora and Fauna) Attachment 11 - Table of Mitigation measures (Water) Section 10 - Offsets
– provide evidence (preferably from equivalent activities and regions) for the feasibility and effectiveness of mitigation or offset methods	Mitigation measures proposed will be adopted and correctly implemented in accordance with State and Commonwealth Conditions and DMPE approved EP. Theses mitigation measures are consistent with previous unconventional exploration activity in the Canning basin (Asgard and Valhalla North), consistent with the recommendations from the HFS Scientific enquiry, the Northern Territory Code of Practice and state Policy and Guidelines that have been effectively implemented for similar activities for many years. No offsets are proposed.

– describe how monitoring will be able to demonstrate the effectiveness of the mitigation measures.	Soil Quality Monitoring Appendix E Valhalla Monitoring Program Section 3.1 To understand if the Proposal and associated emissions have had any short or long-term adverse impacts to soil quality, BNR collected initial soil samples prior to submitting the draft ERD and followed up with the collection of localized samples in August 2023. In addition, BNR will collect soil samples and analyse local soil quality at all well sites associated with the Proposal located within the Development Envelope and compare these to the earlier soil collections to finalise a pre-impact baseline. Pre-impact and post activity sampling can then be used to demonstrate upon completion of the activities that no contamination events occurred, or that contamination events occurred, and the area was appropriately rehabilitated. In completing this monitoring program, BNR can verify if the Proposal was undertaken in a manner that maintained the quality of land and soils such that that environmental and social values were protected. Air Quality Monitoring Appendix E Valhalla Monitoring Program Section 3.2 BNR does not believe that the Proposal activities will result in any significant impacts to air quality. Subsequently, the air quality monitoring program has been developed to meet the following objective: • no short or long-term adverse impacts to air quality. To understand if the Proposal and associated emissions have had any short or long-term adverse impacts to air quality, BNR plans to collect air quality samples and analyse for presence of dust and volatile organic carbon (VOC). Pre-impact (baseline) and post activity sampling can then be used to demonstrate upon completion of the activities that no short or long-term impacts to air quality have occurred. In completing this monitoring program, BNR can verify if the Proposal was undertaken in a manner that maintained the quality of air such that that environmental and social values were protected. Methane Emission Modelling Appendix E Valhalla Monitoring Program
Describe the risks of potential cumulative impacts of all past, present and reasonably foreseeable actions and activities that are likely to impact on water resources, including from multiple stressors arising from the proposed action.	PD Section 5.3 - Water Resources That Relate to Unconventional Gas Development and Large Coal Mining Development Section 6.2 - Water Resources EPBC Referral Section 4.1.9 - Water resource in relation to large coal mining development or coal seam gas
Specify all sources of uncertainty in the assessments of each risk and describe how information has been and will be collected to reduce this uncertainty.	PD Section 5.3 - Water Resources That Relate to Unconventional Gas Development and Large Coal Mining Development
Investigate relevant context for the risk assessment, such as bioregional assessments, Commonwealth and state water resource plans (e.g., Murray–Darling Basin Plan, Hunter River Salinity Trading Scheme) and state processes such as those that apply in the Surat Cumulative Management Area and the Commonwealth's Joint Industry Framework on Coal Seam Gas.	N/A to proposal location.
Assess residual risks remaining after the implementation of the proposed mitigation and management options, to determine whether these effectively reduce risks to an acceptable level based on the identified environmental objectives.	ERD Section 5.11 Residual Impact Significance model - assessment
Modelling of water storage and movement	
Incorporate causal mechanisms and pathways identified in the risk assessment (e.g., IPDs) in conceptual and numerical modelling. Use the results of these models to update the risk assessment.	PD Attachment 13 - Human Health Risk Assessment

Provide a detailed description of all analytical, numerical and conceptual models used, and any methods and evidence (e.g., expert opinion, analogue sites) employed in addition to modelling.	PD Attachment 3 - Section 17 ERD Appendix L - INTERA 2024 PD Attachment 3 - Section 17
Explain the conceptualisation of the system(s), including multiple conceptual models if appropriate. Describe the data and information, including field data, on which the models are based; all key assumptions; and model limitations and their consequences.	ERD Appendix L - Section 2 INTERA 2024 .
Calibrated models require adequate monitoring data from either the project area or sites representative of local conditions, ideally with calibration targets related to model predictions. Summarise the extent to which parameterisation is consistent with expectations based on literature values, outcomes of field or laboratory investigations, or with values obtained by calibration in similar nearby applications.	ERD Appendix L - Section 4 INTERA 2024 for information on parameterisation of the model relative to literature data and calibration-based estimates presented in Section 3 of Rockwater 2016 (Appendix I).
Where possible, verify models by using past and/or existing site monitoring data that were not used for calibration.	It was not possible to verify the models as there is insufficient site data (i.e., quantified bore abstraction from Liveringa completions within the development envelope) to perform verification.
Assess the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling, particularly with respect to predicted potential impact scenarios. Identify key gaps in data and knowledge and describe how they can be addressed.	PD Attachment 3 Response 17 The uncertainty associated with the model parameters was characterized in RFI Response 17.
Describe the various stages of the proposed project (construction, operation and rehabilitation) and their incorporation into the model. Provide predictions of changes and recovery in each water resource for the life of the project and beyond, including an assessment of the impacts of climate change where applicable, and cumulative impacts.	ERD Appendix L - Section 4 INTERA 2024 As described in INTERA 2024 the model incorporates operation of the rig supply bores and recovery of water levels following the cessation of abstraction. Construction was deemed irrelevant to the predictions of interest and was therefore not included. The timing of impact is short compared to climate change predictions and the model setup does not incorporate inputs that could be affected by climate change (e.g., recharge rates); therefore climate change was not included in the assessment.
Provide a program for reviewing and updating models as more data and information become available, including reporting requirements.	Monitoring of existing bores during operation of the rig supply bores can be used to verify the model results and potentially develop a calibration for the model. Groundwater Management Plan
Groundwater	
Undertake groundwater modelling in accordance with the Australian groundwater modelling guidelines (Barnett et al. 2012), including independent peer review.	ERD Appendix L - Cover letter INTERA 2024 The groundwater model was prepared in accordance with the Barnett et al., 2012 guidelines. The initial version of the model was subject to peer review as discussed in the cover letter for INTERA 2024.
Describe each hydrogeological unit as incorporated in the groundwater model, including the thickness, storage and hydraulic characteristics, and hydraulic linkages between units, if any.	ERD Appendix L - Section 2 and 3 INTERA 2024 .
Describe the existing recharge/discharge pathways of the units and the changes that are predicted to occur upon commencement, throughout, and after completion of the proposed project.	ERD Appendix L - Section 2 INTERA 2024 .
Select and justify appropriate boundary conditions across the model domain to enable a comparison of groundwater model outputs to seasonal field observations.	ERD Appendix L - Section 3 INTERA 2024 .
Where possible, calibration should incorporate measurements of both potentiometric head (or pressure) and flux, such as measured mine inflows or measured discharges to streams or springs.	There are insufficient data on Liveringa bore abstraction response to calibrate the model to address the predictions of interest.
Undertake sensitivity analysis of boundary conditions and hydraulic and storage parameters, and justify the conditions applied in the final groundwater model. Where the interaction between surface water and groundwater is important, parameters describing their connectivity, such as riverbed conductance, should be assessed.	ERD Appendix L - Section 6.3.1 in INTERA 2024.
Assess the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts. Consider and describe:	ERD Appendix L - INTERA 2024.As discussed in INTERA 2024 the impacts from the rig supply bores are expected to be temporary as each individual well is not expected to be operated for more than a 6-month period.
– any hydrogeological units that will be directly or indirectly dewatered or depressurised (including lateral effects), interactions between water resources (inter-aquifer connectivity), and connectivity with sea water	ERD Appendix L - Sections 5 and 6 in INTERA 2024

– the magnitude, extent and change over time of drawdown/mounding, including the time for post-development equilibrium to be reached	ERD Appendix L - Sections 5 and 6 in INTERA 2024 PD Attachment 3 - RFI Response 17
– the extent of impacts on surface water/groundwater connectivity, water-dependent assets, flow direction and surface topography, including resultant impacts on the groundwater balance	ERD Appendix L - Sections 5 and 6 in INTERA 2024 PD Attachment 3 - RFI Response 17
– the potential range of drawdown at each affected bore, and clearly articulate the spatial and temporal scales of impacts on other water users	ERD Appendix L - Sections 5 and 6 in INTERA 2024 PD Attachment 3 - RFI Response 17
– the potential impacts on hydraulic and storage properties of hydrogeological units, including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units	ERD Appendix L - Sections 5 and 6 in INTERA 2024 PD Attachment 3 - RFI Response 17
– the possible fracturing of and other damage to confining layers.	ERD Appendix L - Sections 5 and 6 in INTERA 2024 PD Attachment 3 - RFI Response 17
Undertake an uncertainty analysis of key predictive outputs (i.e., quantities of interest as per Peeters and Middlemis 2023).	PD Attachment 3 - RFI Response 17
For each relevant hydrogeological unit, describe the proportional increase in groundwater use and impacts as a consequence of the proposed project, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal.	ERD Appendix L - INTERA 2024 INTERA 2024 As discussed in INTERA 2024 the impacts from the rig supply bores are expected to be temporary as each individual well is not expected to be operated for more than a 6-month period.
Surface water	
For flood estimation, use methods in accordance with the most recent publication of Australian rainfall and runoff (Ball et al. 2019); for rainfall-runoff modelling, use methods as outlined by Vaze et al. (2012); and for the modelling of water and salt balances related to mine water management, refer to the water accounting framework (Minerals Council of Australia 2022). Consider the relevance of regional information (see Nathan and McMahon 2017). It is expected that flood risks are assessed for annual exceedance probabilities of at least 1% (i.e., 1 in 100); however, in many instances it may be necessary to estimate floods with rarer annual exceedance probabilities, such as 0.1% (i.e., 1 in 1,000), or events which have a negligible chance of being exceeded (the probable maximum flood).	PD Section 5.3.2.3 - Potential Risk to Site Activities and Infrastructure due to Extreme Rainfall Events
Describe all potential impacts of the proposed project on surface waters. Include a clear description of the impact on the resource and the likelihood and consequences of the impact. Consider:	
– impacts on streamflow under the full range of flow conditions, focusing on metrics that are most relevant to ecologically important flow components (e.g., the timing, frequency and variability of zero- and low-flow days, low flows exceeded 90% of the time, flow pulses related to ecological processes such as spawning and migration) as well as those relevant to water supply reliability	The Proposal has no planned discharges. PD Attachment 3 - RFI Response 17 As indicated in INTERA 2024 and RFI Response 17 the model predicted impacts at the nearest stream (Mt Hardman Creek) are expected to be negligible under the conservative conditions assumed for the groundwater models
– impacts associated with surface water diversions	There will be no surface water diversions related to the Proposal. The Proposal has no planned discharges.
– impacts on water quality, including consideration of mixing zones (i.e., areas downstream of discharges where water quality objectives do not apply) if applicable	The Proposal has no planned discharges. PD Attachment 3 - RFI Response 17 As indicated in INTERA 2024 and RFI Response 17 the model predicted impacts at the nearest stream (Mt Hardman Creek) are expected to be negligible under the conservative conditions assumed for the groundwater models

– the quality, quantity and ecotoxicological effects of operational and emergency discharges of water (including saline water) at different flows, and the likely impacts on water resources and water-dependent assets	No planned discharges to water resources. ERD Section 2.4.4.1 - HFS Drilling fluid Appendix A
– landscape modifications such as subsidence, voids, post-rehabilitation landform collapses and on-site earthworks (including disturbance of acid-forming or sodic soils, roadway and pipeline networks), and describe how these could affect surface water flow, surface water quality, erosion and sedimentation within and downstream of the project area.	No Planned discharges to water resources. ERD Appendix L - INTERA 2024 As discussed in INTERA 2024 the rig supply bores will temporarily produce from the near-surface Liveringa aquifer. The aquifer is not suspect to experiencing subsidence and modern subsidence has not been documented in the Canning Basin. Subsidence was therefore not considered to be a potential risk for the project area and was therefore not assessed or evaluated. ERD Section 5.2.5.1 - Erosion or scouring from a reduction in soil stability during civil works
Identify processes to determine surface water quality guidelines and quantity thresholds which incorporate seasonal variation but provide early indication of potential impacts on assets.	No planned discharges to surface waters. Only indirect exposure through a spill event. Possibility is low given engineering mitigations. PD Attachment 11- Table of mitigation Measures (Water)
Assess the risks of flooding (including channel form and stability, water level, depth, extent, velocity, shear stress and stream power) and the impacts of flooding on water-dependent assets, project infrastructure and the final project landform.	PD Section 5.3.2.4 - Potential Risk to Site Activities and Infrastructure due to Extreme Rainfall Events
Identify and evaluate the quality (including uncertainty) and other aspects of streamflow and other hydrological data, such as proximity to rainfall stations and stream gauges, duration of data records, and whether missing data have been patched.	PD Section 5.3.2.4 - Potential Risk to Site Activities and Infrastructure due to Extreme Rainfall Events Noting detailed pond design is subject to further engineering work. To be approved under the PGER Act by DMPE.
Develop and describe a plan for ongoing ecotoxicological monitoring, including direct toxicity assessment of discharges to surface waters where appropriate.	No planned discharges of surface water.
Ecology	
Assess direct and indirect impacts of the proposed project (e.g., landscape modifications such as voids, on-site earthworks, roads, pipelines and stream-channel diversions, mine dewatering, operational releases of water affected by mining or CSG activities) on water-dependent ecological assets such as flora and fauna dependent on surface water and groundwater, including springs and other GDEs.	N/A not a CSG activity
Using suitable IPDs based on an initial ecohydrological conceptualisation, describe the likely cause–effect mechanism(s) from impact sources to each receptor. Consider:	
– direct and indirect impacts on aquatic and water-dependent terrestrial populations, species and communities, including those whose water dependence may not yet be demonstrated (e.g., terrestrial GDEs)	PD Attachment 13 - Human Health Risk Assessment
– how predicted alterations of the hydrological regime (especially ecologically relevant components such as durations, timing and frequency of periods when no surface water is present; and timing and duration of overbank flooding) in standing and flowing waters might affect each water-dependent ecological asset in and near the project area at a range of temporal scales (e.g., seasonal, annual, decadal)	N/A - no impact to surface waters - recovery of surface each year with wet seasons. PD Section 4.2.5.1 - Ground Water Dependent Ecosystems (GDEs)
– how predicted alterations of water quality (including water temperature and salinity) might affect each water-dependent ecological asset in and near the project area at a range of temporal scales (e.g., seasonal, annual, decadal)	BNR believes the ERD has addressed impacts to vegetation communities through groundwater drawdown in the ERD. The groundwater drawdown was from the proposal activities has been assessed in ERD Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction. This section assesses in detail the previous groundwater drawdown was monitoring undertaken during water extraction activities by Buru Energy in 2012, in summary, short-term drawdown is expected to remain within the extent of natural variability, and therefore would be indistinguishable from normal seasonal fluctuations. Discussions with DWER identified the need for additional modelling, therefore, additional modelling was commissioned from Intera Geosciences Pty Ltd. Based upon modelling predictions (ERD Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction and Appendix L Groundwater modelling) from (Intera Geosciences Pty Ltd, 2023), BNR does not believe that the potential drawdown associated with the Proposal pose a significant impact to the Mount Hardman Creek GDE or associated vegetation communities based upon 1 mm drawdown within 700 m of the abstraction bore (or the wellsite) that recharges rapidly once pumping ceases.

– how interactions of predicted alterations of quantities and quality of surface water and/or groundwater might affect each water-dependent ecological asset in and near the project area at a range of temporal scales (e.g., seasonal, annual, decadal)	BNR believes the ERD has addressed impacts to vegetation communities through groundwater drawdown in the ERD. The groundwater drawdown was from the proposal activities has been assessed in ERD Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction. This section assesses in detail the previous groundwater drawdown was monitoring undertaken during water extraction activities by Buru Energy in 2012, in summary, short-term drawdown is expected to remain within the extent of natural variability, and therefore would be indistinguishable from normal seasonal fluctuations. Discussions with DWER identified the need for additional modelling, therefore, additional modelling was commissioned from Intera Geosciences Pty Ltd. Based upon modelling predictions (ERD Section 5.4.5.1 Changes to groundwater levels (groundwater drawdown) associated with water extraction and Appendix L Groundwater modelling) from (Intera Geosciences Pty Ltd, 2023), BNR does not believe that the potential drawdown associated with the Proposal pose a significant impact to the Mount Hardman Creek GDE or associated vegetation communities based upon 1 mm drawdown within 700 m of the abstraction bore (or the wellsite) that recharges rapidly once pumping ceases.
– the likely cumulative impacts of the proposed development with those of pre-existing water-intensive activities and other drivers such as climate change.	PD Section 6.2 Water Resources (cumulative impact)
For ecological risk-based assessment, evaluate the likelihood and consequences of the impacts and their pathways based on the impact assessment and IPDs (outlined above), particularly for highly valued receptors and in 'hot spots' where impacts are especially likely. Consider that some impacts may be especially likely during particular phases of the proposed development, and describe these 'hot moments' and their associated risks to water-dependent ecological assets.	PD The only direct impact is groundwater drawdown. All other pathways to hydrogeological resources are risks. Likelihood is low with some (such as vertical migration) deemed non-credible. Section 5.3 - Water resources that relate to Unconventional Gas Development and Large Coal Mining Development
Water and salt balances	
Describe the proposed development's water requirements and on-site water management infrastructure, including modelling to demonstrate the infrastructure's adequacy under a range of potential climatic conditions, including extremes associated with predicted climate change.	PD Section 2.4.3 - Water Balance
Provide salt balance modelling that includes stores and the movement of salt between stores, and takes into account seasonal and long-term variation.	N/A
Indicate the vulnerability to contamination (e.g., from salt production and salinity) of, and the likely impacts of contamination on, the identified water-dependent ecological assets.	PD Section 5.3 - Water resources that relate to Unconventional Gas Development and Large Coal Mining Development Section 7 -Avoidance and Mitigation Measures
Identify how produced water, brine and waste from water treatment plants that are stored on site during operations will be managed and disposed of after operations cease, where applicable.	PD Section 2.4.2 - HFS Activities Attachment 11 - Table of Mitigation Measures (Water) Table 5-2 - Sump and pond calculations Section 2.5 - Decommissioning Pond design In accordance with WQPN 26 (DoW, 2013), surface ponds used for short-term containment of wastewater or solids that may leach contaminants, require synthetic membranes and need to meet specific requirements, including: •all fluid containment liners should have a coefficient of permeability of less than 2 × 1010 m/s •a minimum thickness of 0.75 mm •dual liners •leak detection All surface ponds will be constructed to meet these requirements.
Provide a quantitative site-level water balance model describing the total water supply and demand under a range of rainfall conditions and allocations of water for mining activities (e.g., dust suppression, coal washing), including all sources and uses.	PD Section 2.4.3 - Water Balance
Provide estimates of the quality and quantities of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events, and the likely impacts on water-dependent ecological assets.	PD Section 2.4.2 - HFS Activities ERD Section 5.2.5.2 - Contamination of land and soils from surface spills
Geochemistry (e.g., acid-sulfate soils)	
Identify the presence and potential exposure of acid-sulfate soils (including from oxidation arising during groundwater drawdown) and other geochemical sources of contaminants and extreme ph.	N/A

Identify the presence and volume of potentially acid-forming waste rock and fine-grained amorphous sulfide minerals and describe coal reject/tailings material and potential exposure pathways.	N/A
Identify other sources of contaminants, such as high metal concentrations in groundwater, leachate generation potential and seepage paths. Where identified, quantify potential contaminants in coal rejects and leachate with appropriate testing methods.	PD Section Section - 5.3.2 Water Quality of a Water Resource
Assess the potential impacts on and risks to water-dependent ecological assets, taking into account dilution factors and including solute transport modelling where relevant; representative and statistically valid sampling; and appropriate analytical techniques.	PD Section 5.3.1.1 - Groundwater Dependent Ecosystems
Describe proposed measures to avoid or mitigate risks of impacts on water resources, water users and water-dependent ecosystems and species, and provide evidence for the likely feasibility and effectiveness of these measures. Specify handling and storage plans for acid-forming materials (e.g., co-disposal, tailings dam, encapsulation) to reduce their risks to water-dependent ecological assets.	PD Attachment 11 - Table of Mitigations (Water)
Subsidence	
Provide predictions of subsidence impacts on surface topography, water-dependent assets, groundwater (including enhanced connectivity between aquifers) and the movement of water across the landscape (see CoA 2014b; CoA 2014c).	ERD Appendix L - INTERA 2024 As discussed in INTERA 2024 the rig supply bores will temporarily produce from the near-surface Liveringa aquifer. The aquifer is not suspect to experiencing subsidence and modern subsidence has not been documented in the Canning Basin. Subsidence was therefore not considered to be a potential risk for the project area and was therefore not assessed or evaluated.
– Consider multiple methods of prediction and apply the most appropriate method.	
– Consider the limitations of the applied method, including the adequacy of empirical data and site-specific geological conditions, and justify the selected method.	
– Consider the timing of subsidence impacts, identifying whether impacts will occur rapidly or develop over the longer term.	
Describe subsidence monitoring methods, including the use of remote or on-ground techniques, and explain the predicted accuracy of such techniques.	
Assess both conventional and unconventional subsidence. For project expansions, provide an evaluation of past or current effects of geological structures on subsidence and the implications for water resources and water-dependent assets.	
Consider geological strata and their properties (strength/hardness/fracture propagation) in the subsidence analysis and/or modelling. Anomalous and near-surface ground movements with implications for water resources and compaction of unconsolidated sediment should also be considered.	
Chemicals	
List the chemicals proposed for use in drilling and hydraulic stimulation of CSG production bores, including:	
– proprietary names (trade names) of compounds (e.g., fracturing fluid additives) being produced	ERD All chemicals that may be used as ingredients in drilling and hydraulic fracture is included in Appendix A. As per the requirements of Regulation 9 of PGER(E)R 2012, chemicals or substances must be disclosed for acceptance by DEMIRS before commencing activities where they are: •in, or added to, any treatment fluids to be used for drilling or hydraulic fracturing undertaken in the course of the activity •otherwise introduced into a well, reservoir, or subsurface formation in the course of the activity In addition, all chemicals to be used downhole under the Proposal must be included on the Australian Inventory of Chemical Substances (AICS) or are otherwise approved for use in Australia. The chemicals will be used solely for the activity purpose they will serve as stated under the EP. The constituents, toxicity, ecotoxicity, and bioaccumulation data of each chemical product or system will be disclosed
– chemical names and CAS numbers of each additive used in each of the fluids	
– general purpose and function of each of the chemicals used	
– mass or volume of each of the chemicals proposed for use and its maximum concentration (mg/L or g/kg)	
– ecotoxicology	
– any material safety data sheets for the chemicals or chemical products used.	
The use of drilling and hydraulic fracturing chemicals should be informed by appropriately tiered deterministic and/or probabilistic hazard and risk assessments, based on ecotoxicological testing consistent with Australian Government testing guidelines (see CoA 2012; NRMMC-EPHC-NHMRC 2009).	ERD All chemicals that may be used as ingredients in drilling and hydraulic fracture is included in Appendix A. As per the requirements of Regulation 9 of PGER(E)R 2012, chemicals or substances must be disclosed for acceptance by DEMIRS before commencing activities where they are: •in, or added to, any treatment fluids to be used for drilling or hydraulic fracturing undertaken in the course of the activity
Chemicals for use in drilling and hydraulic fracturing must be identified as being approved for import, manufacture or use in Australia (i.e., listed on the Australian Inventory of Industrial Chemicals; see CoA 2020b).	ERD All chemicals that may be used as ingredients in drilling and hydraulic fracture is included in Appendix A. As per the requirements of Regulation 9 of PGER(E)R 2012, chemicals or substances must be disclosed for acceptance by DEMIRS before commencing activities where they are: •in, or added to, any treatment fluids to be used for drilling or hydraulic fracturing undertaken in the course of the activity •otherwise introduced into a well, reservoir, or subsurface formation in the course of the activity In addition, all chemicals to be used downhole under the Proposal must be included on the Australian Inventory of Chemical Substances (AICS) or are otherwise approved for use in Australia. The chemicals will be used solely for the activity purpose they will serve as stated under the EP. The constituents, toxicity, ecotoxicity, and bioaccumulation data of each chemical product or system will be disclosed
Propose waste management measures (including salt and brines) during both operations and legacy after closure.	ERD Waste generated during the Proposal, including potential spill-contaminated soils and materials, will be separated and stored until an appropriately licensed waste contractor disposes of the waste at a licensed facility. Specifically, any controlled waste will be managed in accordance with the Environmental Protection (Controlled Waste) Regulations 2004. Employing an appropriately licensed waste contractor reduces the risk of other accidental release events given the contractor will be experienced in transfer and transport of waste

Drilling and hydraulic stimulation	
Describe the scale of fracturing (number of wells, number of fracturing events per well), types of wells to be stimulated (vertical versus horizontal), and other forms of well stimulation (e.g., cavitation, acid flushing).	ERD Section 2.4.1 Phase I and Phase II, a total of 20 wells on 10 well pads.
Describe proposed measurement and monitoring of fracture propagation, and specify associated uncertainties and challenges.	PD Attachment 11 - Table of Mitigations (Water)
Identify water source(s) for drilling and hydraulic stimulation, and specify the volumes of fluid and mass balance (quantities/volumes).	PD Section 2.4.2 - HFS Activities Section 2.4.3 - Water Balance
Describe the rules (e.g., water sharing plans) covering access to each water source to be used for drilling and hydraulic stimulation, and how the project proposes to comply with them.	No water sharing rules ERD Section 5.4.3.4.4 Local and regional use (show location of pastoral bores) The known locations of pastoral bores within the Development Envelope are plotted on Figure 5 34. The nearest pastoral bore is located at least 1.5 kilometres away from any proposed groundwater abstraction points (well sites).
Quantify and describe the quality and toxicity of flowback and produced water and how it will be treated and managed.	PD Section 2.4.2 - HFS Activities
Assess the potential for inter-aquifer leakage or contamination, and describe the risks to water-dependent assets if such leakage or contamination occurs.	PD Section 5.3.2 - Water quality of a water source
Closure, rehabilitation and post-development final landforms and voids	
Describe the timing and processes planned for cessation of operations and the closure of the development, particularly any risks of impacts on water-dependent assets that may arise during this phase (e.g., when dismantling and removing infrastructure). Explain how such risks will be avoided or mitigated.	PD Section 2.5 - Decommissioning Section 7 - Mitigations ERD Section 2.6 - Waste characterisation and management process
If appropriate, qualitatively describe the various final landform options that were considered and their likely legacy impacts on water resources. This context will be useful for justifying the choice of the proposed final landform and how it avoids or mitigates risks of legacy impacts on water resources.	N/A to unconventional gas
Ideally, describe how land disturbed by mining activities will be progressively rehabilitated to a safe and stable landform that does not cause environmental harm to water resources and is able to sustain one or more approved post-mining land uses (PMLUs). Give details of the consultation with regulators and the community about the intended PMLUs, the targets associated with their achievement, and how achievement of these targets may be hampered by, for example, site geology and climatic extremes.	N/A to unconventional gas
If requested by regulators, specify and justify the methods and techniques that will be used to achieve particular rehabilitation targets and milestones. Explain how these methods may be constrained by project-specific features (e.g., topography, climate, geology and hydrology).	N/A to unconventional gas
If appropriate, describe how the effectiveness of the proposed rehabilitation methods and techniques for protecting or restoring water resources will be monitored, and present details (e.g., parameters, sampling frequency) of a monitoring program for demonstrating successful achievement of the targeted PMLUs across the project area after mining or CSG extraction has finished. These monitoring programs should be linked to explicit milestones for completion of progressive stages of rehabilitation, and should include appropriate baseline data against which to judge the effectiveness of the rehabilitation.	N/A to unconventional gas
Describe the final landform and any voids that may remain after closure, and specify the predicted legacy impacts that may persist, such as ongoing effects on surface water and groundwater movements and water quality, erosion and sedimentation, and habitat fragmentation of water-dependent species and communities. Evaluate the adequacy of the modelling underlying these predictions, especially all sources of uncertainty.	N/A to unconventional gas
Assess qualitatively the likely long-term risks of impacts on water resources and water-dependent assets posed by various options for the final landform design, including complete or partial backfilling of mining voids. Assessment of the final landform for which approval is being sought should consider:	N/A to unconventional gas

– stability (e.g., resistance to erosion and slumping), soil geochemistry and quality (relevant for post-closure establishment of vegetation) and the likely effects of the final landform on long-term surface water and groundwater behaviour (e.g., fluxes and runoff) and on water quality, including salinity, pH, toxicity and concentrations of contaminants	N/A to unconventional gas
– geochemistry and its potential effects on seepage through waste rock (e.g., fully or partially refilled voids, remnant rock dumps) and on the quality of water exiting from mine adits and other post-closure sources	N/A to unconventional gas
– groundwater behaviour and rate and depths of water table recovery, including timeframe and final levels of stabilisation	N/A to unconventional gas
– available measures (and their likely effectiveness and feasibility) to avoid or mitigate legacy impacts from the final landform and any voids on water resources and water-dependent assets.	N/A to unconventional gas
Baseline data	
For groundwaters, surface waters and ecological water-dependent assets that have been identified in the risk-based assessment, present data that are sufficient to establish pre-development (baseline) conditions and that have been collected at an appropriate sampling frequency and spatial coverage of monitoring sites, ideally over a period sufficiently long to characterise the impacts of climatic variability.	ERD Appendix J - Local Groundwater Characterisation Results Appendix L - Groundwater Modelling PD Attachment 12 - Groundwater Management Plan
Groundwater	
Provide data from surveyed boreholes to demonstrate the varying depths of the hydrogeological units and associated standing water levels or potentiometric heads, including directions of groundwater flow, contour maps and hydrographs.	ERD Appendix L - Sections 2 and 3 in INTERA 2024
Present information from site-specific studies (e.g., geophysical, coring/wireline logging) to characterise the local stress regime and fault structure (e.g., damage zone size, open/closed along fault plane, presence of clay/shale smear, fault jogs or splays).	ERD Appendix L - Sections 2 in INTERA 2024 Maps of structural features in the study area (derived from Taylor et al., 2021) are presented in Section 2 of INTERA 2024. The rig supply bores are producing from the surficial Liveringa aquifer and the local stress regimes are not considered to be relevant to simulating the predictions of interest.
Provide site-specific values for hydraulic parameters (e.g., vertical and horizontal hydraulic conductivity and specific yield or specific storage characteristics, including the data from which these parameters were derived) for each relevant hydrogeological unit. In situ observations of these parameters should be sufficient to characterise the heterogeneity of these properties for modelling.	ERD Appendix L - Section 4 in INTERA 2024
Provide hydrochemical characterisation (e.g., acidity/alkalinity, electrical conductivity, metals and major ions) and a suitable suite of environmental tracers (e.g., heat; stable isotopes of water; tritium, helium, strontium isotopes) (e.g., Kurukulasuriya et al. 2022; OWS 2020) commensurate with the risks of the proposed development to water resources and water-dependent assets.	The only expected impacts to terrestrial water resources are associated with short-term drawdown impacts and the potential to impact GDEs in the project area. Environmental tracers are not considered relevant to the predictions of interest; therefore, they are not proposed for this project.
Provide sufficient data on physical aquifer parameters and hydrogeochemistry to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes. This should include time-series data for water levels and water quality that represent seasonal and climatic cycles.	ERD Appendix J - Local Groundwater Characterisation Results
Provide long-term groundwater monitoring data, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	ERD Appendix J - Local Groundwater Characterisation Results
Surface water	
Provide data for the hydrological regime of all watercourses, standing waters and springs across the site, including:	
– spatial, temporal and seasonal trends in streamflow and/or standing water levels	PD Section 4.2.4 - Surface Water and Waterways (Including Mount Hardman Creek) Section 4.2.5.1 - Groundwater Dependent Ecosystems
– spatial, temporal and seasonal trends in water quality data (such as turbidity, acidity, salinity, relevant organic chemicals, metals, metalloids and radionuclides).	N/a no planned discharges to surface waters (or groundwaters)
Ecology	

Provide clear statements of the goals of the baseline data, specifying how the information will address knowledge gaps (e.g., current ecological condition of water-dependent assets in the project area, potential impact pathways) and justifying the choice of parameters and measures.	PD Section 5.1 - Threatened and Migratory Species Attachment 1 - Valhalla Flora and Fauna Survey Report 2021 Attachment 2 - Targeted significant fauna survey ERD Section 5.1 - Flora and vegetation Section 5.3 - Terrestrial Fauna
Describe and justify the sampling program (e.g., sampling frequency, locations of impact and control sites) and collection methods for gathering appropriate baseline data on all ecological water-dependent assets that have been identified in the risk-based assessment. The data and methods used may also help address information gaps in the IPDs and be used to monitor responses to predicted impacts of the development and the effectiveness of mitigation measures.	PD Section 5.1 - Threatened and Migratory Species Attachment 1 - Valhalla Flora and Fauna Survey Report 2021 Attachment 2 - Targeted significant fauna survey ERD Section 5.1 - Flora and vegetation Section 5.3 - Terrestrial Fauna
Ensure ecological sampling methods reflect best practice, are quantitative if needed, and comply with relevant state or national monitoring guidelines (e.g., Queensland Government (2015) for sampling stygofauna). Identify plants and animals (including stygofauna and aquatic invertebrates) to the lowest feasible taxonomic resolution to optimise the value of the baseline data. Where possible, make baseline data publicly available.	PD Section 5.1 - Threatened and Migratory Species Attachment 1 - Valhalla Flora and Fauna Survey Report 2021 Attachment 2 - Targeted significant fauna survey ERD Section 5.1 - Flora and vegetation Section 5.3 - Terrestrial Fauna
Identify potential aquatic and terrestrial GDEs, using the method outlined by Eamus et al. (2006) and information from the GDE Toolbox (Richardson et al. 2011), the GDE Atlas (CoA 2023) and the GDE Explanatory Note (Doody et al. 2019).	PD Section 4.2.5.1 - Groundwater Dependent Ecosystems
Present information on the distribution of potential aquatic and terrestrial GDEs within and near the project area, and explain how their groundwater dependence has been ground-truthed and on which hydrogeological units they are likely to depend (see Doody et al. 2019).	PD Section 4.2.5.1 - Groundwater Dependent Ecosystems
Monitoring and management	
Describe the rationale for selected monitoring parameters and their sampling duration, frequency and methods, including the use of satellite or aerial imagery to identify and monitor large-scale impacts. Target monitoring programs to address key areas of uncertainty, especially for valued assets and water resources that are at greater risk of impacts from the proposed development.	PD Attachment 12 - Groundwater Management Plan Section 2 - Context, scope and rationale Section 3.1 - Groundwater Monitoring Program
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy guidelines (ANZG 2018) and relevant legislated state protocols (e.g., Queensland Government 2018).	PD Attachment 12 - Groundwater Management Plan Section 2 - Context, scope and rationale Section 3.1 - Groundwater Monitoring Program
Identify and justify monitoring sites representative of the diversity of potentially affected water-dependent assets and the nature and scale of potential impacts. Match suitably replicated control and reference sites (BACI design, Downes et al. 2002) to enable detection and monitoring of potential impacts.	PD Attachment 12 - Groundwater Management Plan Section 2 - Context, scope and rationale Section 3.1 - Groundwater Monitoring Program
Describe the processes employed to determine impact thresholds for water-dependent assets (e.g., threshold at which a significant impact on an asset may occur).	PD Attachment 12 - Groundwater Management Plan Section 2 - Context, scope and rationale Section 3.1 - Groundwater Monitoring Program
Describe proposed mitigation and management actions, and their adequacy, for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	PD Attachment 12 - Groundwater Management Plan Section 2 - Context, scope and rationale Section 3.1 - Groundwater Monitoring Program

Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts, and provide evidence of the likely success of these measures (e.g., case studies).	PD Attachment 12 - Groundwater Management Plan Section 2 - Context, scope and rationale Section 3.1 - Groundwater Monitoring Program
Propose adaptive management measures and management responses, giving details of trigger action response plans (TARPs) for valued assets and water resources that are at greater risk of impacts from the proposed development.	PD Attachment 12 - Groundwater Management Plan Section 2 - Context, scope and rationale Section 3.1 - Groundwater Monitoring Program
Groundwater	
Describe a robust groundwater monitoring program using dedicated groundwater monitoring bores – including nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing information on the groundwater regime and on recharge and discharge processes and identifying changes in quantities and quality of groundwater over time.	PD Attachment 12 - Groundwater Management Plan
Where reinjection schemes are proposed to manage wastewater (e.g., managed aquifer recharge), the monitoring program should include components specifically targeted at identifying any potential impacts from this management action.	[not applicable]
Surface water	
Identify and justify dedicated sites to monitor hydrology, water quality, and channel and floodplain geomorphology before, during and for a suitable period after the proposed development.	No planned dischages to surfgace or groundwaters. BNR has justified that there will be no impact to Surface Waters (Mount Hardman Creek) therefore no monitoring of surface water is required.
Describe a surface water monitoring program that will collect sufficient data to detect and identify the cause of any changes from established baseline conditions, and assess the effectiveness of mitigation and management measures. The program should:	
– include baseline monitoring data for physico-chemical parameters, as well as contaminants (e.g., metals)	
– compare physico-chemical data to national/regional guidelines or to site-specific guidelines derived from reference condition monitoring if available	
– identify baseline contaminant concentrations and compare these to national guidelines, allowing for local background correction (e.g., bioavailability) if required.	
Ecology	
Provide clear statements of the goals of the monitoring program, specifying how the information will address knowledge gaps about, for example, changes in abundance, composition and condition of ecological water-dependent assets in and near the project area. Ensure that the monitoring program is powerful enough to detect relevant changes that indicate significant impacts or where management and mitigation measures are not working as predicted.	PD Section 9.1- Groundwater Management Plan Attachment 12 - Groundwater Management Plan Section 2 - Context, scope and rationale Section 3.1 - Groundwater Monitoring Program
Describe and justify the monitoring program (e.g., sampling frequency, locations of impact and control sites) and collection methods for gathering appropriate monitoring data on all ecological water-dependent assets that have been identified in the risk-based assessment. Where possible, match the methods to those used in the baseline surveys so that the data are directly comparable and can be used to monitor responses to predicted impacts of the development and the effectiveness of mitigation measures.	*No ecological monitoring has been proposed given impacts are not deemed to be significant. Groundwater monitoring will enable BNR to determine the duration and recovery of groundwater drawdown having regard to standard seasonal variability. Trigger thresholds should these levels be exceeded will enable for additional monitoring programs to be triggered in the extremely unlikely event the groundwater levels do not recover rapidly.*
Ensure that all proposed ecological monitoring uses standard sampling methods that reflect best practice and are quantitative if needed. Identify plants and animals (including stygofauna and aquatic invertebrates) to the lowest feasible taxonomic resolution to optimise the value of the monitoring data, and strive to make these data publicly available.	*No ecological monitoring has been proposed given impacts are not deemed to be significant. Groundwater monitoring will enable BNR to determine the duration and recovery of groundwater drawdown having regard to standard seasonal variability. Trigger thresholds should these levels be exceeded will enable for additional monitoring programs to be triggered in the extremely unlikely event the groundwater levels do not recover rapidly.*
Describe how the monitoring data will be analysed and reported, specifying how the information will feed back into regular assessment of whether (and where) impacts are occurring and whether mitigation measures are being effective. Ensure that this information is explicitly linked to TARPs that guide adaptive management of impacts of the proposed development on ecological water-dependent assets in and near the project area during and for a suitable period after the proposed development.	PD Attachment 12 - Groundwater Management Plan No ecological monitoring has been proposed given impacts are not deemed to be significant. Groundwater monitoring (Attachment 12) will enable BNR to determine the duration and recovery of groundwater drawdown impacts having regard to standard seasonal variability. Trigger thresholds should these levels be exceeded will enable for additional monitoring programs to be triggered in the extremely unlikely event the groundwater levels do not recover rapidly.
Specify and justify all proposed management and mitigation measures to protect ecological water-dependent assets that were identified in the risk-based assessment. Present relevant evidence to demonstrate the likely effectiveness of these measures. Specify how the data to be collected in the monitoring program will illustrate the effectiveness of these management and mitigation measures, and present relevant TARPs describing this adaptive management.	PD Attachment 11- Table of Mitigation Measures (Water)

Cumulative impacts	
Assess the condition and likely responses of all water-dependent assets and water resources likely to be cumulatively impacted by the proposed development combined with all developments (past, present and/or reasonably foreseeable) and other water-intensive activities.	ERD Appendix L - Sections 5 and 6 in INTERA 2024 PD Attachment 3 Response 17 The likely responses of water resources to abstraction from rig supply bores are described in Sections 5 and 6 of INTERA 2024 and in RFI Response 17. As indicated in these documents, the rig supply bores will only operate for a short time (~6-months each) and the overall impacts on water resources are expected to be negligible.
Assess the cumulative impacts on potentially affected water-dependent assets and water resources, considering:	ERD Appendix L - Sections 5 and 6 in INTERA 2024 PD Attachment 3 Response 17 The likely responses of water resources to abstraction from rig supply bores are described in Sections 5 and 6 of INTERA 2024 and in RFI Response 17. As indicated in these documents, the rig supply bores will only operate for a short time (~6-months each) and the overall impacts on water resources are expected to be negligible.
– the full extent of potential impacts from the proposed project (including whether there are alternative options for infrastructure and mine configurations which could reduce impacts)	PD Section 6 - Consequential and Cumulative Impacts ERD Section 7 - Cumulative Impact Assessment
– all stages of the development, including exploration, operations and post-closure/rehabilitation	Proposal is an exploration and appraisal project ONLY ERD Section 7 - Cumulative impacts
– the likely spatial magnitude and timeframe over which cumulative impacts will occur (ensuring that the analysis has sufficiently broad geographic and temporal boundaries to include all potentially significant impacts)	Proposal is an exploration and appraisal project ONLY ERD Section 7 - Cumulative impacts
– opportunities to work with other water users to avoid or mitigate potential cumulative impacts to meet specified environmental objectives.	ERD Section 5.5.3 As detailed in Section 5.5.3, the Development Envelope overlays two pastoral stations (leased Crown land)—Blina Station and Noonkanbah Station—that are leased for pastoral grazing purposes. Pastoral bores are not monitored for water abstraction.