Technical Assessment

Lake Eyre Basin RIS

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Acronyms

APPEA	Australian Petroleum Production and Exploration Association Ltd
BTEX	benzene, toluene, ethylbenzene, and xylene
CSG	coal seam gas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DES	Department of Environment and Science
DP	Designated Precinct status
DSA	Design Storage Allowance
EA	Environmental Authority
EIS	Environmental Impact Statement
EOW	End of Waste
EP Act	Environment Protection Act
GBA	Geological and Bioregional Assessment
GDE	groundwater dependent ecosystems
GHG	greenhouse gas
IEA	International Energy Agency
km^2	square kilometres
L	litre
LEB	Queensland Lake Eyre Basin
LNG	liquefied natural gas
MRL	Mandatory Reporting Level
ML	mega litre
OGIA	Independent Office of Groundwater Impact Assessment
PFAS	per and polyfluoroalkyl substances
QRC	Queensland Resources Council
RDM	residual drilling mud
RIDA	Regional Interests Development Approval
RIS	Regulatory Impact Statement
RPIA	Regional Planning Interests Act 2014
SEA	Strategic Environmental Area
UWIR	Underground Water Impact Report

1 Introduction

EHS Support Pty Ltd (EHS Support) on behalf of the Australian Petroleum Production and Exploration Association Ltd (APPEA) and the Queensland Resources Council (QRC) has completed a comprehensive review of the Queensland's Department of Environment and Science (DES) report titled "*Consultation Regulatory Impact Statement for the Queensland Lake Eyre Basin*", dated June 2023 (hereafter referred to as the RIS). The purpose of the review was to provide a technical assessment of the analysis and recommendations contained in this report as part of general public consultation process.

As described in the RIS, "*the broad goal of the Queensland Government is to ensure that adequate long-term protection of the Queensland Lake Eyre Basin rivers, watercourses and floodplains are achieved while supporting sustainable economic development in the region. The Queensland government also has important goals concerning Path to Treaty and supporting First Nations, cultural social, economic and ecological priorities and aspirations, building from protection of Country and enabling greater involvement in decision-making. The intent is to develop a long-term framework for the Queensland LEB to deliver on these goals collaboratively with stakeholders and through community consultation*" (p. 1).

The RIS states that a "*legitimate question for the Queensland government is how to best anticipate and proactively manage future risks and threats, and address potential fundamental shifts in risk* ***before they become major problems or widespread or create irreversible ecological and cultural impacts*** *which may have national and international ramifications*" (p. 2).

Through this assessment process the RIS lays out a combination of alternatives/changes to the spatial mapped protections, regulatory for approval/management of unconventional oil and gas development and attributes to be preserved within the Queensland Lake Eyre Basin (LEB) natural systems. The stated goal is "*finding the optimal mix of spatial, regulatory, and environmental attribute approaches as well as proposed responses to First Nation Priorities* ***will enable government to best protect the Queensland river systems, and at the same time support economic prosperity across the region of the long term***" (p. 3, emphasis added).

There is no contention by APPEA or the QRC that the LEB rivers, watercourses, and floodplains are not important resources/habitats that require protection and careful management associated with all current and future activities within the region (agricultural, oil and gas, mining and tourism). However, what is contended is that the nature and scale of unconventional gas/oil exploration and development requires large-scale regulatory changes and that the current regulatory process and associated management approaches are insufficient to ensure long term protection. Our assessment below provides key technical clarifications to address inaccuracies contained in the report, provides a review of cited documents and systematically and critically provides a more comprehensive assessment of the nature of unconventional oil and gas development relative to conventional and coal seam gas (CSG) developments which are effectively being developed and operated within the existing regulatory framework (including areas of the LEB River both in Queensland and South Australia).

Our review highlights the unbalanced nature of the assessments and critical information that was not considered in the RIS. The omission of this information has resulted in an inaccurate assessment of the risks and associated conclusions about the need for regulatory change to support protection of resources and habitat in the LEB.

2 RIS Review

The stated purpose of the RIS, *"is to lay out options for proposed government action and to seek community benefits on the merits, benefits, limitations and costs of them"* (p 6). Further, "*the Queensland government publicly committed to release a consultation RIS as a means to seek community preferences, feedback and responses to options for delivering the* ***best framework for river/floodplain protections in the Queensland LEB, which also support sustainable economic activities.*** *For this reason, the options provided in the consultation RIS are* ***presented in a neutral way, with no preferred or recommended directions at this point****" (p 6, emphasis added).*

We concur that consultation is a critical component of any effective regulatory and project approval process, which relies on the effective transfer of complex information to stakeholders to aid in the development of understanding and provision of comments. As highlighted in the statement above, one of the stated objectives of this report was to **provide a neutral or balanced assessment** as part of this consultant process. In this context, it would be our expectation that the RIS would provide an unbiased assessment of data using technically accurate and scientific (where available) assessments of data. However, from our detailed review there are numerous instances where technical inaccuracies, partial citations of report findings, exclusion of key information, and phrasing does not indicate that this is an unbalanced assessment. This has resulted in factual misrepresentations, misconceptions, and biases that flow through to the recommendations. These are summarised in **Table 2-3**.

For the purposes of the RIS, unconventional gas is defined as comprising *"gas produced from complex geologic systems that prevent or significantly limit the migration of gas and require innovative technological solutions for extraction. There are numerous types of unconventional gas such as coal seam gas, deep coal gas, shale gas and tight gas".* This is important as current DES is already regulating through the issuance of Environmental Authorities (EA) unconventional gas development in Queensland, this includes the large scale unconventional (CSG) activities in South-east Queensland. These EA conditions, example refer **Table B-1**, have been effective at managing risks associated with unconventional gas development and effectively regulating/controlling all facets of exploration and development of unconventional gas resources. Further, the high-risk activities described in the RIS have specific conditions that require robust evaluations of risk (and associated risk management decisions) and limit the likelihood and consequence of environmental impacts.

Unfortunately, the RIS did not include a discussion of the current framework of EA conditioning and its effectiveness in managing the high-risk activities identified in the RIS, which is a critical omission. For example, Pg 12 of the RIS notes that despite ~180 wells which have been drilled and hydraulically fractured in the LEB, the absence of regulatory reporting requirements in Queensland of 'unconventional' oil or gas extraction as distinct activities means the precise level or nature of current hydraulically fracturing activity, and associated intensity of industrialization, in the Queensland LEB or on floodplains is not completely clear. As such, the precautionary approach must be adopted. This statement is not supported by evidence and inherently has a complete disregard for the reporting requirements that already exist to DES as part of the EA conditions and DNRME associated with exploration, appraisal, and development activities[1].

Further, it is industry's goal to implement projects in a sustainable manner that does not cause irreversible harm to the environment and at the same time provides economic opportunities in the region, as well as royalties to government that can support critical infrastructure and social services

[1] https://www.resources.qld.gov.au/__data/assets/pdf_file/0010/273394/diagram-pg-wells-drill.pdf

across the State and regions. As highlighted in the RIS, current conventional oil and gas development activities are occurring in the LEB (both in Queensland and SA) that do have interactions with the floodplain and rivers, and as highlighted in the document *"are generally regarded as having minimal negative impacts on water quality and overland flow"* (p. 1). Based on an accurate assessment of the scale of potential development, abilities to leverage existing petroleum infrastructure and regulatory frameworks, and well-developed best management practices already in use, it is reasonable to expect that the outcomes from unconventional development will be similar to or better than the outcomes from historical conventional oil and gas development activities.

Interestingly, despite the overall bias in the RIS against unconventional gas, this absence of impact from historic and existing petroleum activities in the LEB is further supported by other statements contained within the RIS which are further discussed below.

2.1 Potential Issues Identified by the RIS

In general, the RIS presents the following high-level issues:

- Management of environmental threats associated with unconventional gas exploration and extraction and mineral exploration.
- A lack of regulatory controls and/or oversight.
- Poorly mapped spatial boundaries of the hydrological features within the LEB.
- The need for better assessment and protection of all the features present within the LEB.

Each of these issues will be compartmentalised and discussed in the sections below to clarify the numerous incidents where technical inaccuracies, partial citations of report findings and phrasing within the RIS Report may lead to an unbalanced assessment of activities.

In addition, it is important to acknowledge that in the problem definition (Section 3.4 of the RIS Report), DES noted that sustainable economic activities need to be enabled and has recognized that current resource related activities have generally not had major negative impacts on the region's river systems. However, they have indicated that there are major concerns with whether the current planning and regulatory frameworks will be strong enough to protect the river systems from potential impacts from future unconventional oil and gas extraction on the floodplains and rivers. DES has then stated that in order to "*protect these river systems and prevent widespread and irreversible impacts, a new and precautionary approach may be needed to ensure risks are avoided in culturally and ecologically sensitive areas*" (p. 12).

Further, on the use of the precautionary principle, the RIS argues that the precautionary principal is one where risks are avoided (i.e. advocating zero risk). As stated in the RIS, "t*o properly protect the river systems and prevent the potential for widespread and irreversible impacts from these activities, it could be argued that a new and precautionary approach may be required; one which can ensure* ***risks are avoided*** *in ecologically sensitive areas" (p 47, emphasis added)*. This statement is at odds with the generally agreed use of the precautionary principal. That is under the United Nations Global Compact as per Principle Seven: Environment[2], "*Precaution involves the systematic application of risk assessment, risk management and risk communication. When there is reasonable suspicion of harm, decision-makers need to apply precaution and consider the degree of uncertainty that appears from scientific evaluation. Deciding on the "acceptable" level of risk involves not only scientific-technological evaluation and economic cost-benefit analysis, but also political considerations such as acceptability to the public. From a public policy view, precaution is applied as long as scientific information is incomplete or inconclusive and the associated risk is still considered too high to be*

[2] https://unglobalcompact.org/what-is-gc/mission/principles/principle-7

imposed on society. The level of risk considered typically relates to standards of environment, health and safety".

In review of this report and documents referenced, the magnitude of potential effects described in the RIS Report are not supported. The development of more than 180 wells with no major negative impacts on the regions river systems and the magnitude of development in South Australia within a similar physiographic setting all indicated that the potential effects of both conventional and unconventional oil and gas development can be effectively managed. In the context of this report the precautionary approach has been interpreted to be and has been applied in the recommendations as a zero risk approach where by development is precluded. This type of approach is at odds with the objective of balance economic activities with environmental protection. No activities (even existing activities such as agriculture and tourism) are zero risk. Rather what should be considered is whether risks can be effectively managed such that cumulative impacts are acceptable and/or irreversible harm does not occur.

2.1.1 Management of Environmental Threats Associated with Unconventional Gas and Mineral Exploration and Extraction

The RIS has emphasized that the potential for unconventional oil and gas development within the Queensland LEB "*presents challenges to the future health and integrity of these sensitive areas"* (p. 1) with the impacts associated with industrialized processes including as stated (p. 2):

- *"Intensive hydraulic fracturing techniques and associated requirements for substantial greater volumes of water, use of chemicals, and the generation of contaminants, wastewater, and other processes;*
- *Accidents leading to pollution of the waters of Kati-Thanda Lake Eyre, and its rivers and floodplain systems could potentially be catastrophic for nature, for the people and the economic and social prosperity of the region; and*
- *Major disruptions to the ecological processes and ecosystem functionality of the region which depend on overland flows and alluvial recharge process, could be detrimental and potentially irrevocable outcomes for the region".*

However, at the same time, the RIS Report acknowledges that conventional oil and gas development activities occurring in the LEB have had minimal impacts on water quality and overland flow. Importantly, this acknowledgment occurs during a time when the regulation and environmental controls may not have been as rigorous as it is today. Therefore, this begs the question; what are the main differences between conventional and unconventional oil development that would cause such an increase in risk?

The answer is that the surface and subsurface infrastructure, technologies, and controls used for unconventional development is largely the same as that for conventional development, and there is no inherent difference in the overall level of environmental risks between the two. The level of risk is dependent on the specific characteristics of the individual development, and unconventional oil and gas development can pose less risk than conventional. For example, CSG developments in the Surat Basin use relatively shallow and simple well construction as compared to conventional wells. Further, although CSG fields may require a greater density of wells, the pad construction has a generally smaller footprint. Additionally, although large volumes of CSG produced water are generated, it is largely non-toxic and benign (aside from certain risks associated with salinity), and can be readily treated and supplied for beneficial uses. Shale gas development, while producing poorer quality water (potentially containing hydrocarbons) than CSG, produces smaller volumes of water than CSG and conventional oil wells. Currently, conventional oil and gas development (which has been demonstrated to have not resulted in irreversible harm) stores oily water in open ponds.

As noted by DES, conventional and unconventional wells are subjected to hydraulic fracturing and stimulation activities, however unconventional wells (particularly shale gas wells) can use larger volumes of water in the hydraulic fracturing process. However, there is no major difference in the risk profile between conventional and unconventional wells for a number of reasons, which are outlined in **Table 2-1** below.

Table 2-1 Difference Between Conventional and Unconventional Wells

Risk Process/Asset	Difference between Conventional and Unconventional
Equipment/Use	Both conventional and unconventional wells use similar drilling techniques, drilling mud systems, and equipment in the drilling process. However, many historical conventional wells that were completed were at a greater risk of failure due to: 1. Outdated casing construction methods; 2. Casing construction materials (casing more susceptible to corrosion, pitting and degradation); 3. Well abandonment or plugging process; and 4. Bacterial degradation of cement. Therefore, construction of unconventional wells using the current best practices are at a lower risk of failure compared to historic conventional assets.
Above grade infrastructure	Above grade infrastructure to support the drilling and operations of the wells are similar with respect to well heads, above grade oil, condensate storage, and water storage infrastructure. The main differences are the sizes/capacity of the infrastructure, which are specific to the individual development. Notable is that ancillary infrastructure such as camps, laydown areas, borrow pits etc. (excluding the well site) and large-scale fluid storage can typically be constructed outside the river and floodplain.
Water Production (Flow back to Surface)	Conventional oil wells (already operating) produce more water and have larger water management requirements than shale, tight gas, and deep coal as the intrinsic permeability of these formation (outside the hydraulically fractured areas) are very low.

Risk Process/Asset	Difference between Conventional and Unconventional
Water Use/Operational Requirements	Deep coal or shale gas wells may use surface to inseam drilling methods with horizontal laterals that extend over large distances (potential kilometres). These types of methods use higher water volumes (potentially up to 20 million litres) with water usage proportional to the length of the perforated casing intervals used to collect gas/oil. Wells with larger horizontal laterals inherently have lower well densities and therefore less surface infrastructure. Alternatively vertical unconventional wells with smaller perforated intervals or limited lateral sections use a lot less water for hydraulic fracturing and these volumes can be similar to the those used in the hydraulic fracturing of CSG wells. The water requirements for shale gas wells are mitigated by a number of factors including the recycling of flow back for use in subsequent hydraulic fracturing events, and or the use of produced water from conventional oil wells to support hydraulic fracturing[3]. This reduces the need for access to surface water or groundwater resources. In the context of development, it is improbable that surface water during the seasonal floods or shallow groundwater (which is in hydraulic communication with surface water) would be the source of this water. Low volumes (under the appropriate licensing) would be sourced from deeper bores and given the factors described above would not be as large as inferred in the RIS. Further the number of wells completed in a year (especially in seam wells) would be low due to the extended drilling time frames and correspondingly annual water usage would be low.
Water Storage and Recycling	Unconventional gas and oil wells in tight formations (for example shale) use water to support the hydraulically fracturing and the flowback and produced water is only an increment (40 to 60%) of the injected volume.
Water Chemistry (Hydraulic Fracking)	Typically, conventional wells are not hydraulically fractured, but wells can be stimulated using other methods and/or where secondary recovery is occurring (using injector wells), large volumes of water containing chemicals are continuously injected into the formation. Further, the chemistry of hydraulic fracturing systems are not significantly different to those used in CSG and primarily comprise non-toxic and/or biodegradable compounds. An effective hydraulic fracturing risk assessment framework (as prescribed in the EA conditions, refer **Section 3.1**) and risk management practices have been established for CSG development. This type of framework would be equally effective for other unconventional gas or oil wells. The report provides no consideration of the numerous hydraulic fracturing risk assessments and other related assessments that have been completed to date risk assessment framework. In addition, the report disregards the chemical make-up and nature of stimulation fluids. For example, Fielder et al., 2019, which is a key reference used in the RIS Report states "*The fluid used in this process is made up of predominantly water and sand or proppant (e.g. nutshells, ceramics or bauxite) (99 %) and a small percentage of chemicals (e.g., sodium hypochlorite, detergent additives, vinegar) which holds the fractures open after the initial injection"… "The risk to public health or to the environment from these fluids is considered negligible by the Commonwealth Government" ... "Furthermore, the use of BTEX chemicals (benzene, toluene, ethylbenzene, xylene) as fracking agents has been banned (pg 9)*".

The potential for water contamination remains a low risk, simply because certain actions with the EA approvals are not permitted and appropriate risk management actions are implemented. For

[3] Refer NT Fracking enquiry, https://frackinginquiry.nt.gov.au/inquiry-reports?a=494293 *"It is increasingly common practice for proponents to recycle as much of the flowback fluid from the hydraulic fracturing operations as possible. This can comprise up to 30-80% of the water requirements for the operation, depending on the amount that reports as flowback, and therefore, reduce the demand for groundwater"* (Pg 119).

example, industry is precluded from discharging wastewater to the river, chemical management requires secondary containment and/or other spill controls, and residual drilling materials must be managed in a manner where they have no potential to contact surface water. Discharges of wastewater or flow-back from hydraulic fracturing activities directly to surface water are also not authorized by DES and all produced water/flow back must be contained. Therefore, the potential for impacts are limited to incidental spillages and/or accidents, which would be localised, and it is improbable that this would cause large scale downstream contamination or flocculation of contaminants as described in the RIS. Further operational controls are established to contain releases and any releases during operations can be easily remediated and the site rehabilitated.

Further, it is critical to emphasize that despite the scale of CSG development (which is considerably larger than any probable unconventional shale gas project in the Eyre Basin) there have been no events resulting in irreversible harm, catastrophic events, or major disruptions to ecological processes and ecosystem functions. No discussion of the success of the CSG industry (an unconventional gas source that often requires hydraulic fracturing) in management of risks was provided in the document and it is expected that implementation of processes and systems already developed would have similar successful outcomes for unconventional gas/oil development in the LEB.

2.1.2 Lack of Regulatory Controls

The RIS states "*the risks of future environmental and cultural harm, and impacts on non-resources based economies, there is a clear case for considering options to both improve the extent of regulatory reach (spatial) and the regulatory toolkit itself"* (p. 43). As presented in **Section 2.1.1**, we argue that unconventional developments are not likely to present an appreciable increase in risk as compared to conventional development. From the relevant contents of the RIS, it seems that the Lake Eyre Basin Stakeholder Advisory was not adequately advised of the effectiveness of existing regulations and maturity of environmental conditioning (as part of the EA process) and the effectiveness of industry practices (including leading practices) to avoid, manage, and mitigate risks. This is explained in more detail in **Table 2-2**.

Further, throughout the assessment numerous inferences are provided to the lack (absence) of regulatory reporting requirements, which is not an accurate reflection of the regulatory environment for the oil and gas industry. For proponents conducting activities within an oil and gas tenure, EA-related reporting requirements include:

- Firstly, as part of the EA application process, the numbers/intensity of the proposed activities are required to be provided (and based on this, constraints limiting the activities, and where available the location of where the activities can be conducted are set out in the EA).
- Notification of various matters, including, but not limited to, loss of well integrity, unauthorised releases of contaminants to waters or land, the use of *restricted stimulation fluids* (i.e. stimulation fluids containing BTEX), changes in water quality in landholder bores over specified thresholds.
- Submission of a Plan of Operations, which has a maximum life of five years identifying existing and proposed disturbance (including calculation of estimated rehabilitation costs (ERC)).
- Submission of various, and regular, monitoring reports and/or data as required by the EA, including information and data regarding monitoring of hydraulic stimulation flowback fluids.
- Completion of a hydraulic stimulation and chemical risk assessment applicable for any stimulation activities (the required content of these assessment reports is extensive, and

covers chemical properties (including PBT properties), risks to groundwater, risks to water supply bores, risks to surface water, and other matters. These reports are required to be provided upon request.

In addition, the Water Act 2000 requires petroleum tenure holders to submit a "Baseline Assessment Plan", which identifies all water bores within a tenement and a timeframe for undertaking baseline assessments for each bore. The baseline assessments are required to be completed prior to commencement of production or production testing. Detailed bore assessments are also required in some cases to establish whether a water bore has impaired capacity due to extraction of underground water. Make good agreements are required in cases where a bore has or is likely to have an impaired capacity. In most cases, petroleum tenure holders are also required to prepare and submit an underground water impact (UWIR) report within 14 months of commencing production and periodically throughout life of a tenure. The purpose of an UWIR report is to assess potential impacts of underground water extraction as a result of production, and to identify management strategies to mitigate such risks. A monitoring strategy is also required to ensure that aquifers are responding as predicted.

In combination with these requirements, DES conducts routine inspections and audits of operations and compliance with EA conditions, and there are numerous statutory reporting requirements pertaining to the Water Act 2000 and Petroleum and Gas (Production and Safety) (P&G) Act 2004. For example: There were 90 compliance activities (31 site inspections and 59 desktop actions) of CSG compliance and enforcement activities carried out by the department during the 2020–21 financial year, refer https://environment.des.qld.gov.au/__data/assets/pdf_file/0026/254654/coal-seam-gas-compliance-enforcement-report-2020-21.pdf.

2.1.2.1 Comparison of Historical and Current Regulatory Programs

Section 4 of the RIS highlights changes in the regulatory framework that have occurred with the repeal of the Wild Rivers Act 2005 in 2014 and introduction of the Regional Planning Interests Act 2014 (RPIA). As part of the RPIA, sections of the LEB Rivers were declared as a Strategic Environmental Area (SEA), including a Designated Precinct status (DP) where certain activities are identified as unacceptable uses. Petroleum activities (oil and gas extraction) are currently permitted under this framework. It is also notes that in 2014 critical parts of the Queensland LEB river systems (previously mapped) were omitted.

The RIS (pp 13 to 17) has indicated that the post-2014 protected areas were reduced in area compared to the high preservation areas and special floodplain management areas contained within the pre-2014 legislation. The pre-2014 legislation declarations did not limit petroleum tenures, however there were restrictions on the type of infrastructure permitted (authorized petroleum activities) within areas requiring a higher level of protection. The post-2014 legislation allows all petroleum activities subject to demonstrating that the activities do not result in widespread or irreversible impact and obtaining a regional interest development approval.

In the former regulation (pre-2014), the RIS notes that the following activities were excluded from authorized petroleum activities:

1. Processing and storage facilities including dams.
2. Borrow pits.
3. Permanent campsites/workforce accommodation.
4. Waste disposal.
5. Other supporting infrastructure (e.g., sewage treatment plants).

Further, the RIS notes that conditions were imposed to limit the nature and size of authorized activities and ensure impacts to natural values were minimised, including the size of temporary accommodation, proximity to water courses, preclusion of direct or indirect discharges to water or land, preclusion of waste disposal, and a requirement for progressive rehabilitation with beds and banks of watercourses.

Notably the old regulations also placed prohibitions on non-resource activities (for example agriculture and animal husbandry) in high preservation areas, special floodplain management areas, floodplain management areas, preservation areas, and nominated waterways.

In the context of regulation moving forward, the application of a tiered structure of authorised petroleum activities within sensitive areas would make sense, as numerous activities have low potential for impact and/or a small disturbance footprint. For future development, the framework of approval of lower disturbance/lower risk infrastructure within higher protection areas and the preclusion of set infrastructure from these areas would be typically viable for permanent camps, borrow pits, waste disposal facilities, support facilitates, and dams.

The combination of deviated wells or wells with horizontal laterals would facilitate the ability to establish well pads on the edges of river channels, and in combination with smaller well pads with minimal infrastructure (for example, nominal tank storage) and underground pipeline infrastructure to more comprehensive facilities and/or temporary development/laydown areas (which are progressively rehabilitated), the magnitude of disturbance could be effectively managed.

As discussed further in **Section 2.1.1** the risks associated with hydraulic fracturing are misunderstood and overinflated within the RIS, which is confusing because DES has an effective existing framework for assessment of risks. This framework has successfully been used on CSG hydraulic fracturing for 10 years with no failure of annular seals recorded (potentially allowing for vertical movement of injected fluids) and no major releases of chemicals or flowback to the receiving environment (notwithstanding the typically low toxicity of hydraulic stimulation fluids).

In the assessment of planning structure, the RIS Report states that "*modern regional planning is the weighing of land use constraints and opportunities in conjunction with public consultation, to enable sustainable planning outcomes to be prioritized"* (p. 17). The document in this section notes that some 1700 wells have been drilled to date in the Queensland LEB and comprehensive regulatory framework is currently in place that guides these activities. The RIS notes that recently there has been interest in the potential to develop unconventional gas and oil resources and in this context "*consideration of the adequacy of the protections for the LEB must consider the effectiveness of the existing regulatory framework for both current and future activities"(Id).*

The track record to date in the LEB and the effectiveness of regulation of CSG and other developed CSG basins of Australia (such as Surat and Bowen Basins) provides a clear demonstration of the effectiveness of the current regulations with efforts to avoid, manage, and mitigate impacts, providing an effective means for long term management while providing economic benefits to the State.

The basis of the RIS statements that the regulatory framework is not sufficiently protective for unconventional oil and gas development is outlined as followed (pp 18 to 24):

- Reference to studies completed by Redleaf (2018) and Cote (2022) which have stated that the regulations are not sufficiently protective, although detailed descriptions and citations from these reports are not provided.

- Consistent with the discussion above, emphasising that the definition of sensitive environments is limited and does not include critical features of the Queensland LEB. For example cumulative consequence to the largest internal drainage system in Australia.
- Describing the LEB hydrological environments as highly variable, unpredictable, and not fully understood and then providing an unsupported opinion that it is challenging to condition/authorize under an Environmental Authority.
- Stating without support that the EP Act would require amendments to integrate the full risk of sensitive receiving environments noting that these systems are complex and have many environmental and physical variables and citing additional studies completed by Hamilton (2005).

Furthermore, numerous statements do not accurately represent the full findings of the reports such as Redleaf (2018) and Cote (2022). We consider this disingenuous and a deliberate effort to develop an artificial construct that does not reflect the success industry has had to date in management of risks and environmental stewardship.

On Page 20 of the RIS, a table is provided that provides a regulatory analysis of potential threats and impacts from existing and future development activities. For simplicity our response to each of the relevant acts and the identified limitations of management tools is provided in the table below.

Table 2-2 Regulatory Analysis of Potential Threats and Impacts from Existing and Future Development Activities

Relevant Act	RIS Identified Deficiency	Technical Response
Water Act	**Monitoring of Groundwater** - No risk identified.	The Underground Water Impact Report (UWIR) process has been well defined on CSG projects and provides a robust framework for assessment of cumulative impacts on groundwater, springs, and groundwater dependent ecosystems. Note: for low-risk tenures The Water Act outlines circumstances where a resource tenure holder may be exempted from providing an UWIR or final report. However, the Water Regulation 2016 does not currently prescribe any circumstances in which a tenure is taken to be a low risk resource tenure. As such this exemption cannot be used at this time.
Environment Protection Act	**Water Quality Objectives/Environmental Values** – No established environmental values or water quality objectives for the LEB under the EP (Water and Wetland Biodiversity) Policy 2019. There is a risk that existing objectives/values are unsuitable for the unique water related issues of the LEB .	Technical studies that are conducted as part of an EIS process or other environmental approval could be used to define relative values and objectives. The EIS process and EA conditions for petroleum activities requires an assessment of both hydraulic, physical, and chemical impacts on surface water and groundwater quality. A requirement for completion of a well-considered, site-specific assessment for the LEB does not require an amendment to the Act.
	Water Management – CSG water management policy provides guidance to assist CSG operations in determining management solutions for produced water, but there is no equivalent policy for Shale/Tight Gas.	The process of management of water requires the completion of process/site specific risk assessment to aid in the determination of management solutions. This process is applicable to any water management activity. In the context of risks there are not major differences in the risk profile between conventional oil and gas produced water, CSG water and Shale/Tight Gas. The hydraulic fracturing processes and chemicals used and constituents present and tested in flowback/produced water are similar. In fact, the risks associated with water management can be considered lower based on the volumes of flowback from Shale and Tight gas being orders of magnitude smaller than those from conventional reservoirs or CSG wells.

Relevant Act	RIS Identified Deficiency	Technical Response
Regional Planning Interests Act	**Regulation of Storage Structures** – There is a risk that if a flood occurred contaminants could be release from these liquid storage areas to sensitive environmental areas.	As described above, the volumes of flow back from unconventional wells (shale and tight gas) are orders of magnitude lower than that from conventional and CSG wells. Large scale ponds are not required for water management and inherently more stable structures with smaller footprints (for example tanks) can be utilised with transfer of fluids out of the sensitive area for reuse, recycling, and treatment. Risk can be effectively managed through engineering and management controls.
	Extent of SEA/DP – Mapped extent of SEA/DP does not include all watercourses and floodplains and water storage dams could be constructed.	Large scale water storage dams do not need to be constructed on the floodplain to support tight/shale gas development. The process can involve the delivery of water in stages to temporary structures that are removed at the end of the fracturing. This work can be conducted in the dry season. For example, concrete panel tanks are increasingly used in the resources industry for water storage in lieu of smaller ponds. These structures can be strategically placed outside of sensitive areas and/or in locations that are not prone to flooding, and can be dismantled when no longer required and reconstructed elsewhere. Further, contemporary panel tanks are constructed on a prepared hardstand surface, are typically double-lined and equipped with interstitial liquid collection and detection. This configuration allows even small leaks readily detected and contained, and the risk of high-volume release events from these structures is low.
	Land Use Suitability – P&G – No planning mechanisms exist for precluding high risk activities. Restrictions on authorised activities located in sensitive areas would address risk.	As described above the management of petroleum activities consistent with the historic authorised petroleum activities can be effectively used to limit activities in sensitive areas in combination with engineering and management controls (and associated EA conditions) for authorised activities. The establishment of well pads, drilling and hydraulic fracturing can be conducted in a manner where risks are minimised and do not have the potential for irreversible harm.
	Environmental Attributes – Regional Interests Development Approval (RIDA) – There is a risk that activities impact on environmental attributes not considered in the RIDA, including geomorphic process, riparian functions, and wildlife corridors.	The EIS process and streamlined EA conditions for petroleum activities require assessment of these processes and the proponent will need to demonstrate that impacts are avoided, managed, and mitigated. Supplemental studies would have to be conducted to support approvals.
	Landuse suitability – infrastructure – All environmental attributes are vulnerable to the impacts of linear and non-linear infrastructure.	Proponents have successfully established and maintained infrastructure in the LEB associated with the 1700 wells that have been drilled to date. Design and construction practices have been successfully developed and implemented to avoid, manage, and mitigate impacts. The RIS has concluded that the impacts from these activities are limited and infrastructure requirements for tight/shale gas are not materially different to conventional and CSG wells. Large scale produced water ponds are not required as part of tight/ shale gas development

Relevant Act	RIS Identified Deficiency	Technical Response
	Extent of SEA/DP – Mapped extent of the designated precinct does not include all areas of significant hydrologic connections.	Simply expanding the mapper extent is an unnecessarily simplistic policy response to a concern that has not been validated. Instead, a framework of authorised and non-authorised petroleum activities within these areas can be accommodated consistent with the responses above. Preclusion of permanent large ponds, borrow pits, compressor stations, permanent camps etc within these areas (and associated roads) will avoid and manage potential impacts. Well pads as part of an operational field (not initial exploration and appraisal works) can be sited and sized to minimise impacts.
Waste Reduction and Recycling Act	**End of Waste (EOW) Code** – There is an end of waste code for CSG drilling muds which states when a waste becomes a resource. No equivalent code for tight/shale.	There are no major material differences between the drilling mud chemicals used and the residual drilling mud properties between CSG and shale gas. Adoption of the existing process and assessment of site specific risks will be sufficient to manage the potential for impacts (e.g. through EA conditioning). The End of Waste Code for CSG Drilling Muds could also be readily amended to accommodate drill muds from tight/shale gas drilling (or a parallel End of Waste Code could be developed for such), although it is not anticipated that material technical changes would be required. Risks can be controlled by limiting the spreading and shallow burial of materials in sensitive areas.
Fisheries Act 1994	**Accepted Development requirements for operational work that is constructing or raising waterway barrier works that may impact on fish passage** – Oil, gas and petroleum activities do not trigger assessment.	Assessment of hydrology and fish passage can be accommodated within the existing EA process and impact assessment process. The construction of temporary roads, leveraging of existing state roads etc can be used to limit impacts. Further, as noted above proponents currently working in the LEB have existing design and construction processes to mitigate these types of risks.

2.2 Misappropriated References

This section outlines either misappropriated references or where we believe other key findings from referenced material were excluded which has resulted in misleading and inaccurate statements and conclusions. The RIS cites several prominent river scientists and notes the *"potential devastating impacts caused by mining and petroleum infrastructure, including all weather roads and levee banks, cutting off or diverting flows across Channel Country floodplains and compromising aquatic ecosystems, drought refugia (water holes) and grazing pasture (Arthington and Balcombe 2011; Sheldon et al 2010; Dickman et al 2017; Kingsford 2017)".* However, the report does not balance this with an assessment of the successes to-date in management of impacts associated with both conventional and CSG developments and contains numerous inaccurate or misleading statements, inferences, or conclusions. These instances are summarised in **Table 2-3**. Many of the statements provided are not supported by scientific data, and are rebutted by data collected in other studies and reports submitted to DES and/or assessed/managed in accordance with current EA conditions. **Table 2-3** provides a summary of these statements along with associated commentary and rebuttals.

Further, major components of studies cited in the RIS have been excluded. For example, the RIS includes mention of a statement from the Australian Council of Learned Academies (ACOLA) (cited in Crothers (2016)), warning that a fully developed shale gas industry in an arid area has the potential to become a major user of groundwater. However, ACOLA also produced a report in 2013 titled, Securing Australia's Future. Engineering Energy Unconventional Gas Production. A Study of Shale Gas in Australia (saf06-engineering-gas-report.pdf (acola.org))(ACOLA, 2013), which is not referenced in the RIS. ACOLA (2013) included over 51 key findings (not discussed in the RIS), many of which either clarify statements provided in the RIS or that directly contradict the RIS. ACOLA (2013) identifies risks, but provides a more balanced assessment of management, including highlighting the knowledge and regulatory processes that have been developed for CSG, which have applicability to shale gas development projects. Key findings from this evaluation that were omitted from discussion in the RIS are highlighted in

Table 2-4.

In addition, the RIS makes no reference to the Australian Government Cooper Basin, Geological and Bioregional Assessment (GBA) program which presents a geological and environmental baseline assessment for the Cooper GBA region and a synthesises knowledge about the geology and prospectivity of shale, tight and deep coal gas resources, water resources, protected matters and risks to water and the environment. As part of the GBA assessment, it found "*A qualitative review of nine domestic and international inquiries into onshore gas industry operations, historical Cooper Basin data and the hazard scoring for the Cooper GBA region indicated that the likelihood of occurrence of the three impact modes associated with hydraulic fracturing (hydraulic fracture growth into an aquifer, a well or a fault) is low*" (p. 23 Holland et al., 2020).

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Table 2-3 Rebutted RIS Statements, Inferences or Conclusions

Page	RIS Statements	Commentary/Rebuttal
21	*"Impacts from unconventional oil and gas extraction will generally be more significant in terms of use of chemicals, significant additional water use, storage of waste materials and overall industrial footprint of the operating site"*	This statement is inaccurate for a number of reasons, including the chemicals used in hydraulic fracturing are consistent with those already used in conventional and CSG wells, and while some well configurations may use more water (wells with long horizontal sequences) the cumulative impact is not large because: a) The resulting well density is lower; b) Drilling times are longer and activities are conducted over longer time intervals allowing for the movement of water and waste; c) Flowback from wells is slow and large scale storage of produced water does not occur; d) The majority of chemicals used are biodegradable and do not pose a risk in the subsurface and have no potential for irreversible harm; and e) The footprint of wells in a developing field is small and does not look like the footprint for a single well during exploration and appraisal (the report has attempted to portray the Beetaloo appraisal location as a typical development well pad).
21	*"The cumulative impacts associated with the scale of shale gas and oil resources were identified as a greater risk than conventional oil and gas resources" (reference to Huddlestone – Holmes 2018)"*	This statement is inaccurate and does not reflect that the chemicals and technologies used in unconventional wells are not markedly different to conventional wells. Initially, conventional gas and oil reservoirs can have low well densities when formation pressures are high, however structural constraints to flow require infill drilling and corresponding increases in well densities and the inclusion of injection wells (water and gas drive) to improve recovery. As described in the RIS, over 1700 wells have been drilled in the Queensland LEB with the majority comprising conventional wells with the development of unconventional resources not involving the drill. For unconventional oil and gas wells, development occurs over time, and with horizontal (in seam sections) well densities can be lower than that observed for CSG wells. Activities framed in the RIS as having a higher risk (for example, hydraulic fracturing) occur in discrete and short periods of time with a finite number completed in a year (after well completion). Notable for unconventional wells (which are completed in low permeability formations) is the absence of secondary recovery activities where injector wells are installed where gases or water is injected to increase recovery from conventional reservoirs.

Page	RIS Statements	Commentary/Rebuttal
31	*Photograph of Unconventional Well Site*	The RIS contains a photograph of the unconventional infrastructure at Beetaloo and provides the inference that this is a standard development layout. The photograph provided depicts a standalone exploration and appraisal site where all infrastructure was concentrated in a single location. In a development project centralised facilities would be developed (outside of sensitive areas) resulting in considerably smaller footprints for individual well sites. Photographs could have been provided of typical production well sites in the Cooper Basin, and as described above it is not considered that unconventional development well sites will significantly differ from those already present within the LEB.
37	*"Overall and given the relative insignificance of gas production in the Cooper Basin when considered at the national and Queensland levels, there may also be availability constraints, as well as potential limitations associated with the actual extraction of them. This leads to important questions about the future commercial viability of those resources."*	The report discusses uncertainty with petroleum reservoir estimates and makes the inference that numbers could go down. This process of uncertainty is applicable to both conventional and unconventional oil and gas resources and values could go down but also go up as new data becomes available. The report states (p 37) that these uncertainties lead to difficulties in assessing financial costs and benefits of the status quo or alternative options. However, the provision of gas supply security, the critical role that gas provides as a transition fuel (or for backup energy supply) as part of greenhouse gas (GHG) reduction efforts and the economic benefits already being observed (in jobs and royalties) clearly demonstrates the importance of gas development. Future gas development projects that can leverage existing infrastructure (such as that present in the area) are more economic to develop and have a lower disturbance footprint than green fields projects. The Lake Eyre Basin has significant access to pipelines, compression and gas treatment facilities, pump stations and critical support infrastructure (including airports, roads, and water facilities) already established by the oil and gas industry. Further, the RIS does not consider that current gas resources that are being depleted need to be replaced and as a result new resources need to be developed to keep gas production at current levels. The anticipated increases in gas prices over time (as the transition from coal to gas occurs) as well as the price differential of landed liquefied natural gas (LNG) on the east coast of Australia (as a potential alternatives) provides a pricing point that will support further gas development to support the eastern Australian energy market.

Page	RIS Statements	Commentary/Rebuttal
35	*"The long lead-in for any potential unconventional gas projects is also relevant in this context. It is understood that the average timeline through exploration, appraisal, development and into full production for gas fields, typically exceeds 12-15 years. It therefore appears clear that the domestic gas supply/distribution issues of today will not be solved by potential or possible unconventional gas projects which are many years away from production"*	This timeframe is not accurate and the associated conclusion flawed. The development time frames are shorted where existing infrastructure and gas/oil production facilities exist and unconventional gas/oil sources can be integrated into existing production activities. As described below, critical infrastructure is already present and the time period from exploration and appraisal to development in this area can be relatively short.
35	*"In this context, it should also be noted that while there are no major hurdles to accelerated production of already operational or approved conventional gas projects in the Queensland LEB, there may be some practical constraints on additional supply rates due to infrastructure capacity constraints (such as pipe size limits or use contract-related congestion)."*	The report discusses the presence on physical constraints on additional supply rates (p 35) due to infrastructure capacity constraints and states that pipelines from the Cooper Basin are "already close to capacity". However there remains some capacity in the pipelines and debottlenecking of pipelines is a common process that can be rapidly implemented within existing easements to increase capacity. This can include duplication of pipelines (in sections) and the establishment of booster pumping and compression facilities. The proponents do not consider there to be significant, insurmountable obstacles to transfer of gases and liquids out of the basin. Further there is significant additional capacity within the existing Moomba and Ballera Gas plants to treat gas and separate and management liquids and condensate.
37	*"The analysis illustrated in the maps above indicates relatively limited availability at a high confidence level of the three main unconventional resources (shale, tight and deep coal gas/oil), and that their availability is not spatially linked or limited to the floodplains of the Cooper system."*	The RIS infers that the assessment provided by Geosciences Australia has limited availability of high confidence areas. However, this statement does not reflect that this assessment was based on available data and relative prospectivity is affected by data availability. The completion of exploration and appraisal activities will significantly impact on the prospectivity assessment and can include expansion of the target areas and improvement in prospectivity and reserve determination.

Page	RIS Statements	Commentary/Rebuttal
38	*"Any future development of unconventional resources in the Queensland LEB is unlikely to occur before the end of this decade, the commerciality of prospective sites will also be subject to this context. Prospective oil and gas productivity will therefore have to undergo an additional viability test arising from the strengthening global policy and commercial context of addressing atmospheric carbon and methane."*	This statement is highly subjective about future regulation and prospectivity and does not reflect statements contained in the referenced Clean Energy Regulator Report 2022. This statement ignores a number of key considerations including gas being a key transition fuel where gas replaces coal and that development which leverages existing infrastructure provide lower life cycle greenhouse gas emissions. The RIS rightly states that "ultimately, decision to undertake exploration of prospective resources includes consideration of regulatory and market factors, assumptions around costs of exploration, development and production and forecasts of inflation. However, this statement does not reflect the market fundamentals that gas demand is projected to persist due its key role in the transition, needs for other fundamental functions (other than electricity) and global demand to use it to substitute coal. The market fundamentals for gas remain positive as supported by the International Energy Agency (IEA).
8	High turbidity in most of the aquatic features in the LEB limits potential for eutrophication, even in the presence of high nutrient loads (which may be natural) (McDougall et al, 2021). However, the risks of leakage of wastewater and drill spoil lead to greater concerns about impacts	The McDougall et al. (2021) reference notes that "*High turbidity in most of the aquatic features in the LEB limits potential for eutrophication*". The RIS goes on to suggest the risks of leakage of wastewater and drill spoil lead is of greater concerns about impacts. This is simply an incorrect assumption and as McDougall et al. (2021) states in their risk assessment; Water pollution (e.g. via uncontrolled and controlled releases – including CSG releases, Mine discharges) = **LOW RISK** (Table 22) as opposed to a **MEDIUM RISK** for Nutrient enrichment by terrestrial animals (domestic and exotic). The extracts from McDougall et al. (2021) reflecting the above are presented in **Appendix A** (refer green highlight) for transparency.
8	*CONTINUED…..* High turbidity in most of the aquatic features in the LEB limits potential for eutrophication, even in the presence of high nutrient loads (which may be natural) (McDougall et al, 2021). However, the risks of leakage of wastewater and drill spoil lead to greater concerns about impacts	

Page	RIS Statements	Commentary/Rebuttal
39	*"environmental accidents in the fossil fuels industry are not rare: on average, one accident happens each year (based on 43 accidents on Australian mainland and surrounding waters between 1970 and 2013), causing unauthorised environmental contamination".*	This statement does not provide appropriate context, and is inflammatory and misleading. It is a little like saying, there is a plane crash every year, so air travel is a high-risk activity. This statement is flawed as it does not reflect the magnitude of petroleum use and handling in Australia and does not provide any context around the causation, nature, severity, or duration of the impacts. Additionally, this does not identify the areas of the fossil fuel industry to which the releases are attributed (e.g. conventional vs. unconventional, gas vs. oil production, upstream vs. downstream operations, etc.), or compare the rates of accidents occurring during earlier vs. later years (environmental regulations and controls would have been far less robust during earlier as compared to latter years). Effectively, the statement is designed to elicit an emotive response when in fact the three events cited had nothing to do with the key risks identified in the RIS and have not led to irreversible harm. For example, using the likelihood category from Fiedler et al. (2021), and assuming a 100-year recurrence interval: • rare = up to 1% chance; • unlikely = up to 10% chance; • possible = up to 30% chance As this RIS statement is an overarching (industry wide) one which covers 43 years, of which they report 43 accidents have occurred, we can estimate the overarching (industry wide) likelihood. Kingsford and Walburn (2023) report that 831 oil and gas wells have been completed over the LEB and if we assume each well has 82 potential impact activities (as suggested by Fielder et al 2021 (p. 23), this suggests 68,142 risk activities have been undertaken. As there have been 43 incidents, this equates to 0.06% likelihood, which using the Fielder et al. (2021) likelihood rating is **RARE**.
40	"*In the last 10 years, there have been for notable incidents: Zeus Oil Spill, 2013, the Montara Oil Spill 2009, the Pilliga State Forest CSG Water spill 2011, and the Port Bonython hydrocarbon groundwater contamination*"	In the context of three cited events none were associated with hydraulic fracturing, two of the releases have been subject to remediation works, all have been demonstrated to pose no unacceptable risks to sensitive receptors, and the combination of active remediation and natural attenuation is supporting future restoration. It's important to note that only one of these notable events has occurred in the LEB. In this instance 0.25ML of oil for a well head leaked and was contained within the well operational area and the soil quickly remediated. Using the Fielder consequence rating, this would be rated a Minor consequence, that is; • occurs in an existing disturbed, or isolated/contained area (e.g. up to a 1km^2); and • can be easily remediated; or • last days-months.

Page	RIS Statements	Commentary/Rebuttal
28	This section suggests the employment benefit from O&G exploration is of limited economic benefit with the Statement *"On average, around 5,290 people were employed in oil and gas extraction across the whole of Queensland over the year (Australian Bureau of Statistics, 2022) with an estimate of 89 individuals as fly in/out workers"*.	This statement provides an inference that the employment of 5,290 people is insignificant. Oil and gas industry jobs and in particular development projects involve large work forces of highly qualified and compensated people, and in combination with royalty payment provide a significant contributor to the Queensland economy.
22	"*the panel undertook a risk assessment process and determined that there were medium to high risk associated with conventional and unconventional petroleum and gas under the current regulatory framework" (pp 22)*	No regulators or industry peers with the exception of 1 water bore driller were involved in this report. This is a fatal flaw as there is a disconnect with the application of regulation and also the practicality of what is being suggested. Furthermore, the risk assessment looked at cumulative impacts over 50 years and did not consider the rehabilitation of wells over this development timeline. Furthermore the panel concluded (Figure 3) that 37 residual high and 7 very high risks remain. If this was the case and the residual risk was attributed to Possible (likelihood) x Extreme (Consequence), over the last 10 years, 3 events having an impact occurring across a widespread area (e.g. at least 100 km^2) that cannot be remediated would have eventuated. If the residual risk was attributed to Likely (likelihood) x Major (Consequence), over the last 10 years there would have been up to 30 events leading to an impact occurring across a widespread area (e.g. 10-100 square/linear kilometres), lasting years and that is difficult to remediate. Of course, none of the above predictions have happened.
23	"*regulatory frameworks may not be strong enough to protect river systems of the Queensland LEB from possible future unconventional resource activities and their potential impacts*"	This is contradicted by numerous other reports including the Commonwealth Scientific and Industrial Research Organisation (CSIRO) report and the University of Queensland review, and ACOLA (2013). The RIS highlights and discusses the potential risks based on water usage requirements, chemical usage, and flow back management and states that these are likely to "*represent a new order of risks and potential threats to water quality in the river systems and to cultural values in the landscape*" …. Further, "*linear infrastructure related to those activities can also impede, alter or reduce the flow and drainage of water*". However, as described above this is based on a flawed set of assumptions: The chemicals used in hydraulic fracturing of shale are similar to those used in CSG and the risk posed by these chemicals has already been assessed at a Commonwealth and State level. The majority of chemicals used are low toxicity and readily biodegradable and no persistent, bioaccumulative or toxic chemicals, or chemicals containing benzene, toluene, ethylbenzene,e and xylene (BTEX) or per and polyfluoroalkyl substances (PFAS) compounds are used in the process. Further, a very mature management framework

Page	RIS Statements	Commentary/Rebuttal
		(which is being successfully applied by industry) has been developed for hydraulic fracturing which has not resulted in well failures and or major releases to the environment with no incidents of irreversible harm. The water usage volumes of shale development in the Queensland LEB will be low due to the development timeframes (EHS Support (2021) report on possible development scenarios for unconventional gases in the Cooper Basin) which will only see tens of wells drilled per year, the recycling of flow back water and/or sourcing from conventional well produced water for hydraulic fracturing, the low volumes and slow rates of flowback from unconventional wells (compared to produced water from CSG and conventional wells). The linear infrastructure requirements are no different to the 1700 wells that have already been drilled in the Queensland LEB which the report has stated poses no irreversible harm. Further proponents working in the Cooper Basin have developed processes for the construction of roads which do not involve permanent crossings or levees and construction of tracks pipelines etc. that do not create permanent impediments to flow and/or materially alter or reduce the flow and drainage of water.
25	Section 5 of the report evaluates Economic activity in the Queensland LEB region and has identified the following potential impacts on the grazing industry (pp 25): 1. Impacts on beneficial flooding and increased erosion. 2. Water quality and dewatering. 3. Organic certification. 4. Reduction in climate resilience.	In term of beneficial flooding and increased erosion the RIS has indicated *"the potential for loss of fodder due to impacts from the obstruction or afflux from petroleum infrastructure (roads, pipelines, pads and wastewater dams) on floodplains presents a high risk of high impact to industry"*. However, as described above this impact has not been observed in the Cooper Basin or from CSG activities and in many cases the maintenance of infrastructure and the provision of produced water (in the Cooper Basin) has supported critical agricultural functions. The implementation of industry best practices and appropriate design and construction of infrastructure can be conducted to preclude large scale impacts on flow and water quality.
26	The assessment of impacts on water quality and dewatering in the RIS discusses *"shallow perched sub-surface alluvial systems which are often relied upon for stock and domestic use"* (pp 26), *"managed use of accidental release of chemicals that can have negative impacts on local and regional water quality if not adequately controlled or managed"* (Id)	These statements are based on industry needing to access shallow groundwater (which they do not) and/or seeking to bury or dispose of Residual Drilling Mud or flow back within the floodplains and/or areas of shallow groundwater (which they do not). The EA conditions for petroleum activities and the EOW Code require the completion of application and site specific risk assessments, and in the context of these activities no proponent would look to dispose of wastes/chemicals in these types of environments. As stated in the RIS that if water was extracted from surface water, *"the water requirements for oil and gas production represent about two percent of annual flows and the model showed extraction of that magnitude would not impacts flows or alter flow regimes in Cooper Creek"* (p. 26). Given that other sources of water would be used (recycling and reuse) then the demands would be even lower than modelled, making it highly unlikely that impacts would occur in agricultural productivity.

Table 2-4 Key Findings from ACOLA (2013) that were Omitted from Discussion in the RIS

Finding	Technical Response
Finding 10	*In addition to shale targets, overlying and underlying rock formations, in some basins such as the Cooper Basin, contain tight gas in deep low permeability sandstones, which similarly require hydraulic fracturing for extraction* *This vertical column of deep gas-bearing strata, with higher permeability than shale, can be accessed by hydraulic fracturing at several depths in the same well bore; this is compatible with drilling a number of near-vertical wells from a single pad.*
Finding 20.	*"Strategic Environmental Assessment prior to development, including the use of cumulative risk analysis tools applied at the catchment and appropriate regional scales, are now technically feasible* ***provided they are supported by an enabling regulatory environment and spatially adequate and explicit ecological, hydrological and geological data, these tools and the social consideration involved, have the potential to contribute to the management and*** **minimisation of regional environmental impacts arising from shale gas developments" (emphasis added)**
Finding 21	*"Shale gas developments can extend over large land areas and have aggregated and cumulative environmental impacts through surface disturbance and clearing of native vegetation for drilling pads, roads, pipelines and related infrastructure. These activities need to be effectively managed to avoid impacts such as destruction and fragmentation of habitats and the overall landscape function, loss of threatened species habitats and ecological communities or an increase of invasive species.* ***The use of cumulative risk assessment and best practice in minimal impact infrastructure will be crucial to the future of the shale gas industry"*** (emphasis added)
Finding 22	***"****The potential exists for conflicts between current land, water and infrastructure use and competition by new multiple or sequential uses (e.g. traditional land owners, conservation, agriculture, other resource projects, tourism and urban development).* ***The shale gas industry, governments and the community needs to learn from experience of the CSG industry to avoid these conflicts. Use of best practice tools including cumulative risk assessment and strategic land use planning and policies such as the proposed Multiple Land Use Framework developed by the Land Access Working Group under the Standing Council on Energy and Resources should assist to resolve potential conflicts"*** *(emphasis added)****.***
Finding 23	*The volume of water required to hydraulically fracture shale gas strata can be an order of magnitude larger than that for coal seam gas depending on well depth and extent of horizontal drilling. Conversely, the total volume of produced water in shale gas operations is orders of magnitude less than the total amount produced during CSG operations* ***The information available to the Expert Working Group leads it to conclude that while initial extraction of water for shale gas operations will be significant, shale gas operations will not be faced with the ongoing disposal and subsequent replacement of large volumes of produced water as is the case for CSG operation*"** (emphasis added).

Finding	Technical Response
Finding 26	***"**All gas wells pass through aquifers ranging from freshwater to saline and at depths ranging from very near surface (tens of metres) to deep (hundreds to thousands of metres), and are subject to well integrity regulation. In important Australian basins such as the Cooper-Eromanga Basin, in addition to surface aquifers, shale gas wells (like conventional gas wells) pass through deep aquifers of the Great Artesian Basin. **To minimise the risk to this vital groundwater resource, best practice should be adopted in both well integrity and the use of sensing technology to accurately and closely monitor the hydraulic fracturing process, particularly the potential for extended vertical growth of fractures"*** (emphasis added
Finding 39	*"**A number of the activities associated with shale gas exploration development and production have the potential to have an adverse impact on the natural and the human environment and therefore it is essential that shale gas activities are carefully and comprehensively monitored and transparently regulated to best practice**. These include monitoring of surface and subsurface water, air quality, greenhouse gas emissions, and seismicity. The current lack of baseline data in many areas and lack of information on natural variability in particular need to be addressed. Many existing Australian regulations for onshore conventional and unconventional gas production will be applicable to shale gas. Nonetheless the overlapping and regional aspects of shale gas impacts will confront Australian regulators with new challenges. The likelihood of shale gas operations producing damaging induced seismicity is low; but there is a need to better understand and mitigate the risk of induced seismicity and this will require site, local and regional monitoring of earthquakes at a far greater resolution in key areas than is currently the case in Australia. It is also important to address uncertainty, including through the use of remote sensing technology, and close monitoring of the hydraulic fracturing process"* (emphasis added).
Finding 48	"*While techniques and practices used in other countries will need to be adapted in some cases to Australian conditions, **there are no major technology gaps relating to shale gas production which would constitute grounds for delaying the development of a shale gas industry in Australia. However, there are knowledge gaps in the environmental and social areas that will require the collection of more data and additional research to ensure that the impact of the industry is minimal and that any potential difficulties can be adequately remediated, or stopped if a significant threat were to arise**, so that the industry and the community can move forward confident in the knowledge that resilient systems are in place"* (emphasis added).

3 Regulatory Requirements and Risk Based Conditioning

We would agree that the position of government should be "*Protecting the rivers, watercourses and floodplains of the Queensland LEB while also supporting sustainable economic activities*" (p. 43). The RIS provides a set of specific ecological, economic, cultural, and social objectives to guide the development of options (refer p. 44) and there is no disagreement that these require protection/management. However, what is clearly lacking in the RIS is a specific demonstration that the current processes and regulations do not protect these objectives. Effectively, the report without any technical demonstration has inaccurately described the nature of unconventional oil and gas development, and using preconceived opinions of risk, has inaccurately characterised the existing regulatory processes as insufficient to provide protection and proponents as having no effective systems or interest in protecting the environment. The existing regulatory program is and can be used effectively for protection of these objectives.

In the RIS the argument that the regulatory environment is inadequate is supported by stating that the RPI Act and its regulations do not include any LEB spatially specific considerations. The RIS follows on to state that in order to "*properly protect the river systems and prevent the potential for widespread and irreversible impacts from these activities, it could be argued that a new and precautionary approach may be required*" (pp 47). However, what the document fails to discuss is that the broad nature of other regulatory mechanisms provides protection; waters cannot simply be extracted, waste discharged, petroleum activities initiated, hydraulic fracturing conducted, facilities built without necessary approvals. Further, the regulations are sufficiently broad (for example, the Environmental Protection Act) that any proponent is required to avoid, manage, and mitigate harm and is not authorized to cause widespread and irreversible harm.

DES via issuance of an Environmental Authority regulates activities that may pose a risk. These conditions are used to protect all environmental aspects and specifically those highlighted in this study. The existing model conditions (noting that conditions vary from project to project) are described further in **Section 3.1** and **Table B-1** solely for the purposes of demonstrating the breadth of issues that can be managed through this existing process. Further, the RIS infers that once approved, oil and gas development can occur unabated and beyond the scale originally approved. The Environmental Protection and Other Legislation Act (EPOLA) requires automatic notification of major amendments (for example well expansion beyond the original EIS and amendments)

The RIS then infers that unconventional oil and gas development will involve increased industrialisation and significantly more intensive hydraulic fracturing. But this is not an appropriately informed statement, as past development (primarily conventional development) in the LEB has been at a significantly greater scale than the potential future development, and this new development has the ability to leverage existing facilities and processes and best management practices which have significantly improved over time (noting that historical practices which are less rigorous and have not resulted in widespread and irreversible harm).

The simple process of avoiding placement of select infrastructure in the floodplain (consistent with the historic definition of approved petroleum activities), careful site selection where infrastructure are placed (for example, wells), and use of appropriate management and mitigation controls is an effective approach which has demonstrated success (a fact not discussed in the document). In this context the status quo does have considerable benefits which are not captured in the RIS option analysis, and given the effectiveness of the EA conditioning there is no reason to believe that they would be ineffective in management of unconventional oil and gas development.

Using the justification of the inadequacies of the current regulatory environment the RIS evaluates 3 alternative regulatory frameworks (Regulatory Option 2, 3 and 4). However, the statements on the inadequacies of the current regulatory framework are poorly supported and the conclusions inconsistent with the work completed by the University of Queensland (2022). This study, rather than dismissing the current regulatory framework, looks to support it (consistent with Option 2) and states:

> *"Under the EP Act, gas production activities require a site-specific Environmental Authority (EA) to be granted and applications for an EA are subject to an approvals process supported by an environmental impact statement (EIS). The Stage 3 Bioregional Assessment has delivered regional-scale datasets, methodologies and modelling tools that will provide strong support to any EIS study undertaken in the Cooper region" (p.41)*

Data gaps have been identified in this study indicating the need for additional data collection. While the study states that they consider the "regulatory framework untested", the report does not state that the EIS and EA process is inadequate. As described further in **Section 3.1** this regulatory framework requires proponents to assess and manage risks including those relevant to the LEB.

In the assessment of alternative regulatory options the RIS has described the potential augmentation to the status quo (Regulatory Option 2) and discusses the potential that projects or proposals "*could be assessed on a case-by-case basis, with considerations including how to best manage possible increased risks from increased industrialization and new extraction methods*"(p. 52). Notably it is stated that this option would have a focus on strengthening existing provisions under the EP Act as well as the RPIA with additional measures including "better defining unacceptable used in the DPs, such as permanent gas processing facilities, regulated dams, landfill, large sewage treatment facilities, and major underground pipelines" (p. 52). Further,

1. "*Operators could also be required to anticipate moderate and major flood events and implement conditions to cease drilling or related activities when water was present or anticipated on wells sites*" (p. 52).
2. Industry representatives have suggested consideration could also be given to declaring a Cumulative Management Area for the Cooper Basin under the Water Act 2000, overseen, and coordinated by the Independent Office of Groundwater Impact Assessment (OGIA).

While the option analysis highlights the advantage of this approach being moderate amendments to the current approach, the assessment does not consider how effective the current regulatory framework has been in avoiding, managing, and mitigating risks, that operators are already operating within the Queensland LEB and are effectively managing risks associated with moderate and major flood events, and that a robust and effective framework for Cumulative Management (for example the OGIA) has been developed and implemented for CSG development and can be easily applied to other unconventional activities.

In summary, familiarity with the processes and systems and leveraging programs that have already demonstrated success provides the greatest level of certainty that risks can be effectively managed. The absence of specific examples of failings of the status quo (Option 1) or enhancements to the status quo (Option 2) provides clear support for either of these options relative to a new regulatory framework. The disadvantages raised in the RIS include:

1. The need for significant investment in resources to support the regulator in their work including rigorous inspections and compliance monitoring.
2. Uncertainty regarding hydrological processes make it potentially unpredictable and therefore it is unknown what is an appropriate response to major flood events.

In the context of the disadvantages listed we do not consider these to be major shortcomings as the requirements for inspections and compliance monitoring are consistent with what is already being conducted for CSG developments and place no additional burden on the regulatory community. While the uncertainties may exist, there is the ability to design and execute work with contingencies to address potential uncertainties. Regular floods have occurred in the Queensland LEB and Cooper Basin and proponents have developed design and management practices that have been effective in mitigating risk and preventing environmental harm. The report states that while it may be "possible to move drilling rigs, it is not possible to move well heads, borrow pits, and other site infrastructure". However as noted above infrastructure can be sited and designed to manage flood related concerns and minimize the potential for releases or impacts on the broader hydrodynamics of these systems. Further ancillary infrastructure such as borrow pits or ponds (if required as tanks for the smaller flow back volumes may be preferred) can be located outside of sensitive areas.

Regulatory Options 3 and 4 are proposed based on a "precautionary principle" where no consideration of actual risks (including probability of occurrence and/or consequences) were used to inform the decision making. This is evident in regulatory Option 3 where rather than regulating higher risk processes and proposing applicable management responses, it is proposed that a whole industry (rather than specific activities) is regulated with unconventional oil and gas activities considered unacceptable on the basis they represent high impact activities. In the assessment it notes that high risk activities include:

1. Intensive hydraulic fracturing using chemicals and including diagonal/horizontal drilling.
2. Groundwater extraction for fracturing and other exercise of underground water rights.
3. Contaminant storage and contaminant disposal.
4. High impact well sites, borrow pits and petroleum facilities.
5. Other supporting infrastructure.

However, as noted throughout this letter these operations are not unique to unconventional gas development, and with the CSG development regulation and processes have been developed to effectively assess and manage risks. Notable is that the chemicals and potential risks associated with hydraulic fracturing have been robustly assessed and are effectively managed. No loss of containment events or major release which have resulted in widespread and/or irreversible harm have occurred, demonstrating that the best management practices adopted by industry are effective. The chemical used in hydraulic fracturing and the methodologies are identical to those already employed; the only difference is the potential well configuration, which is not material to the determination of risk (involves the same annular seals and means of zonal isolation).

In terms of access to water for hydraulic fracturing, this can be effectively managed and regulated. Extensive options for reuse of recycling exist (both from conventional and unconventional oil and gas activities) as well as sourcing of water from other authorized resource development activities. Further, a robust regulatory framework exists (via the OGIA) to assess and manage potential risks associated with water sourcing from deeper aquifers. The assessment provided highly exaggerates any potential risks and is not support by data. The use of groundwater resources from deeper aquifer systems will have no material impact on surface water flows and/or existing beneficial uses of water (including groundwater dependent ecosystems [GDEs]).

Contaminant storage and disposal including activities where Residual Drilling Muds (RDM) are used for other beneficial uses (EOW code) must be conducted in a manner that does not result in harm. The process for assessment and management of RDM is well defined and is effective. In no context would RDM be placed in riverine settings where they could be exposed, eroded, or cause contamination.

Further, a number of higher impact activities (for example, borrow pits or centralised petroleum facilities) can be located outside of sensitive areas. However, the rigid definition of high impact wells sites based on size is not logical as it does not allow for multi-well sites (in less sensitive areas to have larger numbers of horizontal wells therefore avoiding disturbance or more sensitive areas). The primary concerns associated with well pad sites has been noted as the potential impact of disturbance in the flood plain and impacts on flows. However, with effective placement (on the fringes of the flood plains) and design, the potential risks can be mitigated, and in the context of the LEB these impacts would be immaterial. Similarly, with other infrastructure (for example, camp sites, sewage treatment plants, borrow pits, and major infrastructure sites (outside of what is needed in the well pads)) these can be practically located outside of the most sensitive areas and designed and constructed in a manner that the risks identified in the RIS are mitigated.

The absence of demonstrated impacts from past activities in combination with the effectiveness of the current system to regulate unconventional CSG gas development does not support the implementation of a precautionary approach as advocated in the RIS. Therefore, there are no material benefits for large scale preclusion of unconventional oil and gas development (Option 3) or a complete ban on all oil and gas development (Option 4). The RIS uses as justification with limited support (1) the potential magnitude of environmental risks (which as described above have not been accurately portrayed and have not been observed), the capacity of the existing regulatory and planning framework being unknown and untested (which is an inaccurate assessment given the current frameworks are effectively regulating both conventional and unconventional oil and gas development activities), and the consequences of things going wrong (which is unlikely and the magnitude of effects inferred in the document are not supported by data only supposition).

The lack of widespread or irreversible harm within the LEB from current development is a true testament to the effectiveness of the current regulation, government, and industry in effectively and responsibly completing development. The development and refinement of best industry practices over time will only enhance outcomes and limit the potential for impacts.

3.1 Risk Based Conditioning

As outlined in DES Information Sheet on Risk Based Conditioning[4], "*the department adopts a risk-based approach when assessing EAs and determining the conditions imposed. Risk is considered in the context of the nature and location of the activity (what is termed inherent and residual risk), but also the quality of information provided in the application, and the existing knowledge of the baseline condition of the receiving environment and environmental values that may be impacted by the activity. Where the risks of an activity are lower, or detailed information is provided about the baseline condition of the receiving environment and potential impacts to environmental values, the activity may be approved with outcome-focused conditions that outline the environmental outcomes the operator must achieve. Conversely, where the consequences of a breach of regulatory obligations may have significant negative consequences, or there is a limited understanding of the baseline condition of the receiving environment or potential impacts to environmental values, more prescriptive and management-based conditions may be required. Where a proposed activity poses an unacceptable risk to the environment based on the nature or location of the activity, or the level of information provided in the application about environmental impacts is insufficient, the EA application may be refused*".

The RIS has no discussion of risk-based conditioning as described in the Information Sheet and no discussion of how effective this conditioning has been in regulating both conventional and unconventional oil and gas development in Queensland. As further documented in the information sheet, "*the department operates under an **evidence-based decision-making framework** and sufficient information is required to support an application. Applications should identify the environmental values likely to be affected by the activity, the nature and extent of the impact, the performance criteria able to be achieved for the activity, and any prescriptive measures necessary to mitigate impacts to environmental values."* This evidence-based decision making framework has not been utilized in the RIS, and other than emphasizing uncertainty the RIS has not provided sufficient evidence to demonstrate that the activities are high risk.

Rather, they have emphasized uncertainty and the precautionary principle, and have either inadvertently or deliberately paraphrased or misquoted studies and ignored a plethora of impact studies and risk assessments (required as part of environmental approvals) that are informative and better frame petroleum activities and associated risks. The existing regulatory framework provides a robust system by which proponents need to collect data, complete assessments, define risks and recommend risk management actions. When provided with sufficient information DES has the means to evaluate and condition projects accordingly, request additional information and in certain circumstances refuse an application or components of an application.

Within this framework, DES regulates activities and manages risks by imposing conditions to:

- Specify the activity authorised to be carried out.
- Place clear parameters around the activity.
- Regulate the environmental impacts of the activity.
- Require the carrying out of appropriate mitigation measures for such impacts.
- Avoid, minimise, or offset the adverse impacts of the activity.
- Set out monitoring and reporting requirements for the activity.
- Set out auditing requirements to monitor compliance.

[4] https://environment.des.qld.gov.au/__data/assets/pdf_file/0012/311502/era-is-risk-based-conditioning.pdf

The conditions can include:

- General conditions.
- Outcome-focused conditions.
- Prescriptive conditions.
- Management-based conditions.

The effectiveness of EA conditions for regulation of the CSG industry (an unconventional gas development), on the scale of development occurring within South-east Queensland, as well as conventional oil and gas development in both the South-west and South-east, demonstrates this risk based conditioning approach is effective at managing risks.

The EAs that have been issued for petroleum activities in Queensland clearly demonstrate that frameworks for the assessment and management of impacts to land, air and water and management risks and wastes already exist (refer **Table B-1**). Further a risk assessment, monitoring and management framework for hydraulic fracturing exists and has been successfully implemented. These risks assessment have provided a comprehensive understanding of the chemicals used, associated risks, and required risk management actions. Hydraulic fracturing risk assessments completed by all proponents have demonstrated that the majority of hydraulic fracturing chemicals comprise predominantly non-toxic chemicals and/or chemicals that rapidly biodegrade and pose no risk in the subsurface. The implementation of best practices industry practices for hydraulic fracturing and appropriate storage, treatment and reuse of flow back will result in low risks and cumulative impacts. The absence of large scale impacts and irreversible harm from hydraulic fracturing including areas proximal to waterways clearly demonstrates that this existing regulatory framework is effective.

Consistent with the risk based conditioning framework described above, EA conditions differ by development area, petroleum lease or authority to prospect. For the purposes of an example only the model conditions (which we understand may be revised and inherently are modified/tailored to the address specific risks for projects) are provided as **Appendix B** and demonstrate that EA conditions have been developed for potential risk identified in the RIS.

4 Conclusions

EHS Support has completed a review of the RIS, references cited in the report, and other key reference materials. From our assessment of the RIS and our experience in oil and gas development projects over the last 20 years (including work in the Cooper Basin, Northern Territory (conventional and unconventional) as well as CSG development in South-East Queensland) we do not concur with the findings of the RIS report.

Our review of the report has highlighted major deficiencies, biases, and subjectivity which have directly impacted on the recommendations. The distinction between conventional and unconventional wells are not as large as inferred in the report, and in combination with the successful implementation of CSG development, confidence exists that industry can successfully implement strategies to avoid, manage, and mitigate risks.

Further, in the context of the LEB considerable gas and oil processing and ancillary infrastructure is in place which can be leveraged. The net effect of this is that the impacts associated with development will be reduced and development time frames shortened. Clear synergies between existing conventional and unconventional developments exist and the use of industry best practices in combination with the existing approvals framework (including EA conditions) will ensure that impacts are effectively assessed and managed.

Industry is aligned with the State in wanting exploration, appraisal, and development activities not to result in unacceptable cumulative impacts or irreversible harm to the LEB (or indeed anywhere else in Queensland). In combination with the existing regulatory frameworks effective design and siting (including ensuring infrastructure such as camps, laydown yards, borrow pits and large ponds are not located on the flood plains) can be used to manage and mitigate risks. Further the use of multi-well pads (with horizontal in-seam laterals) and staged development can be used to minimise impacts and limit the potential for cumulative impact.

Consistent with University of Queensland's Lake Eyre Basin Synthesis Report additional data collection is supported to enhance the EIS process and associated risk assessments (and risk management decisions). A robust understanding of environmental conditions will support industry in leveraging their site selection and design processes to manage risk.

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Appendix A

Table 22: Threats and associated risks to meeting Objective 5: To maintain healthy water quality by: a) identifying acceptable bounds for fluctuation in water quality, namely nutrients, toxicants, heavy metals, suspended sediment and blue algae; and b) establishing baseline water quality parameters and variability for ecosystems and consumptive use.

Threat	Environmental Response	Spatial Zones	Likelihood	Likelihood Justification	Likelihood References	Consequence	Consequence Justification	Consequence References	Qualitative Risk	Confidence
Vegetation clearing (general)	Altered catchment processes (e.g. runoff patterns) result in altered riverine habitat characteristics through delivery of sediment and nutrients.	All zones	Unlikely	Low levels of vegetation clearing through the Qld catchments of LEB up until 2010. Greater than 90% of vegetation remaining across LEB	(Bastin et al. 2010) Regional and landscape-scale pressures: Land clearing | Australia State of the Environment Report	Moderate	Grass cover and tree cover are protective against wind erosion in areas with low rainfall and high evaporation. Removal of this vegetation increases erodibility with resultant input of sediment and nutrients.	(Arthington et al. 2005; Bastin et al. 2010)	Low	High
Land use development	Increased runoff and erosion leading to infilling of waterholes and nutrient enrichment, reductions of sensitive species and increased spread and abundance of exotic species.	Neales	Possible	Existing land clearing affecting recharge, runoff and nutrients, particularly to waterholes in the Neales catchment.	(Wakelin-King 2011; Costelloe & Russell 2014) Glen Scholz, Landscape SA, pers. comm., 2021	Moderate	Clearing of vegetation and disturbance of topsoil for construction of roads or pads for petroleum development can increase erosion and infilling of waterholes. However, tractive forces are capable of removing sediment as long as the rate of deposition is not increased. Nutrients associated with soil particles can lead to eutrophication.	(Marshall, Clifford & Choy 2013; Clifford et al. 2008; Cendón et al. 2010; Box et al. 2008)	Medium	Medium
		All other zones	Unlikely	Level of current pressure considered low for the Cooper and Georgina/Diamantina. Low level of development throughout the NT.	(Clifford et al. 2008; Marshall, Clifford & Choy 2013; Negus et al. 2013; Mancini 2017a)				Low	Low
Water pollution (e.g. via uncontrolled and controlled releases – including CSG releases, Mine discharges)	Reduced water quality and associated population reductions of aquatic species. Altered water chemistry can impact on carapace and shell development of crustaceans and molluscs – leading to food web impacts.	Channel country, Coongie Lakes, lower Cooper, Lower Diamantina, Warburton, Neales, Finke	Unlikely	The Arkaringa Basin contains 11 petroleum wells, 9 coal seam gas wells and 14 stratigraphic wells. There may be potential for coal seam gas extraction in the eastern part of the Pedirka basin, but exploration is at an early stage. One advanced CSG proposal identified in Cooper subregion. There are approximately 190 producing gas fields, with approximately 820 gas wells, and approximately 115 producing oil fields and 400 producing oil wells in the Cooper Basin. Extensive regulatory and legislative controls. Controls largely effective. Water Plan (Cooper Creek) 2011; Industry standards, Licence conditions. Litter and spills from CSG operations in the Cooper were ranked low priority as these are well managed. Poor quality water is disposed of in evaporation ponds and infiltration basins.	(Australian Government 2018a; Clifford et al. 2008; Negus et al. 2013; Keppel, Inverarity & Wohling 2015; Wilson, Imgraben & Aurich 2014; Northern Territory Government 2018; Lake Eyre Basin Ministerial Forum 2017b) (State of Queensland 2016; Holland et al. 2021) Damien Ogburn, DEPWS, pers. comm., 2021.	Moderate	Pollution to water sources can increase biota deaths and reduce sensitive species. Even controlled releases of CSG water with inherent low ionic composition and turbidity can change the depth of the photic zone, exposing the waterhole to eutrophication if nutrients are present. Low ionic water can cause physiological stress to aquatic organisms. Impacts are localised in many cases.	(Viney et al., 2021; Wilson et al., 2014) (Marshall, Clifford & Choy 2013)	Low	Low
		All other zones	Rare							
Nutrient enrichment by terrestrial animals (domestic and exotic)	Increased nutrients reaching waterholes leading to eutrophication and loss of sensitive species	Barcoo, Thomson, Channel Country, all Diamantina and Georgina zones	Likely	Imperfect management of grazing animals and their close proximity to water features suggests a higher likelihood of interaction with water feature. The threat is classed across all spring systems where there is a mix of fenced and unfenced springs – hence a moderated likelihood.	(Marshall, Clifford & Choy 2013; Clifford et al. 2008; Negus et al. 2013; Costelloe & Russell 2014; Lake Eyre Basin Ministerial Forum 2017b)	Minor	High turbidity in most of the aquatic features in these zones limits potential for eutrophication, even in the presence of high nutrient loads (which may be natural). There is natural high variability in water quality within the arid systems.	(Sheldon & Fellows 2010) Mike Williams, CSIRO, pers. comm., 2021	Low	Medium
		Finke, Todd, Hay, Neales, Kati Thanda Lake Eyre, Coongie Lakes, Lower Cooper	Possible		(Box et al. 2008; Butcher & Hale 2011)	Moderate	Nutrient enrichment is exacerbated in shallower waterholes, those that have naturally lower natural turbidity and can lead to blue green algae outbreaks.	(Butcher & Hale 2011; Pettit et al. 2012; Box et al. 2008)	Medium	Low

Appendix B

Table B-1 EA Conditions (sourced from current model conditions)

Condition	Specifics
12 Notification	In addition to the requirements under Chapter 7, Part 1, Division 2 of the Environmental Protection Act 1994, the administering authority must be notified through the Pollution Hotline and in writing, as soon as possible, but within 48 hours of becoming aware of any of the following events: **(a) any unauthorised significant disturbance to land** (b**) potential or actual loss of structural or hydraulic integrity of a dam** (c) when the level of the contents of any regulated dam reaches the mandatory reporting level (d) when a regulated dam will not have available storage to meet the design storage allowance on 1 November of any year **(e) potential or actual loss of well integrity** (f) when the seepage trigger action response procedure required under condition (Water 14(g)) is or should be implemented (g**) unauthorised releases of any volume of prescribed contaminants to waters** **(h) unauthorised releases of volumes of contaminants, in any mixture, to land greater than: i. 200 L of hydrocarbons; or ii. 200 L of stimulation additives; or iii. 500 L of stimulation fluids; or iv. 1 000 L of brine; or v. 5 000 L of untreated coal seam gas water; or vi. 5 000 L of raw sewage; or vii. 10 000 L of treated sewage effluent.** **(i) the use of restricted stimulation fluids** (j) groundwater monitoring results from a landholder's active groundwater bore monitored under the stimulation impact monitoring program which is a 10% or greater increase from a previous baseline value for that bore and which renders the water unfit for its intended use (k) monitoring results where two out of any five consecutive samples do not comply with the relevant limits in the environmental authority.
20 Erosion and sediment control	For activities involving significant disturbance to land, **control measures that are commensurate to the site specific risk of erosion, and risk of sediment release to waters must be implemented to**: (a) allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities (b) minimise soil erosion resulting from wind, rain, and flowing water (c) minimise the duration that disturbed soils are exposed to the erosive forces of wind, rain, and flowing water (d) minimise work-related soil erosion and sediment runoff; and (e) minimise negative impacts to land or properties adjacent to the activities (including roads)
22 Certification	A certification must be prepared by a suitably qualified person within 30 business days of completing every plan, procedure, program and report required to be developed under this environmental authority, which demonstrates that: (a) relevant material, including current published guidelines (where available) have been considered in the written document (b) the content of the written document is accurate and true; and (c) the document meets the requirements of the relevant conditions of the environmental authority.

Condition	Specifics
Waste 2	Waste, **including waste fluids**, but excluding waste used in closed-loop systems, **must be transported off-site for lawful re-use, remediation, recycling or disposal, unless the waste is specifically authorised by conditions to be disposed of or used on site**
Waste 3	**Waste fluids**, other than flare precipitant stored in flare pits, **or residual drilling material or drilling fluids stored in sumps, must be contained in either: (a) an above ground container; or (b) a structure which contains the wetting front.**
Waste 19	The landfill used for the disposal of general waste must be: (a) on land owned by the holder of the relevant resource authority(ies) (b) **designed by a suitably qualified person and certified as being suitable for the containment of the waste** **(c) designed and located so that the landfill is protected from any potential adverse consequences of regional or local flooding to the probable maximum flood level** (d) designed and operated to exclude stormwater runoff from entering the landfill (e) capped upon closure with capping methodology certified by a suitably qualified person as being suitable for containing the waste
Land 1	**Contaminants must not be directly or indirectly released to land except for those releases authorised by conditions <>.**
Land 3	Land that has been significantly disturbed by the petroleum activities **must be managed to ensure that mass movement, gully erosion, rill erosion, sheet erosion and tunnel erosion do not occur on that land.**
Land 5	**Chemicals and fuels stored, must be effectively contained** and where relevant, meet Australian Standards, where such a standard is applicable.
Land 9	**Backfilled, reinstated and revegetated pipeline trenches and right of ways must be:** **(a) a stable landform** (b) re-profiled to a level consistent with surrounding soils (c) **re-profiled to original contours and established drainage lines**; and (d) vegetated with groundcover which is not a declared pest species, and which is established and growing
Biodiversity 1	**Prior to undertaking activities that result in significant disturbance to land in areas of native vegetation, confirmation of on-the-ground biodiversity values of the native vegetation communities at that location must be undertaken by a suitably qualified person.**

Condition	Specifics
Biodiversity 4	The location of the petroleum activity(ies) must be selected in accordance with the following site planning principles: (a) **maximise the use of areas of pre-existing disturbance** (b) **in order of preference, avoid, minimise or mitigate any impacts, including cumulative impacts, on areas of native vegetation or other areas of ecological value** (c) minimise disturbance to land that may result in land degradation (d) in order of preference, avoid then minimise isolation, fragmentation, edge effects or dissection of tracts of native vegetation; and (e) in order of preference, avoid then minimise clearing of native mature trees.
Biodiversity 5	Linear infrastructure construction corridors must: (a) maximise co-location (b**) be minimised in width to the greatest practicable extent**; and (c) for linear infrastructure that is an essential petroleum activity authorised **in an environmentally sensitive area or its protection zone, be no greater than 40m in total width.**
Biodiversity 8	Where petroleum activities are to be carried out in environmentally sensitive areas or their protection zones, the petroleum activities must be carried out in accordance with Protection of Biodiversity Values, Table 1— Authorised petroleum activities in environmentally sensitive areas and their protection zones
Biodiversity 10	**Significant residual impacts to prescribed environmental matters** << other than if the impacts were authorised by an existing authority issued before the commencement of the Environmental Offsets Act 2014 >>, **are not authorised under this environmental authority or the Environmental Offsets Act 2014 << unless the impact(s) is specified in Protecting biodiversity values, Table 2**—Significant residual impacts to prescribed environmental matters >> Noting that the Table 2 includes waterways, wetlands, fish passage, regulated vegetation, protected areas etc.
Water 2	**The extraction of groundwater** as part of the petroleum activity(ies) from underground aquifers **must not directly or indirectly cause environmental harm to a wetland**
Water 3	**Petroleum activities must not occur in or within 200m of a:** **(a) wetland of high ecological significance** **(b) Great Artesian Basin Spring** **(c) subterranean cave GDE**
Water 4	Only construction or maintenance of linear infrastructure is permitted in or within any wetland of other environmental value or in a watercourse

Condition	Specifics
Water 5	The construction or maintenance of linear infrastructure in a wetland of other environmental value must not result in the: (a) **clearing of riparian vegetation outside of the minimum area** practicable to carry out the works; or (b) ingress of saline water into freshwater aquifers; or (c) **draining or filling of the wetland beyond the minimum area practicable** to carry out the works.
Water 6	**After the construction or maintenance works for linear infrastructure in a wetland** of other environmental value are completed, **the linear infrastructure must not**: (a) **drain or fill the wetland** (b) **prohibit the flow of surface water in or out of the wetland** (c) lower or raise the water table and hydrostatic pressure outside the bounds of natural variability that existed before the activities commenced (d) **result in ongoing negative impacts to water quality** (e) result in bank instability; or (f) result in fauna ceasing to use adjacent areas for habitat, feeding, roosting or nesting.
Water 7	**The construction or maintenance of linear infrastructure activities in a watercourse must be conducted in the following preferential order**: (a) firstly, in times where there is no water present (b) secondly, in times of no flow (c) thirdly, in times of flow, providing a bankfull situation is not expected and that flow is maintained.
Water 11	**Petroleum activity(ies) on floodplains must be carried out in a way that does not:** **(a) concentrate flood flows in a way that will or may cause or threaten a negative environmental impact; or** **(b) divert flood flows from natural drainage paths and alter flow distribution; or** **(c) increase the local duration of floods; or** **(d) increase the risk of detaining flood flows**

Condition	Specifics
Rehabilitation 2	**Significantly disturbed areas that are no longer required for the on-going petroleum activities, must be rehabilitated within 12 months** (unless an exceptional circumstance in the area to be rehabilitated (e.g. a flood event) prevents this timeframe being met) and be maintained to meet the following acceptance criteria: (a) contaminated land resulting from petroleum activities is remediated and rehabilitated (b) the areas are: i. non-polluting ii. a stable landform iii. re-profiled to contours consistent with the surrounding landform (c) surface drainage lines are re-established (d) top soil is reinstated; and (e) either: i. groundcover, that is not a declared pest species, is growing; or ii. an alternative soil stabilisation methodology that achieves effective stabilisation is implemented and maintained.
Well Activities 1	**Oil based or synthetic based drilling muds must not be used in the carrying out of the petroleum activity(ies).**
Well Activities 2	**Drilling activities must not result in the connection of the target gas producing formation and another aquifer**
Well Activities 5	**Polycyclic aromatic hydrocarbons or products that contain polycyclic aromatic hydrocarbons must not be used in stimulation fluids** in concentrations above the reporting limit.
Well Activities 6	**Stimulation activities must not negatively affect water quality,** other than that within the stimulation impact zone of the target gas producing formation.
Well Activities 7	**The internal and external mechanical integrity of the well system prior to and during stimulation must be ensured such that there is:** **(a) no significant leakage in the casing, tubing, or packer; and** **(b) there is no significant fluid movement into another aquifer through vertical channels adjacent to the well bore hole.**
Well Activities 10	**Prior to undertaking stimulation activities, a risk assessment must be developed to ensure that stimulation activities are managed to prevent environmental harm**.

Well Activities 11	**The stimulation risk assessment must be carried out for every well to be stimulated prior to stimulation being carried out at that well and address issues at a relevant geospatial scale such that changes to features and attributes are adequately described and must include, but not necessarily be limited to**: (a) a process description of the stimulation activity to be applied, including equipment and a comparison to best international practice (b) provide details of where, when and how often stimulation is to be undertaken on the tenures covered by this environmental authority (c) a geological model of the field to be stimulated including geological names, descriptions and depths of the target gas producing formation(s) (d) naturally occurring geological faults (e) seismic history of the region (e.g. earth tremors, earthquakes) (f) proximity of overlying and underlying aquifers (g) description of the depths that aquifers with environmental values occur, both above and below the target gas producing formation (h) identification and proximity of landholder' active groundwater bores in the area where stimulation activities are to be carried out (i) the environmental values of groundwater in the area (j) an assessment of the appropriate limits of reporting for all water quality indicators relevant to stimulation monitoring in order to accurately assess the risks to environmental values of groundwater (k) description of overlying and underlying formations in respect of porosity, permeability, hydraulic conductivity, faulting and fracture propensity (l) consideration of barriers or known direct connections between the target gas producing formation and the overlying and underlying aquifers (**m) a description of the well mechanical integrity testing program** **(n) process control and assessment techniques to be applied for determining extent of stimulation activities (e.g. microseismic measurements, modelling etc.)** **(o) practices and procedures to ensure that the stimulation activities are designed to be contained within the target gas producing formation** (p) groundwater transmissivity, flow rate, hydraulic conductivity and direction(s) of flow **(q) a description of the chemical compounds used in stimulation activities (including estimated total mass, estimated composition, chemical abstract service numbers and properties), their mixtures and the resultant compounds that are formed after stimulation** **(r) a mass balance estimating the concentrations and absolute masses of chemical compounds that will be reacted, returned to the surface or left in the target gas producing formation subsequent to stimulation** **(s) an environmental hazard assessment of the chemicals used including their mixtures and the resultant chemicals that are formed after stimulation including:** **i. toxicological and ecotoxicological information of chemical compounds used ii. information on the persistence and bioaccumulation potential of the chemical compounds used; and iii. identification of the chemicals of potential concern in stimulation fluids derived from the risk assessment**

Condition	Specifics
	(t) an environmental hazard assessment of use, formation of, and detection of polycyclic aromatic hydrocarbons in stimulation activities (u) identification and an environmental hazard assessment of using radioactive tracer beads in stimulation activities (v) **an environmental hazard assessment of leaving chemical compounds in stimulation fluids in the target gas producing formation for extended periods subsequent to stimulation** **(w) human health exposure pathways to operators and the regional population** **(x) risk characterisation of environmental impacts based on the environmental hazard assessment** **(y) potential impacts to landholder bores as a result of stimulation activities** **(z) an assessment of cumulative underground impacts, spatially and temporally of the stimulation activities to be carried out on the tenures covered by this environmental authority; and** **(aa) potential environmental or health impacts which may result from stimulation activities including but not limited to water quality, air quality (including suppression of dust and other airborne contaminants), noise and vibration.**
Well Activities 12	Prior to undertaking any stimulation activity, a baseline bore assessment must be undertaken of the water quality of: (a) all landholder's active groundwater bores (subject to access being permitted by the landholder) that are spatially located within a two (2) kilometre horizontal radius from the location of the stimulation initiation point within the target gas producing formation; and (b) all landholders' active groundwater bores (subject to access being permitted by the landholder) in any aquifer that is within 200m above or below the target gas producing formation and is spatially located with a two (2) kilometre radius from the location of the stimulation initiation point; and (c) any other bore that could potentially be adversely impacted by the stimulation activities in accordance with the findings of the risk assessment required by conditions (Well activities 10) and (RMW026).
RMW030	**A stimulation impact monitoring program must be developed prior to the carrying out of stimulation activities** which must be able to detect adverse impacts to water quality from stimulation activities and must consider the findings of the risk assessment required by conditions (RMW025) and (RMW026) that relate to stimulation activities and **must include, as a minimum, monitoring of: (a) the stimulation fluids to be used in stimulation activities at sufficient frequency and which sufficiently represents the quantity and quality of the fluids used (b) flow back waters from stimulation activities at sufficient frequency and which sufficiently represents the quality of that flow back water (c) flow back waters from stimulation activities at sufficient frequency and accuracy to demonstrate that 150% of the volume used in stimulation activities has been extracted from the stimulated well; and (d) all bores in accordance with condition (RMW027).**

Dams	**Relevant DES guidance is contained within:** **1. Guideline. Manual for assessing consequence categories and hydraulic performance of structures** **2. Guideline. Structures which are dams or levees constructed as part of environmentally relevant activities (ESR/2016/1934 version 9.02)** In the later guideline it specifically states that *"the administering authority requires that any regulated structure be designed, constructed, operated and maintained to an engineering standard appropriate to the nature of the contents of the structure, the purpose for which it is to be used, and the environment in which it is located and may discharge if authorised to. The administering authority also requires that the condition of regulated structures and their operations will be monitored on a regular basis, and that timely action will be taken to prevent or minimise any actual or potential environmental harm".* ***Notable in the guidance are the following key requirements*** (X 5) All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19338). (X 6) Construction of a regulated structure is prohibited unless: a) the holder has submitted a consequence category assessment report and certification to the administering authority; and b) certification for the design, design plan and the associated operating procedures has been certified by a suitably qualified and experienced person in compliance with the relevant condition of this authority. (X 7) Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19338), and must be recorded in the Register of Regulated Structures. (X 8) Regulated structures must: a) be designed and constructed in compliance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19338); b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: i) floodwaters from entering the regulated dam from any watercourse or drainage line; and ii) wall failure due to erosion by floodwaters arising from any watercourse or drainage line; c) have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam. (X15) The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable. (X 16) The holder must, as soon as practicable but within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL. (X 17) The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam. (X18) By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).