ENVIRONMENTAL DEFENDERS OFFICE NT

7 Searcy Street, Darwin, NT
GPO Box 4289 Darwin NT 0801
Tel. 08 8981 5883
edont@edont.org.au
www.edont.org.au

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The Panel
Scientific Inquiry into Hydraulic Fracturing in the Northern Territory
GPO Box 4396
Darwin NT 0801
By email: fracking.inquiry@nt.gov.au

Dear Panel

Submission on the Draft Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Thank you for the opportunity to make a submission on the draft Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory ('draft Final Report').

The Environmental Defenders Office NT (EDO) congratulates the Panel on the delivery of the draft Final Report. We acknowledge the Panel's efforts to engage with communities and stakeholders across the Northern Territory (NT) and to bring together a wide range of complex information and diverse views.

As the only public interest environmental law centre in the NT, the EDO has heard directly from clients and community members about their concerns with hydraulic fracturing ('fracking') and the onshore shale gas industry. These concerns stem, significantly, from the low levels of trust in the NT's current legal framework, in particular its environmental laws. The efforts of the Panel to hear and respond to these concerns are commendable.

The EDO has been closely engaged with this Inquiry since its inception. We have appeared at hearings on 10 March and 1 August 2017, and have provided extensive written submissions dated 30 April and 4 September 2017.

This final submission builds on our previous input and responds to the draft Final Report by:

- Identifying key issues that are critical to resolve for the final report to government, and
- Commenting on select recommendations related to our expertise.

The EDO previously engaged a range of experts to prepare technical reports for the Inquiry, which were attached to our previous submissions. Further reports from three of those experts are provided as Attachments A, B and C to this submission.

1. Key issues

The EDO acknowledges that the draft Final Report proposes many important reforms to the NT legislative and regulatory framework for fracking and onshore shale gas.

We are pleased to note that of our original 32 recommendations (EDO submission dated 30 April 2017), 28 are reflected, either in part or in full, in the draft Final Report. Many of the Panel's recommendations will strengthen the existing legal and regulatory framework to deliver more accountable decision-making processes in the NT, by supporting enhanced transparency and public participation in decision-making and promoting access to justice. This overarching direction is strongly supported.

However, the EDO has identified three key issues that undermine the Panel's recommendations.

Key issue 1: The draft Final Report recommends different regulation for exploration and production processes

Many of the draft Final Report's recommendations propose reforms at either the exploration or production stage. It is often not clear why these distinctions are made, and in particular, why some recommendations do not apply to the exploration stage. This approach ignores the fact that there are similarities between exploration and production processes, with both involving significant environmental risk. Key regulatory mechanisms for mitigating environmental risk should apply to the entirety of the exploration and production process.

Examples of recommendations that inappropriately separate exploration and production include (the following list being non-exhaustive):

I. That water extraction licenses be required prior to any production license being granted (recommendation 7.1) – this recommendation should be extended to exploration

II. That objections may be lodged by any person to the proposed grant of an exploration permit and that the Minister must consider these objections (recommendation 14.9) – this recommendation should also apply to the proposed grant of a production permit

III. That the Minister must not grant an exploration permit unless satisfied a gas company is a fit and proper person (recommendation 14.11) – this condition should apply at the grant of a production permit and should be subject to Ministerial review and revocation at any time

IV. That the government develop and implement reforms related to the regulator prior to any production licenses being issued (recommendation 14.32) – these reforms should be implemented prior to any further exploration permits being granted, and prior to lifting of the moratorium and continuation of exploration under existing permits

V. That a strategic regional environmental and baseline assessment be undertaken prior to the grant of any production licence for onshore shale gas (recommendation 15.1) – this assessment should be a legislative requirement and must be required prior to lifting the moratorium and continuation of exploration under existing permits.

Although acknowledging it as a common community concern, the draft Final Report fails to genuinely respond to the fact that exploration permits have already been granted over up to 85% of the NT. Valuable recommendations that focus on mitigating risks before exploration (e.g. II and III above) will effectively be redundant if they are not applied to existing exploration activities.

Finally, it is unclear whether the Panel is recommending that the NT Government must implement *all* legislative and regulatory reform prior to lifting the moratorium (if it chooses to do so), or whether it recommends that reform could be sequenced over time.

Resolving these matters will be essential for the community to have any confidence in the Panel's proposals for a new legislative and regulatory framework.

Recommendation 1

The EDO submits that the draft Final Report must be amended to:

a. Reconsider the distinctions made between the recommended regulation of exploration and production, and extend the application of recommendations to both processes

b. If there are reasons to distinguish between the recommended regulation of exploration and production, clearly explain the rationale for any difference

c. Provide clear direction to government that the legislative and regulatory reforms must be applied to operators with existing exploration permits

d. Provide clear direction to government on proposed timing / sequencing of legislative and regulatory reforms, including identifying the recommendations that must be implemented prior to lifting the moratorium and continuation of exploration under existing permits.

Key issue 2: The Panel should link its recommendations with the ongoing reforms to the environmental regulatory framework

Although the draft Final Report proposes many important and significant reforms to the legislative and regulatory framework for fracking and the onshore shale gas industry, it does not address their relationship to the environmental regulatory reform process underway in the NT (via development of a new Environment Protection Act). While discussed briefly in the context of the options for a regulator (draft Final Report section 14.12), it is confusing that the many recommendations related to mitigating environmental risks through improved regulation are not placed in the context of these reforms.

The Panel must clarify and emphasise that the new environmental impact assessment and approvals process established by an Environment Protection Act will apply to fracking and the onshore shale gas industry. Many of the important recommendations in the draft Final Report should be proposed for incorporation in the Environment Protection Act, such as obligations to apply ESD principles and consider cumulative impacts in decision making, transparent and accountable decision-making processes, third party merits review rights, open standing for judicial review, and strong enforcement and compliance provisions.

The Petroleum Act and Regulations would 'dovetail' into this new Environment Protection Act. The Panel's recommendations that are specific only to fracking and onshore shale gas would of course remain in the petroleum framework (e.g. certain technical standards / enforceable codes of practice, merits appeal rights against decisions made under that legislation).

This integrated approach will deliver a consistent, accountable, environmental regulatory framework for fracking and the onshore shale gas industry.

Recommendation 2

The EDO submits that the final report to government must:

a. Clearly link its proposed legislative and regulatory reforms with the ongoing environmental regulatory reforms, and

b. Provide clear direction to government that the recommendations relevant to establishing environmental assessment and approvals processes, including those promoting transparent and accountable decision-making processes and access to justice, be integrated into the new Environment Protection Act, which will apply to fracking and the onshore shale gas industry.

Key issue 3: the Panel should make a clear recommendation about the regulator

The EDO supports the Panel's observations and analysis regarding the importance of a strong compliance and enforcement framework within the regulatory scheme (section 14.10), and its recognition that the regulator must be independent, transparent and accountable (section 14.12). Decisions about the regulator will be critical to how the community perceives proposed reforms, and whether or not the risks associated with fracking and onshore shale gas will have the chance of being appropriately mitigated and managed through regulation.

Options 1 and 2 outlined by the Panel (draft Final Report section 14.12) both assume that environmental approvals will rest with the Minister for the Environment, and that the compliance function must be removed from the department tasked with promoting the industry and land release. This is supported.

However, given the significance of the choice of regulator, the EDO considers the Panel should provide a clear recommendation to government about its preferred model, rather than 'sitting on the fence'. Although the EDO acknowledges the appeal of a single 'one stop shop' onshore shale

gas regulator, we consider this would not be effective in the NT, with ongoing challenges associated with resourcing and attracting and retaining staff. As we have previously submitted, we consider that it is preferable to have a strong, independent and properly resourced NT EPA responsible for compliance and enforcement across the spectrum of environmental laws. Advantages include efficiencies associated with sharing skills and costs synergies associated with centralising compliance and enforcement for all NT environmental regulation.

Recommendation 3

The EDO submits that the Panel revise recommendation 14.32 and make a clear recommendation to government that a strong, independent and properly resourced NT EPA is the most appropriate regulator.

As a result of these three key issues, the draft Final Report does not provide a clear and holistic picture of the proposed legislative and regulatory framework that would apply to fracking and onshore shale gas operations, nor the timing for implementing proposed reforms. Clarity around these issues is critical for the community to be confident in the NT's regulatory framework being adequately designed and implemented to sufficiently mitigate risks associated with the industry.

2. Comments on specific recommendations

Beyond the key issues described above, there are many important recommendations in the draft Final Report that the EDO supports. Many implement fundamental principles of environmental law, which unfortunately have been lacking in the NT for far too long.

We particularly support the following recommendations:

- Application of prescriptive minimum standards for operators including via mandatory, enforceable codes of practice (e.g. recommendations 5.1, 5.3, 9.1, 9.2, 14.17)
- That the Commonwealth be requested to apply the EPBC Act water trigger to onshore shale gas (recommendation 7.3)
- Application of ESD principles in decision-making in the Petroleum Act and consideration of cumulative impacts in the environmental approvals process (recommendation 14.10, 14.19)
- Accountability mechanisms for operators including a financial assurance framework and levy for abandoned wells (recommendations 14.12 and 14.13)
- That draft EMPs are to be made available for public comment before Ministerial approval and comments must be taken into account (recommendation 14.14)
- The provision of reasons for decision-making, data publication, public access to monitoring and reporting information (e.g. recommendations 9.5, 14.14, 14.15)
- Open standing for judicial review, third party merits review rights and public interest costs rules (recommendations 14.21, 14.22 and 14.23)
- Strong compliance and enforcement provisions including enhanced powers, sanctions, and penalties, and civil enforcement (recommendations 14.27, 14.28 and 14.30).

The EDO has also identified various recommendations that could be revised or strengthened. In particular:

- Various recommendations relating to impacts on biodiversity in chapter 8 are supported, but must be strengthened and underpinned by legislative provisions, for example 8.6 (rehabilitation) 8.8 (offset policy), and 8.10 (avoiding impacts on critical habitat)
- Recommendations related to greenhouse gas emissions should be strengthened by requiring decision-makers to take into account greenhouse gas emissions (including downstream emissions) when determining permit applications and by imposing prescriptive measures to

set emissions limits from onshore shale gas activities, having regard to the implications for Australia's domestic emissions and international climate change obligations, and the principles of ESD (recommendations 9.1 - 9.7)

- The recommendation to 'consider' mechanisms to ensure extant applications are not granted where coexistence with existing land use is not possible, should be strengthened to a direct recommendation to make necessary legislative amendments to give effect to this position (recommendation 14.3)
- The inclusion of 'no go' zones is supported but the mechanism to achieve this should be strengthened via inclusion in legislation (with specific criteria), and this should also apply to land with an existing exploration license (recommendation 14.1)
- The requirement for operators to enter into land access agreements with pastoral lease holders should be expanded to land rights / native title holders (recommendation 14.5)
- The recommendation to 'consider' enacting legislative provisions that reverse the burden of proof for pollution and environmental harm offences should be strengthened to a direct recommendation to reverse the burden of proof (recommendation 14.29).

The draft Final Report is complex and its recommendations are far reaching. The final report will require careful, detailed consideration by government. The EDO emphasises that any future legislative and regulatory reform must be undertaken comprehensively prior to any lifting of the moratorium, must not be rushed, and must be progressed in full consultation with the community.

Kind regards

Environmental Defenders Office (NT) Inc

Gillian Duggin
Principal Lawyer

Scientific Inquiry into Hydraulic Fracturing in the Northern Territory Draft Final Report: Review of Recommendations in Chapter 8, Land

Matthew J. Colloff

Visiting Fellow, Fenner School for Environment and Society, Australian National University

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Introduction

Following from my submission to the enquiry (Environmental Defenders Office NT, Submission #213, Attachment E), I was requested by EDO NT to provide advice on whether the recommendations made in the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory Draft Final Report (hereafter 'Draft Final Report') appropriately address and/or mitigate the level of risk outlined, particularly regarding information in Chapters 6 and 8.

In this review I outline the main issues detailed in Chapter 8 in relation to risks to terrestrial ecosystems and biodiversity from shale gas development, assess whether recommendations are likely to be effective in addressing those risks, and highlight any additional issues that may need to be addressed. I do not consider in detail the recommendations relating to regulatory reform (Chapter 14) or strategic regional environmental and baseline assessment (Chapter 15) in relation to terrestrial ecosystems and biodiversity. Exceptions are where recommendations in Chapter 8 relate directly to these (as for Recommendation 14.4), or where their efficacy may be compromised by proposed regulatory reform and assessment processes (as for the regulatory burden of monitoring and assessment; cf. below).

Chapter 4, evidence and risk assessment methodology, is relevant to this review, particularly how environmental objectives and risks were identified and assessed. Also of relevance is the issue of whether the risks and recommendations are consistent with the principles of ecologically sustainable development (the precautionary principle, intergenerational equity, environmental conservation, pricing and incentive principles and consideration of long-term, cumulative impacts; p. 26).

Extent of development

Chapter 6 details the scenarios for the extent of the surface footprint of shale gas development, noting considerable uncertainties, and that "the long lead time from exploration to development of shale gas resources…the most likely area for shale gas

development in the foreseeable future (5-10 years) would be the Beetaloo Sub-basin" (p. 85), and that the scale of development over the next 25 years based on industry estimates was ca. 1,000-1,200 wells on 150 well pads; at odds with the DPIR prediction of 15,500 wells in the greater McArthur Basin and 6,250 wells in the Beetaloo Sub-basin (p. 86). The enquiry estimates for the development scenario for Beetaloo Sub-basin is for more than 1,000 wells on 200 well pads (p. 87), with significant infrastructure requirements, including:

> …several hundred roads in the first instance, and the installation of connecting pipelines to treatment/production facilities...Pipeline infrastructure in the Northern Territory is currently inadequate to handle the potential magnitude of new discoveries in the McArthur Basin, of which the Beetaloo Sub-basin is a part. Accordingly, trucking, or possibly rail, may be the most practicable initial options to transport the gas. (p. 87).

The environmental footprint for a full scale shale gas industry includes "the drilling of thousands of wells, the construction of thousands of kilometres of roads and access tracks, the clearing of vegetation from well pads, accommodation facilities, production facilities, and pipelines for transporting the gas." (p. 87).

The extent of land clearance required is highly uncertain, given the range of development scenarios. However, a perspective on the general magnitude at least allows a comparison with rates of land clearance in the Northern Territory and nationally. Based on estimates for development of the Beetaloo Sub-basin (cf. Chapter 8, Sections 8.3, 8.44, Table 8.1), the extent of land clearing required ranges from ca. 3,300 ha to 33,000 ha. By comparison, from 2003-2009, some 10,000-20,000 ha of native vegetation was cleared annually in the Northern Territory, mostly for pastoral production (Environment Centre NT, 2018). An average of 130,000 ha of native vegetation was newly cleared (rather than cleared again after re-growth) annually nationwide during the decade to 2014 (Metcalfe & Bui, 2017, p. 20), so the estimate of 3,300-33,000 ha (over a 25 year period), represents about 2.5-25% of the average annual national rate for first-time clearing (2004-2014).

The total area of land affected by shale gas operations in the Beetaloo Sub-basin (based on submissions from three companies, Origin Energy, Santos and Pangaea) was estimated at 1,000-1,500 km^2, or 4-6% of the total area (27,000 km^2) of the Sub-basin (p. 169).

Risks and recommendations – general

Synergistic risks

The Draft Final Report does not adequately identify and account for *synergistic risks* (also referred to as *complex risks*; Coburn *et al*., 2014). These risks result from the combined and

cumulative effects of different, sometimes seemingly unrelated risk factors or driver variables that interact in ways that increase exponentially the likelihood of a risk eventuating. In other words, the risks of multiple interacting factors are considerably greater than the risks from just one or two factors. Such interactions are typically unpredictable, non-linear and complex. An example of synergistic risk factors in relation to fire regimes is the *combined effects* of increased human activity and vehicle traffic, the development and production of flammable gas and its associated infrastructure, the high prospect of weed invasions (particularly high biomass grasses) and, finally, projections of a greater frequency and severity of extreme weather events driven by climate change on increases in fuel load, flammability, sources of ignition and hence frequency and intensity of wildfires. Most environmental risks and uncertainties arise from the interaction of such synergising variables. The concept of synergistic or complex risk has been widely adopted within healthcare and epidemiology (e.g. Breakwell, 2014, p. 48), the insurance sector and in disaster risk management.

A major contributor to the failure to identify and mitigate synergistic risks, especially in regulatory contexts, is the tendency to compartmentalise risk as individual factors according to sectorial, jurisdictional or legislative relevance or 'fit'. Such a normative, non-systematic approach fails to address that the environment, landscapes and ecosystems function as a complex adaptive systems and that driver variables of the structure and functions of landscapes and ecosystems interact in ways that are difficult to predict and manage for.

The impacts of climate change

The Draft Final Report deals extensively with the risks associated with the contribution of shale gas production to greenhouse gas emissions, but does not consider the threat of climate change in its interaction with shale gas production as an environmental risk. While some limited interactions have been identified in the Draft Final Report (e.g. the link between increased vehicular traffic, the spread of weeds and the impact on fire regimes), the likely effect of climate change, particularly of predicted increases in mean surface temperature and evapotranspiration, extreme rainfall and drought events and their subsequent effects on rapid vegetation growth, fuel accumulation and drying, have not been adequately addressed in the recommendations. The Draft Final Report contains only one mention of climate change impacts: "The implications of climate change for groundwater processes and recharge rates are also unclear at this stage" (p. 91).

Average air surface temperatures have increased in Australia by 1.1°C since 1910, and 0.7°C since 1980 (CSIRO and BoM, 2016). 2013-2017 was hottest five-year period on record, of

which 2016 was the hottest and 2017 the hottest year in which temperatures were not elevated by an El Niño event. Climate change is happening now, with an increased frequency of heat waves, droughts and extreme weather events. Higher temperatures increase evaporation leading to droughts, even in regions where there is no decrease in rainfall. As plants and soil lose moisture, they are less effective sinks for solar radiation, so the air becomes warmer and dryer, increasing the risk of wildfires. Warmer air can contain more water vapour and energy than cool air; released as extreme rainstorms that cause flash flooding, even in areas where rainfall may have declined. Higher sea surface temperatures are leading to greater frequency and severity of tropical cyclones.

These statements about climate change are not predictions, projections or expressions of uncertainty, but realities for which there is overwhelming empirical scientific evidence (NOAA, 2017). Failure to address the realities of current climate change and its implication for the future is a serious risk to the integrity and credibility of the Draft Final Report, and stands in contradiction to the claim that the principles of Ecologically Sustainable Development "are at the core of the panel's analysis" (p. 26). The duration for shale gas production is estimated as 20-40 years, with a lag time of 5-10 years (pp. 86, 88), giving a production period of ca. 2043-2068. By 2050, climate change is likely to have intensified considerably.

Downscaled projections of climate change in the Northern Territory are available for the monsoonal north (N of Elliot), in which the Beetaloo Sub-basin is situated (Moise *et al*., 2015) and the rangelands below latitude 17°S (Watterson *et al*., 2015). For the monsoonal north, there is *very high confidence* of increased warming (0.5-1.3°C by 2030 above the 1985-2006 average), and increased frequency and duration of extreme heat events (fourfold increase in days over 35°C in Darwin by 2030) and *high confidence* of increased intensity of heavy rainfall events, evapotranspiration rates and that wildfires will be more extreme.

Heat stress caused by extreme temperature events is a serious cause of morbidity and mortality, and likely to be one of the most dangerous aspects of climate change. As extreme heat events increase in frequency, magnitude and duration, so will human exposure, posing a severe threat to health, infrastructure, and outdoor activities (Coffel et al. 2018). In the Northern Territory, extreme heat events already pose a serious health risk to people required to work outdoors, and is likely to increase in coming decades, risking a safe operating environment for the production of shale gas. The risk of accidents related to heat stress is an important factor in the assessment of synergistic risk to the environment.

The Draft Final Report states that assessment of risk was only undertaken if there was sufficient information or evidence to do so (p. 29). Despite the existence of such information, the risks from climate change were not assessed. This omission calls into question the credibility of all assessments of environmental risk contained within the Draft Final Report.

The regulatory requirements for monitoring and assessment

Issues of regulation and compliance are addressed in Chapter 14. Underpinning these is a considerable increase in the task of monitoring and assessment for both gas production companies and NT Government agencies. These monitoring activities, for land, include terrestrial biodiversity assessments conducted as part of strategic regional environmental and baseline assessments (SREBA; Chapter 15), the occurrence and spread of weeds, population changes in threatened species, fuel loads and fire mapping and the identification of areas of high ecological value. Much of the monitoring required is ongoing and long-term. These activities are proposed for a region in which the biota is "vastly under-described" (p. 155), where ecosystems and vegetation communities have barely been studied or surveyed, and in which remoteness and large areas required to be surveyed pose major impediments to the practical implementation of such monitoring.

The monitoring and assessment in a SREBA for terrestrial ecosystems includes: (1) identification of locations of high conservation value via systematic survey of vascular plants, vertebrates and selected invertebrates; (2) establish current distribution and abundance of weed species; and (3) determine effects of habitat loss from fragmentation on threatened species (p. 396). For the Beetaloo Sub-basin alone (27,000 km^2), even if confined to the total area estimated to affected by shale gas operations (1,000-1,500 km^2) would require an enormous effort. The procedures required can be gauged by comparison with those of other States and Territories for assessing impacts on threatened species and ecological communities; for example the NSW Biodiversity Assessment Method for assessing biodiversity offsets (NSW, 2017) or the assessment process for approvals for clearing of native vegetation in Victoria (DELWP, 2015). These procedures are complex, exacting, and require trained and accredited staff for their completion. Furthermore, they are designed for relatively small areas in regions with a high knowledge base of existing biodiversity and vegetation communities.

The capacity of Northern Territory Government agencies and gas companies to recruit, train and retain sufficient numbers of qualified staff able to carry out the monitoring and assessment activities to the standards required to implement the recommendations

represents a formidable logistical challenge. Given the lack of ecological documentation of the region, particularly regarding drivers and threats to ecosystem function and integrity, the monitoring task requires engagement of research officers with broad experience in the reliable identification of native biota and exotic species of the region, the nature and extent of stressors on terrestrial ecosystems and their responses, as well as research-level skills in data handling and interpretation. Such skills are rare, unlikely to be met fully from within the Northern Territory, and thus have potential draw-down impacts on the environmental monitoring capabilities of other States and Territories. A detailed and careful assessment of the tasks associated with the monitoring requirements for all relevant recommendations is required, together with consideration of the agencies involved, skills, staff numbers, recruitment, retention, training, accreditation and reporting, if the monitoring recommendations are to be regarded as credible.

Long-term environmental monitoring has a poor track record in Australia, especially in terms of quality of data, accessibility and interpretation. For example, the authors of each *State of the Environment Report* since 1996 have highlighted the lack of data that indicates ecological changes over time and have repeatedly called for major improvements in design and implementation of long-term monitoring. A significant increase in environmental monitoring capability and knowledge in the Northern Territory is unlikely to be achieved without a sustained and well-resourced programme of change in governance and culture regarding the monitoring, regulation and compliance rules within and between Government agencies and departments and the gas companies.

The Panel acknowledges the lack of trust by the community in the ability of Government and the gas companies to adequately regulate industry (pp. 218, 330). Lack of trust is based on a history of Government and industry not doing the right thing and, in the process, breaching the faith the community may have had in regulatory governance arrangements intended to hold industry to account. The Panel does not address how in its proposed new regulatory model (pp. 384 *et seq*.), improved governance, independence, transparency and accountability will be implemented and ensured; only that these are desirable attributes for regulatory reform.

In this regard, the failure to implement a new regulatory model represents a significant synergistic risk factor (cf. above) for environmental damage. The risk assessment used in the Draft Final Report has not accounted for the prospect that the recommendations of the Panel on regulatory reform will either not be accepted or fully implemented by the NT Government. Indeed, the Draft Final Report states “In making an assessment, the Panel has

assumed the application of the current regulatory regime." (p. 29). However, failure to ensure the governance and culture of a new regulatory system is resourced, maintained and is adaptable to change poses a systemic risk to its continuation.

Risks and recommendations – specific

Specific risks and recommendations are discussed below and outlined in Table 1.

Areas of high conservation value

Criteria to determine areas of high conservation value that should be excluded from shale gas development are subject to interpretation and change, requiring ongoing monitoring and assessment. Capability to conduct assessments is a major logistical challenge, as outlined above. What constitutes an area of high conservation area depends on its capacity to be conserved. If it and the biota it contains cannot be conserved in the long-term, there is little or no point in designating it as such. A major weakness of the recommendations is that decision-making as to how principles of ESD are applied, including consideration of damage to areas high conservation values, still sits with the Minister responsible for Petroleum Act (Recommendation 14.10, p. 359).

Criteria to assess conservation policy and management objectives are changing because of the threat of climate change and other global stressors, including development of natural resources, pressures from agricultural land-uses and the impacts of these on native ecosystems. Conservation objectives are shifting from *ecosystem protection* (e.g. of threatened and highly endemic species) and preserving current ecosystem character towards *managing changing ecosystems*. Factoring plausible scenarios of change into conservation policy and management is shifting conservation practice towards managing for dynamic responses to multiple drivers of change (Colloff *et al*., 2017). Where these drivers cause transitions to alternative ecosystem states, emphasis will be on facilitating transitions, preserving ecosystem functions, and minimizing species losses, regardless of threatened status (Dunlop *et al*., 2013).

With regard to ESD principles on long-term considerations in decision-making (p. 26), including the decisions about recommendations in the Draft Final Report, over the lifetime predicted for shale gas production, it is highly likely that changes in conservation policy and practice will be mainstreamed into legislation and operations, rendering existing recommendations on what constitutes high conservation value areas outdated. An example is the recent changes to biodiversity legislation in New South Wales, now intended "to support sustainable development and productive farming that responds to environmental

risk" (OEH, 2017). Current legislative frameworks that are subject to political pressure and change offer little or no protection to ecosystems and biodiversity over the long term.

Spread of weeds

Acceptance by the Panel that the prospect of significant spread of weeds is 'high' and that "even with best management practice in place…introduction of new species is likely" (p. 175) appears to contradict principles of ecologically sustainable development in relation to conservation of ecological integrity, intergenerational equity and consideration of long-term, cumulative impacts. This position of acceptance also violates social and environmental justice principles through environmental impairment for people other than those in the mining sector whose livelihoods and wellbeing depend on the land. Weeds such as the invasive grasses (e.g. gamba grass, grader grass and buffel grass) and woody perennials (mesquite, mimosa, prickly acacia) regenerate from fire-resistant seedbanks or vegetative structures. These weeds are associated with increased risk of wildfires by creating high fuel loads that drive intense late-season fires (cf. below) which, combined with the invasion of these species, permanently alter the structure and function of native ecosystems, plant communities, animal diversity and water regimes. A change in fire regimes in a region of gas production brought about by weed invasion poses a major threat to the integrity of ecosystems in that region.

Of 32 Weeds of National Significance (WoNS: weeds with major potential for spread and causation of environmental, social and economic impacts), 19 have been detected in the Northern Territory but only eight are subject to statutory weed management plans (NT Government; 2017). For the Beetaloo Sub-basin, the following WoNS have been recorded (NT Government; 2017; cf. also Atlas of Living Australia www.ala.org.au; asterisk indicates statutory weed management plan in place): athel pine*, bellyache bush*, gamba grass*, grader grass*, lantana, mesquite*, mimosa*, parkinsonia, parthenium and prickly acacia. Additionally, chinee apple and neem, not WoNS, are present in the Sub-basin and have statutory management plans in place. This occurrence is despite the assertion of the Department of Environment and Natural Resources (DENR, 2017) quoted in the Draft Final Report (p. 173), that "the Sturt Plateau is highly regarded as relatively free of weeds." One of the most significant weeds of the NT associated with environmental degradation, buffel grass, is not subject to a statutory management plan, in part because of controversy regarding its environmental impact, especially in increasing the risk of fire, versus its value for cattle grazing (Miller *et al*., 2010).

Control and eradication of WoNS requires coordination and resourcing between all levels of government, organisations and individuals with weed management responsibilities. However, the spread of none of the weeds listed above has been successfully controlled in the Northern Territory. Information on the progress and efficacy of statutory management plans is not available on the weeds section of the NT.gov.au website. The history of very significant impact of weeds on terrestrial ecosystems in the Northern Territory, combined with historical failure of effective weed control and legislation, and the lack of a strong evidence base for the efficacy of statutory weed management plans, does not provide a sufficient basis for the Panel to conclude that "strengthening the current regulatory regime *should* mitigate the risk of the spread of weeds" (p. 175) [my emphasis], where baseline surveys and weed management plans done by gas companies and compliance with the *Weeds Management Act 2001* (NT) form the basis of the recommendation.

Changes in fire regimes

The Draft Final Report ranks the consequences for native vegetation and other biodiversity and increased greenhouse emissions from increased risk of fire due to shale gas development as 'high' but that they can be mitigated to 'low' by recommendation 8.4 (p. 181), which involves gas company compliance with statutory regional bushfire management plans, monitoring fuel loads, mapping changes in fire frequency and extent compared with a pre-development baseline and management to reduce sources of ignition and carry out fuel reduction burns. The rationale behind the large risk mitigation effect ('high' to low' rather than to 'medium') from these measures, some of which are already carried out by DENR (e.g. fire mapping), is not made clear in the Draft Final Report.

Mapping of scars from early and late dry season fires (DENR submission 473, Attachment C) shows that fires occurred in the Beetaloo Sub Basin at least twice every year in the decade 2007-2016, with extent (estimated by me) ranging from 1,040 km^2 in 2013 to 13,520 km^2 in 2012 (average 6,650 km^2 or 25% of the total area). Burns of over 9,000 km^2 (a third of the total area) occurred in 2007, 2009, 2012 and 2014. Many areas burned seven times in ten years. The whole-of-Territory map in Figure 8.8 (p. 179) under-represents the frequency and extent of fires in the highly fire-prone Beetaloo Sub-basin.

The likelihood of changes in fire frequency, intensity and extent due to synergistic risks of climate change, weed invasion, fuel loads, gas development (including flaring activities), and increased human activity, including fuel reduction burns, has been outlined above (cf. *Synergistic risks* and *Impacts of climate change*). There is the prospect that over the timeframe for development and production of shale gas, this synergistic risk may grow to

the point that occurrence of catastrophic fire becomes near-inevitable. Such a hazard could be envisioned where higher wildfire frequency and extent causes damage to infrastructure and increases a flammability or explosion risk, which in turn triggers more intense fire and more extensive and long-lasting environmental damage than from wildfire alone.

Changes to native vegetation

The Panel assessed the overall risk of unacceptable changes to native vegetation resulting from land clearing for gas exploration and production as 'medium' (p. 182), and acknowledges the substantial areas (up to 330 km^2; Table 8.1) that will require clearing. The risk of permanent transformations of native vegetation communities due to synergistic interactions between land clearing, changes in fire regimes and weed invasions were not considered in the Draft Final Report (cf. above).

The Panel recommends baseline surveys for threatened species with ongoing monitoring of any such populations, minimising the area of land clearance, progressive native vegetation rehabilitation, recommendations with regard to 'no go zones' (p. 342) and that "the Government develop and implement an environmental offset policy to ensure that, where environmental risks are unable to be avoided or adequately mitigated, they are offset" (p. 184). Further, "the Panel recognises that for offsets to be effective, there must be a scientific approach to assessing the impact of development on biodiversity" (p. 183).

A fundamental design fault with biodiversity offset programmes is they promote the protection of high conservation value habitats as suitable offset areas. But a site that is in good condition, has high biodiversity values and is not at risk of clearing or degradation has little scope for improvement. So, this strategy effectively results in a net loss of vegetation. This would be the case with most vegetation communities available for offsetting of land clearance for gas development in the Northern Territory. In other jurisdictions biodiversity offset schemes have led to perverse outcomes (Maron *et al*., 2016) and are widely mistrusted as being susceptible to regulatory capture by developers. A widely-held view amongst ecologists is that offsets do not halt the loss of biodiversity or environmental degradation. Less than 40% of offset schemes in Western Australia delivered an effective outcome (May *et al*., 2016). An assessment of 10 years of offsets in NSW, found it would take 146 years to achieve no net loss in the area of native vegetation because 82% of the total area offset was obtained by averting losses to existing native vegetation and the rate that averted losses accrue had been greatly over-estimated by policy makers and Government agencies (Gibbons *et al*., 2017).

The Panel does not consider the ecological roles, or ecosystem functions, of the vegetation communities likely to be cleared. Tropical savanna woodland was recently discovered to have a vital role in global carbon sequestration. Aboveground carbon losses from clearing of tropical forests were offset by a massive increase in carbon sequestration following wet conditions in savannahs of northern Australia and southern Africa (Liu *et al*., 2015). These savanna woodlands thus function as rapid response buffers against carbon loss through their capacity for enormous increase in biomass in response to rainfall. Tropical savanna woodland is the only vegetation type known to respond in this way at this scale.

How might one design and implement an offset system that results in no net loss of a vegetation community that plays such a critical role in ensuring the future health of this planet? This is not just an environmental problem to be solved with scientific approaches, but also a profound issue of ethics and values, including careful consideration of what constitutes 'unacceptable changes to native vegetation'.

Roads and pipelines as ecological barriers and corridors

The Panel identified a medium overall risk that roads and pipelines will contribute to ecological fragmentation, acting as ecological barriers to faunal movement and as corridors, including as conduits for weed invasion. Recommendations for mitigation are based on avoiding detrimental impacts during corridor construction; minimising corridor width and the impacts on water flows, reducing risks of erosion and effects on water flow at wet season stream crossings. These recommendations mostly depend upon existing environmental legislation relating to corridor construction by mining companies and best practice for erosion control and pipeline construction (p. 185). The adequacy of the recommendations thus depends in large part upon the degree to which existing legislation has ensured compliance by mining companies so far. The Draft Final Report gives no indication that the Panel sought information on compliance issues from the relevant agencies or took these matters into consideration in the design of its recommendations.

Landscape transformation

The recommendations deal only with amenity, aesthetics and scenic value. Landscape transformation is conceptualised narrowly in terms of visibility of infrastructure. The overall risk is assessed as 'high' (p. 188). The Panel does not consider changes in ecosystem character, structure and function and therefore do not effectively address the issue of unacceptable landscape transformation in the broad sense. What is considered 'unacceptable', and to whom, is not defined in the Draft Final Report. The recommendations

deal only with spacing of well pads and that infrastructure is not visible from major roads (p. 189).

Heavy vehicle traffic

High volumes of heavy vehicle traffic are an inevitable consequence of shale gas development, but the risks are considered only in terms of landscape amenity. This approach is inadequate. Multiple detrimental effects on the environment from increased vehicular traffic are foreseeable and quantifiable. The Panel does not make an assessment of the risks because it lacked information on 'increase in volume at various times of year, types of vehicles… and the cumulative effects of multiple developments' (p. 190). This lack of information could have been addressed though modelling of scenarios for increase in heavy vehicle traffic.

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Table 1. Summary of risks and issues for terrestrial ecosystems and biodiversity (Chapter 8 Land), recommendations to address those risks and an assessment of their effectiveness.

Issue or risk	Recommendation	Likely effectiveness	Other issues not addressed
Shale gas development should be excluded from areas of high conservation value; e.g. with high biodiversity, endemism or threatened species (p. 172)	8.1 Terrestrial biodiversity assessments conducted as part of a strategic regional environmental and baseline assessment (SREBA)	High if SREBA is rigorous and enforceable. Low if not	Criteria to determine areas of high conservation value subject to interpretation and change, requiring ongoing monitoring and assessment. Capability to conduct assessments may represent a serious constraint on the integrity of the recommendation
The status of park or reserve in the NT does not protect land from shale gas development (p. 159)	14.4 Declaration of national parks, conservation reserves and areas of high ecological value as reserved blocks under s 9 of the Petroleum Act	High for protection of existing parks or reserves. Moderate for protection of newly-identified areas: proposed designation likely to be subject to economic and political pressure	Criteria to determine areas of high conservation value subject to interpretation and change
High risk of the spread of weeds through shale gas development, including several Weeds of National Significance (p. 175). Gas companies not currently liable for weed management	8.2, 8.3 Baseline assessment of weeds in a permit area prior to exploration; ongoing monitoring by Weeds Officer employed by gas companies. Prior to entering permit area, companies complete a weed management plan	Low. Introduction of new weeds is highly likely, "even with best management in place" (p. 175). Agency responsibilities for compliance not defined. Obstacles include remoteness, large areas for monitoring and of staff trained in weed identification and management	Introduction of weeds that damage ecosystems contradicts principles of ESD and environmental justice: impairment of environment for other people whose livelihoods and wellbeing depend on the land
Changes in fire regimes: high risk of increased fire frequency	8.4 Gas companies comply with statutory fire management plans: baseline assessments, fuel load monitoring, fire mapping and fuel reduction burns	Low to moderate. Risk of catastrophic fire not considered. Rationale behind the large risk mitigation effect ('high' to low') not made clear in the Draft Final Report.	Likelihood of altered fire regimes due to synergistic risks of climate change, weed invasion, fuel loads, gas development and human activity not considered.
Medium overall risk of unacceptable changes to native vegetation	8.5-8.9 Determination of impact on threatened species of habitat loss; minimise area cleared; rehabilitation; offsets	Low: no net loss of tropical savanna woodland through offsets not addressed adequately. Criteria for assessment of impact on biodiversity is based on population declines, but monitoring may be inadequate to demonstrate decline	Vital functional role of tropical savanna woodland in global carbon sequestration and buffering not considered. Offset recommendation wanting in basic design principles, including what constitutes 'unacceptable change in native vegetation'
Medium overall risk that roads and pipelines contribute to ecological fragmentation, acting as ecological barriers and corridors	8.10-8.14 Avoid detrimental impacts during corridor construction; corridor width minimised. Minimise impacts on water flow, of erosion and wet season stream crossings	Moderate. Recommendations mostly rely on existing environmental legislation on corridor construction and minimising impacts, so efficacy depends largely on extent of compliance and enforcement	No indication that the Panel sought information on compliance with regulations or took these matters into consideration in designing its recommendations.
Unacceptable landscape transformations and impacts on landscape amenity	8.15 Gas companies demonstrate they have minimised surface footprint: well pads at least 2 km apart & infrastructure not visible from public roads	Low. Recommendations deal with a narrow view of risk of landscape transformation, considered only in terms of amenity, not changes in ecosystem character, structure and functions	Even when assessed only in terms of amenity value, the impact of landscape transformation on tourists and residents could not be assessed because the Panel found it 'difficult to assess' (p. 188) because the consequences were 'subjective'
Unacceptable increase in heavy vehicle traffic	8.16 NT Government develop a management plan to mitigate impacts: forecasting traffic volume, road upgrades and feasibility of use of existing rail	Moderate. Recommendations based on feasibility of alternative transport via rail, road upgrades and forecasting traffic volumes	Recommendations could be informed by modelling of scenarios of increase in heavy vehicle traffic

COMMENTS ON SCIENTIFIC INQUIRY INTO HYDRAULIC FRACTURING IN THE NORTHERN TERRITORY DRAFT FINAL REPORT

Prepared by Dr Renata Bali

February 2018

I was briefed by the Environmental Defenders Office NT on behalf of Lock the Gate Alliance to review the Final Draft Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, in light of my previous comments to the Inquiry, namely:

- Response to Scientific Inquiry into hydraulic fracturing in the Northern Territory Interim Report (Bali 2017a); and
- Scientific inquiry into hydraulic fracturing in the Northern Territory – Expert Advice (Bali 2017b).

In preparing this review, I particularly considered Chapter 8 (Land), Chapter 14 (Regulatory Reform) and Chapter 15 (Strategic Regional Environmental & Baseline Assessment).

Most of the background information and references relating to my comments can be found in my previous two submissions.

POSITIVE OUTCOMES

There is much to commend in the Final Draft Report.

Firstly, the more robust regulatory framework (Recommendations 14.1-14.32) that includes the formation of an independent regulatory body, the addition of enforceable objective-based legislation and a transparent regulatory process, is a major step towards regaining public trust and ensuring that environmental matters are given proper and independent consideration. In particular, recommendations aimed at operationalising ESD principles (14.10) and requiring that the Minister consider cumulative impacts (14.19) are welcomed. Regulatory reforms (Recommendation 14.32) to ensure that decisions about environmental impacts are made independently, are long overdue.

Recommendation 8.1 to conduct Strategic Bioregional Environmental & Baseline Assessments (SREBAs) for each bioregion prior to shale gas production is laudable. This will act to avoid areas of regionally high conservation value and to inform any decision to release land for exploration. SREBA assessments (15.1) would overcome many of the weaknesses of the Commonwealth Strategic Environmental Assessment (SEA) process and combine the positive aspects of strategic and bioregional assessments.

While I agree that bioregions may be the appropriate scale at which to conduct surveys and assess conservation significance, they are not an appropriate scale

for measuring vegetation clearing impacts at the site scale (see discussion below).

I agree with the Panel that the SREBAs should be comprehensive and that regional data should be examined for species richness and endemism, as well as occurrences of threatened species. I also agree that the EPA guidelines described in Section 15.3.3 should be considered as a 'starting point' only. I previously noted that the NT government and its agencies take a very narrow view of biodiversity when it comes to major project assessments and does not consider the impacts of shale gas extraction to be 'significant'.

While I have not found any evidence to convince me that offsetting has halted the decline of biodiversity anywhere in the world, I support the Panel's call for the NT government to develop a new innovative offset scheme using a scientific approach and using known biodiversity values instead of prescriptive ratios as a trade-off (Recommendation 8.8). This appears to recognise the fact that existing offset schemes are deficient. However there is no guarantee that any new offset scheme will be innovative or overcome the weakness inherent in existing schemes. More importantly, and based on extensive literature reviews, there is no evidence that existing offsetting schemes will halt the decline in biodiversity.

I also note that the Panel has acknowledged the interaction between alterations to fire frequency and predation by feral cats on small mammals by raising the overall risk of increased fire frequency from 'medium' to 'high'. This recognises the cumulative effects of predation and changed fire regimes, particularly with regard to small mammal population declines, that has been lacking in previous reports. However, the Panel does not expressly consider the role of climate change in changing the frequency, intensity and distribution of fires in the future.

In the Interim Report, the Panel found that impacts on wildlife related to noise, light and the drinking of wastewater represented 'low risks without the need for mitigation'. I note that the Panel's draft Final Report has reconsidered its position with respect to some of these by confirming that noise and light impacts were being addressed in EMPs and by recommending that wastewater be stored in enclosed facilities (Recommendation 7.11) to restrict access by fauna.

However, it is apparent that the Panel continues to take a limited view of fragmentation caused by roads and pipelines by mainly considering their effects on water flow and fire frequency, while underestimating the impacts of barriers and corridors on fauna movement. In my opinion this is a major deficiency and is discussed further below.

OUTSTANDING ISSUES

The Panel recommendations continue to promote reactive rather than proactive responses to biodiversity conservation.

It is disappointing that the Panel's approach to biodiversity conservation is still more reactive than proactive, particularly with regard to no go areas, SREBA assessment and cumulative impacts. This is despite the laudable move to assess conservation values at the regional level.

While the recommendation (14.4) to declare all National Parks, conservation reserves and other significant sites (with appropriate buffers) as 'reserved blocks' is supported, there is the risk that these will eventually be surrounded by a matrix of development, if they are not consolidated via a comprehensive and representative network of no go zones.

It is apparent from the literature that many of the common NT vegetation assemblages have not been adequately reserved or even reserved at all (Table 6, Bali 2017b). Furthermore, less than 1% of the bioregions covering the Beetaloo Sub-basin are reserved. By prioritising the protection of high conservation and other significant areas, there is a risk that, without careful conservation planning, many of the more common and iconic NT ecosystems and the environmental services that they provide, will be lost to development.

For example, North Star Pastoral's proposal to clear 20,431 ha (204.31 km^2) of mixed eucalypt woodlands and shrublands over perennial grasses submitted to the NTEPA in October 2017 was not considered to be 'significant' as these communities are considered representative of the wider Sturt Bioregion. This is despite the moderate likelihood of two nationally listed species occurring there. However the EPA Statement of Reasons cautions that: "*The cumulative impact on terrestrial fauna as a result of habitat loss within the Sturt Plateau bioregion will need to be carefully considered for any future land clearing applications*."

The need to conserve the more common vegetation associations and habitats extends beyond bioregional boundaries. I am concerned that conservation values for each bioregion will be assessed in isolation, without regard for the flora and fauna distributions and/or populations, movement corridors and migratory pathways that span two or more bioregions. In particular, these will become more critical for flora and fauna as the global effects of climate change increase. A holistic approach to ecological planning is required but is not mandated in the Panel's recommendations.

Under Recommendation 14.2 the Minister would, when releasing land for gas exploration, be required to take into account its prospectivity and the possible coexistence of the gas industry with other existing and future industries, as well as its conservation or other values. While making this a requirement is a positive step, I am concerned that future no go zones will comprise mainly those

areas deemed to be unsuitable for gas exploration (or other industries) or that are 'avoidable', thereby remaining severely underrepresented in shale basins.

Recommendations 8.5-8.7 propose that cumulative impacts on threatened species be identified as part of the SREBA assessment, and followed up with monitoring and mitigation if 'a decline in populations' is observed. In my opinion, this is too late to take action and is reactive. A more proactive approach offered by EDO NT is quoted on p. 183 of the Draft Final Report:

"...from a bioregional planning perspective, it would be much more proactive and precautionary to nominate priority no go areas prior to the development of shale gas fields; these would form the core conservation areas to which future additions, including offsets, can be made".

The SREBA assessment process should be used not only to identify areas of high conservation significance but also to determine regionally important corridors comprising typical vegetation communities. This preliminary ecological planning should be used as a basis towards consolidating a network of no go zones and for prioritising sites for future acquisition, management and/or offsetting. These should be set up prior to the development of shale gas fields (i.e. proactive approach discussed in Bali 2017a, b).

In my view, Recommendations 8.1 and 15.1 will lead to more areas of high conservation being identified and (possibly) declared as reserves or 'reserved blocks'. However, Bali (2017b) pointed out that even the largest reserves are inadequate for the maintenance of some ecological and evolutionary processes and for highly dispersive species.

Consequently there has been a shift away from protecting large representative ecosystems through the formal reservation system to retaining, restoring and facilitating active management of corridors through public and private lands. We can expect these to support more species, to contain more interior habitats and to be more resilient. An extensive network of corridors would insure against climate uncertainty and provide alternative pathways for species' movement and adaptation.

The mitigation measures recommended to reduce the impacts of weeds, alterations to fire frequency and habitat loss and fragmentation have not been shown to halt the decline of biodiversity.

As noted in my previous submissions, the mitigation measures recommended to reduce the risk of significant impacts are not likely to be effective as they are essentially the same ones as are already being applied for major projects. The Australia SoE (2016, in Bali 2017a) has shown that accepted and best practice mitigation measures have not been successful in controlling feral animals and weeds, or in halting the decline of biodiversity.

While I agree that gas companies should be responsible for weed management and be required to have dedicated weed officers and to follow weed management plans, I do not agree that other mitigation measures recommended (Section 8.4.2) will 'substantially reduce' the risk of weed proliferation associated with shale gas extraction activities.

It is interesting to note that the Panel does not nominate a final risk level taking into account mitigation. In my opinion, there is no evidence to justify lowering the risk level below 'medium'.

Monitoring and management are unlikely to be effective from a logistical point of view because these activities would have to be undertaken over vast and remote areasin perpetuity. The Draft Final Report states on p. 177:

"...*the development of any onshore shale gas industry in the NT will require the construction of a comprehensive interconnected network of access roads and linear infrastructure within previously contiguous landscapes*."

The extensive network of roads and pipelines associated with shale gas operations would open up vast areas of presently inaccessible land to traffic and human activity, separate to that associated with shale gas development. Weed officers would have to cover large areas (i.e. 1000-1500 km^2 in the case of Beetaloo Sub-basin alone) in perpetuity. Despite rehabilitation efforts and underground pipelines, road verges and easements will need to be maintained in the long-term (i.e. 1000 km in the Beetaloo Sub-basin). Edge effects associated with weed dispersal can extend over 2 km from roads.

Similarly, mitigation measures recommended to prevent unacceptable changes to fire regimes (Section 8.4.3) are not, in my opinion, likely to be effective given the impacts of climate change and the likely increase in the spread of exotic grasses (with or without gas exploration). The Panel has not expressly taken into account the changes in frequency, intensity and distribution caused by climate change.

Most disappointing of all are the mitigation measures recommended to reduce the risk of biodiversity loss. The 'business as usual' approach of avoidance, monitoring, mitigating and offsetting has not halted the decline of biodiversity anywhere in Australia. In fact, the number of threatened species and ecological communities has shown no signs of abating during the past 20 years (SoE 2016).

Offsetting is of particular concern as it has not been shown to halt biodiversity decline and it may in fact exacerbate it. The weaknesses of existing offsetting schemes have been highlighted in my previous submissions. In cases where proposed shale gas development cannot be relocated to avoid areas of high conservation value, it is likely that these will be offset. However there is a concern that, because offset trade-offs are undertaken on a case-by-case basis,

this piecemeal approach does not result in good conservation outcomes for the many species potentially impacted.

A more precautionary and proactive approach would be to determine a comprehensive and representative network of no go areas as part of the SREBA assessments. These areas should be extensive and connected and contain vegetation communities that are representative of all affected bioregions. These would then become the core conservation areas to which future offsets and/or acquisitions could be added.

The Panel's estimation of risk associated with vegetation clearing is misleading.

As stated in my previous submission, I do not agree that impact assessment associated with shale gas development should be approached on the basis of clearing associated with individual well pads, roads and pipelines. This is not appropriate because it ignores the cumulative impacts of vegetation loss and fragmentation at a landscape scale.

For example, the Panel has calculated vegetation loss as a percentage of the total area of the Beetaloo Sub-basin (i.e. 4-6%). This is meaningless in an ecological context and a similar argument is often used by gas companies to justify their operations as having a minimal effect on terrestrial biodiversity.

Similarly, vegetation clearing was calculated using three different densities of well pad spacing over a 2500 km^2 'development area' (i.e. gas field). Estimates varied from 1.3% to 13%. However, in my opinion the entire development area would be subject to <u>both vegetation loss and fragmentation</u> which are, to all intents and purposes, inseparable in their impacts. Linear developments cause fragmentation, isolation and degradation of habitats (i.e. habitat loss). They also act as movement barriers or population sinks and as vectors for pest plants, animals and pathogens (i.e. habitat loss).Habitat loss associated with fragmentation is likely to occur over longer time frames.

Moreover, the Panel has used these calculations to estimate the consequences of vegetation loss as 'low', thus reducing the overall risk of unacceptable changes to native vegetation to 'medium'. In my opinion, this underestimates the cumulative impacts of habitat loss and fragmentation.

Neither the Beetaloo Sub-basin (i.e. 20,600 km^2) nor the individual gas fields (i.e. 2500 km^2), relate directly to any known ecological or habitat boundaries or to the distribution ranges of any flora or fauna populations or their critical resources. From an ecological perspective, it should not be the area of cleared vegetation *per se* that is most relevant to risk assessment; it is instead the removal of vegetation as a proportion of relevant ecological communities, habitats and/or populations occurring within the bioregion.

For example, it is not inconceivable that the entire population of a threatened species could be wholly or mostly contained within a 2500 km^2 'development' area, thus significantly increasing the risk of unacceptable changes in that area. Similarly, if gas production areas happen to coincide with particularly rare or underrepresented vegetation communities within affected bioregions, then the risk of unacceptable changes to native vegetation is unlikely to be 'low'.

We cannot expect flora and fauna distributions to be homogeneous over entire bioregions and, while I recognise that there may the potential for shale gas infrastructure to avoid areas of high conservation value to some extent, biodiversity impacts need to be assessed at a finer scale. I therefore disagree with Origin's suggestion (p. 182) that:

"...*the bioregion is considered an appropriate unit with which to assess the level of loss and/or fragmentation of habitat for fauna on a 'regional' scale*."

As the Sturt Bioregion alone comprises 98,575 km^2, vegetation loss or fragmentation is at the site scale will always tend to underestimate vegetation loss unless considered cumulatively with all existing and future vegetation clearing in the bioregion (including the North Star Pastoral proposal). Vegetation loss should be represented as a proportion of the total community/habitat type occurring within each subregion. Undertaking impact assessment at the scale of the entire gas field and not just cleared areas, is precautionary because it takes into account potential cumulative impacts of vegetation loss and fragmentation over the long-term.

The effects of fragmentation are underestimated.

In my view, a major deficiency of the Interim and Draft Final Reports is to consider and assess vegetation loss and fragmentation as separate issues. Although the Interim and Draft Final Reports attempt to separate the effects of vegetation clearing from those related to fragmentation, this is not practical or realistic.

There is a wealth of scientific literature that point to habitat loss and fragmentation as the primary drivers of biodiversity loss and ecosystem degradation (see Bali 20171a, b).

It is apparent from the Draft Final Report that it is the above-ground infrastructure that will have the most significant potential impacts on terrestrial biodiversity:

"*Pipelines and roads will have the largest impact on the landscape, even though it is anticipated that these will be underground*." (p. 170)

"*Origin has noted that roads and pipelines, not well pads, make up the majority of the surface footprint of onshore shale gas development in the NT*. (p. 169)

Moreover the vast interconnected network of access roads and linear infrastructure comprising thousands of kilometres of roads and cleared easements would be constructed in "*previously contiguous landscapes*" of which less than 1% have been previously cleared.

These statements appear to contradict the Panel's assessment of the consequences of vegetation loss being 'low' because "*only a small proportion of the landscape will be cleared and fragmentation and edge effects are therefore likely to be limited*."

The Panel also states on p.182 that:

"...*it is not possible to determine the risks from habitat fragmentation and edge effects due to vegetation loss along linear corridors until there is better understanding of the sensitivities and critical effects thresholds for NT vegetation types*."

Despite this lack of knowledge, the Panel concludes that the overall consequence of vegetation loss and fragmentation "*is expected to be relatively low, even when accounting for cumulative impact*" and that edge effects associated with shale gas production in the NT "*will be considerably lower than in forest habitats*".

I disagree with these statements because they are not based on scientific evidence, they underestimate the impacts of linear infrastructure on fauna movement and they are not precautionary in their approach.

Firstly, there is no scientific evidence to suggest that edge effects associated with semi-arid environments would be significantly less than those in forested habitats with respect to following: changes in microhabitat, hydrology (as noted by the Panel), floristics, pattern and frequency of fire (as noted by the Panel), invasion of pest species, road mortality and access to predators. The paucity of studies undertaken in semi-arid landscapes should not be taken as evidence that edge effects do not exist or are less prevalent.

There are a number of papers that examine the differences between edge effects in forest (closed) and grassland (open) habitats (e.g. Hansen and Clevenger 2005). However, this relationship is also influenced by other factors such as fragmentation, soil fertility and road type. Gelbard & Belnap (2003) examined the effect of road improvements on exotic weed cover and species richness in semi-arid habitats in the US. They found that these were significantly higher within 50 m of paved roads than along 4-wheel drive tracks. Although the authors noted that resource-poor soils appear to be most resistant to weed invasion, Williamson & Harrison (2002) cautioned that there is a risk of even relatively nonaggressive exotics becoming established in harsher environments.

Weed invasion is only one type of edge effect. For example, Forman et al. (2003) found that grassland birds (i.e. open habitats) were more sensitive to

noise generated by varying levels of traffic and that population densities decreased within 1200 m of roads with high traffic volumes and within 400 m of roads with moderate traffic volumes. In the Murray Mallee region of South Australia, the rate of nest predation was higher along human-created edges compared to natural edges (Luck et al. 1999). It should be noted from these examples that edge effects are not only associated with newly constructed roads but also with road upgrades and increased traffic.

Secondly, the consequences and risks of linear infrastructure acting as ecological barriers and corridors to fauna movement have been underestimated in my opinion.

The Panel assessed the risk of increasing access by feral animals as a result of the onshore shale gas industry as 'low' and acceptable (Section 8.4.2.3). The Panel is of the opinion that mitigation is not required because landowners have legislative obligations to control feral animals and that Threat Abatement Programs can be established under the EPBC Act. In my view, this decision not only ignores the fact that these measures have not worked in the past (SoE 2016) but also fails to recognise the importance of predation as a driver of extinction in the small mammal populations of the NT.

The Panel assessed the risk associated with all other ecological barriers and corridors to be 'low' and acceptable, if mitigation measures are applied. Although Recommendations 8.12-8.14 are necessary, avoidance of critical habitat and minimisation of corridor width are part of the 'business as usual' approach that has had little success in significantly ameliorating fragmentation impacts in the past. There is no reason to believe that these will be effective over the vast network of linear infrastructure proposed in previously contiguous landscapes.

Low risk is defined as minor, short-term damage to an area of limited significance but not affecting ecosystem functions. However, fragmentation can reduce dispersal, foraging and mating success thereby increasing a species' risk of extinction. It can create significant barriers across corridors which may be crucial in maintaining the resilience of populations exposed to climate change. Furthermore it typically occurs at "*rates dramatically faster than long-lived organisms are capable of adapting, thus disrupting life history cycles and ecological processes*" (Duchamp and Swihart 2008, in Bali 2017a).Together with cumulative impacts, this may result in medium and long-term impacts on species (i.e. high risk).

Increased heavy vehicle traffic was only assessed with respect to impacts on landscape amenity and not as a barrier to fauna movement. This is despite the fact that "*any onshore shale gas development requires high volumes of heavy-vehicle traffic*".

However, the Panel was unable to make an assessment of this risk "*because of a lack of relevant information on the estimated increase in heavy-vehicle traffic*

that will result from any shale gas development in the Beetaloo Sub-basin, or elsewhere in the NT". The Panel noted that while gas companies are required to address traffic risks as part of their EMPs, these do not take into account cumulative impacts. In my view it is essential to take into account cumulative impacts of increased traffic as a barrier to fauna movement.

A possible mitigation measure for landscape amenity impacts recommended by the Panel includes requiring heavy vehicles to travel at night. While the Panel recognises that this timing corresponds to the highest risk of road kills, it does not expressly rule this option out. Impacts of road mortality are already significant in Australia (see Bali 2017a, b), affecting a wide range of fauna groups, including some endangered species in the NT. This mitigation measure should be expressly ruled out or deleted from the report. It is not advisable to minimise landscape amenity impacts by increasing impacts on terrestrial biodiversity.

While recommended traffic mitigation measures may reduce risk to landscape amenity to an' acceptable' level, their effect on road mortality is less clear. However, greater use of rail would be welcomed.

Has the precautionary principle been applied?

For practical purposes the Inquiry is investigating the risks associated with shale gas extraction in the Beetaloo Sub-basin. As part of the Draft Final Report, we are presented with indicative scenarios put forward by gas companies with exploration leases in the area. Risk assessment is undertaken for 3 gas fields, comprising 50 well pads each, as shown in Figure 8.5. In this relatively static and restricted situation, there is a high probability that the recommendations provided in the report would be effective.

However, past experience has shown that we should not expect an orderly roll-out of shale gas industry once the moratorium is lifted. In particular, I note that the published literature often refers to the rapid development of unconventional gas fields, once approved. Moreover, the SoE (2016) cautions that the greatest potential for negative impacts results from the "*cumulative impacts of extensive development in highly prospective regions or where diffuse exploration and development take place across large regions.*"

The time frame proposed in the Draft Final Report suggests that baseline studies including SREBAs, be undertaken during the exploration and appraisal activity phase which is likely to last until 2019-20. Assuming it is found to be commercially viable, shale gas production could begin in 2021-22.

It is clear from Section 6.5 of the Draft Final Report that there are still many uncertainties surrounding the scale and rate of shale gas development in the NT. In particular, the discrepancy between the gas companies' estimates of 1000-1200 gas wells and the Energy Division of DPNR prediction of 15,506 wells in the

greater McArthur basin, with 6250 in the Beetaloo Sub-basin, is of concern. Up to 30% of the Sub-basin may be required for development.

The Panel has recommended that a SREBA be conducted for the Beetaloo Sub-basin, which covers three bioregions, as a priority. Will all the SREBAs be conducted over the 3 year period or will these be progressively rolled out over time? How will important conservation values that straddle two or more bioregions be taken into consideration? How will cumulative impacts of multiple gas fields over multiple bioregions be assessed and avoided? Would the SREBA process preclude any future survey work within each bioregion (i.e. as for the SEA)? Are there resources (e.g. expertise, equipment and funding) available to undertake SREBAs over multiple NT bioregions over a 3-year period?

I understand that there is a move away from prescriptive regulation towards more 'risk-based' or 'outcome focussed' governance because it encourages more innovative, flexible and leading practice results. However the weaknesses of this approach are discussed in Section 14.7.4. In the case of environmental assessment associated with shale gas production, I am of the view that minimum standards are required, particularly for the proposed SREBA assessments and for any future NT biodiversity offset scheme. These should be provided by independent experts and based on accepted scientific methods.

I understand that the Panel is of the opinion that if the 120 recommendations made in the draft report <u>are adopted and implemented in full</u>, environmental risks may be mitigated or reduced. This implies that if one or more recommendations are not implemented, there is a risk of serious and irreversible harm to the environment. Given the many uncertainties and unknowns regarding environmental impacts associated with the shale gas industry in Australia, I am concerned that the precautionary principle has not been applied (see Section 14.7.1.2).

For example, the recommendations relating to terrestrial biodiversity rely on the identification and protection of areas of high biodiversity value, their protection or avoidance (if possible), mitigation using standard techniques and offsetting. If any one of these steps fails, there is likely to be a consequent loss of regional biodiversity and possibly a cumulative loss of biodiversity over larger areas.

However, the early identification and protection of a comprehensive and representative network of no go zones, prior to shale gas production, would be a more precautionary approach. This would provide additional assurances that any failures in the detection, protection and/or offsetting of biodiversity values would not result in serious or irreversible harm at the bioregional scale. It would also provide core conservation areas to which future offsets or acquisitions could be added, thus preventing poor conservation outcomes associated with offsetting on a case-by-case basis. Importantly, this approach would also protect landscape amenity.

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MACQUARIE University

EXPERT ADVICE

SCIENTIFIC INQUIRY INTO HYDRAULIC FRACTURING IN THE NORTHERN TERRITORY

REVIEW OF DRAFT FINAL REPORT

DR SCOTT WILSON

MACQUARIE University

PREAMBLE

1. This report was requested by Environmental Defenders Office NT, on behalf of Lock the Gate Alliance, to comment on the Draft Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (December 2017).

2. I, Dr Scott Paton Wilson, am an expert in the field of ecotoxicology with over 20 years' experience, specialising in water quality and impacts of inorganic and organic contaminants to aquatic species and their ecosystems.

3. The context of this report specialises in points relevant to the groundwater and surface water quality, alterations to these and potential biological and ecological effects. I do not provide comment on whether or not hydraulic fracturing (fracking) in the NT should proceed, but discuss issues that should be considered in any consideration of fracking in the NT.

4. I acknowledge that I have read and prepared the following report in accordance with the NT Supreme Court Practice Direction for Expert Reports and the Expert Witness Code of Conduct.

5. In my opinion the material presented in the Draft Final Report relating to water issues was on the whole covered in a fair and even manner.

6. The Panel for the most part comprehensively assessed the current state of knowledge and gaps in information or data and recommended relevant further study or research, where appropriate.

7. Northern Australia's wetlands and rivers are of international importance for migratory bird habitat, high biodiversity, ecological intactness and free-flowing waters. There is still however limited knowledge of the ecology of surface and groundwater systems in these areas. The potential impact that further drawing water from these systems, which are already close to full allocation, is unknown and that petroleum activities are currently exempt under the NT Water Act from requiring a water extraction licence, means these systems could be mismanaged. Hence the recommendation (7.1) from the Panel for the Water Act to be amended to require gas and other petroleum operations to obtain water licences before granting any production licence is welcomed.

8. Further to this the recommendation (7.2) for shale gas developments to be included under the water trigger in the EPBC Act is also commended.

9. As the Panel has highlighted, it is imperative that a human and environmental risk guidance document be developed for the shale gas industry and applied to individual operations. In particular, this should include both introduced and geogenic chemicals used or mobilised during the mining process and include direct toxicity assessment of complex mixtures (e.g. fracking fluids or produced waters). Without these a true risk assessment cannot be conducted.

10. With limited knowledge on the natural conditions and systems of the region it is important for reliable management of any shale gas operations that a baseline assessment of aquatic ecosystems be conducted. This includes models of surface and groundwaters. Therefore, the Panel's recommendation (7.4) for strategic regional environmental baseline assessments is warranted.

11. The prohibition of the use of surface waters for shale gas fracturing and the need for relevant information on groundwater reserves and extraction limits and the development of water allocation plans prior to any operation, as detailed by the Panel, is required.

12. While the recommendation (7.9) from the Panel for publicly reporting of the composition and management of the hydraulic fracturing fluid, flowback and produced waters in any operation is welcomed, a more detailed assessment would be more informative. The model used in the UK, should be applied. The UK Onshore Shale Gas Well Guidelines stipulate that operators disclose:

    a. The estimated and actual volume of fluid to be recovered during flowback;

    b. The expected rates, pressures and temperatures of fluid recovery and production;

    c. Water compositional analysis;

    d. Water mineralogical analysis;

    e. Any identified contamination issues;

    f. Any radioactive contaminated fluids;

    g. The proposed method of handling the recovered fluids, including but not limited to, tank requirements, pipeline requirements, flaring, flow-back and storage periods, recycle and re-use for other activities;

    h. Proposed disposal method of the recovered fluids up to the end location;

    i. Proposed volume of flow-back fluids to be recycled and re-used; and

j. Regulatory approval and compliance records.

13. The document sufficiently details the different pathways of shale gas wastewater to potentially contaminate ground and surface waters.

14. The need for an extensive routine groundwater monitoring programme including real time recording both around and off site of any operation is an important aspect highlighted in the report. The need for public scrutiny of this data, as per recommendation 7.10, is also encouraged.

15. In agreeance with the Panel, no untreated wastewater from the fracturing operations should be discharged to the surface or re-injected into aquifers. All wastewater should be stored and treated appropriately, and be designed to handle worst case scenario conditions.

16. There is limited detailed information on aquatic ecosystems and biodiversity in the region and though there is a recommendation for SREBA, an ongoing programme monitoring key biotic elements should be implemented. Similar to the recommended groundwater monitoring, a streamwatch style programme of routine biotic condition should be employed around all operational areas where surface and groundwater fauna are found. This information should be accessible to the public.

17. In time, consideration of a regional (e.g. Beetaloo Sub-basin) report card for environmental health could be developed with condition indices based on water quality, quantity and ecological health. A model such as the Port Curtis Integrated Monitoring Program in Gladstone Queensland, where industry partners support the far field monitoring with oversight by independent agencies could be applied. The inclusion of both groundwater and surface water condition in this would produce a more comprehensive assessment and would make this a world leading initiative.