Submission to the Legislative Council Standing Committee on Environment and Public Affairs:

“Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas”
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1. Regulating the emerging shale and tight gas industry

1.1 Introduction

Natural gas is an important and significant energy source underpinning Western Australia’s economic growth and energy security. Reliable supply of natural gas has been taken for granted in supporting Western Australia’s energy needs. The State’s economy and its energy sector, however, operate in an increasingly globally connected environment which is complex and unpredictable. Against this background, as articulated in the State Government’s Strategic Energy Initiative\(^1\) (SEI), the State’s objective is to have affordable, reliable, secure and clean energy. Meeting this goal depends on a diverse and secure supply of energy. Western Australia’s endowment of natural gas resources means this aim may be progressed through not only securing supply from offshore reserves, but increased development of onshore gas resources.

Future onshore gas supplies will include natural gas from shale and tight rock resources. The timing as to when the shale and tight gas industry will progress to meaningfully contribute to Western Australia’s energy supply is determined by several factors. These include economic conditions in the global energy industry and the pace of exploration driven by the preparedness of the private sector to invest.

Western Australia’s limited energy infrastructure, relatively small energy market and geographic remoteness of gas resources, makes it a challenging environment in which to commit to full commercial production of any onshore gas project. Of paramount significance is the State Government’s long term plan to ensure the success of this emerging industry. Such an approach means the Government continues to enhance its regulatory approvals framework to be prepared for commercial production.

Enhancing Western Australia’s energy security through development of a shale and tight gas sector also brings immediate practical economic and social benefits. For example, unlike most developments in Commonwealth offshore waters, royalty payments on onshore shale and tight gas projects will directly accrue to the State. Onshore shale and tight gas projects will also increase employment and stimulate regional economies in Western Australia, plus add value to mineral resource projects. There will also be potential for exporting LNG to overseas markets, providing further support to regional economies and the State.

Now and looking to the long term, the State Government’s approach and commitment in the development of natural gas from shale and tight rocks is based on the following principles:

- Effective, transparent and risk based regulations
- Whole of government coordinated regulatory framework, with the Department of Mines and Petroleum (DMP) as the lead agency
- Engagement with stakeholders, particularly local communities
- Ensuring national initiatives support the Western Australian Government strategy

With commitment to these principles, DMP has made significant progress to date, in particular:

- A safety regulatory system was introduced in early 2012 when the Petroleum and Geothermal Energy Safety Levies Act 2011 received royal assent. This Act provides for stronger safety regulation of petroleum operations, geothermal energy operations, pipeline operations and offshore petroleum operations.
- New petroleum environmental regulations were gazetted in August last year, strengthening obligations on industry including chemical disclosure.
- New petroleum resource management regulations will be released for public comment in fourth quarter 2013 and will include new requirements for well integrity.
- Establishment of a shale and tight gas inter-agency working group to improve communication and coordination across government to enhance the regulatory processes around issues such as water, environmental management and land access.
- Preparation of a draft whole of Government approach to regulating this emerging industry through a comprehensive framework document, “Western Australian development framework for natural gas from shale and tight rocks”, for consideration by the Minister for Mines and Petroleum.

• Building on the experience of other jurisdictions through assessment of international and Australian research, reviews and recommendations.

• Implementation of a comprehensive stakeholder and community engagement program in the Mid-West and Kimberley regions.

In regard to the national initiatives, DMP is mindful of the significant community concern relating to coal seam gas development in New South Wales, Queensland and overseas. However, it is important to differentiate between Western Australia and the circumstances that exist in these other jurisdictions.

Firstly, there are no known prospective coal seam gas resources in Western Australia. Secondly, the shale and tight gas resources in Western Australia are typically found at significantly greater depths, usually beyond 2,000 metres, while coal seam gas is generally found between 300 to 1,000 metres. Further, Western Australia is at a very early stage of development. Combined with the State's robust regulatory framework for the oil and gas sector (that has developed over 50 years), this means that national legislative initiatives implemented for coal seam gas may not be relevant or necessary in Western Australia. Such national measures could result in further regulatory duplication and an undermining of community confidence in State processes.

1.2 Legislative framework

The petroleum exploration and production industry, which includes shale and tight gas, is specifically regulated in Western Australia under the following acts, schedules and regulations:

Acts
Petroleum and Geothermal Energy Resources Act 1967 WA  
Petroleum (Submerged Lands) Act 1982 WA  
Petroleum Pipelines Act 1969 WA

Schedules
Schedule of Onshore Petroleum Exploration and Production Requirements 1991  
Schedule of Specific Requirements as to Offshore Petroleum Exploration and Production 1990

Regulations
Petroleum and Geothermal Energy Resources (Occupational Safety and Health) Regulations 2010  
Petroleum Pipelines (Occupational Safety and Health) Regulations 2010  
Petroleum Pipelines (Management of Safety of Pipeline Operations) Regulations 2010  
Petroleum and Geothermal Energy Resources (Environment) Regulations 2012  
Petroleum Pipelines (Environment) Regulations 2012  
Petroleum (Submerged Lands) (Environment) Regulations 2012

Other acts and regulations petroleum operators need to abide by include:

- Environmental Protection Act 1986  
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004  
- Wildlife Conservation Act 1950  
- Rights in Water and Irrigation Act 1914  
- Rights in Water and Irrigation Regulations 2000  
- Dangerous Goods Safety Act 2004  
- Dangerous Goods Safety (General) Regulations 2007  
- Radiation Safety Act 1975  
- Aboriginal Heritage Act 1972  
- Native Title Act 1993 (Cwlth)  
- Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)  
- National Greenhouse and Energy Reporting Act 2007 (Cwlth)

The above regulatory framework covers all petroleum activities and applies strict requirements on operators on all phases of their work.
1.3 Whole of government approach

The industry is still in its early stages of development. Therefore, DMP has the advantage of being able to review regulatory reform and arrangements across government to ensure approval processes for shale and tight gas developments are robust. As part of the Government’s 2009 ‘Lead Agency Framework’ and whole of government approach, DMP established an Inter-Agency Working Group for shale and tight gas in mid-2011. This Group facilitates coordination and reform of regulatory processes across government. Led by DMP, it comprises the Departments of Water (DoW), Environment Regulation, Parks and Wildlife, Health, Agriculture and Food, State Development and the Office of the Environmental Protection Authority (EPA).

The Inter-Agency Working Group has provided input into a draft framework document prepared by DMP titled ‘Western Australian development framework for natural gas from shale and tight rocks’. It outlines how this emerging industry is regulated to protect community and environmental values, while providing economic benefits. The draft document is being prepared for the Minister for Mines and Petroleum’s consideration.

As a result of cooperation between agencies, a working group has also been established to focus specifically on science issues relating to shale and tight gas. The first meeting of the Inter-Agency Science Needs Working Group was held in early September 2013 to examine the priorities of research required (such as baseline monitoring), so that the shale and tight gas sector can evolve in a safe, sustainable and environmentally responsible manner.

Inter-agency collaboration continues to be enhanced through the review and establishment of administrative agreements and memorandums of understanding between DMP and the Department of Health and DoW. The common aim is to deliver robust and effective regulatory arrangements.

1.4 Review of petroleum regulation

In mid-2011, DMP commissioned an independent review by Dr Tina Hunter on the ‘Regulation of Shale, Coal Seam and Tight Gas Activities in Western Australia’. The report commended Western Australia on its capacity to regulate this emerging industry. Its recommendations have guided DMP with a suite of reforms to strengthen its regulatory framework for oil and gas exploration and development, leading to new environment regulations; and new resource management and administration regulations being developed.

1.5 Building on international and Australian experience

In addition to commissioning its own review, DMP regularly undertakes analysis of international reviews and reports conducted overseas and interstate. Reports assessed to date are listed in Appendix A.

DMP has also assessed the recommendations from the first Australian review of shale gas released in 2013 by the Australian Council of Learned Academies.

These analyses provide a basis upon which DMP can consider further enhancing Western Australia’s regulatory framework and inform best practice methods for the industry.

1.6 Hydraulic fracture stimulation

Hydraulic fracture stimulation, or fraccing as it is more commonly known, is the process of fracturing low permeability or tight rock formations which contain gas and oil resources, to stimulate the flow of gas and oil. This process requires fluid to be pumped down a well at pressure to create fractures (narrow openings) within the rock formation. This allows trapped oil and gas to flow into the fractures and flow out of the well to the surface.

The process of fraccing is not new to Western Australia and has been applied safely to more than 780 wells since 1958. It should be noted that approximately 740 fracture stimulations have occurred on Barrow Island in nearly 50 years, an island 202 km² in area. Despite this activity, Barrow Island maintains its status as an ‘A’ class nature reserve. DMP maintains a public record of previous fracture stimulations which is available on its website.

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2 Dr Tina Hunter, “Regulation of Shale, Coal Seam and Tight Gas Activities in Western Australia - Final”, July 2011
5 Department of Mines and Petroleum, “WA Hydraulic Fracture Stimulation - Well List”
Recent advances in hydraulic fracture stimulation and drilling technologies over the past decade have made the application of these processes for the production of shale and tight gas highly technical, reliable and safe. Such technology is essential in order to extract the natural gas found in the State’s shale and tight rock formations between two to five kilometres underground.

Currently Western Australia’s shale and tight gas and oil industry is in the early exploration and proof of concept phases. In 2012, three petroleum exploration wells were hydraulically stimulated in the Mid-West region of Western Australia. While there are no plans to hydraulically stimulate any petroleum wells in 2013, petroleum companies have indicated they are planning to do so in several exploration wells in 2014.

The geology of Western Australia indicates that the Canning, Perth and to a lesser extent the Southern Carnarvon and Officer Basins have potential for future shale and/or tight gas and oil development.

Figure 1 details the location of sedimentary basins that are prospective for shale gas. The Perth Basin while prospective for shale gas, is also prospective for tight gas.

![Figure 1: Areas prospective for shale gas in onshore Western Australia](image-url)
1.7 Stakeholder and community engagement

DMP recognises the shale and tight gas industry is relatively new and is attracting significant community interest. It is imperative the community has confidence and trust in the way this sector is regulated. In particular, State Government regulatory processes must be transparent and clearly and unambiguously communicated. This entails working with the broader community and providing a clear understanding of what is required to undertake petroleum operations in Western Australia.

To date, DMP has focused its community engagement initiatives on the Mid-West and Kimberley regions, where some small scale shale and tight gas and oil exploration activities have already occurred. These initiatives, led by DMP, have engaged a variety of stakeholders including local shires, regional communities, land owners, environmental groups, CSIRO, traditional owners, industry, media and other government agencies. Engagement has occurred through community workshops, one-on-one meetings and stakeholder briefings both in a proactive and as-required basis.

A dedicated shale and tight gas web page has been established on DMP’s website to specifically provide the community with information on this emerging industry (www.dmp.wa.gov.au/shaleandtightgas). This includes basic information on the oil and gas industry communicated through a DVD, in addition to factsheets tailored to the shale and tight gas industry on topics such as:

- Petroleum geology basics
- Gas resource types
- Hydraulic fracture stimulation: the basics
- Shale and tight gas exploration in WA
- Shale and tight gas and WA’s future energy security
- Shale and tight gas: addressing misinformation
- Petroleum water use and management
- Petroleum environment regulations
- Petroleum resource safety regulations
- Petroleum land access

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6 Department of Mines and Petroleum, “An introduction to oil and gas in Western Australia” (Video Clip)
7 Department of Mines and Petroleum, General Information and Fact Sheets: Shale and Tight Gas
2. Inquiry Terms of Reference

The Western Australian Legislative Council’s Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas has the following terms of reference:

1. How hydraulic fracturing may impact on current and future uses of land
2. The regulation of chemicals used in the hydraulic fracturing process
3. The use of ground water in the hydraulic fracturing process and the potential for recycling of produced water
4. The reclamation (rehabilitation) of land that has been hydraulically fractured

The following information addresses each of the Inquiry’s terms of reference in detail.

2.1 How hydraulic fracturing may impact on current and future uses of land

2.1.1 Prospectivity and current activities

In Western Australia, the highest potential shale gas and oil resources underlie areas of the Mid-West and Kimberley (Figure 1). Estimates suggest the State’s onshore shale and tight gas resources are significant and potentially twice that of its known off-shore gas resources. The resource potential is detailed in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Canning Basin</th>
<th>Perth Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale Gas</td>
<td>235 Tcf (Goldwyer Formation)</td>
<td>33 Tcf (Kockatea, Carynginia and Irwin Formations)</td>
</tr>
<tr>
<td>Tight Gas</td>
<td>To be confirmed</td>
<td>12 Tcf* (High Cliff, Dongara and Wagina Sandstones)</td>
</tr>
<tr>
<td>Oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale Oil</td>
<td>9.75 Bbl (Goldwyer Formation)</td>
<td>0.54 Bbl (Kockatea Formation)</td>
</tr>
<tr>
<td>Tight Oil</td>
<td>-</td>
<td>To be confirmed</td>
</tr>
</tbody>
</table>

* DMP estimate

Table 1: Estimated Shale and Tight Oil and Gas Resource Potential

Other formations in the Canning Basin also have the potential to contain shale oil and gas such as the Bongabinni, Gogo, Laurel and Noonkanbah Formations.

In addition to the Canning and Perth Basins, potential basins which are currently untested for shale and tight gas include the Carnarvon and Officer Basins.

The shale and tight gas industry is currently in its early exploration and proof of concept stages, with production of shale or tight gas yet to occur. Since 2005, 15 wells have explored for shale and tight gas. Seven of these wells were fractured, with six of the fractures occurring in the last five years.

### Table 2: Shale and tight gas wells that have been subject to fracture stimulation in the past five years

In 2012, the State Government signed a State Agreement with Buru Energy Limited and Mitsubishi Corporation (the Operators) to facilitate the development of a domestic gas project and pipeline in the remote Canning basin, where a significant majority of the State’s shale gas resources are located.

As part of the 25-year agreement, the Operators are required to submit a proposal for the development of a domestic gas project and pipeline by mid-2016.

Once sufficient gas has been identified to sustain the domestic market, the State Agreement also provides a framework for the potential development of an LNG facility in the Pilbara.

#### 2.1.2 Potential footprint

Ecological Australia, 2013⁹ reported that existing operations in some United States gas fields have a well density of one well per 13km² after six years, increasing to one well per 0.8 km² after 13 years of development.

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⁹ Eco Logical Australia, “Shale Gas Development in Australia, Potential Impacts and Risks to Ecological Systems”, January 2013
Should shale and tight gas and oil development proceed in Western Australia, DMP considers production well completions, particularly for shale gas, will be completed horizontally. Additionally, DMP anticipates that multiple horizontal wells could be completed on a single site, a practice that is now common in the United States. The experience in the United States has demonstrated that multi-well drilling sites require a larger drilling pad. However, DMP considers this would be more than offset by fewer well pads required in a given area and the need for only a single access road and gas gathering system for multiple wells. Site visits to shale oil and gas operations in Southern Texas have indicated that up to nine wells can be located on a single well pad.

The 2013 ACOLA report indicates that well pads for shale gas networks average 1.5 to 2.0 hectares in size during the drilling and fracturing stage and are reduced in size to 0.4 to 1.2 hectares in size during production stages.

All oil and gas developments require road and pipeline infrastructure. Roads are generally 4 to 6 metres wide and can be co-located with any existing infrastructure. Pipelines would be located and buried to minimize disruption to existing land users.

2.1.3 Rate of development

While the United States shale oil and gas industry has grown at a rapid rate over the last decade, it is unlikely that Western Australia will experience the same rate of development due to the differences in the physical and economic environments. These include:

- Equipment, services and skilled labour: the United States has high levels of skilled personnel coupled with modern drilling rigs capable of deep horizontal drilling. This may be contrasted to Western Australia where there are no hydraulic fracturing spreads or other service units yet available in the State without mobilisation from the east coast or overseas locations. Drilling rigs and personnel are also limited in Australia.
- Ready access to infrastructure: the United States had a substantial network of existing infrastructure which was readily available for the development of the shale oil and gas industry. The remote location of Western Australia’s resources, particularly in the Canning Basin, means there is a need for additional facilities such as pipelines, roads and general services to be established before production can take place.
- Rights to the petroleum: in most circumstances in the United States, private landholders maintain ownership of resources below their land. Any development of these resources usually requires agreements for payment of royalties to the private landholders, providing an incentive for development. In Western Australia, however, the mineral rights are held by the Crown (State).
- Market size: Western Australia, in comparison to the United States, has a much smaller energy market.

DMP estimates it could take eight to ten years to have substantial production in this State as a result of the above limiting factors.

2.1.4 Accessing land

The Western Australian Petroleum and Geothermal Energy Resources Act 1967 outlines the rights and responsibilities of petroleum titleholders and private landholders with regards to access to private land. The main points include:

- A petroleum company cannot access private land until compensation is paid or agreed
- A private land holder does not have a right of refusal for access to their land by a petroleum title holder except where:
  - freehold title is less than 2,000m² in area; or
  - within 150 metres of a:
    - cemetery or burial place;
    - substantial improvement; or
    - reservoir, or natural accumulation of water, spring dam, bore or artesian well

State Law Publisher, Petroleum and Geothermal Energy Resources Act 1967
If land access and compensation cannot be agreed the land holder and the petroleum title holder may refer to a Magistrates Court for decision.

Owners of private land in the vicinity affected by activity may be entitled to compensation.

DMP’s Petroleum and Geothermal Energy Explorer’s Guide 201211 provides further information on the legislative framework and land access regime for Western Australia’s upstream petroleum and geothermal industries.

2.1.5 Multiple Land Use Framework

DMP is cognisant that the continued growth of all industry sectors is reliant on access to land. To avoid conflict between differing land uses, on-going access discussions need to be inclusive of all stakeholders, taking account of environmental, heritage and cultural values.

The department chairs a working group under the Council of Australian Governments’ (COAG) Standing Council on Energy and Resources12, that has developed a Multiple Land Use Framework. This Framework addresses land access and use challenges, expectations and opportunities, to ensure these are met effectively and efficiently into the future by multiple and sequential land use.

The shale and tight gas industry can successfully co-exist with other industries such as agriculture. Petroleum resources at any one location are finite, and as such, the land will be ultimately returned to the landowner once the natural gas has been extracted.

2.2 Regulation of chemicals in the hydraulic fracturing process

DMP recently released ‘Chemical Disclosure Guidelines, August 2013’13. This guidance outlines the chemical disclosure requirements for products, chemicals and other substances used ‘down-hole’ in petroleum or geothermal related activities regulated under regulation 15(9) of the:

- Petroleum and Geothermal Energy Resources (Environment) Regulations 2012
- Petroleum (Submerged Lands) (Environment) Regulations 2012
- and may be required for activities regulated under the Petroleum (Pipelines) (Environment) Regulations 2012

It also supplements information provided in DMP’s ‘Guidelines for the Preparation and Submission of an Environment Plan’.

By way of background, DMP uses chemical disclosure information to assess environmental impacts and risks (both above and below-ground) as part of assessing an Environment Plan (EP). DMP considers it important to have an accurate and transparent public record of all products and chemicals used in regulated petroleum and geothermal activities.

DMP requires all chemical disclosure information to be submitted via its Chemical Disclosure Reporting Template. The Chemical Disclosure Reporting Template should be attached as an Appendix to the EP and Summary EP. This enables the Appendix to be easily updated and re-submitted to DMP should future modifications be made to product and chemical use.

The reporting template is based on ‘systems-based disclosure’. A ‘system’ refers to each systematic stage of well drilling, well construction, well testing, hydraulic fracturing, production and well closure (as appropriate). Specific products and chemicals are used for each system. Examples of system names include: ‘drilling fluids’, ‘cementing slurry’, ‘hydraulic fracturing fluid’, ‘well closure fluids’, etc.

‘Systems-based’ disclosure means that product information is disclosed separately from its chemical ingredients. In this way, details about products and chemicals are still provided to DMP without compromising the level of disclosure and without compromising commercially sensitive information about product recipes.

12 The Council of Australian Governments’ (COAG) Standing Council on Energy and Resources (SCER) is responsible for pursuing priority issues of national significance in the energy and resources sectors and progressing the key reform elements of the former Ministerial Council on Mineral and Petroleum Resources and the Ministerial Council on Energy.
This allows operators to have greater flexibility with their choice of products, potentially allowing commercially sensitive products that are:

i) more efficient – i.e. reducing the need to use larger quantities of common chemicals

ii) more environmentally friendly – i.e. less hazardous chemical alternatives; or

iii) scientifically beneficial – i.e. a better understanding of underground petroleum activities, hydrogeology or tracking fluid movement

It should be noted that ‘systems-based’ disclosure does not make any provision for exempting proprietary chemicals from being publicly disclosed.

The operator must inform the supplier or manufacturer that all chemical information disclosed to DMP will be made publicly available. If chemical disclosure information is not forthcoming from a supplier or manufacturer, then the operator should consider selecting alternative products and/or suppliers that will be able to meet chemical disclosure requirements.

2.2.1 Toxicity and ecotoxicity information

Toxicity refers to any adverse effects on humans from a product or chemical over a period of time. Ecotoxicity refers specifically to the toxic effects of a product or chemical on biological organisms within a population, community or ecosystem. DMP uses this toxicity information in the review of environmental risk assessment of chemicals.

DMP requires details relating to:

- Acute toxicity: data relating to toxicity for mammals (i.e. rat toxicity is most commonly used as a proxy for human toxicity), in addition to data relating to ecotoxicity (fish, crustacea and algae);

- Chronic toxicity: information relating to whether the chemical is a known carcinogen, mutagen, reproductive toxin, etc. or a chronic toxicant; and

- Persistent, biodegradation and bio-accumulative chemicals: data relating to a chemical’s ability to remain in the environment for long periods of time or to biograde, and / or its ability to build up in food chains over time.

2.2.2 Material Safety Data Sheets

DMP requires copies of the Material Safety Data Sheets (MSDS) for each product identified. This information should be included in the Appendix of an EP. A MSDS is a document supplied by the manufacturer, supplier or importer that contains important information about a product, additive or chemical and generally contains information about the product including the:

- product trade name
- the manufacturer’s, supplier’s or importer’s details
- chemical composition and ingredients
- the chemical and physical properties of the product / additive
- toxicity and ecotoxicity information
- response information for managing spills, accidents or emergencies

More information on chemical disclosure, including a reporting template, is available from DMP website.

2.3 The use of ground water in the hydraulic fracturing process and the potential for recycling of produced water

In Western Australia, most of the water currently used for petroleum activities – conventional or unconventional – is taken from underground aquifers.

The quality of water for use in drilling and hydraulic fracturing does not need to be potable and water quality standards for fracturing fluids may vary due to various fracture fluid formulations that may be employed.

2.3.1 Water regulation

DoW manages the water resources of the State and regulates the use of water under the Rights in Water and Irrigation Act 1914 (RIWI Act). A licence is required to take and use groundwater from proclaimed groundwater areas or from artesian wells.

Areas where shale and tight gas are known to exist (for example the Perth and Canning Basins), are proclaimed as groundwater areas. Therefore any taking of groundwater for shale or tight gas activities, including for fracing fluids, will require a licence from DoW.

Allocation limits are set for most water resources to sustainably manage the resources and protect existing users and the water dependent environment. Licences may be granted by DoW up to the allocation limit. In fully allocated areas, where all of the available water has already been allocated, water may be obtained by trading. Other alternative sources of water may include recycled water, new discoveries of groundwater or bringing water in from other areas.

Applications for water licences are assessed on a case by case basis in accordance with clause 7(2) of Schedule 1 of the RIWI Act, including but not limited to:

- is it in the public interest?
- is it ecologically sustainable?
- is it environmentally acceptable?
- would it prejudice other current and future needs for the water?
- would it have a detrimental effect on another person? and
- could the water be provided by another source?

Any proposal that is likely to have a significant effect on the environment (including water resources) may be referred to the EPA for assessment under the Environmental Protection Act 1986.

Should a licence to take water be granted by the DoW, it will have terms and conditions, to manage risks and the possible impacts associated with taking the water.

DMP requires an EP to be submitted as part of its approval processes under the Petroleum and Geothermal Energy Resources (Environment) Regulations 2012. The plan must describe the existing environment (including water resources) and how environmental risks and impacts will be reduced to as low as reasonably practicable. DMP liaises with other agencies as required and refers proposals to the EPA in accordance with the DMP/EPA Memorandum of Understanding (MOU). The MOU requires DMP to liaise with the EPA if a petroleum well is within 500 metres of a environmentally sensitive area, if the proposed activity is likely to impact on a water resource area, or is within two kilometres of a town site. DMP and DoW are currently considering developing a similar arrangement.

Department of Mines and Petroleum, Environmental Protection Authority, “Memorandum of Understanding between the Department of Mines and Petroleum and the Environmental Protection Authority in relation to the referral of Mineral and Petroleum (Onshore and Offshore) and Geothermal Proposals”, June 2009
2.3.2 Water volumes

The volume of water it takes to hydraulically fracture a well varies between individual projects. This depends on the size and length of the well, and the geological properties of the rocks that are to be fractured.

There are three key phases of petroleum development during which hydraulic fracture stimulation can occur; exploration, proof of concept and production. Hydraulic fracture stimulations occur in discrete stages where each stage requires water. Water requirements can be reduced, however, by recycling water. As the industry develops in Western Australia, the opportunities for recycling water (for hydraulic fracturing in addition to other industries such as agriculture) will grow. This will be a key focus area for industry and Government.


Fracture stimulation in the Perth Basin indicates that the probable number of hydraulic fracturing stages per vertical well (of up to three kilometres deep) would likely be three stages. This equates to using around 7,000kl of water per vertical well: 1,000kl for drilling and 6,000kl for hydraulic fracturing. By comparison, this is equivalent to 2.8 Olympic size swimming pools (a standard Olympic sized swimming pool contains 2,500kl of water).

Horizontal well completions, which to date have not been completed in onshore Western Australia, but are common in the United States, may have up to 20 fracture sections (but typically around 10). For example, horizontal wells (with a horizontal reach of one kilometre) utilising ten fracture stages, need approximately 20,000kl of water for the hydraulic fracturing and approximately 1,000kl for drilling. In total this equates to about 8.4 Olympic size swimming pools in water volume. Horizontal wells in the United States are typically drilled to lengths of around 1.5km though occasionally reach lengths of 3kms.

In addition, there are a large number of variables which impact the volume of water potentially required to undertake hydraulic fracturing, such as the rock type and density, the number of fractures required, depth of the well etc. Therefore, at this stage in Western Australia it is difficult to precisely quantify the amount of water potentially required to undertake hydraulic fracturing per well. In addition to those variables identified above, the density of wells to be constructed for a given production field will also influence the volumes of water used.

Table 3 indicates the water used in the United States in some of their predominant shale resource basins.

<table>
<thead>
<tr>
<th>Shale Gas Play</th>
<th>Volume of water used (kl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnett, Texas</td>
<td>10,600</td>
</tr>
<tr>
<td>Haynesville, Texas</td>
<td>21,500</td>
</tr>
<tr>
<td>Eagleford, Texas</td>
<td>16,500</td>
</tr>
<tr>
<td>Marcellus, Pennsylvania</td>
<td>17,100</td>
</tr>
</tbody>
</table>

*Source: ACOLA Report 2013*

Table 3: Median volume of water used per shale gas well in the United States

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\(^{16}\) Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory, "Modern Shale Development in the United States: A Primer", April 2009 (prepared by Ground Water Protection Council)
2.3.3 Wastewater and water re-use

There are three main sources of wastewater produced during the process of drilling and hydraulically stimulating a well to extract shale or tight gas:

1. Used drilling fluid: Added to cool and clean the drill bit, stabilise the well bore and carry out drill cuttings which are the small broken pieces of rock formed during drilling.

2. Flow back water: When the fracturing fluid is injected into the well under pressure, anywhere from 10 to 40 per cent of the fluid will be extracted for shale gas operations and up to 80 per cent for tight gas.

3. Produced formation water: Naturally occurring water trapped in oil and gas reservoirs/formations that may be recovered during extraction of hydraulic fracturing fluids and production of gas (or oil). The volume of produced formation water is likely to be insignificant due to the low porosity and permeability of these formations.

DMP requires petroleum operators to meter and report the volume of fluids injected and extracted from a petroleum well.

It is quite common for fracture flow-back water to be treated and reused in further drilling and hydraulic fracturing operations in the United States, particularly on sites which have multiple wells. The recycling of drilling and hydraulic fluids has not yet occurred in Western Australia because fracture stimulations have only occurred on single, exploration well sites. However, DMP would be strongly advocating the treatment and re-use of water on multiple well sites should it occur in the future.

The Department of Environment Regulation requires all oil and gas production premises (including wells) of more than 5,000 tonnes per year to obtain a licence to operate and a works approval to change the premises under the Environmental Protection Act 1986. In parallel, DMP regulates the re-use or disposal of wastewater through the Petroleum and Geothermal Energy Resources (Environment) Regulations 2012 with referral to the DoW under certain circumstances.

Wastewater from drilling and fracturing may be re-used or disposed of through:

- Recycling: The fluid that flows back to the surface may be re-used in the drilling/hydraulic fracturing process.

- Injection/re-injection: This involves injecting the wastewater deep underground. It may not be practical if a suitable ‘injection zone’ is not available near-by. Re-injection of produced water into aquifers is not permitted to avoid any degradation of the quality of groundwater in aquifers.

- Evaporation ponds: These are open ponds or pits constructed with clay or lined with a double layer of high density polyethylene plastic to prevent soil infiltration. When the water evaporates, drill cuttings and chemicals remain in the pond. At the end of drilling operations, the contents of the ponds are tested for residual chemicals. The plastic liners are removed together with the residual chemical waste and disposed at an appropriate licenced waste disposal facility (as determined by Environmental Protection (Controlled Waste) Regulations 2004).

- Enclosed tanks: Hydraulic fracturing fluid and flow-back water can also be stored in enclosed tanks to be disposed or re-used as required. This may be preferable in environmentally sensitive areas, or where there is risk of exposure to humans or animals.

Petroleum operators use different methods to dispose of produced water and other wastes depending on the outcomes of the risk assessment process for each activity. The risk assessment process requires identification of the potential impacts and mitigation measures appropriate to the waste type. Through assessment of the Environment Plans, DMP ensures that risks are managed to a level ‘As Low as Reasonably Practicable’ with appropriate mitigation measures.
The ACOLA 2013 report commissioned EcoLogical Australia to provide a preliminary risk assessment for ecological and hydro-geological impacts. Three major potential impacts were examined:

1. Reduction in surface water
2. Contamination of surface water
3. Impacts on groundwater ecology

The risks were analysed according to Australian Standards (AS/NZ ISO 31:000:2009), taking into account the likelihood of the impact and its consequences. The report can be located on the ACOLA webpage.

2.4 The reclamation (rehabilitation) of land that has been hydraulically fractured

Under the Petroleum and Geothermal Energy Resources Act (1967), it is a requirement that the operator include details in the Environment Plan of proposed rehabilitation activities, objectives and commitments for all areas impacted by any proposed activity. Depending on the scale and nature of the petroleum activity, rehabilitation activities may include:

- removal of soil and cuttings stockpiles, sumps and fluid ponds
- soil re-contouring and stabilisation
- re-vegetation of cleared areas – which may also be a condition of clearing permits where required under the Environmental Protection Act (1986)
- weed control
- removal and appropriate disposal of any waste – this may include putrescible (e.g. food scraps), inert waste (e.g. concrete), recyclables (e.g. plastic packaging), septic waste, industrial waste (e.g. tyres, scrap metals), liquid wastes and hazardous wastes. Hazardous waste may include waste oils, solvents and any chemicals used. Any contaminated soil or waste fluids are also disposed of at an appropriate licensed waste facility according to Landfill Waste Classification and Waste Definitions Act 1996 requirements.

Depending on the scale and nature of the petroleum activity, the Environment Plan will require monitoring of rehabilitation activities and reporting progress to DMP.

2.4.1 Regulation

DMP through its Guidelines for the Preparation and Submission of an Environment Plan regulates the rehabilitation of land. Specifically, Regulation 4 of the Petroleum and Geothermal Energy Resources (Environment) Regulations 2012, a petroleum activity is defined as:

- any operations or works carried out in the State under a petroleum instrument; or
- any other operations or works carried out in the State relating to petroleum exploration or development which may have an impact on the environment.

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18 Eco Logical Australia, “Shale Gas Development in Australia, Potential Impacts and Risks to Ecological Systems”, January 2013
More specifically, a petroleum activity can include any of the following:

a) seismic or other geological surveys
b) drilling
c) hydraulic fracturing
d) construction and installation of a facility
e) operation of a facility
f) modification of a facility
g) decommissioning, dismantling or removing a facility
h) storage of petroleum

Any petroleum operator wanting to conduct a petroleum activity in Western Australia must prepare and implement an adequate Environment Plan for the period of the activity. An Environment Plan must have undergone formal assessment and been accepted by DMP before being implemented.

Decommissioning can include:

- Removal of all infrastructure/rehabilitation
- Transport of equipment
- Fuel, chemical and hazardous materials handling
- Timing of activities (in areas of temporal significance)
- Treatment of residual drill cuttings piles
- Naturally Occurring Radioactive Minerals (NORMS)

2.4.2 Field abandonment

When a field is to be abandoned, DMP requires the title holder to submit a work program detailing the abandonment procedure and a description of the plugging and sealing of the wells, including removal of the wellheads. It should also cover the removal of facilities and environmental rehabilitation for the field — which may be bridged to the Environment Plan. As with all oilfield operations, it must adhere to industry best practice standards and codes.

2.5 Further information

The department would be pleased to expand upon the information provided in this submission through the provision of further documentation or via verbal briefings.

Appendix A provides a list of references which have been reviewed by DMP and may assist the Committee in its Inquiry.
Appendix A – Recent Australian and International Reports Reviewed by DMP


“Implementing a Well Integrity Management System” Anders J, SPE Distinguished Lecturer Program, March 2008


“Chemicals used in Hydraulic Fracturing”, Committee on Energy and Commerce to the US House of Representatives, April 2011


“State Oil and Gas Agency Groundwater Investigations: And their role in Advancing Regulatory Reforms, A Two-State Review: Ohio and Texas” Ground Water Protection Council, August 2011

“Plugging and Abandonment of Oil and Gas Wells”, prepared by the Technology Subgroup of the National Petroleum Council (NPC), Paper #2-25, September 2011


“Shale gas extraction in the UK: a review of hydraulic fracturing”, The Royal Society, Royal Academy of Engineering, June 2012


“Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe”, Report for the EU by AEA, August 2012

“Code of Practice for Coal Seam Gas: Well Integrity”, NSW Department of Trade & Investment, Regional Infrastructure & Services, Resources & Energy, September 2012

“Chief Medical Officer of Health’s Recommendations Concerning Shale Gas Development in New Brunswick”, New Brunswick Department of Health, September 2012

“Roadmap for Unconventional Gas Projects in South Australia”, DMITRE, December 2012


“UK Onshore Shale Gas Well Guidelines: Exploration and appraisal phase” United Kingdom Onshore Operators Group (UKOOG), February 2013


“Generating the Energy We Need While Protecting the Environment We Treasure: the Regulation of Hydraulic Fracturing in the United States”, Neslin D, April 2013


“Getting Shale Gas Working”, IOD Report, May 2013

“Constraints on Upward Migration of Hydraulic Fracturing Fluid and Brine”, Flewelling SA, Sharma M, NGWA.org, June 2013

“Leveraging Natural Gas to Reduce Greenhouse Gas Emissions”, Centre for Climate and Energy Solutions (C2ES), June 2013


“Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use “, Prof MacKay DJC, Stone TJ fo DECC, September 2013