Environmental Protection Authority

Environmental Protection Bulletin No. 22

Hydraulic fracturing for onshore natural gas from shale and tight rocks

Hydraulic fracturing, commonly known as fracking, is a process that uses fluids and other materials that are pumped under high pressure into gas-bearing rock formations in order to open fractures (cracks) to create a path for the gas to flow.

Hydraulic fracturing is not a new process but it is increasingly used to develop gas from shale and tight rocks. Advances in technology are making it more commercially viable to use this technique to unlock liquid and gas petroleum resources that are trapped in underground geological formations.

In recent years, a number of proposals involving hydraulic fracturing have been referred to the Environmental Protection Authority (EPA) for environmental impact assessment (EIA). Being small scale, proof-of-concept proposals that were unlikely to have a significant effect on the environment, the EPA decided not to formally assess these proposals. In each case, the EPA published advice explaining the reason for its decision[1] and provided information to assist the proponent and decision-making authorities to ensure that environmental impacts would be minimised and managed.

The EPA acknowledges the high level of community interest in hydraulic fracturing and believes that building community confidence in the regulation of this activity is best achieved through:

- transparent and open communication by both regulators and proponents;
- a robust regulatory framework;
- a sound knowledge-base of the hydrogeology of the target area, the receiving environment and the chemicals and techniques involved; and
- the application of a precautionary approach and best practice management, especially where there is uncertainty about the potential risks and impacts to the environment.

Purpose of this bulletin

The purpose of this bulletin is to:

- define the circumstances under which the EPA will assess proposals that include hydraulic fracturing;
- outline the EPA's expectations for EIA with respect to hydraulic fracturing activities; and
- ensure that the EPA has sufficient information to undertake a thorough assessment of impacts and risks to the environment from proposals involving hydraulic fracturing.

The focus of this bulletin is on those activities and potential environmental impacts specifically related to hydraulic fracturing, which have not routinely been assessed by the EPA, and not on the broader range of environmental issues which may be associated with the development of gas resources from shale and tight rocks.

Background

Unconventional gas is a collective term which includes natural gas trapped in coal seams, shale and tight rocks. This gas is found onshore, trapped in sedimentary basins. Although difficult to extract, technological developments in the past thirty years in horizontal drilling and hydraulic fracturing, technically known as hydraulic fracture stimulation, have made these resources more accessible and commercially viable to produce.

[1] Public Advice is available on the EPA website at www.epa.wa.gov.au

The drilling process prior to hydraulic fracturing is the same as for the exploration of conventional resources where the oil and gas flow freely when tapped by a well. Drilling through multiple aquifers for conventional gas resources is standard practice and is well regulated in Western Australia (WA).

According to the Department of Mines and Petroleum (DMP), WA has abundant shale and tight gas and liquids resource potential in the Perth and Canning basins, estimated to represent about twice WA's offshore gas reserves.[2] The Carnarvon and Officer basins have been identified as areas for potential further resources but they have not been widely explored.

The majority of exploration work in WA is for shale and tight gas. Shale gas is found in shale formations and requires hydraulic fracturing to be extracted. Tight gas is trapped in compacted sandstone and limestone and only requires hydraulic fracturing in some circumstances to be extracted. While WA does have some coal deposits, no known commercially prospective coal seam gas resources have been identified to date.

This bulletin only addresses hydraulic fracturing for shale and tight gas. The EPA will develop further guidance if hydraulic fracturing for coal seam gas is likely to be considered in WA.

Shale and tight gas differ from the coal seam gas resources being targeted in the eastern States in that they are typically located more than 2,000 metres below the surface, whereas coal seam gas is generally found between 300 and 1,000 metres below the surface and requires dewatering to extract the gas. The latter means that a large amount of groundwater extraction is required, with potential impacts on other groundwater users. This is not the case for shale and tight gas extraction in WA.

EPA assessment of hydraulic fracturing proposals

One of the EPA's primary roles under the *Environmental Protection Act 1986* (EP Act) is to assess the environmental impacts of development proposals that may have a significant impact on the environment and make recommendations to the Minister for Environment. While the EPA does not approve proposals, its EIA process is vitally important as it provides a transparent process through which environmental impacts of proposals are considered.

A key test for the EPA in determining whether it should assess a proposal is whether the proposal, if implemented, is likely to have a significant impact on the environment. Therefore the EPA does not assess all proposals but has a responsibility to assess hydraulic fracturing proposals which it considers may have a significant environmental impact.

In deciding whether to assess a proposal, the EPA will have regard to the significance of the predicted environmental impacts, taking into account cumulative impacts. Applying a significance framework as set out in Environmental Assessment Guideline No. 9[3], the EPA may decide to assess a proposal that involves hydraulic fracturing if it is likely to have significant impacts on the environment, regardless of whether it is at a proof-of-concept stage or not. For example, a proof-of-concept proposal that involves multiple wells in an area where insufficient geological and hydrogeological information is available may require formal assessment by the EPA.

Additional criteria the EPA may apply in its decision to formally assess a proposal may include, but are not limited to, the scale of the proposal, uncertainty with respect to the available information, whether the proposal is likely to impact an environmentally sensitive area, or whether the proposal may impact a drinking water source area or other water supplies.

The EPA has published policies and procedures which describe the criteria it considers in deciding whether to assess a proposal, the process it applies for EIA, and its environmental policy framework for considering impacts to various environmental factors (see text box). These policies and procedures can be found on the EPA's website at www.epa.wa.gov.au.

[2] Information on estimated shale and tight gas reserves is available from the DMP's website at www.dmp.wa.gov.au

[3] *Environmental Assessment Guideline for Application of a significance framework in the environmental impact assessment process* (EAG 9).

Information received from proponents on the basis of the requirements included in the attachment to this bulletin (see section on information requirements below) will guide the EPA in its decision to assess a proposal, as well as information gained from consultation with other Government agencies that have relevant expertise.

The EPA uses environmental factors and associated environmental objectives, as set out in the EPA's Environmental Assessment Guideline No. 8 (EAG 8 – *Environmental factors and objectives*), as the basis for assessing whether expected impacts on the environment are acceptable.

In determining whether a proposal is likely to have a significant impact on the environment, the EPA will apply the significance test outlined in the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012*. If the proposal is assessed, the Significance Framework in Environmental Assessment Guideline No. 9 will be applied to make decisions throughout the environmental impact assessment process. It should be noted that this test and framework include consideration of the extent to which other decision-making processes can regulate a proposal to meet the EPA's environmental objectives.

Another requirement under the EP Act is that any decision-making authority must refer proposals that potentially have a significant effect on the environment to the EPA for its consideration of whether or not they should be formally assessed. To this end, the EPA has established criteria for referral and working arrangements with other Government agencies, such as the DMP and the Department of Water (DoW).

Potential environmental impacts

The environmental impacts of proposals involving hydraulic fracturing activities are most likely to relate to one or more of the following environmental factors:

- hydrological processes;
- inland waters environmental quality;
- terrestrial environmental quality;
- air quality;
- human health; and
- rehabilitation and closure.

Through the assessment process the EPA will consider whether the potential impacts on any of these environmental factors are likely to be significant and whether the EPA's objectives can be met.[4]

A number of potential impacts of proposals involving hydraulic fracturing are likely to be similar to those associated with other development proposals, such as: a fragmentation of landscapes and impacts on flora and vegetation due to the clearing of native vegetation and the construction of linear infrastructure and processing facilities; the impacts of water abstraction; the release of greenhouse gas emissions including fugitive methane emissions; and impacts on air quality and amenity in relation to the release of pollutants and the generation of noise and dust. These impacts are associated with many types of proposals and are considered by the EPA on a regular basis. The EPA will consider such impacts associated with proposals involving hydraulic fracturing in the same way as other proposals.

Where production scale projects are referred, the EPA will also consider broader cumulative impacts to the environment from associated infrastructure such as gas processing hubs, pipelines, access tracks and other land use changes.

However, there are a number of practices which are more specific to the hydraulic fracturing activity and which have not regularly been assessed by the EPA. These include, but are not limited to, horizontal well drilling and construction, the injection of water, chemicals and proppants (such as sand or ceramic beads), and the storage, use and disposal of fracturing fluids and eventual closure of the petroleum operation.

[4] The objectives for these factors are listed in the Table at Attachment 1.

Potential risks and impacts to the environment associated with hydraulic fracturing may include:

- contamination of groundwater and surface waters;
- altering groundwater systems (e.g. by unintentionally breaching natural seals or connecting aquifers); and
- increased seismic activity.

Although hydraulic fracturing for shale and tight gas typically extends well below water supply aquifers, increased separation distances between aquifers and target gas reserves will further minimise the risk of chemical contamination of groundwater aquifers with fracking fluid. Ensuring well casings meet best practice industry standards and maintaining well integrity throughout hydraulic fracturing processes, production and closure will help to reduce the risk of well failure and corrosion and resulting impacts to groundwater and surface water systems. Minimising the use of harmful chemicals and disclosure and management of the risks associated with chemicals used, together with adequate contingency plans, are important in this regard. Furthermore, proponents will need to ensure that the management, storage and disposal of wastewater from the fracturing activity is appropriate to manage risks, given the quantities involved and the potential toxicity of the materials.

Information requirements for EPA assessment of hydraulic fracturing projects

The attachment to this bulletin sets out the information the EPA may require proponents to provide for the formal assessment of hydraulic fracturing activities. This is in addition to the information required for the assessment of other activities and potential environmental impacts which may be associated with the proposal.

Information provided to the EPA on the basis of the attachment to this bulletin does not replace the requirement to prepare a scoping document for each individual proposal. Scoping documents will be prepared by the proponent or the EPA, as is current practice for most formally assessed proposals.

While not a referral requirement, proponents are encouraged to provide as much information as possible about the proposal at referral, to enable the EPA to make a decision about whether the proposal needs to be formally assessed.

A key issue for the EPA is the level of understanding about the various sedimentary basins and the aquifer systems which may be impacted by hydraulic fracturing. There is generally a good fundamental knowledge about the Perth Basin as a result of many years' investigative work and monitoring by the DoW, the Water Corporation, other agencies and proponents. This means that the impacts from hydraulic fracturing in this area will be well informed by science, enabling the EPA to have confidence through the EIA process.

The hydrogeology of the Canning, Carnarvon and Officer basins are less well understood and the EPA will take this into account when considering the need for a proposal to be formally assessed, and in determining the environmental impacts and risks.

While region-wide studies are beyond the capacity of any individual proponent, proponents will be required to provide the EPA with local-scale details of aquifer characteristics with conceptual models, supported by data obtained through any exploration or proof-of-concept proposals that have been implemented. Recognising the importance of a sound knowledge base, the EPA will encourage cooperative efforts to obtain relevant information.

Other guidance to proponents

The EPA encourages proponents to discuss their proposal with the EPA as early as possible and liaise with other agencies who also have regulatory responsibilities with respect to hydraulic fracturing activities in parallel.

The EPA also underlines that, in accordance with the objectives under the EPA Act to 'protect the environment and to prevent, control, and abate pollution and environmental harm', the EPA

will apply its guiding principles of encouraging best practice industry standards and continuous improvement in technology and process management to proposals which include hydraulic fracturing activities in the same way as it applies these principles to other proposals. This means that a proponent, in addition to meeting regulatory requirements, may be required to demonstrate how potential environmental impacts will be minimised and managed.

Furthermore, the EPA will expect proponents to conduct thorough and transparent consultation on their proposal.

Regulatory framework

In Western Australia, the DMP is the lead agency responsible for the regulation of petroleum activities. The development of shale and tight gas is regulated under the *Petroleum and Geothermal Energy Resources Act 1967* and the *Petroleum Pipelines Act 1969* and associated regulations.[5] Proponents are required to implement best practice management measures and demonstrate that risks will be managed to 'as low as reasonably practicable'. The Regulations further require proponents to submit an Environment Plan and a Safety Management System and public disclosure of all chemicals used for all well operations, including hydraulic fracturing activities.

The DMP is also developing new Resource Management and Administration Regulations[6] which will update the requirement to prepare a Well Management Plan and Field Development Plan and provide a risk-based management system for the exploration for, and production of, petroleum and geothermal energy resources, including shale and tight gas. The Well Management Plan is to ensure that the well is designed and managed to best practice standards. The Field Development Plan outlines the recovery strategy and the position of wells.

The DMP, in close cooperation with the Office of the EPA, the departments of Water, Environment Regulation, Health, and other agencies, is furthermore developing a Western Australian Shale and Tight Gas Framework which is to provide a whole of government description of the regulatory framework for shale and tight gas. This approach recognises that other Government agencies also play an important role in regulating and managing this emerging industry.

As with other projects, the DMP will refer a proposal to the EPA if it is considered likely to have a significant impact on the environment, having particular regard to environmentally sensitive areas and cumulative impacts. The DMP will also liaise with the Office of the EPA on whether referral is required if a proposed activity is within two kilometres of a town site, the coastline or within a public drinking water source area (including a water reserve, water catchment and groundwater protection area and declared or proposed water supply catchment area) or an area used for other water supply purposes.[7]

As the agency responsible for managing both the quantity and the quality of water within the State, the DoW also has a key advisory role in the assessment of proposals involving hydraulic fracturing. The DoW provides advice to the EPA on water resources and potential impacts on those resources in relation to regions that have been identified as the areas for future hydraulic fracturing activities. The EPA draws on this and other expertise in the context of the EIA process.

Proponents need approval from the DoW under the *Rights in Water and Irrigation Act 1914*[8] to construct a water well[9] and take water from surface or groundwater resources for use in drilling, hydraulic fracturing or related purposes. In assessing an application for a licence to construct a water well or to take water, the DoW takes a risk-based approach and considers, among other things, the quantity of water available, whether the action would prejudice other current and future needs for water, and the potential risk of surface or groundwater contamination.

[5] Petroleum and Geothermal Energy Resources (Environment) Regulations 2012; Petroleum and Geothermal Energy Resources (Management of Safety) Regulations 2010. Available from the State Law Publisher: www.slp.wa.gov.au

[6] Draft Petroleum and Geothermal Energy Resources (Resource Management and Administration) Regulations 2014

[7] These requirements are included in a Memorandum of Understanding between the DMP and the Office of the Environmental Protection Authority, which can be found on the EPA website.

[8] A copy of this Act can be obtained from the State Law Publisher: www.slp.wa.gov.au

[9] Licence to Construct or Alter a Well

The Department of Environment Regulation has regulatory responsibilities with respect to oil and gas production under Part V of the EP Act. Where any well is designed for the threshold production capacity of 5,000 tonnes or more per year and commences production of oil or gas, the premises are considered prescribed and will require works approval and licensing under Schedule 1 of the Environmental Protection Regulations 1987[10] (Category 10 or 11). Any discharge ponds constructed for the storage or evaporation of returned fracturing fluids and waste water, both of which may contain contaminants, are considered part of the prescribed premises and would therefore require a works approval prior to construction and would be subject to regulatory conditions within the licence.

References and further information

Department of Mines and Petroleum 2014, *Natural Gas from Shale and Tight Rocks, An overview of Western Australia's regulatory framework*. DMP, February 2014. http://dmp.wa.gov.au/documents/Natural_Gas_from_Shale_and_Tight_Rocks_-_An_overview_of_Western_Australia_regulatory_framework.pdf

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Department of Energy and Climate Change (UK) 2013. *Developing Onshore Shale Gas and Oil – Facts about 'Fracking'*, December 2013. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/265972/Developing_Onshore_Shale_Gas_and_Oil__Facts_about_Fracking_131213.pdf

United States Environmental Protection Agency (In progress). *Study of Hydraulic Fracturing for Oil and Gas and Its Potential Impact on Drinking Water Resources.* http://www2.epa.gov/hfstudy

OGP-IPIECA 2013. *Good practice guidelines for the development of shale oil and gas*, International Association of Oil and Gas Producers, December 2013. http://www.iogp.org/Reports/Type/489/id/697

[10] A copy of these Regulations can be obtained from the State Law Publisher: www.slp.wa.gov.au

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Attachment 1

Information requirements to support the environmental impact assessment of proposals involving hydraulic fracturing

Although hydraulic fracturing activities are likely to have broader environmental impacts similar to the development of conventional gas reserves, the purpose of this attachment is to focus only on the impacts of hydraulic fracturing as an activity which has not been regularly assessed by the EPA and for which little precedent exists.

The practices relating specifically to the process of hydraulic fracturing which are considered in this attachment include, but are not limited to, the storage, use and disposal of fracking fluids, and well drilling, casing and eventual closure.

Table 1 outlines the information the EPA may require a proponent to submit in order to address the environmental impacts of hydraulic fracturing and related activities on the relevant environmental factors. The information requirements have been grouped together as there is considerable overlap across the factors.

Table 1 – Information requirements to support the environmental impact assessment of hydraulic fracturing activities

Factors	**Hydrological Processes** Objective: To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.	**Inland Waters Environmental Quality** Objective: To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.	**Terrestrial Environmental Quality** Objective: To maintain the quality of land and soils so that the environmental values, both ecological and social, are protected.	**Human Health** Objective: To ensure that human health is not adversely affected.	**Rehabilitation and Closure** Objective: To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State.
Applicable project components and activities	Groundwater abstraction for fracking water supplies. Drilling and construction of wells to be fracked. Injection of fracking fluids.	Injection of fracking fluids. Storage and handling of fracking fluids and additives (e.g. chemicals and proppants). Storage and disposal of flowback fracking fluids and produced formation water.	Storage and handling of fracking fluids and additives. Storage and disposal of flowback fracking fluids and produced formation water.	Injection of fracking fluids. Storage and handling of fracking fluids and additives. Storage and disposal of flowback fracking fluids and produced formation water.	Well closure and decommissioning. Disposal of contaminated wastes. Storage pond and site rehabilitation.
Potential environmental impacts	Changed water regimes impacting on groundwater dependent ecosystems. Induced seismicity. Intersection and unintended connection of aquifers, impacting on flow regimes, aquifer quality and water users.	Contamination of groundwater with fracking fluids and cross-contamination of aquifers through casing failure, breaching seals or hydrogeological faults. Surface water contamination directly or through pond leakage or overflow.	Contamination of soils.	Contamination of drinking water sources, public and private, and other water supplies.	Contamination of soils, surface water and groundwater.

Information Requirements

Groundwater and surface water characteristics

- Characterise baseline hydrological regimes and water quality for surrounding aquifers, especially those intersected by drilling, and any groundwater dependent ecosystems.
- Where relevant, provide information on surface water systems including location of systems, hydrology, water quality, and catchment boundaries.
- Provide data from baseline and surveillance groundwater monitoring programs where available.
- Provide a conceptual model of the geology and hydrogeology of the area, including stratigraphy, aquifers, seals or aquicludes, faults/fractures, connectivity between surface and groundwater systems and across aquifers, water quality, groundwater flow direction and travel time between petroleum wells/fracking locations and sensitive receptors.
- Identify the distance from the surrounding aquifers to the target zones.
- Identify surrounding fault lines/systems to the target zones.
- Describe the proposed monitoring and reporting regime to measure the impacts of the proposal on groundwater and surface water quality and quantity.

Fracking propagation

- Develop a numerical model and provide information on the extent of propagation of fracking, vertically and horizontally (trajectory modelling) and confirm with data from proof-of-concept fracking.
- Compare modelled data with available real data (e.g. microseismic monitoring, data from tracer use) collected during proof-of-concept fracks.
- Provide a plan view of drilling showing spatial extent of planned horizontal drilling and modelled extent of fracking.
- Assess risks of fractures intercepting aquifers, faults/fractures, and existing wells.
- Based on conceptual understanding of geology and hydrogeology, and evidence from other areas, assess the risks of induced seismicity.

Water use

- Identify current and potential future uses of water (drinking and other) from surrounding aquifers and surface water catchments.
- Provide data on local public and private water abstraction in the area, including location of bores, aquifers used, abstraction quantities and use of water.
- Provide information on any proposed groundwater or surface water abstraction, including modelled groundwater drawdown/pressure reduction or altered water regime, and impacts on any groundwater dependent or surface water ecosystems.

Well design and integrity

- Provide information about well integrity over the short- and long-term including tests undertaken to confirm integrity (e.g. cement bond logs, pressure testing), risk assessment of loss of well control and breaches of well integrity, and measures taken to ensure protection against corrosion and high pressures (e.g. materials used, corrosion inhibitors).
- Identify likely impacts of breaches of well integrity on the environment and water users.
- Identify systems used to detect breaches of well integrity during and after fracking operations.
- Identify well control systems (e.g. emergency shutdowns, blow-out preventers) and how long it would take to activate them should a well control situation arise. Indicate the likely volume and concentration of fracking fluid or formation water chemicals lost under possible scenarios.
- Identify monitoring and reporting arrangements for well integrity, pre-, during and post-production.
- Identify remediation plans for contamination of water resources resulting from any loss of well integrity.
- Identify expected life of well casings.
- Discuss well closure and rehabilitation timelines and arrangements, including how any casing failure will be mitigated for the long-term.
- Provide information on well design in relation to protection of aquifers (e.g. isolation of aquifers using cement grouting, multiple casing and grout barriers, and capping at the surface).

Fracking fluids and produced water[11]

- Identify chemicals and likely concentrations in fracking fluids and produced water.
- Provide ecotoxicity and biodegradability information on all chemicals used.
- Demonstrate a best-practice approach to the choice and use of fracking fluids.
- Identify expected final concentrations of fracking chemicals, released formation chemicals (e.g. metals, hydrocarbons) and radioactive elements in flowback and produced formation fluid.
- Provide information about expected volumes of fracking, flowback and produced formation fluids.
- Detail arrangements for storage and management of wastewater (i.e. drilling fluids, flowback water and produced formation water), including choice of tanks or ponds, liners, risk of leakage and monitoring, and reporting arrangements for leakage.
- Using relevant climate data, model pond water balance to demonstrate adequacy of storage volume and identify risk and frequency of any overflows.
- Model the likely extent and distribution of spills, leakages and overflows of flowback fluid and produced water.
- Outline response measure to be implemented in the event of a spill.
- Describe measures for disposal of contaminated waste from ponds or other sources.
- Provide a description of the design, location and extent of discharges of the proposed waste facilities.
- Provide information on any proposed reinjection of wastewater, particularly in relation to potential impacts on aquifers.

[11] Please refer also to the DMP's *Chemical DIsclosure Guideline*, August 2013, http://www.dmp.wa.gov.au/documents/ENV-PEB-178.pdf

Other

- Describe any other elements of the proposal with the potential to impact surface water or groundwater quality.
- Describe closure and rehabilitation arrangements, including completion criteria for site rehabilitation.
- Discuss proposed management, monitoring and mitigation methods to be implemented during construction, operation and closure to ensure that the EPA's objectives for these factors can be met.
- Where relevant, provide information in the context of other fracking activities in the area (historic, existing and proposed) in order to understand cumulative impacts.
- Have key conceptual and numerical modelling independently reviewed. ■