



Government of **Western Australia**
Department of **Health**
Office of the Director General



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Dear Mr Hatton

**DEPARTMENT OF HEALTH SUBMISSION TO THE INDEPENDENT SCIENTIFIC
PANEL INQUIRY INTO HYDRAULIC FRACTURE STIMULATION IN WESTERN
AUSTRALIA 2017**

Thank you for your letter of 27 November 2017 inviting the Department of Health to make a submission on the Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia 2017.

Please find enclosed our submission for your review and consideration.

Should you require further information, please contact Dr Peter Franklin on



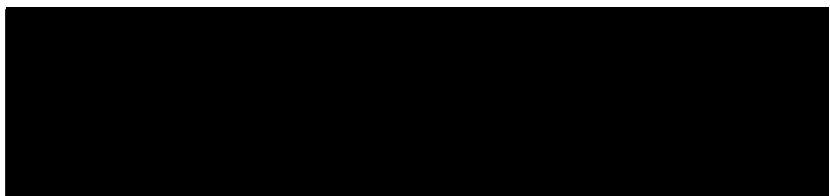
Yours sincerely

Dr D J Russell-Weisz
DIRECTOR GENERAL

23 March 2018

*Att. – WA Department of Health Submission to standing committee on Environment and Public Affairs
Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas
October 2013.*

*WA Department of Health Submission Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation
in Western Australia 2017*



WA DEPARTMENT OF HEALTH SUBMISSION

TO

***Independent Scientific Panel Inquiry into Hydraulic
Fracture Stimulation in Western Australia 2017***

Background

On 5 September 2017 the Western Australian Government announced an independent scientific panel inquiry into the effects on the environment of the process of hydraulic fracture stimulation (fracking) for unconventional gas. Submissions from stakeholders and the wider public were called for to assist the inquiry and to ensure the Panel has:

- a) A full and appropriate understanding of the environmental values potentially at risk from unconventional oil and gas developments involving fracking,
- b) Any data or other evidence that might inform a scientific risk analysis of those impacts, with an emphasis on local geographies and geologies, and local evidence from Western Australia; and
- c) Any reflections or experience on what a regulatory framework should ideally look like if the Government lifts the current Moratorium.

The Department of Health (DOH) has an interest in the health of the WA population and, therefore, we have reviewed the data on health risks posed by fracking. Based on that review we have made recommendations for a regulatory framework for hydraulic fracture stimulation (fracking) for unconventional gas

Submission to 2013 Inquiry

The DOH made a submission to the Standing Committee on Environmental and Public Affairs Inquiry into fracking (Sept 2013 - attached). In that submission we identified four key factors that needed to be considered. These were;

- 1. good risk communications with transparent and accountable disclosure of risks;
- 2. confidence in “the regulator” to properly oversee and hold proponents accountable in relation to Public Health risk management commitments;
- 3. the precautionary principle;
 - a. if there is a serious Public Health risk, lack of full scientific certainty should not be used as a reason for postponing measures to prevent, control or abate that risk; and
 - b. in the application of the precautionary principle, decision-making should be guided by;
 - i. a careful evaluation to avoid, where practicable, serious harm to Public Health; and
 - ii. an assessment of the risk-weighted consequences of the options;
- 4. respect for Commercial in Confidence needs to be balanced as much as possible against the benefits of transparency in the risk communication

process. DOH support of proposals may be limited by the degree of information sharing regarding use of potential contaminants by proponents¹.

These factors remain important and are relevant to the current Inquiry. Our submission at that time, however, focussed on the potential contamination of water, which we saw then as the greatest threat posed by hydraulic fracture stimulation. We still consider water contamination as a concern but have reviewed the latest literature with regards to public health implications of hydraulic fracturing irrespective of the exposure pathway. A brief overview of the review is provided below.

Hydraulic fracturing and public health

The public health implications of hydraulic fracturing remain a controversial issue. The potential for harm is real but the available evidence is inconclusive. In recent years there have been a number of reviews (1-5) of studies of the health effects of hydraulic fracturing and all have had similar conclusions. These are;

- there is a paucity of rigorous epidemiological studies,
- most studies focus only on short-term health effects,
- a number of adverse health outcomes have been observed but data are inconsistent,
- both exposure assessment and disease (mis)classification are major methodological limitations of existing research,
- due to study design problems, results need to be considered more hypothesis generating than hypothesis testing,
- the lack of conclusive evidence, however, does not indicate evidence of a lack of an effect, and
- more research, particularly long-term health studies, is required.

Hazards

The main hazards for human health arise from chemicals used in the fracking fluid and the potential for these to contaminate water, air and land (and subsequently food). Greenhouse gas emissions (methane), noise, vibration and water depletion are also issues with potential public health impacts. Contamination of water, air and land can occur at any stage of the operation, if adequate controls are not in place.

Although chemicals make up a very small fraction ($\leq 0.5\%$) of fracking fluid, the volume of fluid means that tonnes of these chemicals can be used. Many of the chemicals are known mutagens, carcinogens and irritants. Indeed an assessment of over 300 of the chemicals used found 25% to be carcinogens or mutagens and about 75% to be skin, eye, respiratory and gastro-intestinal tract irritants (6). Known endocrine disrupting chemicals (EDCs) have also been used in fracking fluids (6).

¹ We note that DMIRS regulations now require petroleum companies to publicly disclose all chemicals and additives introduced to a well or formation during hydraulic fracture stimulation.

For some chemicals, particularly EDCs, adverse effects are possible at extremely low doses (7).

Health effects from hydraulic fracture stimulation activities

Based on the known toxicology of many of the chemicals used in the process of hydraulic fracturing there is potential risk to human health. However, health effects relating to specific exposures have not been fully assessed. Furthermore, health effects relating to specific exposure pathways (air, water, food) are not well known. Human health (epidemiological) studies have only used proximity as a surrogate for exposure. This has limitations as it cannot take into account geological, meteorological or other factors that affect the movement of contaminants in air, water and soil and, therefore, the actual exposures of individuals (3). Disease misclassification, particularly self-reporting, as well as information and selection biases and confounding are other methodological issues that limit the interpretation of the existing health literature.

Despite the methodological limitations health effects have been observed. These include;

1. Cancers: two studies have assessed cancer incidence in populations living near hydraulic fracturing operations (8) or in populations before and after operations began (9). For most cancers assessed in these studies rates were not increased, although some elevated standardised incidence rates (SIRs) were observed. For example, there was a small increase SIR in central nervous system cancers in children once hydraulic fracturing had started compared with beforehand (9), while bladder cancer was slightly higher in counties in Pennsylvania where shale-gas activity was greatest, although increases were observed prior to shale gas development (8).
2. Birth outcomes: proximity to hydraulic fracturing operations has been associated with reduced birth weight (10), preterm birth (11) and congenital heart defects (12). However, the data are mixed with studies showing either increased (12) or decreased birth weight (10), and increased (11) or no increased (10) risk of preterm birth.
3. Hospitalisations: a series of studies in Queensland compared hospital records for populations in areas of coal seam gas (CSG) activity, coal mining, and no mining (rural) (13-15). The researchers found increased hospitalisations for 'all causes' (13), as well as specifically for neoplasms and blood/immune diseases (15) and childhood respiratory disease (14) in populations living in the CSG activity area.
4. Non-specific symptoms: symptoms such as headaches, nausea, dizziness, and rashes and other skin conditions have been reported by residents living nearing hydraulic fracturing activities (5). However, these studies have a high chance of both reporting (those living closer to mining operations are more likely to report symptoms) and selection (those living close to operations with symptoms are more likely to participate) biases.

Greenhouse gas emissions

Apart from the more immediate effects (both short- and long-term) of hydraulic fracture stimulation operations, the extraction of unconventional gas could have indirect effects via its contribution to climate change. The potential effects of climate change on health have been well documented (16). The combustion of gas produces about 40% of greenhouse gases (GHG) than coal. However, fugitive emissions of methane and other GHG during the extraction and transport of unconventional gas can negate any benefit. Above about 4 per cent fugitive emissions, the greenhouse benefits are lost (17).

Conclusion

There is a small but growing body of literature suggesting that communities living near natural gas developments involving hydraulic fracture stimulation may experience a range of adverse health effects. However, the evidence is limited and the rigour of the epidemiological studies can be questioned. The exposure pathways (air, water or land) most responsible for the observed health effects have not been identified as all epidemiological evidence is based on proximity to activities rather than specific exposures.

The lack of conclusive evidence does not suggest that there is no effect and the DOH maintains that the precautionary principle be applied in considering future hydraulic fracturing stimulation projects in Western Australia. The DOH also holds the view that, if well managed and under the right conditions, public health risks can be minimised. However, in any regulatory framework public health risk needs to be considered.

Recommendations for regulatory framework

The DOH is not aware of additional evidence that would alter our recommendations from the previous Senate inquiry into hydraulic fracture stimulation (see Appendix A), and on balance the limited health studies undertaken since 2013 further emphasise the importance of a regulatory system that takes into account-, and is protective of, public health. Therefore, the DOH recommends;

1. The approval process for projects that may impact communities, either directly or indirectly (eg. via the water supply), includes an adequate public health assessment, either through consultation with DOH via the Environmental Impact Assessment process or directly through the Public Health Act 2016 (Part 7). A high degree of variation in site-specific circumstances, methods and fracking chemicals means that all project proposals should be assessed on a case-by-case basis.
2. Potential emissions, including fugitive emissions, or contaminants to be managed through agreed industry and engineering best practice standards and regulation.
3. Use of approved substances only in hydraulic fracturing.

4. International best practice to be used for the storage and disposal of hydraulic fracturing fluids.
5. Baseline and ongoing monitoring of water and air to allow for ongoing assessment of potential human health risks.
6. Exclusion zones around well heads, to ensure adequate separation between hydraulic fracturing operations and sensitive water supplies.
7. Adequate separation distances (buffer zones) between operations and human communities.
8. Closure of hydraulic fracturing sites should be subject to the implementation of post closure management plan which includes a requirement for ongoing monitoring of closed site.

References

1. Costa D, Jesus J, Branco D, Danko A, Fiuza A. Extensive review of shale gas environmental impacts from scientific literature (2010-2015). *Environ Sci Pollut Res Int* 2017; 24: 14579-14594.
2. Saunders PJ, McCoy D, Goldstein R, Saunders AT, Munroe A. A review of the public health impacts of unconventional natural gas development. *Environ Geochem Health* 2018; 40: 1-57.
3. Stacy SL. A review of the human health impacts of unconventional natural gas development. *Curr Epidemiol Rep* 2017; 4: 38 - 45.
4. Werner AK, Vink S, Watt K, Jagals P. Environmental health impacts of unconventional natural gas development: a review of the current strength of evidence. *Sci Total Environ* 2015; 505: 1127-1141.
5. Wright R, Muma RD. High-volume Hydraulic Fracturing and Human Health Outcomes: A Scoping Review. *J Occup Environ Med* 2018.
6. Colborn T, Kwiatkowski C, Schultz K, Bachran M. Natural Gas Operations from a Public Health Perspective. *Hum Ecol Risk Assess* 2011; 17: 1039-1056.
7. Kassotis CD, Tillitt DE, Davis JW, Hormann AM, Nagel SC. Estrogen and androgen receptor activities of hydraulic fracturing chemicals and surface and ground water in a drilling-dense region. *Endocrinology* 2014; 155: 897-907.
8. Finkel ML. Shale gas development and cancer incidence in southwest Pennsylvania. *Public Health* 2016; 141: 198-206.
9. Fryzek J, Pastula S, Jiang X, Garabrant DH. Childhood cancer incidence in Pennsylvania counties in relation to living in counties with hydraulic fracturing sites. *J Occup Environ Med* 2013; 55: 796-801.
10. Stacy SL, Brink LL, Larkin JC, Sadovsky Y, Goldstein BD, Pitt BR, Talbott EO. Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania. *Plos One* 2015; 10.
11. Casey JA, Savitz DA, Rasmussen SG, Ogburn EL, Pollak J, Mercer DG, Schwartz BS. Unconventional Natural Gas Development and Birth Outcomes in Pennsylvania, USA. *Epidemiology* 2016; 27: 163-172.
12. McKenzie LM, Guo R, Witter RZ, Savitz DA, Newman LS, Adgate JL. Birth outcomes and maternal residential proximity to natural gas development in rural Colorado. *Environ Health Perspect* 2014; 122: 412-417.
13. Werner AK, Cameron CM, Watt K, Vink S, Jagals P, Page A. Is Increasing Coal Seam Gas Well Development Activity Associated with Increasing Hospitalisation Rates in Queensland, Australia? An Exploratory Analysis 1995-2011. *Int J Environ Res Public Health* 2017; 14.
14. Werner AK, Watt K, Cameron C, Vink S, Page A, Jagals P. Examination of Child and Adolescent Hospital Admission Rates in Queensland, Australia, 1995-2011: A Comparison of Coal Seam Gas, Coal Mining, and Rural Areas. *Matern Child Health J* 2018.

15. Werner AK, Watt K, Cameron CM, Vink S, Page A, Jagals P. All-age hospitalization rates in coal seam gas areas in Queensland, Australia, 1995-2011. *BMC Public Health* 2016; 16: 125.
16. IPCC, 2014: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK.
17. CSIRO. What is unconventional gas?
<https://www.csiro.au/en/Research/Energy/Hydraulic-fracturing/What-is-unconventional-gas>. Sourced 16 March 2018.

Appendix A:

**WA DEPARTMENT OF HEALTH SUBMISSION
TO
STANDING COMMITTEE ON
ENVIRONMENT AND PUBLIC AFFAIRS**

WA DEPARTMENT OF HEALTH SUBMISSION

TO

STANDING COMMITTEE ON

ENVIRONMENT AND PUBLIC AFFAIRS

***Inquiry into the Implications for Western Australia of Hydraulic
fracturing for Unconventional Gas***

October 2013

Background

On 7 August 2013, the Standing Committee on Environment and Public Affairs resolved to inquire into and report on the implications for Western Australia of hydraulic fracturing for unconventional gas, including:

- a) how hydraulic fracturing may impact on current and future uses of land;
- b) the regulation of chemicals used in the hydraulic fracturing process;
- c) the use of ground water in the hydraulic fracturing process and the potential for recycling of produced water; and
- d) the reclamation (rehabilitation) of land that has been hydraulically fractured.

Department of Health (DOH) Roles and Responsibilities

The *Health Act, 1911* (as amended) (the Act) identifies the powers of the Executive Director Public Health (EDPH), including the power to make inquiries (Section 13) and the power to act in emergencies (Section 15). Sections 129, 130 and 131 of the Act do provide some specific powers to DOH in relation to the protection of water supplies.

The Act, due to its age, is limited in its capacity to be applied proactively and on a risk management basis.

Other regulatory agencies that have statutory decision making powers are now seeking our advice to inform their processes. For instance, The Department of Health (DOH) Environmental Health Directorate (EHD) assists the Environmental Protection Authority (EPA), the Department of Environment Regulation (DER), the Department of Mines and Petroleum (DMP), upon request, with assessments and provides advice on health issues related to safety of food and drinking water, wastewater management, mosquito control and where applicable, exposure protection from emissions.

However, this usually occurs because of interagency agreements rather than a legislative requirement. Further, the standing of DOH advice has not been tested. At best this occurs after a project has been designed and an impact/risk assessment has been scoped. This means that, at times, in dealing with contentious public issues, DOH input has not been sought until the end of the process, or when a crisis develops. As a result, DOH are often trying to interpret existing situations rather than proactively informing best practice to avoid or manage risks to Public Health.

Better results have been achieved where DOH has been consulted from the start. This allows early recognition of the issues and inclusion of DOH advice in making the decision and in the ongoing management approach.

The recent approach taken by the Department of Water (DoW), in regards to Managed Aquifer Recharge, is a good example of the benefits of early engagement with the DOH to address both real and perceived Public Health risks. (WA Department of Water, 2010)

In 2007, the Legislative Assembly Education and Health Standing Committee Inquiry into the Cause and Extent of Lead Pollution in the Esperance Area was "...persuaded that the Department of Health's position, that it be given a defined legislative role in the approval of resource proposals should be supported." (Legislative Assembly, 2007 p. 94). The Public Health Bill, which contains provisions to clearly define the DOH's role and provide it with the necessary risk-management powers, has not yet entered Parliament and the standing of any DOH advice has not legally changed since 2007.

The Committee also identified a recurring theme of a “...failure to place Public Health considerations on the same basis of other considerations.” (Legislative Assembly, 2007 p. 93). In order to protect Public Health and to reassure the public of Western Australia (WA) it is imperative that in the case of approvals for Hydraulic fracturing, the DMP as the decision making body do place Public Health considerations on the same basis of other considerations. In order to do this the DMP should engage DOH in the decision - making process.

In addressing Public Health considerations, related to Hydraulic fracturing, DOH has identified four key factors that need to be considered:

1. good risk communications with transparent and accountable disclosure of risks;
2. confidence in “the regulator” to properly oversee and hold proponents accountable in relation to Public Health risk management commitments;
3. the precautionary principle;
 - a. if there is a serious Public Health risk, lack of full scientific certainty should not be used as a reason for postponing measures to prevent, control or abate that risk; and
 - b. in the application of the precautionary principle, decision-making should be guided by;
 - i. a careful evaluation to avoid, where practicable, serious harm to Public Health; and
 - ii. an assessment of the risk-weighted consequences of the options;
4. respect for Commercial in Confidence needs to be balanced as much as possible against the benefits of transparency in the risk communication process. DOH support of proposals may be limited by the degree of information sharing regarding use of potential contaminants by proponents.

The DMP regulates the oil and gas industry and the DOH has no formal role in the approvals process for petroleum drilling licenses, or in the establishment of onshore or offshore drilling fields. However, the DOH is involved in continuing communication with DMP. In recent times the EHD has had the opportunity to review and comment on legislation and guidance documents for the petroleum industry and continues to contribute to several DMP working groups providing advice on the development of relevant documents and processes.

Definitions:

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (World Health Organisation, 1948).

Public Health means the physical, mental and social wellbeing of the community (Draft *Public Health Bill*, 2008)

Riparian proprietor under common law is someone who owns land on the bank of a natural watercourse or body of water. (The Macquarie Dictionary Online © Macquarie Dictionary Publishers Pty Ltd.)

Sensitive land uses means land uses considered to be potentially sensitive to emissions from industry and infrastructure, and includes residential developments, hospitals, hotels, motels, hostels, caravan parks, schools, nursing homes, child care facilities, shopping centres, playgrounds, and some public buildings. Some commercial, institutional and industrial land uses which require high levels of amenity or are sensitive to particular emissions may also be considered “sensitive land uses”. Examples include some retail outlets, offices and training centres, and some types of storage and manufacturing facilities. (EPA, 2005)

The Department of Health Preliminary Health Risk Assessment of Hydraulic fracturing

The DOH has undertaken a Preliminary Health Risk Assessment of hydraulic fracturing for Unconventional Gas (PHRA) (copy attached) and has reviewed its legislative powers in this area. As a result the following issues have been identified in relation to potential impacts on Public Health from hydraulic fracturing.

1. Potential for contamination of Drinking water supplies

The PHRA identified that hydraulic fracturing has the potential to contaminate groundwater including drinking water supplies. The major sources of potential contamination were identified as the hydraulic fracturing fluid and flowback fluid.

Although the PHRA attempts to be as comprehensive as possible in the assessment of the potential adverse consequences to the water supply from hydraulic fracturing, there are some issues that have not been addressed in detail. Issues such as contamination through radiation, bioaccumulation, disturbance of toxic sediments in aquifers and contamination through gaseous seepage of substances other than methane are some of the issues that have not been addressed in this study. This is because there is currently insufficient research to permit proper consideration of their risk.

2. Public Health Legislation

Section 129 of the *Health Act 1911* provides that it is an offence to pollute or defile or to permit or suffer a water supply to be polluted or defiled.

Section 130 grants the rights of a riparian proprietor to the local government whenever any water supply becomes, or is likely to become injurious to health.

Section 131 provides the power for a local government in its own right or if required by the EDPH to close a water supply if it should become unfit for human consumption.

These Health Act provisions provide powers to prosecute offenders (with limited penalties) and to close water sources that become unfit for human consumption, however, they provide little in the way of proactively assessing risks to water supply and preventing contamination.

In the absence of broad reaching Public Health Legislation, the DOH has limited scope to manage risks to Public Health related to hydraulic fracturing. As a result, the DOH is largely reliant on other legislation administered by other government departments to take proactive action for the protection of Public Health.

3. Other Regulatory Frameworks

It is understood that the DMP will be the principal decision making authority with regard to proposed Hydraulic fracturing operations. Considering the limited scope the DOH has for taking proactive measures for protecting Public Health, it is vital that the DMP regulatory framework includes provision for requiring the full disclosure by proponents of substances to be used in hydraulic fracturing fluids, and requires the conduct of a HRA where there are no Australian standards or guidelines for those substances in drinking water. It is critical that in assessing any such proposal the DMP, the EPA, the DER and the DoW seek and properly consider advice from the DOH regarding any potential risk to Public Health.

4. Department of Water: Protection of Water Sources

Furthermore the DOH is reliant on DoW to protect water sources. The DOH supports the protection of Public Drinking Water Source Areas (PDWSA) through the designation of P1

and P2 Priority source protection areas implemented under the PDWSA Protection Framework. Hydraulic fracturing activities should not take place within such areas. Additionally, the DOH promotes the separation of hydraulic fracturing from private drinking water wells, 100 year flood plains and "sensitive land uses" by the EPA industrial separation distance of 2000m for all oil and gas production fields (EPA, 2005).

5. Beneficial use of Waste Water

Where it is proposed to use waste water from hydraulic fracturing for a beneficial non-potable use such as in agriculture, industry, fire control, or municipal, residential or commercial property use, the proposal should be assessed using the National Health Medical Research Council (NHMRC) *National Guidelines for Water Recycling: Managing Health and Environmental Risks* (Phase 1).

6. Other Potential Contamination Issues

The most significant potential risk to Public Health from hydraulic fracturing is from the contamination of water supplies. As a result this submission focuses on managing impacts of this kind. There may be some Public Health risk associated with air or soil contamination issues, and these can be addressed if and when the need arises.

7. "Mine" Closure plan

In order to ensure the protection of Public Health after the closure of a Hydraulic fracturing "mine", it should be necessary to require the submission and approval of a Closure Plan prior to the issue of a drilling licence. This will be particularly important in situations where there is ongoing storage of returned flowback water and hydraulic fracturing fluids. These plans may need to include ongoing monitoring of the stored liquid waste and groundwater for some time after the closure of fracturing operations.

Response to Inquiry Issues

a) How hydraulic fracturing may impact on current and future uses of land;

- Most unconventional gas "plays" in WA are in shale deposits. These plays are usually quite dry and require the introduction of large quantities of water. This results in large volumes of flowback and process water. This flowback and process water may contain; cuttings, proppants, total dissolved solids, chlorides (brine), surfactants, gelling agents, metals, corrosion inhibitors, friction reducers, micro-biocides, hydrocarbons (oil), gas, heavy metals (e.g. arsenic) and naturally occurring radioactive materials. Many of these substances may be present in toxic concentrations.
- Mismanagement of these waters may impact on current and future land uses via the following mechanisms.
 - the abstraction of water resources may modify groundwater levels, surface water levels and stream flows;
 - surface water issues: stormwater runoff, flood damage, surface spills, leaks and erosion of pit or surface impoundment failures;
 - ground water contamination;
 - loss of concentrated fracturing fluids and flowback water through tank ruptures, equipment failure or overfills, contaminating groundwater or surrounding land; and
 - environmental release of chemicals used during exploration or production leading to potential contamination of food or fibre (livestock or plant).
- It is known that the extraction and processing of natural ores, oils and gases may give rise to the concentration of naturally occurring radioactive materials (NORMs) in

both process and waste water streams. Radiation monitoring of these streams will need to be conducted and if the radiation levels exceed the exemption levels contained within the *Western Australian Radiation Safety (General) Regulations* the requirements of the *Western Australian Radiation Safety Act 1975* will apply.

b) The regulation of substances used in the hydraulic fracturing process;

- The PHRA produced a list of 195 chemicals of concern. Some are known as suspected carcinogens and some have been reported to have possible developmental or reproductive toxicity. Many of the chemicals do not have a health guideline value for oral intake.
- There is also the potential for contamination of the fracturing fluids and/or flowback water by the ground water or other material encountered during the fracturing operation. These contaminants will also need to be identified and risk assessed.
- There is a lack of chemical disclosure on the proponents' website citing commercial in confidence reasons for non-disclosure (<http://www.dmp.wa.gov.au/15147.aspx>) This lack of disclosure may delay or prevent the proper assessment of the potential impacts on human health and lead to appropriate precautionary measures being put in place to protect Public Health. Further, open and transparent disclosure of these chemicals to the public is fundamental to proper risk communication.
- DOH approval for a project will be contingent upon the preparation of a proper risk communication plan.

c) The use of ground water in the hydraulic fracturing process and the potential for recycling of produced water;

- The principal concerns around the use of groundwater and its potential for recycling, centre on the impacts associated with any contamination of the ground water, which may occur through addition of fracturing fluids or from the fractured area (eg Oil, naturally occurring radionuclides, or heavy metals).

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

- Upon closure of the hydraulic fracturing operation it is vital that the bore is properly sealed to prevent leakage.

Recommendations

DOH has a number of recommendations to make with regard to the implications of hydraulic fracturing for unconventional gas. These recommendations have been grouped into two categories being Strategic and Technical.

The Strategic Recommendations relate to high level issues aimed at ensuring that Public Health and risk communication issues are adequately addressed during the project approvals process as regulated by DMP.

The Technical Recommendations address more detailed issues of a technical nature.

Strategic Recommendations

1. A Memorandum of Understanding (MOU) between DMP and DOH should be put in place to review chemical risk assessment for petroleum programs drilling, including hydraulic fracturing for unconventional gas. The MOU should include details of:
 - a. an initial assessment scoping process to provide for an early decision as to whether there are likely to be any Public Health risk and whether they should be assessed and by whom; and

- b. early alert conditions for referral of proposals to DOH.
2. The DMP approvals framework should acknowledge and include the role of DOH including details:
 - a. as to whether and when proposals are referred to DOH for advice;
 - b. approvals transparently showing how DOH advice was used;
 - c. ensuring that, where risks to Public Health do exist, appropriate measures are put in place to deal with them according to DOH guidelines; and
 - d. of DMP commitments to audit the proponent's compliance with DOH guidelines and report on any non-compliances, impacting on Public Health, to DOH in a timely manner.
3. Proponents should be required to prepare and implement an open and transparent risk communication strategy.
4. All decisions relating to hydraulic fracturing should be transparent with all decision-making being properly supported with scientific evidence and in accordance with the Precautionary Principle.
5. If onshore unconventional oil and gas wells are not defined as "mining operations" under the Mine Operations Regulations 16, then the regulation of radioactive substances will fall under the jurisdiction of the Radiological Council

Technical Recommendations

1. Proponents should be required to make full public disclosure of substances used in hydraulic fracturing, and likely to be present in flowback fluid and processing water.
2. All substances used in hydraulic fracturing should be subject to approval.
3. Background measurements of waterways and groundwater should be undertaken.
4. Monitoring of substances in surrounding water sources should be conducted.
5. Application of the Australian Drinking Water Guidelines to chemicals found in water used or available for use for drinking water purposes.
6. Guideline values for each substance present in hydraulic fracturing fluid or flowback fluid should be provided and an appropriate health risk assessment undertaken.
7. A Health Risk Assessment should be undertaken where no health guidelines are available for chemicals in water.
8. Gross alpha and beta radiation monitoring of process and waste water streams should be conducted and if the radiation levels exceed the exemption levels contained within the *Western Australian Radiation Safety (General) Regulations* the requirements of the *Western Australian Radiation Safety Act 1975* will apply.
9. Proponents should be required to conduct mandatory monitoring of substances present in the hydraulic fracturing process and surrounding waterways and sources at multiple time points (to be specified) after hydraulic fracturing has occurred.
10. Hydraulic fracturing bore design should reflect best practice to prevent contamination of groundwater.
11. Operators should be subject to compulsory competency and compliance auditing. (DMP).
12. Drill cuttings should be subject to controlled waste disposal (DER).
13. International best practice should be used for the storage and disposal of hydraulic fracturing fluids.

14. Exclusion zones should be created around well heads, to ensure adequate separation between hydraulic fracturing operations and water supplies intended for human consumption.
15. Any (beneficial) water re-use should be subject to NHMRC *Phase 1 Recycled Water Guidelines*.
16. Provision should be made for the adequate sealing of bores and containment of waste flowback and process water.
17. Closure of hydraulic fracturing sites should be subject to the implementation of post closure management plan which includes a requirement for ongoing monitoring of closed site.

References

EPA, WA 2005 *Guidance for the Assessment of Environmental Factors (Separation Distances between Industrial and Sensitive Land Uses) No. 3* EPA June 2005.
http://www.epa.wa.gov.au/docs/1840_GS3.pdf

Haluszczak, A., Rose, W. & Kump, L. (2013). Geochemical evaluation of flowback brine from Marcellus gas wells in Pennsylvania, USA. *Applied Geochemistry*, vol. 28, pp. 55-61.
Legislative Assembly, Education and Health Standing Committee, 2007, *Inquiry into the Cause and Extent of Lead Pollution in the Esperance Area*. Legislative Assembly, Parliament of Western Australia, Perth.

WA Department of Water (2010). *Draft approval framework for the use of non-drinking water in Western Australia. Urban developments*. Government of Western Australia.
<http://www.water.wa.gov.au/PublicationStore/first/95272.pdf>

WA Department of Water (2013). *Drinking Water*. Government of Western Australia. Accessed <http://www.water.wa.gov.au/Managing+water/Drinking+water/default.aspx>