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(On behalf of our children Emma, Rebecca and Jack Digby and our
grandchildren Tyrell, Izaya and Kyden Thomas)

Date: 15/03/2018

Submission to:
WA Scientific Inquiry into Hydraulic Fracture Stimulation in WA

We are landowners of a special rural lot located in the last remaining tuart forest in the world, in the south west of WA. We moved from Perth to this area to raise our family, as it offered the opportunity to live in a semi-rural environment, surrounded by local flora and fauna, access to clean ground water and untainted soil for our organic gardening.

We live in a prime agricultural and tourist district that relies heavily on ground water to maintain these industries. We are not connected to or do we have access to scheme water. We are dependent on ground water supplies for drinking and running our home, sustaining our organic garden, fruit trees, chooks and ornamental gardens.

We are extremely concerned by the potential onshore gas industry mining in this area; the amount of water used in the gas extraction (fracking) process, the toxicity of the chemicals used and mining by-product management, well integrity and documented well failures and the gas industry's lack of credibility. We are extremely concerned at the risks of contamination to our ground and surface water, the impact on our air and soil quality and the long-term health impacts to residents, local animals and environment (*Finkel et al. 2013; Goldstein et al. 2012; Saberi 2013; Witter et al. 2013*)

Our direct experience with the Petroleum and Gas Industry primarily involves a company previously known as Unconventional Resources Pty Ltd, now known as Bunbury Energy Pty Ltd. In October 2017, this company was granted a new lease to explore around Capel, Dardanup, Boyanup, Donnybrook and surrounds (including parts of the Cities of Bunbury and Busselton). The license covers 56% of our local shire of Capel.

According to their website, Bunbury Energy is proposing an exploration program targeting conventional onshore gas deposits. However the geology is tight sandstone and limestone in this area. We are informed by 'The Government of Western Australia Department of Mines and Petroleum; *Petroleum Information Sheet - Natural gas from shale and tight rocks*,' that fracking is required to extract the gas in this geology.

(<http://www.dmp.wa.gov.au/Documents/Petroleum/PD-SBD-NST-103D.pdf>)

"Shale and tight gas requires hydraulic fracture stimulation (fracking) to create fractures (cracks) in the gas-bearing rocks to create a path for the natural gas to flow at commercially viable rates"

The Department of Mines and Petroleum (DMP) is responsible for regulating extractive industries in Western Australia; ensuring safety, environmental practice and resource management meet relevant legislation, regulations, guidelines and policies that reflect community expectations. DMP regulates onshore petroleum and geothermal activities through the Petroleum and Geothermal Energy Resources Act 1967; the Petroleum Pipelines Act 1969, the Petroleum (Submerged Lands) Act 1982 and associated regulations. It has a range of information sheets on it's website.

These information sheets reinforce our drive to put forward our concerns with regard to this industry and unconventional gas mining. A public meeting at the Capel Town Hall in 2016, held for residents to meet with energy companies with interests in our area, was most unsatisfactory, raising our concerns and desire to research this subject for our selves.

We have sourced documentaries, information and a comprehensive list of scientific peer reviewed journal articles and references so we can better understand the impact of onshore gas mining. Our own research together with access to this scientific information has prompted us to write this submission.

We have read scientific papers and case studies on the fracking industry in Canada, North America, Europe and Australia (Queensland) many referenced from the following sites:

- *The Physicians Scientists and Engineers for Healthy Energy.*
They maintain a citation database on shale and tight gas development which provides an exhaustive and evolving list of bibliographic information, abstracts and links to vetted scientific papers and peer reviewed articles
The Physicians Scientists and Engineers for Healthy Energy: Study Citation Database on Shale and Tight Gas Development – 1400 papers:
https://www.zotero.org/groups/248773/pse_study_citation_database/items
- The New York based health organisation *Concerned Health Professionals of New York* compilation of 900 papers (*Compendium of Scientific, Medical, and Media Findings demonstrating Risks and Harms of Fracking*)
- *The Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking* (the Compendium) is a fully referenced compilation of the evidence outlining the risks and harms of fracking. It is a public, open-access document that is housed on the websites of *Concerned Health Professionals of New York* (www.concernedhealthny.org) and *Physicians for Social Responsibility* (www.psr.org).

In our submission, we will be presenting the case for a permanent ban on the use of hydraulic fracturing for gas extraction in WA. Fracking poses an irreversible and serious risk to people and our environment. There are risk factors that operate cumulatively on many levels. We do not believe it possible for environmental regulation to be able to prevent the threat of serious irreversible harm to our water, air and land resources.

In our submission we will cover these main points:

- Gas wells use excessive amounts of water infused with numerous toxic chemicals that are harmful to the environment
- Gas wells leak and contaminate the air, water and soil
- Lack of integrity or transparency by the gas industry
- 98.7% community support for Stratham to remain gas field free

1. Water Use

Fracking is a water intensive mining method. The Australian gas industry provides a figure of 11 million litres per shale or tight gas frack. Each well can have up to 10 fracks per well life. Other sources suggest that water use is often much higher. According to a 2013 UN report (*Can we safely squeeze the rocks / Environmental Development 6 (2013) 86–99*) http://www.grid.unep.ch/products/3_Reports/gas_fracking_article.pdf a single frack operation on a shale gas well will use between 11 and 34 million litres of water. Drilling a shale or tight gas well also requires around 1 million litres per well.

Tight gas requires 100 times more water than Conventional Gas, and shale gas between 2000 and 10000 times compared with conventional gas exploitation (IEA, 2012). Although water can be recycled, excessive water usage can have broad and serious negative impacts (IEA, 2012) on biodiversity and local ecosystems, while lowering the water table, resulting in reduced availability of water for use by local communities and agriculture.

In the paper *Vogwill R., 2017 Western Australia's Tight Gas Industry - A review of groundwater and environmental risks.*, Dr. Vogwill states “We are working towards a sufficient level of understanding of the geology, hydrogeology, groundwater dependent ecosystems and their links to social values to manage the existing groundwater use in the northern Perth Basin. The increase in water required for a tight gas industry amplifies this issue. There is also the risk of local to regional scale impacts to water quality. The Canning Basin, in particular, is only just starting to be understood in this context”.

Withdrawals for hydraulic fracturing can directly impact drinking water resources by changing the quantity or quality of the remaining water. Local impacts on drinking water quantity have occurred in areas with increased hydraulic fracturing activity. (*Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States - EPA-600-R-16-236ES December 2016* www.epa.gov/hfstudy)

The Western Australian Water Authority (WAWA) indicates that approximately 50% of Perth’s drinking water and over 60% of the south west’s drinking water is derived from underground water sources. In February 2018 WAWA announced runoff into the dams supplying Perth and its surrounds has been reduced to 20% p.a. of the volume prior to the year 2000. WA already has threatened water security. It would be grossly irresponsible and negligent to

allow the gas industry to utilise the amount of water required to complete its fracking processes.

2. Waste water and contamination

A typical shale gas well can produce wastewater volumes from 300 – 4500 litres (*Bill Chameides “Natural Gas, Hydrofracking and Safety: The Three Faces of Fracking Water” National Geographic September 20, 2011*)

The wastewater from fracking may contain heavy metals, salts, radioactive materials and volatile organic compounds (*excerpts from the Fifth Edition of the Compendium, focused on water contamination*)

Benzene, Toluene, Ethylbenzene and Xylene (BTEX) are found naturally in gas deposits and associated ground water. Whilst prohibited for use, they can be released through the process of fracking. There are two potential exposure sources to BTEX from hydraulic fracturing: 1) use of BTEX in fracking fluids, and 2) fracturing through hydrologic confining layer and creating of a hydraulic communication between the coal seam and underground aquifers used for groundwater.

<https://www.ehp.qld.gov.au/management/coal-seam-gas/pdf/btex-report.pdf>

In Australia, BTEX chemicals have been found in 5 out of 14 monitoring wells at Arrow Energy’s gas fields near Dalby Queensland. Benzene was detected at 6 to 115 times the Australian drinking water standard (*media release ‘Arrow Advises of Monitoring Results, 26th August 2011*). This is highly concerning.

In the *Environmental Public Health Dimensions of Shale and Tight Gas Development* Seth B. Shonkoff, Jake Hays, and Madelon L. Finkel <http://dx.doi.org/10.1289/ehp.1307866> the paper states “an increasing body of studies suggest water contamination risks exist through a variety of environmental pathways, most notably during wastewater transport and disposal and via poor zonal isolation of gases and fluids due to structural integrity impairment of cement in gas wells”.

In the state of Pennsylvania in the United States of America, more than 240 drinking wells have been contaminated or dried up as the result of drilling and fracking operations over a 7 year period. There has been widespread water contamination in 550 samples throughout the heavily drilled Barnett Shale region in Northern Texas (Hildenbrand, Z.L., Carlton, D.D., Fontenot B.E., Meik, J.M., Walton J.L., Taylor, J.T., ...Schug, K.A., *A Comprehensive Analysis of Groundwater Quality in The Barnett Shale Region* Environ. Sci. Technology DOI: 10.1021/acs.est.5b01526 • Publication Date (Web): 16 Jun 2015)

In Western Pennsylvania, a team of researchers looked at sediments in the Conemaugh River watershed downstream of a treatment plant that was specially designed to treat fracking wastewater. The researchers found contamination for many miles downstream with fracking-related chemicals that included radium, barium, strontium, and chloride, as well as endocrine-disrupting and carcinogenic compounds. The peak concentrations were found

in sediment layers that had been deposited during the years of peak fracking wastewater discharge. Elevated concentrations of radium were detected as far as 12 miles downstream of the treatment plant and were up to 200 times greater than background.

Some stream sediment samples were so radioactive that they approached levels that would, in some U.S. states, classify them as radioactive waste and necessitate special disposal.

Burgos, W. D., Castillo-Meza, L., Tasker, T. L., Geeza, T. J., Drohan, P. J., Liu, X., ... Warner, N. R. (2017). *Watershed-scale impacts from surface water disposal of oil and gas wastewater in Western Pennsylvania*. *Environmental Science & Technology*, 51(15), 8851–8860. doi: 10.1021/acs.est.7b01696
Johnston, I., (2017, July 12). *Fracking can contaminate rivers and lakes with radioactive material, study finds*. *The Independent*. Retrieved from <http://www.independent.co.uk/news/science/fracking-dangers-environment-waterdamage-radiation-contamination-study-risks-a7837991.html>

Between 40 – 70% of fracking fluid is not recovered. It is apparent that water contamination is an unavoidable risk with fracking.

3. Fracking chemicals risks

In Western Australia, all chemicals to be used need government approval. The National Industrial Chemicals Notification Assessment Scheme (NICNAS) has assessed only 2 of the 23 ‘fracking’ chemicals commonly used, and neither in regard to CSG and fracking.

Little is known about the synergistic effects of these chemicals in high pressure high temperature environments. Many chemicals have not been assessed for their long-term impacts on the environment and human health. (Lloyd-Smith, MM & Senjen, Rye, *Hydraulic Fracturing in Coal Seam Gas Mining: The Risks to Our Health, Communities, Environment and Climate*, National Toxics Network September 2011. www.ntn.org.au)

A typical 15 million litre fracking operation would use from 80 – 330 tons of chemicals (*Water Resource Reporting and Water Footprint from Marcellus Shale Development in West Virginia and Pennsylvania* Evan Hansen, Dustin Mulvaney, and Meghan Betcher http://www.downstreamstrategies.com/documents/reports_publication/marcellus_wv_pa.pdf)

One study, based on Pennsylvania Department of Environmental Protection and the Susquehanna River Basin Commission Material Safety Data Sheets for 41 products used in fracturing operations, assessed the chemicals used in fracturing and found that 73% of the products had between 6 and 14 different adverse health effects including skin, eye, and sensory organ damage; respiratory distress including asthma; gastrointestinal and liver disease; brain and nervous system harms; cancers; and negative reproductive effects. Diamanti-Kandarakis E, Bourguignon JP, Giudice LC, et al. *Endocrine-disrupting chemicals: an Endocrine Society scientific statement*. *Endocr Rev*. 2009;30(4) :293–342

Of greatest concern is that no health impact assessment is required for gas fracking under Western Australian legislation, and no baseline health studies are required in communities before fracking is approved. This seems extraordinary given the toxicity of fracking chemicals used and the lack of scientifically based maximum contaminant levels identified. This makes it very difficult to quantify the public health risks. This should be great cause for caution and established before proceeding further with this sort of industry.

4. Well Integrity

According to Schlumberger, one of the world's largest companies specialising in fracking, about 5% of wells leak immediately, 50% leak after 15 years and 60% leak after 30 years. Bruffato, C. (2003) From Mud to Cement – Building Gas Wells *Oilfield Review*, 15 (3) They also state “Failure to isolate sources of hydrocarbon either early in the construction process or long after production begins has resulted in abnormally pressured casing strings and leaks of gas into zones that would otherwise not be gas bearing”.

Dusseault, M.B., Jackson, R.E., & MacDonald, D., *Towards a Road Map for Mitigating the Rates and Occurrences of Long-Term Wellbore Leakage*. Geofirma Engineering Ltd. states in 2014 the University of Waterloo researchers warned that gas seeping from 500,000 well bores in Canada represented threat to environment and public safety due to groundwater contamination, greenhouse gas emissions and explosion risks. 10% of all active and suspended gas wells in British Columbia now leak methane. Some hydraulically fractured shale gas wells are emitting as much as 2000 kilograms of methane per year. Methane is a more powerful greenhouse gas than carbon dioxide – 86 times more powerful when considered over a 20-year timeframe (Howarth, R. W. *Methane emissions and climatic warming risk from hydraulic fracturing and shale gas development: Implications for policy Energy and Emission Control Technologies*, 2015)

In 2016 an interdisciplinary team led by the University of Colorado researchers found methane in 42 water wells in the densely drilled Denver-Julesburg Basin, where horizontal fracking operations began in 2010. Of 42 wells affected 11 had been identified as suffering from ‘barrier failures’ Sherwood, O. A., Rogers, J. D. Lackey, G., Burke, T.L., Osborn, S.G % Ryan, J. N. (2016). *Groundwater Methane in relation to oil and gas development in shallow coal seams in the Denver- Julesburg Basin of Colorado*. Proceedings of the National Academy of Sciences 113 (30).

In 2014, the Council Of Canadian Academies identified inherent problems with well integrity as one of its top concerns about unconventional drilling and fracking. According to one expert panel, “the greatest threat to groundwater is gas leakage from wells from which even existing best practices can not assure long term prevention” *Environmental Impacts of Shale Gas Extraction in Canada*. The Expert Panel on Harnessing Science and Technology to Understand the Environmental Impacts of Shale Gas Extraction

Davies *et al* (2014) reviewed reliable databases of well integrity from around the world and found wells that have had some form of well barrier or integrity failure is highly variable (1.9%–75%). It was concluded that it is not possible to have 0% well integrity failure.

The shale and tight gas deposits in South West WA sit beneath the Leederville and Yaragadee aquifers. Being a major ground water source for this entire area the scientific information would indicate there is a 100% risk of contamination from drilling to access these gas deposits.

The documentation of well failures across the gas fields in Northern America and Canada support the consensus that well integrity is an ongoing risk with major consequences to the environment.

5. Integrity and transparency of the Gas Industry

It is evident that the gas industry wishes us to believe there are no threats or risks that cannot be managed by the industry. However from extensive reading these claims are in direct contradiction with published scientific papers and articles reporting a range of negative impacts that cannot be reversed. Science cannot make accurate health impact predictions without clear disclosure of the industry's processes and chemicals used.

In an excerpt from *Endocrine-disrupting chemicals: an Endocrine Society scientific statement*. Diamanti-Kandarakis E, Bourguignon JP, Giudice LC, Hauser R, Prins GS, Soto AM, Zoeller RT, Gore AC., it states: 'Hydrofracking fluid and flowback fluids contain candidate endocrine disruptors, but because of the lack of disclosure by the drilling companies of the individual chemicals with their unique Chemical Abstracts Service registry numbers used in fracking fluids, it is difficult to truly assess their potential adverse effects, and so the cumulative exposure impact is not known.'

The Australian Petroleum Production and Exploration Association (APPEA) and the Department of Mines, Industry, Regulation and Safety claim:

- Mining for unconventional gas is safe, and the risks known can be managed

On the APPEA website <https://www.appea.com.au/oil-gas-explained/mythbusting/> this page is designed to bust the myths around fracking. Some excerpts from this site are considered below -

“Myth: No one understands hydraulic fracturing (fracking) or knows the chemicals being used.

The facts: Industry and government have a detailed knowledge of the hydraulic fracturing process and of the chemicals being used. The process has been used for more than 65 years in more than 2 million wells around the world. Numerous studies have found that there have been no proven cases of contamination of aquifers...

This statement is in total contrast to the evidence and papers from across the US, Canada and Europe. In the NRDC Issue brief: *Fracking Fumes: Air Pollution from Hydraulic Fracturing Threatens Public Health and Communities* it states:

“At the same time, a growing body of new research points to health threats from unconventional oil and gas development and fracking in particular. Although health discussions, particularly in eastern states, have focused on drinking water contamination, there is mounting evidence for a range of health threats from air pollution as well.”

<https://www.nrdc.org/sites/default/files/fracking-air-pollution-IB.pdf>

Myth: Gas operations cause gas to migrate into waterbores and aquifers outside the gas-bearing rock formations.

The facts: *Gas wells are constructed in a way that ensures there can be no migration of gas to neighbouring bores and aquifers. It is not in the gas companies' interests to allow leakage of gas into aquifers. Such leaks would make it difficult to extract the gas and would reduce the amount of gas available for sale.*

Davies *et al.*, reviewed extensive data regarding well integrity. In the paper *Oil and Gas wells and their Integrity: Implications for shale and unconventional resource exploitation*. *Marine and Petroleum Biology*, 56, 239 – 254 introduction it states:

.... Of the 8030 wells targeting the Marcellus shale inspected in Pennsylvania between 2005 and 2013, 6.3% of these have been reported to the authorities for infringements related to well barrier or integrity failure.....

The companies have been required to address these infringements, indicating gas migration occurred.

Well leakage is a real and documented issue. It is apparent reporting and ongoing maintenance and review is costly, not well regulated and there is a practice of failures and leaks going unrecorded. This paper also states: “The ownership of up to 53% of wells in the UK is unclear; ... estimates that between 50 and 100 are orphaned” Clearly no review and ongoing testing for leaks or well integrity can occur in these circumstances.

It is difficult to see how the APPEA can make these ‘myth busting’ claims. A traditional landowner, Mitch Torres, recounted her experience at a negotiation meeting with a gas company, where the company representatives misled the indigenous people by saying the chemicals used in fracking were similar to those used in jelly beans. The participants had quite a different view about fracking when it was later explained correctly.

It is clear that the Oil and Gas Industry are misleading in their responses and representation of the various products and processes involved in their industry. Their credibility and integrity is highly questionable.

6. Stratham Community Survey

In May and June 2016, 16 local residents formed a voluntary committee to complete a documented door-to-door survey of all Stratham households in the Stratham locality. The survey asked residents over the age of 16 years “Do you want Stratham to remain gas field free?” 98.7% of residents surveyed said yes. This figure shows overwhelming community opposition to the establishment of the onshore gas industry in the locality.

Prior to the survey residents were provided with information about the gas license and onshore mining implications (fracking) in the area through a letterbox drop. Following this there was a community meeting to ensure residents had the opportunity to make an informed response when they were surveyed.

Brunswick, Dandaragan, Greenhough, Cervantes, North Boyanup, Moora, The Vines, Forrest Grove, Stirling Estate, Quedjinup, Caversham East, Leeman, Greenhead, Exmouth, Irwin, Jurien, Carnamah and Chittering have completed the same survey with similar results. Since this time representatives from the south west communities have formed the South West WA Gasfield Free Alliance. This group meets regularly to review developments regarding onshore gas mining, both locally and across the state. It provides updates through extensive networks on these developments. The GFSW WA Alliance committee endorses this submission.

On a broader scale, there are many countries and counties have enacted fracking bans including France; Bulgaria; Romania; South Africa; Germany; the Czech Republic; Argentina; Spain; Scotland; Wales; Northern Ireland and a number of states and counties in the United States of America and Canada. The list is extensive - <https://keptapwatersafe.org/global-bans-on-fracking/> and is evidence of widespread concern with this industry’s practices, impact and culpability.

Conclusion

Our findings from scientific, medical and journalistic investigations leads us to conclude that fracking poses significant threats to air, water, public health and safety, climate stability, community cohesion and long term economic viability. Fracking incurs more risks and long-term damage than benefit to community and environment:

- Regulations cannot prevent harm
- Drinking and ground water can be threatened
- Emissions contribute to toxic air pollution at levels known to have negative health impacts
- Earthquakes and seismic activity are a consequence of drilling and fracking related activities in many locations, notably Groningen (Netherlands), Lancashire (UK) and Oklahoma (USA)
- Drilling and fracking can bring naturally occurring radioactive materials to the surface

- Fracking infrastructure poses serious potential exposure risks to those living nearby. There are inherent engineering problems with wells that worsen with time
- Abandoned and active wells provide pathways for gas and fluid migration
- Stress in communities from noise and light pollution
- Economic instability - inaccurate employment claims, threats to property values and mortgages
- Lack of transparency of gas mining companies
- Lack of veto rights for landholders in relation to unconventional gas development
- No regulatory framework has been shown to adequately protect public health or the environment.

The evidence is overwhelming. We recommend legislation passed by Parliament to permanently ban onshore unconventional gas exploration and extraction, including coal seam gas and fracking to protect the integrity of our aquifers, soil, and air and for the health of our and future generations.

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