THE WILDERNESS SOCIETY

Submission of the Wilderness Society WA Inc.

5 September 2013

REPORT OF THE STANDING COMMITTEE ON ENVIRONMENT AND PUBLIC AFFAIRSREPORT 33: **INQUIRY INTO THE IMPLICATIONS FOR WESTERN AUSTRALIA OF HYDRAULIC FRACTURING FOR UNCONVENTIONAL GAS**

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TERMS OF REFERENCE REFERENCE AND PROCEDURE
Inquiry pursuant to Standing Order 179

At a regularly conducted meeting of the Standing Committee on Environment and Public Affairs (the Committee) held on 7 August 2013, the Committee 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.

The Wilderness Society (WA) Inc. welcomes the opportunity to make a submission to this important and timely inquiry.

We have for several years been very concerned by the stealthy manner in which fracking has been/is being introduced into WA.

In 2011 we asked a volunteer with sound technical knowledge to prepare a report on the impacts and implications of fracking in WA (*"What the Frack"*; see attached updated version).

This was the first real attempt by any non-government organisation in WA to investigate the industry and highlight issues relevant to its operation here.

This led to a series of visits to areas where fracking was starting to occur, e.g. the Mid West, and meetings with local landholders and other concerned residents. These visits and meetings confirmed to us that all our fears were well-founded: local communities were being kept in the dark; clear environmental damage was occurring, for example the destruction of parts of gazetted nature reserves; and the agencies supposedly regulating the incipient industry were nowhere to be seen.

Meetings were also held with departmental officials, including the EPA and DMP, and companies involved in fracking projects.

From there our concern has only grown as the scale of the possible onshore unconventional gas industry in WA keeps growing, at least in terms of industry and government rhetoric.

Some of our key concerns include:

1. The failure of government to carry out any form of broad policy discussion with the WA community as a whole, or individual communities, given the scale and well-documented risks of the industry being proposed;
2. The failure of government to properly inform the public and individual communities of the scale of industrial activity envisaged if fracking proceeds to full production. For example, in the Canning Basin, there would potentially be thousands of separate fracking operations; thousands of production wells; hundreds of kilometres of new roads and tracks; billions of litres of water use, and hundreds of miles of pipelines. Nowhere has this been explained to affected communities, despite politicians talking up the huge potential of the industry in the region;
3. The failure of the state's primary environmental impact assessor, the EPA, to carry out its statutory functions, preferring instead to transfer its responsibilities to bodies like the Department of Mines and Petroleum (DMP) which has a clear conflict of purpose and interest;
4. The conflicted role of Ministers and government departments (DMP) who are both keen promoters of the fracking industry while at the same time assuming responsibility for regulating it in the public interest;
5. The systematic public misinformation produced by DMP and industry groups, starting with the false claim that 'fracking has been happening here for decades (without any problems)'. In fact the type of fracking being done now or proposed is orders of magnitude different from, and more risky than, 'fracking' that was done decades ago;
6. The abject failure of agencies such as the Department of Water, DEC/DPaW and the Department of Agriculture (or their Ministers) to counter pressure from industry and the Department of Mines for large scale fracking in areas that clearly have conflicting land uses and values;
7. The failure to inform, consult with and seek consent from Traditional Owners of areas being considered for large scale fracking operations, e.g. Kimberley/Canning Basin;

8. The serious and potentially irreversible environmental, social and economic impacts and risks of fracking (both individual wells and the entire production field 'footprint') including:
    a. Short, medium and long term pollution of groundwater aquifers, including from guaranteed future well failures;
    b. Overuse and depletion of groundwater;
    c. Land subsidence;
    d. Storage of polluted water in surface ponds which may leak, overflow, flood or otherwise fail;
    e. Pollution of creeks, streams, wetlands and rivers with contaminated water from fracking operations – with implications for freshwater species (see below for example);
    f. Widespread destruction and degradation of natural ecosystems and habitat by works associated with the construction of a network of drill sites, ponds, roads and pipelines;
    g. Spread of dieback and other pests and diseases by fracking machinery and works;
    h. Potential for high levels of fugitive emissions of methane, a highly 'greenhouse intensive' gas, from fracking operations and guaranteed future well failures;
9. The continued, misplaced promotion and subsidising of the fossil fuel industry by the state government despite the availability of the clear and effective alternative: expanding WA's vast solar, wind and other renewable energy sources.

The Wilderness Society believes that WA does not need to proceed down the path of fracking for onshore unconventional gas. The impacts are serious, the risks severe, the consequences irreversible and the safe, sustainable alternatives are clear and available.

Accordingly we recommend that the Committee call for a permanent ban on fracking in WA.

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Attached: "What the Frack" briefing paper
Below: Literature review and articles

Unconventional Gas Literature Review 2013

Water contamination

The risk of water contamination from unconventional gas production is one of the most serious environmental concerns. A report conducted for the European Commission found the risk of contamination to surface waters and groundwater to be high (AEA Technology, 2012). Numerous reports from the US have documented the contamination of water systems surrounding gas developments (Wiseman, 2009; Michaels *et al.*, 2010). Water contamination can potentially occur to both groundwater and surface water systems from fracking fluids, drilling fluids, methane, waste water, and solid wastes. Water contamination could occur due to spills at the surface, leaking of fracking fluids or wastewater from wells and pipes, discharge of insufficiently treated waste water, or direct movement of methane, fracking fluids or wastewaters upwards through the rock body (IEA, 2012).

Well blowouts, where high pressures cause the eruption of wells during drilling, can result in the release of large amounts of drilling/fracking fluids and wastewater into surrounding water systems. In the US, blowouts and resulting water contamination have occurred on numerous occasions (Michaels *et al.*, 2010). For instance in Pennsylvania, a well blowout resulted in the release of nearly one million gallons (3.79 million L) of wastewater which polluted nearby creeks (Michaels *et al.*, 2010). Blowouts have been found to be caused by failures to adhere to appropriate operating guidelines, including failures to maintain sufficient numbers of pressure barriers, failure to test blow-out preventers prior to use, and improper casing of wells (Michaels *et al.*, 2010).

Methane contamination

The over-pressurisation of natural gas in wells has been shown to cause the vertical migration of gas through fractures into overlying aquifers and surface water wells (Michaels *et al.*, 2010). River systems in the US and Australia have been found to be contaminated with methane (Pennsylvania DEP, 2010; DNRM, 2012; Santos, 2012). Such methane contamination can in some cases be linked to inadequately cemented well casings (Michaels *et al.*, 2010), although questions remain about the sources of such leaks in Australia (DNRM, 2012).

Understanding of the local geology and hydrology is needed to assess the potential for methane to travel through the rock body. However, such data are limited, and therefore more local and regional studies are required to assess the risks of methane contamination. The environmental and health impacts of methane contamination are unknown, and also warrant investigation (Jackson *et al.*, 2011).

Water consumption and extraction

Surrounding aquifers and springs could also be affected by the extraction of water from coal beds, but this risk depends on the local and regional connectivity of groundwater systems and remains unquantified (NRC, 2010). Studies in Australia predict that water extraction from coal beds will impact underlying and overlying aquifers, lowering pressure and water levels (Moran and Vink, 2010; WG, 2010). The river systems which depend on the discharge from springs could in turn be impacted by a reduction in water flow (WG, 2010). Threatened ecological communities reliant on spring complexes could also be significantly impacted by CSG operations (WG, 2010).

Soil contamination

Contamination of soils from fracking and drilling fluids and wastewater is also a potentially serious environmental hazard. Soil contamination has been caused by spills of wastewater and fracking fluids, which can contain toxic chemicals, high levels of salts and sodium, and other organic compounds (Santos, 2012; IEA, 2012). Contamination of soils has also occurred through the common practice of using evaporation ponds to store waste water in Australia and the associated seepage of chemicals into soils (Batley and Kookana, 2012).

Land clearing and habitat disturbance

Unconventional gas developments can impact habitats and biodiversity through the direct clearing of land, habitat fragmentation, the potential spread of invasive species, and an increased risk of fire (Williams *et al.*, 2012). Unconventional gas developments have a larger scale of industrial operation and land use compared to conventional gas (IEA, 2012). Access roads, pipelines, wells and other infrastructure require the clearing of large tracts of land (Williams *et al.*, 2012). Unconventional gas requires a large number of drilling wells, with often more than one well per square kilometre, compared to less than one well per 10 square kilometres for conventional gas developments (IEA, 2012). In CSG operations wells may be as close as 200 m apart in a grid-like pattern, connected by roads and pipelines (Williams *et al.*, 2012). An analysis of gas developments in the Marcellus Shale in the US found nearly 3.6 ha per well pad of land were required, with an additional 8.5 ha of indirect edge effects (Johnson, 2010). A US study found that pipeline construction was the major contributor to forest loss and fragmentation, as well as a large increase in edge effects (Slonecker *et al.*, 2012).

Reports looking at the impacts of habitat loss from gas developments have stated that disturbance on local ecosystems is likely to have a long-term detrimental effect, as the installation of infrastructure means there is little chance of habitat recovery (Slonecker *et al.*, 2012).

Air pollution

Air pollution from volatile chemicals and substances during unconventional gas production may pose environmental risks (Poole, 2012). A report conducted for the European Commission found the overall risk of air pollution across all phases of operation to be moderate (AEA Technology, 2012). Air pollution can occur from the flaring of wells to release excess gas (Poole, 2012), or from equipment such as drilling engines, pump engines, and compressors, and from very heavy vehicle use (IEA, 2012; Williams, 2012). Toxic chemicals can also be released from fracking fluids or wastewater (AEA Technology, 2012). For instance, aeration of wastewater impoundments can release toxic chemicals into the air (Bamberger and Oswald, 2012).

Potential air pollutants, aside from greenhouse gases, identified in the US include hazardous BTEX chemicals, butane, hydrogen sulphide, polycyclic aromatic hydrocarbons, propane, and particulate matter (Poole, 2012). In the US, several emissions inventories have shown that gas operations caused local air pollution, with increased levels of hazardous air pollutants (Clark *et al.*, 2012). A US study found concentrations of hydrocarbons around unconventional gas developments, including benzene, were higher than the majority of EPA air toxics monitoring sites, including urban sites (McKenzie *et al.*, 2012). Within areas of gas development operations, average concentrations of hydrocarbons, such as BTEX chemicals, were most elevated around wells (McKenzie *et al.*, 2012). The potential air pollutants in Australia would be similar to the US, but will depend on the chemicals used, chemicals present in wastewater, and the equipment used.

Recommendations

- The full disclosure by industry of all chemicals used, their health impacts and safety regulations, which is essential to assessing potential impacts of contamination to surrounding ecosystems;
- Assessments of the composition and quality of waste and produced water, including concentrations of heavy metals, sulphates and salts, which is needed to understand the risks of contamination and wastewater/produced water discharge;
- Studies into the chemical interactions in waste and produced waters, which can result in the transformation or release of other chemicals or compounds;
- Ecotoxicological studies to assess the full impacts of chemical contamination of aquatic ecosystems, which will allow for an assessment of cumulative impacts;
- Analysis of the causes and risks of methane seepage and the associated water contamination, soil contamination and diffuse greenhouse gas emissions;
- Studies into the contamination risks and impacts of reinjection of waste water underground;
- Studies into the environmental impacts from soil contamination, from methane seepage and from spilled chemicals/waste products;

- Better methods and modelling for quantifying the greenhouse gas footprint of unconventional gas, particularly focusing on fugitive emissions;
- Monitoring of air quality and emissions in areas surrounding gas projects;
- Documentation of health impacts in surrounding communities exposed to contaminated water, soils or air pollution, and investigations into the links to unconventional gas developments.

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Fracking chemical leak kills threatened fish

http://www.newscientist.com/article/mg21929332.300-fracking-chemical-leak-kills-threatened-fish.html#.Uifwqj-K8cY

- **04 September 2013** by **Michael Marshall**
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A THREATENED fish has been fracked to within an inch of its life. Chemicals used in the controversial extraction process spilled into a river in 2007, killing off the local population of the vulnerable *Blackside dace*.

Fracking is a way of extracting natural gas by pumping a cocktail of chemicals underground to crack open shale rock, releasing the gas trapped within. One of the reasons it is controversial is because of concerns that the chemicals might contaminate drinking water, although the evidence for this is weak. In all the kerfuffle, little attention has been paid to fracking's effects on ecosystems.

Yet, in May and June 2007, fracking chemicals leaked into a 2-kilometre stretch of Acorn Fork Creek in Kentucky. The chemicals were being stored in surface pits, which overflowed. The creek turned acidic and all visible life forms died.

"This may be the first report of effects on aquatic biota," says Diana Papoulias of the US Geological Survey, who investigated the incident with Anthony Velasco of the US Fish and Wildlife Service in Frankfort, Kentucky. They examined 45 fish from the polluted stretch, belonging to two species, and found severe gill lesions. Moving healthy fish into the leak zone caused them to develop lesions within hours (*Southeastern Naturalist*, vol 12, p 92).

Acorn Fork Creek is one of the few remaining habitats for blackside dace. Papoulias couldn't find any alive in the worst-affected stretch. Dace in neighbouring regions were clearly distressed: they were moving slowly, rocking back and forth just beneath the surface.

As fracking often takes place in remote areas, it's unclear how frequent such events are. "This accident was not reported by the company," says Papoulias, "but by a resident who noticed the water turned red and fish had died."

Op-Ed Contributor

Gangplank to a Warm Future

http://mobile.nytimes.com/2013/07/29/opinion/gangplank-to-a-warm-future.html?emc=edit_tnt_20130728&tntemail0=y

New York Times

By ANTHONY R. INGRAFFEA

July 28, 2013

ITHACA, N.Y. — MANY concerned about climate change, including President Obama, have embraced hydraulic fracturing for natural gas. In his recent climate speech, the president went so far as to lump gas with renewables as "clean energy."

As a longtime oil and gas engineer who helped develop shale fracking techniques for the Energy Department, I can assure you that this gas is not "clean." Because of leaks of methane, the main component of natural gas, the gas extracted from shale deposits is not a "bridge" to a renewable energy future — it's a gangplank to more warming and away from clean energy investments.

Methane is a far more powerful greenhouse gas than carbon dioxide, though it doesn't last nearly as long in the atmosphere. Still, over a 20-year period, one pound of it traps as much heat as at least 72 pounds of carbon dioxide. Its potency declines, but even after a century, it is at least 25 times as powerful as carbon dioxide. When burned, natural gas emits half the carbon dioxide of coal, but methane leakage eviscerates this advantage because of its heat-trapping power.

And methane is leaking, though there is significant uncertainty over the rate. But recent measurements by the National Oceanic and Atmospheric Administration at gas and oil fields in California, Colorado and Utah found leakage rates of 2.3 percent to 17 percent of annual production, in the range my colleagues at Cornell and I predicted some years ago. This is the gas that is released into the atmosphere unburned as part of the hydraulic fracturing process, and also from pipelines, compressors and processing units. Those findings raise questions about what is happening elsewhere. The Environmental Protection Agency has issued new rules to reduce these emissions, but the rules don't take effect until 2015, and apply only to new wells.

A 2011 study from the National Center for Atmospheric Research concluded that unless leaks can be kept below 2 percent, gas lacks any climate advantage over coal. And a study released this May by Climate Central, a group of scientists and journalists studying climate change, concluded that the 50 percent climate advantage of natural gas over coal is unlikely to be achieved over the next three to four decades. Unfortunately, we don't have that long to address climate change — the next two decades are crucial.

To its credit, the president's plan recognizes that "curbing emissions of methane is critical." However, the release of unburned gas in the production process is not the only problem. Gas and oil wells that lose their structural integrity also leak methane and other contaminants outside their casings and into the atmosphere and water wells. Multiple industry studies show that about 5 percent of all oil and gas wells leak immediately because of integrity issues, with increasing rates of leakage over time. With hundreds of thousands of new wells expected, this problem is neither negligible nor preventable with current technology.

Why do so many wells leak this way? Pressures under the earth, temperature changes, ground movement from the drilling of nearby wells and shrinkage crack and damage the thin layer of brittle cement that is supposed to seal the wells. And getting the cement perfect as the drilling goes horizontally into shale is extremely challenging. Once the cement is damaged, repairing it thousands of feet underground is expensive and often unsuccessful. The gas and oil industries have been trying to solve this problem for decades.

The scientific community has been waiting for better data from the E.P.A. to assess the extent of the water contamination problem. That is why it is so discouraging that, in the face of industry complaints, the E.P.A. reportedly has closed or backed away from several investigations into the problem. Perhaps a full E.P.A. study of hydraulic fracturing and drinking water, due in 2014, will be more forthcoming. In addition, drafts of an Energy Department study suggest that there are huge problems finding enough water for fracturing future wells. The president should not include this technology in his energy policy until these studies are complete.

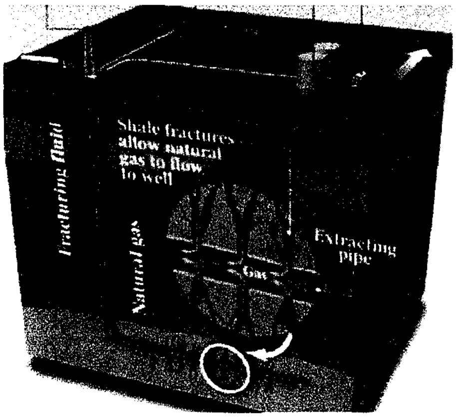
We have renewable wind, water, solar and energy-efficiency technology options now. We can scale these quickly and affordably, creating economic growth, jobs and a truly clean energy future to address climate change. Political will is the missing ingredient. Meaningful carbon reduction is impossible so long as the fossil fuel industry is allowed so much influence over our energy policies and regulatory agencies. Policy makers need to listen to the voices of independent scientists while there is still time.

Anthony R. Ingraffea is a professor of civil and environmental engineering at Cornell University and the president of Physicians, Scientists and Engineers for Healthy Energy, a nonprofit group.

What the Frack?

The threat of fracking and onshore unconventional gas in WA

Briefing Paper - January 2012



Hundreds of tons of chemical mixed with water are forced at extreme pressures to fracture underground rock formations and release gas

What is Unconventional Gas?

"Unconventional gas" refers to methane[1] gas deposits that until now have been either technically unrecoverable or economically unviable. Typically, 'unconventional gas' is onshore gas deposits trapped within deep geological formations with very low permeability, and often contained within shale rock, coal deposits or tight sandstone. These gas deposits require expensive, technical drilling operations and 'fracture stimulation' (or 'fracking') to extract gas at a viable rate.

Today's high domestic gas prices and global demand for energy has caused a boom in exploration and production of onshore unconventional gas worldwide.

WHAT IS.....

Coal Seam Gas?

Coal seam gas (CSG), also known as coal bed methane (CBM), is methane which has been absorbed into the solid matrix of the coal deposit. Coal seam gas is distinctly different from other gas deposits as the gas is actually in a near liquid state lining the inside of pores within the coal. 'Free' gas can also be stored within natural open fractures within the coal, called 'cleats'. Coal seams typically occur at depths of 500 – 1500m.

In most cases, to extract gas from coal requires drilling into the coal deposit, then drilling horizontally along it, then hydraulically fracturing ('fracking') the coal to create fissures through which the methane can escape into the well bore. Not all CSG wells require fracking; simply dewatering of the coal seam can sufficiently de-pressurise the gas allowing it to migrate into the well.

Underground Coal Gasification (UCG) is another method of extracting methane from coal. This is a process by which oxidants are pumped into the coal seam via an injection well; the coal is then set on fire and burned underground at temperatures of up to 1500 degrees Celsius. The gas is extracted via a second 'production' well. Fracking is often used to increase the flow of gas between the injection well and the production well.

Shale Gas?

Shale gas is methane trapped within shale rock formations. The gas is absorbed into the organic material in the shale rock. Shale formations which hold commercial quantities of gas usually have a high organic content (0.5 – 25%). Shale rock formations in Western Australia usually occur at depths of 1500 – 4000m.

Shale rock has very low permeability, so in order to extract the gas, the shale formation also requires horizontal drilling into the shale and fracking to create a viable rate of gas flow. All shale gas wells require fracking.

Tight Gas?

Tight gas refers to methane gas trapped between the fine grains of 'tight' sand formations (sandstones). As with shale gas, gas absorbed and trapped within tight sand formations requires fracking to increase the permeability of the formation and release the gas to allow it to flow into the wellbore at a viable rate. Some tight gas wells flow quite a lot of gas for a short period of time when first drilled, but all tight gas wells will require fracking to release gas at a sustained and viable rate.

WHAT IS HYDRAULIC FRACTURING?

Hydraulic fracturing - 'fracking', 'fraccing'. 'hydrofracking' or 'hydraulic stimulation' - is the process used to create fractures and fissures in source rock formations that hold unconventional gas such as coal seams, shale and sandstone. In most cases, a well is drilled vertically down to the target formation, then horizontally through the formation. Small explosive charges are then set off at intervals along the horizontal section to make a series of small cracks in the target formation. Multiple horizontal wells can be drilled from the main vertical section of the gas well. Multiple layers of shale and tight formations can be drilled into and fracked from the main well.

A typical single shale/tight gas frack in WA requires a mixture of approximately 5 million litres of water and approximately 25,000 litres of chemicals (conservative estimate based on chemical additives of 0.5%; most 'slick-water frack fluid' mixes consist of 0.5% to 2% chemical additive)[2] to be pumped at extremely high pressure (15,000psi) into the well to fracture the formation through the cracks generated by the explosive charges. The fractures in the rock are then kept open with a 'proppant' (grains of sand or ceramic beads) that are introduced to the fracturing fluid.

On average, a shale gas well requires up to 15 fracks (3 lateral wells drilled horizontally from the main vertical well, with 5 frack stages per lateral) in order to produce gas at a viable rate of sustained production. Some wells in the US are undergoing much larger fracking operations as the industry grows. The largest fracking operation to date (in the US) consisted of 274 fracks over a 111 day period requiring an unknown, but huge, volume of chemicals.[3]

Hundreds, or possibly thousands, of wells are needed to develop an unconventional gas field – as seen here in the USA. Onshore unconventional gas developments turn wilderness areas and prime farmland into full blown industrial wastelands.

WHAT ARE THE ENVIRONMENTAL CONCERNS?

Underground Water and Fracking

To drill and fracture a well is an extremely water intensive process. The Department of Mines and Petroleum WA (DMP) recently revealed that a single frack in WA will use, on average, 5 million litres of water. A further 4 million litres of water is used to drill the well. All up, an average shale or tight gas well will use approximately 30million litres of water. This applies unnecessary stress on the dwindling groundwater resources that WA's natural environment, agriculture and communities rely on.

Fracking operations currently being undertaken in the Perth Basin – without EPA assessment - are all directly below the Yarragadee and Parmelia aquifers, putting South West WA's most valuable water resources at risk.

The DMP has assured the public that there is no risk to our aquifers from hydraulic fracturing of shale or tight formations as the formations in WA are of "great depth"[4]. However, WA's shale and tight formations are the same depth as those in the US that are causing major problems.[5] Studies showing evidence of groundwater gasification due to exploration and development of shale and tight formations in the US are based on formations that occur at similar depths to formations in WA.

Chemicals commonly associated with fracking include hydrochloric acid, benzene, toluene, xylene, formaldehyde, aldehyde, polyacrylamides and chromates. Of 23 commonly used fracking chemicals used in Australia, only TWO have been assessed for safety by the Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS)[6]. Many of the commonly used chemicals associated with fracking are known carcinogens. Recently, benzene, toluene and xylene have been banned for use in fracking in some parts of Australia. These three chemicals are, however, naturally present in coal seams and shale and are released when fracking of any hydrocarbon bearing formation occurs. Simply banning the use of these chemicals in fracking does nothing to control their release into the environment. Many other chemicals are used in fracking but the companies are not required to disclose exactly which chemicals or in what concentrations.

Radioactive material – in the form of Radium 226 - is also present in shale and coal seams. Fracking wastewater in the US has been found to have up to 32,000 times more radionuclides than drinking water standards allow[7, 8]. Fracking can release these chemicals and radioactive material into the environment including groundwater drinking supplies.

The three most common ways in which contaminated frack fluids and/or gases can make their way into our groundwater are:

- Migration of fluids/gases through small existing underground fault systems
- Migration of fluids and gases along the outside of the gas well casings
- Leaching of surface wastewater ponds into shallow aquifers[9].

Before any wells are drilled companies conduct 3D seismic surveys of the underground geology to find the layers of gas bearing formations and find the best places to conduct drilling and fracking. 3D seismic surveys are also used to find geological fault systems. Companies try to avoid fracking too close to fault systems. However, the very best 3D seismic survey data cannot find all faults, in fact, about 20% of all minor fault systems are not detected by seismic survey.

Internal government documents recently obtained by The Wilderness Society WA include an assessment of aquifer connectivity surrounding a proposed fracking operation 250km north of Perth. The internal assessment states that, *"the hydraulic properties along the faults in the area are difficult to assess as* ***specific investigations have not yet been undertaken*** *however, where permeable strata are juxtaposed across a fault there could be groundwater flow between aquifers."*

The proposed fracking operation, which is in the middle of a gazetted nature reserve, is 'estimated' to extend to within 150m of a major fault – the Peron Fault. The EPA chose not to assess this proposal.

To produce all recoverable gas from an unconventional gas field, hundreds, or maybe even thousands of wells need to be drilled. The more wells that are drilled in an area the greater the likelihood of a well intersecting an undetected fault system. For companies to continue economically viable operations, they need to continue drilling hundreds of wells, as wells only flow at viable rates for 5-10 years, with peak flow occurring in the first 1-3 years.

The risk of gas and fluid migrating along the outside of well casings also increases as multiple fracking operations can intersect existing fracked wells. In the Barnett shale region in the US, 7,931 wells were drilled from 2000 to 2008[10]. This "fracking frenzy" is indicative of the way unconventional gas fields are developed. The DMP has promoted a US style 'fracking frenzy for Western Australia.[11]

3D seismic survey tracks scar WA wilderness

It is also common for gas companies to dispose of huge volumes of wastewater by injecting it deep underground at high pressures. This practice could result in migration of wastewater through fault systems.

Casings that are designed to protect groundwater from contamination are likely to, and in fact do, corrode over time. A senior officer of DMP recently told a stakeholder reference group meeting held at the EPA offices in Perth that we need not worry about the likelihood of failure of abandoned gas wells due to casing corrosion because "well casings do not corrode, they are good for a lifetime - up to 100 years".

This is an entirely rhetorical statement. In fact, casing corrosion is a common problem in the petroleum industry.

For example, a conventional oil well – Hovea 8 - in the northern Perth basin, operated by Origin Energy, had to be 'shut in' earlier this year due to casing corrosion during production.[12] This well had only been in operation for 8 years and was not subject to the high pressures of fracking or high volumes of unknown chemicals used in the fracking process.
In WA, nobody is held responsible for failure of abandoned wells. Future generations will be left with this legacy.

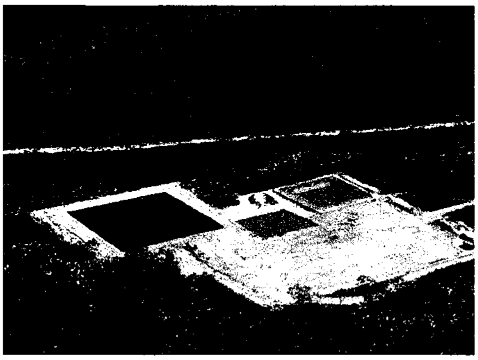
Surface water contamination and fracking

Fracking operations in WA are currently been undertaken – without EPA assessment - on prime farmland and within the water catchments of internationally and nationally significant wetlands, major river systems and Kimberley floodplains. All WA fracking operations are within the state's declared *'Water Resource Areas'*. [13, 14]

Huge volumes of chemicals, fuel, and wastes need to be kept on-site during drilling and fracking operations. Spills of up to 500L do not need to be reported under Western Australian legislation.

Drilling waste in WA does not need to be stored in plastic lined ponds, instead it is usually kept in earthen 'evaporation ponds.' Conventional oil and gas exploration drilling uses fine bentonite clay as a drilling lubricant. However, shale/tight gas exploration drilling requires the use of synthetic chemical drilling fluid additives as clays 'damage' the shale/tight formation and inhibit gas flows.

Drilling additives being used in WA right now are proven to cause eye, skin and respiratory irritation as well as central nervous system effects. Shale 'cuttings' bought to the surface during drilling can contain high levels of Radium 226.



Fracking wastewater is typically stored in open, plastic lined wastewater ponds. Large quantities of fracking wastewater also come to the surface through routine venting and flaring during flow testing of the well. The 'flare pit' is earthen, just like the drilling waste pond. It is usually not until the flare pit is completely filled that it overflows into the fracking wastewater pond. Fracking wastewater is left to seep into surrounding soils of the flare pit. Both the drilling waste pond and the fracking wastewater pond are generally designed to hold the estimated volume of waste water that will be recovered from the well. Unforseen high rainfall events can result in overflow of these wastewater storage ponds.

WA's first dedicated shale gas well – north of Perth in our famous 'wildflower country' -with an unlined drilling waste pond.

Waste water treatment and disposal

Most water treatment facilities are not designed to handle fracking wastewater due to the chemical additives in the fluid and also due to the huge volumes of wastewater generated by fracking. Wastewater from fracking is often left in large ponds to eventually evaporate. This also causes release of toxins into the atmosphere as some of the chemicals in the wastewater 'off-gas'.

Another common way companies dispose of huge volumes of wastewater is by injecting the waste at high pressure deep into the ground. The Department of Mines and Petroleum (DMP) recently announced that they support this method of wastewater disposal. This method of wastewater disposal has resulted in earthquake swarms in the US state of Arkansas. (see below)

No current method of water disposal deals with the problem of remaining chemicals and radioactive material. Even after evaporation or filtration, chemicals and radioactive material remain and have to be disposed of – probably by burial. The world's best transportable industrial water filtration system recently released for use by the unconventional gas industry in the US does not treat water to a standard that can be released safely into the environment. Water treated by this system still requires deep injection or evaporation for 'disposal'.[15]

The surface footprint

The surface footprint of unconventional gas starts at the beginning of exploration. Tracks are initially cleared in a grid pattern across the landscape to conduct 2D and 3D seismic surveys to determine where to focus their drilling efforts. If an area is found to have significant gas and is finally developed into a producing gas field, hundreds or even thousands of wells could be drilled and fracked. Each individual well requires up to 35,000 square metres of land to be cleared. In an operating gas field, every well will be connected via piping and every well will require vehicle access. A road plus pipeline easement can be up to about 40m wide.

A gas field eventually ends up resembling a giant pin cushion, with every pin connected to one another by roads and pipes, destroying farmland and fragmenting natural ecosystems to the point of collapse.

Gas mining operations in the Perth Basin are causing the spread of the fungal disease *Phytophthora* – 'dieback' – through gazetted Nature Reserves in WA's iconic 'wildflower country'. Dieback is a soil pathogen which kills native vegetation and can be spread via vehicles and earthmoving works. The Perth Basin is part of an internationally recognised 'global biodiversity hotspot'. WA's Kwongan heathland, an area being targeted by the onshore gas industry, is the second most florally diverse ecosystem on the planet. Dieback is one of the single biggest threats to the biodiversity of Southwest WA.[16]

A huge amount of industrial infrastructure is required to operate a gas field, including central processing plants, compressor stations, site offices, workers camps, equipment storage areas, chemical storage areas, condensate tanks and all-weather heavy haulage transport roads. Gas fields quite literally turn farmland, wilderness areas and regional communities into large scale industrial centres.

Shale formations and radioactive materials

Due to the maturity of shale rock, along with its high organic content, shale can also contain very high levels of radioactive Radium 226. Once removed from its source rock deep in the earth and exposed to water and air, radium starts to decay rapidly and has a half-life of 1600 years. The decay product of radium is radon gas. Radium is over 1 million times more radioactive than the same mass of uranium.[17]

A recent study of fracking wastewater in the US has revealed that wastewater from fracked shale gas wells contains levels of radionuclides 3,200 times higher than US safe drinking water guidelines.[18, 19]

Earthquakes

During the fracking operation, frack fluids can migrate at high pressure into unmapped fault systems and, in effect, liquefy and lubricate the fault, causing the fault (which was previously inactive) to slip and move – thus causing an earthquake. Injection of fracking wastewater deep into the ground at high pressure can also cause earthquakes. Some earthquakes associated with fracking have reached magnitude 4.7 which is strong enough to cause property damage to surrounding communities.

Fracking and associated unconventional gas industry activities have been blamed for earthquake swarms in Blackpool (UK) and Arkansas and Oklahoma in the US. Fracking is highly likely to have caused the earthquakes in Oklahoma and Blackpool.[20, 21] Wastewater injection has been blamed for earthquakes in Arkansas.[22]

Earthquake swarms in a gas field are of great concern. Earthquakes can cause cement well casings to crack and fail in other gas wells, causing further problems of groundwater contamination and gasification.

The industry has known for decades that deep injection of wastewater is likely to cause earthquakes. In the late 1960's the US Army wastewater deep injection well in Denver, was proven to be the cause of thousands of earthquakes,[23] the strongest being in excess magnitude 5. Yet the gas industry still uses deep injection as a primary means of disposal for huge volumes of wastewater, as the issue of wastewater treatment cannot yet be solved.

Unconventional gas – one of the single largest threats to WA's internationally recognised biodiversity

Is unconventional gas a 'clean', 'cheap' energy solution?

Gas produced by fracking shale and tight formations is NOT a clean energy source.

Over their full life cycle, from exploration to end use, shale gas projects are a higher greenhouse gas emitter than conventional gas, and possibly oil or even coal. The main source of emissions which make gas derived from shale / tight formations such a dirty fossil fuel are 'fugitive' emissions of methane (CH^4), plus CO^2 emissions from production, processing, transport and end use.

Studies based on technical data from hydraulic fractured shale gas wells in the US shows that the very high carbon pollution from shale gas developments makes this possibly the world's dirtiest fossil fuel.[24]

Over the average life of shale gas wells, between 3 and 8% of the total production of a well is emitted into the atmosphere as pure methane – one of the world's most potent greenhouse gases. The gas is emitted during well testing, routine venting and from common equipment leaks. Methane is also emitted with flow-back return fluids following the fracking of the well.

Drilling unconventional gas wells is extremely carbon intensive. The Tyndall Centre for Climate Change Research estimates that CO^2 emissions from drilling of shale gas wells amount to 15kg CO^2 per foot drilled from diesel powered engine use alone[25]. In addition, diesel use during the hydraulic fracturing process adds significantly more carbon pollution.[26] On average 110,000 litres of diesel is used to frack a shale or tight formation.

For an average West Australian shale gas well, carbon pollution from drilling and fracturing combined, will likely result in at least 495 tonnes of CO2 emissions per well from diesel engine use alone. Total emissions including gas processing, transport, end use, and fugitive methane emissions will greatly exceed this estimate. Australia currently has no standard methodology to measure fugitive emissions, enabling the gas industry to get away with releasing massive amounts of methane gas into the atmosphere with no standard for measuring or reporting these emissions under current legislation.

Shale and tight gas is not cheap energy either.

A single shale/ tight gas well costs approximately $13million to bring into production.

The WA State Government's draft Energy Strategy[27] is heavily focussed on the development of unconventional gas as WA's next domestic energy source, however this would cost $billions and would further lock WA into a future of buying dirty, carbon-intensive fuel.

Western Australia has access to world-class renewable energy resources that can be developed and brought online at a cost comparable to gas fracking, with a fraction of the environmental impact.

For example, the Verve Energy 10 Megawatt photovoltaic solar project in WA's Midwest will only cost $50 million.[28] New solar technology in Europe has now overtaken conventional photovoltaic solar panels and is producing 24 hour base-load power.[29]

In the United Kingdom, a report recently found that the amount of investment needed to exploit gas reserves – about £32bn – would be enough to build 2,300 offshore wind turbines. It was also found that shale gas supports fewer jobs than renewable energy generation.[30]

As is the case with coal, shale should be viewed as just another dirty fossil fuel source blocking the road to renewable energy.