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Health Effects of Coal Seam Gas - Tara

Please note: some information about individual cases has been deleted from this version of the report, which is intended for public distribution, to ensure those individuals' privacy.

I visited Tara on 11 and 12 October as requested, to undertake a review of individuals who believe their health has been adversely affected as a result of coal seam gas exploration being undertaken in the region. Queensland Health provided the consultation room with the Tara health facility, and also advertised my attendance, and made appointments for those families and individuals who telephoned. In addition, I undertook telephone consultations of 2 individuals who were not able to attend in person. I explained to all attendees that I was collecting information to present a report to Queensland health. I assured them that I would only be presenting the identified the group data, rather than individual case histories, but explained that, because the small numbers involved, it might be possible to identify some individuals from the symptoms described, and hence I could not provide complete anonymity. I have listed in an Appendix to this report the individuals who presented for examination, or telephoned, so that the names could be omitted if the report is to be released to the public.

Health Complaints

I was provided with a questionnaire which has been developed by Queensland Health for use when individuals telephoned the helpline. I used that as a template to provide some structure to my interviews, although I was not constrained by the template. Please find set out below the symptoms reported by the individuals whom I examined.

Common symptoms

- headache - specific comments: all the time now; headaches began around 2005/2006, CT scan normal, diagnosed as migraine; however reported to coincide with gas wells; Endone and tramadol didn't work
- nausea and vomiting
- nosebleeds - descriptions varying from some blood on a handkerchief, some crusting in the nose, through to frank bleeding. Some have been referred to, and are awaiting ENT review.
- irritation of nose, throat and eyes
- Various rashes and sores (a hand infection requiring antibiotic treatment; a diagnosis of school sores, with swabs apparently negative) and ongoing reported redness and cracking over the metacarpo-phalangeal joints of the hand
- a case of asthma, with a reported aggravation with a sulphur smell possibly associated with drilling.
- A complaint of pins and needles in hands and feet, and a complaint that it hurts to walk.

Individuals reported that they can smell gas morning and evening, when they report nostrils and throat burning, particularly when the wind drops. It is also reported that visitors will complain of a smell and irritation to which local residents have apparently become somewhat more tolerant.

Some individuals also complained of an awareness of a low frequency vibration, which was noticeable when they placed their head on a pillow.

A common pattern reported is of improvement in symptoms when away from the area with a recurrence of symptoms on return.

Examination

I undertook an examination of individuals where relevant. In several cases, the nasal mucosa appeared a little inflamed, but I did not see any other evidence of bleeding or crusting of the nasal mucosa. One individual had a papular rash which I was unable to identify. That apart, I was not able to find any objective evidence of the clinical conditions which were reported.

Other Information

Several individuals expressed a lack of confidence at a lack of trust in Queensland Health, and in some cases in local doctors. Some of the residents interviewed feel they have been treated poorly by Queensland Health, and question why results have not been returned. Residents also reported concern about anecdotal information, for example, "people are getting brain aneurysms in the USA". Another individual had become concerned about visitors from outside the area, because of a perception that is now too dangerous.

Locations and utilities

Most homes were located approximately 1-1.2 km from nearest well, and more distant from compressor stations. There were usually several wells in the vicinity, but further away. One examinee told me that the nearest well was drilled two and a half years ago, but symptoms were first experienced six months ago.

In most cases, drinking water was provided rainwater collected from the roof and stored in tanks. One family used to bottled water for drinking. Some families used settled dam water for toilet flushing.

Coal Seam Gas

Coal seam gas (CSG) is the name given to any naturally occurring gas trapped in underground coal seams by water and ground pressure. The most common gas found in coal seams is methane, which is why the term Coal Bed Methane (or CBM) is used interchangeably with CSG. The water, which is under pressure from the weight of overlying rock material, holds the gas in place - when the water pressure is reduced the gas is released. In the extraction (or production) process, the water pressure is reduced when a well is drilled into a coal seam and the water is gradually pumped out of the seam. This allows the gas to flow to the surface in the well. Intrinsic properties of coal as found in nature determine the amount of gas that can be recovered. Once a well has been drilled it becomes the only conduit for gas and water to reach the surface. The two products are separated below ground, with water being transferred to centralised collection and treatment points, and the gas being piped to processing facilities where it is dried, compressed and fed into commercial pipelines.

Gas contained in coal bed methane is mainly methane and trace quantities of ethane, nitrogen, carbon dioxide, and few other gases. Unlike much natural gas from conventional

reservoirs, cabled methane contains very little of the heavier hydrocarbons such as propane or butane, and no natural gas condensate.

Coal seam gas is not novel or unique. Coal seam gas is also released during coal mining, when effective mine ventilation is required to prevent methane reaching explosive levels (5-15%). Thus, coal miners have been, and are regularly exposed to coal seam gas in the course of their work. Despite regular monitoring of the health of coalminers both in Queensland and internationally, no health effect from potential exposure to methane has been recognised.

What are the main health hazards associated with breathing in methane?

Methane is not toxic below the lower explosive limit of 5% (50000 ppm)[1]. However, when methane is present at high concentrations, it acts as an asphyxiant. Some closely related aliphatic hydrocarbons (propane, butane and isobutane) which may be present in trace quantities may be weak cardiac sensitizers in humans following inhalation exposures to high concentrations (greater than 5% for isobutane and greater than 10% for propane).

Methane gas is not a skin irritant. Methane gas does not irritate the eyes. Harmful effects are not expected following long-term exposure. Methane does not accumulate. Methane is not expected to cause cancer.

Hydraulic fracturing - fracc(k)ing

Hydraulic fracturing - or fraccing - is a process used in areas where the character of a coal seam impedes gas flowing readily into a gas well. In these areas, hydraulic fracturing (fraccing) may be used to increase the permeability of a coal seam and improve gas flow. During the process, a fluid comprising mostly (99.5%) water and sand, and 0.5% of other additives, outlined below, is pumped at high pressure down the cased well and into the coal seam. This creates fractures in the seam in a horizontal plane up to 100's of metres around the well, which are then held open by sand. Additives may be required to:

- enhance fracture initiation
- help lubricate the flow of the sand into the fractures
- prevent microbial or chemical reactions prevent or limit microbial or chemical reactions from occurring in the seam
- prevent formation of scale deposits that may affect the well or pumps.

They might include the following[2]:

Additive Type	**Main Compound(s)**	**Purpose**
Diluted Acid	Hydrochloric Acid, muriatic acid	Dissolves minerals
Biocides	Glutaraldehyde, Tetrakis, hydoxymethyl phosphonium sulfate	Eliminates bacteria in water that produce corrosive products
Breaker	Ammonium persulfate/ sodium persulfate	Delayed break gel polymer
Corrosion Inhibitor	n,n-dimenthyl formamide, methanol, naphthalene, naptha, nonyl phenol, acetaldehyde	Prevents corrosion of pipes
Friction Reducer	Mineral oil, polyacrylamide	Reduces friction of fluid

[1] http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/methane/health_met.html

[2] Hydraulic Fracturing in Coal Seam Gas Mining: The Risks to Our Health, Communities, Environment and Climate. Dr Mariann Lloyd-Smith and Dr Rye Senjen, National Toxics Network, September 2011

Additive Type	Main Compound(s)	Purpose
Gel	Guar gum	Thickens water
Iron Control	Citric acid, thioglycolic acid	Prevent metal oxides
KCl	Potassium chloride	Brine solution
pH Adjusting Agent	Sodium or potassium carbonate	Maintains pH
Scale Inhibitor	Ethylene glycol	Prevents scale deposits in pipe
Surfactants	Isopropanol, 2-Butoxyethanol	Affects viscosity of fluid
Crosslinker	Ethylene glycol	Affects viscosity of fracking fluid

A good deal of community concern around the fraccing process arises from:

1. the potential harmful effects of some of the chemicals used (although they are used in very low concentrations)
2. the possibility for environmental contamination when some of the material is released from the well, and
3. the possibility of contamination of underground aquifers.

Whilst the coal seam gas companies provide generic information about the additional materials used in fraccing solutions, there is some reluctance to provide details of chemicals used due to commercial confidentiality. This leads to a perception that the companies are "hiding something".

It is true that some of the chemicals used in drilling and hydraulic fraccing, and naturally occurring contaminants released from the coal seam during mining, could harm human health, *given sufficient dose and duration of exposure*. However, the information and misinformation provided to the community about these chemicals by the drilling companies on one hand, and those opposed to coal seam gas on the other contribute to the concerns in the community, and the lack of confidence in the information provided. On the one hand, the coal seam gas companies emphasise that many of the additives used in fraccing fluids "*are made of substances commonly found in many household products*". On the other hand, information provided both to the community, and in submissions to government enquiries by those opposed to coal seam gas fails to correlate the effects attributed to the various chemicals to likely exposure scenarios.

For example, Arrow energy provides the following information:

About 99.5 per cent of the material pumped into a frac well comprises water and sand. The remaining 0.5 per cent is made up of minor quantities of additives used to:

Different additives may be used in different wells depending on the local conditions. In general, the additives used in fraccing fluids are made of substances commonly found in many household products.

The fraccing fluids used by Arrow are:

- *acetic acid, food grade (the basis of vinegar, also used in herbicides)*
- *surfactants (also used in soaps and toothpaste)*
- *bactericides (to inhibit the formation of bacteria that may corrode steel and cement, also used in agricultural treatment of crops)*
- *guar gum (from the guar bean, vegetable gum is also used in ice cream and fed to cattle).*

Like many common household products these additives can be toxic in highly concentrated forms, however in fraccing they are heavily diluted and present minimal risk as they remain isolated throughout the process."

On the other hand, the National Toxics Network asserts that "*Over 78% of the chemicals are associated with skin, eye or sensory organ effects, respiratory effects and gastrointestinal or liver effects. The brain and nervous system can be harmed by 55% of the chemicals. Symptoms include burning eyes, rashes, coughs, sore throats, asthma-like effects, nausea, vomiting, headaches, dizziness, tremors, and convulsions.*" The same could be said about a wide range of chemicals, provided the dose was high enough. More specifically, they state that "*Methanol causes central nervous system depression in humans and animals as well as degenerative changes in the brain and visual system. Chronic exposure to methanol, either orally or by inhalation, causes headache, insomnia, gastrointestinal problems, and blindness in humans and hepatic and brain alterations in animals.*" They provide no information about the dosage or duration of exposure necessary to produce some of these more severe effects.

Some of these concerns could be allayed by better and more objective information provided by the various informants, and by the results of monitoring testing for air and water contamination. During my interviews, I was told that a variety of monitoring had been undertaken in and around Tara, and some of the people interviewed had even been provided with evacuated stainless steel canisters, to allow them to collect air samples at the time when they are aware of a particular smell. However, the results of this testing appear to have been presented in an ad hoc fashion by different people at different times, without necessarily giving a clear overview of likely exposure.

Uninformed comments by doctors who are not familiar with toxicological principles may also contribute to concerns.

Environmental Monitoring

I was provided with the following reports of investigations into environmental contamination associated with coal seam gas extraction:

- Wieambilla Estates Odour Investigation Report, July – December 2012. Environmental Monitoring and Assessment Sciences, Science Delivery Division, Department of Science, Information Technology, Innovation and the Arts, January 2013 (DSITIA).
- Environmental Health Assessment Report – Tara Complaint Investigation Report. Report prepared for Queensland Gas Company by Environmental Resources Management Australia Pty Ltd, January 2013 (ERM).

I also understand that sampling was undertaken by SIMTARS in March 2010, but I have not seen the results of those tests.

The DSITIA air monitoring investigation at Wieambilla Estate focused on measuring the concentration of volatile organic compounds species in the air when it was present in the community. Sample for analysis were collected by residents during times when odour was considered to be at its worst, by drawing on the sample into evacuated Summa canister. The samples are collected was then sent for laboratory analysis by GCMS. In addition, DEHP staff collected 2 samples, together with a control sample collected in the Barakula State Forest, 38 km north Chinchilla. Additional monitoring is conducted by using passive diffusion samplers, which measure average concentrations over a period of time. A number of volatile organic compounds were detected in samples collected from different sites, but all results were substantially less than the ambient air quality guidelines, often by a factor of 100 or more. There was no evidence of harmful levels of any substance, even when collected at the time of maximal odour. The power of this study is that it gave residents the opportunity to collect samples at a time when they felt the odour was maximal, rather than just samples collected at a point in time, which may or may not have corresponded to maximal odour (and hence presumed exposure).

The ERM study undertook an analysis of samples of air, soil, and potable water collected from 9 Lots in the Wieambilla area in July 2012. A minimum of 4 soil samples, one water sample of drinking water, and one air sample was collected from each site. Five of 9 water samples demonstrated the presence of *E. coli*, a human bowel pathogen which is used as a marker of possible contamination of water supplies. It is not related to CSG activity. Two samples showed an excessive level of cadmium, and one of those also contained lead. I would not expect these to arise from CSG exploration or production. Further exceedances were documented in relation to water aesthetics, but again it was not possible to relate them directly to CSG activity. No soil constituents exceeded standards, and one air sample demonstrated the presence of benzene. Two air samples had been collected from outside, and the other sample did not demonstrate the presence of benzene. Benzene is not a normal constituent of coal seam gas, and so its source is uncertain.

One criticism which can be made of this study is that in some cases, the standard against which the results were being compared was less than the limit of detection of the analytical method. For example, the US EPA RSLS for 1,1,1,2-tetrachloromethane is 0.33 $\mu g/m^3$, whilst the limit of detection varied between 8.3 $\mu g/m^3$ and 12 $\mu g/m^3$. Thus it cannot be stated with certainty that the standard was not exceeded, although it does not invalidate the conclusion that 1,1,1,2-tetrachloromethane was not detected at the limit of detection. Despite this criticism, the testing provides comfort that despite testing for a wide range of substances, the vast majority were not able to be detected.

Overall, these results do not indicate any significant exposure which could account for the ongoing symptoms

Summary and Opinion

I undertook interviews with a number of individuals and families who live in and around Tara, and who are concerned about the potential effects of coal seam gas. Given the apparent level of community concern, I was perhaps surprised that a relatively small number of people elected to come and see me. Whether this was due to a lack of widespread interest, or due to limited pre-publicity, as was suggested to me by some people I cannot determine. In any case, the small numbers make it difficult to generalise from my observations.

It was also clear from my discussions that potential health effects are only one of the concerns, alongside environmental concerns, and distress about the manner in which the coal seam gas companies are able to establish wells without necessarily securing the agreement of all stakeholders.

Affected individuals describe a variety of symptoms predominantly including headache, nose bleeds, and nausea, as detailed above. Objectively, there was little to be seen, although of course, clinical signs would not be expected for headaches or nausea.

The relationship between these symptoms and potential exposure to chemicals involved in the production of coal seam gas remains unclear, and indeed in many cases there appears to have been little effort to correlate symptoms with exposure, or with the known toxicological effects of specific substances. Exposure to coal seam gas has now occurred for many years, first in coal miners, and now in the coal seam gas drilling industry, without evidence of unique or substantial harm to employees in those industries. Most of the information I was able to identify on searching was anecdotal or speculative; there is little to support the current assertions in peer-reviewed literature. I would expect that the circumstances of exposure described to me for the most part would lead to relatively low level exposure, given the distance between the homes of affected individuals and wells, and the testing results made available to me would support that presumption.

It would appear that the Department of Natural Resources and Mines, and the Department of Environment and Heritage Protection have each undertaken some monitoring, and some individuals have been left with evacuated flasks to capture samples when they next become aware of the smells. I am aware that the gas companies have undertaken some of their own monitoring. I am not sure if any individual body has taken responsibility for collating and assessing all of this information, to gain an overall impression of potential exposures, or to correlate with specific complaints. In addition, where such monitoring has been undertaken, the process of feedback to some individuals would appear to have been ad hoc without an appreciation of other sources of information provided, or the context in which the information is being received, increasing the risk that the results might be misunderstood, or that individuals may be being given mixed messages. I would therefore recommend that the following further information be obtained, or collated where already available:

1. mapping of the location of wells, with current status, together with location of complainants/complaints, to better understand the relationship between possible exposure and reported symptoms. This has been done to some extent for the Wieambilla area in the ERM report (page 26), but this would not appear to have covered all complaints.
2. some general meteorological data concerning prevailing winds, to understand where any fugitive emission plume might go
3. information about monitoring which has been undertaken to date by government agencies and/or coal seam gas companies in
    a. air, and
    b. water.

In cases of public health concern such as this, it is important to ensure that all appropriate investigations have been undertaken, and a thorough risk assessment be completed. However, this alone is insufficient, if the concerns of the population are not allayed. This may require a comprehensive communication strategy over some time to regain the confidence of the community, and to dispel perceptions that information is being withheld. As a relative latecomer, I may be unaware of some of the strategies which have already been implemented. However, it is important that one organisation or agency should have ownership of the problem, and the role of coordinating the responses by all involved parties.

There were also complaints of noise/vibration noticed particularly at night, and sometimes described as being heard in the pillow when in bed at night. I am aware that the fraccing process requires the sand/water slurry to be pumped underground at high pressure, but I do not have detail about how this is achieved. However, it is plausible that high-pressure pumps, particularly if they utilise pistons, might produce a vibration which is transmitted through the ground for some distance from the site of the pump. I consider this is an issue which warrants further investigation.

In circumstances such as these, complaints around health can become intertwined with environmental and other concerns. Whilst it is important from a scientific point of view to attempt so far as possible to separate these issues, one must remain mindful when communicating with the community that they tend to view them all as parts of a whole.

I would welcome the opportunity to have further discussions with you, should you so desire.

Yours faithfully

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