Doctors for the Environment Australia
www.dea.org.au

Submission to the Rural Affairs and Transport References Committee Inquiry

into management of the Murray Darling Basin – impact of mining coal seam gas

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Submission from
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SUMMARY

- Coal seam gas mining (CSG) may have adverse impacts on human health by contamination of drinking and agricultural-use water, and air. Contaminants of concern include many of the chemicals used for fracking, as well as toxic substances produced through this process and mobilised from the sedimentary regions drilled. Some of these compounds can produce short-term health effects and some may contribute to systemic illness and/or cancer many years later.

- The public health consideration of these matters has been inadequate; leaving the population exposed to potential health hazards.

- Publicly available information on the chemicals used for this purpose in Australia is inadequate, as is their assessment and regulation.

- Evidence from several countries has shown that environmental exposures are occurring which may put people at risk, and these concerns have led to moratoria on further mining operations.

- There is a significant threat of ground water pollution, for the hydrological systems involved are complex and inadequately researched. CSG mining in the Great Artesian Basin is unwise because of the potential for contamination in a system which may not be renewable.

- The monitoring of potential contamination of water supplies in coal seam gas mining areas is inadequate.

- Coal seam gas mining uses prodigious amounts of water, which will compete with human and agricultural needs. Great Artesian Basin water is essentially a non-renewable resource. It is already at an advanced stage of depletion. Remaining water should be used with great care and only for essential agricultural and human purposes. Coal seam gas mining must not be permitted.

- Human health relies on having clean safe drinking water and unpolluted air. Coal seam mining operations should not be allowed to endanger these basic health needs of Australians. The development of this industry in Australian conditions is very unwise without adequate scientific studies and the application of precautionary principle.

- Health impacts are occurring now from the disruption of hitherto stable farming communities with much of the stress, family discord and mental illness expected to be reminiscent of the Murray Valley region due to drought.

- The long-term impacts of unconventional gas mining in the United States suggest significant damage to the ecological systems upon which human life exists. There are significant health impacts in loss of good agricultural

land in the face of the long-term need to feed Australians. The impact on Australia's ability to feed other countries as the world moves to increasing food shortages must also be considered.

- Australia is also one of the world's food bowls. According to the FAO, there are currently more than one billion human beings in hunger. Over the past 18 months, climate unpredictability in both the northern and southern hemispheres has led to massive crop failures. Such effects are what the active climate science community has been predicting for years. The projected economic gains from the industry have been widely promulgated but a full cost-benefit analysis of the impacts on the wider economy of a massively expanded CSG industry has not been done. Financial benefits from employment, mining royalties and the export of coal seam gas must be offset against damage to agriculture, food exports, tourism, soil, water and air quality, and human health and well-being.

- Methane is a fossil fuel, and contributes to green house emissions and therefore climate change. As such it will be contributing to the increasing burden of illness due to climate change globally. These factors have not been considered in Environmental Impact Assessment (EIS) processes or by Australian governments. There are implications for Australia's relations with other countries and for future international agreements.

- The fossil fuel footprint of coal seam gas is said to be half that of coal. This is in some doubt and further information is needed. Detailed monitoring of fugitive emissions is necessary. In particular, such figures become meaningless if there is methane leakage at the point of extraction. At least in the short term, methane is an infinitely worse green house gas than CO_2.

- Doctors for the Environment Australia considers that the EIA processes used have been inadequate and have failed to assess health impacts appropriately. Notifications of terms of reference and dates of CSG and coal projects are poorly advertised and response times inadequate.

About Doctors for the Environment Australia

Doctors for the Environment Australia is a voluntary organisation of medical doctors in all Australian states and territories. We work to address the diseases – local, national and global – caused by damage to the earth's environment. The medical profession has a proud record of service to the community. This record not only includes personal clinical care, but also involvement in global issues that threaten the future of humanity. We aim to use our scientific and medical skills to educate governments and industry, the public and our colleagues to highlight the medical importance of our natural environment. To our patients we try to provide a role model in the care of the environment for this is part of a preventative health ethos.

Doctors for the Environment Australia is a branch of the International Society of Doctors for the Environment (ISDE), based in Switzerland, which is a global network of concerned medical professionals. There are now branches in 35 other countries. ISDE has significant achievements in Europe and has established strong links to and influence in the European Community and WHO.

Introductory remarks

Terms of reference

Doctors for the Environment Australia, in reviewing the terms of reference, notes that reference 5 refers to "other related matters including health impacts" and we will address these impacts in detail. However each of the other terms of reference 1 to 4 has the potential to impact on human health in some way. These impacts will also be considered.

Coal Seam Gas (CSG) mining in the context of human health

Health is not simply the absence of disease, it is life in an environment that is supportive of human essential needs and which does not contain harmful substances which can cause ill health in the future. The basis of public health is prevention of harm based on careful scientific assessment of possible hazards, their risks and methods of prevention. Therefore it deals particularly with clean air, clean water and nutritious and uncontaminated food. Increasingly public health has a global dimension since actions in one country may affect the health of people in other countries. These are all issues pertinent to the assessment of the health hazards of mining coal seam gas.

Global environmental changes such as climate change, biodiversity loss, and degradation of ecosystems on land and in the oceans pose major, increasing threats to sustainability, population health and survival. In medical terms climate stability, biodiversity and healthy ecosystems are the life support systems for humanity. These threatened determinants are enmeshed in a wide set of 'global changes' exemplified by the growing scale, speed and intensity of social, economic and environmental change. In today's increasingly

interconnected world, human health is recognised as having wide social, economic and environmental determinants.

This submission draws attention to our concerns about the potential health impacts of the CSG industry on Australians through direct or indirect contact with toxic substances via water, air and food. Within Australia, this affects water and land (food) resources and their sustainability and determines whether the industry is a social and economic positive or negative. These impacts are covered in **section (1)** and we contend that they require urgent consideration by the Committee.

Internationally, the CSG industry involves Australia's commitment to the health of all nations with our emerging obligations to reduce green house emissions. These matters are dealt with in **section (2)**.

Although many of these factors are interdependent we will examine some of them separately.

Section (3) covers the need for Heath Impact Assessment, Conclusions and Recommendations.

Section (1)

STATE AND NATIONAL HEALTH IMPACTS

IMPACT ON WATER RESOURCES

Clean, drinkable water is an absolute need for maintaining human health.

Australia's management of its major water resources leaves much to be desired. Like many other nations we have over-utilised groundwater stores and aquifer water without proper scientific study as to the consequences, and sometimes even when we knew the likely consequences.

Great Artesian Basin water

If very carefully used this Basin is potentially a source of potable water for some generations to come, a vital resource in a drying continent. Studies of its sustainability are inadequate, but suggest that its renewal is extremely limited –perhaps non-existent. In the last 100 years some 50 million megalitres have been withdrawn with 80% of the water wasted. It is estimated that only 20 million megalitres or so of available water remains.
http://www.onlineopinion.com.au/view.asp?article=993&page=0

In general governments do not accept the existing recharge data because they wish to exploit it and indeed do so, for example the Olympic Dam mine uses 30 million litres of water per day from the Basin. When this was opposed on environmental grounds an Indenture Act was passed that overruled environmental considerations and indeed future human need.

Contamination of Basin water with exogenous or endogenous chemicals **must** be avoided, and for that reason, CSG procedures with their known high-probability contamination of adjoining water bodies should therefore be banned in the Basin.

Ground water

The scientific understanding of groundwater and aquifer flows is poor and the consequences of high pressure injections cannot be modelled sufficiently to ensure that contamination of drinking water can be avoided. Reference has been made below to the various reports expressing concern. The Rudd government established The National Centre for Groundwater Research & Training, at Flinders University. The centre has said:

"Groundwater is now recognised as a crucial asset that must be an integral part of Australia's long-term water planning. But to effectively manage this resource requires far more knowledge of sub-surface water systems than is currently available. Because existing data is limited or non-existent,

management decisions are being made using hydrogeologic conceptual models that can be grossly misleading".

Should coal seam gas mining occur, then from the public health perspective it is important that water sources are constantly monitored for methane, chemicals used in fracking and toxic contaminates from sediments over the life of the mine and for a long period after the mine is closed.

Water consumption by CSG operations
Given that climate change predictions point to increasing water shortages in SE Australia, the vast quantities of water required for CSG operations is of concern. The JP Morgan report 2010 indicated that CSG activities in Queensland Surat and Bowen Basins alone are estimated to extract between 125-350 gigalitres of water per year over the coming 20 to 30 years. This equates to approximately an additional 30-80% of current water volumes being extracted from the Great Artesian Basin per annum solely from CSG activities.
http://lockthegate.org.au/documents/doc-268-jpm-csg1.pdf

In the USA, the EPA estimates that 35,000 wells are fractured annually, using the equivalent amount of water used each year in 1 to 2 cities of 2.5 million people, or 40 to 80 cities with a population of 50,000.
http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711.pdf

POTENTIAL FOR WATER, LAND AND AIR TO BE CONTAMINATED WITH CHEMICALS DURING COAL SEAM GAS EXPLORATION AND MINING

Here we discuss the direct impacts on coal seam gas mining on human health.

Around the world, alarm bells have been sounding about the potential public health implications of coal seam gas (CSG) mining, and the technique of hydraulic fracturing (fracking). This relatively new technology is being rapidly rolled out in Australia and elsewhere, without the legal and administrative protections necessary to ensure that public health is not harmed and that environmental damage does not leave a legacy for generations.

We ignore this situation at our peril – there have been other instances, such as the case of asbestos, where a product that was mined was considered an economic boon and a benefit to society at the time, but where in the absence of appropriate regulation and research on health impacts, a legacy of disease has caused suffering to thousands.

The process of mining coal seam gas and hydraulic fracturing
The procedure of hydraulic fracturing (fracking), as used to assist production in 10% to 40% of Queensland wells and nearly all US wells for coal seam gas, involves the pressurised injection of fluids commonly comprising water and

chemical additives into rock to open up or enlarge fractures . When the underground rock formation is fractured, a "propping agent" is pumped into the fractures to keep them open and allow gas to flow. A proportion of the fracturing fluids is then returned to the surface and needs to be treated or disposed of in some way. (http://www.gwpc.org/e-library/documents/general/Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs.pdf

The gas extraction process requires coal seams to be depressurised through the withdrawal of water. As the water pressure is reduced the gas is released from the coal. Depressurisation affects the water levels in coal seams and can potentially affect interconnected aquifers overlying or underlying the coal seam, and water supply to water bores in the surrounding area.

A US EPA document notes
"*Large hydraulic fracturing operations require extensive quantities of supplies, equipment, water and vehicles, which could create risks of accidental releases, such as spills or leaks. Surface spills or releases can occur as a result of tank ruptures, equipment or surface impoundment failures, overfills, vandalism, accidents, ground fires, or improper operations. Released fluids might flow into a nearby surface water body, infiltrate into soil and near-surface ground water, potentially reaching drinking water aquifers".*
Whilst these remarks were directed at shale gas mining, which uses far greater volumes of fracturing fluids than coal seam gas mining, the concerns are similar.
http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711.pdf

Chemicals used in hydraulic fracturing
One of the biggest problems with understanding the potential health impacts is the lack of transparency and consistency around the chemicals used, and the lack of monitoring under the normal protections afforded to drinking water supplies.

A recent report by a US House of Representatives Committee noted
"As the use of hydraulic fracturing has grown, so have concerns about its environmental and public health impacts. One concern is that hydraulic fracturing fluids used to fracture rock formations contain numerous chemicals that could harm human health and the environment, especially if they enter drinking water supplies. The opposition of many oil and gas companies to public disclosure of the chemicals they use has compounded this concern."
http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf

That committee's inquiry found that over a four year period, 14 leading oil and gas companies used more than 2,500 hydraulic fracturing products containing 750 chemicals and other components, which constituted (excluding water added at the well site) 780 million gallons of hydraulic fracturing products. A number

of these chemicals were known to be hazardous to health through release into water and/or air including endocrine-disrupting and cancer-causing agents.

The authors of a US paper due to be published in a few months (Colborn et al, 2010) attempted to review the chemicals used in gas extraction and found the available data fraught with gaps. However, they managed to independently compile a list of 944 products used, containing a total of 632 chemicals. They noted that more than 75% of the chemicals could affect the skin, eyes, respiratory and gastrointestinal systems. Approximately 40-50% could affect the brain and nervous system, immune and cardiovascular systems and kidneys. Over a third could affect the endocrine (hormonal) system and a quarter could lead to cancer and mutations.
http://www.endocrinedisruption.com/files/Oct2011HERA10-48forweb3-3-11.pdf

A recent UK study reviewed information on chemicals supplied to New York State using a European chemical substances database and found that 58 of the 260 substances listed were of concern: 17 were classified as toxic to aquatic organisms, 38 were classified as acute toxins to humans, 8 were known carcinogens, 6 were suspected carcinogens, 7 were classified as mutagenic and 5 were classified as having reproductive effects.
http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf

The situation of lack of information about chemicals, despite potentially serious adverse effects, is also true for Australia. A paper by Lloyd-Smith & Senjen (2011) found extremely limited data available about fracking fluids used in Australia and a lack of any comprehensive hazard assessment of the chemical mixtures used and their impacts on the environment or human health. Industry secrecy and lack of legislative requirements for disclosure prevent an adequate assessment of safety to human health.

Furthermore, only two of the 23 most commonly used fracking chemicals said to be used in Australia have been assessed by the National Industrial Chemical Notification and Assessment Scheme (NICNAS), and neither of these has been specifically assessed for use in fracking. This leaves the population vulnerable to a range of potential health threats.
http://ntn.org.au/wp-content/uploads/2011/04/NTN-Fracking-Briefing-Paper-April-2011.pdf

Exposure through water

Chief amongst the potential threats to health is the contamination of surface and ground waters. Vast quantities of water are required for fracking, and only a reported 60% or possibly less of the volume of fluid injected may be recovered (this is difficult to estimate as records are not required). Aside from the issues of loss of water for other beneficial uses, contamination of drinking water with the chemical additives themselves, their degradation products, and compounds that can be mobilised from sediments during the process pose an unacceptable risk to health.

There are already examples in the US and in Australia where harmful chemicals have been found in ground water subsequent to coal seam gas exploration and mining.
http://www.scientificamerican.com/article.cfm?id=drill-for-natural-gas-pollute-water
http://www.smh.com.au/environment/toxins-found-at-third-site-as-fracking-fears-build-20101118-17zfv.html

A recent report by JP Morgan indicated a range of risks, including reduced water quality from cross contamination of water tables, addition of drilling chemicals, gas migration to existing water bore wells, and problems with treatment, disposal and storage of waste water brought to the surface.
http://lockthegate.org.au/documents/doc-268-jpm-csg1.pdf

Waste water has to be stored in tanks or pits at the well site, where spillage can occur and then has to be recycled for future use in fracking, injected into underground storage wells, discharged into nearby surface water or transported to wastewater treatment facilities.

CSG water brought to the surface is often highly saline and not suitable for agricultural or domestic purposes. Flowback water and produced water from coal seam gas fracking can contain volatile organic compounds, high concentrations of ions such as calcium, iron, magnesium, sodium, strontium, and also radioactive substances. Substances that can be mobilised from rock formations may include arsenic, cadmium, chromium, lead, thallium, selenium, thorium and uranium.
http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711.pdf

The 2011 Tyndall Centre (University of East Anglia, UK) report notes that *"flowback fluid is likely to be of greater concern than that of the fracturing fluid itself, and is likely to be considered as hazardous waste in the UK."*
http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf

Exposure through air
Fracking chemicals can also be volatile and be released into the air, where they exert their effects through inhalation. Volatile organic compounds (VOCs) can be released during drilling, during methane separation from other gases and by compressors and other equipment. Fracking chemicals and produced water held in evaporation ponds can be released into the local atmosphere and inhaled.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1817691/pdf/ehp0115-a00076.pdf

In addition to direct effects, volatile organic compounds can contribute to production of ground-level ozone, a known respiratory irritant with detrimental effects on lung function. It was been reported that in 2006, the Colorado Air Quality Commission approved several new restrictions on the oil and gas industry in an effort to curb emissions from ozone-forming compounds affecting air quality in the region. http://www.earthworksaction.org/Coloairpollution.cfm

Methane exposure

Gas can migrate from coal seams to aquifers where a pathway exists. It can migrate some distance though natural or man-made geological pathways. A study published this year by scientists at Duke University found *"systematic evidence for methane contamination of drinking water associated with shale-gas extraction".*
http://www.propublica.org/documents/item/methane-contamination-of-drinking-water-accompanying-gas-well-drilling

Investigation is complicated by the fact that tracing a definitive source of contamination can be difficult, as groundwater supplies and gas deposits are often separated by considerable distances.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2866701/pdf/ehp-118-a199.pdf

Methane is a colourless odourless flammable gas, which can form an explosive mixture with air at levels as low as 5%. Methane can displace air and cause symptoms of tiredness, headaches and dizziness.
http://www.dhs.wisconsin.gov/eh/chemfs/fs/Methane.htm

A recent example in Victoria of a community affected by methane gas pollution can be found in the case of the Cranbourne's Brookland Greens housing estate where a class action was brought by residents who were evacuated from their homes due to explosive levels of methane gas coming from a neighbouring landfill. This has recently resulted in a settlement of $23.5 million. In this case the source was a local landfill, but similar concerns apply wherever there is a source of uncontrolled methane which can migrate underground.
http://www.abc.net.au/news/stories/2011/03/25/3173631.htm

Adverse health impacts of chemicals

Effects on human health of chemicals depend on toxicity, dose, route and duration of exposure and the health status and vulnerability of the people involved. Exposure to chemicals can have immediate health effects, or long-term effects, can be direct or indirect (such as effects via the food chain).

Long-term concerns of some chemicals used in or generated by CSG mining include endocrine (hormone) system) disruption, fertility and reproductive effects, and development of cancer.

These types of effects may not be immediately obvious, but can nevertheless occur with very low chemical exposures and have far reaching consequences. Plasticizers, surfactants in detergents, polyaromatic hydrocarbon by-products and heavy metals are some of the compounds which may have unanticipated effects on the endocrine system.

A recent article in the American Journal of Public Health (Finkel & Law, 2011) called for the precautionary principle to be used in relation to fracking, stating *"of concern is that endocrine-disrupting chemicals may alter developmental pathways, manifesting decades after exposure*".
http://ajph.aphapublications.org/cgi/content/abstract/101/5/784

It should also be noted that with any chemical mixture it is not only the effects of each chemical which may be problematic, but also the potential for multiple unpredictable chemical combinations.

Space does not permit the full enumeration of all the potential health effects of chemicals which may be used for fracking, but some examples illustrate the concerns.

The BTEX chemicals

The BTEX chemicals (benzene, toluene, ethylbenzene and xylene) are frequently found together in petroleum compounds. They are in a class of chemicals known as volatile organic compounds (VOCs) which easily vaporise so people can be exposed through drinking water, bathing or breathing in vapour. Long-term exposure to benzene for instance, even in very small amounts, can affect the bone marrow, causing anaemia, and increasing the risk of leukaemia, and can affect unborn children.
http://www.atsdr.cdc.gov/tfacts3.pdf.

Toluene and ethylbenzene can damage the nervous system, liver and kidneys and ethylbenzene is a possible human carcinogen.
http://www.atsdr.cdc.gov/tfacts110.pdf; http://www.atsdr.cdc.gov/tfacts56.pdf.

BTEX chemicals have been used as fracking fluids, even though they have now been banned in Queensland. However, the fracking process itself can release BTEX from natural gas reservoirs, allowing them to escape into aquifers or the surrounding air. BTEX chemicals have been found after at least two fracking operations in Queensland.

A 2010 assessment of the impacts of proposed coal seam gas operations in the Murray-Darling Basin noted:
"*No data have been made available to examine the possible implications of hydrocarbons, eg, BTEX, in associated water*"
http://www.environment.gov.au/epbc/notices/assessments/pubs/coal-seam-gas-operations-impacts.pdf

Other chemicals

A range of other hazardous chemicals are reported to be used in Australian fracking operations, for example ethylene glycol, glutaraldehyde, fumaric acid, 2-butoxyethanol. Ethylene glycol is used to make anti-freeze. When ethylene glycol breaks down in the body, it forms chemicals that crystallize, collecting in the kidneys and affecting kidney function. It also forms acidic chemicals in the body, affecting the nervous system, lungs and heart.
http://www.atsdr.cdc.gov/tfacts96.pdf.

Glutaraldehyde is very irritant to skin, eye, throat and lungs. Repeated skin contact can cause allergic reactions.
http://www.cdph.ca.gov/programs/hesis/Documents/glutaral.pdf

Fumaric acid is an irritant of skin and mucous membranes.
http://www.sciencelab.com/msds.php?msdsId=9927173.

2-butoxyethanol is easily absorbed and rapidly distributed in the human body and is particularly toxic to red blood cells, carrying the risk of haemolysis, and damage to spleen, liver and bone marrow.
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~FGaXfN:1

In summary, human health relies on having clean safe drinking water and unpolluted air. Coal seam mining operations should not be allowed to endanger these basic health needs of Australians.

This submission will now consider the social and economic impacts on coal seam gas mining communities which are likely to damage their stability, health and sustainability. We will also consider some impacts on the entire Australian community.

General Health Impacts in Coal Seam Gas Communities

In this section we detail the wider implications on human health of coal seam gas mining. The potential impacts are diverse.

The pathways for the influence of socioeconomic status on health are numerous and complex. Indeed any new industry affecting the social and economic variables of an individual or community will have health outcomes. It is with this in mind that the following sections explore a number of ways the coal seam gas industry will impact on local economies, community social capital, and the mental health of communities living in a gas field.

Community and individual health is influenced by circumstances and factors associated with socioeconomic status. The Health Report 2010 from the Australian Institute of Health and Welfare describes the "socio-economic gradient of health" where health status closely follows social and economic status along a continuous gradient from advantage to disadvantage.
http://www.aihw.gov.au/publication-detail/?id=6442468376&tab=2

Expanding the industry tenfold in Queensland alone will multiply any adverse impacts on the general health of CSG communities. As many of these impacts are only now being researched, a "primum non nocere" (first, do no harm) approach is warranted.

Economic impacts

There are economic benefits of the mining and resources boom. Like most of our coal, most of our coal seam gas will be exported. This activity brings jobs and state revenue. Do these economic benefits filter back to the communities

impacted directly by coal seam gas mining? And are those benefits enough to offset the negative economic impacts which will include all externalities such as the costs of health care?

Currently, analysis of wider economic impacts of the coal seam gas industry is lacking.

In 'gas communities' in the United States there are economic 'winners and losers'. The winners are those leasing their land, finding work in the industry or business from the industry. The losers are those with no land to lease, not employed by the gas industry, and paying more for rent, goods and services. http://solveclimatenews.com/news/20110517/fracking-marcellus-shale-natural-gas-montrose?page=2

The gas industry is dividing previously close-knit rural communities, increasing tension and disharmony. Many jobs are going not to local residents of these communities but to interstate workers. Even those benefiting economically may be suffering due to the social impacts of the industry and the division of their community.
http://solveclimatenews.com/news/20110518/natural-gas-marcellus-shale-pennsylvania-communities-fracking?page=show

We agree with the comments of Professor Ross Garnaut, who said:
http://www.garnautreview.org.au/update-2011/garnaut-review-2011/garnaut-review-2011.pdf (page 91)

"The Governor of the Reserve Bank of Australia, Glenn Stevens, noted in February 2011 that the high prices for Australia's resource exports meant that other industries had to invest and produce less: 'on this occasion, the nominal exchange rate has responded strongly', he said. *'This ... gives price signals to the production sector for labour and capital to shift to the areas of higher return.'"*

"In other words, Australia is enjoying a resources boom and for each new coal mine or gas plant that opens up, there must be a cut in jobs and investment in some combination of tourist hotels and restaurants, universities, steel mills, farms and other businesses producing exports or competing with imports. If it is a big investment in gas and coal, a lot of jobs and investment have to go. Prop up jobs in one area, and even more have to go in others."

And he asks the question *"But why should all Australians carry the costs of the gas industry's exceptional expansion and prosperity? Why should the education, farming, tourism and manufacturing industries pay for the extra emissions that have come with the exceptional prosperity of the coal and gas industries, when their own prospects have been damaged by the resources boom?"*

As explained above, we contend that the social and economic disruptions caused by CSG mining will affect the health of local communities. It is ironic that some politicians express concern at the imagined job losses in successful

resource industries resulting from a carbon emissions tax, but not at the loss of long-standing sustainable jobs in farming and tourism in country areas. Further, community disruption, breakup of settled communities and job losses are all well-recognised health hazards.

This raises the further issue of the need for a full economic balance sheet. Will the income from CSG royalties exceed the costs of damaged agricultural land, use and contamination of water resources, health and social disruption costs and the externalities of green house emissions?

Finally, history has documented the social and health costs in Dutch Disease and no attempt is being been made to measure what these costs might be so they can be avoided in Australia.

Agricultural Impacts on Health

The CSG industry threatens Australia's ability to feed itself by damaging the ecology of soils and therefore the health and productivity of agricultural land. A Federal Government report from its Science, Engineering and Innovation Council indicates that Australia could become a net importer of food, as the country's population continues to grow and climate change cuts agricultural production. Importing food can be more expensive and will raise the cost of living. Supply chains can be susceptible to disruption by military conflict and natural disasters. Food miles and the carbon footprint of the food we eat will increase. The nutritional value of fresh foods will diminish due to prolonged time in transit between farm and table. Reduced nutrition affects health in many ways, in particular by increasing the risk of the two biggest causes of death in Australia: cardiovascular disease and cancer.

A detailed assessment of the sustainability and productivity of agricultural lands occupying potential CSG fields should be integral to the approval process for CSG projects. Soil is fundamental to human survival. The debate regarding CSG has focused largely on water effects. It is vital that impacts on our agricultural soils are also considered. Australian soils are mostly low in carbon and nutrients. Rainfall in many areas is scarce and will become more variable still with climate change.

The Liverpool Plains south of Gunnedah has some of the best soil in Australia but is earmarked for CSG mining. The soil there is a black or grey vertosol, well structured, high in nutrients and with excellent water holding capacity and the ability to hold salt below the level of the roots. The Liverpool Plains is a highly productive region for crops, as the patchwork appearance from air attests. Land values there are five times the surrounding areas. Wheat, canola and sorghum yields are up to 4 times those of other growing areas. This has not been taken in to account when approving CSG mining in the area. As well as the loss of productive land from infrastructure, and the contamination and reduction of water supplies, CSG development may poison these very valuable soils due to flooding from containment/evaporation ponds used to hold wastewater from gas wells. Flood events will become more frequent with changing climate. The risk

of contamination of crops under Australian conditions needs to be assessed urgently.

The loss of productive land from the infrastructure of CSG mining is considerable. The Nature Conservancy, USA, estimates that 8.8 acres of land are required per shale gas well, including roads and ponds. If collecting and distributing pipelines are included in the calculation the area doubles. http://solveclimatenews.com/news/20110421/natural-gas-fracking-environmental-footprint-marcellus-shale-pennsylvania-forests?page=2

Export Industry Impacts on Health

Australia has many valuable export industries, on which the health of rural communities depend, other than fossil fuels and minerals. For example Queensland's beef production and processing industry was worth 4.5 billion dollars last year (3.1 billion in exports); and this accounts for 50% of Australia's total production of beef. The beef we export is scrutinised closely by overseas customers and is currently highly regarded for its quality and lack of residues. The CSG industry threatens this by leading to contamination of soil and groundwater. Once contamination of beef producing land has occurred the clean-up costs are large and the result uncertain. Valuable export markets may be lost for good. Considering the wide area over which the coal seam gas industry will be spread, this is a major cause for concern.

In NSW the coal seam gas industry has projects approved in Gloucester (330 wells), in the Hunter Valley (10 holes, 2 test wells), as well as Macarthur in southwest Sydney (130 wells) and Narrabri (5 pilot wells in production). Sales of Hunter Valley wines in 2004-05 totalled over $362 million with over $40 million in exports. Australian wines are internationally acclaimed. CSG mining in the Hunter Valley winegrowing area threatens this valuable industry.

Tourism Impacts on Health

The vineyards and wineries of the Hunter Valley support a thriving tourist industry. Official statistics for the Hunter Region for 2008/09 estimate that $1.3 billion was spent by visitors - 58% by domestic overnight visitors. A total of 6.3 million visitors went to the region – 68% were domestic day visitors. Fifty three per cent of domestic visits and 93% of international visits were related to food and wine. Fourteen per cent of domestic visits and 74% of international visits were related to nature-based activities. http://www.ret.gov.au/tourism/Documents/tra/Regional%20tourism%20profiles/NSW/NSW%20-%20Hunter%20-%20FINAL2.pdf

These statistics demonstrate that visitors are attracted to the natural landscape and the high quality wine and food industries of the Valley. Both the amenity of the natural and rural landscape and the quality and safety of the food and wine produced in the area are under threat from CSG mining. Many jobs in the region depend upon the wine and tourism industries.

An example of what might change with development of the CSG industry in the Hunter Valley can be in found in small tourist towns in Pennsylvania, USA, such as Montrose. There, constant noise from heavy truck movements has completely transformed the main street, turning a quiet rural tourist destination in to an industrial town.
"…members fear narrow rural roadways clogged with the never-ending grind of drilling-related trucks, and landscapes marred with gas wells will be a turnoff to tourists and artisan farmers."
http://solveclimatenews.com/news/20110517/fracking-pennsylvania-natural-gas-drilling-marcellus-shale

In Pennsylvania, USA, there is mounting concern regarding the environmental impact of the shale gas industry on the forests for which the state is famous and much visited. Even forests that are in state reserves are under threat. Pennsylvania has a total of 4.5 million acres of public lands. Estimates show that as few as 500,000 of these are permanently protected from gas drilling.
http://solveclimatenews.com/news/20110422/number-crunching-environmental-footprint-fracking-boom-forests-pennsylvania?page=2
We have a chance to say no to such unchecked development of the CSG industry in NSW.

Possible seismic activity related to hydraulic fracturing
In Lancashire UK, the British Geological Survey (BGS) recently recorded magnitude 1.5 (27 May) and magnitude 2.3 (1 April) earthquakes in the Blackpool area near to the Preese Hall shale gas drilling site operated by Cuadrilla Resources. Fluid injection, between depths of 2–3 km, was ongoing at the Preese Hall site shortly before both earthquakes occurred.
http://www.bgs.ac.uk/research/earthquakes/blackpoolMay2011.html

The BGS said the timing of the two events in conjunction with the fluid injection suggested that they may be related and that it is well established that fluid injection can induce small earthquakes. Cuadrilla Resources has suspended fracking at the shale gas drilling site near Blackpool while it investigates the data.

In the US, over 700 mild earthquakes have shaken an area of north central Arkansas in the past six months. State geologists are unsure if the quakes are part of a natural swarm, such as the state experienced in the 1980s, or if they are related to natural gas production in the Fayetteville shale gas sites.

These mild earthquake events have occurred with shale gas mining where larger volumes of water are used than with coal seam gas mining, nevertheless concerns over possible seismic events due to coal seam gas must remain.

Mental Health Impacts
Water and air pollution, water shortages, permanent degradation of productive agricultural land and loss of livelihood and landscape...all have mental health consequences for communities living in a gas field.

Solastalgia is a recently developed concept in Australian psychiatry which identifies and describes environmentally induced distress.

"As opposed to nostalgia the melancholia or homesickness experienced by individuals when separated from a loved home, solastalgia is the distress that is produced by environmental change impacting on people while they are directly connected to their home environment."

"...the following responses clearly resonate with the dominant components of solastalgia, the loss of ecosystem health and corresponding sense of place, threats to personal health and wellbeing and a sense of injustice and/or powerlessness."
http://informahealthcare.com/doi/abs/10.1080/10398560701701288

Nick Higginbotham, Glenn Albrecht and colleagues have studied solastalgia in the context of severe prolonged drought and the Upper Hunter experience of open cut coal mining
http://www.sciencedirect.com/science/article/pii/S1353829209001105.
It will be one of the mental health consequences of Coal Seam Gas mining as irreversible change to the landscape occurs over time.

Solastalgia was all too evident in farmers and landowners of Queensland in the 4 Corner's program *"The Gas Rush".* Katie Scott from Chinchilla describes a neighbour who sold up after 77 gas wells were built on their property saying, *"They had to go for sanity*". She also describes being confronted on a daily basis with the infrastructure of a gas field: roads, wells, signs, saying*, "It's a different landscape to what we have always been used to".*
http://www.abc.net.au/4corners/special_eds/20110221/gas/default.htm

Informed consent of landholders is often lacking in the contract process when mining companies first approach landholders about unconventional gas extraction. Lack of full information and disclosure to landholders before leases are signed has contributed to a sense of betrayal and powerlessness. Landowners are not told they have a choice whether to sign a contract with the gas companies or what the implications of a gas field over their property are. They are often told: the resource is there, and you have no rights to stop us obtaining it. The injustice and powerlessness that this engenders contributes to solastalgia and poorer mental health outcomes.

In Queensland the conflicts and stress are in effect acknowledged by the Queensland government in spending $250,000 for landowners to contest the claims of companies which have been approved by the same government.

Many are asking whether it would be possible for advanced wealthy countries to manage these matters in a more sustainable way.

Coal seam gas mining takes place in rural communities. These are the very same communities who are already at most risk from the adverse health effects of climate change and the degradation of the Murray Darling Basin river systems.
http://www.racgp.org.au/afp/200712/200712Blashki.pdf.
They are dependent upon agriculture for their livelihoods and local economies.

Agriculture, already under attack from more severe and prolonged drought conditions associated with climate change, will be further compromised by the coal seam gas industry. This will occur due to the loss of land to gas related installations (wells, access roads and gas and water pipelines) and reduced utility of available land due to the frequent interruption caused by such infrastructure. In addition the potential to reduce and contaminate water supplies, and the problem of contaminated wastewater disposal, are as yet unresolved. Contaminated water leads to contaminated soils, and to unknown consequences on the purity of crops and livestock grown on that land. The stress and disruption caused to farmers has already been shown to force some of them to leave a CSG mining area, allowing once productive lands to lapse into disuse.
http://www.abc.net.au/4corners/special_eds/20110221/gas/default.htm

Elizabeth McGowan eloquently describes solastalgia in US shale gas communities in a series of online articles for *"SolveClimate"* news. Long time residents are moving, unable to bear the changes the gas industry has wrought on their landscape and community.

"…even those with deep taproots are wrestling with whether they still belong in a place they thought they would never leave"

"It feels like you either have to fight the drilling or move…but either choice is difficult. Where do you go anyway? When I think about it though, I just don't know if this is home anymore"
http://solveclimatenews.com/news/20110517/fracking-marcellus-shale-natural-gas-montrose?page=2

"They are going to drill to kingdom come and this is breaking my heart. I didn't move here to be embroiled in this. And now, not a day goes by that I don't want to get in my car and get out of here."
http://solveclimatenews.com/news/20110517/fracking-pennsylvania-natural-gas-drilling-marcellus-shale

Growing community and government concern around the globe:
The US EPA announced in March 2010 that it will conduct a comprehensive research study to investigate the potential adverse impact that hydraulic fracturing may have on water quality and public health.

http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711.pdf. This will help to inform the need for federal regulation.

Meanwhile, on 6th June 2011 the New York State Assembly passed a one-year moratorium on hydraulic fracturing. This replaces an existing ban on horizontal fracking that was due to expire. The new ban includes all types of fracking and will remain in place until the state Environmental Conservancy Department reports on the environmental and health risks of hydraulic fracturing.

In South Africa the government has passed a moratorium on all hydraulic fracturing licences in the Karoo, a large semi-desert region in South Africa.

The French National Assembly last month introduced legislation to ban hydraulic fracturing in shale gas mining.
http://www.connexionfrance.com/Shale-gas-drilling-ban-France-fracking-hydraulic-fracturing-12722-view-article.htmlntamination

A 2011 report from the Tyndall Centre, University of East Anglia, UK, concluded:
"Evidence from the US suggests shale gas extraction brings a significant risk of ground and surface water contamination, and until the evidence base is developed, a precautionary approach to development in the UK and Europe is the only responsible action."
The report calls for a moratorium on shale gas development until there is a much more thorough understanding of impacts of the extraction process.
http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf

In Australia, the Byron Shire Council has joined the other shires of Ballina and Tweed in calling for an immediate moratorium on CGS and on 23rd May the new NSW state government introduced a 60-day moratorium on new coal, coal seam gas and petroleum exploration licences.

Finally, the House of Representatives Standing Committee on Regional Australia's Inquiry into the impact of the Guide to the Murray-Darling Basin Plan recommends that the Commonwealth Government ensure that the mining industry is placed under the same obligations as other water users in the Murray-Darling Basin by ensuring:

- *"That no mining activities are approved that impact on Basin water resources until such time that the impact of such activities is fully understood and able to be mitigated;* and

- *Relevant legislation/regulations are applied with a specific focus on mining activities in the Basin as a matter of urgency to ensure that the long-term health and productivity of water resources are protected"*
  http://www.aph.gov.au/house/committee/ra/murraydarling/report/fullreport.pdf

Section (2)

INTERNATIONAL HEALTH IMPACTS

This important issue has not been addressed adequately by state and federal governments in relation to the development of coal seam gas mining.

GREEN HOUSE GAS EMISSIONS

All governments should be well aware by now that a significant and prolonged change in the world's climate - which is where we seem to be heading on current trends - poses fundamental and long-term risks to human health and survival.
The current situation has been well reviewed.
http://www.guardian.co.uk/environment/2011/jun/06/natural-gas-climate-change-no-panacea/print

The rise in green house emissions is a key factor in climate change which, according to a WHO research project, carried out during 2000-2002, was responsible for an additional 150,000 deaths per annum, mainly in developing or poor countries. These deaths were due to impaired food yields and consequent malnutrition; diarrhoeal diseases associated with freshwater shortages (especially in poorer and unhygienic settings); increased ranges and rates of some infectious diseases; and heightened exposures to storms and floods. Today, taking into account increased population sized exposure and increasing climate change it has been estimated that this figure may be 300,000 to 400,000.
http://www.canberratimes.com.au/news/opinion/editorial/general/folly-to-ignore-climatechange-dangers-on-health/2169741.aspx?storypage=0

There is universal recognition that emissions have to be reduced and there will have to be collective responsibility for this, although mechanisms may differ between each country. There is a perception that Australia, as a very wealthy country and already the world's leading per capita emitter of green house gases, is not fulfilling its obligations to reduce emissions. Indeed, the mining of CSG will increase our emissions, both here and in other countries that might purchase the gas, even though CSG is said to emit less carbon than coal, (a claim under review, see below).

Recognition of Australia's impact on international health, via its contribution to global climate change, has not yet featured in the deliberations of Australian governments. Indeed, if short-term economic considerations were to continue to be the major political influence on Australia's climate change policies, our emission record would be increasingly difficult to defend. The world's economic and trading systems are interdependent and assiduously defended, and economic imposts are now likely for those countries that take insufficient action to reduce emissions. As a consequence for Australia not yet having a price on

green house gas emissions, Qantas is now penalized with a tax on its emissions by the European Union. Many other such decisions are likely in future.

GREEN HOUSE GAS EMISSIONS FROM COAL SEAM GAS MINING

An Australian analysis of this issue is vital, since it is possible that the full life cycle analysis of CSG may not support the cleaner-than-coal statements – especially if other externalities such as the cost of loss of productive land and of the consumption and contamination of water are taken into account.

Natural gas is regarded as an important bridging fuel, a fuel for use during the transition period from high carbon content fossil fuels to low or no carbon renewable fuels. Although the composition of natural gas varies according to its source, in all cases the major component is methane (CH4). On combustion methane releases more thermal energy than other fossil fuels: methane 55.5 MJ/kg, gasoline 47.30 MJ/kg, diesel 44.80 MJ/kg and coal (moist) 13-30 MJ/kg, expressed as HH value.
http://webbook.nist.gov/chemistry &
http://www.railpage.org.au/articles/coal.html

Importantly, natural gas on combustion releases less carbon dioxide than other fossil fuels for the same amount of available thermal energy, 52gCO2/MJ for natural gas compared with 67gCO2/MJ for gasoline, 70gCO2/MJ for diesel and 92gCO2/MJ for coal, *(approximate values)*.
http://archive.defra.gov.uk/environment/business/reporting/pdf/conversion-factors.pdf
Compared with coal and other fossil fuels, natural gas burns cleanly, producing far less nitrogen oxide and almost no sulphur dioxide, mercury, and particulates. Thus overall, less health and environmentally threatening pollutants enter the atmosphere through its use. Provided that on life cycle analysis the total global warming potential of coal seam gas is less than that of other fossil fuels, in particular coal, then its use as a transitional fuel might be justified.

Whilst it is impossible to mine, process, store or transport natural gas without the unintended loss of some methane and lesser amounts of other green house gases, unnecessary loss through cost cutting and negligence is unacceptable. These fugitive emissions can be minimised by capture during the establishment of wells and by applying high standards of monitoring and maintenance to pipelines and all equipment. Flaring is a far less satisfactory means of emissions reduction than capture. A further source of fugitive emissions is from the clearing of land for wells, pipelines and processing plants. Finally, there are the green house gases produced by the industrial equipment used during the extraction, processing, transport and combustion of the fuel to produce useable power. If the coal seam gas industry is to continue, care should be taken to minimise all green house gas emissions associated with the industry.

The Queensland government recently commenced leakage testing of coal seam wells near Tara
http://www.dme.qld.gov.au/zone_files/petroleum_pdf/tara_leaking_well_investigation_report.p

df in response to the airing of a television documentary that was critical of the environmental and ethical standards of the coal seam gas industry. http://www.abc.net.au/4corners/content/2011/s3141787.htm.
The investigation found 26 of 58 wells to be leaking, one seriously, and as consequence the government issued compliance orders on all of the Queensland coal seam gas companies. All were directed to inspect their production wells for leaks and to undertake risk assessments in relation to well heads. Despite assurances based on the industry's subsequent state-wide self audit 34 (2%) of 2719 CSG wells were found to leak, 5 at a flammable level, public concern persists. http://media-newswire.com/release_1151986.html
Ongoing reports of well blowouts do not assist the industry's reputation.

A recent US study claimed that on full life cycle analysis, shale gas has a heavier carbon footprint than coal, when used to generate electrical power. http://graphics8.nytimes.com/images/blogs/greeninc/Howarth2011.pdf
By extrapolation this raised concerns over the hitherto accepted advantage of coal seam gas over coal. We have now examined the matter and found that on the balance of the available evidence coal seam gas has a lighter carbon footprint than both shale gas and coal (**see Appendix**). We do not however consider the matter to be closed- good quality Australian data is needed to establish the true facts.

Fugitive emissions from natural gas of any geological origin remain a concern. Enhanced monitoring and control of fugitive emissions from both gas and coal needs to be implemented as these together could significantly reduce Australia's green house gas emissions.
http://www.climatechange.gov.au/en/publications/projections/australias-emissions-projections/fugitive-emissions.aspx
The introduction of an appropriate carbon price could assist the control of fugitive emissions e.g.
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/343452/Connell_Capture-of-fugitive-emissions-from-open-cut.pdf
It should also be noted that liquefaction of natural gas uses some 10% of the natural gas's energy.
http://what-when-how.com/energy-engineering/liquefied-natural-gas-lng-energy-engineering/
Thus the probable global warming impact advantage of natural gas over coal is reduced when natural gas is liquefied for export.

The preferred option from the climate change and human health perspectives is discontinuation of the coal seam gas industry, with a rapid transition to renewable energy sources, rather than the current projected expansion. Fugitive emissions from Australian coal seam gas, despite the paucity of data, are currently projected to increase to about 7.2MtCO2-e by 2020. (http://www.climatechange.gov.au/en/publications/projections/australias-emissions-projections/fugitive-emissions.aspx).

The great danger in utilising gas in the transition to renewable energy sources is that it delays their introduction. This is occurring with the shale gas industry in the United States
http://www.reuters.com/article/2011/06/16/us-energy-summit-costs-idUSTRE75F44D20110616

In the rush to coal seam gas in Australia we can find no evidence that governments have considered this issue as part of their responsibilities for the long term reductions in emissions. The argument used to develop coal seam gas is that it is cleaner than coal whereas the real issue is that it is a fossil fuel which is retarding renewable energy development. As indicated by International Energy Agency Executive Director, Nobuo Tanaka:

"While natural gas is the cleanest fossil fuel, it is still a fossil fuel. Its increased use could muscle out low-carbon fuels such as renewables and nuclear, particularly in the wake of Fukushima. An expansion of gas use alone is no panacea for climate change." http://www.iea.org/press/pressdetail.asp?PRESS_REL_ID=415

These words epitomize the message of this submission. Major economic decisions are being made without appropriate consideration of future human health and it is our role to draw attention to them.

IMPACTS ON WORLD FOOD PRODUCTION

Australia cannot divorce itself from the needs of the world when making decisions in its own financial interests. To forfeit or contaminate good farmland is to reduce the nation's capacity to produce food. There is already a world food crisis www.earth-policy.org/plan_b_updates/2011/update90 with falling yields due to soil erosion and climate change (changes in temperature, rainfall, and seasonal timing), and to steadily rising costs. A State of the World Report indicates that the front-lines of this crisis are occupied by the world's 925 million undernourished people.
http://www.worldwatch.org/sow11

In large parts of South Asia, including almost all of India, and parts of sub-Saharan Africa - chiefly West Africa - there are 369 million food-insecure people living in agriculture-intensive areas that are highly exposed to a potential five percent decrease in the length of the growing period. Such a change over the next 40 years could significantly affect food yields and food access for people -- many of them farmers themselves - already living on the edge.
http://www.ebionews.com/news-center/research-frontiers/ag-bio-a-bio-agriculture/38808-study-maps-global-hotspots-of-climate-induced-food-insecurity.html
A comprehensive review of the literature can be found at
http://www.sciencemag.org/cgi/content/full/327/5967/812

In an increasingly hungry world, Australia has an ethical commitment to produce what it can and to increase horticultural production instead of importing fruit and vegetables for the needs of its own population.
http://www.energybulletin.net/node/52706

Agriculture is a sustainable income-producing industry; CSG is not.

Section (3)

PROBLEMS WITH ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND THE NEED FOR HEALTH IMPACT ASSESSMENT (HIA)

An Environmental Impact Statement should detail all human health impacts of CSG development for the subsequent consideration by the State and Federal Ministers. This is clearly not occurring or most of the developments would not have been approved on the grounds discussed in this submission.

Over many years the medical profession has prosecuted the need for Health Impact Assessment (HIA) for major projects. In the early 1990's a National Framework for Health Impact Assessment within an Environmental Impact Assessment was developed under the National Better Health Program. In 1993 a Draft National Framework was published. It was apparent that the HIA was a major task and medical opinion was that it should be prosecuted as a process separate to an EIS. In general, separation has not been pursued by governments most likely for financial reasons. In 2001 Health Impact Assessment Guidelines were issued and it was expected that these would be incorporated into all EIS processes.

"To promote and enhance the incorporation of Health Impact Assessment (HIA) into environmental and planning impact assessment generally, thereby improving the consideration of health issues"

The responsibilities of proponents are defined within these guidelines (3.3.1), these include *"this process should include the need to explicitly address potential impacts on human health."* The responsibilities of the Public Health authorities are also presented in detail.

Because of the inadequacies of the EIA process and its differing requirements in each state there is a strong case for initiating an independent HIA for the CSG industry in its entirety. In view of the threats to human health this should be retrospective for projects already approved. This case is strengthened by the recognition that in contrast to an EIS where independent experts prepare the environmental case, health is delegated to state departments of health which do not have extensive expertise, particularly in global health and may not have full independence from government influence. A national approach under new guidelines must ensure global health issues are also properly considered, in order to embrace Australia's international obligations.

Doctors for the Environment Australia considers that notifications of terms of reference and dates of CSG and coal projects are poorly advertised and response times inadequate. Environmental Impact Assessments are in progress in most states and it becomes extremely difficult to note current assessments

and so protect the public health on what should be considered national interests rather than limited to states. We support complaints from the Queensland Environmental Defenders Office on this matter. For the adequate surveillance of public health matters we suggest that there should be a national website that promptly lists submission dates for all coal and CSG developments.

It is in the interest of governments and community that Health Impact Assessment be conducted promptly by the Commonwealth. The use of legislation to do this must be considered – we understand that such legislation could regulate the activities of trading, financial or foreign corporations (as well as any other persons engaged in interstate or international trade). This would be a valid approach, given the High Court's 2006 Work Choices decision. The HIA process would be established for one or more industries (which might be specified in the legislation itself, or could be prescribed later by regulation), prohibiting corporations from being involved in development projects in that industry without a positive HIA.

CONCLUSIONS

- Doctors for the Environment Australia regards the development of coal seam gas mining in Australia as a significant threat to public health.

- Coal seam gas mining (CSG) may have impacts on human health by contamination of drinking and agricultural-use water, and air. Contaminants of concern include many of the chemicals used for fracking, as well as toxic substances produced through this process and mobilised from the sedimentary regions drilled. Some of these compounds can produce short-term health effects and some may contribute to systemic illness and/or cancer many years later.

- The public health consideration of these matters has been inadequate, lacking cohesion and depth of investigation and leaving the population exposed to potential health hazards.

- Publicly available information on the chemicals used for this purpose in Australia is inadequate, as is their assessment and regulation.

- Evidence from several countries has shown that environmental exposures are occurring which may put people at risk, and these concerns have now lead to moratoria on further mining operations in several countries.

- There is a significant threat of ground water pollution, for the many hydrological systems involved are complex and inadequately researched. CSG mining in the Great Artesian Basin is unwise because of the potential for contamination in a system which may not be renewable.

- The monitoring of potential contamination of water supplies in coal seam gas mining areas is inadequate and will require major resources.

- Coal seam gas mining uses prodigious amounts of water, which will compete with human and agricultural needs. This has led to a conflict of interest in stable rural communities because successful coexistence of agriculture and CSG mining is unlikely.

- Human health relies on having clean safe drinking water and unpolluted air. Coal seam mining operations should not be allowed to endanger these basic health needs of Australians. The development of this industry in Australian conditions is very unwise without adequate scientific studies and the application of precautionary principle.

- The announced economic gains from the industry have been widely promulgated, but we can find no evidence that these remain positive

when all externalities are costed. In moving towards a sustainable society, Australia should make these assessments before the industry is allowed to proceed further.

- Health impacts are occurring now from the disruption of hitherto stable farming communities with much of the stress, family discord and mental illness expected to be reminiscent of the Murray Valley region due to drought.

- The long term impacts of unconventional gas mining in the United States suggest significant damage to the ecological systems upon which human life exists through agriculture. There are significant health impacts in loss of good agricultural land in the face of the long term need to feed Australians. The impact on Australia's ability to feed other countries as the world moves to increasing food shortages must also be considered.

- Financial benefits from the export of coal seam gas must be offset against damage to food exports and tourism, which are sustainable activities. These losses can have adverse social and health impacts.

- Methane is a fossil fuel, and contributes to green house emissions and therefore climate change. As such it will be contributing to the increasing burden of illness due to climate change globally. These factors have not been considered in EIA processes or by Australian governments. There are implications for Australia's relations with other countries and for future international agreements.

- The fossil fuel footprint of coal seam gas is said to be half that of coal. This is in some doubt and further information is needed. In particular detailed studies of fugitive emissions are necessary.

- Because natural gas is a fossil fuel concerns have been expressed by many energy experts that its increasing use is significantly delaying renewable energy development; such an eventuality would lead to world temperature significantly exceeding a 2 degree centigrade rise.

- Doctors for the Environment Australia considers that the Environmental Impact Assessment processes used have been inadequate and inconsistent and have failed to assess health impacts appropriately and have not protected the public health.

RECOMMENDATIONS

- **For the protection of human health, the Federal government should impose a moratorium on all new CSG operations until health risk assessments of procedures and chemicals performed on an industry wide basis have been undertaken.**

- **A comprehensive Health Impact Assessment process should be instituted promptly by legislation for the industry of coal seam gas mining. The process should ensure:-**

- Full mandatory disclosure of all chemicals used in fracking and assessment of their potential for short and long term human harm. Mandatory records for each fracking activity- type and volume of chemicals used, and volumes recovered.

- Review of all water legislation under drinking water Acts to ensure protection of surface and groundwater.

- Air quality monitoring of operations for Volatile Organic Compounds (VOCs), ozone.

- Comprehensive water monitoring programs that would provide early warning of potential contamination events.

- Restriction of Great Artesian Basin water use to human consumption and minimal wastage agricultural practices in recognition of the finite nature and advanced depletion of this resource.

- Full lifecycle analysis of the carbon emissions of mining CSG in Australian conditions and comparison with coal and renewable energy sources.

- Wide economic analysis of the benefits versus the costs of the CSG industry in Australia, including health and social costs.

- Agricultural land should be protected from exploitation. The belated measures to do this by the Queensland government must be expanded and national guidelines instituted.

- Health Impact Assessment must consider the health implications of green house emissions on both Australian and international communities.

Appendix

Evidence on the lifecycle carbon footprint of coal seam gas

Coal seam gas *(together with shale gas, tight sands gas and methane hydrates)* is classified as an 'unconventional' natural gas in that its extraction differs from that of conventional natural gas. *(Conventional natural gas is sourced by similar means as crude oil from entrapment within porous rock beneath impermeable geological formations.)*
There are difficulties in making comparison between the merits of 'unconventional' natural gas with coal in regard to total green house gas emissions for a given amount of power generated. This is because of a paucity of data and uncertainty over data quality. It is noteworthy that both the US Environmental Protection Agency (http://www.epa.gov/climatechange/emissions/downloads10/Subpart-W_TSD.pdf) and the US Governmental Accountability Office (http://www.gao.gov/new.items/d1134.pdf) have recently expressed concern that fugitive emissions from unconventional gas may be far greater than reported.

A 2011 Cornell University study has now presented evidence, that on a life cycle basis, green house gas emissions from shale gas *(which is extracted in a similar manner to coal seam gas)* exceed that of both conventional natural gas and coal, for a similar amount of generated power (http://graphics8.nytimes.com/images/blogs/greeninc/Howarth2011.pdf).
This study estimated fugitive methane emissions to be 2.2-4.1% during extraction, 0-0.2% during processing and a further 1.4-3.6% during transport, storage and distribution to end user. Total fugitive methane losses were thus calculated to be between 3.6% and 7.9%. The study concluded that the total global warming potential of shale gas *(including the processes involved in raw material acquisition, raw material transport and combustion)* was 20-100% greater than coal on a 20 year horizon and comparable to coal on a 100 year horizon when expressed on an equivalent energy available during combustion basis.

The Cornell study's findings have been criticised as inaccurate by a number of authors. These criticisms have been partially substantiated by a second study, this time from the National Energy Technology Laboratory (NETL) of the US Department of Energy. http://www.netl.doe.gov/energy-analyses/refshelf/PubDetails.aspx?Action=View&PubId=386
The NETL study estimated losses with shale gas of 1.75% during extraction, 2.4% during processing and a further 0.5% during transport *(storage and distribution excluded)* giving a total methane loss of 4.65% *(with the actual fugitive methane figures presumed lower due to an uncertain amount of flaring)*. Calculations based on the NETL data showed that the lifecycle global warming potential of shale gas was about 690KgCO2e/MWh, 57% of that of coal on a 20 year horizon *(GWP of 72)* and 531KgCO2e/MWh, 48% of that of coal on a 100 year horizon *(GWP of 72)* when used to generate the same amount of

base-load power. *(These figures are inclusive of raw material acquisition, raw material transport, and energy conversion.)*

Both studies acknowledged major deficiencies in the quality of the available data that could influence the findings. Differences in input data and assumptions were sufficient to account for the differences in findings between the studies.

The first cause of difference between the studies was the consequence of differing assumptions over the amount of fugitive methane emitted at various stages of the natural gas lifecycle. This was due in part to differing assumptions over the amount of emission flaring and an apparent failure of the Cornell study to appreciate that some of the gas unaccounted for between extraction and delivery was used to power equipment.

A second cause of difference was the Cornell study's use of energy available during combustion as its endpoint rather than actual generated electrical power. This is relevant because of the differing efficiencies of gas and coal fired power stations*. (Average coal fired power plants (net plant HHV efficiency 33.0%); average gas fired power plants (net plant HHV efficiency 47.1%)*

The third difference was the use in the first study of higher global warming potentials *(GWPs)* for methane compared with carbon dioxide at both the 20 year *(105 versus 72)* and 100 year *(33 versus 25)* time horizons (Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) and Shindell, D.T., Improved Attribution of Climate Forcing to Emissions, Science, 326 no 5953 pp716-718). These differences had an added small effect in widening the disparity between studies.

Despite uncertainty over the merits of shale gas, coal seam gas on a lifecycle basis seems likely to be a more climate friendly power generating fuel than coal. Coal seam gas although not considered by the Cornell University study was included in the NETL study. With coal seam gas, fugitive emissions during extraction were estimated at 0.14% *(as against 1.75% for shale gas and 1.3% for averaged mixed source natural gas)*, other stages having identical emissions to shale gas giving a total emission figure of 3.2% *(with the actual fugitive methane figures presumed lower due to an uncertain amount of flaring)*. Calculations based on the NETL data found that the lifecycle global warming potential of coal seam gas was about 577KgCO2e/MWh, 47% of that of coal on a 20 year horizon *(GWP of 72)* and 497KgCO2e/MWh, 45% of that of coal on a 100 year horizon *(GWP of 25)* when used to generate the same amount of base-load power. *(These figures are inclusive of raw material acquisition, raw material transport, and energy conversion.)*

The lower fugitive emission intensity of coal seam gas production relative to shale gas production is related to the differing geologies and associated extraction complexities.
(http://www.all-llc.com/publicdownloads/CBMPRIMERFINAL.pdf).
Coal seams are generally shallower and more friable than shale gas seams, are accessed by vertical rather than horizontal wells, and require lower pressures and about 2% of the volumes of fracturing fluid *(when used)* to stimulate production.
(http://www.gwpc.org/e-library/documents/general/Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs.pdf, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711.pdf).
The Queensland Government estimates that 10% to 40% of potential coal seam gas wells may be hydraulically fractured with 8% currently being hydraulically fractured
(http://www.derm.qld.gov.au/factsheets/pdf/environment/en10.pdf).
In addition coal seam gas *(>98% methane)* is less contaminated with unwanted impurities than shale gas and thus needs less processing to achieve pipeline quality.
http://www.climatechange.gov.au/en/publications/projections/australias-emissions-projections/fugitive-emissions.aspx

Terms of Reference

Inquiry into management of the Murray Darling Basin – impact of Mining coal seam gas

Rural Affairs and Transport References Committee, as part of its inquiry into management of the Murray Darling Basin, is examining the impact of mining coal seam gas on the management of the basin.

The committee will examine:
The economic, social and environmental impacts of mining coal seam gas on:

- the sustainability of water aquifers and future water licensing arrangements;
- the property rights and values of landholders;
- the sustainability of prime agricultural land and Australia's food task;
- the social and economic benefits or otherwise for regional towns and the effective management of relationships between mining and other interests; and
- Other related matters including health impacts.