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Working globally for a toxic free future

Submission :
Santos Narrabri Unconventional Gas Project

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Introduction

The Santos Narrabri project proposal is not compatible with NSW agriculture and puts at risk the region's agricultural productivity, air quality and ground and surface water quality. The project encompasses approximately 850 new gas wells on up to 425 well pads, 750 metres apart, as well as a central gas hub including compression, dehydration and treatment of gas, a major water management facility for the storage and treatment of produced water (the term used by the industry to describe the wastewater produced along with the gas) plus infield flares, generators and pipes. It will produce an average of 47 tonnes of salt per day with the peak of around 115 tonnes per day in years 2 to 4, which will need to be transported to an, as yet, unidentified hazardous waste landfill.

In 2012, the United Nations Environment Programme acknowledged that it is impossible to regulate the unconventional gas (UG) industry into safety and noted unintended impacts are inevitable.

'UG exploitation and production may have unavoidable environmental impacts. Some risks result if the technology is not used adequately, but others will occur despite proper use of technology. UG production has the potential to generate considerable GHG emissions, can strain water resources, result in water contamination, may have negative impacts on public health (through air and soil contaminants; noise pollution), on biodiversity (through land clearance), food supply (through competition for land and water resources), as well as on soil (pollution, crusting).'

- UNEP Global Environmental Alert System 2012

Santos Narrabri project not consistent with Chief Scientist Report on CSG

The Chief Scientist and Engineer's Independent Review of coal seam gas (CSG) Activities in New South Wales,[1] (CSS report 2014) recommended CSG only go ahead if there is *'appropriate engineering and scientific solutions in place to manage the storage, transport, reuse or disposal of produced water and salts.'* The environmental impact statement (EIS) notes the quantity of salts to be disposed is substantial and, other than transport to an unidentified landfill, Santos offers no solution for this potentially environmentally hazardous waste. Similarly, they propose to bury considerable quantities of drilling cuttings at the well site. Neither of these proposals fit the description of '*appropriate engineering and scientific solutions*.'

Despite many years of operation, the UG industry still does not have effective ways to deal with its solid wastes and its impact on groundwater aquifers, nor as the Australian National Pollutant Inventory demonstrates, can the industry, including Santos Queensland and South Australian operations, control their toxic air emissions.

The CSS report also found there were human health risks at all stages of CSG extraction with exposures via water, soil and air pollution and listed possible adverse health outcomes as respiratory, cardiovascular, genitourinary and digestive diseases, skin problems, some types of cancer, injuries, hormonal disruption, and fertility and reproductive effects. The CSS report acknowledges there was a need to better understand the nature of the risks of pollution or other environmental damage from CSG, as well as the capacity and cost of mitigation and/or remediation, e.g. for abandoned wells. It stressed the need for a better understanding of the industry impacts and to better manage cumulative impacts of the industry. The Santos EIS fails to address these priority issues and, in effect, ignores the growing body of scientific and medical literature reporting adverse outcomes from unconventional gas exploration and production.

EIS Failings

The Santos Narrabri EIS has numerous significant omissions, which clearly indicate it should be rejected:

- In regards to the chemicals to be used, the EIS lists drilling and water treatment chemicals, noting they may resort to other drilling chemicals not listed in the EIS. While they propose not to use hydraulic fracturing, they have not provided a legally enforceable guarantee that 'fracking' will not be used over the 20 years lifetime of the gasfields.

- Many of the chemicals proposed to be used are proprietary chemicals and their full identity kept secret under commercial business information protection (CBI). While chemical ingredients are not revealed then it must be assumed they have the potential to be hazardous.

- Of those chemicals and products identified, at least serious seven are very toxic. For others, some do not have chronic health data while others provide no reproductive data. There are also serious omissions in the consideration of carcinogenic, silica-based products.

- There is no acknowledgement or discussion of the synergistic impacts of the chemical mixtures (e.g. particulates and air pollutants), despite the wealth of medical studies showing adverse health impacts for those residents exposed to UG mixture pollution.

- There is no serious consideration of fugitive emissions or natural contaminants existing in the coal seam such as toluene, benzene, polyaromatic hydrocarbons (PAHs) and semi volatile substances. A serious omission is the lack of consideration of naturally occurring radioactive materials (NORMs) potentially occurring in the coal seam and produce water.

- The assessment of air contaminants focuses on an extremely small number of pollutants and appears to ignore the growing body of evidence demonstrating significant air pollutants associated with gas fields and infrastructure.

- There is no citing of environmental monitoring or real world pollution data from Santos' extensive wells and gas infrastructure in Queensland.

- There are many unsubstantiated assumptions, e.g., the highly unlikely statement that there will be no emissions from any of the gas compression infrastructure or the water treatment facility; or that all gas extracted will be near 100% methane with no contaminants except for a small amount of ethane. No data for the unprocessed coal seam gas is provided.

- All resulting waste streams that cannot be treated are said to go to 'licensed landfill', yet these landfills are not identified nor their capacity to deal with a significant waste stream generated by the Santos project.

- Importantly, there is no review of the growing body of scientific and health research focusing on the adverse human health and environmental impacts of UG both in Australia and overseas. These appear to have been simply ignored.

Failure to provide a legally enforceable guarantee of "no fracking"

Santos has not provided a legally enforceable guarantee that will ensure that hydraulic fracturing is never used at the Narrabri gas fields over the 20-year lifetime of the gasfields. Until that is provided, the EIS should include an assessment of fracking chemicals, quantities and related pollution.

EIS does not provide the full details on chemicals to be used nor assesses all impacts

In Australia, a wide range of chemicals are used and released in UG exploration and production, including drilling fluids, wastewater treatment chemicals and industrial cleaners. Santos provides a list of drilling chemicals, but states that these may be substituted with other chemicals based on *'suppliers, market availability and product improvement at the time of drilling.'* Hence, the chemical assessments provided in the EIS may be irrelevant. Many of the chemicals proposed to be used in the water treatment are proprietary chemicals and their full identity kept secret under commercial business information protection (CBI).

While drilling chemicals, such as silica or crystalline quartz and cristobalite, used as weight additives and bridging agents, are known to be carcinogenic with the primary malignancy associated with exposure through inhalation,[2] there is no consideration of their potential adverse impacts on human health or the environment in the EIS. Exposure to respirable crystalline silica, as experienced in the UG Industry, is known to cause silicosis, lung cancer, autoimmune diseases, pulmonary disease and chronic kidney disease.[3]

The US National Institute for Occupational Safety and Health (NIOSH) released a Hazard Alert, in 2012, identifying exposure to airborne silica as a health hazard to workers in the UG industry.[4] While workers experience the most direct exposure, silica dust may also be an air contaminant of concern to nearby residents.[5] NIOSH acknowledges a lack of information on occupational dust exposure in the gas industry, including exposure to diesel particulates. Diesel exhaust is also classified as a Group 1 carcinogen by IARC,[6] yet the large volume of truck movements and use of infield diesel generators will result in substantial diesel pollution that has not been addressed in the EIS.

Highly toxic chemicals to be used in Santos drilling

The EIS notes the toxicity of primary drilling fluids, with specific reference to:

Glyoxal : an antimicrobial preservative that works by forming formaldehyde in products. People exposed to such formaldehyde-releasing ingredients may develop a formaldehyde allergy or an allergy to the ingredient itself. Glyoxal is a human skin toxicant or allergen, according to the US Cosmetic Ingredient Review Assessments and there is also evidence of immune system toxicity. The main routes of occupational exposure to glyoxal during use as a disinfectant are via inhalation of aerosol and dermal absorption, which can result in local irritations of the eyes and respiratory tract as well as hyperemia and foamy secretion in the lungs.

The WHO[7] reports that in the laboratory, Glyoxal has been shown to have impacts on mammalian cells (inducing DNA adducts, mutations, chromosomal aberrations, DNA repair, sister chromatid exchanges and DNA single strand breaks), while in rat studies it appeared to impact on DNA synthesis and DNA simple strand breaks in the rat's liver. Glyoxal also demonstrated a capacity to promote tumours in male Wistar rats. Exposure to glyoxal has also been shown to inhibit activities of aerobic and anaerobic bacteria, green algae and invertebrates.

Glutaraldehyde (pentanedial) : a biocide / antimicrobial, is highly irritating to the eyes, skin and the respiratory tract of humans and laboratory animals. It has caused skin sensitisation in humans and laboratory animals and asthma in occupationally exposed people. In animal tests, glutaraldehyde by inhalation caused lung damage in rats and mice and, in tests using mammalian cells in culture, glutaraldehyde caused DNA damage, mutations and some evidence of chromosome damage. Glutaraldehyde is acutely toxic to aquatic organisms and is equally toxic to warm water and cold water fish, but is slightly more toxic to freshwater fish than salt water fish. Data indicates that both algae and fish embryos may be particularly sensitive to long-term glutaraldehyde exposure.

Methanol *:* a biocide / antimicrobial, corrosion inhibitor, a volatile organic compound (VOC), is highly toxic to humans. It 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. Methanol is included in the TEDX List of Potential Endocrine Disruptors.[8] Methanol is highly mobile in soil and can volatilize from water. Once in air, its half-life is over 2 weeks. The chemical reacts with photochemically-produced smog to produce formaldehyde. Methanol was listed as the most commonly used hydraulic fracturing chemical by the United States House of Representatives Committee on Energy and Commerce.[9]

Dazomet : biocide / antimicrobial, is very toxic to aquatic organisms, acutely toxic to mammals and may be hazardous to the environment.[10] It is unstable in the environment and hydrolyses rapidly to form the very toxic methyl isothiocyanate (MITC). Dazomet is irritating to the eyes and its degradation product, MITC, is a skin sensitiser. Even dilute solutions cause skin irritation and sensitisation in humans. Exposure to dazomet can occur through dermal contact, inhalation of its decomposition product, MITC, and/or water runoff. Inhalation of dusts or powders may result in irritation of the upper respiratory tract. MITC is a potent, direct-acting irritant to the eyes and respiratory tract. Death results from acute pulmonary congestion and haemorrhage. Developmental studies indicate that MITC caused delayed growth at maternally toxic concentrations.[11]

Toxic chemicals to be stored on well pad

The drilling chemicals will be prepared on the well pad, and maybe stored there for extended periods. When drilling fluids and drill cuttings are returned to the surface, they are to be stored in lined pits or tanks at the well pad. Once drilling is completed, recovered drilling fluids would be transported back to the drilling fluid treatment facility for either reuse or disposed of at a licensed waste facility.

The EIS states that well pads would be designed and managed to contain all activities (including the handling of liquids and drilling muds) to the well pad area; but with the use of pits and even with full concrete bunding, this cannot be assured. US researchers compiling data on spills associated with unconventional oil and gas development in four states between 2005 and 2014 found that 50 percent of the 6,648 spills were related to storage and moving fluids via pipelines. They noted that equipment failure was the greatest factor, and that the loading and unloading of trucks with material had a lot more human error than in other places.[12]

Table 5-2: Drilling Fluid Chemicals

Chemical Name/Use	CAS Registry Number	Use	Quantity[1]
Primary Drilling Fluids			
Copolymer of acrylamide and sodium acrylate	25085-02-3	Shale inhibitor	0.33 ml
Drilling water/Water in Product	7732-18-5	Base fluid	321.06 ml
Glyoxal	107-22-2	Fluid loss stabiliser	1.25 ml
Methanol	67-56-1	Antimicrobial	1.25 ml
Pentanedial / Glutaraldehyde	111-30-8	Antimicrobial	0.2 ml
Potassium chloride	7447-40-7	Inhibitor	11.08 ml
Sodium carbonate	497-19-8	Buffer	0.42 ml
Sodium carboxymethyl cellulose	9004-32-4	Fluid loss stabiliser	1.25 ml
Sodium hydroxide	1310-73-2	pH stabilizer	0.09 ml
Starch	9005-25-8	Fluid loss stabiliser	1.33 ml
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	Fluid loss stabiliser	1.33 ml
Xanthan gum	11138-66-2	Viscosifier	0.91 ml
Methylisothiocyanate (MITC)	556-61-6	NA [2]	0 ml [2]
Ethylene oxide/propylene oxide copolymer	9003-11-6	Defoamer	0.02 ml
Polyalkylene	9038-95-3	Shale inhibitor	10.49 ml
Polypropylene glycol	25322-69-4	Defoamer	0.02 ml
Silicic acid, potassium salt	1312-76-1	Shale stabiliser	10.66 ml
Sodium chloride	7647-14-5	Additive	12.5 ml
Secondary Drilling Fluids			
Almond Hulls	NA*	Loss circulation material	NA
Copolymer of acrylamide and potassium acrylate	31212-13-2	Shale inhibitor	NA
Bentonite	1302-78-9	Weight additive	NA
Calcined petroleum coke	64743-05-1	Loss circulation	NA
Calcium Carbonate	471-34-1	pH stabiliser	NA
Cellophane	9005-81-6	Loss circulation	NA
Crystalline silica, cristobalite	14464-46-1	Weight additive	NA
Crystalline silica, quartz	14808-60-7	Bridging agent, weight additive, pH stabiliser, Loss circulation material	NA
Crystalline silica, tridymite	15468-32-3	Weight additive	NA
Walnut hulls	Mixture (1756)*	Loss circulation	NA
Wood fibre	Mixture (1757)*	Loss circulation	NA

EIS dismisses chemical impacts too easily

The independent scientific assessment (2015) undertaken at the request of the California State Government noted that UG operators have unrestricted use of many hazardous and uncharacterized chemicals. The assessment acknowledged that no agency has systematically investigated the possible impacts and noted the environmental characteristics of many chemicals remain unknown: '[We] *lack information to determine if these chemicals would present a threat to human health or the environment if released to groundwater or other environmental media.'* [13]

The EIS acknowledges there are risks from exposures to chemicals of potential concern (COPCs) identified in recovered drilling fluids and drill cuttings and focuses on the very toxic biocides that will be used in both drilling activities and water treatment. It also notes that limited quantities of drilling fluids will be recovered.

"6.3.1 Drilling records indicate that the typical mass balance of fluids recovered from drilling is approximately 70percent solids / cuttings and 30 percent fluids (at field saturation)."

Yet, the EIS argues the biocide MITC, a by-product of the biocide dazomet (tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione), due to its high volatility in water, will likely evaporate in the aqueous phase soil, and therefore, not present any risk. The risks associated with glutaraldehyde, a chemical with high toxicity and with varying biodegradation rates (half-life of 1.7 days in aerobic soil, 10.6 hours in the water/sediment system, but up to 18 days for photolytic degradation in water /combined sunlight and air) are also dismissed. These half-lives are presented as representing very low persistency with no risk to aquatic and terrestrial life and, despite the biocides high toxicity to aquatics species and their ability to remain in water for many days, it is argued that they will not represent a risk. This is clearly not the case for a substance which is highly toxic to aquatic species and has the ability to remain as a residual in water for over two week.

The EIS also acknowledges the majority of drilling chemicals used will exceed predicted no effect concentrations (PNECs) in water and/or soil in residual drilling materials. It argues that chemical additives used during drilling are unlikely to migrate to a potable water source due to the 'additives chemical and physical properties, the area's geology and the distance to water bores' (not within 200 metres of an occupied residence) and concludes that there will be no exposure of receptors to chemical additives used in the drilling fluids and cuttings and, therefore, they will not be further evaluated in the risk assessment. As much of the residual drilling material will be buried on site, with the potential to leach into the surrounding environment, this lack of assessment is unacceptable.

In support of a more detailed investigation, trials undertaken in Queensland on a proposal for land spraying of drilling by-products identified environmental hazards including release of potentially toxic additives, salt compounds, heavy metals, hydrocarbons, pH-control additives, and total suspended solids (TSS). [14] The report notes that concentrations of aluminium, boron, iron, manganese, molybdenum, vanadium and mercury exceeded the Australian and New Zealand Environment and Conservation Council (ANZECC 2000) Guidelines[15] and detectable concentrations of petroleum hydrocarbons were observed in drilling muds. They concluded that the C6–C9 fraction, which include benzene, toluene, ethyl benzene and xylenes (BTEX) may pose a risk to the environment and to human health.

Table 6-9: Summary of Chemical Additives in Residual Drilling Materials Exceeding Relevant Screening Criteria

Chemical Name	Cas Number	Exceed Drinking Water Guideline	Exceed $PNEC_{water}$	Exceed $PNEC_{soil}$
Potassium chloride	7447-40-7	X	X	
Copolymer of acrylamide and sodium acrylate	25085-02-3			
Glyoxal	107-22-2	X	X	X (a)
Methanol	67-56-1			
Pentanedial / Glutaraldehyde	111-30-8		X	X
Sodium carbonate	497-19-8	X		
Sodium carboxymethyl cellulose	9004-32-4		X	
Sodium hydroxide	1310-73-2	X		
Starch	9005-25-8		X	
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	X	X	
Methylisothiocyanate (MITC)	556-61-6	X	X	X
Xanthan gum	11138-66-2	X		
Ethylene oxide/propylene oxide copolymer	9003-11-6		X	
Polyalkylene	9038-95-3	X	X	
Polypropylene glycol	25322-69-4	X	X	X
Silicic acid, potassium salt	1312-76-1	X		
Sodium chloride	7647-14-5	X		
Sodium polyacrylate	9003-04-7	X	X	X

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a/ $COPC/PNEC_{solid}$ ratio only exceeded by spent drilling muds concentration. Cuttings (surficial and buried) $COPC/PNEC_{solid}$ ratio not exceeded.

EIS presents no solution for residual materials as required by the CCS

The EIS concludes residual materials will be generated through the construction and operational phases of the well life cycle will include recovered drill cuttings, drilling fluids and produced water. The project will produce a long-term average of 47 tonnes of salt per day with the peak of around 115 tonnes per day in years 2 to 4. The salt waste will be transported to an, as yet unidentified, licensed landfill. There is no discussion of potential contamination of salt in the EIS, including the possibility of NORMs in this waste product.

Leaving the landholder with liabilities

Drill cuttings generally comprise rock and solid material and makeup around 30 percent of the material recovered from the well. Drill cuttings would be stockpiled until they are used in well pad 'rehabilitation.' The EIS states concentrations of select COPCs within residual drilling fluids mixed in with the drill cuttings will decrease over time through biodegradation and photolytic degradation. During the proposed 'rehabilitation' of the well pads, drill cuttings would be used in a "mix, turn and bury process," effectively burying the waste and leaving any future responsibilities to the landholder.

In June 2013, New Zealand milk giant, Fonterra, announced it would no longer accept milk from farms that accept CSG muds and drilling cuttings on their properties, citing both contamination concerns and the extra cost of testing the milk at about $80,000 per year.[16]

Drill cuttings too contaminated to be used in this way would be transported off site and disposed of at an, as yet unidentified, licensed waste management facility.

EIS does not adequately consider pollution risks to water

Many potential risks to ground and surface water from the UG industry have been identified including leakage of drilling fluids from the well bore into near-surface aquifers; accidental spills of fluids or solids at the surface; discharge of insufficiently treated waste water into surface water or underground and naturally occurring contaminants finding their way from the producing zone to shallow or drinking water aquifers through fractures in the rock.[17]

In 2014, Santos coal seam gas project in the Pilliga Forest, New South Wales, was found to have contaminated aquifers with uranium at 335 micrograms per litre (µg/L), 20 times the Australian Drinking Water guideline of 17 µg/L. [18]

Yet, the EIS claims the "*potential for releases to groundwater associated with the storage and conveyance of produced water, brine and treated water is considered negligible."*

The EIS incorrectly states that the *"chemicals within the produced water are limited to residuals from the chemicals used in the drilling fluids and if present are at very low concentrations",* while scientific literature shows that produced water is likely to be contaminated with heavy metals, naturally occurring radioactive materials (NORMs), fracking or drilling chemicals, volatile and semi volatile organic compounds and high concentrations of salts.

In Australia, high levels of lead, mercury, chromium, hydrocarbons and phenols have been detected seven months after a spill of produced water in the Pilliga Forest CSG gas field.[19] The Australian CSG company, AGL was forced to end its trial of CSG wastewater for irrigation after regulators found it left behind unacceptably high levels of salt and heavy metals.[20] The EPA reviewed the monitoring data from the irrigation trial and, based on this review, would not support a continuation of the trial.

The US EPA investigation of water contamination in 23 drinking water wells near natural gas extraction sites detected high concentrations of benzene, xylenes, gasoline range organics, diesel range organics, and other hydrocarbons in groundwater samples from shallow monitoring wells near pits indicated that the latter were a source of shallow ground water contamination. [21]

The EIS incorrectly concludes that *"Beneficial uses of treated water have a limited potential to contain chemicals of concern and are unlikely to lead to infiltration to groundwater.*

Beneficial uses for dust suppression and construction water are short-term activities and insufficient water volumes will be applied to lead to leaching to groundwater. Similarly, irrigation is not considered to lead to a significant flux to groundwater as activities will be conducted to minimise leaching fractions to deeper soils."

On this basis and with little supporting information, the EIS simply claims that the potential for impacts to groundwater from chemicals associated with drilling and water treatment in the water gathering and transfer pipelines, ponds and beneficial uses are considered limited. No supporting evidence is provided for these claims.

EIS ignores BTEX chemicals

BTEX chemicals were found in 5 out of 14 monitoring wells in Arrow's Queensland gas fields with benzene at levels 6 and 15 times Australian drinking water standard,[22] while toluene was found in a private drinking water bore adjacent to Queensland gas fields.[23] In 2014, BTEX were detected in the water from two of four CSG wells and in an above ground water storage tank at the AGL CSG project in Gloucester in New South Wales. Five samples included BTEX, one at a concentration of 555 ppb.[24] The New South Wales EPA suspended AGL's CSG Waukivory Project.

Yet, the EIS does not mention toluene and has no discussion regarding the potential for BTEX contamination of produce water or solid UG wastes.

EIS does not consider potential limitations of water treatment

The treatments to remove contaminants from produced water are limited by the chemicals they can remove, the energy needed and their economic costs. Reverse osmosis has significant limitations and cannot remove many of the organic chemicals used in UG activities. Low molecular weight, non polar, water-soluble solutes such as methanol and ethylene glycol are poorly rejected by reverse osmosis filtration.[25] In 2011, bromine was detected in treated produced water released by Eastern Star Gas at six times background levels. Methane was also detected at 68 µg/L, whereas it was not detected in the upstream control sample.[26]

It is reported that in Queensland, Santos claimed in an EIS they would treat the produced water to Australian standards before disposing of it in local waterways. However, the company found that they were unable to treat the water to Australian standards and, in late 2012, requested permission to release the contaminated water (est.12-18 million litres) into Dawson Creek.

There is no guarantee that the water treatment facility proposed for the Narrabri gas fields will be capable of removing all contaminants; evidence suggest that they will not be able to.

The proposed water treatment facility will also use an extensive number of water treatment chemicals, which will either find their way into the waste stream or be captured as residues that will then require treatment or disposal. Many of the water treatment chemicals are listed as proprietary chemicals with no information on their ingredients, so their risk remains unassessed.

EIS does not consider potential of methane to contaminate groundwater

Methane has been detected in private drinking water bores adjacent to Queensland gasfields.[27] US studies have shown that methane levels in drinking water are higher in areas with a high density of wells and methane levels increased over time coinciding with the increasing number of wells. Methane contamination of water was evident in 60 water wells near active gas wells in the US.[28] Contamination at 19 to 64 parts per million (ppm) was above US federal government safety guidelines. The majority were situated one kilometre or less from a gas well. Wells more than a kilometre from active gas wells had only a few ppm. In a follow up study, the distance to gas wells was found to be the most significant factor. Water wells close to gas-drilling sites had methane levels more than six times higher than more distant wells.[29] There is no discussion in the EIS of the potential of methane to contaminate groundwater or the bores of neighboring properties.

EIS does not consider the endocrine impacts of UG chemicals

Many chemicals used in the UG industry have been identified as endocrine disrupting compounds (EDCs), e.g.,methanol which is listed to be used in the Santos EIS. As Santos maintains the option to use any product, including those not divulged in the EIS, there is a strong likelihood that these may also include other EDCs. Chemicals associated with unconventional oil and gas (UOG) can block or antagonise hormone receptors, particularly androgen and oestrogen receptors (anti-oestrogens, anti-androgens).[30] Prenatal exposure to anti-androgenic EDCs like ethylene glycol, can lead to delayed sexual development, birth defects such as hypospadias and other problems, while perinatal exposure to toluene can reduce serum testosterone in rats. Perinatal exposure to EDCs has been shown to cause permanent changes in the brain and effect behaviour, obesity, fertility, cancer and result in other adverse health outcomes in laboratory animals depending on the timing of exposure. Some impacts may be inherited and passed through epigenetic[31] changes that may not become apparent for many years.[32] In a 2013 US study,[33] surface and groundwater near areas experiencing high levels of unconventional gas activity in Colorado were shown to contain endocrine-disrupting chemicals (EDC) with moderate to high levels of EDC activity. The concentrations of chemicals detected in surface and ground water were in high enough concentrations to interfere with the response of human cells to male sex hormones and estrogen. The EIS does not consider the endocrine impacts of either the chemicals used or released by the Narrabri project.

EIS does not address chemical mixtures

A 2015 review[34] of more than 100 scientific, peer-reviewed publications on UOG chemicals and their impacts found that research points to potential adverse health outcomes from mixtures of these chemicals. The World Health Organisation's (WHO) framework for assessing mixtures[35] provides example situations where a risk assessment for combined exposure to multiple chemicals might be necessary, such as the emissions of multiple substances from a common source as in the case of fracking or drilling; the presence of multiple substances in surface waters; exposure to multiple pollutants in the atmosphere; and exposure to a formulated multi-component chemical product. The potential impact of co-occurrence of, and concomitant exposure to, multiple chemicals should be taken into account in problem formulation for a risk assessment. The EIS does not consider this issue.

EIS fails to address known UG air pollutants

Data from the Australian government's National Pollutant Inventory (NPI) shows the UG industry is a significant source of air pollutants with releases of particulates (PM_{10}, $PM_{2.5}$), nitrogen oxides and VOCs. According to the NPI data, the quantities emitted are increasing. Air toxics associated with UG activities can cause serious, irreversible health effects, including cancer, neurological problems and birth defects.[36] In 2013, the World Health Organisation[37] declared that outdoor air pollution is carcinogenic.

There are many sources of toxic air pollutants in gas fields and related infrastructure that are not adequately addressed in the EIS assessment of air pollution, including high point vents, equipment/engines, drilling rigs, boilers/heaters, generators, flares, storage tanks, injection pumps, dehydrators, vehicles and gas skimmers. Major sources of air pollutants are the compressor stations that move natural gas through pipelines and gas processing plants.[38]

Santos now has many years of air emissions data and measured environmental impacts from their equivalent production areas in Queensland, yet the EIS relies on unverified assumptions. The EIS fails to discuss and quantify known air pollutants associated with this industry and, instead, focuses on a very small number of criteria pollutants (nitrogen dioxide, carbon monoxide, acetylene, ethane, propane, propylene).

The following priority pollutants have been identified, with some forming precursors of secondary pollutants such as ozone.[39] The majority are not considered in the EIS.

***Nitrogen Oxides* were the focus of the air pollutant assessment.** NO_x are emitted from numerous UG sources including machinery, compressors and flaring. NO_x react with VOCs to form ground-level ozone, which is linked to asthma attacks and other serious health effects. Nitrogen dioxide can cause respiratory problems, heart conditions and lung damage. This aspect was not adequately assessed.

Carbon monoxide - CO is emitted during flaring and from UG machinery. It is poisonous if inhaled and inhibits the blood's ability to carry oxygen and can cause dizziness, unconsciousness and even death. Not assessed.

Sulfur dioxide - SO_2 reacts with other chemicals to form acid rain and particulate pollution, which can damage lungs and cause respiratory illness, heart conditions and premature death. Not assessed.

Hydrogen sulfide - H_2S occurs naturally in some gas formations and can be released when gas is vented or flared, or via fugitive emissions. It is a toxic gas which is lethal if inhaled at high concentrations. Not assessed.

Volatile Organic Compounds **-** VOCs are present during all stages of UG activities including drilling, flaring, from equipment/machinery and holding pits/ponds. Some VOCs cause cancer in animals (e.g. methylene chloride), in humans (e.g. formaldehyde) or are suspected human carcinogens (e.g. chloroform, bromodichloromethane). VOC exposure may result in eye, nose, and throat irritation, headaches, visual disorders, memory impairment, loss of coordination, nausea, damage to liver, kidney, and central nervous system.[40] Some VOCs like formaldehyde and styrene are EDCs.[41] Not assessed.

Sampling of the air around homes near Queensland gasfields detected a wide range of VOCs, many of which were toxic.[42] Community sampling around Queensland gas activities also detected dichlorodifluoromethane, a potent chlorofluorocarbon (CFC) which damages the ozone layer.[43]

BTEX (benzene, toluene, ethylbenzene, xylene) **-** BTEX chemicals are naturally occurring VOCs in gas, coal deposits and groundwater.[44] Drilling and the removal of produced water release BTEX from the coal seam. Their short-term health effects include skin, eye and nose irritation, dizziness, headache, loss of coordination and impacts to respiratory system while chronic exposure can result in damage to kidneys, liver and blood system. Not assessed.

Benzene - The WHO identified exposure to benzene as a major public health concern. They note that benzene is a well-established cause of cancer in humans, with IARC classifying benzene as carcinogenic to humans (Group 1). Benzene causes leukemia, non-Hodgkin's lymphoma and also affects the immune system.[45] It has been linked to birth defects[46] and sperm abnormalities.[47] Not assessed.

Polycyclic Aromatic Hydrocarbons **-** PAHs are a group of very toxic volatile compounds. They are a significant air pollutant associated with UG production. People living or working near active natural gas wells may be exposed to pollutants at higher levels than the US EPA considers safe for lifetime exposure.[48] High levels of PAHs were found across the study area with levels increasing closest to the wells. Not assessed.

Another key omissions is the lack of consideration of volatile and semi volatile organic compounds emitted from containment pits/ponds, high point vents, flaring and other infrastructure, both in construction and operational phases.

EIS fails to address synergy between PM and air pollutants

Chronic inhalation of PM_{10} and $PM_{2.5}$ can cause respiratory problems, cancer, heart attacks, strokes, diabetes, asthma, hypertension, renal disease or premature death. PM also provides an effective pathway for other contaminants, such as heavy metals and NORMs, into the broader environment. The Australian government acknowledges that there is no threshold for PM at which health effects do not occur,[49] yet UG companies are not required to report emissions of either $PM_{2.5}$ or PM_{10} unless they exceed a threshold of 400 tonnes per year, or 1 tonne per hour.

PM travels deep into the lung and crosses directly into the bloodstream carrying with it other toxic chemicals. The surface area of the particle drives a synergistic response, producing greater than an additive response.[50] Together, the mixture is even more dangerous to health than the added individual risks and importantly, there is no evidence of a safe level of exposure to the combined air pollutants or a threshold below which no adverse health effects occur. The EIS fails to address this recognised synergy.

EIS Ignores impacts of flaring

The US EPA has banned gas flaring (the burning off of natural gas from a new well) in most cases since January 2015 due to growing concerns over air pollution.[51] There are no restrictions on UG flaring in Australia. Flaring releases hydrogen sulphide, methane and BTEX,[52] and is recognised as a significant source of soot or black carbon pollution,[53] yet this is not acknowledged in the EIS and the risks of air pollution from flaring are dismissed.

EIS ignores Australian National Pollutant Inventory UG industry reports

showing high levels of toxic emissions

Australia is one of the few countries where the UG companies are required to self-report their emissions to land, air and water to the government's National Pollutant Inventory (NPI).[54] The data submitted each year represents their calculated estimated emissions for a limited list of around 100 chemicals and heavy metals. The data show many thousands of tonnes of toxic chemicals are annually being released to air by the UG industry and the figure is increasing.

In 2014-15, Santos Fairview Gasfield Reported emitting 1,300 tonnes of carbon monoxide, 1,800 tonnes of oxides of nitrogen, 28 tonnes of PM and 31 tonnes of VOCs. In South Australia, Santos Merrimelia Gas projects in Leigh Creek, have significantly increased their emissions of CO and NOx over the last three reporting periods.

Table 4: Santos Merrimelia Gas, Leigh Creek, South Australia

EMISSIONS	2012-2013	2013-2014	2014-2015
CO	32 tonnes	850 tonnes	1,900 tonnes
NOx	220 tonnes	580 tonnes	1,200 tonnes

The numerous gasfields and infrastructures in a single region may add up to significant cumulative releases. For example, in the Leigh Creek, South Australia region, where Santos has 23 oil and gas facilities and activities, reporting to the NPI in 2014-15 included significant amounts of volatile toxic compounds:

Table 6: Combined Santos Oil & Gas facilities, Leigh Creek, South Australia

SANTOS GAS FACILITIES 2014-2015	VOLATILE ORGANC COMPOUNDS (tonnes)	BENZENE (tonnes)
Big Lake shale gas	890	
Toolachee Gas	370	17
Merrimelia Gas	150	
Tirrawarra Gas	460	23
Strzelecki Gas	100	
Kidman Gas	160	
Gidgealpa Gas	360	15
Della Gas	250	11
Daralingie Gas	220	
Bookabourdie	210	
TOTAL	**3,170**	**66**

The emissions resulted in over 3,170 tonnes of total VOCs and at least 66 tonnes of the very toxic benzene released into the Leigh Creek region from Santos gas projects alone. These projects also reported many thousands of tonnes of CO and NOx and smaller amounts of many other contaminants. NPI figures reflect the steady growth in cumulative air emissions from UG activities across regions. These issues are not addressed in the EIS.

EIS denies gas processing is key source of air pollution

Gas processing can produce many by-products, which are often vented to the air e.g. ethane, propane, butanes, pentanes, higher molecular weight hydrocarbons, hydrogen sulphide and carbon dioxide.

The NPI data confirms that the processing of coal seam gas is a major and increasing source of air pollution in Australia. Emissions of (PM) from the QGC's Kenya Processing Plant (ATP620) and Compressor Stations near Tara, have consistently risen over the last 5 years.

Table 1: QSG's Kenya Processing Plant (ATP620) and compressor stations, Queensland

EMISSIONS	2011-2012	2013 - 2014	2014-2015
Particulate matter (PM)	54 tonnes	342 tonnes	1,113 tonnes

Table 2: QGC's Kenya Processing Plant

EMISSIONS	2013-2014	2014-2015
NOx	710 tonnes	1,300 tonnes
CO	410 tonnes	1,000 tonnes
Total VOCs	89 tonnes	180 tonnes

The Santos Queensland Curtis LNG (QLNG) plant, which produces liquefied natural gas, reported to the NPI for the first time for 2014-2015 reporting year. The facility released 4,800 tonnes of deadly carbon monoxide, 4,300 tonnes of nitrous oxides, 620 tonnes of VOCs, 190 tonnes of formaldehyde, 29 tonnes of acetaldehyde, and 17 tonnes each of benzene and toluene (methylbenzene). It also released 546 tonnes of particulate matter. It was third largest emitter in Gladstone.

In the light of the NPI data, including Santos's own data, the EIS's unsubstantiated statement that there will be no emissions from any of the Narrabri gas compression infrastructure, nor from the water treatment facility, appears unrealistic, indeed far-fetched.

EIA fails to assess fugitive emissions

Many volatile and semi-volatile compounds are released to air and water as fugitive emissions from UG activities. Some are the products of industrial UG uses and UG wastes and others are the naturally occurring toxic substances released from the coal seams or shale rock. Nevertheless, the issue of the fugitive emissions appears to have been ignored in the EIS.

A 2015 study using hourly measurements from Photochemical Assessment Monitoring Stations in the Baltimore, MD and Washington, DC areas of the United States, observed that daytime ethane concentrations have increased significantly since 2010, growing from 7% of total measured non-methane organic carbon to 15% in 2013. They noted this trend appears to be linked with the rapidly increasing natural gas production in upwind neighbouring states.[55]

Research conducted at Australia's Southern Cross University[56] measured atmospheric radon (^{222}Rn and ^{220}Rn) and carbon dioxide (CO_2) concentrations as a measure of fugitive emissions in the Queensland gas fields. The researchers found a 3-fold increase in maximum radon ^{222}Rn concentration inside the gas field compared to outside with a significant relationship with the number of wells.

The authors suggest the presence of radon and CO_2 indicates the possible release of other gases, such as VOCs.

They argue that CSG activities, such as the depressurisation by groundwater extraction from the coal bed strata, change the geological structure and pressures, helping gases to seep through the soil and be released to the atmosphere.

In a submission to the Australian government, the same researchers reported hotspots with concentrations of methane (CH_4) as high as 6.89 ppm and CO_2 as high as 541 ppm near Tara. Background atmospheric CH_4 outside the gas fields were lower than 2 ppm.[57] In a follow up study, they confirmed the widespread enrichment of both CH_4 and CO_2 within the production gas field, compared to outside. The CH_4 and CO_2 values showed distinct differences within and outside the production field, indicating a CH_4 source within the production field had a signature comparable to the region's CSG.[58]

EIS presents unsubstantiated conclusion

While noting air pollutant potential sources as the central gas processing facility (incorporating a hot oil boiler; carbon dioxide removal circuit), the safety flare and power generation facility at Leewood, the safety flare and diesel fired generators at Bibblewindi, as well as the gasfield's gas fire generators and pilot well flares, the EIS then surprisingly concludes *"the potential for impacts on community health from the project associated with changes in air quality as evaluated in the air impact assessment in the project area are estimated to be negligible."*

Pollutant release information from Santos' other gas fields and infrastructure clearly indicate that UG activities are the source of many serious air pollutants, which have the potential to impact on community health. The failure to acknowledge the pollutants released by the extensive infrastructure to be built at Narrabri, the failure to address fugitive emissions from the gas fields, examine the synergy between PM and contaminants as well as the subsequent failings of the Health impact assessment means that the conclusion that there will be no impacts from air pollution on community health must be rejected.

EIS Fails to assess naturally occurring radioactive materials

Naturally Occurring Radioactive Materials or NORMs, like uranium, thorium and their progeny radium-228 and radium-226, are found in both coal seams and shale,[59] yet the issue is not considered in the EIS.

The level of reported radioactivity can vary significantly, depending on the radioactivity of the reservoir rock and the salinity of the water co-produced from the well. The higher the salinity, the more NORMs are likely to be mobilised. Since salinity often increases with the age of a well, old wells tend to exhibit higher NORM levels than younger ones.[60]

UG activities such as drilling, removal of produced water, earthworks and transport result in radioactive substances being remobilized and relocated either via wastewater, 'bonding' with dust particulates or via resuspension in air. Direct particle fallout, as well as washout from rain, provides an effective pathway for these contaminants to find their way into the wider environment including surface water and onto rooftops and into domestic water tanks.

Both radon and radium emit alpha particles, which are most dangerous when inhaled or ingested. Radium is a known carcinogen[61] and exposure can result in increased incidence of bone, liver and breast cancer. Consuming radium in drinking water can cause lymphoma, bone cancer, and leukemia.[62] Radium also emits gamma rays, which raise cancer risk throughout the body from external exposures. Radium-226 and radium-228 have half-lives of 1,600 years and 5.75 years, respectively. Radium is known to bioaccumulate in invertebrates, molluscs, and freshwater fish,[63] where it can substitute for calcium in bones.

Radon is an inert gas, so it doesn't react with other elements and usually separates from produced water along with methane at the wellhead. When inhaled, radon can cause lung cancer, and there is some evidence it may cause other cancers such as leukemia.[64]

A US analysis of waste obtained from reserve pits used in unconventional natural gas mining confirmed elevated beta radiation readings. Specific radionuclides present included ^{232}Thorium decay series (^{228}Ra, ^{228}Th, ^{208}Tl), and ^{226}Radium decay series (^{214}Pb, ^{214}Bi, ^{210}Pb). The research indicated the potential for exposure to technologically enhanced naturally occurring radioactive materials and potential health effects from individual radionuclides.[65]

The EIS does not consider NORMs and their impacts.

EIS provides an inadequate assessment of human health impacts

The EIS does not include a comprehensive assessment of human health implications. There is no review of the growing body of evidence and research focusing on human health impacts from the exposure to UG activities. For example, a US-based human health risk assessment of air emissions concluded residents closest to well pads, i.e. living less that 'half a mile (approx. 800m) from wells, have higher risks for respiratory and neurological effects based on their exposure to air pollutants, and a higher excess lifetime risk for cancer.[66]

Children living in close proximity to UG activities are at particular risk from air pollutants, due to their unique vulnerability to hazardous chemicals.[67] Children's exposure to chemicals at critical stages in their development may have severe long-term consequences for health. WHO has expressed a priority concern around children's exposure to air pollutants.[68]

A large study from Colorado found that children born in areas with the highest number of gas wells had a 30% increased rate of congenital heart defects compared to children born in areas with no gas wells within 10km.[69] A 2015 retrospective cohort study using electronic health record data on 9,384 mothers linked to 10,946 neonates, between January 2009 to January 2013, showed that prenatal residential exposure to unconventional natural gas development activity was associated with two adverse pregnancy outcomes – preterm births and high risk pregnancies – adding to evidence that unconventional natural gas development may impact health.[70] An earlier study from Cornell University concluded that babies born within 2.5km of a gas well had lower birth weight and more health problems than babies who were born within 2.5km of a well that was planned but had not been drilled.[71]

As discussed by Dr Geralyn McCarron in her submission, evaluating responses to UG air toxics is not as simple as averaging out exposure and carry out a standard desktop risk assessment for individual contaminants. Dr David Brown et al [72] in their paper

"Understanding exposure from natural gas drilling puts current air standards to the test", published in 2014, noted "*real-time measures of patterns of exposures are needed, and these must include peak levels, durations, and components of mixtures.*"

"Underlying current standards is the assumption that each toxic agent in air emission mixtures acts independently when it is inhaled or ingested into the body…At UNGD sites, this assumption is negated by the fact that PM is generally present at all sites; and it has been demonstrated that PM increases the amount of absorbed toxin by increasing transport into the deep lung."

The quality of the presented health impact assessment for the Santos Narrabri project is far from acceptable and does not fulfil the requirements of the most basic scientific method, i.e. to undertake a literature review to scope and understand the relevant issues.

We provide the following case study as evidence of real world human health impacts experienced by residents living in and around gas fields in Queensland and as an example of the type of issues that should have been addressed in the EIS.

For a more detailed discussion of the failings of the EIS Health Impact Assessment please see Dr Geralyn McCarron's Submission on the Narrabri Gas Project (April 2016)

Supplementary Information

Case study - Darling Downs / Tara, Queensland

The people of the Western Downs gas fields had been reporting adverse impacts since 2008 when untreated CSG waste was sprayed on local roads for 'dust suppression.' In 2009, residents reported health impacts such as rashes, nosebleeds, nausea and vomiting which forced people to leave their homes. In 2013, the Queensland Government released its Health Report into residents' complaints, which acknowledged that there was *'some evidence that might associate some of the residents' symptoms to exposures to airborne contaminants arising from CSG activities.'* [73]

Air Pollutant Testing
Despite the knowledge of the significant releases in the Tara region, there has been no comprehensive monitoring of air pollutants. However, single point sampling of ambient air around Tara homes by industry and government has detected a wide range of VOCs, many of which are toxic. These include acetone, acrolein, alpha-pinene, benzene, benzothiazole, chloromemethane, cyclohexane, dichloroflurommethane, ethanol, ethyl acetate, ethylbenzene, 2-ethyl-1-hexanol, heptane, hexane, heptadecane, hexadecane, 2-methylbutane, methylcyclohexane, methylene chloride, methyl ethyl ketone, 3-methylhexane, 3-methylpentane, naphthalene, pentane, phenol, propene, tetradecane, tetrachlorethylene, 1,2,4-trimethylbenzene, toluene, vinyl acetate, xylene, ethanol, phenylmaleic anhydride, and methyl ethyl ketone.[74]

In sampling undertaken by Australian gas company QGC[75] (the ERM Report), in response to residents' complaints, only 13 air samples were collected in all. A single sample was taken at five Tara properties with two samples at each of the remaining four properties.

Benzene
While many VOCs were detected in the air, the ERM Report concluded that, apart from the benzene exceedance, there were no other exceedances of the air quality screening criteria. Yet, in the case of 26 chemicals, the health criterion was below the detection level used by the laboratories. For example, US EPA Regional Screening Levels for 1,1,1,2-tetrachloromethane is 0.33 μg/m^3, whilst the limit of detection used by the different labs varied between 8.3 μg/m^3 and 12 μg/m^3, well above the health criteria. The report acknowledges it cannot be categorically stated that concentrations in the samples were also below the relevant criteria value.

In the case where benzene was detected above health risk criteria, it was dismissed stating that 'benzene was not a compound that is found in CSG and therefore could not be attributed to CSG activities.' This was in contrast to statements found on the website of the Queensland Government's Department of Environment and Heritage Protection where it states that: *"BTEX compounds (benzene, toluene, ethylbenzene, xylene) are found naturally in crude oil, coal and gas deposits and therefore they can be naturally present at low concentrations in groundwater near these deposits".*[76] Benzene had already been detected in monitoring bores at an Arrow Energy fracking operation[77] in Queensland. The dismissal of benzene exceedances was unacceptable when other BTEX chemicals such as toluene, a neurotoxin, had been found in the air around a number of Tara homes and in the air above a resident's water bore.[78] The level of toluene in air above the bore was measured at 0.33 ppm but was dismissed as 'below levels of concern'. Yet, it was above the 'Chronic Reference Exposure Limits' used for long-term exposure by California, Massachusetts and Michigan states in the USA.[79]

Inadequate Monitoring
The total ERM monitoring period was only nine days and clearly inadequate. The methodology resulted in testing limits of reporting for some chemicals that were substantially higher than the reference air quality criteria. The monitoring was not designed to identify short-term peaks or troughs in air concentrations. In order to assess air contaminants, sampling is needed over an extended period of time. This was demonstrated in a 2012 study on air pollution associated with unconventional gas activities. The 12 month study[80] detected 44 hazardous air pollutants at gas drilling sites including a wide range of air toxics, e.g. CH_4, methylene chloride, ethane, methanol, ethanol, acetone, propane, formaldehyde, acetaldehyde, and PAHs / naphthalene. Most importantly, the authors noted a great deal of variability across sampling dates in the numbers and concentrations of chemicals detected. Notably, the highest percentage of detections occurred during the initial drilling phase, prior to hydraulic fracturing on the well pad.

Community Testing
The Queensland Government facilitated some *ad hoc* sampling for VOCs in air at the Wieambilla Estate in Tara in response to ongoing community concerns. They provided Summa canisters[81] with a 1-minute sampling period and passive diffusion samples to residents for use when appropriate. Again, many VOCs were detected and, while most were below relevant guidelines and the criteria used, the number and type of compounds was diverse.

Summa canister sampling found the following VOCs: hexane, propene, chloromethane, dichlorodifluromethane, methylene chloride, ethanol, acetone, methyl ethyl ketone, acrolein, and vinyl acetate. Vinyl acetate exceeded the annual criteria in one case.

Passive samplers also found the following VOCs: pentane, hexane, heptane, tetradecane, hexadecane, heptadecane, cyclohexane, 2-methylbutane, 3-methylpentane, 3-methylhexane, methylcyclohexane, tetrachloroethylene, 2-ethyl-1-hexanol, ethyl acetate, benzene, toluene, xylene, ethylbenzene, 1,2,4-trimethylbenzene, phenol, benzothiazole, naphthalene, and alpha-pinene.

Benzene was detected at 0.6 ppb, above the US EPA recommendations of 0.4 ppb which, over a lifetime, could cause a risk of one additional cancer case for every 100,000 exposed persons.[82] The benzene result was simply dismissed as an *'outlier'.*

In community sampling around UG activities over an eight-hour period, ethanol and chlorofluorocarbons (CFCs) were detected.[83] Dichlorodifluoromethane, a potent ozone depleting CFC was detected in all three air samples.

In July 2014, a small suite of tests were undertaken by the Queensland State government around a Tara family residence, which identified acrolein at 9.6 ppb, more than 100 times higher than acceptable chronic exposure standard.[84] The Texas (US) annual criterion is 0.066 ppb. Acrolein is an acute irritant of the eyes, nose, throat, lungs and skin, and is reported to be used by the oil and gas industry as a biocide in drilling waters, as well as a scavenger for hydrogen sulphide and mercaptans. Flares are also a possible source of acrolein. Formaldehyde[85] was also detected.

Despite the increased rate of radon detected inside the Queensland gas fields, there has been little radionuclide analyses or testing in the Tara communities surrounding gas fields. However, limited independent testing has detected worrying levels of beta and alpha radioactivity in Tara residents' water tanks. This represents a significant concern for the children, as they are far more vulnerable to radioactivity than adults with sensitivity to radiation being highest early in life.[86] Particulate pollution provides an effective pathway for radioactive substances into the broader environment, and it is hypothesized that through resuspension of radioactive substances and washout from rain, as well as direct particle fallout onto roofs and tanks, this has resulted in the detection of radioactivity in the water and sediment of Tara residents' water tanks.

An assessment of the scope and severity of the Tara region's air pollution is not possible from a review of the data sets that are available or from industry's reports of the estimated air releases. However, both the real world experience of serious particulate pollution and the consolidation of available information, does paint a worrying picture of the region's air quality and its possible impacts. This requires both an urgent investigation and precautionary management responses to protect human and environmental health.

Tara Residents' Observed Symptoms

The physical and social impacts on the affected residents have been substantial, but the Queensland Government's Health Report[87] into residents' complaints was cursory and included little clinical investigation. The report concluded that it was unable to determine whether any of the health effects reported by the community were clearly linked to exposure to CSG pollutants. This was not a surprising finding and one that is common in cases of chronic chemical exposures and suspected health effects, especially when no baseline health or environmental data was available. The report did, however, acknowledge that there had been "some evidence that might associate some of the residents' symptoms to exposures to airborne contaminants arising from CSG activities".

In response to the Queensland government report, which did nothing to allay community concern, in February-March 2013 a Brisbane based GP, Dr Geralyn McCarron, conducted a health survey of residents within the Western Downs gasfields. Her findings were published in the Australian and New Zealand Journal of Public Health.[88] Full details are also available in her report, "Symptomatology of a gas field."[89] Thirty-five households in the Tara residential estates and the Kogan/Montrose region were surveyed in person and telephone interviews were conducted with three families who had left the area. Information was collected on 113 people from the 38 households. Over half (58%) the residents surveyed reported that their health was definitely adversely affected by CSG, whilst a further 19% were uncertain.

In all age groups, there were reported increases in cough, chest tightness, rashes, difficulty sleeping, joint pains, muscle pains and spasms, nausea and vomiting. Approximately one third of the people over six years of age were reported to have spontaneous nose bleeds, and almost three quarters were reported to have skin irritation. Over half of children were reported to have eye irritation.

Of particular concern were the symptoms that could be related to neurotoxicity (or nervous system damage), and the frequency with which these symptoms were reported in children. Approximately a third of the all the children to age 18 were reported to experience paraesthesia (abnormal sensations such as pins and needles, burning or tingling). Almost all the children aged 6-18 were reported to suffer from headaches and for over half of these the headaches were severe. Of people aged six years and over, severe fatigue and difficulty concentrating were reported for over half. Parents of a number of young children reported twitching or unusual movements, and clumsiness or unsteadiness.

Urine specimens from 16 people living in Queensland's gasfields were tested privately. Testing revealed a mixture of chemical contaminants including phenol, cresol, acetone, PAHs, methyl ethyl ketone, toluric acid (a metabolite of xylene) and hippuric acid (a metabolite of toluene). Thirteen people had mixtures of two or more chemicals in their urine. The chemicals that returned positives in urine samples were not chemicals routinely tested for in normal pathology laboratories. The associated reference ranges relate only to occupational exposure to a single chemical toxin and to adult workers whose exposure is limited to a typical 8-hour working day. There are no "normal" values or reference values for children exposed 24 hours per day, 7 days per week to a chemical cocktail.

Conclusions

The Santos Narrabri EIS has numerous fundamental and significant omissions, which demonstrate it is not acceptable. The growing scientific evidence of the UG industries adverse impacts clearly indicates that, this Santos project, encompassing approximately 850 new gas wells and considerable infrastructure in an agricultural region while producing many hundreds of tonnes of waste per annum with no technical solutions, should be rejected.

Currently, Australian guidelines and standards do not take into account low-level, chronic exposure to environmental contaminants. To fully assess the impacts of UG development, this is a priority. Repeatedly, research and real world experience have pointed to evidence of the adverse impacts of this industry. When so much is at risk, the most simple cost benefit analysis would suggest that this project represents far too great a risk to people, to agriculture and to the environment and must be rejected.

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