Chapter 2

WATER

Introduction

2.1 There is a range of potential impacts on the Murray-Darling system from the coal seam gas industry which are of major concern both in their own right and to the committee's general inquiry - the impacts on ground water and aquifers, the extraction or recovery methods used, the treatment and disposal of extracted water, the management of salt and brine, the impact of the whole process on surface water and soils and the implications for agricultural land use where gas production facilities are located on productive land are all areas of concern to the committee. These matters are considered in this and later chapters.

2.2 Groundwater is a vital resource for agricultural, domestic and urban use across much of the Murray-Darling Basin. Nor can it be considered in isolation from surface water. Depending on the topography and geology, at various places in the Basin surface flow recharges aquifers and, conversely, groundwater contributes to surface flows. The National Water Commission has stated:

> Although it is not always apparent, surface water in many rivers, dams, lakes and wetlands is connected to underground water resources in aquifers. There are several different examples of these connections ...This connectivity means that issues such as over-extraction, environmental flows and river salinity could impact on the water quantity and quality in both ground and surface water systems.[1]

2.3 The major risks associated with the coal seam gas industry are whether it has the potential to significantly deplete the groundwater on which agriculture and regional communities depend, to contaminate higher quality water, to alter the hydrology of the affected regions, or to do irreparable damage to the aquifers containing that water.

Groundwater

2.4 As described in the previous chapter, CSG mining requires the removal of very large volumes of water from coal seams to reduce the pressure in them, enabling the gas to flow into wells for extraction.

2.5 The CSG water is, generally, extracted from much deeper underground than the depths of bores used in agriculture or for town water supply and the coal seams are separated from those water sources by low permeability aquitards. However, while most town and agricultural bore water is at much shallower levels, and the water in

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1 National Water Commission, http://www.nwc.gov.au/groundwater/groundwater-surface-water-connectivity (Accessed 4 November 2011).

coal seams is of low quality, there is some limited use of water extracted from these seams, including, as AP LNG acknowledged in information material, the Walloon Coal Measures in south-west Queensland.[2]

2.6 Some of the gas companies have tended to express the amount of water to be extracted as a proportion of the total volume of the Great Artesian Basin (GAB). For example AP LNG, in its submission to the committee, commented that:

> Compared to the total storage capacity of the GAB, the amount of water projected to be extracted during CSG production is very small. At the peak of water production, the annual water extraction is likely to be less than 0.0002% of total storage. ... It is therefore submitted that the CSG industry will have negligible impact on total storage volumes.[3]

2.7 QGC in its submission stated that:

> At this continental scale, the QCLNG Project environmental impact assessment did not identify any measurable impacts on the MDB surface and subsurface water resources as a result of QGC's gas development.
>
> Hydrogeologic evaluations using available data and modelling also indicated that the impact of coal seam gas extraction on the overall Great Artesian Basin would be insignificant with the QCLNG Project likely to extract less than 0.001% of the water in the basin over the life of the Project.[4]

2.8 The impact on the total storage volume of the GAB is not the issue. The core issue with regard to the possible impact of the CSG industry on groundwater is clearly stated in advice to the Australian Government:

> ...we consider that the overriding issue in CSG development is the ***uncertainty surrounding the potential cumulative regional scale impacts of multiple developments.*** The information provided in the assessed EIS documents is not fully adequate for understanding the likely impacts of CSG development across the Surat and Bowen Basins; nor will any level of information or modelling that can be provided by individual proponents.[5] [emphasis added]

2.9 The Geoscience Australia/Habermehl Advice goes on to state that what is required to provide a full understanding of the possible impacts is "... a regional-scale,

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2 AP LNG, *Coal Seam Gas production and groundwater supplies*, p. 2.

3 AP LNG, *Submission 366*, p. 24.

4 QGC, *Submission 359*, p. 8.

5 Geoscience Australia & Dr M A Habermehl, *Summary of Advice in Relation to the Potential Impacts of Coal Seam Gas extraction in the Surat and Bowen Basins, Queensland, Phase one report summary , (*Canberra, September 2010*)* p. 1. This advice was provided to the Commonwealth Department of Sustainability, Environment, Water, Population & Communities as part of the approval process of the Santos, Queensland Gas and AP LNG projects under the *Environmental Protection & Biodiversity Conservation (EPBC) Act 1999.*

multilayer ground water flow model which incorporates data from both public and private sector sources".[6] The Advice's third recommendation is for the creation of such a model, requiring "concerted Commonwealth and State action" as a "high priority".[7]

2.10 There is an element of 'Catch 22' in the Advice, given that it is part of the approval process for production, in that it also concludes that,

> ... any modelled outcomes will be accompanied by high inherent uncertainties until sufficient CSG production data is available to calibrate the groundwater model.[8]

This suggests that the cumulative impact of CSG production on groundwater will only be fully assessed as production increases.

2.11 The GAB underlies much of the northern part of the Murray-Darling system in northern New South Wales and south-west Queensland, the major areas in which CSG exploration and production is currently taking place. The GAB is,

> ... composed of a sequence of sediments that form aquifers and confining layers (aquitards). The thickness and lateral extent of sediments that have formed aquifers and aquitards depend on conditions at the time of sediment deposition, which ranges from 65 to 250 million years ago, and all the geologic forces that have occurred since.[9]

2.12 The CSIRO adds, with masterly understatement, that "... it is challenging to visualize the exact structure". Aquitards are layers of very low hydraulic conductivity; i.e. water flows through them, if at all, at a very slow rate. The aquitards restrict vertical flow of groundwater resulting in artesian pressure in the aquifers. Similarly aquifers have varying rates of horizontal conductivity.

2.13 The structure of the Basin is important when considering the likely impact of CSG extraction on groundwater. It is not a vast underground 'sea' in which levels and pressures quickly and uniformly adjust to the extraction of water from one part. Rather it is a highly complex system of geological formations at a range of depths, of variable permeability holding water of different quality, at different pressures and through which water flows at very different rates, if it flows at all.

2.14 The reduction in pressure in a coal seam will result in a local fall in the water level and pressure in that particular area which may alter the rate and direction of the movement of groundwater in adjacent formations. The impact of this change may take many years to have a measurable impact on adjacent aquifers. Similarly the contingent

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6 Geoscience Australia & Dr M A Habermehl, *Summary of Advice*, p. 1

7 Geoscience Australia & Dr M A Habermehl, *Summary of Advice*, p. 7, Recommendation 3.

8 Geoscience Australia & Dr M A Habermehl, *Summary of Advice*, p. 1

9 CSIRO, *Hydrology of the Great Artesian Basin*, Coal Seam Gas Factsheet #6, (August 2011).

loss of water from adjacent aquifers may not be made good by natural recharge for decades or even centuries.

2.15 As CSIRO states:

> The principles [of hydrogeology] are well understood, but applying those to characterise the unique situation of each aquifer is fraught with difficulty. To properly understand a groundwater aquifer relies on information about aquifer dimensions, structure, and permeability, as well as the timescales of recharge, discharge and groundwater flow. It requires many bore holes to be drilled and pumped tests to be undertaken.[10]

And:

> The difficulty in the Great Artesian Basin is that groundwater flow velocities are slow, waters are old and any unforeseen consequences of extraction will take decades or centuries to work through the aquifers. ***The overriding issue is the uncertainty of the potential cumulative, regional impacts of multiple developments***.[11] [emphasis added]

2.16 In addition to the possible loss of water from aquifers used for agriculture, town supplies or to maintain environmental flows, depressurisation may allow lower quality water to contaminate higher. CSIRO has warned that,

> The complex movement and interactions of different layers of water can be hard to detect but they have a direct effect on the sustainable use of the resource, such as protecting fresh groundwater from being polluted by nearby saline layers.[12]

2.17 Landholders' organisations have also identified the local impact of water extraction as a key issue. A spokesman for the Basin Sustainability Alliance in Queensland told the committee that,

> The water has to go back to where it came from. We have to maintain that groundwater system; there is no option. The companies cannot develop irrigation farms or tree plantations or pipe it down the river or send it to Toorong or Nathan Dam. It has got to be used beneficially in the area of extraction to maintain the groundwater system for future generations.[13]

2.18 The question of the level of understanding of the system and the capacity to predict likely impacts is at the heart of this whole inquiry. The National Water Commission (NWC) has produced a position paper on coal seam gas in which it identifies a number of areas of concern, both for surface and groundwater. The

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10 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), pp 59–60

11 I. Prosser, L. Wolf & A. Littleboy, *Water in Mining and Industry*, in CSIRO, *Water,* (2011) p. 144.

12 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p. 47.

13 Mr I Hayllor, *Committee Hansard*, 19 July 2011, p. 11.

Commission considers that "...Potential impacts of CSG developments, particularly the cumulative effects of multiple projects, are not well understood".[14]

2.19 The NWC's reservations are based on its scientific work, which has been supported by other scientific bodies. In a recent briefing to members of Parliament, CSIRO emphasised that:

> Prediction of specific impacts of CSG developments requires ongoing research because groundwater responses may take decades or centuries to move through aquifers, especially when groundwater flow velocities are slow.[15]

2.20 CSIRO notes that the attitude to the management of groundwater in Australia has changed in recent decades:

> Groundwater was managed as a resource to be mined, much like the rocks in which it lies, but it is now managed as a renewable resource, recognising that it is recharged from rainfall and discharges in to rivers, lakes and oceans, and through vegetation. Consequently groundwater management faces many of the same sustainability issues as surface water. Ecosystems depend on the discharging groundwater, and over-extraction of groundwater can lower water tables or the pressure of water ... .[16]

2.21 The Organisation has also emphasised the level of uncertainty with regard to the various risks associated with the extraction of water on this scale. In a briefing to the committee, it identified a range of risks associated with lowering aquifer pressures:

- migration of methane ... through aquifers and to other wells;
- changed hydraulic gradients, leading to leakage of water from aquifers or of migration of saline water into aquifers; and
- impact on mound springs; and subsidence.

2.22 CSIRO also commented that "whether these risks are significant depends on the hydrogeological context: information is not available to judge this at the larger scale".[17]

2.23 A paper from the Queensland Department of Mines & Energy makes similar points:

> With the large induced pressure gradients induced by dewatering, hydraulic connections with other seemingly isolated aquifers can easily appear ... the

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14 National Water Commission, Position Paper, *Coal Seam Gas and Water Challenge*, December 2010.

15 CSIRO, *Coal seam gas developments – predicting impacts*, (November 2011).

16 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p. 47.

17 CSIRO, Briefing to the Senate Standing Committee on Rural Affairs and Transport, 7 July 2011, Power Point slide no.17

> reduction of pressure in the aquifer because of dewatering could induce noticeable hydraulic connection in places where it was not noticeable previously.[18]

2.24 CSIRO noted the it was "Difficult to accurately estimate impacts because of":

- the relatively recent history of extraction;
- long time delays associated with groundwater processes; and
- the challenges with setting baseline conditions and measuring cumulative impacts.[19]

2.25 It is important to bear in mind, when considering this issue, that the Murray-Darling system including groundwaters and aquifers, was already a system under stress before the gas industry appeared. The NWC has identified a major risk:

> Extracting large volumes of low-quality water will impact on connected surface and groundwater systems, some of which may already be fully or overallocated, including the Great Artesian Basin and Murray-Darling Basin.[20]

2.26 Major efforts have been undertaken in recent years to try to rectify this situation.

> Thousands of wells have been drilled into the Basin's highly productive confined aquifers, and many have been left to flow, lowering aquifer pressure and encouraging feral animals and weeds ... a program of well capping is restoring pressure to the system to enable sustainable use and maintenance of dependent ecosystems.[21]

2.27 At a regional level, a witness described the impact of the situation on local water users to the committee:

> About 20 years ago bore owners within the entire management area were cut back to 70 per cent of their nominal entitlement and in the last few years during the height of the drought bores within subarea 3 were cut back to 50 per cent. This was without compensation and without access to north branch water or overland flows and so we had to turn the pumps off and watch our crops die.[22]

2.28 This comment refers to the area dependent on the Condamine Alluvium, described elsewhere as, "...one of the most heavily extracted aquifers in the Murray-

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18 Geoff Edwards, *An Issues Paper on the Management of Water Co-produced with Coal Seam Gas*, (December 2006), p. 26.

19 CSIRO, 7 July 2011, Briefing, slide no. 26.

20 National Water Commission, Position Paper, *Coal Seam Gas and Water Challenge*, December 2010, p. 1.

21 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p.56.

22 Mrs Ruth Armstrong, *Committee Hansard*, 19 July 2011, p. 13.

Darling Basin".[23] Another key area for coal seam gas development, the Namoi Catchment in northern NSW, is described as:

> ... one of the most intensely exploited groundwater resources in Australia. It is a stressed system in which it was realised too late that rates of groundwater pumping were too high.[24]

2.29 Government and the industry are not blind to these concerns. Extensive research is being undertaken. The Queensland Government is close to completing a groundwater model of the cumulative impact on the Surat Basin of the CSG industry and the industry itself is undertaking very extensive drilling to contribute to this model and to try to predict the impact of this industry's activities.

2.30 The Environmental Impact Statements (EIS) submitted by QGC, Santos and AP LNG for their Queensland projects were reviewed by Geoscience Australia and given qualified approval at the individual project level. The need for further work and the accumulation of more data was referred to repeatedly.[25]

2.31 In some areas, particularly with regard to the risk of cross contamination and artesian pressure, the likely impact was assessed as low. Groundwater was considered likely to flow into the coal seams rather than the reverse and, because most of the bores in the CSG tenements are sub-artesian (not under natural pressure) they were unlikely to be affected by changing artesian pressures in the medium term.[26] The large variation in pressure between aquifers which gas company drilling confirms does suggest that the strata between them – the aquitards – have very low permeability.

2.32 The wells themselves are also a potential channel which could cause linkage between aquifers, especially in the long-term where abandoned wells degrade over time. Evidence to the committee suggested that this area has not received much attention in Australia.[27]

2.33 It is in the longer term and having regard to the cumulative impacts of a number of developments that uncertainty becomes a real cause for concern. This is acknowledged by the gas companies. For example AP LNG commented in its submission to the committee that:

> The Queensland and Commonwealth Governments have taken the approach of adaptive environmental management with regard to the CSG to LNG industry. This acknowledges that ***there are some unknowns with regard to***

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23 *Draft Water Group Advice on EPBC Act Referrals*, September 2010, p. 14, tabled in the Senate, 16 November 2010.

24 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p. 56.

25 Geoscience Australia & Dr M A Habermehl, *Summary*

26 Geoscience Australia & Dr M A Habermehl, *Summary*

27 CSIRO, *Committee Hansard*, 9 August 2011, p.65-66

> ***groundwater behaviour*** and allows for changes to be made to processes to accommodate new understandings.[28] [emphasis added]

2.34 A study carried out by the University of Southern Queensland for four major gas companies[29] operating in the Surat Basin commented that:

> Despite the low permeability of the aquitards overlying and underlying the Walloon Coal Measures, groundwater extraction to reduce the water pressure in the coal seams may induce some vertical leakage into the coal seams and produce impacts on the surrounding sandstone aquifers.[30]

Baseline Knowledge & Make good provisions

2.35 A key issue for both affected communities and the gas industry is the development of reliable baseline knowledge of groundwater levels and pressures and the condition of existing bores. The issues of compensation and making good adverse affects attributable to the gas industry depend on having such knowledge.

2.36 The industry has already had to deal with claims that its activities are resulting in methane flowing into agricultural bores. AP LNG in its submission to this inquiry noted that, in the Hopelands area in Queensland:

> ... where the Walloon Coal Measures are shallow and are used for stock water supply ... heavy water extraction from water bores can replicate the CSG production process, depressurising the coal measures and causing significant amounts of natural gas to flow.[31]

2.37 As part of its baseline monitoring program AP LNG has tested a large number of bores and "... more than 80% have recorded various levels of methane within the bores. This is prior to CSG operations taking place in these areas".[32] Anecdotal evidence suggests that the presence of methane in stock and domestic bores in this region has been obvious for generations.

2.38 The state governments in cooperation with industry sets trigger points for water levels and pressures in bores which are monitored to give early warning of an adverse impact from CSG mining. To avoid uncertainty (and litigation) no project should be given approval until a comprehensive study of all bores likely to be impacted by a project has been undertaken not only to assess water levels or pressure but also to test for the presence of methane.

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28 AP LNG, *Submission 366*, p. 31.

29 Queensland Gas Co (QGC); Santos, Origin and Arrow Energy.

30 USQ, Preliminary Assessment of Cumulative Drawdown Impacts in the Surat Basin Associated with the Coal Seam Gas Industry, (March 2011), p. 1.

31 AP LNG, *Submission 366*, p. 29.

32 AP LNG, *Submission 366*, p. 29.

2.39 The Queensland Government has recently amended its Water Act to require the industry to:

- provide baseline assessment plans and conduct baseline bore assessments;
- determine potential impacts to landholder's water supply bores and enter into 'make good' agreements with bore owners if bore supply is likely to be impaired by a petroleum tenure holder's extraction of underground water;
- avoid and manage impacts on springs; and
- respond to groundwater modelling by the Queensland Water Commission which will identify areas that are likely to experience groundwater level decline and therefore areas where bores may experience an impaired capacity.[33]

2.40 As an example, Santos has developed a program of groundwater monitoring that:

> includes installation of more than 40 new groundwater bores, installation of automated monitoring facilities on more than 40 existing farm bores, installation of several deep multi-level pressure sensors, and conversion of conventional oil and gas wells to deep basement groundwater monitoring locations. A baseline inventory of more than 350 bores in the Roma, Fairview and Arcadia Valley regions, has been completed already, accompanied by an extensive sampling program.[34]

2.41 The company argues that this will enable it to detect "...groundwater changes several years in advance of their first appearance in local aquifers".[35] This early detection would allow the company to implement 'make good' actions well in advance of any impact on local landholders or communities. Santos has indicated that the 'make good' provision could include the ceasing of water production in the affected area.

2.42 Where there is proven impact by a CSG company on an adjacent landholders water supply, the company is required to make good that damage. The most likely impacts are the loss of pressure in a landholder's bore or the lowering of the water level to such an extent that the bore no longer produces water. Make good options range from the relatively straight forward to the complex and unproven.

2.43 The simplest responses will be to deepen existing bores, sink new bores or improve the capacity of pumps. It may also be possible to provide the landholder with suitably treated water from the companies own storage ponds to supplement or replace the impacted supply.

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33 Queensland Government, *Submission 358*, pp 10–11.

34 Santos, S*ubmission 353*, p. 15.

35 Santos, S*ubmission 353*, p. 15.

2.44 The Queensland Government has adopted reinjection of produced water as its favoured method of managing CSG water. One application of this would be to inject suitably treated water from a coal seam into the aquifer supplying agricultural or domestic users. The gas companies are working on the reinjection question but, at this stage its feasibility is not proven.[36] As a last resort the gas companies acknowledge that some form of 'alternate compensation' may be necessary.

2.45 The committee did not get a satisfactory explanation of what alternative compensation means. A farmer deprived of his water supply requires an alternate, reliable, long term supply; without it the property may cease to be viable. Does alternate compensation mean that in extreme circumstances the property holder will be bought out at a price that reflects the pre-CSG value of his property plus a premium reflecting his loss of livelihood?

2.46 The committee believes that the extent of the gas companies' liability in such extreme circumstances needs to be clarified.

Committee view

2.47 The committee is concerned that the combination of the complexity of interactions within and between aquifer systems, uncertainty with regard to the long-term impact of CSG-related water extraction and the fact that the GAB in the areas under most intensive CSG development is already generally acknowledged to be a system under stress is not being given sufficient weight by policy makers in approving the expansion of the industry.

2.48 As mentioned above the Commonwealth and Queensland Governments have adopted an approach described as adaptive management, which will enable the management of the industry to be adjusted in response to the developing body of knowledge and unanticipated problems. This approach assumes that any unforeseen consequences that appear within the relatively short lifetime of the industry will be manageable.

2.49 The uncertainty inherent in such an approach would be significantly reduced if, before any more approvals are granted for CSG production, the Commonwealth acted on the advice of Geoscience Australia and developed:

> ... a regional-scale, multi-state and multi-layer model of the cumulative effects of multiple developments and a regional scale monitoring and mitigation approach ... to assess and manage these impacts.

Geoscience Australia considered the need for this to be a "high priority".[37]

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36 Santos is at an advanced stage in investigating the potential of reinjection of water into the Gubberamunda aquifer from which Roma draws its water.

37 Geoscience Australia & Dr M A Habermehl, *Summary*.

2.50 The committee recognises that the accumulation of understanding of the system is a major undertaking.

> To resolve the issues of water extraction ... across several development proposals and thousands of wells requires a good characterisation of basin geology and how it controls groundwater pressures, flows, connections and quality. This will help to answer the critical question of how much leakage will occur between coal seam beds and useable aquifers.[38]

2.51 The development of the necessary knowledge is heavily dependent on the research work being carried out by the gas companies. Exploration bores are expensive and, without commercial incentives, including a level of security that discovery of commercial quantities of a resource will lead to production of that resource, it is unlikely that industry would undertake the necessary research.

2.52 Origin Energy report that early production experience in Queensland suggests that the volume of water required to be removed from coal seams is significantly less than was predicted in the early stages of development.[39] While this is welcome it does underline the uncertainty with regard to the reliability of estimated impacts.

2.53 In this situation it appears that the best workable compromise is that future production approvals be delayed until comprehensive modelling at a regional level is undertaken and sufficient data is accumulated to ensure the robustness of the modelling and that no individual project be given approval unless it has been fully assessed in terms of the cumulative impact of all proposals in a given region.

2.54 The Queensland Government is developing "...a regional groundwater model to predict possible cumulative impacts of CSG extraction" including data provided by the CSG companies.[40] CSIRO and Geoscience Australia have also been commissioned by the Commonwealth to undertake "...a basin-scale investigation of water resources to fill knowledge gaps about the status of water resources in the basin and the potential impacts of climate change and resource development".[41] This study is expected to be completed by the end of 2012.

2.55 In New South Wales the Namoi Water catchment includes most of the area currently subject to exploration for coal seam gas. The catchment is the subject of a study undertaken:

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38 I. Prosser, L. Wolf & A. Littleboy, *Water in Mining and Industry*, in CSIRO, *Water*, (2011), p. 144.

39 Data from Origin, Santos, QGC and Arrow was combined for presentation at a recent series of APPEA Water Forums, and indicates that the current estimated average production volumes over the following 30 years is 75,000ML/year (75GL/year), which is approximately 20% lower than that estimated at the time of submission of the 3 approved EIS's. Letter to the committee, A Moser, Groundwater Manager, Origin Energy, 8 November 2011.

40 Queensland Government, *Submission 358*, p. 9.

41 CSIRO, http://www.csiro.au/science/Great-Artesian-Basin-Assessment.html.

- To provide a spatial understanding of underground and surface water flows in the catchment ... [and]
- To undertake a strategic assessment of the likelihood of potential impacts posed by coal and gas developments in the Namoi catchment on the quantity and quality of surface and ground water resources in the catchment.[42]

2.56 In view of the consensus of expert opinion that detailed regional studies of underground water should be undertaken before CSG production is approved, and given the comment quoted above from CSIRO that the Namoi catchment is "... one of the most intensely exploited groundwater resources in Australia", it is clearly desirable that no production permits should be approved for this region prior to the completion and evaluation of this study. The study is scheduled for completion in April 2012.

2.57 In this committee's opinion, in view of the levels of uncertainty acknowledged by professional bodies and industry, the production approvals for the initial projects in Queensland were given prematurely. Studies that are underway should have been completed and their implications fully assessed and recommended studies such as that in the Geoscience Australia/Habermehl report should have been undertaken.

Recommendation 3

2.58 The committee recommends that, given the degree of uncertainty about the long-term consequences of the CSG industry on the water resources of the Great Artesian Basin, that the Commonwealth not give any further approvals for production of CSG in that part of the Murray-Darling Basin overlying the Great Artesian Basin pending the completion of the Queensland Government's regional groundwater model and the CSIRO & Geoscience Australia basin scale investigation of water resources.

Recommendation 4

2.59 The committee recommends that the Commonwealth await the completion of the Namoi Catchment study before considering any applications under the Water Act or the *Environment Protection and Biodiversity Conservation Act 1999* for approvals to undertake coal seam gas production.

Recommendation 5

2.60 The committee recommends that all future CSG development approvals should be preceded by the development of "... a regional-scale, multi-state and multi-layer model of the cumulative effects of multiple developments" of ground and surface water as recommended by Geoscience Australia.

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42 Namoi Water Catchment Study, Terms of Reference, http://www.namoicatchmentwaterstudy.com.au/client_images/966741.pdf

2.61 The potential for the resource industries generally to require special regulation was recognised in the National Water Initiative (NWI):

> Under clause 34 of the NWI the signatory governments agreed that there may be special circumstances facing the petroleum and minerals sectors that need to be addressed by policies and measures beyond the scope of the NWI Agreement.

2.62 The NWC paper notes that "...little progress has been made ... in fleshing out the special provisions for the minerals, petroleum and related industries. As a consequence, there has been little integration of those industries with broader water markets and water planning processes".[43]

2.63 The committee notes the recent announcement by the Commonwealth that it will establish an Independent Expert Scientific Committee to advise the Commonwealth on 'best practice' for the CSG industry. This body may assist in the better integration of the CSG industry with broader water policy. It needs to be noted that this body is primarily to advise the states, which will continue to be the primary regulator of the CSG industry. If implemented as currently envisaged by the Commonwealth Government the states will only need to "take account" of that advice.

2.64 The committee is concerned that the impact of the coal seam gas industry on the Great Artesian Basin is being considered in a piecemeal way. Approvals for the first two CSG projects in Queensland only considered their likely impact at the level of the individual project.

2.65 Later approvals now require an assessment of the regional or cumulative impacts. However given that the Great Artesian Basin in the areas subject to intensive CSG development does not fit neatly into state boundaries, the committee believes that it is important to assess cumulative impacts on the Basin of all projects. The Commonwealth has two main legal avenues to do this.

2.66 The *Water Act 2007* (C'wealth) at section 255 AA states that:

> Prior to licences being granted for subsidence mining operations on floodplains that have underlying groundwater systems forming part of the Murray-Darling system inflows, an independent expert study must be undertaken to determine the impacts of the proposed mining operations on the connectivity of groundwater systems, surface water and groundwater flows and water quality.

2.67 This part of the Act has been used by the Commonwealth to require independent studies of CSG proposals. However the committee believes it would improve the approval system to go further and include the relevant parts of the GAB in the definition of Murray-Darling Basin water resources. This would make it explicit that 'groundwater' included the deep aquifers of the GAB.

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43 National Water Commission, Position Paper, *Coal Seam Gas and Water Challenge*, December 2010

2.68 The general object of the Commonwealth's *Water Act 2007* is "... to enable the Commonwealth, in conjunction with the [Murray-Darling] Basin States, to manage the Basin water resources in the national interest", and specifically to:

> (i) to ensure the return to environmentally sustainable levels of extraction for water resources that are overallocated or overused;
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> (ii) to protect, restore and provide for the ecological values and ecosystem services of the Murray-Darling Basin (taking into account, in particular, the impact that the taking of water has on the watercourses, lakes, wetlands, ground water and water-dependent ecosystems that are part of the Basin water resources and on associated biodiversity); and
>
> (iii) subject to subparagraphs (i) and (ii)—to maximise the net economic returns to the Australian community from the use and management of the Basin water resources.[44]

2.69 The Act specifically excludes "ground water that forms part of the Great Artesian Basin".[45] The committee believes that the effective management of the Murray-Darling Basin, having regard to the objects set out in section 3 of the Act, requires management of the surface and underground water in an integrated manner.

Recommendation 6

2.70 The committee recommends that the Commonwealth take the necessary steps to amend the *Water Act 2007* to include that part of the Great Artesian Basin that underlies the Murray-Darling Basin within the definition of Basin water resources.

2.71 The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) also has a significant part to play in regulating the coal seam gas industry. One of the specific 'triggers' for review of a project under this Act is that it may pose a threat to Ramsar wetlands and "...listed threatened species or endangered ecological communities".[46]

2.72 The committee notes the view expressed by CSIRO that the GAB:

> ... is one of the world's largest continuous groundwater systems and supports hundreds of springs and wetlands, many of which are listed as significant by the Ramsar Convention on Wetlands of National Importance.[47]

2.73 The approvals for the three projects currently in the production phase in Queensland – QGC, Santos and AP LNG – all required approval under the EPBC Act for, among other things their potential impact on Ramsar listed wetlands and the

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44 *Water Act 2007* (C'wealth), s.3 (a) & (d).

45 *Water Act 2007* (C'wealth), s.4 (1)

46 *Environmental Protection and Biodiversity Conservation Act 1999* (C'wealth), s.16 & 18

47 Andrew Herczeg, *Groundwater*, in CSIRO, *Water*, (2011), p.56

communities of native species dependent on natural discharge of groundwater from the GAB.

2.74 All the literature on the movement of groundwater in aquifers, particularly artesian aquifers, agrees that it is slow and complex and that the consequences of changes in one part of the system may take many years to show up in another place. Therefore protecting wetlands and springs ultimately dependent on the GAB must require consideration of 'actions having a significant impact' on the GAB generally, not just in the specific area of the particular spring or wetland.

Recommendation 7

2.75 The committee recommends that the Commonwealth take the necessary steps to amend the *Environmental Protection and Biodiversity Conservation Act 1999* to include the sustainable use of the Great Artesian Basin as a 'matter of national environmental significance'.

Subsidence

2.76 Land subsidence as a result of water and gas extraction has been raised as an issue for the industry. There is concern that significant subsidence could alter surface drainage patterns, with a serious detrimental impact on agriculture on the affected land.

2.77 Extraction of groundwater is a common cause of land subsidence. However the incidence of subsidence is a product of the geology both of the seams from which the water is extracted and the surrounding layers. In the case of coal seams they are largely composed of consolidated material with a very limited capacity for compaction.

2.78 The committee notes the conclusion of Geoscience Australia's advice to the Australian Government on this question: that although "...there is a likelihood of subsurface subsidence and that this could result in surface subsidence...we consider the risk of impacts to surface water and shallow groundwater systems is very low".[48]

2.79 The advice went on to recommend that monitoring by two of the three proponents be "... strengthened by assessing deformation at the land surface". Both surface and subsurface monitoring by the third proponent was considered appropriate.[49]

2.80 The committee has been advised that the three proponents considered in the Geoscience Australia advice, QGC, Santos and AP LNG, plus Arrow Energy have now combined and:

48 Geoscience Australia & Dr M A Habermehl, *Summary*

49 Geoscience Australia & Dr M A Habermehl, *Summary*

> ... have commissioned a regional Interferometric Synthetic Aperture Radar study of historical and current earth surface movements to provide certainty for regulatory and public concerns.[50]

Recommendation 8

2.81 The committee recommends that all future approvals require independent comprehensive monitoring of regional earth surface movements to assess whether any measurable subsidence is occurring. Where subsidence occurs and has an adverse effect on land management or the natural environment, for example by altering drainage, the responsible gas companies would be liable for any necessary remediation. Further all gas exploration and/or production in an area subject to subsidence or impacts from subsidence not foreseen in the EIS should cease until action is taken to ensure that no further damage will occur. Where subsidence occurs in a gas producing region the onus lies with the gas companies to demonstrate that the subsidence is not a result of gas production activities.

Fraccing

2.82 Much of the anxiety about this industry has focussed on the process of flow enhancement by hydraulic fracture. Fraccing has become almost synonymous with the industry as a whole and a shorthand for a wide range of anxieties about the industry.

2.83 As described in the introduction methane, is trapped in pockets or cleats within coals seams. If those seams are relatively open, once the water pressure in them is reduced, the gas will flow. However in some seams the cleat system is too tight to permit easy gas flow and the seam must be opened by fraccing. Fraccing may also be used to increase the efficiency of individual wells thus reducing the number of wells that need to be drilled.

2.84 This involves the injection of large volumes of water, up to 10 megalitres according to CSIRO,[51] mixed with chemicals and sand directly into the target seam to cause cracks to run through the seam; the sand is there to hold the cracks open after the fraccing water is withdrawn. The chemicals have a number of functions, principally to keep the sand in suspension in the water. After fraccing most of the fluid used, including chemicals is withdrawn from the well. The fluids extracted contain both the fraccing chemicals and other chemicals mobilised in the coal seam plus other elements including heavy metals.

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50 E-mail advice, Andrew Moser, Groundwater Manager, Origin Energy, 8 November 2011.

51 CSIRO, *Coal Seam Gas Fact sheet no.3,* p.2.

Recommendation 9

2.85 The committee recommends that it be a requirement of all exploration or production approvals that the fluids extracted from wells after fraccing are kept isolated in secure separate storages and prior to disposal are treated to the highest standards.

2.86 Fraccing is not a new process; it has been practiced in Australia and overseas for many years. It is not in the industry's interest for fraccing to cause unintended damage or leakage into adjacent aquifers during the productive life of the well – that would defeat the purpose of the frac.

2.87 It is important to note that fraccing is not necessary in a large proportion of wells and there are alternative and less intrusive methods of encouraging gas flow. Eastern Star Gas has stated that there is no requirement to use fraccing in its Narrabri, NSW, project:

> Fraccing was tried at Narrabri but the process was found to be unsuitable ... Lateral wells as now utilised are much more efficient and cost effective.[52]

2.88 Similarly Dart Energy, which is undertaking exploration activities in the Newcastle region of NSW indicated that they would rely on horizontal drilling rather than fraccing.[53] AP LNG estimates that approximately 30% of its wells will require fraccing. Note that fraccing and horizontal drilling are not mutually exclusive production methods. Horizontal wells may be fracced. This will reduce the impact of drilling on the land surface.

2.89 In addition to the potential of fraccing to cause damage to geological structures public concern has focussed on the toxicity of the chemical additives in the fraccing fluid and the potential of the fraccing process to mobilise naturally occurring BTEX chemicals. The industry has tended to play down the potential risks associated with the chemical additives used in fraccing, pointing out that they are subject to stringent regulation requiring testing of water both before and after their use, reporting to the authorities and landholders and publication of the chemicals used.[54] However the wide discrepancies in the lists of chemicals used suggests that there is a need for more stringent reporting requirements. There must be a public listing of all fraccing chemicals used by the industry.

2.90 The chemicals represent a small proportion of the fluid and are almost all present in ordinary household products:

> Materials used in the fracturing process include around 99% water and sand, as well as about 1% of a range of chemicals in minute, diluted

52 Eastern Star Gas, *Gas Production well Design- No Need for Fraccing*, undated publication, provided to the committee secretariat.

53 Mr Robert de Weijer, CEO, Dart Energy Ltd, *Committee Hansard*, 9 September 2011, p. 18.

54 See, for example, AP LNG, *Submission 366*, pp 44–46.

> quantities, which assist in carrying and dispersing the sand in the coal seam. The chemicals are not specific to the CSG industry and have many common uses such as in swimming pools, toothpaste, baked goods, ice cream, food additives, detergents and soap.[55]

In addition, it is claimed, residues of the chemicals used quickly degrade.

2.91 The chemicals, when used in household products, are very carefully regulated as to concentrations and use. For example, hydrochloric acid is included in one company's list of fraccing chemicals with the note that it is used in swimming pool maintenance while caustic soda is described as being used as a cleaning agent and in food preparation. At different concentrations or 'not used as directed' many of these chemicals can in fact be extremely dangerous.

2.92 Critics point out that while the proportions may be small the actual amounts used and the residue left in the ground can be very large:

> Environmental authorisations by Queensland regulators identified that in one CSG operation, approximately 18,500kg of additives were to be injected during the hydraulic fracturing process in each well, with only 60% of these recovered and up to 40% of the hydraulic fracturing fluid volume remaining in the formation, corresponding to 7,400kg of chemicals per injection well.[56]

2.93 It is beyond the resources of this committee to settle the claims and counter claims with regard to the safety of the chemicals used in the fraccing process. However it was claimed by the National Toxics Network that,

> In Australia, a review of a selection of CSG companies' environmental authorisations identified 23 compounds commonly used in fracking fluids. Australia's industrial chemical regulator, the National Industrial Chemical Notification and Assessment Scheme (NICNAS) has assessed only 2 out of the 23.[57]

2.94 The committee heard from NICNAS and formed the impression that it is drastically underfunded for the responsibilities it has.[58] NICNAS has considered only four of the "50 to 60" chemicals used in fraccing fluids. The wide discrepancy between the figures given for the number of chemicals used reinforces the need for a public listing of all chemicals used by the industry.

2.95 NICNAS does establish priorities for reviewing chemicals and relies on assessments conducted in other countries that have similar regulatory systems and

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55 Santos, *Submission 353*, p. 29.

56 Coal Seam Hydraulic Fracturing Fluid Risk Assessment. Response to the Coordinator-General Requirements for Coal Seam Gas Operations in the Surat and Bowen Basins, Queensland. Golder Associates, 21 October 2010, in National Toxics Network, *Submission 227*, p. 10.

57 National Toxics Network, *Submission 227*, pp 9–10.

58 *Committee Hansard*, 9 September 2011, pp 40–56.

standards to Australia in deciding whether review of a particular chemical is a matter of urgency. In addition, many of the chemicals used by the gas industry have been in common use in this country for many years and were 'grandfathered' on to NICNAS registers and may never have been subject to assessment in the way that new chemicals are.

Recommendation 10

2.96 The committee recommends that the Commonwealth provide funds to NICNAS to enable that organisation to undertake a comprehensive review of the chemicals used in fraccing, having particular regard to the quantities, combinations of chemicals and the way in which these chemicals are used and to confirm safe levels for their use. This study should be completed within the next two years. The Commonwealth and state governments should act promptly to ensure all fraccing activities comply with any NICNAS recommendations.

2.97 The committee notes that the BTEX group of chemicals which have attracted some comment are not permitted to be used as fraccing chemicals in either Queensland or NSW.[59]

2.98 The responsibility for licensing the use of these chemicals in mining lies with state authorities, who do not have to take NICNAS's findings into account.[60] Action needs to be taken by the Commonwealth and state governments to ensure all fraccing activities comply with any NICNAS recommendations.

2.99 A second major cause of anxiety with regard to fraccing is the physical impact of the process on the coal seams and the surrounding formations. Here again there are disputed claims about the safety of the process. Recent publicity of fraccing carried out in shale formations in north-west England has talked of explosions and minor earthquakes.

2.100 CSIRO has described fraccing as "... injecting fluid ... under high pressure into the cased well. The pressure caused by the injection typically creates one fracture in the coal seam where the well is perforated that ... might typically extend to a distance of 200 to 300 metres from the well. The fracture will grow slowly ... an average velocity may be less than 10 metres per minute initially and slowing to less than 1 metre per minute ...".[61]

2.101 In contrast, the industry describes the process thus:

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59 BTEX is a shorthand for benzene, toluene, ethylbenzene and xylelnes which are found in association with petroleum products. Though not permitted to be used as fraccing chemicals naturally occurring BTEX may be found in coal seams and extracted water and is present in petroleum fuels and lubricants used in industry and agriculture.

60 *Committee Hansard*, 9 September 2011, p. 54.

61 CSIRO. *Coal Seam Gas Factsheet no. 3*, July 2011, p.1

> Hydraulic fracturing is not an explosive or high impact process. It involves pumping a specifically blended fluid, charged with proppants[62] such as sand, down a well at sufficient pressure to force small passageways into the coal seam.[63]

2.102 There is a risk that fraccing, in addition to opening up the coal seam, might also affect geological structures surrounding the coal seam thus allowing the movement of gas and/or water from the seam into adjacent aquifers or conversely allowing groundwater to flow from the aquifer into the depressurised coal seam. Secondly, there is a risk that residues of chemicals used in fraccing may contaminate groundwater and aquifers used for human or stock consumption or irrigation.

2.103 It is acknowledged that in one case in Australia, fraccing resulted in damage to the Walloon Coal measures, causing leakage between that and the Springbok aquifer. While apparently the damage was eventually made good by sealing the damaged area, submissions to the committee raised a number of concerns:

- that there seemed too little accountability. It is claimed that the company involved did not advise the government for 13 months and the Commonwealth Water minister may never have been advised;
- that the potential for damage to occur was known prior to the fraccing and that this was treated as an acceptable risk;
- that part of the boundary between the aquifer and the coal seam was intentionally fracced; and
- that it took 21 months to seal the interconnection.[64]

2.104 The Geoscience Australia report to the Commonwealth concluded that "... the potential risks posed by fraccing are low". While fraccing would "... fundamentally alter the structure of the targeted coal seam aquifers" and that "... the potential for fraccing activities to impact on ... other aquifers and aquitards ... can never be completely eliminated ..." the report concluded that the measures adopted would minimise any risk.[65]

2.105 The Queensland Government has tightened its regulations with regard to fraccing, requiring notification to landholders both before and after a frac and comprehensive reporting to the Government within two months which must include details (and volumes) of all the chemicals.[66] These details should be made public to

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62 Proppants are substances, usually sand, included in fraccing fluids to hold open the fissures made in the rock, allowing the gas to flow.

63 Santos, *Submission 353*, p. 29.

64 Anne Bridle, *Submission 328*, p. 30.

65 Geoscience Australia & Dr M A Habermehl, *Summary*, pp 4–5.

66 Queensland Government, *Submission 358*, pp 20–21.

afford the opportunity for independent evaluation of the health implications of the chemicals.

2.106 With regard to contamination from fraccing fluids, CSIRO advised the committee that "The risk associated with contamination from fracking is a fairly small-scale, low-volume risk associated with a particular well bore".[67]

2.107 The committee accepts that fraccing is an established practice in the industry for which there is many years experience and accepts Geoscience Australia's assessment of the risks involved. However the incident referred to above where fraccing did damage an adjacent aquifer does emphasise the need for the applicable regulatory regimes to be backed up by an independent regulatory agency with the capacity to impose significant penalties for breaches of the regulations.

67 Dr J Underschultz, Theme leader, Petroleum and Geothermal Portfolio, CSIRO, *Committee Hansard*, 9 August 2011, p. 68 .