Chapter 4

Impacts of water extraction

4.1 This chapter examines some of the impacts of water extraction, including environmental, economic, cultural and social impacts. The benefits that arise from activities associated with the extractive industry are also considered.

4.2 The Committee acknowledges that the impacts of water extraction are not limited to water taken by the extractive industry.[1] However, given the terms of reference of this inquiry, this chapter focuses on impacts arising from extractive activities.

Background

4.3 The Minerals Council of Australia noted that proponents of proposed extractive industry projects must draw on detailed scientific analyses in their proposals, including data collection, analysis of potential impacts and water models that integrate local and regional data. As outlined in Chapter 3, regulators may also draw on independent specialist and technical advice when making decisions.[2]

4.4 Because much of the research on impacts by extractive industry activities is fragmented or still emerging, understanding of some types of impacts remains limited. The Law Council of Australia (LCA) stated that knowledge of how underground water extraction impacts on surface water resources and dependant vegetation and ecosystems 'remains patchy'.[3] This sentiment was echoed by Ms Revel Pointon from the Environmental Defenders Office Queensland:

> …one of the biggest risks is that we don't know a lot of the impacts that we are having, especially on our groundwater basins, due to the insufficient understanding of how they interact with each other and the impact of the resource industries on them.[4]

4.5 Evidence provided to this inquiry indicated that the type and extent of impacts depend on local geography and conditions, the nature of the extractive activity and the methods that it employs.[5] Central to whether these impacts take place is how well a company manages and monitors the specific risks that arise from their operations. For example, Buru Energy Limited noted that '[i]n petroleum well activities, the integrity

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1 Dr Stuart Minchin, Chief, Environmental Geoscience Division, Geoscience Australia, *Committee Hansard*, 2 May 2018, p. 42. See also International Association of Hydrogeologists, *Submission 9*, pp. 3–4.

2 Minerals Council of Australia, *Submission 13*, p. 1.

3 Law Council of Australia, *Submission 8*, p. 4.

4 Ms Revel Pointon, Lawyer, Environmental Defenders Office Queensland, *Committee Hansard*, 2 May 2018, p. 24.

5 Geoscience Australia, *Submission 2*, p. 4; Dr Lange Jorstad, President, Australian Chapter, International Association of Hydrogeologists, *Committee Hansard*, 2 May 2018, p. 3.

of the well is a key control for managing potential impacts to aquifers'.[6] Methods of managing well integrity to avoid or remediate negative impacts may include proper well design and construction, monitoring and appropriate decommissioning of the well at the end of its active life. One specific risk that uranium mining companies must manage, which may not be relevant in other types of extractive industries, is radioactive discharge into water.[7]

4.6 The Australian Petroleum Production and Exploration Association argued that because government agencies closely monitor potential impacts on water resources and industry itself imposes risk management measures and safeguards, the possibility of negative impacts on water resources occurring are minimised.[8] Buru Energy highlighted its post-operational monitoring of groundwater at its petroleum well sites, occurring on a 6 monthly basis, with results of the monitoring published on its website. It contended that the 'demonstrated lack of groundwater contamination…restricts the potential for negative social, economic or environmental impacts'.[9]

4.7 The inquiry received evidence emphasising that many of the impacts of extractive activities are long-term. Australian Farmers for Climate Action submitted that extractive industries have 'positive and negative impacts on rural and regional Australia, with short term economic gain often being negatively outweighed by long term negative environmental and social impacts'.[10] The Environmental Defenders' Offices of Australia argued that many impacts arising from the extractive industry's use of underground water are irreversible, and some groundwater bores and springs may never function again. Where recovery is possible, it may take hundreds or even thousands of years.[11]

4.8 The International Association of Hydrogeologists, while acknowledging that timeframes for the full restoration of some resources may take decades, contended that 'mitigation measures are designed to support or compensate for the affected values of the groundwater resource until the values are eventually restored'.[12]

4.9 The Committee heard that one of the major challenges for regulators making decisions about the impacts of proposed projects is the time needed for impacts on groundwater to become apparent, including, sometimes, after mines have closed.[13]

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6 Buru Energy Limited, *Submission 14*, p. 3.

7 Geoscience Australia, *Submission 2*, p. 2.

8 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, pp. 2, 3.

9 Buru Energy Limited, *Submission 14*, p. 3

10 Australian Farmers for Climate Action, *Submission 6*, p. 2. See also Mr Mark McKenzie, Chief Executive Officer, New South Wales Irrigators Council, *Committee Hansard*, 2 May 2018, p. 9.

11 Environmental Defenders' Offices of Australia, *Submission 4*, p. 5.

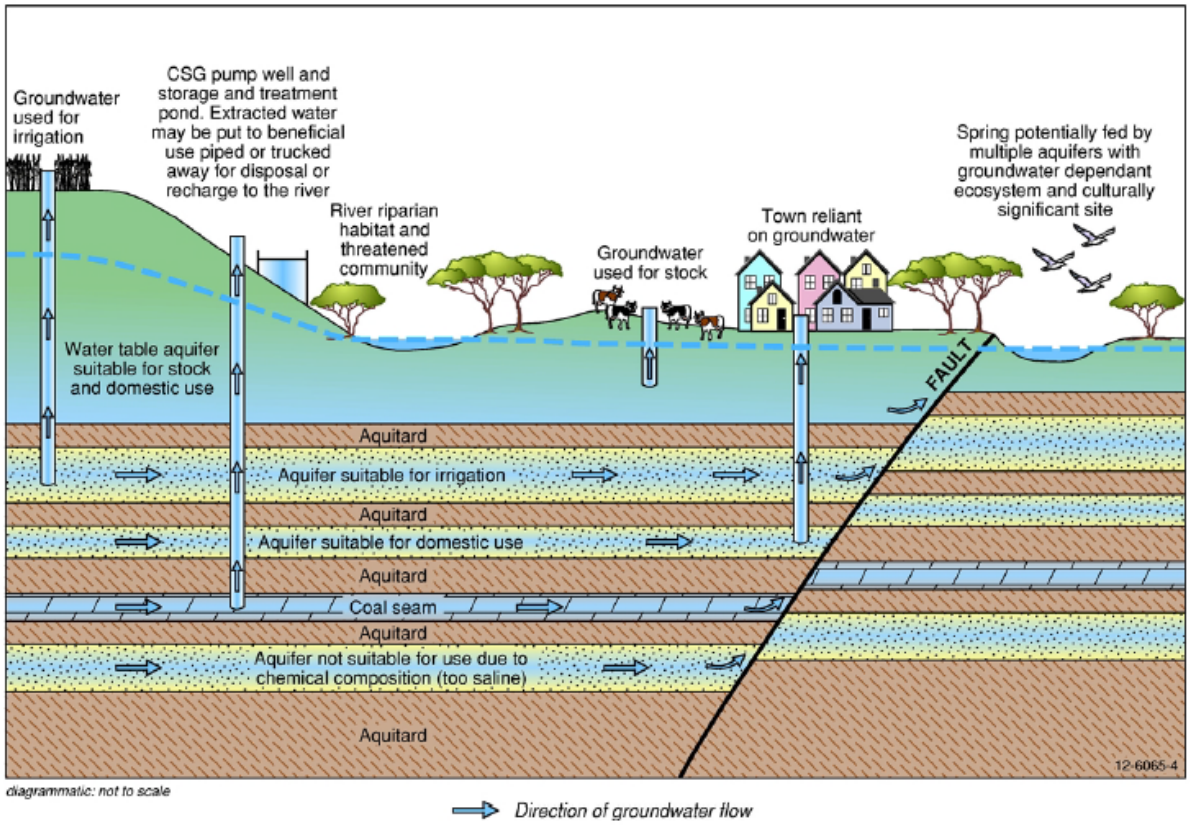
12 International Association of Hydrogeologists, *Submission 9*, p. 4.

13 Geoscience Australia, *Submission 2*, p. 7.

Even after mine rehabilitation is complete, water may continue to leak through evaporation from final voids or from aquifers that have had their structure permanently changed. This issue is outlined further in Chapter 3.[14]

4.10 It should be remembered that there may be several water users in a particular area, including extractive industries, and these different methods of extracting water may interact with each other (see Figure 4.1).

Figure 4.1: Schematic hydrogeological diagram showing how several land uses may interact with groundwater resources[15]



Source: Geoscience Australia

Environmental impacts

4.11 The scale and extent of environmental impacts depend on local conditions and geography. For example, the Northern Territory Government's inquiry into hydraulic fracturing noted that 'impacts on arid zone groundwater systems are likely to be greater and occur for longer, because these systems are recharged far more slowly, if at all'.[16]

14 Environmental Defenders' Offices of Australia, *Submission 4*, p. 9.

15 Geoscience Australia, *Submission 2*, p. 5.

16 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 108.

4.12 Groundwater and surface water are often interconnected and interdependent, with impacts on one part of a water resource regularly extending to others. Recent recognition of this interconnectivity has increasingly led to management of different water resources 'as different parts of a single water system'.[17]

4.13 In broad terms, major environmental impacts on groundwater that may arise from large extractive industry projects include:

- groundwater depressurisation and pressurisation;
- decreased water quantity for other users;
- changes to geographical structures;
- groundwater contamination;
- loss of habitat for groundwater-dependent ecosystems;
- changes in water quality;
- potential seismic activity arising from aquifer reinjection;
- specific impacts arising from hydraulic fracturing;
- legacy water impacts from abandoned mines; and
- cumulative impacts to water sources.[18]

Groundwater pressurisation and depressurisation

4.14 As outlined in Chapter 2, some extractive industries inject water or other fluids into groundwater, whether to remove minerals from the ground or for waste disposal. This injection may increase or decrease groundwater pressure and can lead to negative consequences, such as introducing poor quality groundwater into other formations or changing the flow paths between aquifers, resulting in new connections, pressure changes and the mixing of different groundwater chemistries.[19]

4.15 Lock the Gate Alliance contended that the impacts arising from loss of pressure and drawdown of Great Artesian Basin aquifers through coal seam gas extraction would be long term.[20]

4.16 Dr Lange Jorstad from the International Association of Hydrogeologists acknowledged that impacts arising from extractive processes:

> …can either dewater or depressurise a groundwater resource. Some of those groundwater resources take a very, very long time to recover and during that time the access to that groundwater is diminished for everyone else and

17 Geoscience Australia, *Submission 2*, p. 2.

18 Geoscience Australia, *Submission 2*, pp. 2–3; NSW Irrigators' Council, *Submission 11*, p. 5.

19 Geoscience Australia, *Submission 2*, p. 6.

20 Lock the Gate Alliance, *Submission 28*, p. 5.

> every other ecological groundwater-dependent system to regain that access.[21]

Decreased water quantity

4.17 The Committee heard that water extraction can lead to decreased water quality. The University of Queensland's Centre for Coal Seam Gas submitted that water extraction by resource tenure holders may 'lower water levels in adjacent areas to where the activities are being undertaken', leading to decreased water quantity in water bores and springs in surrounding areas.[22] The Centre's submission outlined ways in which resource tenure holders must remediate potential impacts to water quantity in Queensland, including monitoring, entering into make-good agreements with bore owners and preparing underground water impact reports.[23]

4.18 The Basin Sustainability Alliance argued that water extraction by the coal seam gas industry in the Surat Basin had led to the depressurisation of two aquifers 'to the extent that the agricultural sector is not permitted to construct any new bores into these two aquifers for intensive animal production or irrigation uses'.[24]

4.19 The Northern Territory Government's inquiry into hydraulic fracturing stated in its final report that 'excessive water extraction can potentially cause perennial rivers to become intermittent or temporary'.[25] Lock the Gate Alliance expressed concern that the Adani Carmichael project in Queensland would 'fundamentally change' the Carmichael River:

> The river will lose 25 percent of its catchment area, lose groundwater discharge into the river, and the proportion time the river experiences zero flow will increase. At least 65 springs will be affected and the Carmichael River will experience 1–4 metres of drawdown. The combined effect of drawdown and lost baseflow of 1,000ML will increase zero flow periods of the river by 30–60%. Impacts on the river are predicted to extend 10km upstream and 25km downstream of the mine.[26]

4.20 Ms Elizabeth Laird, a member of the Maules Creek community in New South Wales, argued that Maules Creek had experienced a serious decline in bore water levels over the 10 months prior to September 2018, with 'bores that have held for 60 years' running dry. Ms Laird suggested that this may have been a result of local mining drawdown of underground water resources. She further expressed her concerns that bore failure could impact bushfire fighting efforts:

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21 Dr Lange Jorstad, President, Australian Chapter, International Association of Hydrogeologists, *Committee Hansard*, 2 May 2018, p. 4.

22 University of Queensland, Centre for Coal Seam Gas, *Submission 18*, p. 5.

23 University of Queensland, Centre for Coal Seam Gas, *Submission 18*, p. 9 (p. 5 of legal overview included in submission).

24 Basin Sustainability Alliance, *Submission 20*, p. 9.

25 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 163.

26 Lock the Gate Alliance, *Submission 28*, p. 7.

> We are facing catastrophic fire and continuing intense drought conditions. We are deeply concerned that bore failure could mean that water may not be reliably available to put out fires when we need it.[27]

4.21 Mr Peter Willis, a cattle farmer from New South Wales, expressed frustration that some of his neighbours had 'no water in their bores or a lack of pumpable water at a decent rate' while a neighbouring coal mine had dug further evaporation ponds and used sprayers so that water extracted during the coal mining process would evaporate. He emphasised that despite rainfall, 'There are bores that haven't stayed or recovered… [W]ater has just been draining out of these bores which normally never had a problem'.[28]

Changes to geographical structures

4.22 Many open-cut mines result in a final void. Where this lies below the water table, the void may become a permanent groundwater sink or 'pit lake', with groundwater continually flowing into the void and the water lost to evaporation after the closure of the mine.[29]

4.23 Geoscience Australia noted that coal seam gas mining may lead to a permanent change to the structure of an aquifer because of the removal of coal seams.[30] It further stated that reductions in aquifer pressure and volume of water can lead to cavities and voids that subsequently collapse and lead to changes in the topography of the land surface. These changes to land subsidence, in turn, can affect water flow paths, environmental flows and cause increased erosion.[31]

Groundwater contamination

4.24 Various activities associated with the extractive industry can lead to the release of contaminated groundwater. These include:

- the accidental release of naturally low quality groundwater;
- the accidental release of remnant brine or salts left over from treated groundwater;
- the accidental release of hydraulic fracturing fluid;
- leaching of contaminants from ores and waste rock, which can be made worse by acid mine drainage; and

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27 Ms Elizabeth Laird, Private capacity, *Proof Committee Hansard*, 10 September 2018, p. 12.

28 Mr Peter Wills, Private capacity, *Proof Committee Hansard*, 10 September 2018, p. 17.

29 Geoscience Australia, *Submission 2*, p. 14; Australian Farmers for Climate Action, *Submission 6*, p. 4.

30 Geoscience Australia, *Submission 2*, p. 14. See also Mr Tony Windsor MP and Mr John Clements, *Submission 23*, p. 2.

31 Geoscience Australia, *Submission 2*, p. 3. See also Ms Georgina Woods, Policy Coordinator, Lock the Gate Alliance, *Committee Hansard*, 2 May 2018, pp. 30, 32; Environmental Defenders' Offices of Australia, *Submission 4*, p. 8.

- leaks along well casings between aquifers or between underground water and the surface.[32]

4.25 The New South Wales Minerals Council referred to the 'adequacy of existing water laws and policies' in New South Wales in reducing the risk of contamination.[33] The Australian Petroleum Production and Exploration Association submitted that the risk of contamination because of well integrity or the spread of subsurface chemicals is very low:

> …the latest research by the CSIRO confirms that subsurface risks as a result of well integrity or hydraulic fracture stimulation is considered to be low, and that the risks to people or groundwater dependent terrestrial ecosystems from subsurface chemicals are considered to be very low. While a surface spill of chemical additives could affect water resources, this risk is well understood and is managed effectively by many industries…[34]

4.26 The Association further contended that the use of chemical additives in wells 'is controlled, strictly regulated and managed to minimise environmental risk'.[35]

4.27 Buru Energy stated that environmental impacts on water as a result of its activities in the Canning Basin had been negligible, with a 'demonstrated lack of groundwater contamination'.[36]

4.28 However, the Committee heard that contamination has occurred. The Conservation Council of South Australia stated that between 2001 and 2010, 120 leaking aquifer wells were identified in the south-east region of South Australia alone that required rehabilitation costing $5.5 million. The Council referred to a report by the Australian Council of Learned Academies on the shale gas industry which argued that even with a potential well failure rate of 0.5 per cent, as suggested by a number of studies, the number of wells in large shale gas fields could lead to a significant number of failed wells within an area.[37]

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32 Geoscience Australia, *Submission 2*, pp. 5–6. See also Basin Sustainability Alliance, *Submission 20*, pp. 15–16. For a specific example of contamination of surface water, specifically Sydney's drinking water catchments, see the Colong Foundation for Wilderness Ltd, *Submission 16*.

33 New South Wales Minerals Council, *Submission 15*, p. 5.

34 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 2.

35 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 14. See page 15 for a detailed list of ways in which risks of petroleum activities damaging water quality and quantity are mitigated and reduced.

36 Buru Energy Limited, *Submission 14*, p. 3.

37 Conservation Council of South Australia, *Submission 10*, p. 2; P. Cook, V. Beck, D. Brereton, R. Clark, B. Fisher, S. Kentish, J. Toomey and J. Williams, *Engineering energy: Unconventional gas production*, report for the Australian Council of Learned Academies, 2013, p. 128.

4.29 Ms Corinne Unger, a doctoral candidate at the University of Queensland, gave evidence that in parts of Queensland, groundwater contamination from abandoned mines was especially apparent, with cattle in Queensland drinking acid mine drainage. She argued that '[t]here is a whole section on Mount Oxide in North Queensland. There is bright blue water. Landholders are vulnerable to…the acid mine drainage flowing through their property'.[38]

Loss of habitat for groundwater-dependent ecosystems

4.30 Because of the interconnections between underground and surface water systems, reductions in aquifer water levels can lead to decreased flow of groundwater to surface groundwater-dependent ecosystems, such as wetlands, rivers and springs. Some of these may host endangered or threatened species or communities, particularly in areas dependent on the Great Artesian Basin.[39]

4.31 The Conservation Council of Western Australia was of the opinion that the long-term impacts of water use at the Mulga Rocks uranium deposit in the Goldfields region of Western Australia would significantly impact the ecosystems dependent on local water sources:

> …the taking water from a pristine environment that will take hundreds or thousands of years to recover is not sustainable – in fact it dramatically impacts on that water source and any future potential use of that water resource and the surrounding environment which is constantly competing for the small amount of water that exists.[40]

4.32 Within aquifers themselves, lower water tables or lower groundwater pressure may lead to a loss of habitat and changed environmental conditions for the organisms living in this environment.[41] Associate Professor Grant Hose argued that greater consideration should be given to impacts arising from water extraction on the organisms living in an aquifer:

> Any anthropogenic change to the conditions in an aquifer is likely to have an impact on what lives there and its ability to provide those functions. They are fundamentally important, and they need to be considered in assessments of any development that's going to influence aquifers.[42]

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38 Ms Corinne Unger, Private capacity, *Committee Hansard*, 1 May 2018, pp. 10–11.

39 Geoscience Australia, *Submission 2*, p. 2; Lock the Gate Alliance, *Submission 28*, p. 6.

40 Conservation Council of Western Australia, *Submission 27*, p. 21. In its response to the Conservation Council of Western Australia's submission, Vimy Resources, the company managing the Mulga Rocks uranium project, argued that its consultants had found that once water extraction had ceased, groundwater levels would gradually recover, and 'that there were no groundwater-dependent ecosystems that could be impacted as a result of the extraction'. See Response from Vimy Resources, *Submission 27*, pp. 4–5.

41 Associate Professor Grant Hose, *Submission 5*, p. 2.

42 Associate Professor Grant Hose, Department of Biological Sciences, Macquarie University, *Committee Hansard*, 2 May 2018, p. 36; Associate Professor Grant Hose, *Submission 5*, p. 2.

4.33 Associate Professor Hose explained that some of the organisms living in an aquifer play a key role in maintaining groundwater quality and distribution.[43]

Changes in water quality

4.34 As outlined above, changes to the groundwater pressure in an aquifer can alter water flow directions from adjacent formations as water flows towards the area that has been depressurised. As a result, the groundwater chemistry of water sources that were previously subject to different flows may change through mixing and degradation of groundwater quality.[44] For example, the Conservation Council of South Australia highlighted that one impact of water extraction during coal seam gas developments is potential mixing of saline and freshwater aquifers.[45]

4.35 Associate Professor Grant Hose recommended that greater emphasis be placed on impacts to water quality in regulatory decisions, given that changes to groundwater microbial communities affect their capacity to remove pollutants and contaminants to make water drinkable:

> A lot of discussion is had around the volumes of water and the amount that's extracted. What I don't see enough of in these discussions is changes to the water quality. The pure act of removing water from an aquifer can change the direction of flow. It can change how water moves. That can change the water chemistry. It can change pH. It can change dissolved oxygen or the amount of carbon in that water, and that changes the ecosystem.[46]

4.36 He further outlined that water removal from aquifers 'changes what lives there and it changes their capacity to provide ecosystem services and beneficial services that we rely on'.[47]

Aquifer reinjection and potential seismic activity

4.37 The Committee heard concerns about the impacts of reinjection of water previously extracted from aquifers. Associate Professor Grant Hose questioned the impact water reinjection has on the ecosystems living within aquifers, and called for 'further regulation and consideration and…the knowledge to underpin the decisions made around whether or not' reinjection should happen.[48]

4.38 Lock the Gate Alliance expressed reservations about the reinjection of water extracted during gas mining, stating that '[c]onsiderable research from the United

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43 Associate Professor Grant Hose, *Submission 5*, p. 2.

44 Geoscience Australia, *Submission 2*, p. 3.

45 Conservation Council of South Australia, *Submission 10*, p. 2.

46 Associate Professor Grant Hose, Department of Biological Sciences, Macquarie University, *Committee Hansard*, 2 May 2018, p. 36.

47 Associate Professor Grant Hose, Department of Biological Sciences, Macquarie University, *Committee Hansard*, 2 May 2018, p. 36.

48 Associate Professor Grant Hose, Department of Biological Sciences, Macquarie University, *Committee Hansard*, 2 May 2018, p. 37.

States, where it is widespread, has linked this practice with dramatic increases in earthquakes and other seismic activity'.[49]

4.39 Similarly, the Conservation Council of Western Australia highlighted international concerns about the impacts of reinjection:

> Re-injection schemes around the world are a challenging feat of engineering, and they are notorious for suffering problems with clogging (of the injection bores and/or aquifer), loss of efficiency and even structural/ geological instability (e.g. re-injecting waste-water near faults seems to set them off).[50]

4.40 The Northern Territory Government's independent inquiry into hydraulic fracturing concluded that '[t]here is a direct correlation reported between deep well injection and felt seismic activity'. Because of this, the inquiry recommended that all reinjection of wastewater into aquifers be prohibited until research has established that seismic activity would likely not occur.[51]

4.41 The issue of potential seismic activity arising specifically from the hydraulic fracturing process is outlined further below.

Specific impacts from hydraulic fracturing

4.42 The inquiry received evidence about the specific impacts associated with hydraulic fracturing (also known as fracking). The Australian Petroleum Production and Exploration Association argued that hydraulic fracturing has occurred without incident in various regions around Australia:

> Numerous Australian and international reviews have found that the risks associated with hydraulic fracturing can be managed effectively with a robust regulatory regime.
>
> In Queensland, around 6 per cent of all wells have been hydraulically fractured, without incident. In the Cooper Basin in South Australia, some 40 wells have been hydraulically fractured over the last 2 years. Hydraulic fracturing in the Cooper Basin has occurred for many decades without incident. In Western Australia, hydraulic fracturing has been used extensively to assist with the recovery of oil and gas from conventional resources – an estimated 800 wells have been hydraulically fractured since 1958, without incident.[52]

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49 Lock the Gate Alliance, *Submission 28*, p. 9; Ms Georgina Woods, Policy Coordinator, Lock the Gate Alliance, *Committee Hansard*, 2 May 2018, p. 32.

50 Conservation Council of Western Australia, *Submission 27*, p. 22. In its response to the Conservation Council of Western Australia's submission, Vimy Resources emphasised that its proposed reinjecting of aquifers carried minimal risk because the 'fault lines in the local area are not located anywhere near the reinjection borefield and have not been active for more than 100 million years'. See Response from Vimy Resources, *Submission 27*, p. 8.

51 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 141.

52 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 13.

4.43 The Australian Petroleum Production and Exploration Association stated that most hydraulic fracturing fluids are 90–98 per cent water and sand, with additives making up a small proportion of fluids. The few additives that could harm the environment or be dangerous for human health, it contended:

> …would need to be discharged in large quantities, over a long period, to reach concentration levels which could affect the much larger volumes of water present in aquifers…A recent report by the CSIRO found that chemicals remaining underground after hydraulic fracturing are unlikely to reach people or groundwater dependent terrestrial ecosystems in concentrations that would cause concern.[53]

4.44 The Northern Territory inquiry into hydraulic fracturing noted that although available evidence indicates hydraulic fracturing can cause low-level seismic activity, 'the magnitude of this activity is likely to be very small, with minimal or no damage to surface infrastructure'.[54]

4.45 However, the Northern Territory inquiry also outlined that shale gas operations produce significant amounts of wastewater, which may lead to contamination of surface and groundwater.[55] The inquiry identified eight specific pathways through which hydraulically fractured shale gas could contaminate ground or surface water (see Figure 4.2).[56]

4.46 The Basin Sustainability Alliance expressed concern that the quality of the water extracted through fracking 'is very toxic and presents a significant risk to surface and groundwater resources if it is not appropriately constrained and managed'.[57]

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53 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 16.

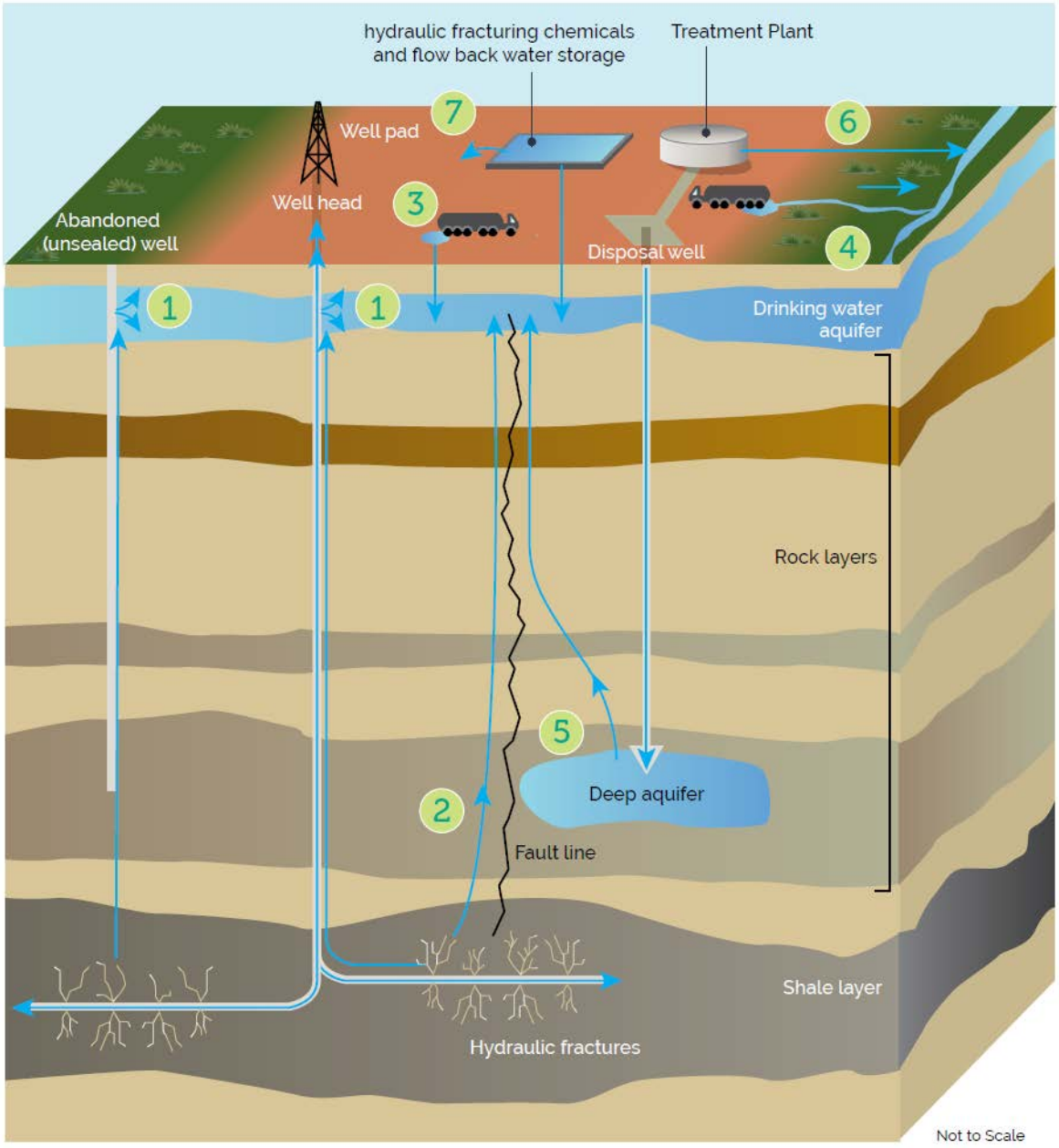
54 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 139.

55 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 141.

56 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 144.

57 Basin Sustainability Alliance, *Submission 20*, p. 16. See also Miss Helen Bender, Private capacity, *Committee Hansard*, 1 May 2018, pp. 4–5; Mr Tom Crothers, Consultant, Property Rights Australia, *Committee Hansard*, 1 May 2018, p. 36; Environmental Defenders' Offices of Australia, *Submission 4*, pp. 18–19; Conservation Council of South Australia, *Submission 10*, pp. 2–3; Miss Helen Bender, *Submission 29*, pp. 13–14.

Figure 4.2: Potential water contamination pathways from a shale gas site[58]



Path 1 - leakage of either hydraulic fracturing fluid, flowback or produced water, or methane from operating or abandoned wells;
Path 2 - contamination of shallow groundwater via fractures induced by the hydraulic fracturing process;
Path 3 - surface spills of chemicals, hydraulic fracturing fluid, flowback water or produced water at the well site or other handling facility within the well pad;
Path 4 - surface spills of chemicals, hydraulic fracturing fluid, flowback water or produced water within the well pad that is washed off-site into a waterbody;
Path 5 - reinjection of untreated wastewater to deep aquifers, with possible seismic activity and fault reactivation;
Path 6 - direct discharge of treated or untreated wastewaters to surface waters or drainage lines;
Path 7 - overtopping or failure of wastewater storage ponds;
Path 8 - spills during transport of chemicals or wastewater from either road transports or pipelines (not shown).

Source: Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

58 Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, *Final Report*, April 2018, p. 145.

Legacy water impacts from abandoned mines

4.47 A further issue when considering the water impacts of mining operations is that of ongoing environmental impacts from historical mines that have been abandoned. In some cases these mines operated prior to modern environmental standards being in place, and continue to impact their surrounding environment.

4.48 A primary issue in relation to many of these sites is that of acid and metalliferous drainage (AMD), whereby the weathering of reactive sulphide rock exposed by mining activities results in acidic or otherwise toxic water runoff. This problem can significantly affect local ecosystems, with prominent examples in Australia including the Mt Lyell mine in Tasmania, where AMD from historical waste rock dumps is still causing significant contamination to the Queen and King River systems; and the Rum Jungle mine in the Northern Territory where copper and other heavy metals and acids have polluted the surrounding environment.[59]

4.49 In addition to AMD, other water-related impacts of closed and abandoned mines can include:

- unknown long term groundwater interactions between mine features and their surrounding environment;
- changes to groundwater quality as a result of saline pit lakes forming in mine voids; and
- decreased surface water quality as a result of mixing with contaminated drainage from mine features.[60]

4.50 The Committee was told that abandoned mines may continue to impact water sources after their closure. Ms Corinne Unger stated that 'it is evident from research that water impacts are a significant closure legacy' for mines.[61] Ms Unger added that a major environmental impact from early mine closure is acid and metalliferous drainage from remaining resources that have not been depleted as planned.[62]

4.51 Ms Unger argued that '[w]ater impacts from abandoned mines do harm aquifers and water systems, but these impacts are largely undocumented, unquantified and unregulated' (see Chapter 3 for further discussion of this regulatory gap).[63] Ms Unger referred to a report from the New South Wales Auditor General in 2012

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59 See: EPA Tasmania, 'Mt Lyell Acid Drainage Remediation', http://epa.tas.gov.au/epa/water/remediation-programs/mt-lyell-acid-drainage-remediation (accessed 30 May 2018); Rum Jungle Traditional Owner Liaison Committee, *Submission 31*, p. 4.

60 Ms Corinne Unger, Private capacity, *Committee Hansard*, 1 May 2018, pp. 9-10.

61 Ms Corinne Unger, *Submission 24*, p. 1.

62 Ms Corinne Unger, *Submission 24*, p. 6, citing Laurence, 2006; Ms Corinne Unger, Private capacity, *Committee Hansard*, 1 May 2018, p. 9.

63 Ms Corinne Unger, *Submission 24*, p. 2.

which suggested that '[d]erelict mines may represent the State's largest category of contamination liability'.[64]

4.52 Geoscience Australia recommended that consideration be given to 'how long-term water use by extractive industry projects approved under Commonwealth legislation will be monitored and managed after the active mining phase', given that groundwater impacts may take years or decades to become apparent.[65]

Cumulative impacts

4.53 Cumulative impacts are the combined, incremental and successive impacts of one or more activities.[66] Geoscience Australia noted that the cumulative impact of developments in areas where there are several extractive industry projects 'on water resources can be greater and more regional in extent than single developments'.[67]

4.54 A number of submitters expressed concerns about the extent of knowledge about cumulative impacts across regions. For example, the Nature Conservation Council of NSW suggested that the cumulative impacts of long-term groundwater use by mining and coal seam gas projects has not been assessed adequately.[68] The Environmental Defenders' Offices of Australia argued that significant uncertainty remains 'as to how many groundwater basins interconnect and therefore the impacts that mining and gas projects will have on our groundwater systems'.[69]

4.55 Dr Gavin Lind, the Director of Workforce and Health, Safety, Environment and Communities at the Minerals Council of Australia drew the committee's attention to the Minerals Council's cumulative environmental impact assessment industry guide. He stated that cumulative impact 'is a consideration that we as an industry strongly believe you can measure and you should measure'.[70]

4.56 However, Dr Lange Jorstad from the International Association of Hydrogeologists acknowledged some of the difficulties inherent in assessing cumulative impacts:

> One of the key things that is not often well captured is the cumulative effect of multiple extractive projects within a small geographical area…Often when, say, a consultant is engaged by a mining company to assess the impact of a specific project, they may not have access to the information for

64 Ms Corinne Unger, *Submission 24*, p. 4, citing New South Wales Audit Office, 2012.

65 Geoscience Australia, *Submission 2*, p. 7. See also Dr Stuart Minchin, Chief, Environmental Geoscience Division, Geoscience Australia, *Committee Hansard*, 2 May 2018, p. 40.

66 Geoscience Australia, *Submission 2*, p. 6, citing Franks et al, 2010.

67 Geoscience Australia, *Submission 2*, p. 7.

68 Nature Conservation Council of NSW, *Submission 7*, p. 3.

69 Environmental Defenders' Offices of Australia, *Submission 4*, p. 6.

70 Dr Gavin Lind, Director, Workforce and Health, Safety, Environment and Communities, Minerals Council of Australia, *Committee Hansard*, p. 27.

> the next mine operated by someone else, with a different consultant providing that service, and you tend to get maybe a bit of guesswork…[71]

4.57 The result, Dr Jorstad stated, was an analysis that covered individual contributions to impacts in a region, but did not necessarily take into account the total, cumulative impact of all projects operating within an area.[72]

Economic impacts

4.58 The Committee heard that environmental impacts may have an economic impact in turn. Reductions in the level of groundwater, along with depressurisation, may mean that other water users, such as farmers, drill new, deeper wells at increased cost because of the depth required, or purchase alternative water sources for stock, such as carted water.[73]

4.59 Australian Farmers for Climate Action submitted that across Australia, 'farmers are coming under increasing pressure from competing land uses, including the mineral and extractive industries'.[74] The New South Wales Irrigators' Council outlined that specific impacts from extractive industries on agricultural production include increased competition for land, labour and water resources:

> The increased demand from mining and energy resource extractive industries has increased overhead costs for irrigated agricultural producers – further exacerbating the overall financial constraints that irrigators in NSW are experiencing…[I]rrigated agricultural producers are price takers in domestic and international markets and are unable to adjust their output prices to accommodate the increased costs to enable them to retain acceptable enterprise gross margins.[75]

4.60 The Nature Conservation Council of NSW stated that in the Murray-Darling Basin, mining companies often purchase high security licences from the New South Wales Government. As a consequence, local farmers who rely on general security licenses have less access to water in dry years because other users have purchased water rights.[76]

4.61 Ms Verity Morgan-Schmidt, the Chief Executive Officer of Farmers for Climate Action, outlined the combined impacts of changing climate conditions and competition for water resources:

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71 Dr Lange Jorstad, President, Australian Chapter, International Association of Hydrogeologists, *Committee Hansard*, 2 May 2018, pp. 4, 5.

72 Dr Lange Jorstad, President, Australian Chapter, International Association of Hydrogeologists, *Committee Hansard*, 2 May 2018, pp. 4, 5.

73 Geoscience Australia, *Submission 2*, p. 3. See also Conservation Council of South Australia, *Submission 10*, p. 3.

74 Australian Farmers for Climate Action, *Submission 6*, p. 2.

75 NSW Irrigators' Council, *Submission 11*, p. 3.

76 Nature Conservation Council of NSW, *Submission 7*, p. 2. See also National Farmers' Federation, *Submission 17*, p. 8.

> There is a feeling of rural Australia being under siege, to be honest. It feels like there are lots pockets occurring right across the country where incompatible land use is being prioritised over the interests of sustainable industries such as Australian agriculture. What we know is that farmers' reliability of production is already threatened and challenged by the impacts of a changing climate. What we are finding is that these incompatible land uses…are also contributing to those risk factors that farmers are finding and they are making life increasingly difficult for them.[77]

4.62 Mr Peter Wills noted the impact of declining water resources on farmers, pastoralists and graziers, stating that if farmers are no longer able to 'irrigate crops, they have to make business decisions. If they can no longer run cattle or a diminished amount of cattle…immediately they have to deal with that situation'.[78]

4.63 Ms Joanne Rea from Property Rights Australia told the Committee that the expansion of Queensland's statutory underground water rights for coal seam gas combined with restrictions on water rights for agricultural use was '[d]riving people out of business by denying access to a valuable resource'.[79]

4.64 Ms Jody Brown, whose family own a sheep and cattle station in Queensland, noted the importance of reliable groundwater access to the value of pastoral land:

> Grazing land in arid and drought-prone areas is much easier to sell if it has reliable access to groundwater. Therefore, if we had been forced to sell due to the Great Artesian Basin water being compromised, it's likely our land would have sold for a much lower value than it was previously worth…Money on its own cannot sustain life out here and there's no replacement for water.[80]

4.65 Mr Maxwell Winders emphasised that lowering of water levels in bores and gasification because of water extraction during coal seam gas mining 'is a matter of concern to individual lot-feeders and to the beef industry as a whole'. Mr Winders submitted that the Queensland regulatory 'make good' system had 'little effect in retarding the loss of the identifiable socio-economic benefits of feedlot beef production'.[81]

Social impacts

4.66 Some evidence provided to the inquiry outlined the social consequences arising from water use by the extractive industry, including impacts on rural communities. Property Rights Australia argued that in the Murray-Darling Basin, 'the exodus from towns shows the effects of insufficient available water on a community'. Further, the water restrictions imposed as part of the Murray-Darling Basin Plan had

77 Ms Verity Morgan-Schmidt, Chief Executive Officer, Farmers for Climate Action, *Proof Committee Hansard*, 10 September 2018, p. 1.

78 Mr Peter Wills, *Proof Committee Hansard*, 10 September 2018, p. 18.

79 Ms Joanne Rea, Chair, Property Rights Australia, *Committee Hansard*, 1 May 2018, p. 31.

80 Ms Jody Brown, Private capacity, *Proof Committee Hansard*, 10 September 2018, p. 8.

81 Mr Maxwell Winders, *Submission 25*, p. 3.

'caused businesses to fail and walk away with no compensation and agriculture to become a memory in some communities'.[82]

4.67 Mr Angus Emmott, a beef cattle producer from Queensland, was of the opinion that new coal and coal seam gas mines should not be approved where best science indicated a probability or even a high possibility of negative impacts. He suggested that:

> Feeding our people over the long term is a lot more important than digging a bit of coal to make some short-term money…I'm not against mining at all. As a society, we're going to have to keep mining, but we have to use the best science and make sure we don't destroy our food-producing system in doing it… If we damage the integrity of our groundwater systems and undermine the long-term sustainability of regional Australia and our water systems, then we really undermine the future of Australia. The idea of doing that for potentially short-lived economic gain that really doesn't bring lasting benefits to the regions is deeply concerning.[83]

4.68 The New South Wales Irrigators' Council also submitted that a major observable impact resulting from mining impacts is 'the depopulation of small rural communities' because of ongoing loss of agricultural productivity.[84]

4.69 Lock the Gate Alliance submitted that the New Acland coal mine had negatively impacted the town of Acland in Queensland which, as of 2016, had one remaining resident who had refused to sell his properties to New Hope Coal company.[85] Lock the Gate Alliance went on to comment:

> The New Acland coal mine has already decimated the former agricultural village of Acland. It has caused extensive hardship, damaged community members' physical and mental health, as well as their livelihoods and eroded the once-thriving and cohesive rural community.[86]

4.70 Lock the Gate Alliance stated that stage three of the New Acland project was the only mining project to have a Queensland Land Court decision that the mine should not proceed. The Alliance argued that this decision 'was largely a result of the considerable consequences the mine would have on groundwater aquifers used by

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82 Property Rights Australia Incorporated, *Submission 21*, p. 4.

83 Mr Angus Emmott, Private capacity, *Proof Committee Hansard*, 10 September 2018, p. 5.

84 NSW Irrigators' Council, *Submission 11*, p. 3.

85 Elly Bradfield, 'Acland "ghosts' returning to breathe life into the coal mining town for census night', *ABC News*, 9 August 2016, http://www.abc.net.au/news/2016-08-09/acland-ghosts-return-to-queensland-town-for-census-night/7704250 (accessed 29 May 2018).

86 Lock the Gate Alliance, *Submission 28*, p. 7.

surrounding farmers'.[87] In May 2018, the Queensland Supreme Court rejected the Land Court's decision and referred the matter back to the Land Court.[88]

4.71 Dr Gavin Lind from the Minerals Council of Australia emphasised that the minerals industry is focused on 'the distributional fairness and procedural fairness of communities in their acceptance' of minerals operations and on 'building trust together with the community'.[89]

Cultural impacts for Aboriginal communities

4.72 The LCA argued the release of gigalitres of water into the environment can have cultural or spiritual repercussions for traditional owners of the land.[90] The Council submitted that the National Water Initiative (NWI) does not adequately take into account impacts of water use on Aboriginal societies:

> The ongoing failure to incorporate the extractive industry into the NWI framework – particularly in relation to resource planning and management – also means that the impact of the industry's use of water is not being systematically addressed in the context of the impact on Aboriginal peoples' connection to, and responsibility for, their land...[T]he current frameworks for recognition of Indigenous cultural flows under the *Water Act 2007* (Cth) and most State water rights systems remain inadequate. Aboriginal people often have the right to 'consultation', but generally no substantive rights or cultural entitlements. Cultural flows will not be appropriately recognised until water rights in Australia recognise substantive rights arising by virtue of Aboriginal custom.[91]

4.73 The LCA suggested that several models may provide a solution to this issue, such as the recent creation of a formal Indigenous Council to advise on water use of the Yarra River in Victoria, and the ongoing National Cultural Flows Research Project.[92] This project aims to achieve water entitlements, or cultural flows, within Australia's water planning and management systems 'that are legally and beneficially

87 Lock the Gate Alliance, *Submission 28*, p. 7.

88 Kirrin McKechnie, 'New Acland coal mine expansion back on the table after Land Court decision rejected', *ABC News*, 2 May 2018, http://www.abc.net.au/news/2018-05-02/new-acland-coal-mine-expansion-back-on-the-table/9718230 (accessed 29 May 2018).

89 Dr Gavin Lind, Director, Workforce and Health, Safety, Environment and Communities, Minerals Council of Australia, *Committee Hansard*, p. 28.

90 Law Council of Australia, *Submission 8*, p. 7; See also Ms Corinne Unger, *Submission 24*, p. 2; Lock the Gate Alliance, *Submission 28*, pp. 5–6; Ms Helen Bishop, *Submission 31*; Ms Revel Pointon, Lawyer, Environmental Defenders Office Queensland, *Committee Hansard*, 2 May 2018, p. 28.

91 Law Council of Australia, *Submission 8*, p. 4.

92 Law Council of Australia, *Submission 8*, p. 4.

owned by Indigenous Nations…to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations'.[93]

Beneficial impacts

4.74 Despite the negative impacts outlined above, some witnesses and submitters focused on the beneficial impacts of water extraction. The International Association of Hydrogeologists argued that there are substantial positive benefits arising from extractive projects in general. These include, for example, groundwater resources being developed by mining companies in rural areas 'that would otherwise not be developed due to the cost and technical difficulty of accessing them'. Other positive impacts that the Association noted included increased employment in local communities, direct spending and royalties.[94]

4.75 The Minerals Council of Australia stated that some water extracted from underground sources may be treated and provided for townships or agricultural purposes. This water, it argued, along with water infrastructure provided and maintained by extractive industries, may be offered to other users 'to their substantial benefit in terms of cost, accessibility and reliability'.[95] The Australian Petroleum Production and Exploration Association also noted that the additional water supply in some regions was particularly beneficial for agricultural communities in times of drought.[96]

4.76 Ms Robyn Glindemann from the LCA gave an example in evidence of a RioTinto irrigation project in Western Australia in which 'water was transported from dewatering bores and fed through an irrigation system to grow hay for stock', although she noted that a major issue for the project was the cost of transporting the hay to areas where it could be used.[97]

4.77 The Australian Petroleum Production and Exploration Association emphasised that '[r]egional communities benefit the most from the onshore gas industry, with new jobs and infrastructure creating stronger, diversified regional economies'. The Association highlighted that in some regions, the resources sector is the biggest contributor to gross regional product, with low unemployment, higher

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93 National Cultural Flows Research Project, *About the project*, http://culturalflows.com.au/~culturalflowscom/index.php?option=com_content&view=article&id=16&Itemid=125 (accessed 28 May 2018).

94 International Association of Hydrogeologists, *Submission 9*, p. 4; See also Dr Malcolm Roberts, Chief Executive Officer, Australian Petroleum Production and Exploration Association, *Committee Hansard*, 2 May 2018, pp. 19, 20–21.

95 Minerals Council of Australia, *Submission 13*, pp. 27, 28. See also Dr Malcolm Roberts, Chief Executive Officer, Australian Petroleum Production and Exploration Association Ltd, *Committee Hansard*, 2 May 2018, pp. 15, 16, 21.

96 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 7.

97 Ms Robyn Glindemann, Deputy Chair, Australian Environment and Planning Law Group, Legal Practice Section, Law Council of Australia, *Committee Hansard*, 1 May 2018, p. 40.

family incomes and a reversal of population decline being features of regions that host the resources sector.[98]

Conclusion

4.78 This chapter has examined the major environmental, economic, social and cultural impacts of water extraction, as well as beneficial impacts arising from extractive activities. The following chapter outlines the Committee's view and recommendations arising from the inquiry.

98 Australian Petroleum Production and Exploration Association Ltd (APPEA), *Submission 22*, p. 34.