Australian Government
Geoscience Australia

A SUBMISSION TO THE INQUIRY INTO WATER USE BY THE EXTRACTIVE INDUSTRY

Terms of Reference

This document addresses the Terms of Reference as per the Letter of Invitation (27 October 2017; addressed to Dr James Johnson, CEO, Geoscience Australia) to provide a submission to the Environment and Communications References Committee's Inquiry into the adequacy of the regulatory framework governing water use by the extractive industry, with regard to:

a) the social, economic and environmental impacts of extractive projects' take and use of water;

b) existing safeguards in place to prevent the damage, contamination or draining of Australia's aquifers and water systems;

c) any gaps in the regulatory framework which may lead to adverse social, economic or environmental outcomes, as a result of the take and use of water by extractive projects;

d) any difference in the regulatory regime surrounding the extractive industry's water use, and that of other industries;

e) the effectiveness of the 'water trigger' under the *Environment Protection and Biodiversity Conservation Act 1999*, and the value in expanding the 'trigger' to include other projects, such as shale and tight gas; and

f) any other related matters.

Executive Summary

Geoscience Australia (GA) is the national geoscience agency that provides scientific information and advice to the Australian Government to support national priorities and interests. Underpinning that advice, GA has deep domain knowledge of the science of Australia's lands, resources and waters. GA conducts a diverse range of terrestrial, marine and spatial science research and monitoring activities, provides geoscience products and services that address national and international issues, and contributes to the evidence base for informed policy development and decision-making.

GA provides groundwater information and scientific advice in support of Australian Government priorities, and to inform the sustainable management and responsible development of groundwater resources. This scientific advice is provided to the Department of Industry, Innovation and Science and the Department of the Environment and Energy and primarily relates to potential impacts to groundwater from Coal, Uranium and coal seam gas (CSG) projects. The primary regulatory framework for this advice is the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and the *Environment Protection (Alligator Rivers Region) Act 1978*.

Against this background, GA presents this submission for the inquiry into the regulatory framework governing water use by the extractive industry. For the purpose of this submission, GA considers 'extractive industries' to comprise Coal, Uranium and CSG projects. GA recognises other extractive industries such as bulk commodities may also use groundwater resources, however potential water resource impacts of those commodities are outside our area of expertise. This submission draws on the knowledge and experience that GA has developed in the provision of scientific groundwater information and advice to Government and the knowledge that outcomes of these activities support Australia's national interests as they relate to securing and protecting water resources. This submission focusses on the main potential impacts to groundwater from the extractive industry and the regulatory framework governing water use by the industry.

There are a wide range of potential social, economic and environmental impacts associated with the take and use of water by the extractive industry, many of which are interrelated. These impacts, common to larger extractive industry developments and of greatest concern include groundwater depressurisation, groundwater contamination, groundwater pressurisation and cumulative impacts to water resources.

Regulatory safeguards to prevent or manage potential impacts to water resources from Coal, Uranium and CSG projects are applied at both a state/territory and Commonwealth level. There is different legislation and some different approaches to managing water resources between the states/territories. In contrast, the protections provided under the EPBC Act enable a nationally-consistent approach to water resource regulation, ensuring the same level of protection for water resources throughout Australia. This consistent approach provides clarity to proponents operating across different jurisdictions.

GA considers the applicability of the water trigger under the EPBC Act should be based on the potential for impacts on water resources, and a consistent approach to all water-using industries would support business certainty when making decisions about progressing resource developments. This submission includes a number of other recommendations that GA considers would be beneficial to improve water resource governance in Australia, including:

- Further assessment of the effectiveness of the current regulation of cumulative impacts to inform the regulatory approach to managing potential impacts to water resources in areas of multiple land use.
- Ensuring water monitoring data are made publically available as soon as possible to improve the available geoscience information for informing and advising government on water resource issues, including economic opportunities and environmental considerations.
- Ensuring that adequate resources and timeframes are provided to regulators reviewing water management and monitoring plans, given they are the primary regulatory tool to manage impacts to water resources.
- Revisiting requirements for project development applications to include clear reporting of uncertainty in model predictions of potential impacts to groundwater resources for extractive industry projects. This should include a discussion of the source of uncertainty and identify ways to reduce uncertainty in model predictions.
- For projects approved under the EPBC Act, approval conditions for mine rehabilitation and closure could be included at the approval stage of project development so industry can plan for closure, and so that regulators are able to implement closure requirements.
- Considering how long-term water use by extractive industry projects approved under Commonwealth legislation will be monitored and managed after the active mining phase.
- Undertaking an independent compliance review to assess the effectiveness of the conditions that have been placed on Coal and CSG projects to date, and the effectiveness of associated monitoring and compliance.

Contents

Introduction

Overview of Geoscience Australia's role in advising on water use by the extractive industry

The Groundwater Branch within GA provides scientific advice to the Australian Government on potential impacts to groundwater from the extractive industries, primarily where these activities are covered by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). GA's experience in these areas is summarised below, to give context to the comments provided in this document.

Prior to 2010, the Groundwater Branch was primarily involved in providing scientific advice relating to nuclear matters under the EPBC Act. In these instances GA was directly engaged by the Department of the Environment and Energy (DoEE) and its predecessors, to provide scientific advice on resource and groundwater issues for Uranium mines during the assessment phase and the drafting of approval conditions.

In 2010, GA provided scientific advice to DoEE on the potential impact of proposed coal seam gas (CSG) projects in the Surat Basin, Queensland, to impact on springs that support matters of national environmental significance (MNES) listed under the EPBC Act.

Throughout 2012 and 2013, the Groundwater Branch provided scientific advice to the Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining, established by DoEE. The Panel was established "to provide expert hydrological and hydrogeological advice to the Minister and … (the department) relating to major coal seam gas (CSG) proposals which are approved, or which require a decision on approval, under … (the EPBC Act)". In this role, GA provided scientific advice on groundwater-related approval conditions for CSG projects, assessed water management and monitoring plans, and worked with the proponents on a joint early warning monitoring network.

In 2013, the EPBC Act was amended to include Sections 24D and 24E, which recognises water resources, in relation to CSG development and large coal mining development, as a MNES. Referred to as the water trigger, this amendment had the effect of giving the Commonwealth a direct regulatory role in a new domain. Since this time GA has provided scientific advice to the Department of Industry, Innovation and Science (DoIIS) at the referral and approval stage of development applications for Coal and CSG developments. GA continues to provide scientific advice to DoEE for CSG and Coal projects, and other areas if requested.

Scope of this Submission

Any extractive industry that removes material from below the groundwater table will have an impact on water resources; however this submission will rely on GA's expertise relating to potential groundwater impacts of Coal, Uranium and CSG projects. While these impacts will clearly have follow-on social, economic and environmental effects, an analysis of the social and economic impacts and regulation around them are outside the expertise of GA.

The social, economic and environmental impacts of extractive projects' take and use of water

There are a wide range of potential social, economic and environmental impacts associated with the take and use of water by the extractive industry, many of which are interrelated. This submission highlights the main potential impacts common to larger Coal, Uranium and CSG projects, however there are potentially many more impacts that are not discussed. The following sections largely relate to environmental impacts associated with the extractive industries' 'take and use of water'.

Connections between groundwater and surface water resources

Groundwater and surface water resources are commonly interconnected and interdependent. Surface water bodies may recharge groundwater in some areas, and groundwater may provide baseflow to surface water features at other locations/times in the same system. A simple example of this is shown in Figure 1. This connectivity is increasingly recognised by groundwater managers, and water resources are increasingly managed in a holistic way, viewing groundwater and surface water systems as different parts of a single water system (e.g. the Basin Plan 2012 for the Murray-Darling Basin). This connectivity is important when considering the discussions below; impacts to one part of a water resource can often extend to others.

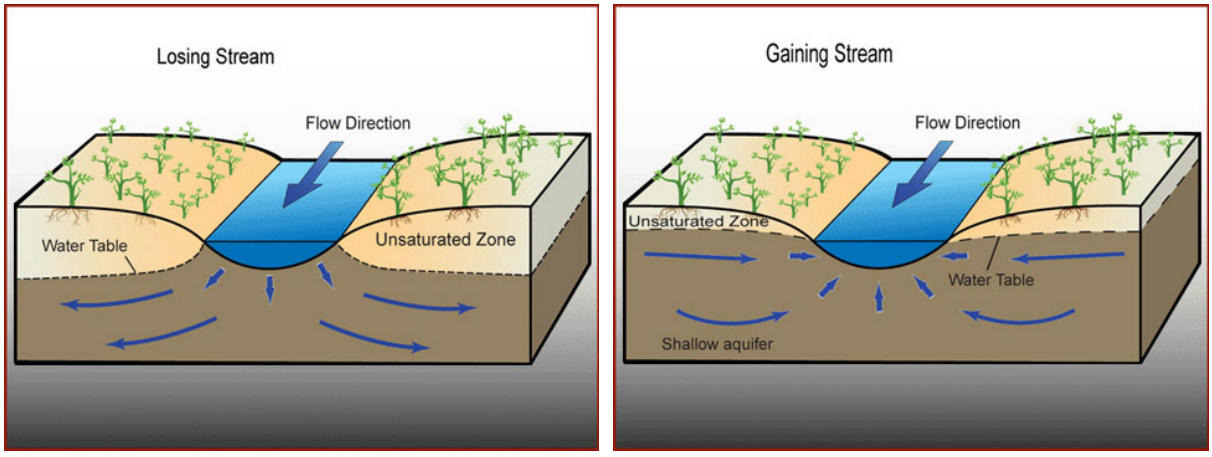

Figure 1 Diagram illustrating the concept of groundwater-surface water connectivity

Potential impacts to groundwater from extractive industries

There is a wide body of literature on the impacts associated with water use by the extractive industries. Some of these impacts may apply to all extractive industries (e.g. groundwater depressurisation where pumping is required, or mine workings occurring below the water table), but others are unique to specific development types (e.g. radioactive discharge from Uranium mining).

These impacts are often interrelated; they do not fit easily into distinct categories. However, in general terms, GA considers the following four groundwater-related impact categories to be of widest concern, and impacts are discussed under these subheadings in the following sections:

- Groundwater depressurisation.
- Groundwater contamination.
- Groundwater pressurisation.

- Cumulative impacts of groundwater extraction.

Groundwater depressurisation

Groundwater is extracted in Coal, Uranium and CSG projects for a variety of purposes, including:

- To enable open cut and underground mining beneath the usual level of the water table (see Figure 2). Groundwater pumping may occur from dedicated pumping wells, or groundwater may simply be pumped out of excavations.
- To enable CSG to flow towards extraction wells.
- To provide water for other mine operations and support staff/industries.

Groundwater extraction results in depressurisation and lowering of groundwater levels, as shown in Figure 2. This can have a range of potential environmental, social and economic impacts, the severity of which depend on local factors such as the scale of extraction, site hydrogeology, and groundwater users. The effects of lowering groundwater levels may include:

- Reductions in the quantity of groundwater available for other users. Even where sufficient groundwater remains for other industries, reductions in groundwater levels can require drilling of deeper wells and lead to increased extraction costs.
- Impacts to groundwater dependent ecosystems (GDEs). There may be direct impacts to stygofauna (fauna that live in groundwater), or reductions in the flow of groundwater to surface GDEs such as rivers, springs, and wetlands. Some GDEs host endangered species or communities (e.g. the ‘community of native species dependent on natural discharge of groundwater from the Great Artesian Basin’ is listed as endangered under the EPBC Act 1999).
- Land subsidence. Removing Coal seams and extracting groundwater during underground mining can result in voids and cavities which may collapse and result in lowering of the land surface. Reducing groundwater pressure may lead to a reduction in aquifer volume, which can also result in subsidence. Such land subsidence can affect groundwater and surface water flow paths, environmental flows and lead to increased erosion.
- Inter-aquifer flow. Changing the groundwater pressure in an aquifer may lead to altered flow directions in adjacent formations as water flows towards the depressurised zone. Where groundwater chemistry varies spatially, this can cause mixing and degradation of groundwater quality.

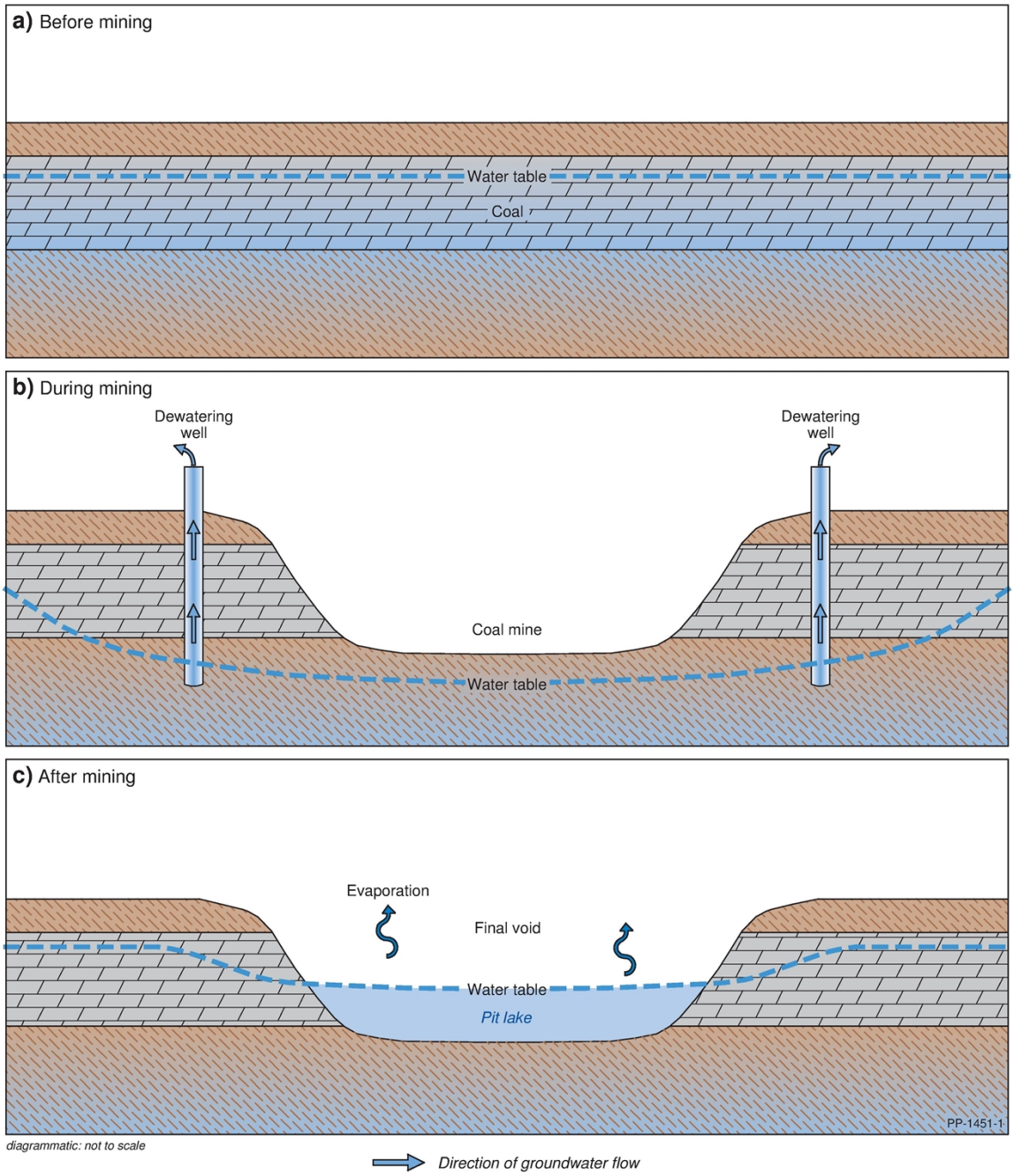

Figure 2 Schematic diagram of (a) an unmined, unconfined Coal seam; (b) the same system after dewatering during open-cut mining - the water table has been lowered around the mine so that groundwater does not discharge into the mine void; and (c) the same system after the mine has closed – dewatering has ceased and the water table rises again, however the final void becomes a groundwater 'sink' permanently lowering the water table in a zone around the void.

It is difficult to generalise on the likely extent and potential impacts of groundwater depressurisation associated with particular extractive industries because of their dependence on local site conditions and extractive practices. However, some factors to consider include:

- Scale. Some extractive industries occur over hundreds of square kilometres and require substantial groundwater extraction, leading to more extensive groundwater depressurisation than smaller scale, local industry developments.
- Depth. In some areas groundwater can be extracted from different depths for different purposes, as shown in Figure 3. Some groundwater extraction will be sourced from the shallowest suitable

aquifers to reduce costs. Shallower mining (e.g. open cut Coal mines) will be close to these aquifers (and surface GDEs), potentially resulting in greater impacts than deeper industries. CSG, for example, commonly focusses on Coal seams >300 m deep (IESC, 2014a). In these multiple use areas, it is important to understand potential interconnectivity between aquifers.

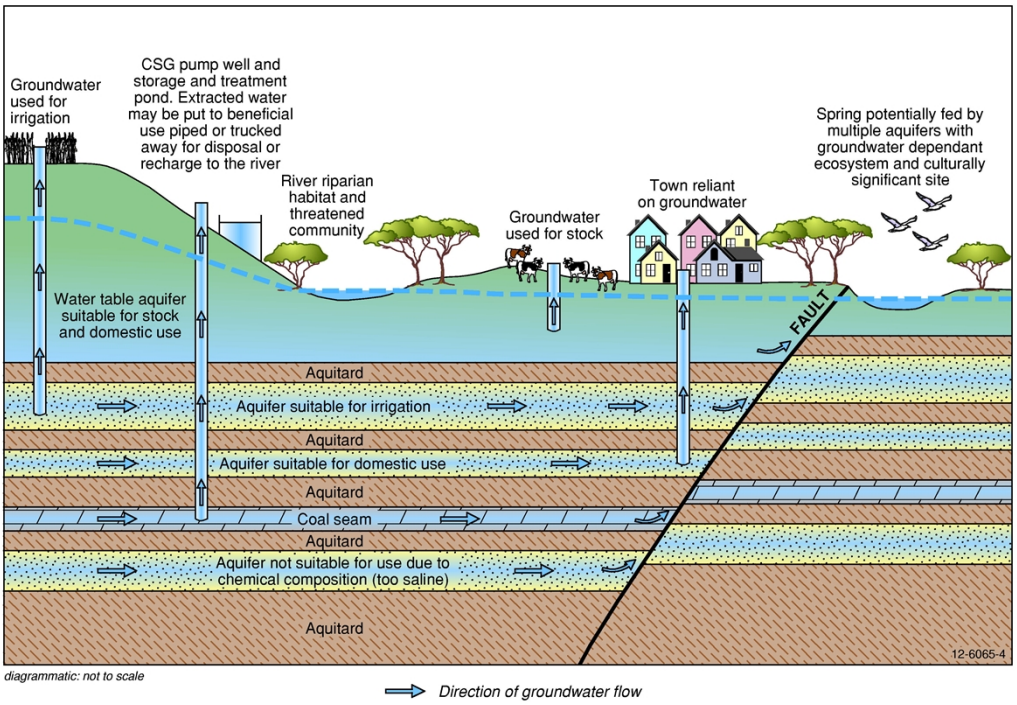

Figure 3: Schematic hydrogeological diagram showing how several land uses may interact with groundwater resources

Groundwater contamination

A range of activities associated with the extractive industries can result in the extraction and subsequent release of contaminated groundwater, or in *in-situ* groundwater contamination (these can also impact surface water, either directly or via the groundwater pathway). The extent of these potential impacts will be influenced by the characteristics of the natural system. Some issues could include:

- ***Naturally low quality groundwater***. Groundwater held within Coal seams is often charactered by higher salinity and trace element concentrations. When this groundwater is extracted during mining processes, it may have impacts on environmental assets if accidentally released. The groundwater can be treated prior to disposal or reinjection, however this process results in substantial volumes of remnant brine or salts that could be accidentally released (e.g. if flooding occurs). Even where extracted groundwater is of high quality, its release may impact negatively on native species that have adapted to different quality water and lower surface water flow volumes.
- ***Hydraulic fracturing*** can be required in the unconventional gas industries. It involves pumping hydraulic fracturing fluid (mostly water and sand) into target formations under pressure to increase permeability and gas yields. This fluid typically includes 0.1–2% chemical additives, some of which have environmental toxicity (IESC, 2014b). Hydraulic fracturing fluid therefore poses a contamination risk, primarily from accidental release at the surface which may infiltrate to groundwater.

- ***Groundwater contamination through preferential pathways***. There are a range of extractive industry processes that can increase connectivity in the subsurface and create contamination risks by inter-aquifer flow, gas migration, or increased connectivity with surface. These include:
    - Leaks along well casings installed for extractive industries (research has shown that there is some potential for failure of the well after it has been decommission (Wu et al., 2016)).
    - Direct connectivity through abandoned mine workings and shafts.
    - Propagation of fractures through overburden as abandoned mine workings collapse.
- ***Leaching of contaminants*** from ores and waste rock, which can be exacerbated by acid mine drainage. Where sulfides are present in these materials, they produce sulfuric acid when exposed to oxygen and water. This acid mine drainage can dissolve various metals which are toxic to many ecological communities. This is recognised as a major environmental concern in Australia (e.g. Harries, 1997), and abandoned mine sites can continue to discharge acid mine drainage to the environment even after extensive remediation.
- ***Fuel and chemical spills*** from substances used in mines and support infrastructure.

The above list is intended only to illustrate the range of contamination issues potentially encountered by the extractive industries. Similarly to groundwater depressurisation, these risks are dependent on many local factors, so require detailed assessment on a project-specific basis.

Groundwater pressurisation

Injecting water or other fluids into groundwater is required in a number of extractive industries. This may be undertaken to remove minerals from the ground (e.g. solution mining in the Uranium industry) or for waste disposal. Water recovered from CSG and other operations may also be re-injected to different formations for disposal. Injecting fluids to the subsurface may increase groundwater pressures/levels, and while this may be beneficial in areas where pressures have been reduced by other industries, it may have a range of other consequences, including:

- Inducing flow of poor quality groundwater away from the injection area into other formations, if hydraulic connections exist.
- Development of preferential flow paths. The hydraulic fracturing process aims to increase permeability of the host rock reservoirs. However, if fracturing propagates away from the intended focus areas or encounters unexpected geological structures, new connections could be made between different aquifers. This may in turn enable inter-aquifer flow, the propagation of pressure changes, and mixing of groundwaters of variable quality. State-of-the-art hydraulic fracturing processes report improved control over fracture propagation, meaning the likelihood of this impact is reduced.

Cumulative impacts of groundwater extraction

Cumulative impacts can be defined as:

> *the successive, incremental and combined impacts of one, or more, activities on society, the economy and the environment. Cumulative impacts result from the aggregation and interaction of impacts on a receptor and may be the product of past, present or future activities (Franks et al, 2010).*

In areas where there are a number of extractive industry projects, the cumulative impact of these developments on water resources can be greater and more regional in extent than single developments.

Other issues

Groundwater impact timeframes

A key challenge for effective Commonwealth regulation of extractive industries is the time taken for groundwater impacts to become apparent. Significant impacts to groundwater may be realised after an extractive industry project is complete, and in some instances these impacts are predictable (e.g. using groundwater modelling) and can be planned for. However, unanticipated impacts can also arise (e.g. if issues arise with well integrity), which may have implications for long-term water monitoring and management.

Recommendation:

Give consideration to how long-term water use by extractive industry projects approved under Commonwealth legislation will be monitored and managed after the active mining phase. Groundwater impacts may take years or decades to become apparent and the regulatory system must ensure ongoing monitoring of water resources occurs.

Existing safeguards in place to prevent the damage, contamination or draining of Australia's aquifers and water systems

Regulatory safeguards to prevent damage, contamination or draining of water resources from Coal, Uranium and CSG projects are applied at both the Commonwealth and state/territory level. These are discussed in turn below.

Commonwealth Regulatory Framework

The Commonwealth legislative instruments that seek to protect water resources include:

- the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); and
- the *Environment Protection (Alligator Rivers Region) Act 1978*; and
- the *Water Act 2007.*

These legislative instruments are supported by a range of publications such as guidelines, industry best practices, and white papers. However, as these are not legislative instruments, they will not be discussed as part of this submission.

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the key piece of legislation that enables the Australian Government to regulate the potential impacts of the extractive industry on water resources. The EPBC Act gives the Australian Government the ability to provide protections to matters of national environmental significance (MNES), while the states and territories have responsibility for matters of state and local significance. The EPBC Act does not cover water take. Under the EPBC Act, a person must not take an action that has, will have or is likely to have a significant impact on any of the MNES, without approval from the Australian Government Minister for the Environment.

The Act defines the nine MNES that it provides protections to, these are:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species and ecological communities
- migratory species protected under international agreements
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mines)
- a water resource, in relation to coal seam gas development and large coal mining development (the water trigger).

The water trigger was enacted in 2013 with the policy intention of addressing a perceived gap in the EPBC Act and to respond to public concern about the impacts to water resources from Coal and CSG developments (Hunter, 2017). The application of the water trigger relates to a development's likely

impact on a water resource, rather than the size of the proposed development. Through the EPBC Act, the Australian Government has a direct role in regulating (approving and placing conditions on) the impacts of water use by large Coal and CSG developments, which will be monitored for the life of the project.

Prior to the inclusion of *'a water resource, in relation to coal seam gas development and large coal mining development'* (the water trigger) as a MNES, the protection of water resources in mining areas was covered, to various extents, by the different legislation of the states and territories. The jurisdictions typically have different approaches to managing impacts to water resources (see Table 1) and the water trigger amendment provides a nationally consistent approach whereby a project likely to result in a significant impact to a water resource will be assessed under the EPBC Act and conditions will be developed to protect the water resource specifically.

Although the EPBC Act includes Coal, Uranium and CSG projects, it also enables regulation of water use by other industries where that water use is likely to have a significant impact on an MNES, for example a threatened species or wetland of international importance.

Independent Expert Scientific Committee

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) was established as a statutory committee in 2012 under the EPBC Act in response to public concern about CSG and Coal mining. The role of the IESC is to provide independent, expert scientific advice on CSG and large Coal mining proposals as requested by the Australian Government and state government regulators. This advice is provided to enable the regulator's decisions about CSG and large Coal mining developments to be informed by the best available science relating to the potential impacts associated with those developments. The Commonwealth Minister for the Environment must obtain the advice of the IESC before deciding to approve a CSG or Coal mining development where there could be a significant impact to water resources.

Water Act 2007 and amendments

The *Water Act 2007* is the primary legislation for implementing water reform in the Murray-Darling Basin and ensures that water resources within the Basin are managed in an integrated and sustainable manner. Whilst the Water Act is Commonwealth legislation, it recognises that the jurisdictions in the Murray-Darling Basin will continue to manage basin water resources. The Water Act framework limits the amount of water (both surface and groundwater) that can be taken from basin water resources on a sustainable basis - known as long-term average sustainable diversion limits. These limits are set for basin-wide water resources and for individual water resources within the Basin and all industries that extract water, including extractive industries and irrigated agriculture, operate within in these limits.

Environment Protection (Alligator Rivers Region) Act 1978 and amendments

The *Environment Protection (Alligator Rivers Region) Act 1978* is the primary legislation under which Uranium in the Alligator Rivers Region is regulated. The Alligator Rivers Region covers approximately 28,000 sq. km in the Northern Territory and includes areas of high Uranium mineralisation as well as important environmental features such as Kakadu National Park and internationally recognised wetlands. The key function of the Act is to establish the Supervising Scientist, with the following functions:

- To devise, develop, coordinate the implementation of, and assess programs for research into the environmental effects of Uranium mining in the Alligator Rivers Region;
- To devise, develop and promote standards and practices in relation to Uranium mining operations and rehabilitation in the Alligator Rivers Region;
- To coordinate and supervise the implementation of legal requirements, under any relevant legislation, associated with environmental aspects of Uranium mining in the Alligator Rivers Region; and
- To advise the Minister on environmental matters within and beyond the Alligator Rivers Region.

State and Territory Regulatory Framework for extractive industries

Each state and territory is responsible for the regulation of water take and use by extractive industries. Table 1 provides a summary of the approaches used; it is drawn primarily from a draft publication produced by the Productivity Commission, and was current at September, 2017 (Productivity Commission, 2017).

Table 1 Jurisdictional approach to regulation of water use by extractive industries

Jurisdiction	*Jurisdiction arrangements for extractive industries*
New South Wales	Under section 60I of the *Water Management Act 2000 (NSW),* mining activities require a licence for any water taken as part of those activities. [under the act a person takes water in the course of carrying out a mining activity if, as a result of or in connection with, the activity or a past mining activity carried out by the person, water is removed or diverted from a water source (whether or not water is returned to that water source) or water is re-located from one part of an aquifer to another part of an aquifer].
Victoria	Under the *Water Act 1989 (Vic),* extractive industries are required to obtain a take and use licence to secure water access, either from the market or via a new entitlement in areas where unallocated water exists.
Queensland	Limited statutory water rights apply to incidental water take or 'associated water' for petroleum, gas and mining production. These rights operate outside of Queensland's water access entitlement and planning framework. Exercising these rights is conditional on underground water obligations, which include preparation of an underground water impact report and the requirement to enter 'make good' agreements with landholders whose water bores are affected. Water access entitlements are required for non-incidental take or 'non-associated water' use. Water rights for some mining companies are specified in special agreement Acts.
Western Australia	Western Australia's water licensing framework applies to water taken by extractive industries, with further guidance on licensing requirements and conditions outlined in government guidelines. Although state agreements for major mining projects can override some legislation such as the *Rights in Water and Irrigation Act 1914 (WA),* most agreements specify that requirements of this Act must be met. The *Collie Coal (Western Collieries) Agreement Act 1979 (WA)* is one exception.
South Australia	Mining and petroleum operations require a water licence where they take water from a prescribed water resource (many mines are outside of prescribed resource areas). In areas outside of prescribed areas, the *Natural Resources Management (NRM) Act 2004 (SA) (s. 127)* allows for control of water take through regional NRM policies which can manage some aspects of water interception and extraction through water affecting permits, but normally do not directly control volume. The exception is the Alinytjara Wilurara NRM Plan which does directly control the actual take of water. Licences are not required for water used to drill petroleum and gas wells for exploration purposes; instead these activities are authorised by the Minister for Sustainability, Environment and Conservation under section 128 of the NRM Act.
Tasmania	Mines are required to have a licence under the *Water Management Act 1999 (Tas)* to take water from for a watercourse or lake but groundwater does not require a licence unless specified under a water management plan or a Groundwater Area.
Northern Territory	Mining and petroleum operations are exempt from water licence and permit provisions under section seven of the *Water Act 1992 (NT).* Currently, a memorandum of understanding seeks to clarify the relationship between relevant agencies with the aim of ensuring water resource use for mining purposes does not impinge on existing allocations for other uses and vice versa. The Northern Territory Government has announced amendments to the *Water Act 1992 (NT)* which will require all new and increased water use by mining and petroleum activities to be subject to the same water licensing requirements as other water users from 2018 onwards. The amendments have not yet been passed.

Source: based on Productivity Commission data, National Water Reform, Draft Report (Productivity Commission, 2017)

Gaps in the regulatory framework which may lead to adverse social, economic or environmental outcomes, as a result of the take and use of water by extractive projects

Geoscience Australia's Groundwater Branch considers the Commonwealth regulatory framework through its provision of scientific advice on impacts to groundwater from Coal, Uranium and CSG projects.

Approval Processes

One-stop-shop

The Australian Government has developed a 'One-Stop-Shop' for environmental approvals by accrediting state and territory planning systems under Commonwealth law, to create a single environmental assessment and approval process for nationally protected matters.

The one-stop-shop process is being implemented by DoEE through bi-lateral agreements with the jurisdictions; these can be assessment bilateral agreements and approval bilateral agreements. An assessment bilateral agreement results in a single environmental assessment process conducted by the state/territory. The Commonwealth Minister for the Environment remains the approving authority for EPBC Act matters, and is provided with a report on the assessment process which is reviewed with reference to advice from the IESC. The state/territory and the Australian Governments each make a decision on project approval and develop approval conditions to meet differing requirements. This may result in two approval decisions and two sets of conditions. Assessment bilateral agreements are in place with Western Australia, Queensland, New South Wales, South Australia and the Australian Capital Territory.

As previously discussed, the 'water trigger' was implemented, in part, to address a perceived gap in the regulation of Coal and CSG projects, and provide a second level of review of these projects. The 'one-stop-shop' assessment process removes the second level of assessment, but still requires Commonwealth Minister for the Environment approval.

An approval bilateral agreement for the 'one-stop-shop' would authorise a jurisdiction to assess the likely impacts of a project on the environment and make a decision on approval, accounting for both state matters and matters of national environmental significance. There are proposals for approval bilateral agreements, however there are none currently in place.

Assessment of uncertainty

Environmental impact statements (EISs) are required for significant extractive industry projects that are likely to have an impact on the environment. These EISs commonly rely on modelling to predict the potential impacts to water resources, and because the data and information used to generate these models can be sparse, there is always a degree of uncertainty in the model predictions. The uncertainties in the resulting predicted potential impacts needs to be communicated clearly so that

regulatory decisions consider these and identify monitoring and management options which reduce this uncertainty.

Recommendation:

That regulating agencies include requirements for clear reporting of uncertainty in model predictions of potential impacts to groundwater resources for extractive industry projects approved under Commonwealth legislation. This should include a discussion of the source of uncertainty and identification of ways to reduce uncertainty in model predictions.

Assessment and management of Cumulative Impacts

In areas of cumulative surface water and groundwater use, establishing scientific baselines to assess, manage and regulate any potential impacts to these resources is highly challenging. This is especially relevant where these cumulative impacts develop over time, such as the gradual growth of a number of extractive industry projects in a region.

Recommendations:

Further assessment of the effectiveness of the current regulation of cumulative impacts is needed to provide evidence to inform the regulatory approach to managing potential impacts to water resources.

Approval conditions should ensure that water monitoring data are publically available as soon as possible to improve the available geoscience information for informing and advising government on water resource issues, including economic opportunities and environmental considerations.

Water Monitoring and Management Plans

Due to the long time periods required to collect data and baseline information to characterise groundwater systems at a mine scale, extractive projects are often approved before all baseline data collection is complete. In these cases approval conditions are often written requiring the completion of the baseline data collection to be included in Water Monitoring and Management Plans (WMMPs) that are submitted for approval by the Commonwealth Minister for the Environment. This approach shifts significant regulatory responsibility from the approvals process to the compliance process and results in the WMMP becoming the key regulatory tool through which water resource impacts are managed.

Recommendations:

Ensure that adequate resources and timeframes are provided to regulators reviewing WMMPs, given they are the primary regulatory tool to assess potential impacts to water resources. It would also be beneficial for the Australian Government to consider developing guidelines for proponents on the key criteria for developing groundwater monitoring and management plans.

An independent compliance review could be undertaken to assess the effectiveness of the conditions that have been placed on Coal and CSG projects to date, and the effectiveness of associated monitoring and compliance.

Long-term impacts

Mine/Project closure

Mine/project closure is usually an expensive and time consuming task that occurs after the profitable phase of mine life. Mine closure is the process whereby a mine is readied to be transitioned to other land uses. It usually involves significant earthworks to reshape the mined area, and overburden, to a sustainable landform that will withstand erosion and can be revegetated. For CSG projects, wells are 'decommissioned' which is a process whereby the bore is filled with specialised cement that is intended to plug the bore in perpetuity. Well pads and access tracks are revegetated or returned to the landholder for future use.

It is relatively common for open-cut mines to result in a final void (see Figure 2c), which means the open-cut pit is not completely filled at the completion of mining and a permanent depression is left in the landscape. Where the bottom of the final void lies below the water table, the void will become a permanent groundwater sink, with groundwater continually draining to the void forming a 'pit lake', and the water being evaporated. Underground mines also cause a permanent change to the structure of aquifers due to removal of Coal seams. These changes may mean groundwater levels are permanently altered, recharge rates change and issues such as acid mine drainage are possible.

This is essentially long-term water take from the groundwater system, which may have long-term impacts on the system and the communities and environment that are dependent on it. It is not clear who will undertake long-term monitoring and management of water resources impacted by the extractive industry, as these impacts may not be realised until after mining has ceased.

Recommendation:

For projects approved under the EPBC Act, approval conditions for mine rehabilitation and closure could be included at the approval stage of project development so industry can plan for closure, and so that regulators are able to implement closure requirements.

The difference in the regulatory regime surrounding the extractive industry's water use and that of other industries

As a technical geoscientific agency, GA is not in the position to comment on the regulatory regime surrounding water take and use by other industries.

The effectiveness of the 'water trigger' under the *Environment Protection and Biodiversity Conservation Act 1999*, and the value in expanding the 'trigger' to include other projects, such as shale and tight gas

The water trigger under the EPBC Act was introduced to:

1. Address community concerns over the impacts of CSG and large Coal mining developments.
2. Enable the Commonwealth Minister to consider and impose approval conditions on CSG and large Coal mining developments directly relating to water resources. Prior to the water trigger, the Minister could only consider matters of national environmental significance previously listed in the EPBC Act (e.g. threatened ecological species and communities).

Effectiveness of the Water Trigger

The effectiveness of the water trigger was recently evaluated through the *Independent Review of the Water Trigger Legislation,* and the findings of the review are reported in Hunter (2017).

Hunter (2017) identified that 74 large Coal and CSG projects had been assessed under the water trigger, as at 15 November 2016. Hunter (2017) was not able to quantify the extent to which the water trigger enhanced public confidence in the regulatory system. However, Hunter (2017) stated that the review found no evidence that the water trigger had reduced confidence, and some evidence that it had increased confidence in the system.

The intention of the water trigger is to provide a nationally-consistent approach under the EPBC Act, ensuring the same level of protection for water resources throughout Australia. This consistent approach to project evaluation and setting approval conditions provides clarity to proponents operating across different jurisdictions and supports the Commonwealth to regulate potential impacts to water resources that cross jurisdictional boundaries. The water trigger also allows the assessment of cumulative impacts to water resources in areas of multiple land use.

The Commonwealth legislation provides a layer of review additional to the jurisdictions' systems. As noted by Hunter (2017), the Commonwealth develops federal approval conditions under the water trigger after the jurisdictions have attached state-level conditions to a project. The Commonwealth approval conditions are informed by advice from the IESC, and address differences between the outcomes sought by jurisdiction and Commonwealth legislation. They therefore provide additional management of water resources beyond that afforded by jurisdictional systems.

Recommendation:

GA suggests that there is no scientific reason to regulate potential impacts to water resources differently. GA considers the applicability of the water trigger under the EPBC Act should be based on the potential for impacts on water resources, and a consistent approach to all water-using industries would support business certainty when making decisions about progressing resource developments.

References

Franks DM, Brereton D, Moran CJ, Sarker T and Cohen T (2010) Cumulative impacts - A good practice guide for the Australian Coal mining industry. Brisbane: Centre for Social Responsibility in Mining & Centre for Water in the Minerals Industry, Sustainable Minerals Institute, The University of Queensland and Australian Coal Association Research Program.

Harries J (1997) Acid Mine Drainage in Australia: Its Extent and Potential Future Liability. Supervising Scientist, Canberra, ACT.

Hunter S (2017) The *Independent Review of the Water Trigger Legislation*, Commonwealth of Australia.

IESC (2014a) Bore integrity, Background review, Commonwealth of Australia.

IESC (2014b) Hydraulic fracturing ('fraccing') techniques, including reporting requirements and governance arrangements, Background review, Commonwealth of Australia.

NWI (2004) Intergovernmental Agreements on a National Water Initiative - Between the Commonwealth of Australia and the Governments of New South Wales, Victoria, Queensland, South Australia, the Australian Capital Territory and the Northern Territory.

Productivity Commission (2017) *National Water Reform,* Draft Report, Canberra.

Wu B, Doble R, Turnadge C, Mallants D (2016) Bore and well induced inter-aquifer connectivity: a review of literature on failure mechanisms and conceptualisation of hydrocarbon reservoir-aquifer failure pathways, prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Canberra.