Australian Government

BIOREGIONAL ASSESSMENTS

PROVIDING SCIENTIFIC WATER RESOURCE INFORMATION ASSOCIATED WITH COAL SEAM GAS AND LARGE COAL MINES

# Compiling water-dependent assets

## A submethodology from the Bioregional Assessment Technical Programme

13 January 2015

### The Bioregional Assessment Programme

The Bioregional Assessment Programme is a transparent and accessible programme of baseline assessments that increase the available science for decision making associated with coal seam gas and large coal mines. A bioregional assessment is a scientific analysis of the ecology, hydrology, geology and hydrogeology of a bioregion with explicit assessment of the potential direct, indirect and cumulative impacts of coal seam gas and large coal mining development on water resources. This Programme draws on the best available scientific information and knowledge from many sources, including government, industry and regional communities, to produce bioregional assessments that are independent, scientifically robust, and relevant and meaningful at a regional scale.

The Programme is funded by the Australian Government Department of the Environment. The Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia are collaborating to undertake bioregional assessments. For more information, visit <http://www.bioregionalassessments.gov.au>.

### Department of the Environment

The Office of Water Science, within the Australian Government Department of the Environment, is strengthening the regulation of coal seam gas and large coal mining development by ensuring that future decisions are informed by substantially improved science and independent expert advice about the potential water related impacts of those developments. For more information, visit <http://www.environment.gov.au/coal-seam-gas-mining/>.

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The Bureau of Meteorology is Australia's national weather, climate and water agency. Under the *Water Act 2007*, the Bureau is responsible for compiling and disseminating Australia's water information. The Bureau is committed to increasing access to water information to support informed decision making about the management of water resources. For more information, visit <http://www.bom.gov.au/water/>.

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Authorship is listed in relative order of contribution.

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### Cover photograph

Brolgas, Paroo River floodplain near Hungerford, NSW, July, 2012

Credit: Frances Marston, CSIRO

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# Executive summary

This submethodology guides the compiling of the asset database and associated water-dependent asset register for each bioregional assessment (BA). It relates to product 1.3 *Description of the water-dependent asset register* within Component 1: *Contextual information of the bioregion or subregion*. It describes the approach to be used in each bioregion or subregion to:

1. Compile national and other asset databases by the Assets and Receptors Project team to produce an asset database (see Section 2). Key inputs to the asset database at this stage are the BA-purpose-built *Water Asset Information Tool* (WAIT) database prepared by natural resource management organisations (NRMs) and contributions from those with expert local knowledge including Indigenous knowledge.
2. Define the preliminary assessment extent (PAE) for a bioregion or subregion by the Assessment team (see Section 3).
3. Creation of an asset list by the Assets and Receptors Project team through selection of assets in the asset database that occur within the PAE (see Section 3).
4. Refine the asset list by the Assessment team to create a water-dependent asset register based on the potential for water-related impacts on assets and feedback from experts with local knowledge (see Section 4).

Though all life is dependent on water, for the purposes of a bioregional assessment, a *water-dependent asset* is an asset potentially impacted by changes in the groundwater and/or surface water regime due to coal resource development. The water must be other than local rainfall. The *water-dependent asset register* lists all the water-dependent assets in the *preliminary assessment extent* (PAE). The PAE is the geographic area associated with a bioregion or subregion in which the potential water-related impacts of coal resource development on assets are assessed. The compiling of the water-dependent asset register is the first step to identifying and analysing potentially impacted assets, which is the goal of the overall bioregional assessment. This asset register is a simple and authoritative listing of the names of the assets that will be included in the other BA components.

During the compilation process, assets are classified into three groups: (i) ecological, (ii) economic and (iii) sociocultural. Many assets are obtained from state and national databases and a key group of ecological assets is provided by NRMs. Meetings are planned with Indigenous knowledge holders to discuss Indigenous cultural water-dependent assets. The assets are compiled into an *asset database,* which is then used to generate the water-dependent asset register. A preliminary version of the asset register is presented to experts and organisations with local knowledge at organised workshops. Feedback is sought about whether the asset register is complete and correct; appropriate amendments are then made. It is at this stage – when assets have been filtered through the PAE and the amended water-dependent assets have been recorded in the database – that the water-dependent asset register is complete for the purposes of producing product 1.3. Each BA asset database and register may be updated for use in other BA products.

Other steps in a BA are described in the pending companion submethodologies including M03 for assigning receptors and impact variables to water-dependent assets.

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# Contributors to the Technical Programme

The following individuals have contributed to the Technical Programme, the part of the Bioregional Assessment Programme that undertakes bioregional assessments. Leaders are underlined.

| | |
|---|---|
| Assistant Secretary | Department of the Environment: Gayle Milnes |
| Programme Director | Department of the Environment: Anthony Swirepik |
| Technical Programme Director | Bureau of Meteorology: Bronwyn Ray |
| Projects Director | CSIRO: David Post |
| Principal Science Advisor | Department of the Environment: Peter Baker |
| Science Directors | CSIRO: Brent Henderson |
| | Geoscience Australia: Trevor Dhu |
| Integration Lead | Bureau of Meteorology: Richard Mount |
| Programme management | Bureau of Meteorology: Graham Hawke, Louise Minty |
| | CSIRO: Paul Hardisty, Warwick McDonald |
| | Geoscience Australia: Stuart Minchin |
| Project Leaders | CSIRO: Alexander Herr, Tim McVicar, David Rassam |
| | Geoscience Australia: Hashim Carey, Kriton Glenn |
| Assets and receptors | Bureau of Meteorology: Richard Mount, Eliane Prideaux |
| | Department of the Environment: Rachael Carter, Larry Guo, Glenn Johnstone, Brad Moore, Jin Wang |
| | Geoscience Australia: Joe Bell |
| Bioregional Assessment Information Platform | Bureau of Meteorology: Brian Cannell, Trevor Christie-Taylor, Jason Guo, Joseph Zhao |
| | CSIRO: Peter Fitch |
| | Department of the Environment: Geraldine Cusack |
| | Geoscience Australia: Neal Evans |
| Communications | Bureau of Meteorology: Mel Martin |
| | CSIRO: Chris Gerbing |
| | Department of the Environment: Sophie Alexander, Milica Milanja, Kirsty Rolls |
| | Geoscience Australia: David Beard, Chris Thompson |

| | |
|---|---|
| Assistant Secretary | Department of the Environment: Gayle Milnes |
| Coordination | Bureau of Meteorology: Julie Burke, Sarah van Rooyen |
| | CSIRO: Ruth Palmer |
| | Department of the Environment: James Hill, Sunita Johar, Craig Watson |
| | Geoscience Australia: Tenai Luttrell |
| Ecology | CSIRO: Tanya Doody, Brendan Ebner, Kate Holland, Craig MacFarlane, Tracey May, Patrick Mitchell, Justine Murray, Anthony O'Grady, Chris Pavey, Jodie Pritchard, Nat Raisbeck-Brown, Ashley Sparrow, Georg Wiehl |
| Geology | CSIRO: Deepak Adhikary, Luke Connell, Emanuelle Frery, Jane Hodgkinson, James Kear, Manoj Khanal, Zhejun Pan, Kaydy Pinetown, Matthias Raiber, Hayley Rohead-O'Brien, Regina Sander, Peter Schaubs, Garth Warren, Paul Wilkes, Andrew Wilkins, Yanhua Zhang |
| | Geoscience Australia: Tim Evans, Steven Lewis, John Magee, Martin Smith |
| Geography | Bureau of Meteorology: Natasha Herron |
| Geographic information systems | CSIRO: Caroline Bruce, Jody Bruce, Malcolm Hodgen, Steve Marvanek, Arthur Read |
| | Geoscience Australia: Gerard Stewart, Kirsten Walker |
| Groundwater modelling | CSIRO: Olga Barron, Russell Crosbie, Tao Cui, Warrick Dawes, Lei Gao, Sreekanth Janardhanan, Luk Peeters, Praveen Kumar Rachakonda, Wolfgang Schmid, Saeed Torkzaban, Chris Turnadge, Binzhong Zhou |
| | Geoscience Australia: Wenping Jiang |
| Hydrogeology | CSIRO: Konrad Miotlinski |
| | Geoscience Australia: Rebecca Cassel, Jim Kellett, Sarah Marshall, Rebecca Norman, Jessica Northey, Tim Ransley, Martin Smith, Baskaran Sundaram, KokPiang Tan, Luke Wallace, Gabrielle Yates |
| Information management | Bureau of Meteorology: Belinda Allison, Jill McNamara, Brendan Moran, Suzanne Slegers |
| | CSIRO: Nick Car, Phil Davies, Andrew Freebairn, Mick Hartcher, Geoff Hodgson, Brad Lane, Ben Leighton, Trevor Pickett, Ramneek Singh, Matt Stenson |
| | Geoscience Australia: Luke Caruana, Penny Kilgour, Matti Peljo |
| Products | CSIRO: Maryam Ahmad, Daniel Aramini, Heinz Buettikofer, Simon Gallant, Karin Hosking, Frances Marston, Linda Merrin, Becky Schmidt, Sally Tetreault-Campbell, Catherine Ticehurst |
| | Geoscience Australia: Veronika Galinec, Daniel McIlroy, |
| Risk and uncertainty | CSIRO: Simon Barry, Jeffery Dambacher, Jess Ford, Keith Hayes, Geoff Hosack, Yang Liu, Warren Jin, Dan Pagendam, Carmel Pollino |
| Surface water hydrology | CSIRO: Santosh Aryal, Mat Gilfedder, Fazlul Karim, Lingtao Li, Dave McJannet, Jorge Luis Peña Arancibia, Xiaogang Shi, Tom Van Niel, Neil Viney, Bill Wang, Ang Yang, Yongqiang Zhang |

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This submethodology was reviewed by several groups:

- Discipline Leaders: Russell Crosbie (hydrogeology, CSIRO) and Jim Kellett (hydrogeology, Geoscience Australia), Alexander Herr (ecology, CSIRO), Steven Lewis (geology, Geoscience Australia), Neil Viney (surface water hydrology, CSIRO)
- Senior Science Leaders: David Post (Projects Director), Trevor Dhu (Science Director, Geoscience Australia), Brent Henderson (Science Director, CSIRO), Becky Schmidt (Products Manager, CSIRO)
- Technical Assurance Reference Group: Chaired by Peter Baker (Principal Science Advisor, Department of the Environment), this group comprises officials from the NSW, Queensland, SA and Victorian governments.

# Introduction

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) was established to provide advice to the federal Minister for the Environment on potential water-related impacts of coal seam gas (CSG) and large coal mining developments.

Bioregional assessments (BAs) are one of the key mechanisms to assist the IESC in developing this advice so that it is based on best available science and independent expert knowledge. Importantly, technical products from BAs are also expected to be made available to the public, providing the opportunity for all other interested parties, including government regulators, industry, community and the general public, to draw from a single set of accessible information. A BA is a scientific analysis, providing a baseline level of information on the ecology, hydrology, geology and hydrogeology of a bioregion with explicit assessment of the potential direct, indirect and cumulative impacts of CSG and coal mining development on water resources.

The IESC has been involved in the development of *Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources* (the BA methodology; Barrett et al., 2013) and has endorsed it. The BA methodology specifies how BAs should be undertaken. Broadly, a BA comprises five components of activity, as illustrated in Figure 1. Each BA will be different, due in part to regional differences, but also in response to the availability of data, information and fit-for-purpose models. Where differences occur, these are recorded, judgments exercised on what can be achieved, and an explicit record is made of the confidence in the scientific advice produced from the BA.

## The Bioregional Assessment Programme

The Bioregional Assessment Programme is a collaboration between the Department of the Environment, the Bureau of Meteorology, CSIRO and Geoscience Australia. Other technical expertise, such as from state governments or universities, is also drawn on as required. For example, natural resource management groups and catchment management authorities identify assets that the community values by providing the list of water-dependent assets, a key input.

The Technical Programme, part of the Bioregional Assessment Programme, will undertake BAs for the following bioregions and subregions:

- the Galilee, Cooper, Pedirka and Arckaringa subregions, within the Lake Eyre Basin bioregion
- the Maranoa-Balonne-Condamine, Gwydir, Namoi and Central West subregions, within the Northern Inland Catchments bioregion
- the Clarence-Moreton bioregion
- the Hunter and Gloucester subregions, within the Northern Sydney Basin bioregion
- the Sydney Basin bioregion
- the Gippsland Basin bioregion.

Technical products (described in a later section) will progressively be delivered throughout the Programme.

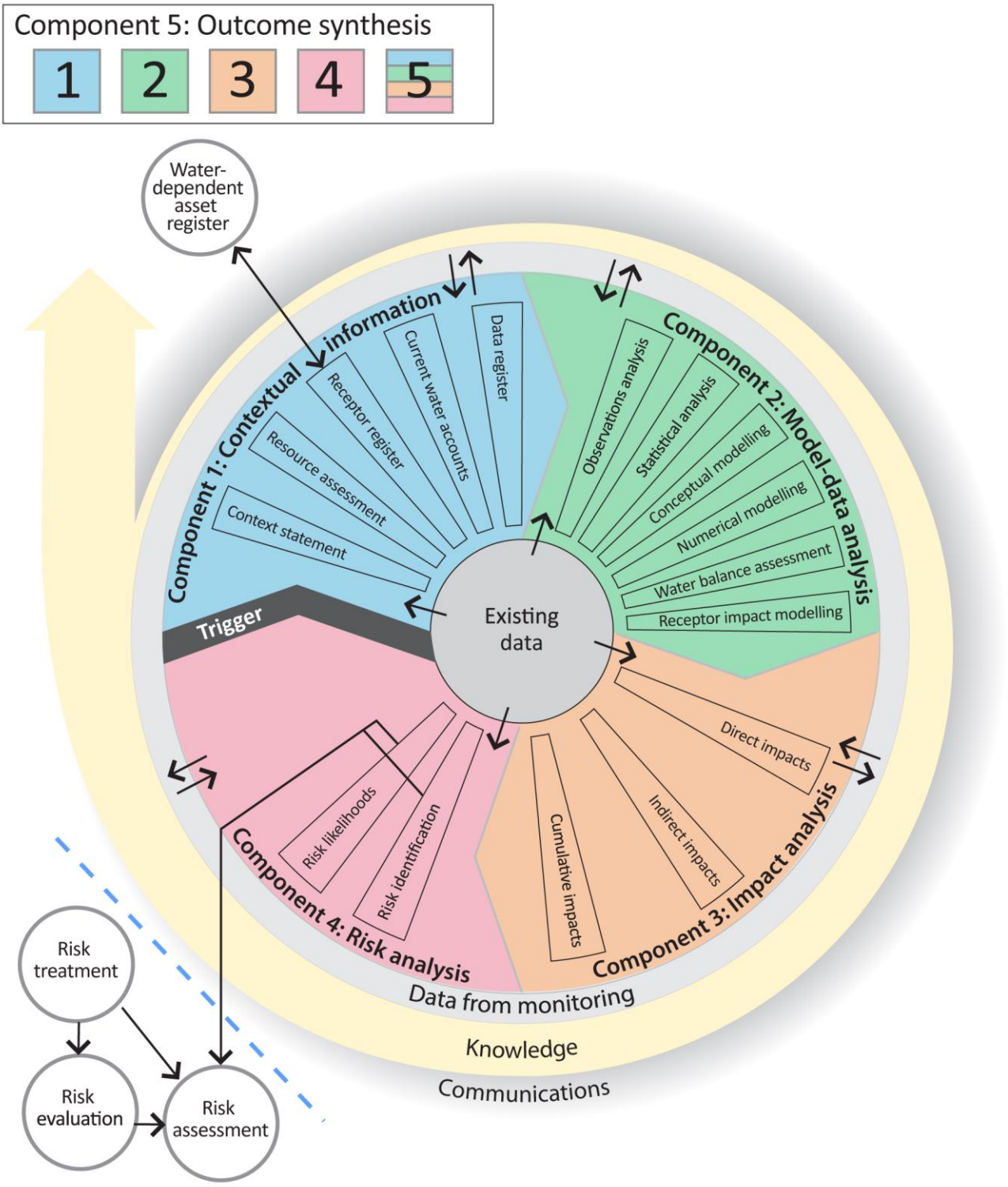


**Figure 1 Schematic diagram of the bioregional assessment methodology**

The methodology comprises five components, each delivering information into the bioregional assessment and building on prior components, thereby contributing to the accumulation of scientific knowledge. The small grey circles indicate activities external to the bioregional assessment. Risk identification and risk likelihoods are conducted within a bioregional assessment (as part of Component 4) and may contribute to activities undertaken externally, such as risk evaluation, risk assessment and risk treatment. Source: Figure 1 in Barrett et al. (2013), © Commonwealth of Australia

# Methodologies

For transparency and to ensure consistency across all BAs, submethodologies have been developed to supplement the key approaches outlined in the *Methodology for bioregional assessments of the impact of coal seam gas and coal mining development on water resources* (Barrett et al., 2013). This series of submethodologies aligns with technical products as presented in Table 1. The submethodologies are not intended to be 'recipe books' nor to provide step-by-step instructions; rather they provide an overview of the approach to be taken. In some instances, methods applied for a particular BA may differ from what is proposed in the submethodologies – in this case an explanation will be supplied. Overall, the submethodologies are intended to provide a rigorously defined foundation describing how BAs are undertaken.

# About this submethodology

The following notes are relevant only for this submethodology.

- All reasonable efforts were made to provide all material under a Creative Commons Attribution 3.0 Australia Licence.
- All maps created as part of the BAs for inclusion in this document used the Albers equal area with a central meridian of 140.0° East for the Lake Eyre Basin bioregion and its subregions, and 151.0° East for all other bioregions and subregions. The two standard parallels for all bioregions and subregions are –18.0° and –36.0°.

**Table 1 Methodologies and associated technical products listed in Table 2. The red rectangle indicates this submethodology**

| Code | Proposed title | Summary of content | Associated technical product |
|---|---|---|---|
| M01 | *Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources* | A high-level description of the scientific and intellectual basis for a consistent approach to all bioregional assessments | All |
| M02 | *Compiling water-dependent assets* | Describes the approach for determining water-dependent assets | 1.3 Description of the water-dependent asset register |
| M03 | *Assigning receptors and impact variables to water-dependent assets* | Describes the approach for determining receptors associated with water-dependent assets | 1.4 Description of the receptor register |
| M04 | *Developing a coal resource development pathway* | Specifies the information that needs to be collected and reported in product 1.2 (i.e. known coal and coal seam gas resources as well as current and potential resource developments). Describes the process for determining the coal resource development pathway (reported in product 2.3) | 1.2 Coal and coal seam gas resource assessment<br>2.3 Conceptual modelling |
| M05 | *Developing the conceptual model for causal pathways* | Describes the development of the conceptual model for causal pathways, which summarises how the 'system' operates and articulates the links between coal resource developments and impacts on receptors | 2.3 Conceptual modelling |

| Code | Proposed title | Summary of content | Associated technical product |
|---|---|---|---|
| M06 | *Surface water modelling* | Describes the approach taken for surface water modelling across all of the bioregions and subregions. It covers the model(s) used, as well as whether modelling will be quantitative or qualitative. | 2.6.1 Surface water numerical modelling |
| M07 | *Groundwater modelling* | Describes the approach taken for groundwater modelling across all of the bioregions and subregions. It covers the model(s) used, as well as whether modelling will be quantitative or qualitative. It also considers surface water – groundwater interactions, as well as how the groundwater modelling is constrained by geology. | 2.6.2 Groundwater numerical modelling |
| M08 | *Receptor impact modelling* | Describes how to develop the receptor impact models that are required to assess the potential impacts from coal seam gas and large coal mining on receptors. Conceptual, semi-quantitative and quantitative numerical models are described. | 2.7 Receptor impact modelling |
| M09 | *Propagating uncertainty through models* | Describes the approach to sensitivity analysis and quantifying uncertainty in the modelled hydrological response to coal and coal seam gas development | 2.3 Conceptual modelling<br>2.6.1 Surface water numerical modelling<br>2.6.2 Groundwater numerical modelling<br>2.7 Receptor impact modelling |
| M10 | *Risk and cumulative impacts on receptors* | Describes the process to identify and analyse risk | 3 Impact analysis<br>4 Risk analysis |
| M11 | *Hazard identification* | Describes the process to identify potential water-related hazards from coal and coal seam gas development | 2 Model-data analysis<br>3 Impact analysis<br>4 Risk analysis |
| M12 | *Fracture propagation and chemical concentrations* | Describes the likely extent of both vertical and horizontal fractures due to hydraulic stimulation and the likely concentration of chemicals after production of coal seam gas | 2 Model-data analysis<br>3 Impact analysis<br>4 Risk analysis |

Each submethodology is available online at <http://www.bioregionalassessments.gov.au>. Submethodologies might be added in the future.

## Technical products

The outputs of the BAs include a suite of technical products variously presenting information about the ecology, hydrology, hydrogeology and geology of a subregion or bioregion and the potential direct, indirect and cumulative impacts of CSG and coal mining developments on water resources, both above and below ground. Importantly, these technical products are available to the public, providing the opportunity for all interested parties, including community, industry and government regulators, to draw from a single set of accessible information when considering CSG and large coal mining developments in a particular area.

The information included in the technical products is specified in the BA methodology. Figure 2 shows the information flow within a BA. Table 2 lists the content provided in the technical products, with cross-references to the part of the BA methodology that specifies it.

Technical products are delivered as reports (PDFs). Additional material is also provided, as specified by the BA methodology:

- all unencumbered data syntheses and databases
- unencumbered tools, model code, procedures, routines and algorithms
- unencumbered forcing, boundary condition, parameter and initial condition datasets
- the workflow, comprising a record of all decision points along the pathway towards completion of the BA, gaps in data and modelling capability, and provenance of data.

Technical products, and the additional material, are available online at <http://ww.bioregionalassessments.gov.au>.

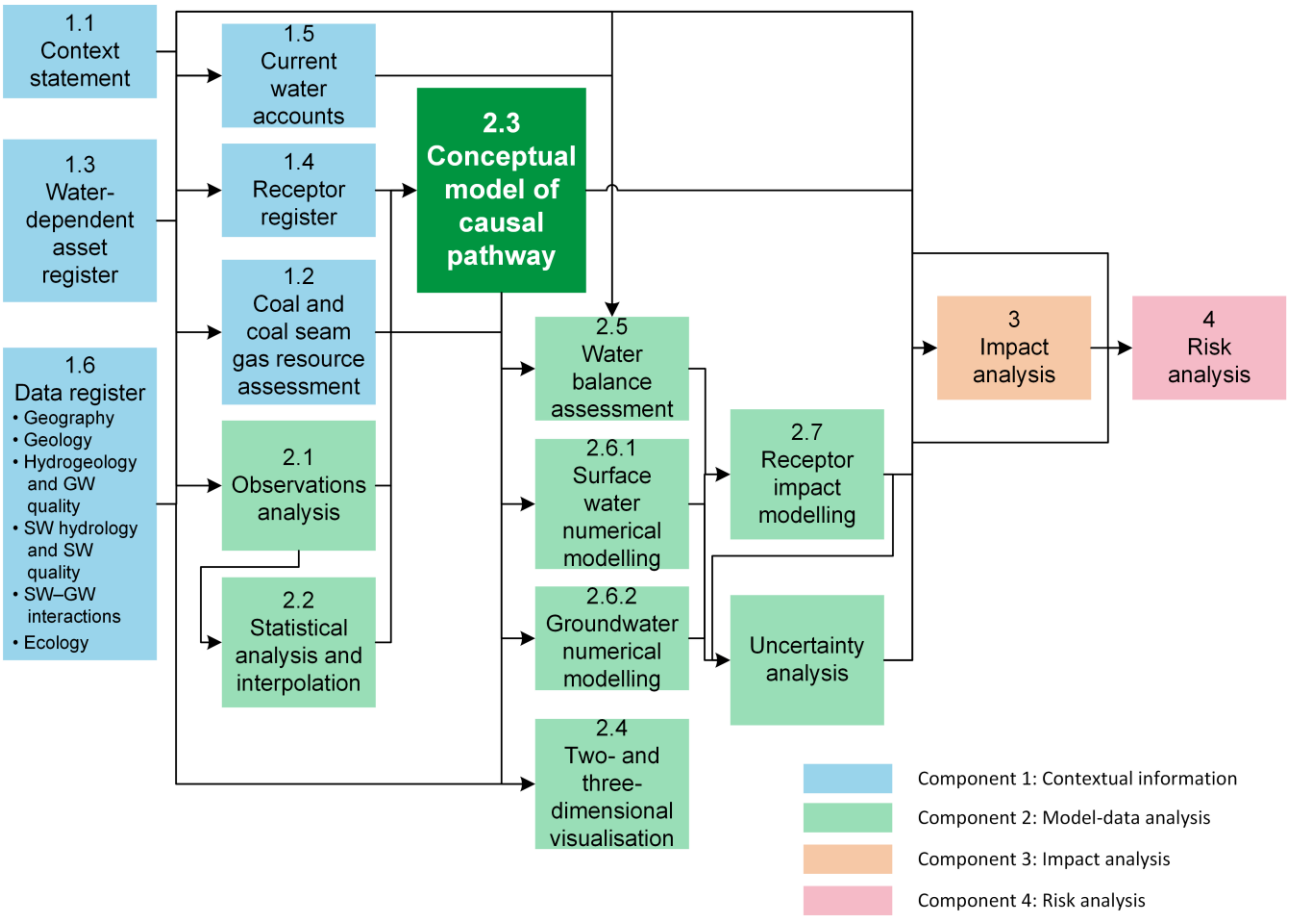


**Figure 2 The simple decision tree indicates the flow of information through a bioregional assessment**

**Table 2 Technical products being delivered as part of the Bioregional Assessment Programme**

For each subregion in a bioregional assessment, technical products will be delivered as data, summaries and reports (PDFs) as indicated by ■ in the last column of Table 2. A suite of other technical and communication products – such as maps, registers and factsheets – will also be developed through the bioregional assessments.

| Component | Product code | Information | Section in the BA methodology[a] | Report |
|---|---|---|---|---|
| Component 1: Contextual information for the bioregion or subregion | 1.1 | Context statement | 2.5.1.1, 3.2 | ■ |
| | 1.2 | Coal and coal seam gas resource assessment | 2.5.1.2, 3.3 | ■ |
| | 1.3 | Description of the water-dependent asset register | 2.5.1.3, 3.4 | ■ |
| | 1.4 | Description of the receptor register | 2.5.1.4, 3.5 | ■ |
| | 1.5 | Current water accounts and water quality | 2.5.1.5 | ■ |
| | 1.6 | Data register | 2.5.1.6 | |
| Component 2: Model-data analysis for the bioregion or subregion | 2.1-2.2 | Observations analysis, statistical analysis and interpolation | 2.5.2.1, 2.5.2.2 | ■ |
| | 2.3 | Conceptual modelling | 2.5.2.3, 4.3 | ■ |
| | 2.4 | Two- and three-dimensional representations | 4.2 | [b] |
| | 2.5 | Water balance assessment | 2.5.2.4 | ■ |
| | 2.6.1 | Surface water numerical modelling | 4.4 | ■ |
| | 2.6.2 | Groundwater numerical modelling | 4.4 | ■ |
| | 2.7 | Receptor impact modelling | 2.5.2.6, 4.5 | ■ |
| Component 3: Impact analysis for the bioregion or subregion | 3 | Impact analysis | 5.2.1 | ■ |
| Component 4: Risk analysis for the bioregion or subregion | 4 | Risk analysis | 2.5.4, 5.3 | ■ |
| Component 5: Outcome synthesis for the bioregion | 5 | Outcome synthesis | 2.5.5 | ■ |

[a]Barrett et al. (2013)

[b]The two- and three-dimensional representations will be delivered in products such as 2.3, 2.6.1 and 2.6.2.

## *References*

Barrett DJ, Couch CA, Metcalfe DJ, Lytton L, Adhikary DP and Schmidt RK (2013) Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment. Department of the Environment, Australia. Viewed 21 January 2015, <http://www.iesc.environment.gov.au/publications/methodology-bioregional-assessments-impacts-coal-seam-gas-and-coal-mining-development-water>.

# 1 Background

As outlined in the *Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources* (the BA methodology; Barrett et al., 2013), the development of a water-dependent asset register is integral to undertaking a bioregional assessment (BA). The BA methodology provides overarching principles for the generation of BAs and this submethodology applies those principles to the specifics of compiling water-dependent asset databases for BA purposes.

An *asset* is an entity having value to the community and, for BA purposes, is associated with a bioregion or subregion. A *bioregion* is a geographic land area within which coal seam gas (CSG) and/or coal mining developments are, or could, take place and for which BAs are conducted. A *subregion* is an identified area wholly contained within a bioregion that enables convenient presentation of outputs of a BA.

A *water-dependent asset* has a particular meaning for BAs; it is an asset potentially impacted, either positively or negatively, by changes in the groundwater and/or surface water regime due to coal resource development. Some assets are solely dependent on incident rainfall and will not be considered as water dependent if evidence does not support a linkage to groundwater or surface water.

The *water-dependent asset register* is a simple and authoritative listing of the assets within the *preliminary assessment extent* (PAE) that are potentially subject to water-related impacts. A PAE is the geographic area associated with a bioregion or subregion in which the potential water-related impact of coal resource development on assets is assessed. The compiling of the asset register is the first step to identifying and analysing potentially impacted assets, which is the goal of the overall BA.

The description of the water-dependent asset register (product 1.3) for each bioregion or subregion is available at <http://www.bioregionalassessments.gov.au/>. Any deviations from the approach described in this submethodology are to be noted in any products based upon its application.

The steps in creating the water-dependent asset register for a BA are explained in this submethodology and are as follows (Figure 3):

1. Compilation and classification of national and other asset databases by the Assets and Receptors Project team to produce the *asset database* (see Section 2). A key input to the asset database at this stage is the BA-purpose-built *Water Asset Information Tool* (WAIT) database populated by natural resource management organisations (NRMs).
2. Definition of the PAE for a bioregion or subregion by the Assessment team (see Section 3).
3. Creation of an *asset list* by the Assets and Receptors Project team through selection of assets in the asset database that occur within the PAE (see Section 3).

4. Refinement of the asset list by the Assessment team (based on the potential for water-related impacts on assets and feedback from experts with local knowledge) to create a water-dependent asset register (see Section 4).

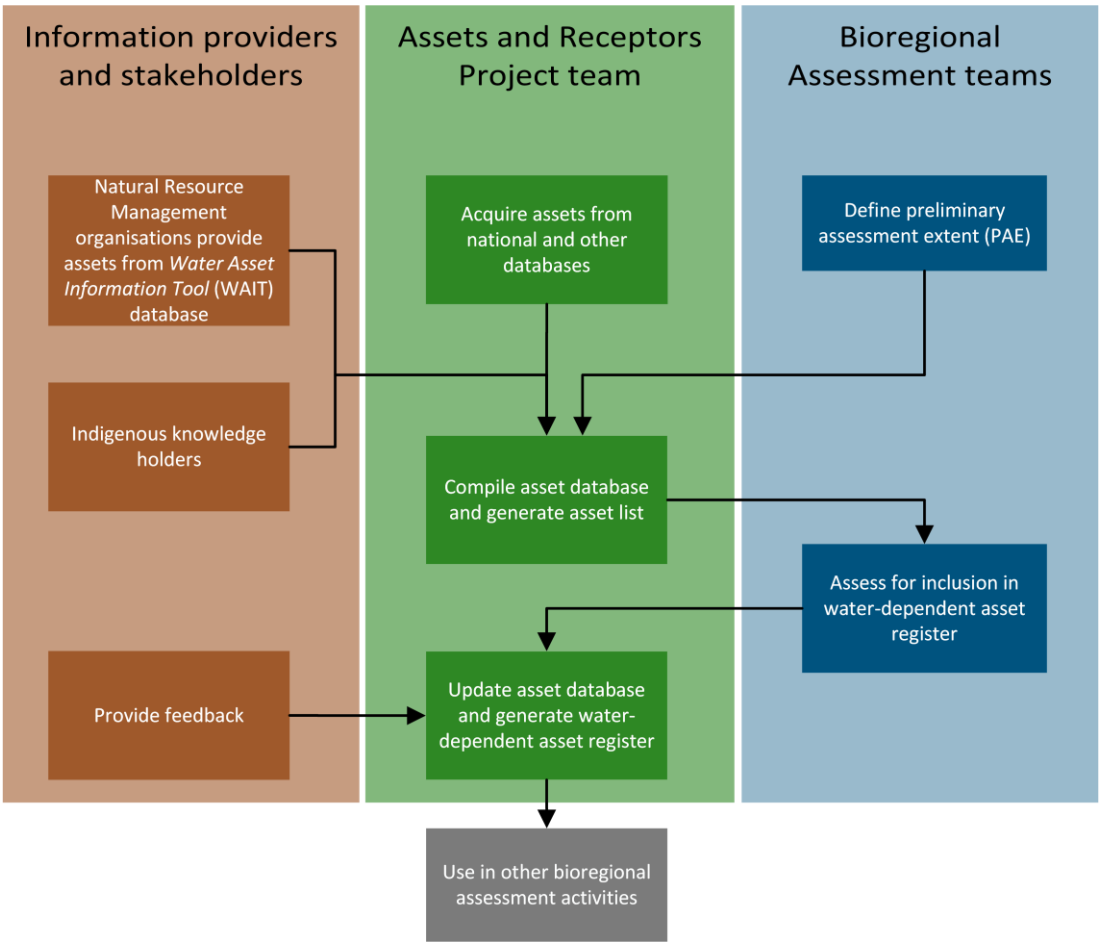


**Figure 3 Process for developing a water-dependent asset register for a bioregional assessment**

The asset source data are compiled into an *asset database*, including the spatial data, which are designated as *elements* (individual spatial features – points, lines and polygons) and *assets* (combinations of one or more elements). During the compilation process, assets are classified into three groups: (i) ecological, (ii) economic and (iii) sociocultural. Many assets are obtained from state and national databases and a key group of assets is provided by NRMs. Meetings are planned with Indigenous knowledge holders to discuss Indigenous cultural water-dependent assets.

The asset database is then used to generate the water-dependent asset register. A preliminary version of the asset register is presented to experts and organisations with local knowledge at organised workshops. Feedback is sought about whether the asset register is complete and correct; appropriate amendments are then made. It is at this stage – when assets have been selected using the PAE and the amended water-dependent assets have been recorded in the database – that the water-dependent asset register is complete for the purposes of producing product 1.3. Note, however, that the addition of new assets to the asset database, or a review of the status of existing assets in the database will mean that the asset register may be updated. As this has implications for other BA components, any updates must be documented and only be done with approval and tight version control. The product 1.3 will not be updated or republished

but an updated version of the asset register (derived from the asset database) may be published at the same time as other products, for example, those associated with Component 3: Impact analysis of a BA.

Following development of the asset register, the connection of the registered assets to coal resource development is assessed using the 'materiality' tests and, if potentially subject to water-related impacts, assigned *receptors* (after Barrett et al., 2013). A receptor is a point in the landscape where water-related impacts on assets are measured and/or estimated. The approach to assigning receptors and impact variables to water-dependent assets is described in the pending companion submethodology M03 (as listed in Table 1).

## *References*

Barrett DJ, Couch CA, Metcalfe DJ, Lytton L, Adhikary DP and Schmidt RK (2013) Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment. Department of the Environment, Australia. Viewed 13 January 2015, <http://iesc.environment.gov.au/publications/methodology-bioregional-assessments-impacts-coal-seam-gas-and-coal-mining-development-water>.

# 2 Compiling the asset database

The compilation and classification of assets is conducted within the scope of a bioregional assessment (BA). The *Methodology for bioregional assessments of the impact of coal seam gas and coal mining development on water resources* (Barrett et al., 2013) specifies a focus on impacts on water resources. While detailed social and economic impact analyses are not within scope of a BA the outputs from the Bioregional Assessments Programme can be used to do so. The assets are compiled and classed accordingly.

## 2.1 Sources of assets

Information is compiled about entities (e.g. a wetland or river) having value to the community and that might be affected by water-related impacts of coal seam gas (CSG) and large coal mining development. This information is compiled from a range of sources into the bioregional assessment (BA) asset database. There are three types of assets: (i) ecological, (ii) economic and (iii) sociocultural (see Section 2.2). Briefly, as set out in the BA methodology (p. 39–40), assets within the database should include but not be limited to:

- landscape elements that have statutory protection including sites listed under World Heritage and Ramsar conventions; national and state parks; and Indigenous Protected Areas
- species[1] and ecological communities protected under federal legislation, such as the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- species habitats protected under international, Australian Government, state or territory legislation
- ecological systems such as riverine floodplains, rivers, groundwater-dependent ecosystems (GDEs), springs, mound springs, karst formations, wetlands, terminal lakes, estuaries, aquifers, and groundwater systems
- cultural sites with water dependencies including areas declared under native title legislation, or pending decisions on native title
- locations of important hydrological processes including recharge of aquifers, or provision of water for industrial, recreational or domestic purposes
- locations of bores or reservoirs and other groundwater and surface water access entitlements and basic landholder rights
- species or community habitats of management or conservation concern currently not protected in their own right.

[1] BAs consider the potential impact to the habitat of species not the individual species per se

Many ecological and sociocultural assets are obtained from state and national sources (Table 3). All assets and elements are quality controlled for any inconsistencies or deficiencies, including duplicates and data without spatial reference.

**Table 3 Data sources from which many ecological and sociocultural assets are obtained**

| Dataset[a] | Custodian |
|---|---|
| *Collaborative Australian Protected Areas Database* (CAPAD) | Department of the Environment |
| *Directory of Important Wetlands in Australia* (DIWA) | Department of the Environment |
| Environmental Assets Database (Commonwealth Environmental Water Holder) | Department of the Environment (restricted access) |
| Great Artesian Basin Groundwater Recharge | Geoscience Australia |
| *Atlas of Groundwater Dependent Ecosystems* | Bureau of Meteorology |
| *Birdlife Australia Important Bird Areas* | Birdlife Australia |
| Key Environmental Assets of the Murray-Darling Basin | Murray-Darling Basin Authority |
| Threatened ecological communities listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) | Department of the Environment |
| Threatened species listed under the EPBC Act | Department of the Environment |
| Threatened species listed under various state legislation, where available | Various state governments |
| Wetlands of International Importance (Ramsar wetlands) | Department of the Environment |
| *World Heritage List* (WHL) | Department of the Environment |
| *National Heritage List* (NHL) | Department of the Environment |
| *Commonwealth Heritage List* (CHL) | Department of the Environment |
| *Register of the National Estate* (RNE) | Department of the Environment |

[a]Full descriptions and citations of datasets and collections will be published in the metadata for each subregional asset database. Italics indicate formal data source name.

A key group of ecological and sociocultural assets is provided by natural resource management organisations (NRMs). The Australian Government funded NRMs in each bioregion or subregion to collate lists and spatial information of assets that might be affected by water-related impacts due to coal resource development. This information was recorded in the BA-purpose-built *Water Asset Information Tool* (WAIT) database for each bioregion or subregion. Key attributes included in the WAIT database and added to the asset database are listed in Table 4.

**Table 4 Fields used for the *Water Asset Information Tool* (WAIT) database**

| Attribute[ab] | Description |
|---|---|
| AssetName | Accepted legal name for location, as provided by regional NRM[c] organisations |
| NRM_region | NRM region or CMA from which data was received |
| ElementID | ERIN[d] generated BA asset identifier. Unique per spatial feature |
| Description | Overall asset description, location, river system, aquifer, area (in hectares), climate and other relevant details |
| coordinates_define | Spatial layer type (points, lines or polygons) |
| EnvironmentalValue | Environmental value (diversity, habitat, distinctiveness, naturalness, and representativeness) |
| EconomicValue | Economic values |
| SocialCulturalValue | Social and cultural values |
| Hydrology | Hydrology, for example water balance (water flowing in, water flowing out) groundwater infiltration and seepage surface water – groundwater interactions tidal regime, inundation regime (volume, frequency, duration, height and seasonality [timing] of inundation) |
| Geology/geomorphology | Notes on geology and geomorphology |
| Other_Relevant_Details | Further relevant information about the asset |
| ManagementAuthority | Authority with responsibility for managing the asset |
| Tenure | Tenure of the asset or the land where the asset occurs |
| Condition | Condition of the asset |
| Primary_contact_for_asset | Name, organisation, role, phone and email |
| Legal_protection | State, Australian Government or international protection (e.g. World Heritage, Ramsar, EPBC-listed[e] community etc.) |
| Notes | Other notes relevant to the asset in the bioregional assessment |

[a]Punctuation and typography appear as used in the WAIT
[b]Not all these attributes were provided in every case
[c]Natural resource management (NRM)
[d]Environmental Resources Information Network (ERIN)
[e]Listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

Additional sociocultural assets are sourced from the Australian Heritage Database (Department of the Environment, 2014). Where possible and appropriate, and with the agreement of Indigenous knowledge holders, Indigenous water-related values will be incorporated into BA products either through an updated water-dependent asset register and/or incorporated into later technical products. Meetings are planned with Indigenous knowledge holders to gain an understanding of Indigenous cultural water-dependent assets.

Water-dependent economic assets are made up of grouped groundwater and surface water access entitlements and basic landholder rights. The Intergovernmental Agreement on a National Water Initiative (COAG, 2004) defines a *water access entitlement* as 'a perpetual or ongoing entitlement to exclusive access to a share of water from a specified consumptive pool as defined in the relevant water plan'. Water access entitlements are recorded by state water agencies.

Within each economic asset, every water access entitlement linked to a works approval is an entity. Each entity, which is known for database management purposes as an *element*, is grouped by type and spatially to create assets (see Appendix B for an example from NSW).

Basic landholder rights, including riparian rights, maintain the right of those adjacent to rivers, estuaries, lakes or aquifers underlying the land to extract water for domestic and stock use without a water access licence. Basic landholder rights are defined by the jurisdiction based on the location of the water source and include an estimated volume of use based on the number of landholders with adjacent water sources. All economic assets are categorised as operational for extractive use and therefore do not contain assets that have been classed as abandoned, cancelled or suspended. This potentially over-estimates the number of basic water rights as the jurisdictional database may not have been notified if a basic water right is no longer active.

## 2.2 Classification of assets

The compiled assets are classified into groups, subgroups and classes as listed in Table 5. Every element or asset is only assigned one class, and thus subgroup and group. This classification was developed during initial BA applications. It may be feasible to use additional classifications – such as the *Australian National Aquatic Ecosystem* (ANAE) classification framework (Aquatic Ecosystems Task Group, 2012) – to complement the subgroups and classes. Decisions should be made on a case-by-case basis.

Classification decisions must be made about entities that appear in the asset database more than once either from different sources or as a result of possessing multiple values. For example, Coongie Lakes in the Galilee subregion of the Lake Eyre Basin bioregion is represented in three ways: (i) as a site listed as a wetland of international significance under the *Ramsar Convention on Wetlands* (Ramsar Secretariat, 2014), (ii) as a site listed in the *Directory of Important Wetlands in Australia* (DIWA; Environment Australia, 2001) as a wetland of national significance and (iii) as a groundwater-dependent ecosystem. As all three data sources carry different information about the asset, all the information is included in the asset database in the form of three distinct assets. Further, an entity may be an ecological asset because of its ecosystem value and could also be an economic asset if it is used as a water source for irrigation. In this instance the entity would be listed as two different assets in the asset database. Typically, sociocultural assets that are landscape water features are generally included within the ecological asset classes to avoid repetition of assets, though the sociocultural information is retained for use in latter BA components, such as the impact and risk analyses.

**Table 5 Classification of assets for a bioregional assessment**

| Group | Subgroup | Class |
|---|---|---|
| Economic | Groundwater management zone or area (surface area)[a] | A groundwater feature used for water supply |
| | | Water supply and monitoring infrastructure |
| | | Water access right |
| | | Basic water right (stock and domestic) |
| | Surface water management zone or area (surface area) | A surface water feature used for water supply |
| | | Water supply and monitoring infrastructure |
| | | Water access right |
| | | Basic water right (stock and domestic) |
| Sociocultural | Cultural | Heritage site |
| | | Indigenous site |
| | Social | Recreation area |
| Ecological | Surface water feature | River or stream reach, tributary, anabranch or bend |
| | | Lake, reservoir, lagoon or estuary |
| | | Waterhole, pool, rock pool or billabong |
| | | Wetland, wetland complex or swamp |
| | | Marsh, sedgeland, bog, spring or soak |
| | | Floodplain |
| | Groundwater feature (subsurface) | Aquifer, geological feature, alluvium or stratum |
| | Vegetation | Groundwater-dependent ecosystem |
| | | Riparian vegetation |
| | | Habitat (potential species distribution) |

[a]This subgroup is not intended to represent only declared groundwater management units referred to in state water management plans

For the economic assets, the priority is, where available, to use the more detailed data linked with water access entitlements. Where these data are not available, it may be necessary to use broader classes of groundwater or surface water features. Water access entitlement assets are divided into two classes:

- Basic water right (domestic and stock) – this is the right to take water for domestic and stock purposes only. A basic right for 'take of groundwater' requires approval for the works (bore) but does not require a licence for the extraction of groundwater. A basic right for 'take of surface water' does not require an approval for the works or approval for the extraction of surface water.
- Water access right – this right requires an approval for the works and a licence for the extraction of the water. The extraction of the water can be for a range of purposes including irrigation, commercial, industrial, farming, dewatering, mining, intensive agriculture etc.

For water access licences that are not linked to a works approval, no specific location information is available. Therefore, in these cases, all remaining licences are aggregated to the corresponding

water source location (polygon) to ensure they are included as an element or asset in the asset database. This is particularly important to ensure all water use is accounted for, including water that is only delivered through trade.

Groundwater entities (known as elements for database management purposes) that were not classified as a basic water right or a water access right are not considered relevant to the BA and are classed as 'null'. These include test bores, bores installed for groundwater remediation, exploratory bores, exploratory research, monitoring bores and waste disposal bores. These works are not operational for extractive use. These elements are retained in the asset database for transparency purposes, but are flagged, or 'turned off', and will not be considered further in the BA.

## 2.3 The asset database

Generating the water-dependent asset register requires the development of a comprehensive geo-referenced relational database known throughout this submethodology as the *asset database*. The asset database holds all assets compiled for the preliminary assessment extent (PAE) of a BA and the asset register lists the subset of assets that meet the water dependency criteria, as defined in Section 4. As there may be many assets within each asset class for each bioregion or subregion, each asset must have a unique identifier (AID, though sometimes referred to in text as 'AssetID' for clarity). A single asset is represented spatially in the asset database by single or multiple spatial features (point, line or polygon). Individual points, lines or polygons are termed *elements* and must also have a unique identifier (ElementID). An element is a spatially discrete unit and all elements are recorded individually in the 'ElementList' table of the asset database – an example of its structure is presented in Figure 4 and the table structure is documented in Appendix A, Table A.1.

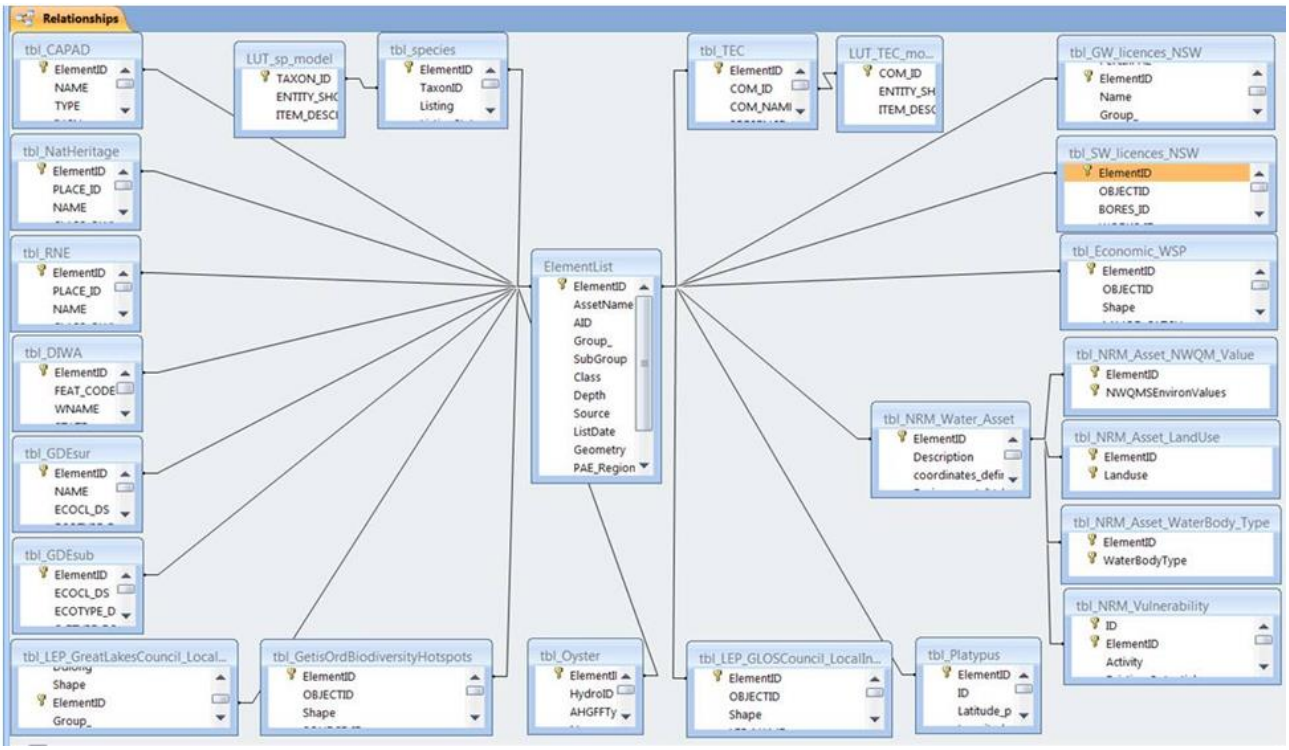


**Figure 4 'ElementList' table structure for the Gloucester subregion**

Assets can be made up of one or more elements. Elements are linked to assets in the database via the 'Element_to_asset' table (see Appendix A, Table A.2). The asset table is called 'AssetList' and the table structure is documented in Appendix A, Table A.3. An example of the relationship between assets and elements is given in Figure 5, which shows that the asset (Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions, listed within the EPBC Act as a threatened ecological community) is composed of 3453 elements.

Grouping the elements into assets is the role of both the Assets and Receptors Project team and the Assessment team in consultation with external experts with specialist and local knowledge. This is achieved by naming elements; elements are given names based on a set of rules devised to capture enough information about the element to be descriptive and relevant to the assessment. The rules are tailored to the source data and the assessment and are recorded in the 'decision tables' of the asset database. Examples of rules for naming assets are given in Table 6. For the example shown in Figure 5, aggregation of the 3453 elements for this asset is based on all elements sharing the same 'Name' value in the database. The Asset and Receptor Project team first applies the naming rules in the asset database to produce the *asset list* which is then provided to the Assessment team for further refinement.

Decisions about water dependence and potential for impact by coal resource development are made and recorded for assets (Section 4). Once this is completed, the asset database is used to generate the *water dependent asset register*. In addition to storing information about assets, the asset database also stores information about receptors (see the pending companion submethodology M03 about assigning receptors and impact variables to registered assets).

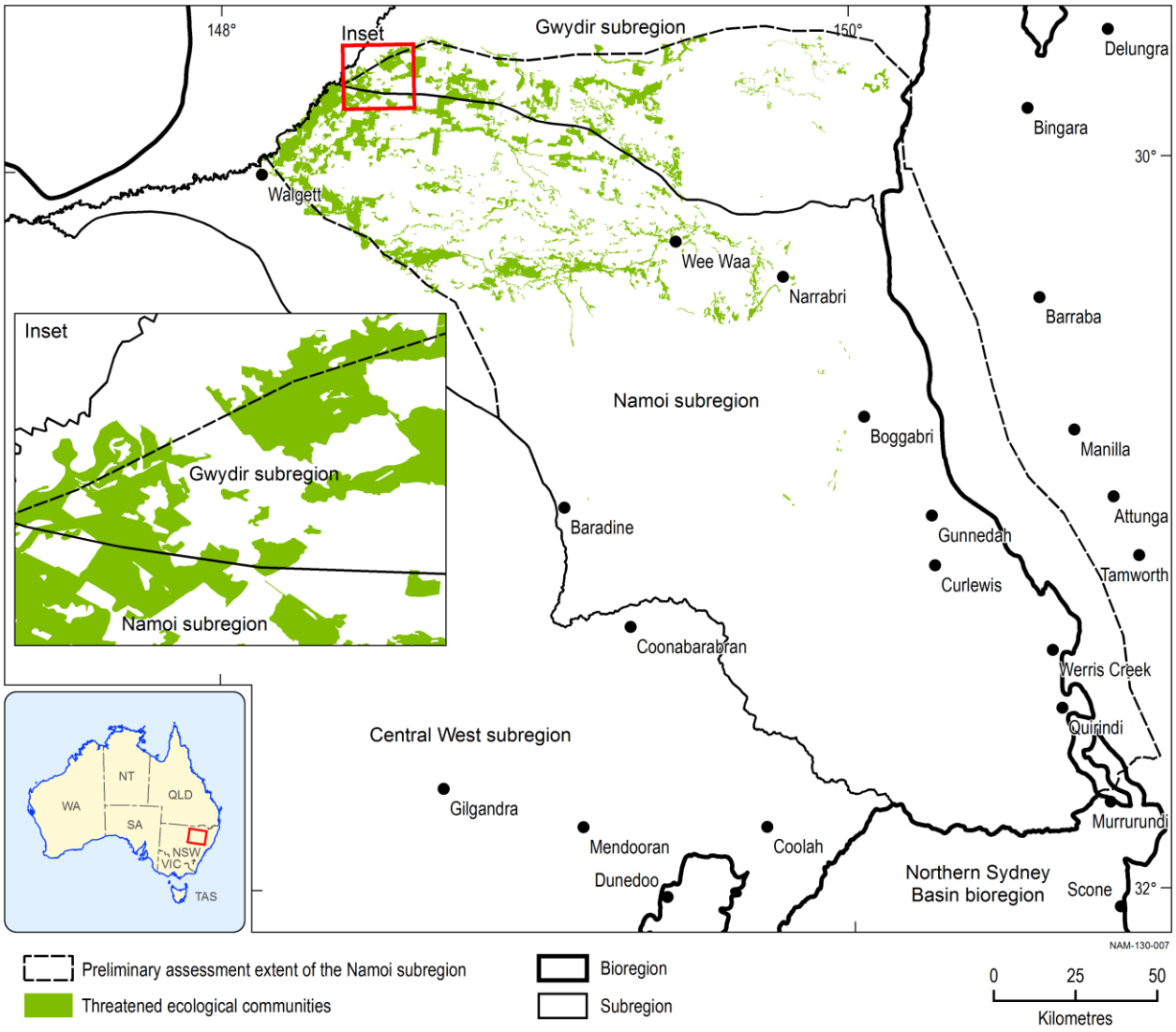


**Figure 5 Example showing the relationship between assets and elements**

The map shows the distribution of an asset (Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions, listed under the EPBC Act as a threatened ecological community) in the Namoi and Gwydir subregions of the Northern Inland Catchments bioregion. Note that the asset comprises many thousands of elements (polygons; shaded green). The inset illustrates that the elements of a single asset may be spatially separate.

**Table 6 Examples of naming assets using rules tailored to source data**

This is not an exhaustive nor definitive list – each bioregional assessment will likely use different datasets and therefore have different naming rules and exceptions. Although examples of individual species are listed below, bioregional assessments consider the potential impact to the habitat of species not individual species per se.

| Source data[a] | Naming rule based on source data field names[b] | Example of asset name[c] | Exceptions[b] |
|---|---|---|---|
| *Collaborative Australian Protected Area Database* (CAPAD) | Name + Type | Karuah National Park | None |
| *Directory of Important Wetlands in Australia* (DIWA) | WNAME | Port Stephens Estuary | None |
| Groundwater-dependent ecosystems, sub-surface (GDEsub) | Name + S_ETYPE_DS + "GDE" | Escarpment Redgum GDE | Major vegetation subgroup + S_ETYPE_DS + "GDE" |
| Groundwater-dependent ecosystems, surface (GDEsur) | Name + ECOTYPE_DS+ "GDE" | Warburton River Permanent waterhole GDE | When Name is blank: MajorVegetationSubgroup + Ecohydrological zone + river basin name + ECOTYPE_DS + "GDE" |
| Listed species | Common_Name + (Scientific_Name) | Australasian Bittern (Botaurus poiciloptilus) | WHEN no common name available: "(ScientificName)" (e.g. (Grevillea guthrieana)) |
| Threatened ecological communities | Name | Lowland Subtropical Rainforest on Basalt Alluvium in NE NSW and SE Qld (threatened ecological community) | None |
| *National Heritage Listed* (NHL) | Name + "(National Heritage Listed)" | The Stroud Gloucester Valley (National Heritage listed) | None |
| *Register of National Estate* (RNE) | Name + "(Register of National Estate)" | Booral House (Register of National Estate) | None |
| Economic assets (sourced from state water agency) | Class + WATER SOURCE | WATER ACCESS RIGHT_UPPER GLOUCESTER RIVER WATER SOURCE | If no WATER SOURCE is listed, allocate a unique identifier followed by NO-WATER SOURCE |

[a]Full descriptions and citations of datasets and collections will be published in the metadata for each subregional asset database.
[b]Syntax used in the asset database
[c]Punctuation and typography appear here as generated by the asset database.

## *References*

Aquatic Ecosystems Task Group (2012). Aquatic ecosystems toolkit. Module 2. Interim Australian national aquatic ecosystem classification framework. Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra. Viewed 5 August 2014, <http://www.environment.gov.au/system/files/resources/08bfcf1a-0030-45e0-8553-a0d58b36ee03/files/ae-toolkit-module-2-anae-classification.pdf>.

Australian Government (2012) National Partnership Agreement on coal seam gas and large coal mining development. Council of Australian Governments. Viewed 5 August 2014, <http://www.coag.gov.au/node/394>.

Barrett DJ, Couch CA, Metcalfe DJ, Lytton L, Adhikary DP and Schmidt RK (2013) Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment. Department of the Environment, Australia. Viewed 20 November 2014, <http://iesc.environment.gov.au/publications/methodology-bioregional-assessments-impacts-coal-seam-gas-and-coal-mining-development-water>.

COAG (2004) Intergovernmental Agreement on a National Water Initiative. Council of Australian Governments., National Water Initiative website. Department of the Environment, Canberra. Viewed 30 April 2014, <http://www.nwc.gov.au/__data/assets/pdf_file/0008/24749/Intergovernmental-Agreement-on-a-national-water-initiative.pdf>.

Department of the Environment (2014) The Australian Heritage Database online. Viewed 9 September 2014, <http://www.environment.gov.au/heritage>.

Environment Australia (2001) A directory of important wetlands in Australia (3rd edition). Environment Australia, Canberra. Viewed 12 June 2014, <http://www.environment.gov.au/system/files/resources/18f0bb21-b67c-4e99-a155-cb5255398568/files/directory.pdf>.

Ramsar Secretariat (2014) The Ramsar List of Wetlands of International Importance. Viewed 27 August 2014, <http://www.ramsar.org/cda/en/ramsar-documents-list/main/ramsar/1-31-218_4000_0__>.

# 3 Determining and applying the preliminary assessment extent

## 3.1 Determining the preliminary assessment extent

Undertaking a bioregional assessment (BA) requires the determination of the preliminary assessment extent (PAE). The PAE is defined as the geographic area associated with a bioregion or subregion in which the potential water-related impact of coal resource development on assets is assessed. The purpose of the PAE is to provide a first step in the process of determining whether a water-related link is possible between coal resource development and the assets. It is intended to be a realistic yet inclusive estimate of the land surface area where potential impacts might occur. As the model-data analysis, impact analysis and risk analysis components of a BA are completed it will be possible to more closely characterise and quantify impacts in terms of their extent and their likelihood.

The PAE is developed by the Assessment team for each bioregion or subregion and, when finalised, is reviewed by a group consisting of the Bioregional Assessments Projects Director, the Science Directors of CSIRO and Geoscience Australia and then submitted to the Principal Science Advisor of the Office of Water Science for approval.

The PAE is derived from the intersection of surface water hydrology features, groundwater management units, mining development leases and/or coal seam gas (CSG) tenements, and directional flows of surface water and groundwater (Barrett et al., 2013). The process of defining the PAE is undertaken via consideration of the vertical and horizontal proximity and scale of surface water and groundwater connectivity pathways and potential for depressurisation or dewatering.

The following information sources, underpinned by spatial datasets, are used to define the PAE in any bioregion or subregion:

**1. Bioregion or subregion boundary**. The PAE might extend beyond a bioregion or subregion boundary. The BA methodology should be consulted where 'far-field' water-related impacts on assets outside a bioregion or subregion boundary may be important and these are incorporated into the PAE where necessary.

**2. Geology and the coal resource**. CSG tenements and large coal mining development leases, as defined in Section 3.3 of the BA methodology (p. 38–39), must be included inside the PAE. Further consideration should be given to known stratigraphic relationships between coal measures, adjacent aquifers and their spatial extent to ensure as accurately as possible that boundaries of the PAE enclose potential important causal pathways between subsurface processes and surface features. The boundary should enclose important geologic features including aquifer recharge and discharge locations. The boundary should enclose any area that, based on the available evidence and expert advice, is likely to be affected by coal resource development occurring within the

subregion, though limited to developments that are either occurring now or anticipated to occur within the next 10 to 15 years. Reasons supporting these judgments are to be recorded in product 1.3.

**3. Surface water hydrology**. There are a number of mechanisms by which coal mine and CSG developments can affect surface water resources. One mechanism is by direct extraction of water from or discharge of water to nearby streams. A second mechanism is through impacts of disturbed areas on surface runoff generation and retention. A third mechanism is through changes in baseflow from parts of the landscape where the development has a significant impact on groundwater levels and where there is surface water – groundwater connectivity. In general, areas associated with the third mechanism will also be included in the groundwater PAE (item 4, below), however, surface water PAE assessors should ensure that there are not streams outside the groundwater PAE with substantial baseflow generation. This section therefore focuses on the first and second impact mechanisms.

Direct impacts on surface water resources from coal mine and CSG developments are likely to occur only at and downstream of the developments, though in rare circumstances, upstream effects may need to be considered. To a first approximation the surface water PAE should therefore include only those streams which produced water can potentially reach or with flows that might be reduced by extraction. The key question, then, is in establishing how far downstream the PAE should extend. To achieve this, different approaches are likely to be applied in different subregions, depending on local climate variability and on the availability of gauged streamflows at suitable locations and details of water management plans. In general, though, they will involve estimates of the proportion of the streamflow in a given downstream reach that is derived from the development locations. In reaches where this proportion is considered significant (typically this will mean about 5 to 10%), the reach should be included in the PAE. In many cases this assessment will result in a surface water PAE extending downstream of the bioregion boundary. A second important consideration is in choosing the width of the buffer zone around the stream. This will depend on local conditions, including geomorphology, topography and typical extents of floodplain inundation. Buffer zones should include potential water-dependent assets near but not in the river. The buffer may extend up to 10 km or further in braided networks with wide floodplains.

**4. Groundwater hydrology**. The PAE must include the extent of any groundwater system that intersects with coal resource development. The groundwater system is defined by the best available knowledge and may be refined based on further information about the geology and stratigraphy from (2) above. In bioregions or subregions where groundwater management units have been defined, these should be used to define the extent of the groundwater system for the purpose of determining boundaries of the PAE. Where uncertainty in groundwater management units exists, the boundaries of the PAE must be positioned at a point where, in the Assessment team's judgment, impacts from coal resource development outside this boundary are not likely. Reasons supporting these judgments are to be recorded in the Assessment's workflow and provided to the Assessment team. Where a river reach is connected to a groundwater system that overlies or underlies (or otherwise is potentially connected to) coal resource development, the groundwater system associated with that river reach must also be considered. For groundwater systems impacted by coal resource development where there is an interaction with a river that

has not already been considered, the in-bank area from the interaction location downstream must be considered.

**5. Flow paths**. Known available information on gradients of pressure, watertable height, stream direction, surface water – groundwater connectivity and any other available data that provide information on surface and subsurface flow paths and the potential effects of coal seam depressurisation or dewatering on these flows must be considered in defining the PAE for a bioregion or subregion. For example, a zero-flow boundary provides a hard constraint on the extent of the PAE. Potential for flow reversal in an alluvium will potentially require the entire geomorphological unit to be considered.

**6. Infrastructure**. The prescribed boundary of the PAE will not take into consideration landscape impacts of infrastructure related to coal resource development such as pipelines, conveyors, roads and railways that have no direct connection with impacts on water resources. Where potential impacts are identified, such as effects of infrastructure on overland flow, these are to be considered in determining the PAE as far as possible. However, in most cases uncertainties in the location and extent of infrastructure development will preclude this consideration in determining the boundary of the PAE.

Based on this information, the PAE is defined by the intersection of the spatial datasets described above. The resulting map of the PAE boundary is approved and deemed as fit for purpose for determining the asset list.

## 3.2 Selecting assets within the preliminary assessment extent

This process is conducted by the Assets and Receptors Project team. Assets with spatial extents that overlap with, or are fully contained within, the PAE are included in the asset database for that bioregion or subregion. Assets made up of multiple elements may have a mixture of elements within and outside the PAE. Only elements that overlap with, or are fully contained within, the PAE are included in the asset list for that bioregion or subregion. Once assets have been reduced to only those within or intercepting the PAE they are labelled as such and, together, form the *asset list*. Next, the asset list is assessed by the Assessment team for potential water-related impacts, as described in Section 4.

### *References*

Barrett DJ, Couch CA, Metcalfe DJ, Lytton L, Adhikary DP and Schmidt RK (2013) Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment. Department of the Environment, Australia. Viewed 20 November 2014, <http://iesc.environment.gov.au/publications/methodology-bioregional-assessments-impacts-coal-seam-gas-and-coal-mining-development-water>.

# 4 Assessing water dependence of assets

It is the role of individual bioregion or subregion Assessment teams to assess water dependence of assets for specific bioregional assessments (BAs). This means identifying all assets in the asset list that may be potentially impacted by changes in the groundwater or surface water regime due to coal resource development. While the vast majority of the assets will be clearly 'water dependent' in the general sense of the phrase (e.g. bores, rivers and wetlands), there is a small group of assets that could be affected but are not as readily identified as being 'water dependent'. Examples of these assets could include historic buildings that are subject to added inundation or salinity impacts, or Indigenous assets that become more difficult to access due to changes in the water regime. This more particular meaning of 'water-dependence' has been defined to meet the specific requirements of the BA methodology which is focussed on 'assets potentially subject to water-related impacts' rather than only on 'impacts on water-dependent assets'.

## 4.1 Ecological assets

Though all life is dependent on water, for the purposes of a BA, an ecological *water-dependent asset* is one that is potentially impacted by changes in the groundwater and/or surface water regime due to coal resource development. The water must be other than local rainfall.

Most ecological assets are water dependent. Landscape features such as wetlands, springs, rivers, pools, riffles, lakes, catchments, etc. are clearly water dependent and thus clearly have potential to be impacted. Terrestrial groundwater-dependent ecosystems (GDEs; e.g. coolibah-black box woodlands) are water dependent, though the mapping that is currently available (e.g. the GDE Atlas (Bureau of Meteorology, 2012)) must provide information of a high enough standard (e.g. adequate identification data) for the Assessment teams to determine whether they should be included in the asset register. The water dependence of species' habitat, based on their potential species distributions, will depend on the ecology of the species and is less certain. The habitats of species such as frogs, fish and waterbirds are clearly water dependent. For other habitats, the Assessment team must make a determination as to the potential for water-related impacts based on the potential species distributions, the species' preferred habitat, feeding, reproduction, behaviour and other relevant factors.

Multiple lines of evidence are used including published habitat information and expert opinion. All decisions to either include or exclude an asset from the register (and thus deciding further participation in a BA) are to be recorded in the asset database (see Section 4.4) and reported in product 1.3. As an example, consider the following evidence about the Ooline (*Cadellia penatasylis*), which is a medium sized spreading tree growing to 10 to 25 m on the western edges of the NSW north-west slopes and extending into Queensland. The species is listed as vulnerable under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and its habitat includes dry rainforest, semi evergreen vine thickets and sclerophyll communities (Curran and Curran, 2005). The population located near Gunnedah falls within the preliminary assessment extent (PAE) of the Namoi subregion of the Northern Inland Catchments

bioregion (Figure 6) and is significant because it represents the southernmost distribution limit for this species (Curran and Curran, 2005). Another line of evidence obtained through studying the habitat requirements within the Blackjack mountain population and the associated vegetation communities (Curran and Curran, 2005) suggests that these communities have no access to groundwater. This is supported by further lines of evidence based on distribution data, showing species and community have no association with stream edges or riparian vegetation, and botanical information, indicating the sclerophyllous nature of the vegetation and the semi-evergreen nature of associated vegetation communities. To conclude findings, external expert opinion was sought which confirmed the conclusion that neither the species nor habitat is likely to be dependent on groundwater or surface water and thus not subject to water-related impacts by coal resource development. Hence, the potential species distribution of Ooline will not be judged to be a water-dependent asset and thus is not in the asset register. Should new information become available about this species, that judgment could be changed.

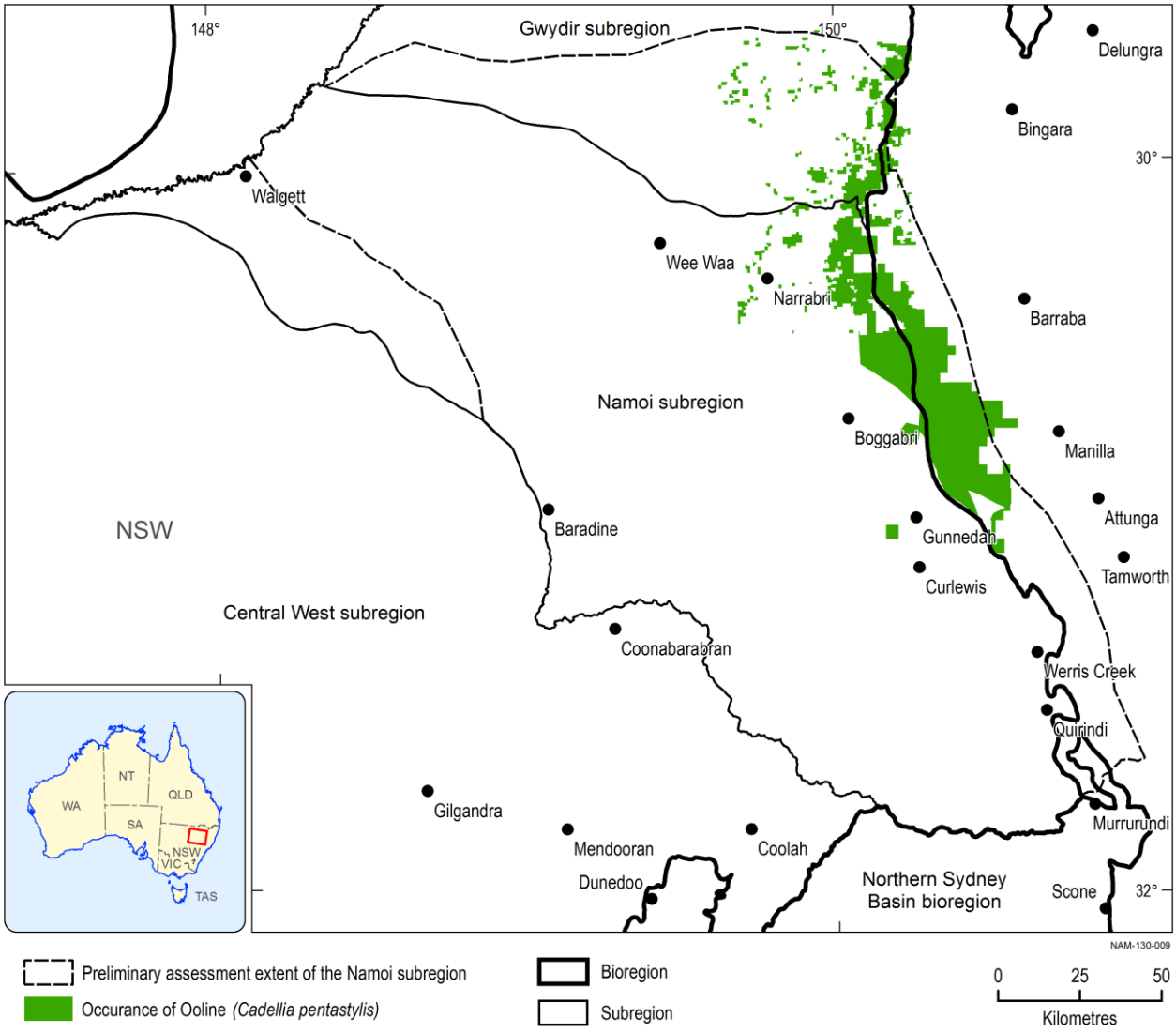


**Figure 6 Modelled species distribution of Ooline (*Cadellia pentastylis*) in relation to the preliminary assessment extent of the Namoi subregion of the Northern Inland Catchments bioregion**

## 4.2 Economic assets

All economic assets include a right to take and use water from a waterway, catchment dam, spring, soak or aquifer, whether for basic water rights (domestic and stock) or a water access right. This inherent reliance on water implies that all economic assets are water dependent and have the potential to be subject to water-related impacts due to coal resource development.

## 4.3 Sociocultural assets

While many sociocultural assets, such as historic buildings, are unlikely to be water dependent in the usual sense, for the purposes of a BA, some may be included as they are subject to potential water-related impacts due to coal resource development such as inundation. For example, floodplain mapping could be used to identify potentially impacted assets, though methods may need to vary with each bioregion or subregion given the variation in the quality and methods of floodplain mapping. Other sociocultural assets will be assessed by the Assessment team on a case-by-case basis when they become available and reviewed by the community and experts with local knowledge during engagement workshops. Where possible and appropriate, and with the agreement of Indigenous knowledge holders, Indigenous water-related values will be incorporated into BA products. Meetings are planned with Indigenous knowledge holders to discuss Indigenous cultural water-dependent assets.

## 4.4 Completion of the water-dependent asset register

Once the potential for water-related impacts by coal resource development has been determined for an asset (see Section 4.1 to Section 4.3) by the combined efforts of the Assessment team and the Assets and Receptors Project team, ‘flags’ are set in the asset database indicating that status for each asset. For each asset the flag must be either 'yes' or 'no' to indicate whether the asset is included in or excluded from the asset register. A flag set to 'yes' indicates that the asset is 'registered' for inclusion in other BA components.

A rationale or justification should be recorded in the asset database for each decision to include or exclude any particular asset or class of assets. It should also be documented in product 1.3. Any data shortfalls due, for example, to its unavailability or inadequate information content should be documented in product 1.3.

The water-dependent asset register is a defined list of assets that fall within, or intersect, the PAE of the bioregion or subregion and have passed the test of being potentially impacted by changes to the water regime. It corresponds to the assets within the ‘AssetList’ table (see Appendix A, Table A.3) of the asset database that are 'flagged' to be included in other BA components. A listing of the register can be generated at any time as ‘reporting output’ from the asset database.

A preliminary version of the asset register, with associated maps and data, is presented to experts and organisations with local knowledge at organised workshops. Participants typically include land managers, water managers, environmental managers, councils, government and industry. Their feedback is sought about whether the register is complete and correct; appropriate amendments are then made by the Assessment team and the Assets and Receptors Project team including with

additional data identified during the workshop. Team leaders can make arrangements for a final viewing of the register by workshop participants before completion if they think it is necessary.

It is at this stage – when assets have been selected using the PAE, the amended and additional assets have been recorded in the asset database, the database error checked and deposited in the data repository – that the formal asset register is complete for the purposes of producing product 1.3. Note that the addition of new assets to the asset database, or a review of the status of existing assets in the database due to, for example, a change in the available information about those assets, will mean that the asset register may be updated (i.e. flags and reasons added or amended). As this has implications for other components of a BA, any updates must be documented and done with approval and tight version control. The product 1.3 will not be updated or republished but an updated version of the asset register (derived from the asset database) may be published at the same time as other products, for example, those associated with Component 3: Impact analysis of a BA.

The asset register is a simple and authoritative listing of the names of the assets that will be included in other components of a BA; all the spatial and other data associated with each asset (including for each element) is stored in the asset database. Other BA components are described in the pending companion submethodologies including M03 for assigning receptors and impact variables to the registered assets.

Product 1.3 for each BA must describe the approach taken to compile each asset register, including reasons for including or excluding assets, and must document any deviations from the approach presented in this submethodology and the reasons why they were considered necessary.

## *References*

Barrett DJ, Couch CA, Metcalfe DJ, Lytton L, Adhikary DP and Schmidt RK (2013) Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment. Department of the Environment, Australia. Viewed 20 November 2014, <http://iesc.environment.gov.au/publications/methodology-bioregional-assessments-impacts-coal-seam-gas-and-coal-mining-development-water>.

Bureau of Meteorology (2012) Atlas of groundwater dependent ecosystems. Bureau of Meteorology, Canberra. Viewed 16 June, 2014 <http://www.bom.gov.au/water/groundwater/gde/>.

Curran TJ and Curran SR (2005) Rediscovery of Ooline, *Cadellia pentastylis*, near Gunnedah: notes on the habitat and ecology of this dry rainforest tree. Cunninghamia 9, 311–316.

# Appendix A Simple descriptions of key tables within the asset database

Microsoft Access is used to manage information about each asset. The following tables are at the core of the structure of the asset database.

The source datasets (e.g. see Table 5) are organised into a standard format defined by the 'ElementList' table (Table A.1), as presented in Figure 4. Spatial elements from the 'ElementList' table are then selected and combined to create each asset, with elements from the same source dataset grouped according to attributes including group, subgroup and class (see Table 3) and name (see Table 4). Asset names are assigned according to the asset naming rules (e.g. see Table 4), and a sequential unique asset identifier (AID) is assigned to each asset that is unique across all bioregional assessment (BA) assets.

The relationship between the 'ElementList' table and the 'AssetList' table (Table A.3) is many-to-one with one or more elements associated with only one asset. The relationship is recorded in the 'Element_to_asset' table (Table A.2) using the element identifiers (ElementIDs).

The 'Element_to_asset' table also links directly to the 'Decisions' table and the 'AssetList' table. The 'AssetList' table is the basis of the water-dependent asset register. The water-dependent register is a subset of the assets that have been selected for inclusion in the bioregional assessment. They are selected on the basis explained in Section 4.

**Table A.1 'ElementList' table**

| Attribute[a] | Description |
|---|---|
| ElementID | Bioregional assessment (BA) element identifier (unique per spatial feature across all BA elements) |
| Name | A name given to each element either by the natural resource management (NRM) region or copied from a name field in an alternative dataset. Not all elements will have a name. |
| Group | The highest level of the BA classification hierarchy. Values are either 'Economic', 'Ecological' or 'Sociocultural' (see Table 3). |
| SubGroup | The second tier of the BA classification hierarchy (see Table 3). |
| Class | The third tier of the BA classification hierarchy (see Table 3). |
| Depth | Values are currently set to either 'surface' or 'subsurface'. |
| Source | The dataset from which the element was sourced. |
| ListDate | The date the element was added to the element list. |
| Geometry | The type of spatial representation of the asset (point, line, polygon). |
| PAE_Region | The bioregion or subregion that the preliminary assessment extent (PAE) relates to. This element list was compiled for BA work in relation to a particular bioregion or subregion. The outer boundary of the area used to select the elements for inclusion in the assessment is spatially defined by the PAE. The PAE does not necessarily coincide with the boundary of the bioregion or subregion (e.g. an asset could be assessed in the PAE of the Namoi subregion but be physically located in the Gwydir subregion). |
| PAE_Date | The date of the 'approved' PAE which was used to select the elements to be included in the element list. |

[a]Punctuation and typography appear as used in the asset database.

**Table A.2 'Element_to_asset' table**

| Attribute[a] | Description |
|---|---|
| AID | Bioregional assessment (BA) asset identifier (sequential and unique per asset across all assets in the Bioregional Assessment Technical Programme). |
| AssetName | Descriptive name given to each asset. All elements will have a name. |
| ElementID | BA element identifier (unique per spatial feature across all BA elements). |
| M1 | Flag indicating whether the asset meets 'Test 1' i.e. inclusion with the PAE ('Yes/No'). |
| DecisionNote | Rationale for decision about the asset. |
| MadeDate | Date decision was made. |

[a]Punctuation and typography appear as used in the asset database.

**Table A.3 'AssetList' table**

| Attribute[a] | Description |
|---|---|
| AID | Bioregional assessment (BA) asset identifier (sequential and unique per asset across all assets in the Bioregional Assessment Technical Programme). |
| Name | Meaningful, descriptive name given to each asset. |
| Group | The highest level of the BA classification hierarchy. Values are either 'Economic', 'Ecological' or 'Sociocultural' (see Table 3). |
| SubGroup | The second tier of the classification hierarchy (see Table 3). |
| Class | The third tier of the classification hierarchy (see Table 3). |
| Depth | Values are currently set to either 'surface' or 'subsurface'. |
| Source | The dataset from which the element was sourced. |
| ListDate | The date the element was added to the element list. |
| Geometry | The spatial geometry type representing the asset (point, line or polygon). |
| PAE_Region | The bioregion or subregion that the preliminary assessment extent (PAE) relates to. This element list was compiled for BA work in relation to a particular bioregion or subregion. The outer boundary of the area used to select the elements for inclusion in the assessment is spatially defined by the PAE. The PAE does not necessarily coincide with the boundary of the bioregion or subregion (e.g. an asset could be assessed in the PAE of the Namoi subregion but be physically located in the Gwydir subregion). |
| PAE_Date | The date of the approved PAE that was used to select the elements to be included in the element list. |
| AssetArea | Calculated area of the asset. |

[a]Punctuation and typography appear as used in the asset database.

# Appendix B  Identifying economic assets

Water access entitlements are licensed by water agencies in each state and territory. A water access entitlement is generally comprised of two components: (i) the right to extract water from a waterway, catchment dam, spring, soak or aquifer and (ii) the works approval with the right to construct and operate the works associated with the extraction of water such as a bore or a pump. For the purposes of bioregional assessments, an economic element is a combination of the right to extract water linked to the works approval which enables the element to have a specific location. The record associated with each right to extract water includes information about the purpose for which water is extracted (e.g. industry, commercial, domestic etc.) and the volume of water that can be extracted in a financial year (water access rights only). The works approval includes information about the location of the works, the water source where the works is located, and in the case of a bore it may include information on the depth or the aquifer intersected.

For a bioregional assessment (BA), water access entitlements are classed into economic elements and assets as either a *basic water right (stock and domestic)* or a *water access right*. Basic water rights, which are commonly referred to as 'stock and domestic rights', only require an approval for the works and do not require a licence for the extraction of water. A further division of basic water rights includes basic landholder rights or riparian rights which maintain the right of those adjacent to rivers, estuaries, lakes or aquifers underlying the land to extract water for domestic and stock use. Any purpose that is listed as domestic, stock, or domestic and stock is included in the class 'basic water right (stock and domestic)'. Where stock and/or domestic is listed with another licensed purpose, it is listed as a 'water access right'. Water access rights require a licence for the extraction of water and the associated works. A water access right is based on anything that has an extractive use purpose such as commercial, irrigation, farming, industrial, dewatering etc.

For a BA, it is essential to map the location for the entitlements. A basic landholder right (i.e. a type of basic water right) that is held adjacent to a river usually does not have a specific location recorded, though it may be known to occur within an area (i.e. a mapped polygon) with an estimated volume of use (for example, based on the number of landholders with adjacent water sources). If so, it is linked (attributed) to that polygon, rather than to a point location. Where available, an aggregate volume of all basic landholder rights is sourced from the relevant water sharing plan, for example, in NSW.

For the purposes of the asset and receptor work undertaken in a BA it is not necessary to associate an extraction volume with each water access entitlement. This association may however be required when modelling hydrological impacts of coal seam gas (CSG) and large coal mining development. To include basic water rights in hydrogeological modelling, it may be necessary to estimate an extraction volume for each works licence.

Water access entitlements are held by companies or individuals; however a single water access entitlement may be distributed across multiple works. It is therefore critical to link each surface water or groundwater works (the location) with the volumetric entitlement (the licence) to avoid double counting volumes and to appropriately aggregate or disaggregate the data.

The example below is from NSW and illustrates how the water access entitlement data for surface and groundwater were used to identify elements and assets in a bioregion for bioregional assessment purposes. The process is similar for Queensland; however, the source datasets in Queensland link the licence to extract water with the work approvals. Also in Queensland, the names of specific attributes or terms are different as they are defined by the jurisdiction.

## *Process for compiling economic asset data: NSW example*

Four relevant datasets were sourced from the NSW Office of Water, namely:

- *Licensed Work Approvals* which show the locations of extraction works for surface water and groundwater (works)
- *Surface Water Licences* which show the volumetric or basic rights to take surface water (water access entitlements)
- *Groundwater Licences* which show the volumetric or basic rights to take groundwater (water access entitlements)
- *Water Sharing Plans* which include the estimated volume associated with basic landholder rights.

Data were extracted from the NSW licensing system in November 2013. Surface and groundwater access entitlements were described as one of six categories – 'Current', 'Active', 'NA', 'Abandoned', 'Cancelled' or 'Suspended'. Those categorised as 'Abandoned', 'Cancelled' or 'Suspended' were removed, all other categories were included in the elements/ assets lists. Also, works approvals that were listed as 'abandoned' or 'decommissioned' were removed. This potentially over-estimated the number of basic water rights (stock and domestic) as the jurisdictional database may not have been notified if a basic water right (stock and domestic) was no longer active. The water access entitlements also included, where available, the total entitlement volume, not just the metered usage.

The works (locations) from the *Licenced Work Approvals* were linked to the water access entitlements to produce a spatial reference for the economic element within the asset database. A count was added to show how many works were associated with each water access entitlement. The volume of the water access entitlement was then equally split among the works to ensure that the entitlement volumes were not double-counted. This dataset was then clipped to the preliminary assessment extent (PAE) of the subregion. Each individual water access entitlement linked to a spatial location became an element within the asset database.

For water access entitlements that were not linked to a works approval, no specific location information is available. Therefore, in these cases, all remaining water access entitlements were aggregated to the corresponding water source area (polygon) to ensure they were included as an element or asset in the asset database.

The class of asset was aggregated from the NSW Office of Water 'purpose' field. This field records the purpose for which the water was to be used. Any purpose that was listed as domestic, stock, or domestic and stock was included in the class 'basic water right (stock and domestic)'. Where stock and/or domestic was listed with another purpose, it was listed as a 'water access right'. 'Water access right' is based on anything that has an extractive use purpose such as commercial,

irrigation, farming, industrial, dewatering etc. Each element or asset can only be assigned to one asset class. Therefore, the most relevant class was used. It would also have been correct to assign the elements and assets as ‘a surface water feature used for water supply’ or ‘a groundwater feature used for water supply’; however ‘basic water right’ and ‘water access right’ were more specific and therefore more appropriate in this case.

This process assumes that each works associated with a water access entitlement extracts an equal share of the volume allocated. Therefore if one groundwater access entitlement of 80 ML/year has four works (bores) associated with it, then 20 ML/year are assigned to each of those works. It was not possible to validate this assumption as it was possible that the majority of extraction occurred at a single works location and was not evenly distributed across all works associated with the licence.

Groundwater elements that were not classified as a ‘basic water right’ or a ‘water access right’ were not considered relevant to the BA and were classed as ‘null’. These included test bores, bores installed for groundwater remediation, exploratory bores, exploratory research, monitoring bores and waste disposal bores. These works were not operational for extractive use. The elements were retained in the asset database for transparency purposes, but were flagged, or ‘turned off’, and take no further part in the BA. Jurisdictional monitoring bores, depending on their location, could be used as receptors to determine changes in water pressure and/or depth to water in the aquifer.

Data provided by NSW Office of Water did not list the river reach where the offtake is located (surface water licences only), instead they included the water source and water management zone that was associated with the management plan. A water source can be any set of rivers, aquifers, and lakes etc. which are defined by a gazetted water sharing plan to be a water source. Therefore when the elements were aggregated into the asset, water access entitlements were grouped together across the water source area (a large polygon). In subsequent components of the BA, this will need to be taken into account when assigning receptor locations as the water source may include multiple river reaches and potentially multiple river branches.

Economic assets were named as [“Class” + “Water Source”]. Where water source information was not available, a unique numeric identifier was allocated.

The process for identifying economic elements and assets will be similar in each jurisdiction with minor changes based on the source datasets supplied and the attributes of those datasets.

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