Australian Government

BIOREGIONAL ASSESSMENTS

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

Description of the water-dependent asset register for the Cooper subregion

Product 1.3 for the Cooper subregion from the Lake Eyre Basin Bioregional Assessment

17 December 2015

A scientific collaboration between the Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia

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.

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Cover photograph

Cooper Creek near Innamincka, SA, 23 May 2013

Credit: Dr Anthony Budd, Geoscience Australia

Australian Government
Department of the Environment
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Geoscience Australia

CSIRO

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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.

Role or team	Contributor(s)
Assistant Secretary	Department of the Environment: Matthew Whitfort
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: Steven Lewis
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, Tim Evans, Martin Smith Bureau of Meteorology: Natasha Herron
Assets and receptors	Bureau of Meteorology: Richard Mount (Discipline Leader), Eliane Prideaux Department of the Environment: Larry Guo, Glenn Johnstone, Brad Moore, Wasantha Perera, Jin Wang
Bioregional Assessment Information Platform	Bureau of Meteorology: Lakshmi Devanathan (Team Leader), Derek Chen, Trevor Christie-Taylor, Melita Dahl, Angus MacAulay, Christine Panton, Paul Sheahan, Kellie Stuart, Carl Sudholz CSIRO: Peter Fitch Department of the Environment: Geraldine Cusack Geoscience Australia: Neal Evans
Communications	Bureau of Meteorology: Karen de Plater CSIRO: Chris Gerbing Department of the Environment: Lea Locke, Milica Milanja Geoscience Australia: Chris Thompson
Coordination	Bureau of Meteorology: Julie Burke, Sarah van Rooyen CSIRO: Ruth Palmer Department of the Environment: James Hill, Angela Kaplish, Megan Stanford, Craig Watson Geoscience Australia: Tenai Luttrell
Ecology	CSIRO: Anthony O'Grady (Discipline Leader), Tanya Doody, Brendan Ebner, Kate Holland, Craig MacFarlane, Patrick Mitchell, Justine Murray, Chris Pavey, Jodie Pritchard, Nat Raisbeck-Brown, Ashley Sparrow, Georg Wiehl

Role or team	Contributor(s)
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: Steven Lewis (Discipline Leader), Stephen Hostetler, Bruce Radke
Geographic information systems	CSIRO: Caroline Bruce, Jody Bruce, Steve Marvanek, Arthur Read Geoscience Australia: Adrian Dehelean
Groundwater modelling	CSIRO: Russell Crosbie (Discipline Leader), Olga Barron, Tao Cui, Warrick Dawes, Lei Gao, Sreekanth Janardhanan, Luk Peeters, Praveen Kumar Rachakonda, Wolfgang Schmid, Saeed Torkzaban, Chris Turnadge, Binzhong Zhou
Hydrogeology	CSIRO: Konrad Miotlinski Geoscience Australia: Tim Ransley (Discipline Leader), Rebecca Cassel, Steven Hostetler, Jim Kellett, Jessica Northey, Baskaran Sundaram, Gabrielle Yates
Information management	Bureau of Meteorology: Brendan Moran (Team Leader), Belinda Allison, Jill McNamara, 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, Matti Peljo
Products	CSIRO: Becky Schmidt (Products Manager), Maryam Ahmad, Daniel Aramini, Clare Brandon, Heinz Buettikofer, Sonja Chandler, Simon Gallant, Karin Hosking, Frances Marston, Linda Merrin, Sally Tetreault-Campbell, Catherine Ticehurst Geoscience Australia: Penny Kilgour, Kathryn Owen
Risk and uncertainty	CSIRO: Simon Barry (Discipline Leader), Jeffery Dambacher, Jess Ford, Keith Hayes, Geoff Hosack, Yang Liu, Warren Jin, Dan Pagendam, Carmel Pollino
Surface water hydrology	CSIRO: Neil Viney (Discipline Leader), Santosh Aryal, Mat Gilfedder, Fazlul Karim, Lingtao Li, Dave McJannet, Jorge Luis Peña-Arancibia, Xiaogang Shi, Tom Van Niel, Bill Wang, Ang Yang, Yongqiang Zhang

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This technical product was reviewed by several groups:

- Discipline Leaders: Anthony O'Grady (ecology), Steven Lewis (geology)
- Senior Science Leaders: David Post (Projects Director), Steven Lewis (Science Director, Geoscience Australia), Maryam Ahmad (Deputy 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, South Australian 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.

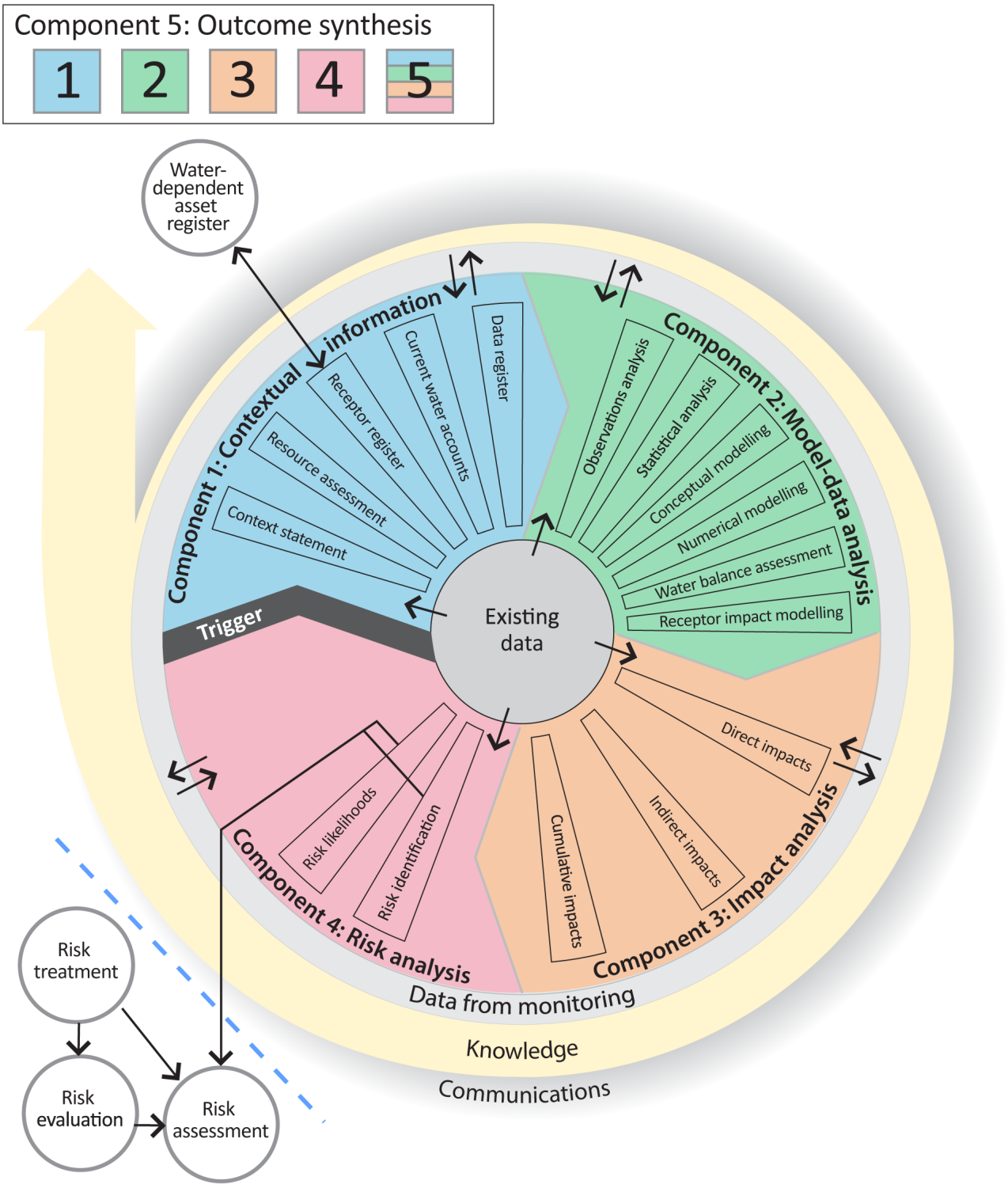


Figure 1 Schematic diagram of the bioregional assessment methodology

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 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 need to 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.

Table 1 Methodologies and associated technical products listed in Table 2

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 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
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

Code	Proposed title	Summary of content	Associated technical product
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 2.6.1 Surface water numerical modelling 2.6.2 Groundwater numerical modelling 2.7 Receptor impact modelling
M10	*Risk and cumulative impacts on receptors*	Describes the process to identify and analyse risk	3 Impact analysis 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 3 Impact analysis 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 3 Impact analysis 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 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. The red rectangles in both Figure 2 and Table 2 indicate the information included in this technical product.

This technical product is delivered as a report (PDF). 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.

The PDF of this technical product, and the additional material, are available online at http://www.bioregionalassessments.gov.au.

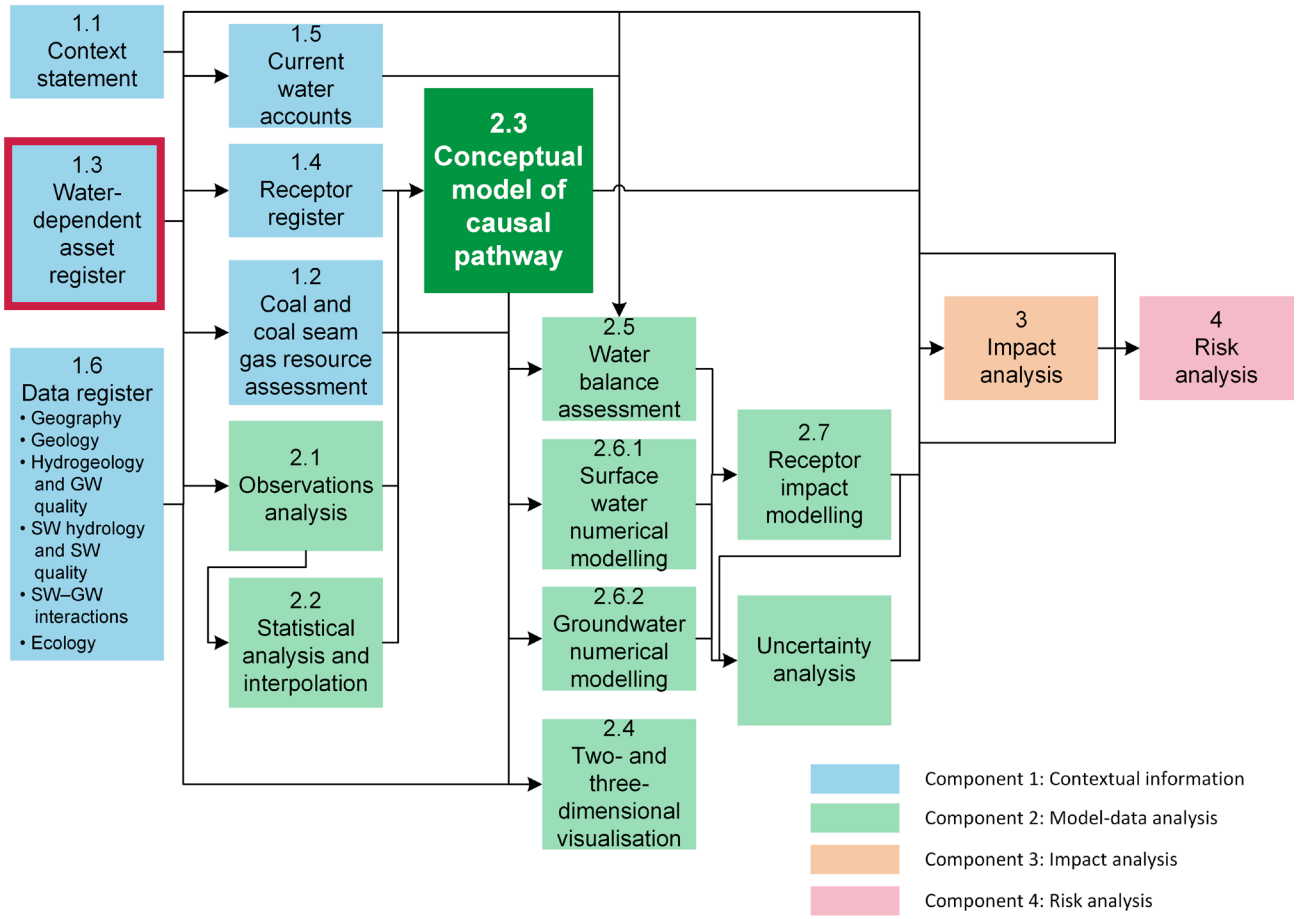


Figure 2 The simple decision tree indicates the flow of information through a bioregional assessment

The red rectangle indicates the information included in this technical product.

Table 2 Technical products delivered by the Lake Eyre Basin Bioregional Assessment

For each subregion in the Lake Eyre Basin Bioregional Assessment, technical products are delivered online at http://www.bioregionalassessments.gov.au, as indicated in the 'Type' column[a]. Other products – such as datasets, metadata, data visualisation and factsheets – are provided online.

Component	Product code	Title	Section in the BA methodology[b]	Type[a]
Component 1: Contextual information for the Cooper subregion	1.1	Context statement	2.5.1.1, 3.2	PDF, HTML
	1.2	Coal and coal seam gas resource assessment	2.5.1.2, 3.3	PDF, HTML
	1.3	Description of the water-dependent asset register	2.5.1.3, 3.4	PDF, HTML, register
	1.4	Description of the receptor register	2.5.1.4, 3.5	PDF, HTML, register
	1.5	Current water accounts and water quality	2.5.1.5	PDF, HTML
	1.6	Data register	2.5.1.6	Register
Component 2: Model-data analysis for the Cooper subregion	2.1-2.2	Observations analysis, statistical analysis and interpolation	2.5.2.1, 2.5.2.2	Not produced
	2.3	Conceptual modelling	2.5.2.3, 4.3	PDF, HTML
	2.5	Water balance assessment	2.5.2.4	Not produced
	2.6.1	Surface water numerical modelling	4.4	Not produced
	2.6.2	Groundwater numerical modelling	4.4	Not produced
	2.7	Receptor impact modelling	2.5.2.6, 4.5	Not produced
Component 3: Impact analysis for the Cooper subregion	3-4	Impact analysis	5.2.1	PDF, HTML
Component 4: Risk analysis for the Cooper subregion		Risk analysis	2.5.4, 5.3	
Component 5: Outcome synthesis for the Lake Eyre Basin bioregion	5	Outcome synthesis	2.5.5	PDF, HTML

aThe types of products are as follows:

- 'PDF' indicates a PDF document that is developed by the Lake Eyre Basin Bioregional Assessment using the structure, standards, and look and feel specified by the programme.
- 'HTML' indicates the same content as in the PDF document, but delivered as webpages.
- 'Register' indicates controlled lists that are delivered using a variety of formats as appropriate.
- 'Not produced' indicates that the product was not developed. A webpage explains why and points to relevant submethodologies (Table 1).

bMethodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources (Barrett et al., 2013).

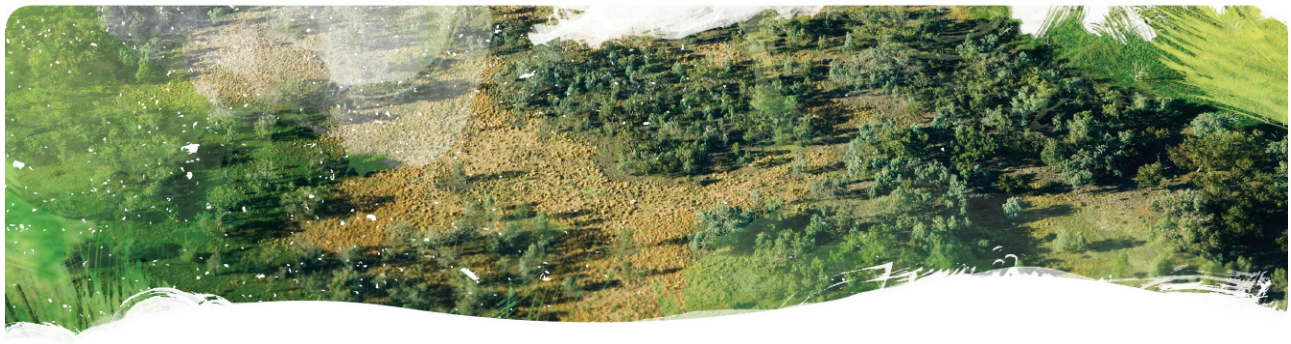
About this technical product

The following notes are relevant only for this technical product.

- All reasonable efforts were made to provide all material under a Creative Commons Attribution 3.0 Australia Licence.
- All maps created as part of this BA for inclusion in this product used the Albers equal area projection with a central meridian of 140.0° East for the Lake Eyre Basin bioregion and two standard parallels of –18.0° and –36.0°.
- Contact bioregionalassessments@bom.gov.au to access metadata (including copyright, attribution and licensing information) for all datasets cited or used to make figures in this product. At a later date, this information, as well as all unencumbered datasets, will be published online.
- The citation details of datasets are correct to the best of the knowledge of the Bioregional Assessment Programme at the publication date of this product. Readers should use the hyperlinks provided to access the most up-to-date information about these data; where there are discrepancies, the information provided online should be considered correct. The dates used to identify Bioregional Assessment Source Datasets are the dataset's published date. Where the published date is not available, the last updated date or created date is used. For Bioregional Assessment Derived Datasets, the created date is used.

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 19 January 2016, http://www.iesc.environment.gov.au/publications/methodology-bioregional-assessments-impacts-coal-seam-gas-and-coal-mining-development-water.



1.3 Description of the water-dependent asset register for the Cooper subregion

A water-dependent asset has a particular meaning for bioregional assessments; it is an asset potentially impacted by changes in groundwater and/or surface water due to coal or coal seam gas development. Some ecological assets solely depend on incident rainfall and will not be considered as water dependent if evidence does not support a linkage to groundwater or surface water.

This product describes water-dependent assets that have been identified in the bioregional assessment and are listed in the water-dependent asset register (available at http://data.bioregionalassessments.gov.au/product/LEB/COO/1.3).

1.3.1 Methods

Summary

The water-dependent asset register described in this product is a list of water-dependent assets identified for the bioregional assessment (BA) of the Cooper subregion. This section details the specific implementation to the Cooper subregion of methods described in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015).

The methods involved (i) nominating and collating different groups of assets, (ii) determining the preliminary assessment extent (PAE) for the Cooper subregion, (iii) determining water dependency based upon multiple lines of evidence (including literature, remote sensing data and available mapping) and (iv) developing and compiling the water-dependent asset register.

The asset list for the Cooper subregion, prior to assessment of water dependence, contains 1558 assets that intersect the Cooper PAE, comprising 1525 ecological assets, 7 economic assets and 26 sociocultural assets.

1.3.1.1 Background and context

This product presents information about the water-dependent asset register for the Cooper subregion. The name of the dated snapshot of the asset register this description refers to is 'Water-dependent asset register and asset list for Cooper subregion on 27 August 2015' (available at Sparrow et al., 2015). The point-of-truth version of the asset register that this snapshot was extracted from resides in the asset database (Bioregional Assessment Programme, Dataset 1). The asset database and the water-dependent asset register can be updated, so a more current version might be available at http://data.bioregionalassessments.gov.au/product/LEB/COO/1.3.

Development of the register used methods and processes defined and outlined in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015); their specific application to the Cooper subregion is described in the following sections.

An *asset* is an entity that has value to the community and, for BA purposes, is associated with a subregion or bioregion. Technically, an asset is a store of value and may be managed and/or used to maintain and/or produce further value. Each asset will have many values associated with it and they can be measured from a range of perspectives; for example, the values of a wetland can be measured from ecological, sociocultural and economic perspectives. A *bioregion* is a geographic land area within which coal seam gas (CSG) and/or coal mining developments are taking place, or could take place, and for which BAs are conducted. A *subregion* is an identified area wholly contained within a bioregion.

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) (discussed in Section 1.3.1.3) 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 asset source data are compiled into an *asset database*, including the geographic location, which are designated as *elements* (individual spatial features – points, lines and polygons e.g. components of a larger system) 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 were obtained from state and national databases and an important group of assets is provided by natural resource management organisations (NRMs) via the BA-purpose-built *Water Asset Information Tool* (WAIT) database. Consultations have been held with Indigenous knowledge holders about Indigenous cultural water values (further discussed in Section 1.3.4.1).

The *asset list* is created through selection of assets in the asset database that occur within the PAE. The assets in the asset list that pass the BA water-dependency test are then 'registered' in 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 as part of BAs 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 (Figure 1 and Figure 2).

Following development of the asset register, the connection of the registered assets to coal resource development is assessed using ‘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 to water-dependent assets is described in the companion submethodology M03 (as listed in Table 1) for assigning receptors to water-dependent assets (O’Grady et al., 2015).

1.3.1.2 Compiling assets and developing the water-dependent asset register

1.3.1.2.1 Ecological assets

Two natural resource management organisations (NRMs) nominated assets through contribution of data to the WAIT database (Australian Government Department of the Environment, Dataset 2, Dataset 3). These NRM-nominated assets were added to the asset database. Contributing organisations are listed in Table 3.

Additional assets were nominated from analysis of data provided by national, state and regional databases (Australian Government Department of the Environment, Dataset 2, Dataset 3) (Table 4). These datasets included:

- areas with various designations of formal conservation at national or state level
- ecosystem types with a threatened status recognised by national or state legislation
- potential distributions of species with a threatened status recognised by national or state legislation
- previously identified water-dependent ecosystem types or water-related topographic features, nominated regardless of any designated conservation status.

Table 3 Natural resource management organisations that contributed data to the Water Asset Information Tool database for the Cooper subregion

Organisation	Description in asset register	Elements	Assets (asset list)
Desert Channels Queensland	WAIT_Desert Channels	4,911	12
SA Arid Lands Natural Resources Management Board	WAIT_SA	6,262	358
Total		11,173	370

Data: Australian Government Department of the Environment (Dataset 2, Dataset 3)

Table 4 Federal, state and regional data sources for ecological assets in the Cooper subregion

Dataset[a]	Dataset citation	Elements	Assets (asset list)
Australian Hydrological Geospatial Fabric version 2.1.1	Bureau of Meteorology (Dataset 4)	16,666	416
Collaborative Australian Protected Areas Database (CAPAD)	Australian Government Department of the Environment (Dataset 5)	3	3
A directory of important wetlands in Australia (DIWA)	Australian Government Department of the Environment (Dataset 6)	24	5
Great Artesian Basin Groundwater Recharge	Geoscience Australia (Dataset 7)	37	1
National atlas of groundwater dependent ecosystems (GDE Atlas)	Bureau of Meteorology (Dataset 8)	10,777	366
Birds Australia Important Bird Areas (IBA)	Birds Australia (Dataset 9)	2	2
National Groundwater Information System version 1.2 (NGIS)	Bureau of Meteorology (Dataset 10)	2911	1
Lake Eyre Basin Rockholes and Waterholes in Queensland	Queensland Department of Environment and Resource Management (Dataset 11)	96	79
Threatened ecological communities listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)	Australian Government Department of the Environment (Dataset 12)	3	1

Dataset[a]	Dataset citation	Elements	Assets (asset list)
Threatened species listed under the EPBC Act	Australian Government Department of the Environment (Dataset 13)	37	12
Threatened species listed under Queensland's *Nature Conservation Act 1992* (Nature Conservation Act)	Queensland Department of Science, Information Technology, Innovation and the Arts (Dataset 14)	10,404	9
QLD Wetland Data version 3: Streams	Queensland Department of Science, Information Technology, Innovation and the Arts (Dataset 15)	4,475	11
Ramsar List of Wetlands of International Importance	Australian Government Department of Sustainability, Environment, Water, Population and Communities (Dataset 16)	1	1
SA Lake Eyre Basin Aquatic Ecosystems Mapping and Classification	South Australian Department of Environment, Water and Natural Resources, (Dataset 17)	6,145	10
SA Wetland Groundwater Dependent Ecosystem Classification	South Australian Department of Environment, Water and Natural Resources, (Dataset 18)	1,058	238
Total		52,639	1,155

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets. Some assets may be captured in multiple databases. These replicates are retained in the asset register as boundaries may differ between databases.

The asset database includes a wide range of information about each asset, including unique asset identifier (AID), name, type and geographic location. Geographic location is specified as 'shapes' in the sense of geographic information systems (GIS). A shape may be a polygon (for an area of land), a line (for a linear feature such as a watercourse) or a point (for a specific location whose area is smaller than the areal resolution of the geographic information (e.g. a spring). Many nominated assets are composed of several geographic parts. For example, a national park may comprise several blocks of land separated by road or railway reserves, the potential habitat of a threatened species of bird may include patches of remnant habitat separated by agricultural land, and the potential habitat of a threatened species of fish may be restricted to the artesian springs scattered widely across a landscape. To accommodate assets composed of many parts, the asset database specifies each shape as an 'element' and one or more elements are then grouped to create assets. A detailed description of the process for classifying and aggregating elements to assets is presented in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015).

A preliminary version of the water-dependent asset register, along with associated maps and data, was presented to experts and organisations with local knowledge at workshops in Brisbane in October 2014, and in Charleville and Quilpie in February 2015, for comment and feedback. The Brisbane meeting was attended by representatives of the Queensland Department of Environment

and Heritage Protection (DEHP), Department of Natural Resources and Mines (DNRM), Department of Science, Information Technology and Innovation (DSITI), and the Queensland Herbarium. The Charleville meeting was attended by representatives of Murweh Shire and South West Natural Resource Management, and the Quilpie meeting was attended by representatives of Bullo Shire and Quilpie Shire. The attendees were given two weeks to review the preliminary water-dependent asset register and to return comments and suggestions.

1.3.1.2.2 Economic assets

As described in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015), economic assets are classed as either a 'basic water right' (stock and domestic) or a 'water access right':

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

Licensing data were sourced from DNRM and the South Australian Department of Environment, Water and Natural Resources (DEWNR).

Within the asset database, every 'water access right' and 'basic water right (stock and domestic)' is an element, and elements are grouped by type and spatial location (according to water management zones or areas) to create assets.

Another, less formal subclass of economic assets occurs in the Cooper subregion: surface water features used for water supply. This type of asset was nominated through the Australian Hydrological Geospatial Fabric datasets from the Bureau of Meteorology (Table 5).

Table 5 Data sources for economic assets in the Cooper subregion

Dataset[a]	Dataset citation	Elements	Assets (asset list)
Australian Hydrological Geospatial Fabric version 2.1.1	Bureau of Meteorology (Dataset 4)	3	1
QLD groundwater licensing from the water management system	Bureau of Meteorology (Dataset 19)	15	5
SA groundwater licensing from the water management system (areas around wells)	South Australian Department of Environment, Water and Natural Resources (Dataset 20)	1	1
Total		19	7

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets. Some assets may be captured in multiple databases. These replicates are retained in the asset register as boundaries may differ between databases.

1.3.1.2.3 Sociocultural assets

Sociocultural assets were sourced from the Australian Heritage Database (Australian Government Department of the Environment, Dataset 22, Dataset 23), which includes assets sourced from the National Heritage List (NHL) and the Register of the National Estate (RNE) (Table 6).

Meetings have been held with Indigenous knowledge holders in the Cooper subregion to gain further understanding of Indigenous cultural water-dependent assets. Where possible and appropriate, and with the agreement of Indigenous knowledge holders, these additional Indigenous water-related values will be published in a separate report. Identified assets will be incorporated into an updated water-dependent asset register and/or incorporated into later technical products.

Table 6 Data sources from the Australian Heritage Database for sociocultural assets in the Cooper subregion

Dataset[a]	Dataset citation	Elements	Assets (asset list)
National Heritage List Spatial Database (NHL) (v2.1)	Australian Government Department of the Environment (Dataset 22)	2	2
Australia, Register of the National Estate (RNE) - Spatial Database (RNESDB) Internal	Australian Government Department of the Environment (Dataset 23)	24	24
Total		26	26

[a]The asset database (Bioregional Assessment Programme, Dataset 1) is a collation of all these source datasets. Some assets may be captured in multiple databases. These replicates are retained in the asset register as boundaries may differ between databases.

1.3.1.2.4 Duplicated or overlapping assets

Some specific areas within the Cooper PAE were nominated several times, from different databases. For example, Coongie Lakes and the immediate surrounding areas (north of Innamincka, in the western part of the PAE) were nominated as:

- a protected area (Collaborative Australian Protected Areas Database; CAPAD)

- an important wetland (*A directory of important wetlands in Australia*; DIWA)
- an important bird area (Birdlife Australia Important Bird Areas; IBA)
- a Ramsar wetland (Ramsar List of Wetlands of International Importance)
- a groundwater-dependent ecosystem (GDE)
- an area of heritage significance recognised within the Register of the National Estate (RNE).

Likewise, some assets sourced from different datasets overlie each other, as they consider slightly different aspects of the same geographic area. For example, a national park may include springs, wetlands, and groundwater-dependent woodlands, and therefore the park may partially overlap assets describing:

- areas of heritage significance to the RNE
- GDEs
- threatened ecological community distributions listed in the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- potential habitats of federal or state-listed threatened species.

Duplicate and overlapping assets were treated as entirely separate assets for the purposes of compiling the register of water-dependent assets for the Cooper subregion. Such an approach meant that no judgment need be made of the priority of one asset or asset type over another asset or asset type, and thereby that equal respect and attention was paid to all stakeholders' asset nominations and contributed databases.

1.3.1.3 Determining the preliminary assessment extent

There were two main steps undertaken to determine the PAE:

1. Defining the extent of geological units known to contain coal seams to derive a geological component
2. Incorporating surface water and ecological features and intersecting these with the geological component.

The first involved assessing the extent of coal seams occurring in the Patchawarra and Toolachee formations in the Cooper Basin. These two units are the most prospective for CSG as a result of their extensively developed coal seams, the depth of these seams and the inferred thermal history of the formations. Depths to the Permian coal measures preclude resource development by open-cut or underground mining. Although coal occurs in other shallower formations, such as the Winton Formation, no economic deposits have been defined in the Cooper subregion, as discussed in companion product 1.2 for the Cooper subregion (Smith et al., 2015). Screening criteria used in defining the geological components of the PAE were:

- Patchawarra and Toolachee formation tops at depths less than 2000 m (Draper, 2002; SA Department of State Development Resource and Energy, Dataset 28)
- mapped extents of coal in the Patchawarra and Toolachee formations (Draper, 2002; Sun and Camac, 2004).

These criteria were used as they represent current maximum depths of extraction for CSG, and the assumption that CSG will not occur in areas without coal. These also represent areas that do not have resources of shale, basin centred, tight or conventional gas, which only occur at depths greater than 2000 m in the geological Cooper Basin.

Coal in the younger Winton Formation (Cretaceous) was not included in this assessment, due to its thin, discontinuous nature and poor gas shows in drilling on the Innamincka dome in PEL 101 and 103 by AGL Energy Limited (AGL). It is thought only to represent a viable resource where it occurs in conjunction with another oil or gas play (such as a basin centred or shale gas play in the underlying Cooper Basin). Further information on the coal and CSG resources can be found in companion product 1.2 for the Cooper subregion (Smith et al., 2015).

This resulted in the delineation of 'Patchawarra' component and 'Toolachee' component polygons (Figure 3). The next step was to merge these two polygons to derive a geological components polygon (Figure 3). The geological components polygon comprises 29.7% of the final PAE area, and 16.2% of the Cooper subregion area.

The next stage in determining the Cooper PAE was to incorporate ecological and surface water features. This was done by intersecting the geological components polygon with lakes from 250,000 scale topographic mapping (Bureau of Meteorology, Dataset 4), CAPAD reserves (Australian Government Department of the Environment, Dataset 5) and the DIWA wetlands dataset (Australian Government Department of the Environment, Dataset 6). Where any part of one of these features intersected the geological components polygon, the entire feature was added to the PAE. The resultant PAE incorporates areas that are of both potential future CSG-only development and are significant ecosystems and surface water resources within the Cooper subregion. It includes limited areas of investigation downstream and outside the subregion boundary.

The Cooper PAE encompasses approximately 70,589 km^2. The PAE includes the Coongie Lakes Ramsar wetland area, Lake Blanche, the Strzelecki Creek wetland system, Cooper Creek swamps–Nappa Merrie, the Cooper Creek–Wilson River junction, the Innamincka Regional Reserve, Strzelecki Regional Reserve, some Lake Eyre Basin mound springs listed in DIWA, and two Great Artesian Basin (GAB) discharge springs from the EPBC Act-listed GAB discharge springs threatened ecological community.

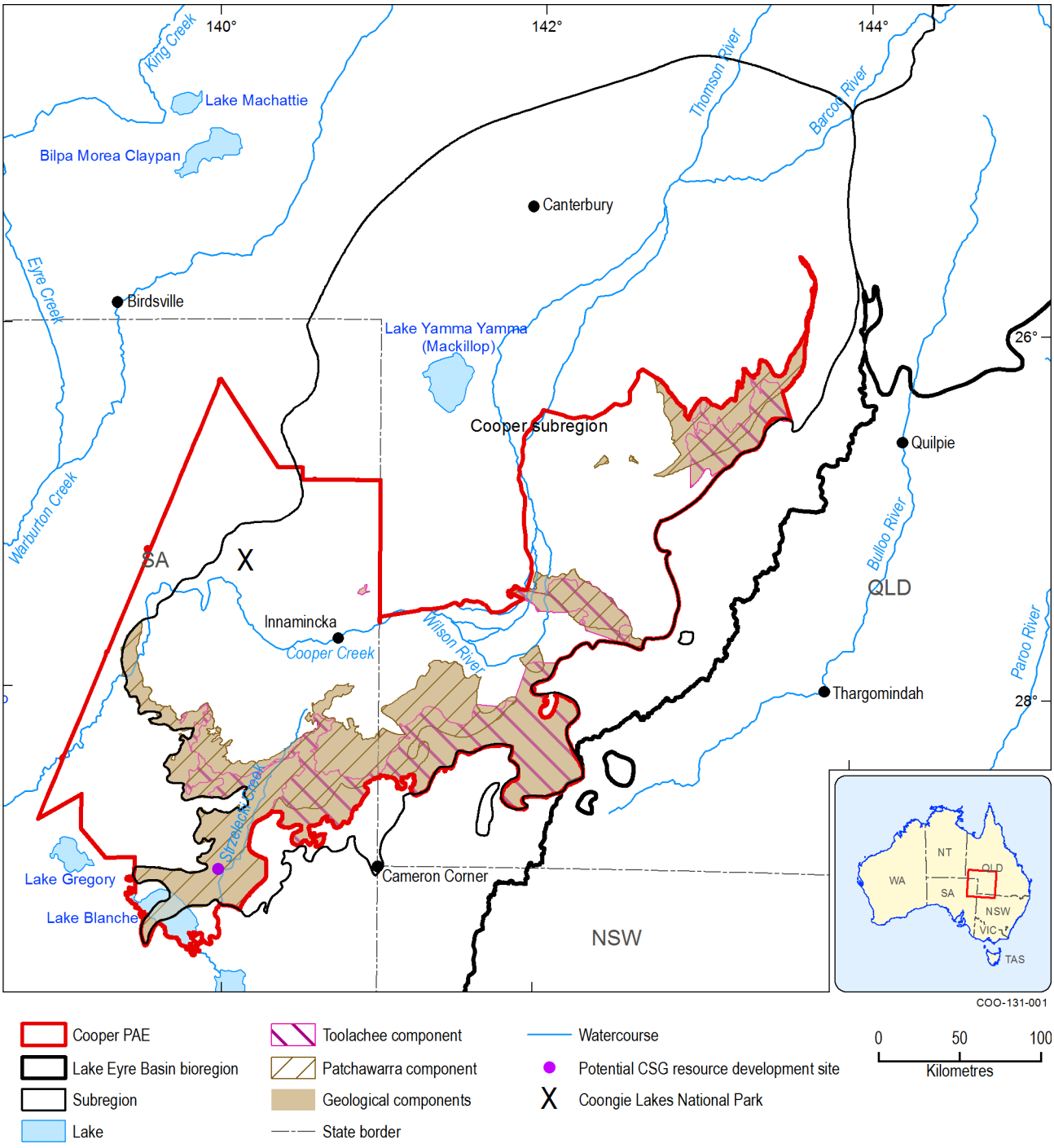


Figure 3 Preliminary assessment extent (PAE) for the Cooper subregion, including the geological components on which the PAE was determined in part

Data: SA Department of State Development Resource and Energy (Dataset 28)

1.3.1.4 Assessing water dependence

1.3.1.4.1 Assessment principles

Once assets were compiled into the asset database and checked for inclusion in the Cooper PAE, they were assessed for water dependence. Although most nominated assets are, by definition of their database sources, 'water dependent' (e.g. groundwater bores, rivers, lakes and wetlands), there are a number of types of assets that are less clearly 'water dependent' (e.g. a national park

with a varied landscape, the habitat of a non-aquatic species and historical places). Because of the diversity of asset types, the spectrum of degree to which assets might be water dependent, and the need for all assessment decisions to be transparent and recorded, a highly structured, formal approach was developed for assessment of water dependency.

Six principles formed the foundation of the approach to assessment of water dependence of assets in the Cooper PAE:

1. *Efficiency*. The methods were suitable for effective application to large numbers of assets.
2. *Transparency*. All decisions in assessments were tracked, including their rationales, any data sources and dates of assessments.
3. *Rigour*. Decision making was based on sound ecological, economic and sociocultural principles and clear logic, and able to withstand close peer and expert scrutiny.
4. *Multiple lines of evidence*. Wherever possible, assessment decisions were based on as many sources of information about water dependence as possible. Three broad groups of evidence were used: (i) asset naming conventions, (ii) documents describing asset management and (iii) GIS and remote sensing databases containing layers that directly or indirectly quantify surface water and groundwater availability.
5. *Precaution*. Where part of an asset is water dependent, the entire asset was assessed as water dependent. Where there is inconclusive evidence, assessment decisions consistently erred on the side of assuming potential water dependence (i.e. if one data source indicates water dependence, then the overall decision across the multiple lines of evidence is water dependence). On this basis, the maximum number of assets was retained within the database for subsequent analysis of potential development impacts.
6. *Separate tracking of assessment for dependence on groundwater and surface water*. Later stages of the BA impact analysis are likely to demonstrate separate causal pathways for potential impact of coal resource development via surface water and groundwater systems. If that proves to be the case, then potential for impact on an asset via the surface water or groundwater pathway will only be true if the asset depends on the corresponding above or below-ground water resource (Figure 4).

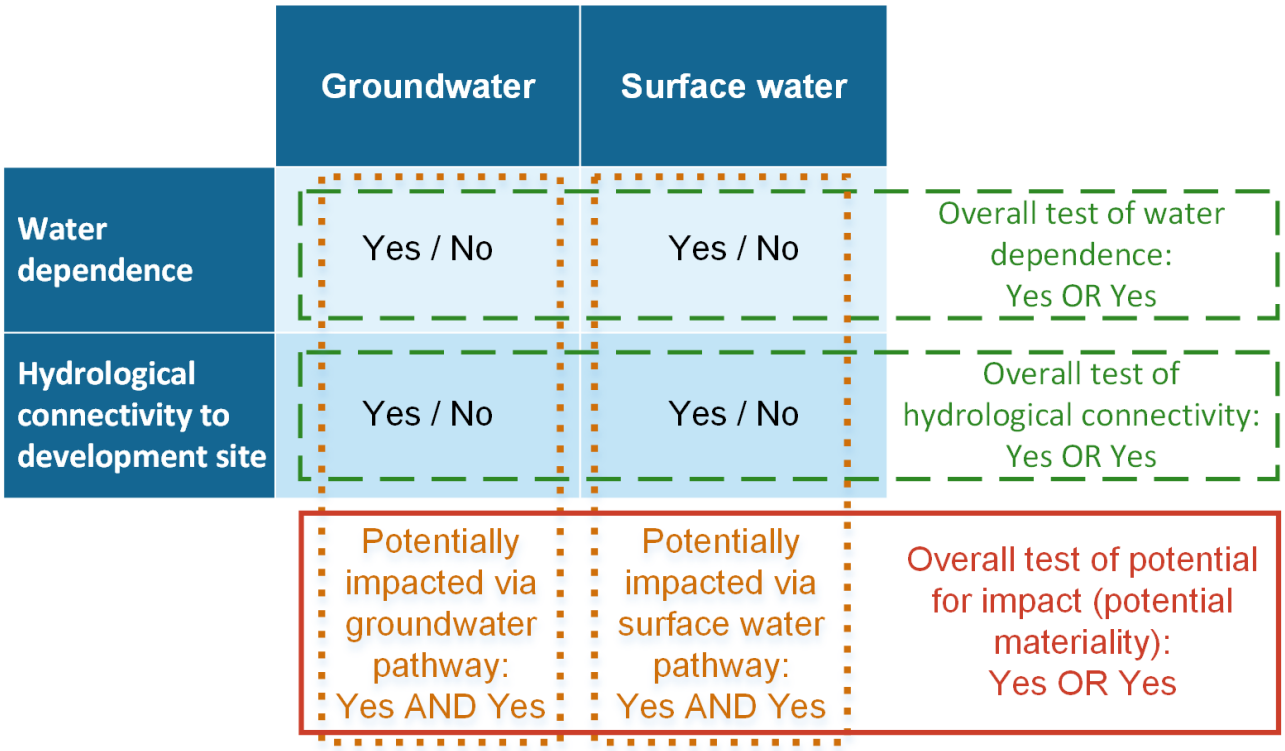


Figure 4 Logic for separate assessment and tracking of dependence on groundwater and surface water

This product focuses exclusively on assessment of water dependence i.e. the upper part of this logic. Future bioregional assessments for the Cooper subregion will assess hydrological connectivity and response, and thus the potential for impact on assets.

1.3.1.4.2 Assessment criteria using asset naming conventions

For some asset sources, the only direct information available for assessing water dependence of each asset is its name. The Australian Hydrological Geospatial Fabric (AHGF), Great Artesian Basin Groundwater Recharge Beds database and National Groundwater Information System (NGIS) are databases in which little asset data other than name and geographic coordinates are available. The Queensland and SA groundwater licensing from the water management system databases are also restricted in terms of information other than asset name and type.

Two simple naming criteria were used to assess water dependence for assets of these types:

- if asset name includes ‘spring’, ‘soakage’, ‘bore’ or ‘groundwater’, then the asset is groundwater dependent
- if asset name includes ‘river’, ‘stream’, ‘floodplain’, ‘waterhole’, ‘billabong’, ‘lake’, ‘wetland’, ‘marsh’ or ‘surface water’, then the asset is surface water dependent.

Although initially developed for specific, information-poor data sources, these rules were subsequently applied to all assets in the asset list, regardless of data source.

1.3.1.4.3 Assessment criteria using documents describing asset management

Most assets sourced from CAPAD, DIWA, and the EPBC Act list of threatened ecological communities are subject to legislatively required management plans that include some degree of ecosystem description. For these assets, management plans and/or asset descriptions were obtained from federal and state agencies. The management plans and their constituent ecosystem

descriptions were then subjected to text analysis, using the following simple criteria to assess water dependence:

- if ecosystem description includes 'spring', then asset is groundwater dependent
- if ecosystem description includes any ecosystem type, community type, habitat type or dominant species and has been identified in any published literature as accessing groundwater (e.g. river red gum, coolibah (*Eucalyptus coolabah*), fish species), then asset is groundwater dependent
- if ecosystem description includes 'riverine vegetation', 'floodplain', 'waterhole', 'billabong', 'lake', 'wetland' or 'marsh', then asset is surface water dependent
- if ecosystem description includes any ecosystem type, community type, habitat type or dominant species known to access surface water (e.g. river red gum, coolibah, lignum, most waterbird species, fish), then asset is surface water dependent.

According to these criteria, examination of documents about one asset may yield determination for both groundwater dependence and surface water dependence in one ecosystem type or in different ecosystem types in different parts of the asset.

The water dependency of threatened species' habitats, including threatened species listed under the EPBC Act and under Queensland's *Nature Conservation Act 1992* (Nature Conservation Act), was assessed by a review of the habitat requirements for each species. It is important to emphasise that BAs consider the potential impact to the habitat of species, not to the population of the species per se. In most cases, profiles from the Species Profile and Threats Database (SPRAT) (Department of the Environment, 2015b; Bioregional Assessment Programme, Dataset 24) and the Queensland Government's Wetland*Info* website (DEHP, 2015) were examined.

Any information suggesting that water dependence was 'certain', 'likely' or 'possible' was interpreted as 'water dependent' for the purposes of the asset register.

1.3.1.4.4 Assessment criteria using geographical information system and remote sensing databases

Criteria based upon asset naming and upon available, published asset descriptions and management plans proved to be inadequate for satisfactory assessment of water dependence in a large proportion of assets. Other sources of information were sought to expand the range of data available for assessment of asset water dependence.

Six mapped GIS and remote sensing data layers were identified as providing additional information relevant to assessing dependence on surface water or groundwater. GIS analyses were used to spatially intersect each asset with each of the five data layers. If any part of an asset was found to overlap with any one of these layers, then that observation was used as evidence for water dependence, according to the precautionary principle previously described in Section 1.3.1.4.1.

The six data layers were:

1. GDEs reliant on subsurface presence of groundwater, derived from the *National atlas of groundwater dependent ecosystems* (GDE Atlas; Bureau of Meteorology, 2012). Subsurface presence of groundwater is defined as groundwater that contributes to the soil water and

near-surface aquifers accessible to plant roots without generating a flow of water at the soil surface. Only those GDEs derived from previous field work or possessing a high or moderate potential for groundwater dependency were used in the intersection. Positive intersection of an asset with this layer indicates potential dependency on groundwater. A map of this data layer across the Cooper PAE is shown in Figure 5.

2. GDEs reliant on surface expression of groundwater, derived from the GDE Atlas (Bureau of Meteorology, 2012). Surface expression of groundwater is defined as groundwater that flows at the soil surface in the form of a spring or seep, including those springs that lie under surface water bodies such as streams, waterholes, lakes or swamps, for which the primary source of water may be from surface flows. Only those GDEs derived from previous field work or possessing a high or moderate potential for groundwater dependency were used in the intersection. Positive intersection of an asset with this layer indicates potential dependency on groundwater and/or surface water. A map of this data layer across the Cooper PAE is shown in Figure 6.
3. A combined multi-state map of wetlands defined according to the Queensland Wetland Data Streams and SA Wetlands Groundwater Dependent Ecosystem Classification. Positive intersection of an asset with this layer indicates potential dependency on subsurface or surface expression of groundwater. A map of this data layer for the Cooper PAE is shown in Figure 7.
4. Mean annual evapotranspiration in excess of incident rainfall across the Cooper PAE (Reside et al., 2013). This layer is calculated as the difference between actual evapotranspiration assessed through remote sensing techniques during 1992 to 2011 and a predicted model of evapotranspiration if water were sourced only from incident rainfall. A positive difference means that long-term observation of the amount of water released into the atmosphere by plant evapotranspiration exceeds the inputs of water from rainfall, and the vegetation is accessing additional water from groundwater pools or contributions to soil water. These contributions to soil water result from surface water flowing from elsewhere in the catchment; however, the data were not able to be interpreted to indicate whether the additional water is from a groundwater pool or surface water flow. Thus, intersection of an asset with high excess evapotranspiration values (>100 mm per year) in this layer indicates potential dependency on groundwater and/or surface water. A map of this data layer across the Cooper PAE is shown in Figure 8.
5. Percentage duration of flood inundation during 1987 to 2015, from the Water Observations from Space database (Bioregional Assessment Programme, Dataset 25). Positive intersection of an asset with higher percentage inundation classes in this layer indicates potential dependency on surface water. A map of this data layer across the Cooper PAE is shown in Figure 9.
6. The distribution of riparian vegetation potentially intersecting groundwater (Geoscience Australia, Dataset 26). This layer summarises the results of an analysis of remote sensing data to measure evapotranspiration rates towards the end of a prolonged period of below average rainfall. Positive intersection of an asset with this layer indicates potential dependency on groundwater. A map of this data layer across the Cooper PAE is shown in Figure 10.

Application of this approach is demonstrated for a single asset in the Cooper PAE, Coongie Lakes National Park (Figure 11 and Figure 12). Coongie Lakes National Park sits to the north of Cooper Creek, west of the border between Queensland and SA (see Figure 10). All six GIS and remote sensing layers provide clear evidence for dependence on groundwater and/or surface water in and around the lakes in the northern portion of the park, the creeklines through the central portion of the park, and the claypans and swales that lie between the sand dunes in the rest of the park. Therefore, this asset was assessed to be water dependent and is included in the water-dependent asset register. However, it is important to note that in the eastern and south-west portions of the park, each of the six layers provides evidence for different patterns of potential water dependence. Thus the six layers provide independent and complementary lines of evidence for the assessment of asset dependence on water.

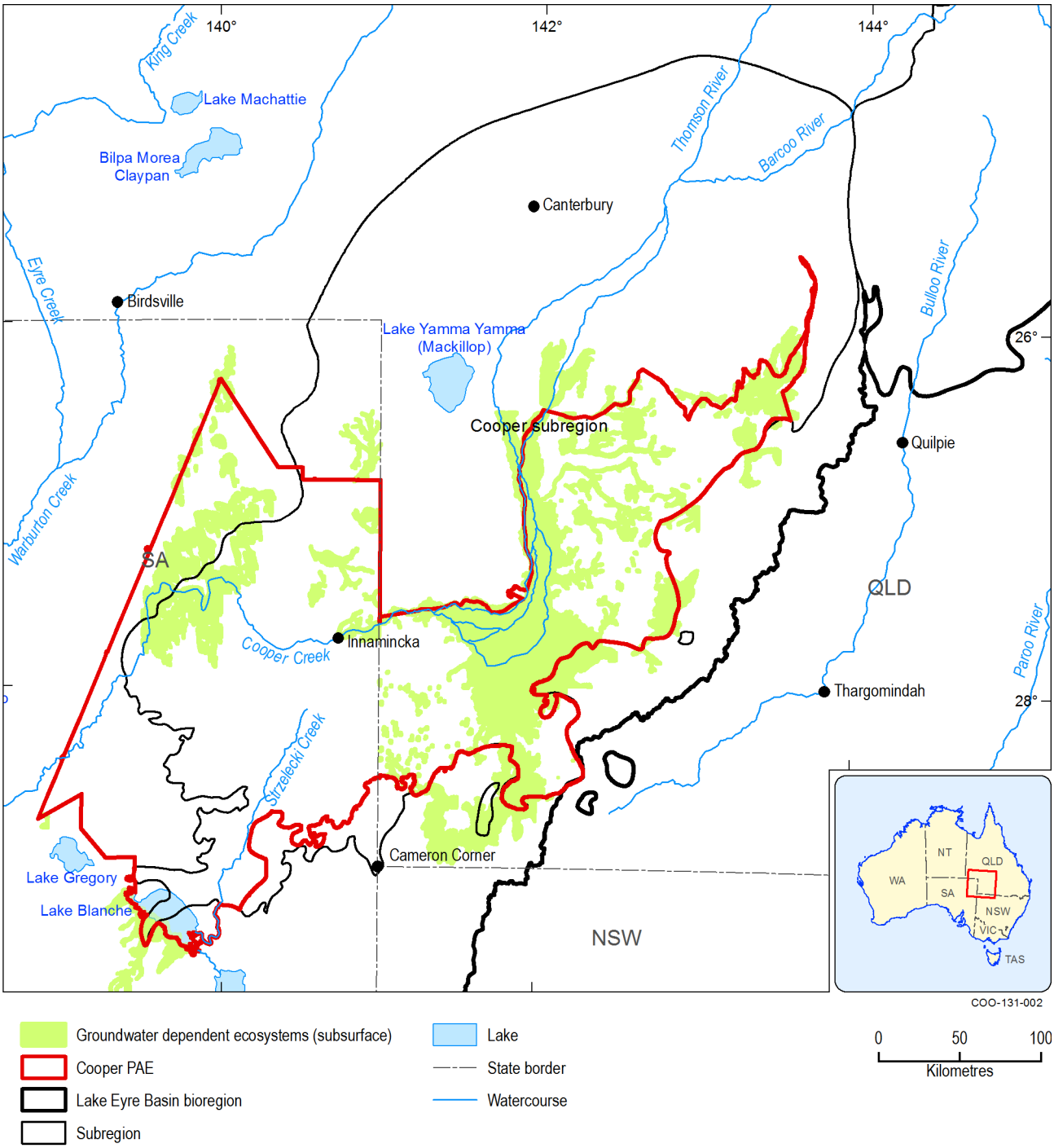


Figure 5 Groundwater-dependent ecosystems reliant on subsurface presence of groundwater in the Cooper preliminary assessment extent (PAE)

Data: Bureau of Meteorology (Dataset 8)

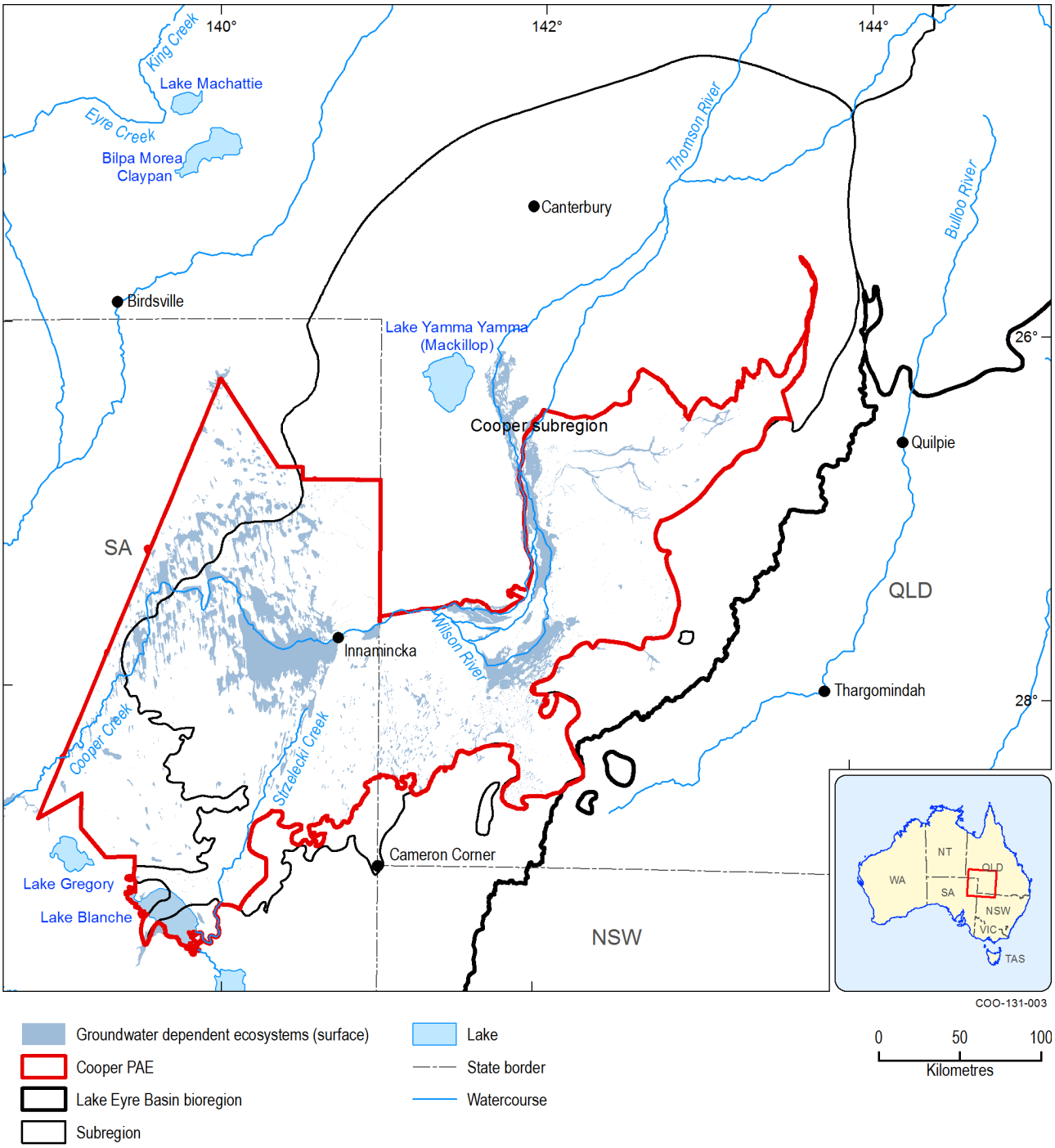


Figure 6 Groundwater-dependent ecosystems reliant on surface expression of groundwater in the Cooper preliminary assessment extent (PAE)

Data: Bureau of Meteorology (Dataset 8)

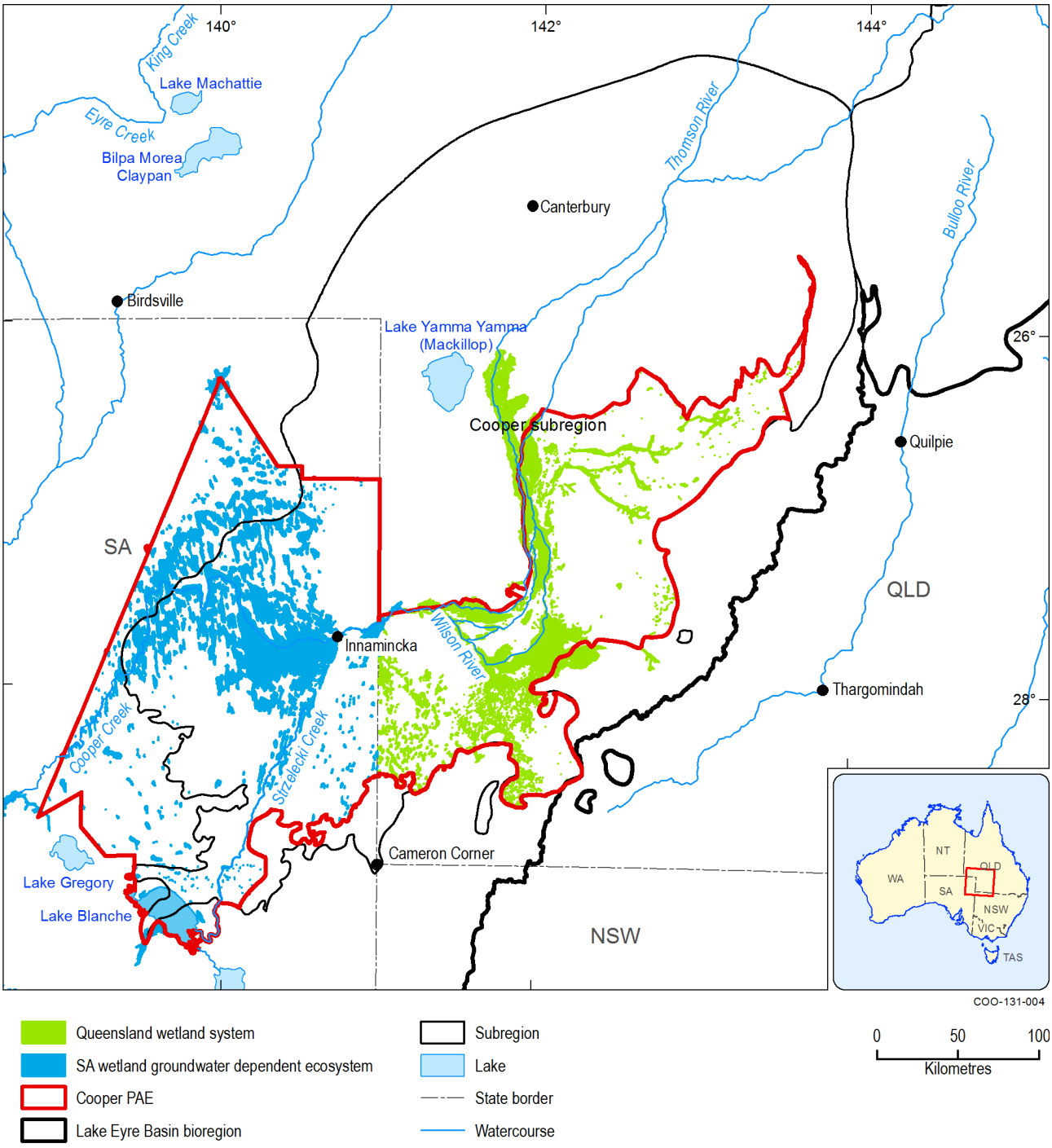


Figure 7 Distribution of wetland ecosystems types in the Cooper preliminary assessment extent (PAE), according to the Queensland Wetland Data Streams mapping and South Australia Wetland Groundwater Dependent Ecosystem Classification mapping

Data: Queensland Department of Science, Information Technology, Innovation and the Arts (Dataset 15), South Australian Department of Environment, Water and Natural Resources (Dataset 18)

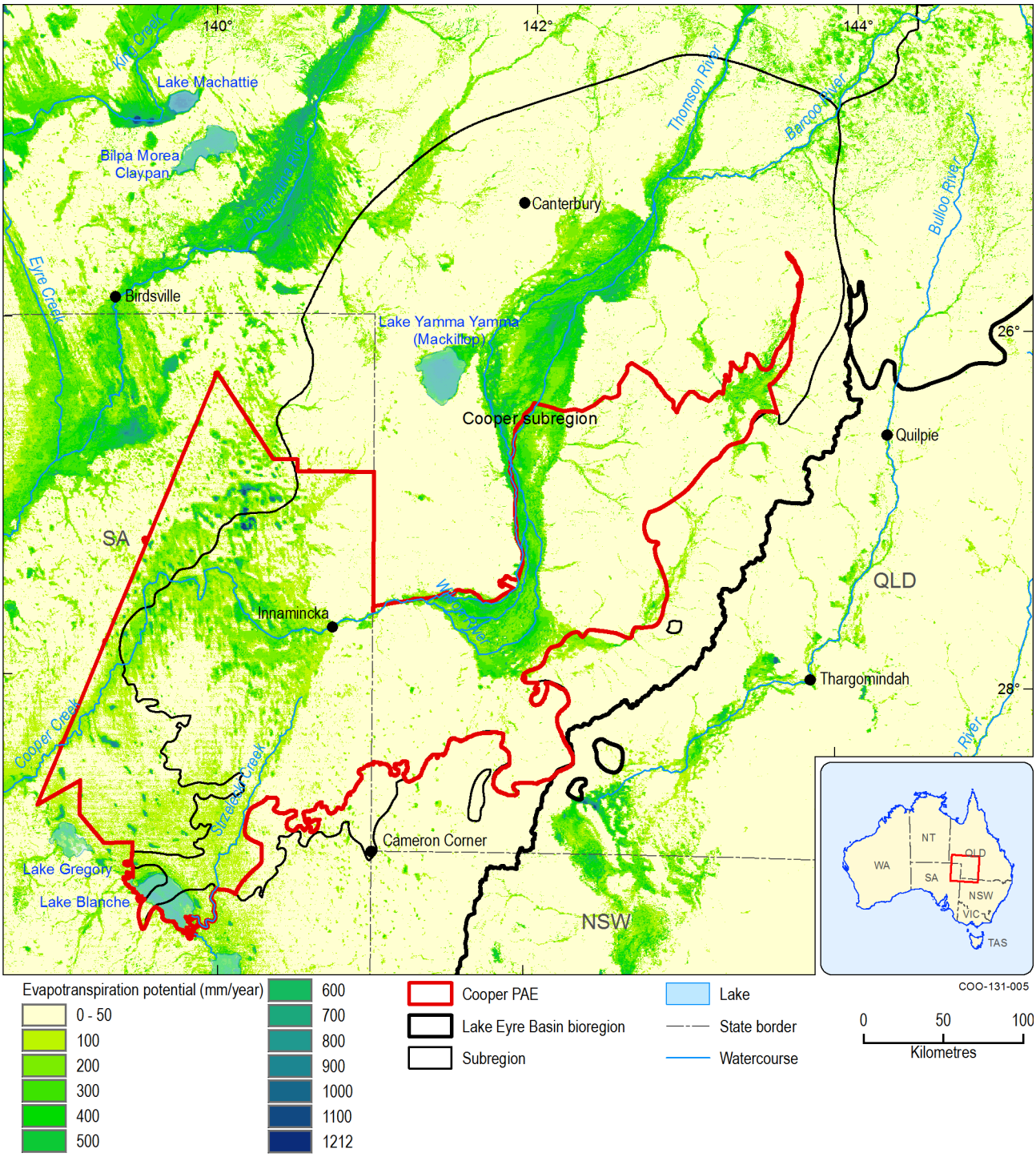


Figure 8 Mean annual evapotranspiration in excess of incident rainfall across the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 27)

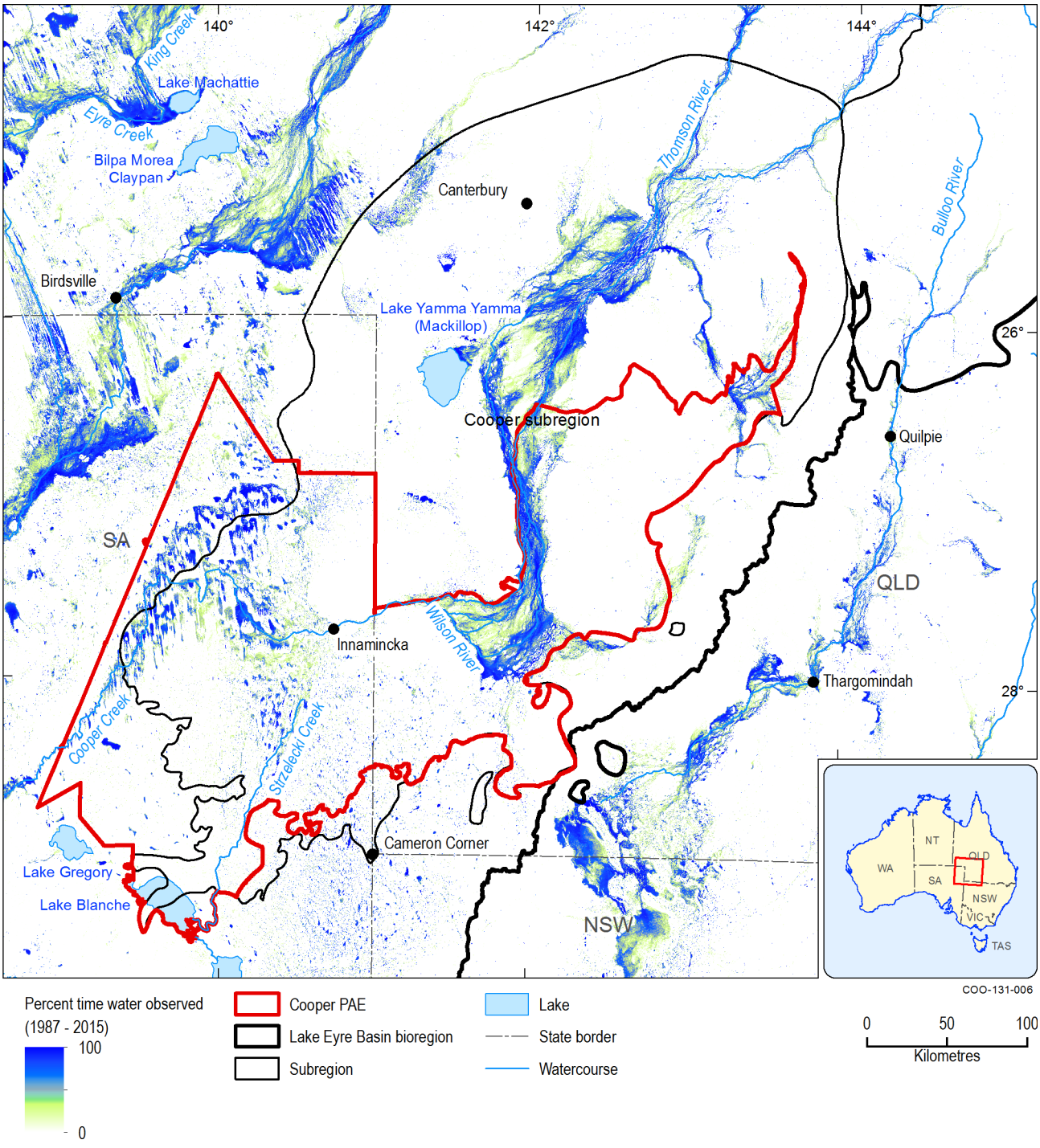


Figure 9 Percentage duration of flood inundation during 1987 to 2015 across the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 25)

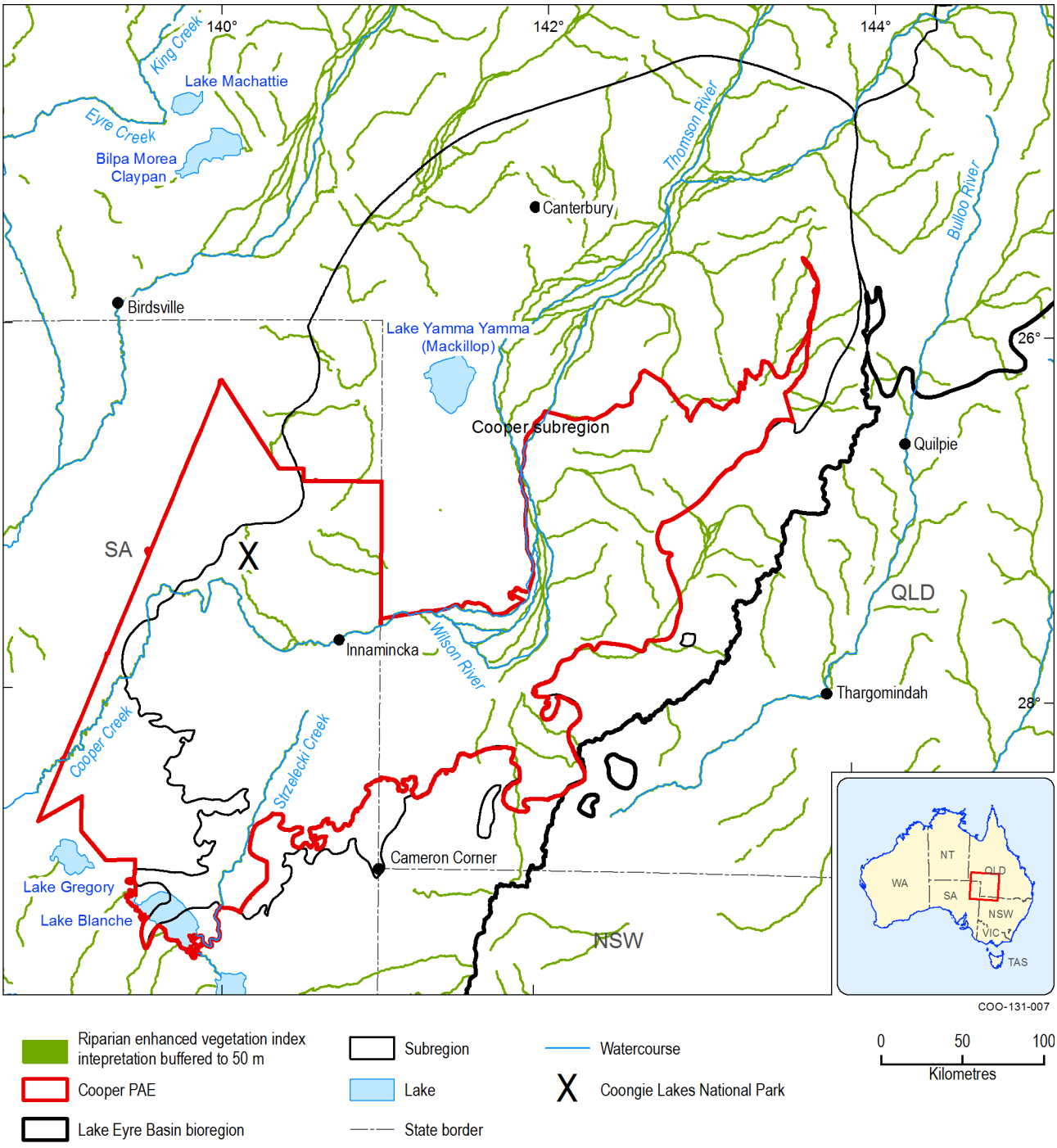


Figure 10 Distribution of riparian vegetation potentially intersecting shallow groundwater in the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 29)

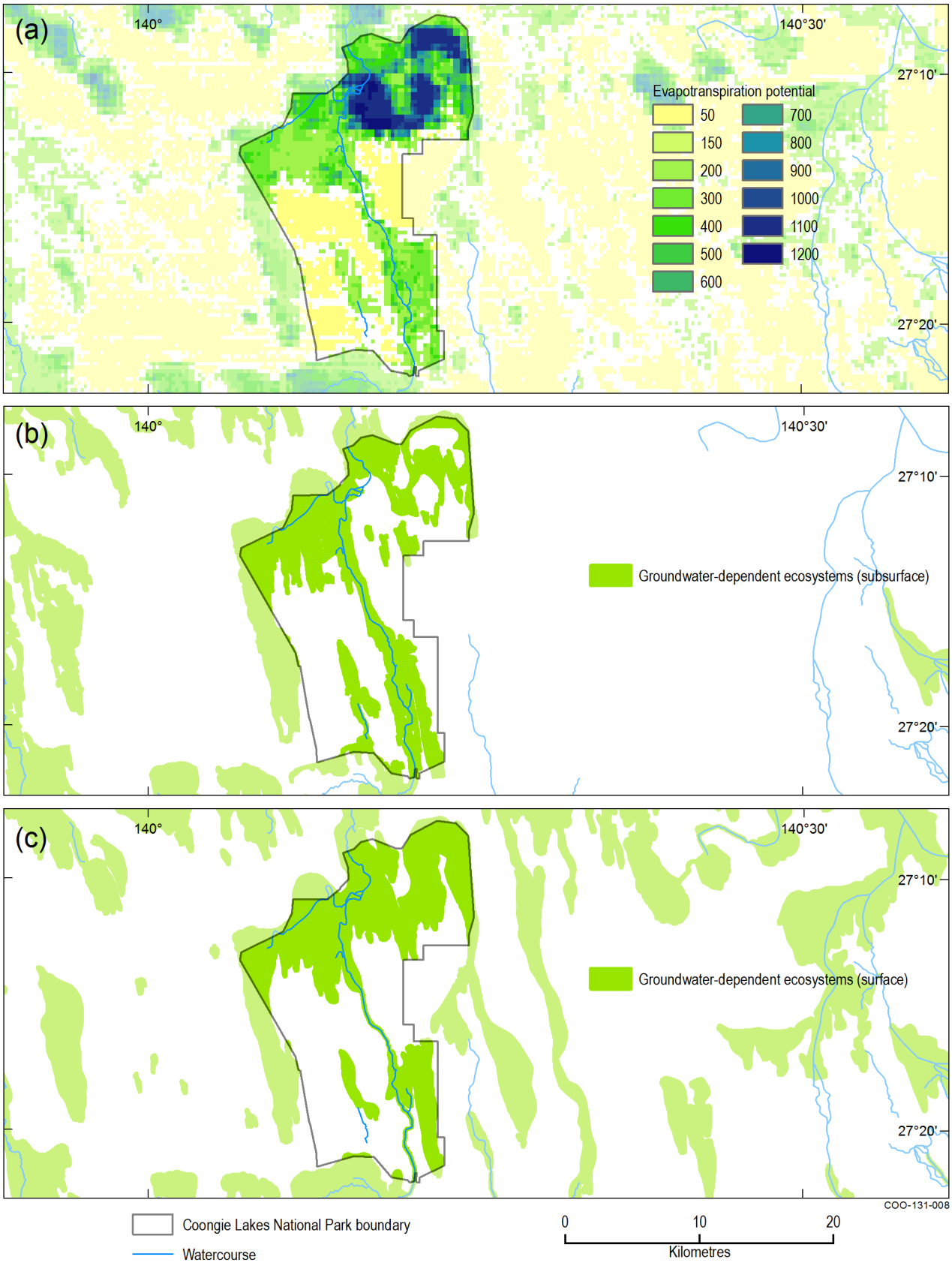


Figure 11 Spatial intersection of a specific asset, Coongie Lakes National Park, with layers of (a) mean annual evapotranspiration in excess of incident rainfall, (b) groundwater-dependent ecosystems reliant on subsurface presence of the water and (c) groundwater-dependent ecosystems reliant on surface expression of the water

Data: Bioregional Assessment Programme (Dataset 27), Bureau of Meteorology (Dataset 8)

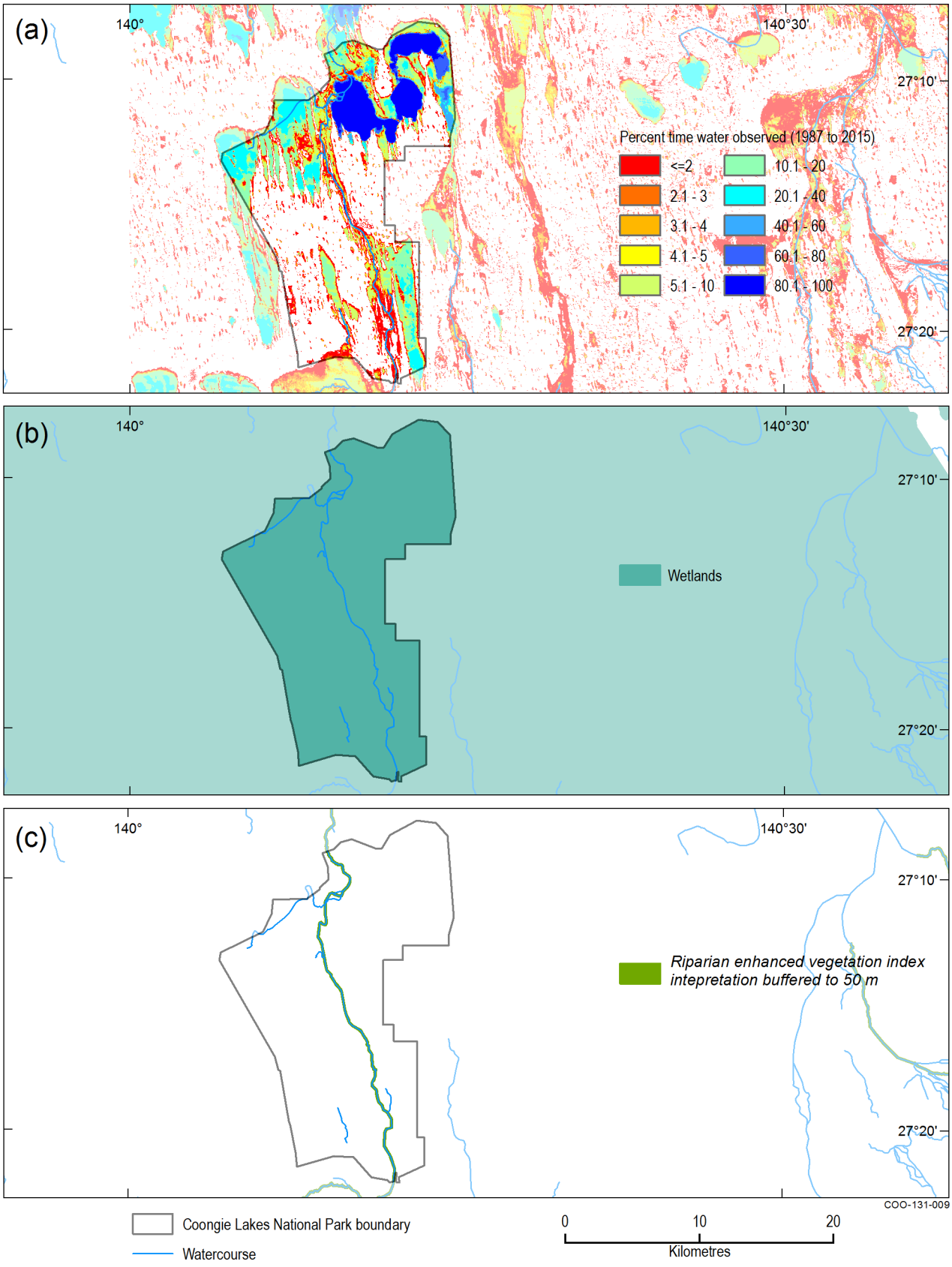


Figure 12 Spatial intersection of a specific asset, Coongie Lakes National Park, with layers of (a) percent duration of flood inundation, (b) South Australia's wetland groundwater-dependent ecosystems and (c) riparian vegetation potentially intercepting shallow groundwater

Data: Bioregional Assessment Programme (Dataset 25, Dataset 29); South Australian Department of Environment, Water and Natural Resources (Dataset 18)

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1.3.2 Ecological assets

Summary

The water-dependent asset register for the preliminary assessment extent (PAE) of the Cooper subregion contains 1516 ecological assets. The water-dependent ecological assets encompass a large proportion of the area of the Cooper PAE. The asset register consists of 595 assets in the 'Vegetation' subgroup, 141 in the 'Groundwater' subgroup and 780 in the 'Surface water' subgroup. All nominated surface water and groundwater assets were assessed as water dependent. Of the nominated 'Vegetation' subgroup assets, nine species habitat assets were excluded as the habitats could not be shown to fulfil the criteria for water dependence.

The asset register includes one threatened ecological community and the potential distribution of seven species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The asset register also includes the potential habitat distributions of five additional species listed under Queensland's *Nature Conservation Act 1992* (Nature Conservation Act).

1.3.2.1 Description

1.3.2.1.1 Introduction to assets by subgroup, class and data source

The total number of ecological water-dependent assets in the PAE of the Cooper subregion is 1516 (from a total of 1525 ecological assets in the asset list). Of the water-dependent assets, 595 assets are vegetation features, 780 assets are surface water features and 141 assets are groundwater features (Table 7). Most of the vegetation features are groundwater-dependent ecosystems (GDEs) and most of the surface water features are lakes, waterholes and billabongs. Of the ecological assets, 1322 assets were assessed as dependent on surface water and 1013 assets were assessed as dependent on groundwater. Of these assets, 449 assets were assessed as dependent or possibly dependent on surface water alone, 140 assets were assessed as dependent or possibly dependent on groundwater alone, and 873 assets were assessed as dependent or possibly dependent on both surface water and groundwater.

Table 8 summarises the ecological assets and their water dependence according to database source. Maps of the distributions of the key data sources are shown in Figure 13 to Figure 19. Total assets cover a large proportion of the 70,589 km^2 area of the Cooper PAE, giving confidence that the asset register is a thorough basis for the assessment of potential impacts of coal resource developments during later stages of the bioregional assessment (BA). In some datasets, some large assets intersect with only a small part of the Cooper PAE and extend far beyond the boundaries of the PAE. This is most strongly the case for the Water Asset Information Tool (WAIT) database, in which large areas encompassing Great Artesian Basin (GAB) groundwater aquifers, recharge beds and dependent ecosystems extend far to the west and south of the Cooper PAE within SA.

Table 7 Summary of ecological assets within the preliminary assessment extent (PAE) of the Cooper subregion, according to asset subgroup and class

Subgroup	Asset class	Number of water-dependent assets	Number of assets dependent on surface water	Number of assets dependent on groundwater
Groundwater feature (subsurface)	Aquifer, geological feature, alluvium or stratum	141	2	141
Surface water feature	Floodplain	4	4	1
	Lake, reservoir, lagoon or estuary	328	328	88
	Marsh, sedgeland, bog, spring or soak	4	4	2
	River or stream reach, tributary, anabranch or bend	162	162	14
	Waterhole, pool, rockpool or billabong	218	218	191
	Wetland, wetland complex or swamp	64	64	51
Vegetation	Groundwater-dependent ecosystem	577	523	513
	Habitat (potential species distribution)	18	17	12
Total		1516	1322	1013

Data: Bioregional Assessment Programme (Dataset 1)

Table 8 Summary of ecological assets in the preliminary assessment extent (PAE) of the Cooper subregion, according to asset data source

Dataset	Number of water-dependent assets	Number of assets dependent on surface water	Number of assets dependent on groundwater
Australian Hydrological Geospatial Fabric	416	416	0
Collaborative Australian Protected Areas Database (CAPAD)	3	3	2
A directory of important wetlands in Australia (DIWA)	5	5	5
Great Artesian Basin Groundwater Recharge	1	1	1
National atlas of groundwater dependent ecosystems (subsurface)	26	25	15
National atlas of groundwater dependent ecosystems (surface)	340	287	287
National Groundwater Information System	1	0	1
Birdlife Australia Important Bird Areas (IBA)	2	2	2
Queensland Lake Eyre Basin Rockholes and Waterholes in Queensland – Indigenous	79	79	79
Queensland Wetland Data Streams	11	11	11
Ramsar List of Wetlands of International Importance	1	1	1
SA Lake Eyre Basin Aquatic Ecosystems Mapping and Classification	10	10	0
SA Wetland Groundwater Dependent Ecosystem Classification	238	238	238
Threatened species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)	7	7	4
Threatened species listed under *Queensland's Nature Conservation Act 1992*, excluding EPBC Act-listed species	5	4	3
Threatened ecological communities listed under the EPBC Act	1	1	1
WAIT Desert Channels	12	4	12
WAIT SA Arid Lands	358	228	351
Total	1516	1322	1013

Data: Bioregional Assessment Programme (Dataset 1)

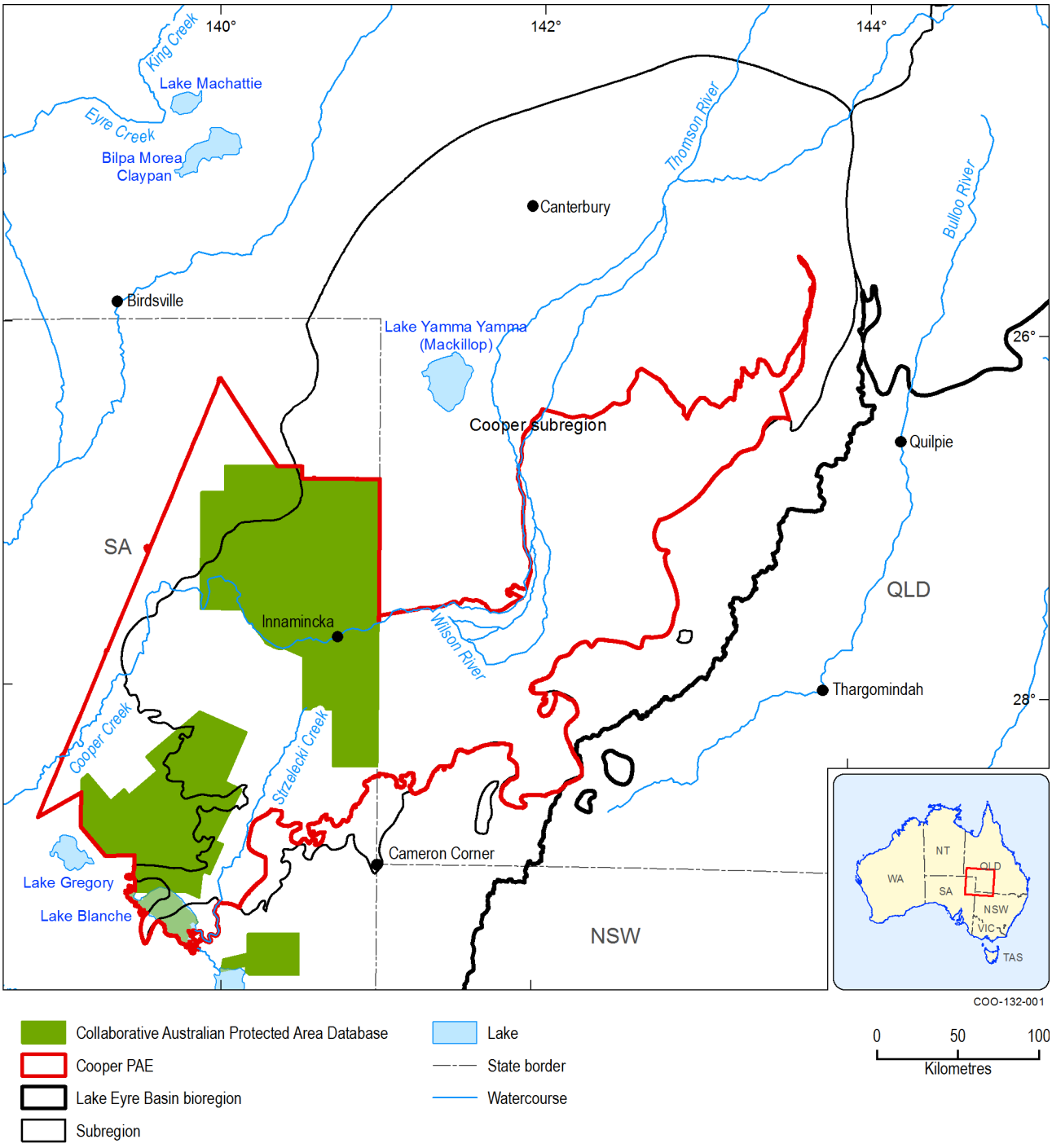

Figure 13 Collaborative Australian Protected Areas Database (CAPAD) assets in the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

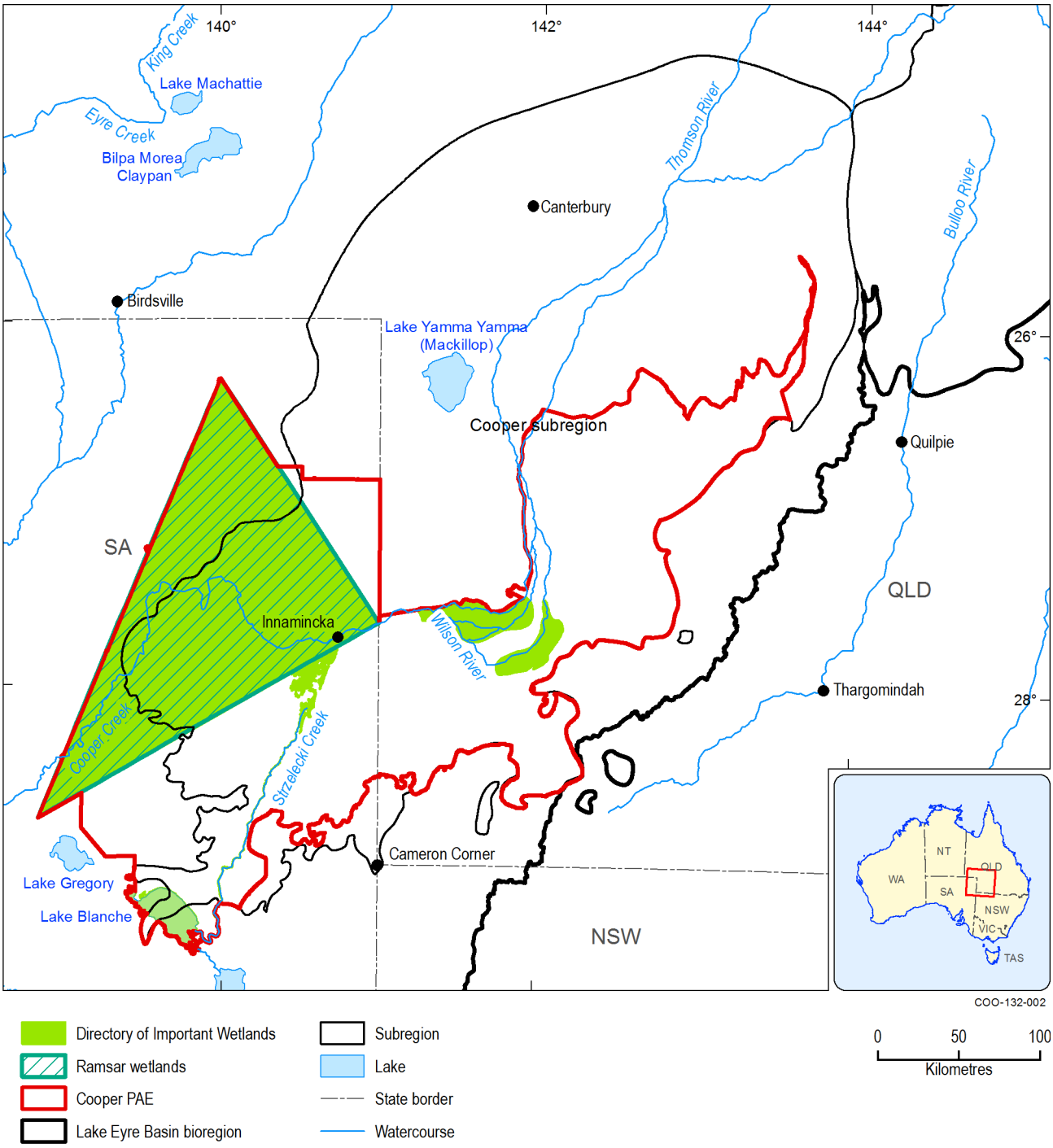

Figure 14 *A directory of important wetlands in Australia* (DIWA) and Ramsar wetland assets in the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

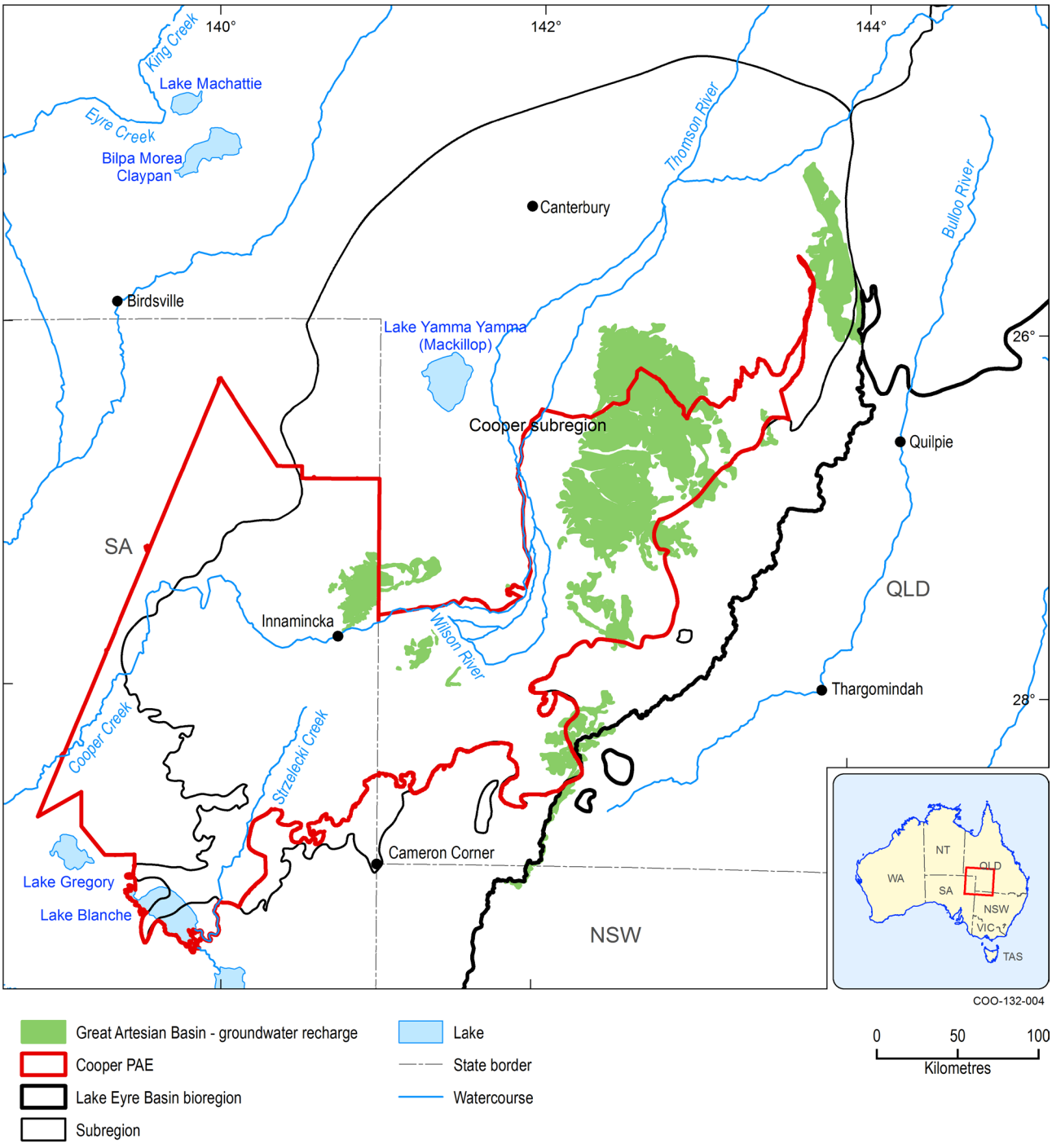

Figure 15 Great Artesian Basin Groundwater Recharge assets in the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

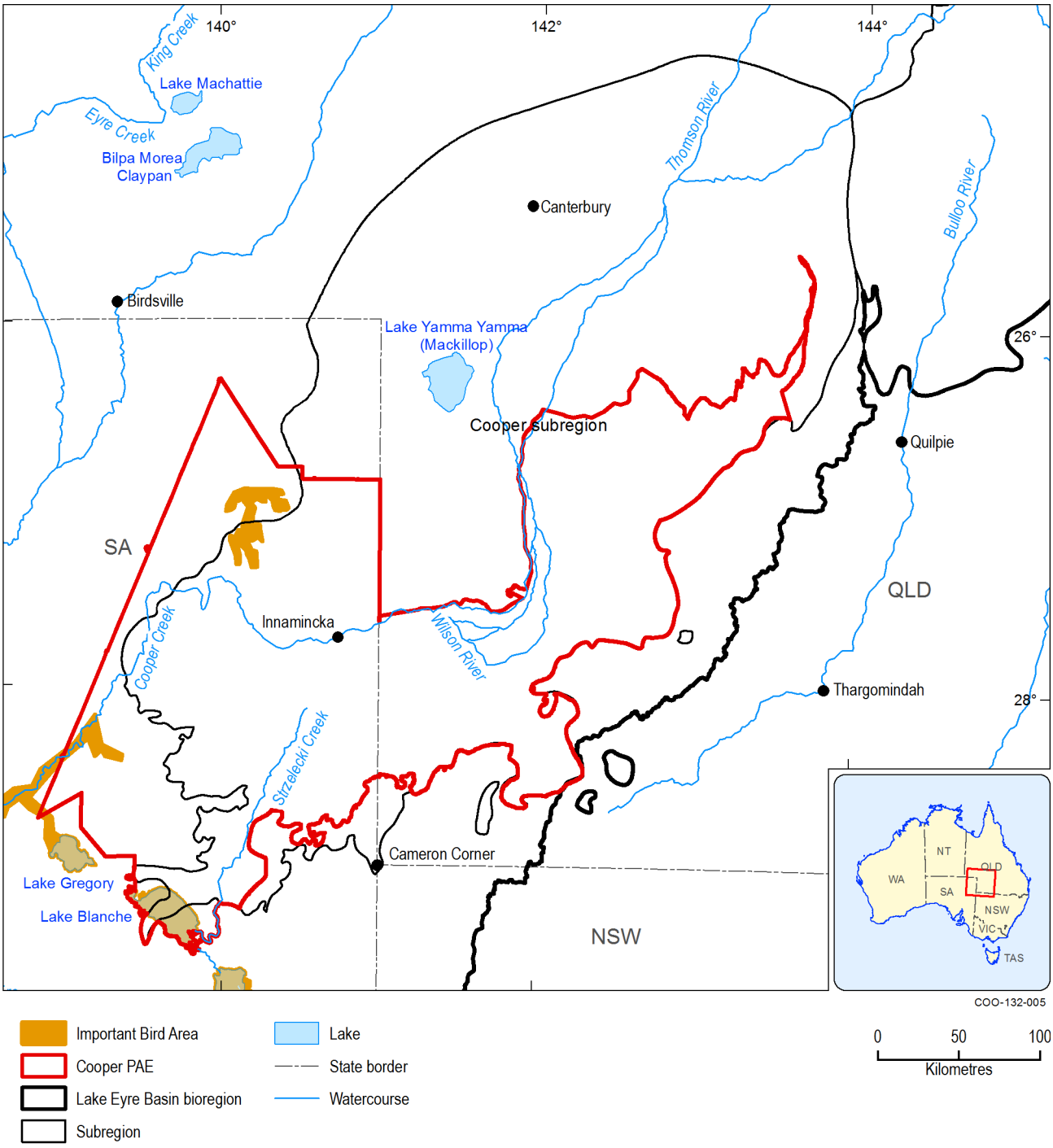

Figure 16 Map of Birds Australia Important Bird Areas (IBA) assets in the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

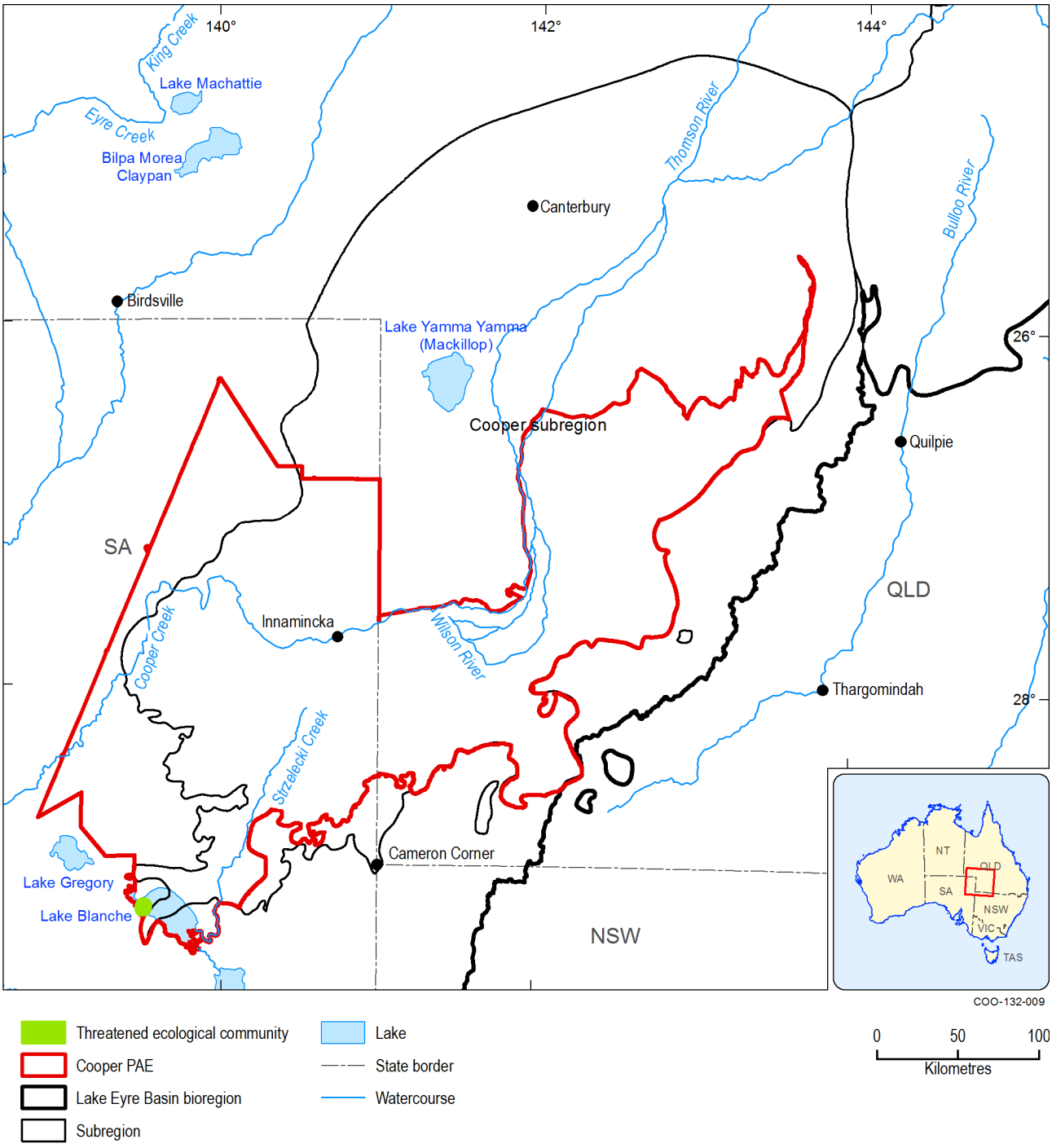

Figure 17 Threatened ecological communities listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* in the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

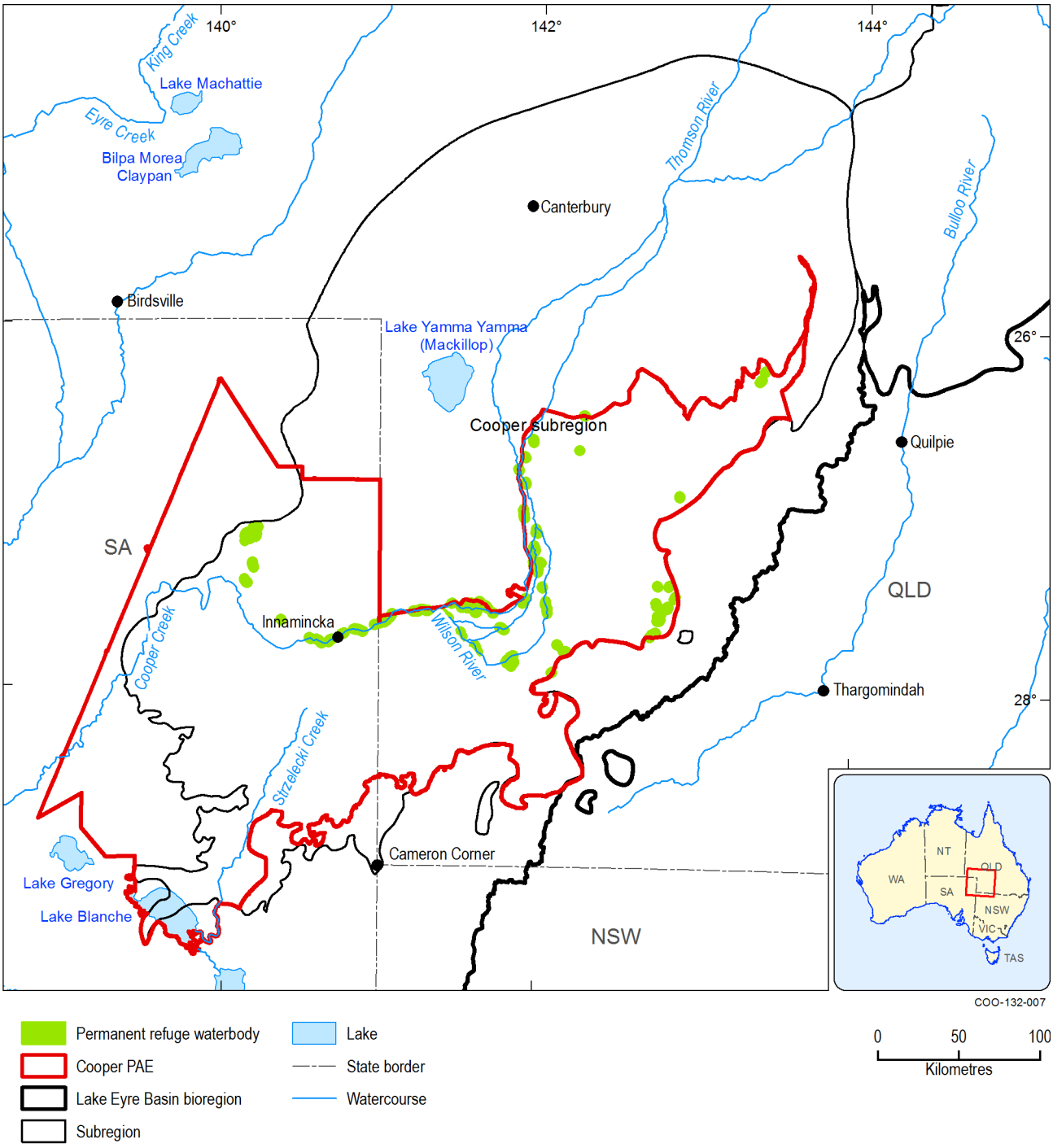

Figure 18 Lake Eyre Basin Rockholes and Waterholes in Queensland (note: 'a') assets in the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

[a]This Queensland dataset extends into north-eastern South Australia as a result of its larger context across the whole Lake Eyre Basin.

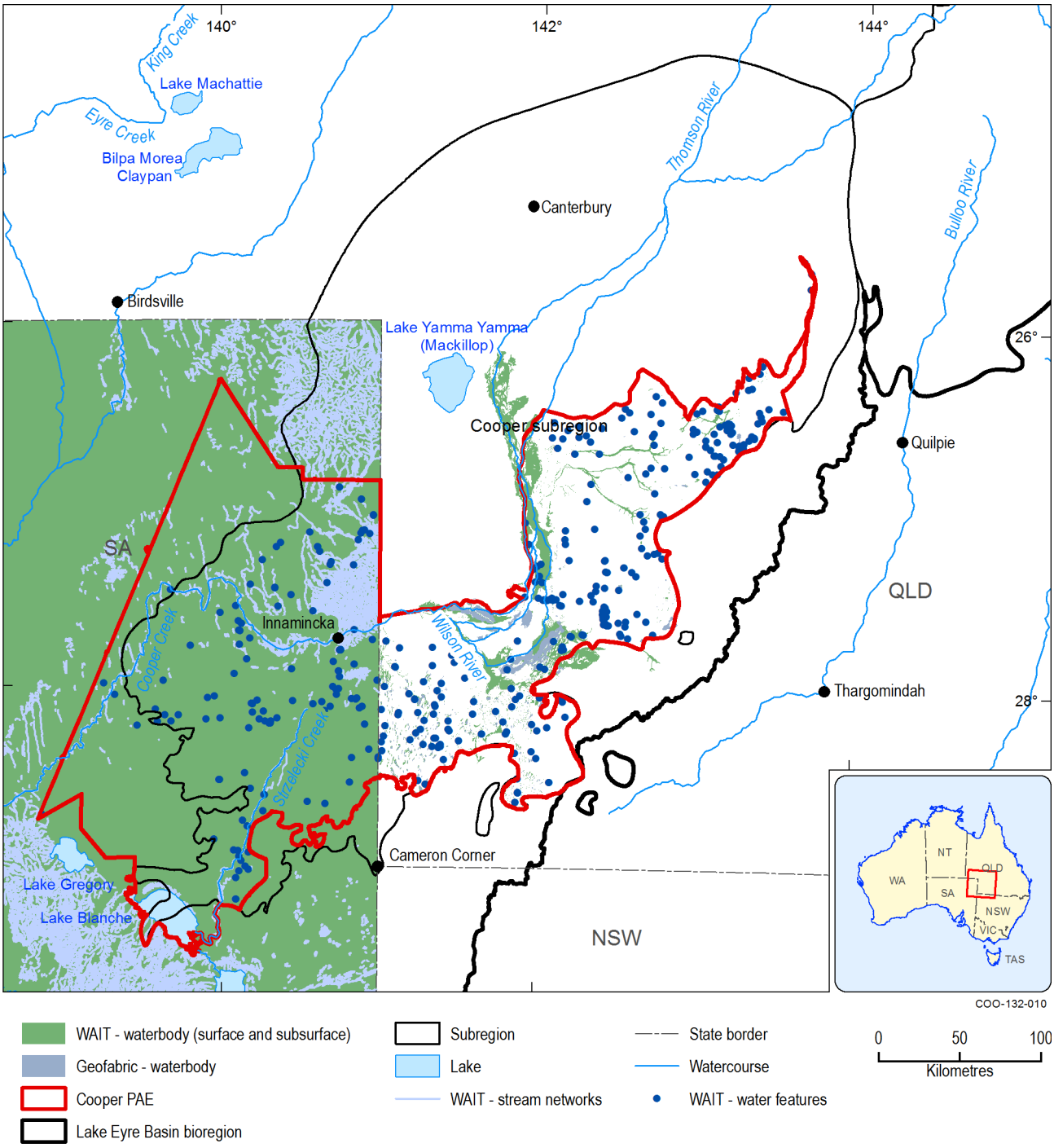

Figure 19 Water Asset Information Tool (WAIT) database assets for Queensland and South Australia in the Cooper preliminary assessment extent (PAE)

Data: Bioregional Assessment Programme (Dataset 1)

1.3.2.1.2 Threatened ecological communities

Only one ecological community listed under the EPBC Act occurs in the Cooper PAE. Management plans indicate that 'The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin threatened ecological community' depends eponymously on groundwater. Assessment data based on all satellite imagery data layers provide independent corroboration that this ecological community is water dependent. These discharge springs occur only at Lake Blanche in SA (Figure 17).

1.3.2.1.3 Habitats of threatened species

Of the 12 species listed as threatened under the EPBC Act, 7 species were assessed to rely upon water-dependent habitats, with 4 species dependent on surface water alone, and 3 species dependent on both surface water and groundwater (Table 9). Application of the precautionary principle means that any species that is 'possibly' dependent on water in excess of incident rainfall is determined to be water dependent and its habitat is included in the water-dependent asset register. None of the three EPBC Act-listed species that are dependent on groundwater is exclusively associated with the community of native species dependent on natural discharge of groundwater from the GAB threatened ecological community. Instead, evidence for dependence on groundwater or surface water is much less clear cut. The species occur across a wide range of community types that are more commonly ephemeral rivers, creeks, wetlands, swamps and floodplains rather than permanent waterbodies. Groundwater may contribute to the water supply in some of these community types, through contributions to subsurface baseflow in rivers and creeks, or to soil water in swamps and floodplains. In all these community types, determination of absolute dependence on water in excess of rainfall (i.e. flows down drainage lines and across floodplains) cannot be made with complete confidence, and in all cases the precautionary principle has been applied to assess these species' habitats.

Of the nine nominated species listed as threatened under the Nature Conservation Act, excluding those also listed under the EPBC Act, five species were assessed to rely upon water-dependent habitats, with four species likely or possibly dependent on surface water, and one species possibly dependent on groundwater (Table 10). The potentially groundwater-dependent species, *Acacia ammophila*, is associated with 'The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin', the sole EPBC Act-listed threatened ecological community in the Cooper subregion. Evidence for dependence on surface water or groundwater is not clear cut for the other four species in this group. As for some of the species listed under the EPBC Act, species listed under the Nature Conservation Act occur across a wide range of community types that are more commonly ephemeral than permanent waterbodies, and may involve some degree of input from groundwater sources. In such community types, determination of absolute dependence on water in excess of rainfall cannot be made with complete confidence, and again the precautionary principle has been applied to assess these species' habitats.

Table 9 Water-dependent threatened species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* and in the preliminary assessment extent (PAE) of the Cooper subregion

Although examples of individual species are listed, bioregional assessments consider the potential impact to the habitat of species not individual species per se.

Scientific name[a]	Common name	Dependence upon surface water	Dependence upon groundwater	Comments
Acanthiza iredalei iredalei	Slender-billed Thornbill (western)	Yes	Unlikely	Commonly located in close proximity to saltlakes
Amytornis barbatus barbatus	Grey Grasswren (Bulloo)	Yes	Unlikely	Occurs in lignum and canegrass on swampy floodplains in the drainage basin of the Bulloo River
Ardea alba	Great Egret	Yes	Possible	Occurs in a wide range of wetland habitats, including freshwater and saline, permanent and ephemeral, open and vegetated
Ardea ibis	Cattle Egret	Yes	Possible	Occurs in a wide range of wetland habitats, including freshwater and saline, permanent and ephemeral, open and vegetated
Botaurus poiciloptilus	Australasian Bittern	Yes	Possible	Preferred habitat is wetlands with tall dense vegetation at the edges of pools or waterways
Macrotis lagotis	Greater Bilby	Possible	No	Associated with drainage systems, salt lake systems and other alluvial areas
Rostratula australis	Australian Painted Snipe	Yes	No	Occurs in shallow freshwater (occasionally brackish) wetlands, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland, saltmarsh, dams, and bore drains

Data: Bioregional Assessment Programme (Dataset 2)

[a]Typology and punctuation are given as they are used in the legislation.

Table 10 Water-dependent threatened species listed under Queensland's *Nature Conservation Act 1992* (but not listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*) and in the preliminary assessment extent (PAE) of the Cooper subregion

Although examples of individual species are listed, bioregional assessments consider the potential impact to the habitat of species not individual species per se.

Scientific name[a]	Common name	Dependence upon surface water	Dependence upon groundwater	Comments
Acacia ammophila	A wattle	Unlikely	Possible	Distribution overlaps with the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin EPBC Act-listed threatened ecological community
Austrobryonia argillicola	Tobermorey Melon	Yes	Not sure	Grows along ephemeral creeks and in poorly drained areas on cracking clay plains. Most abundant in seasonal swamps, clay pans and run-on areas
Epthianura crocea crocea	Yellow Chat	Yes	Unlikely	Birds feed within low vegetation in or near channels and basins, and are seen on the ground at the bases of sedges and on bare mud
Lophochroa leadbeateri	Major Mitchell's Cockatoo	Yes	Possible	Inhabits habitats within easy reach of water
Sclerolaena walkeri	A small shrub	Maybe	No	Occurs on saline river flats and floodplains

Data: Bioregional Assessment Programme (Dataset 2)
[a]Typology and punctuation are given as they are used in the legislation.

1.3.2.2 Gaps

The Cooper subregion asset workshop in Brisbane in October 2014 confirmed three significant data gaps that had been identified previously during collation of the asset list.

The first data gap consists of species listed as threatened under SA's *National Parks and Wildlife Act 1972*, including their threat status in the South Australian Outback region as assessed by Gillam and Urban (2013). Insufficient available spatial data meant that the habitats of these species could not be adequately geographically circumscribed as assets able to be nominated to the asset list. Thus, it was not possible to determine the level of potential water dependence of these species during compilation of the water-dependent asset register. Future assessments will be able to include the habitats of these species should suitable spatial data become available.

Two additional sets of potential assets were proposed at the workshop in Brisbane in October 2014, but they were considered of lower priority than other datasets already nominated by Queensland state agencies and thus these two datasets were not pursued to formal nomination for assets.

These sets of potential assets are from the Queensland Department of Environment and Heritage Protection, which holds the database for Aquatic Conservation Assessments (ACA) and for the Aquatic Biodiversity Assessment Mapping Method (AquaBAMM) (DEHP, 2015).

ACAs are non-social and non-economic assessments that are designed with the sole intent of identifying conservation values of wetlands at any user-defined scale. The ACA database contains a set of 'special features' that are places of hydrological, ecological and/or sociocultural locations that are not necessarily identified as wetlands or conservation places by other means. These features are a potential set of assets that are qualitatively different to any existing asset dataset contributed to the Cooper asset list during the current assessment of water dependence.

AquaBAMM identifies relative wetland conservation values within a specified area – usually a catchment – using criteria, indicators and measures that are based on a large body of literature. The AquaBAMM process identified species of local significance which could be potential assets. Such species are not necessarily on national or state lists of threatened species, but are threatened in a specific catchment.

No other ecological assets were nominated following the Cooper subregion asset workshops in Charleville and Quilpie in February 2015.

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Datasets

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1.3.3 Economic assets

Summary

The water-dependent asset register for the Cooper subregion has seven economic water-dependent assets comprising 19 elements. There is only one asset within the 'Surface water management zone or area' subgroup, comprising three surface water access entitlement elements that supply the town of Innamincka in SA. There are six assets within 'Groundwater management zone or area' subgroup, comprising 16 groundwater access entitlement elements.

1.3.3.1 Description

The total number of economic water-dependent assets in the preliminary assessment extent (PAE) of the Cooper subregion is seven (comprising 19 elements). These are:

- one asset comprising three surface water access entitlements in SA (the water supply for the town of Innamincka)
- six assets comprising 16 groundwater access entitlements grouped according to type and management zone or area in both Queensland and SA.

All assets are water dependent.

A *water access right* is defined 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 (Queensland *Water Act 2000*; Council of Australian Governments, 2004). Water access rights are tradeable with land in a bundled system, or may be tradeable without land in an unbundled system. The consumptive pool may be a body of groundwater or an interconnected set of surface water bodies. For a groundwater pool, access is by bores for domestic, stock, irrigation and/or other commercial uses, or for town water supplies. For surface waters, access is direct by pumping from a river or lake. Pool size and access right allocation of consumptive rights are subject to planning and management within zones, as used here to group the individual elements representing single bores and pumping locations into assets. Within the Cooper subregion, all water access rights are bores that supply pastoral stations and almost all are in the Queensland portion of the subregion.

A *basic water right* (stock and domestic) is a water right held by a rural landowner for domestic, on-farm purposes (Department of the Environment, 2015). Stock purposes are watering stock of a number that would normally be depastured on the land on which the water is used, including pets. Domestic purposes include use within a house and for irrigation of a garden not exceeding 0.25 ha that is cultivated for domestic use rather than sale. Stock and domestic do not include use for dairies, piggeries, feed lots, poultry or any other intensive or commercial use. They may apply to domestic and farm bores, or to pumps in rivers and lakes. In the Cooper subregion, all basic water rights are for bores on pastoral stations.

Table 11 shows the breakdown of water access entitlements (economic elements) for groundwater and surface water in the Cooper preliminary assessment extent (PAE). The locations of the groundwater economic assets are shown in Figure 20.

Table 11 Summary of the water-dependent economic assets in the Cooper preliminary assessment extent (PAE)

All assets are water dependent.

Subgroup	Asset class	State or territory	Number of assets	Number of elements
Groundwater management zone	Basic water right (stock and domestic)	Queensland	4	14
	Water access right	Queensland	1	1
	Water access right	South Australia	1	1
Surface water management zone	Surface water feature used for water supply	South Australia	1	3
Total			7	19

Data: Bioregional Assessment Programme (Dataset 1)

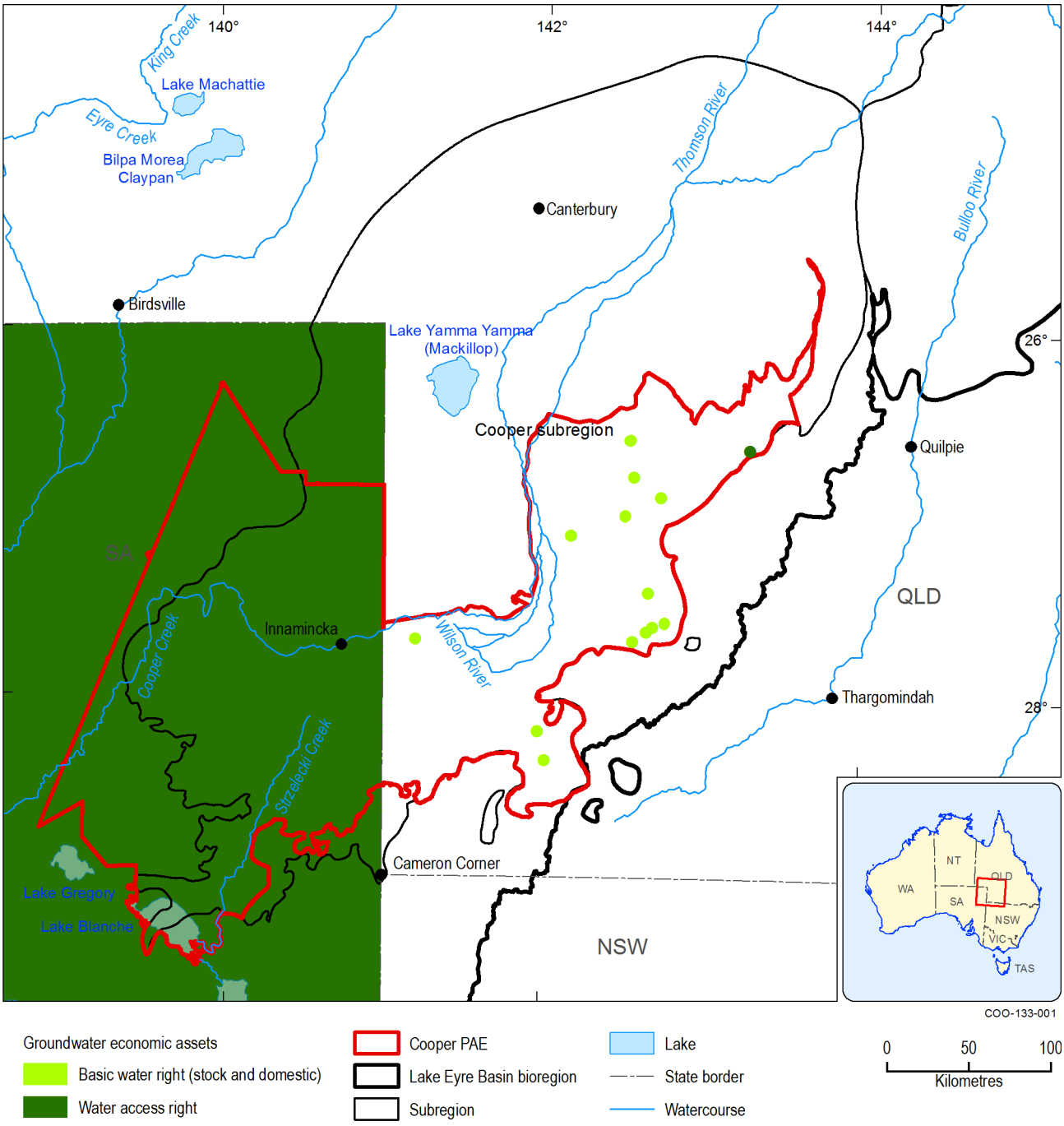

Figure 20 Location of groundwater economic assets in the preliminary assessment extent (PAE) of the Cooper subregion

Data: Bioregional Assessment Programme (Dataset 1)

1.3.3.2 Gaps

No additional economic assets were nominated following the Cooper subregion asset workshops in Brisbane in October 2014, and in Charleville and Quilpie in February 2015.

References

Council of Australian Governments (2004) Intergovernmental agreement on a National Water Initiative. Council of Australian Governments, Canberra. Viewed 22 May 2015, http://www.nwc.gov.au/__data/assets/pdf_file/0008/24749/Intergovernmental-Agreement-on-a-national-water-initiative.pdf.

Department of the Environment (2015) National water market: water rights. Department of the Environment, Australian Government. Viewed 19 August 2015, http://www.nationalwatermarket.gov.au/about/rights.html.

Datasets

Dataset 1 Bioregional Assessment Programme (2015) Asset database for the Cooper subregion on 27 August 2015. Bioregional Assessment Derived Dataset. Viewed 18 September 2015, http://data.bioregionalassessments.gov.au/dataset/0b122b2b-e5fe-4166-93d1-3b94fc440c82.

1.3.4 Sociocultural assets

Summary

All 26 sociocultural assets were sourced from the Australian Heritage Database (Department of the Environment, 2015) and were assessed as potentially water dependent (surface water and/or groundwater). No additional sociocultural assets were nominated at the Cooper subregion asset workshops in Brisbane in October 2014, or in Charleville and Quilpie in February 2015.

Some sociocultural assets with identified heritage values are also areas with natural values. Consequently they are partly or entirely protected under national and/or state conservation legislation, and thus were also nominated as ecological assets. These sociocultural assets are water dependent. Other sociocultural assets are historical places, including several places associated with the 1860 to 1861 expedition by Robert O'Hara Burke and William John Wills. Some of the historical places can be identified as water dependent because they are located near groundwater discharge springs or on floodplains, but for other historical places, there is insufficient information to assess water dependence reliably and thus the precautionary principle was invoked to assess these assets as *potentially* water dependent.

Meetings have been held with Indigenous knowledge holders in the Cooper subregion to gain further understanding of Indigenous cultural water-dependent assets and possible additional nominations.

1.3.4.1 Description

A total of 26 sociocultural assets were sourced from the Australian Heritage Database (Department of the Environment, 2015; Bioregional Assessment Programme, Dataset 1), comprising 24 assets from the Register of the National Estate (RNE) and 2 assets from the National Heritage List (NHL). Because of the dearth of asset descriptions to support accurate assessments of water dependence, the precautionary principle was applied in all cases. Consequently, all 26 assets were considered to be potentially water dependent and were included in the water-dependent asset register. No additional sociocultural assets were nominated at the Cooper subregion asset workshops in Brisbane in October 2014, or in Charleville and Quilpie in February 2015.

Table 12 shows the breakdown of water-dependent sociocultural assets by dataset, subgroup and class. The geographic locations of the assets are shown in Figure 21. There are 24 assets in the ‘Cultural’ subgroup and 2 assets in the ‘Social’ subgroup. Nine of the assets from the RNE are classed as Indigenous sites. On all sides of the Cooper preliminary assessment extent (PAE), large sociocultural assets intersect with only a small part of the PAE and extend far beyond the boundaries of the PAE. During subsequent stages of the Bioregional Assessment Technical Programme, impact will only be assessed for those parts of such assets that lie within the PAE.

Table 12 Summary of the water-dependent sociocultural assets in the preliminary assessment extent (PAE) of the Cooper subregion

Dataset	Subgroup	Class	Number of assets	Number of assets potentially dependent on surface water or groundwater
National Heritage List (NHL)	Cultural	Heritage site	2	2
Register of the National Estate (RNE)	Cultural	Heritage site	13	13
Register of the National Estate (RNE)	Cultural	Indigenous site	9	9
Register of the National Estate (RNE)	Social	Recreation area	2	2
Total			26	26

Data: Bioregional Assessment Programme (Dataset 1)

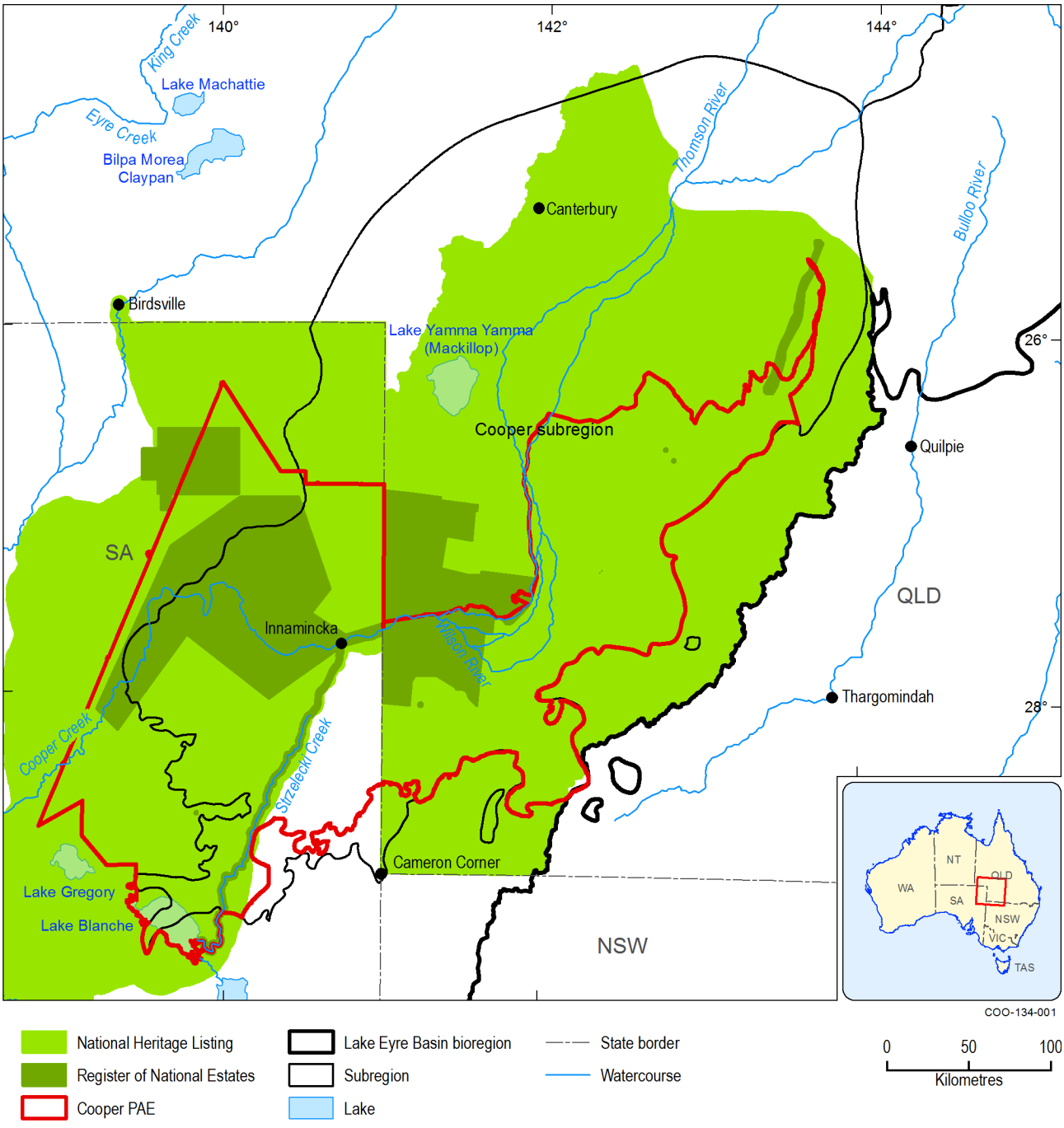

Figure 21 Location of the water-dependent sociocultural assets in the Cooper subregion

Data: Bioregional Assessment Programme (Dataset 1)

The two assets from NHL (the Birdsville and Strzelecki Tracks Area and the Cooper Creek Sub-Catchment) are both areas that have natural values and are partly or entirely protected under national and/or state conservation legislation. Large parts of these sociocultural assets were also nominated as ecological assets. All examples of this type of asset depend on a combination of surface water and groundwater – at least in part.

Three of the 13 assets sourced from the RNE that are classed as heritage sites are also natural areas that have federal or state-level conservation designations (Coongie Lakes, Cooper Creek

Floodplain and the Nappa Merri area). They are also nominated as assets from other databases that were classified as containing ecological assets and depend on surface water, at least in part.

The remaining assets sourced from the RNE and classed as heritage sites are historical places. Some of these assets are associated with the 1860 to 1861 expedition by Robert O'Hara Burke and William John Wills (e.g. the Burke and Wills National Heritage Place, the Dig Tree Reserve, and the Wills Monument and Blazed Tree Historic Registered Place). Some of these assets lie within floodplains of rivers and creek, and they were able to be assessed reliably as water-dependent using the remotely sensed data. However, for other assets that are historical places, there is too little information to assess water dependence with any accuracy, and thus the precautionary principle was invoked to identify all as *potentially* water dependent, pending additional information.

The water-dependent asset register includes nine Indigenous sites sourced from the RNE. Other than the name and location of the asset, very little information was available to assess water dependence. Hercus (2009) described the places in northern SA that are of significance to local Indigenous people and are associated with waterholes and rockholes. On the basis of this information and the secondary analyses through intersections with remotely sensed data sources, in addition to the precautionary principle in each case, these Indigenous sites were assessed as likely or possibly dependent on surface water and/or groundwater.

1.3.4.2 Gaps

No further sociocultural assets were nominated following the Cooper subregion asset workshops in Brisbane in October 2014, and in Charleville and Quilpie in February 2015.

In the Cooper subregion, the Bioregional Assessment programme has funded the South Australian Department of Environment, Water and Natural Resources to research cultural values associated with water assets, including Indigenous values. Reports from this study will be available through the Bioregional Assessment website (www.bioregionalassessments.gov.au) when finalised.

For bioregional assessment purposes, no other specific gaps in the knowledge base related to sociocultural assets in the Cooper subregion have been identified.

References

Department of the Environment (2015) Australian Heritage Database online. Viewed 22 May 2015, http://www.environment.gov.au/topics/heritage/publications-and-resources/australian-heritage-database.

Hercus L (2009) Murkarra, a landscape nearly forgotten: The Arabana country of the noxious insects, north and northwest of Lake Eyre. In: Hercus L and Koch H (eds) Aboriginal placenames: naming and re-naming the Australian landscape. ANU E Press and Aboriginal History Incorporated, Canberra, 257–272.

Datasets

Dataset 1 Bioregional Assessment Programme (2015) Asset database for the Cooper subregion on 27 August 2015. Bioregional Assessment Derived Dataset. Viewed 18 September 2015, http://data.bioregionalassessments.gov.au/dataset/0b122b2b-e5fe-4166-93d1-3b94fc440c82.

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