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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 Central West subregion

Product 1.3 for the Central West subregion from the Northern Inland Catchments Bioregional Assessment

18 March 2016



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 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

Macquarie Marshes, on the north-western end, between Carinda and Warren, NSW, 2009

Credit: Arthur Mostead © Commonwealth of Australia (Murray–Darling Basin Authority)



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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: Julie Burke
Projects Director	CSIRO: David Post
Principal Science Advisor	Department of the Environment: Peter Baker
Science Directors	CSIRO: Brent Henderson Geoscience Australia: Steven Lewis
Integration	Bureau of Meteorology: Richard Mount (Integration Leader) CSIRO: Becky Schmidt
Programme management	Bureau of Meteorology: Louise Minty CSIRO: Paul Hardisty, Warwick McDonald Geoscience Australia: Stuart Minchin
Project Leaders	CSIRO: Alexander Herr, Kate Holland, Tim McVicar, David Rassam Geoscience Australia: Tim Evans, Kriton Glenn, Martin Smith Bureau of Meteorology: Natasha Herron
Assets and receptors	Bureau of Meteorology: Richard Mount (Discipline Leader) Department of the Environment: Glenn Johnstone, 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, Ashley Sommer Geoscience Australia: Neal Evans
Communications	Bureau of Meteorology: Karen de Plater CSIRO: Helen Beringen, Chris Gerbing Department of the Environment: Lea Locke, Milica Milanja
Coordination	Bureau of Meteorology: Julie Burke, Eliane Prideaux, Sarah van Rooyen CSIRO: Ruth Palmer Department of the Environment: Anisa Coric, James Hill, Bronwyn McMaster, Emily Turner
Ecology	CSIRO: Anthony O'Grady (Discipline Leader), Caroline Bruce, Tanya Doody, Brendan Ebner, Craig MacFarlane, Patrick Mitchell, Justine Murray, Chris Pavey, Jodie Pritchard, Nat Raisbeck-Brown, Ashley Sparrow
Geology	CSIRO: Deepak Adhikary, Emanuelle Frery, Mike Gresham, Jane Hodgkinson, Zhejun Pan, Matthias Raiber, Regina Sander, Paul Wilkes Geoscience Australia: Steven Lewis (Discipline Leader), Stephen Hostetler
Geographic information systems	CSIRO: Jody Bruce, Debbie Crawford, Steve Marvanek, Arthur Read Geoscience Australia: Adrian Dehelean, Joe Bell

Role or team	Contributor(s)
Groundwater modelling	CSIRO: Russell Crosbie (Discipline Leader), Tao Cui, Warrick Dawes, Lei Gao, Sreekanth Janardhanan, Luk Peeters, Praveen Kumar Rachakonda, Wolfgang Schmid, Saeed Torkzaban, Chris Turnadge, Andy Wilkins, Binzhong Zhou
Hydrogeology	Geoscience Australia: Tim Ransley (Discipline Leader), Chris Harris-Pascal, Karen Ivkovic, Jessica Northey, Emily Slatter
Information management	Bureau of Meteorology: Belinda Allison (Team Leader) CSIRO: Qifeng Bai, Simon Cox, Phil Davies, Mick Hartcher, Geoff Hodgson, Brad Lane, Ben Leighton, David Lemon, Trevor Pickett, Shane Seaton, 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, Anu Edirisuriya, Simon Gallant, Karin Hosking, Frances Marston, Maryanne McKay, Linda Merrin, Joely Taylor, Sally Tetreault-Campbell, Catherine Ticehurst Geoscience Australia: Penny Kilgour, Kathryn Owen
Risk and uncertainty	CSIRO: Simon Barry (Discipline Leader), Jeffrey Dambacher, Jess Ford, Keith Hayes, Geoff Hosack, Adrian Ickowicz, Warren Jin, Yang Liu, Dan Pagendam
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, Jai Vaze, Bill Wang, Ang Yang, Yongqiang Zhang

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- Senior Science Leaders: David Post (Projects Director), 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, 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 (IESC, 2015).

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 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 (see <http://www.bioregionalassessments.gov.au/assessments> for a map and further information):

- 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.

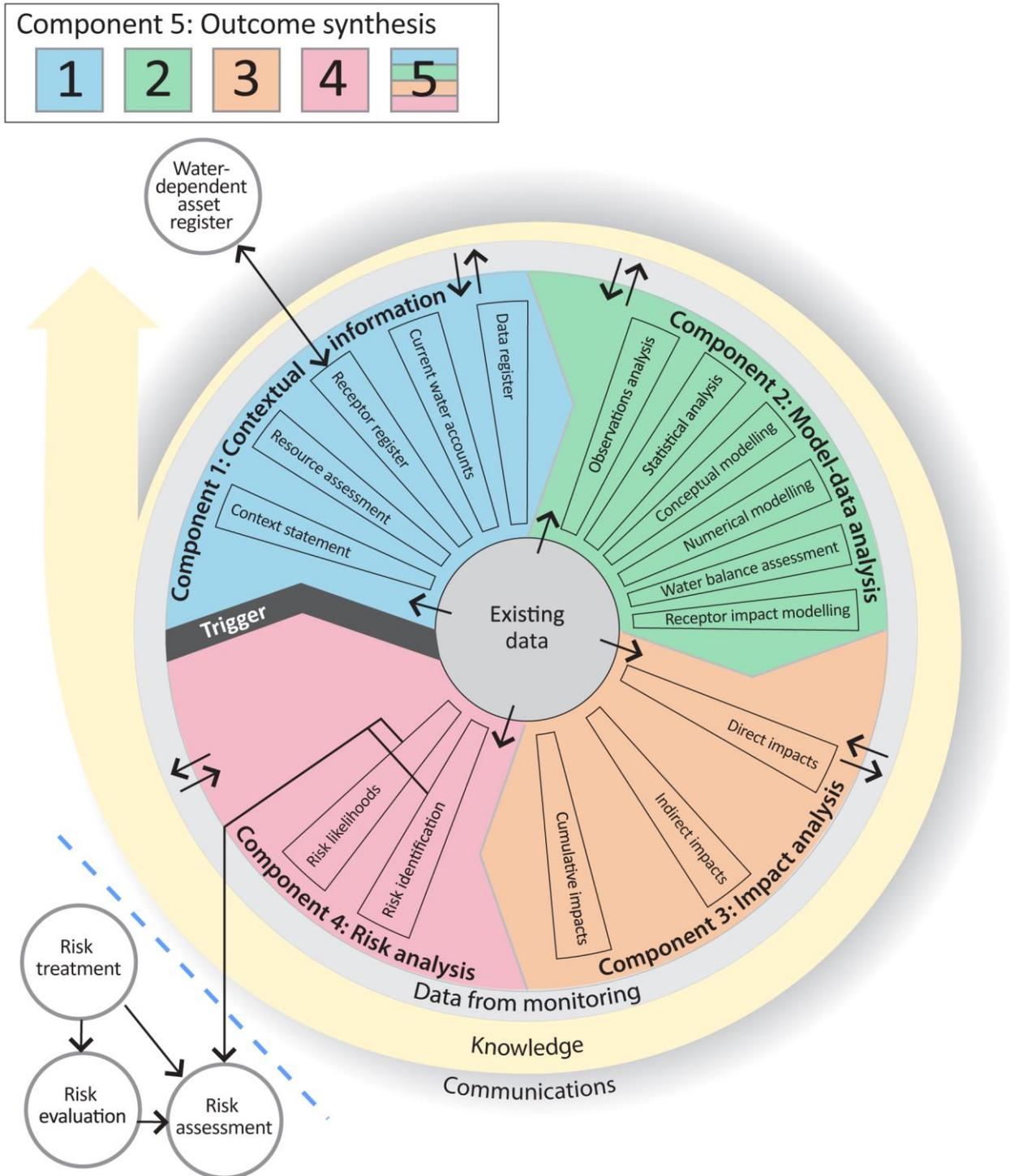


Figure 1 Schematic diagram of the bioregional assessment methodology

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

The overall scientific and intellectual basis of the BAs is provided in the BA methodology (Barrett et al., 2013). Additional guidance is required, however, about how to apply the BA methodology to a range of subregions and bioregions. To this end, the teams undertaking the BAs have developed and documented detailed scientific submethodologies (Table 1) to, in the first instance, support the consistency of their work across the BAs and, secondly, to open the approach to scrutiny, criticism and improvement through review and publication. In some instances, methodologies applied in a particular BA may differ from what is documented in the submethodologies – in this case an explanation will be supplied in the technical products of that BA. Ultimately the Programme anticipates publishing a consolidated 'operational BA methodology' with fully worked examples based on the experience and lessons learned through applying the methods to 13 bioregions and subregions.

The relationship of the submethodologies to BA components and technical products is illustrated in Figure 2. While much scientific attention is given to assembling and transforming information, particularly through the development of the numerical, conceptual and receptor impact models, integration of the overall assessment is critical to achieving the aim of the BAs. To this end, each submethodology explains how it is related to other submethodologies and what inputs and outputs are required. They also define the technical products and provide guidance on the content to be included. When this full suite of submethodologies is implemented, a BA will result in a substantial body of collated and integrated information for a subregion or bioregion, including new information about the potential impacts of coal resource development on water and water-dependent assets.

Table 1 Methodologies

Each submethodology is available online at <http://data.bioregionalassessments.gov.au/submethodology/XXX>, where 'XXX' is replaced by the code in the first column. For example, the BA methodology is available at <http://data.bioregionalassessments.gov.au/submethodology/bioregional-assessment-methodology> and submethodology M02 is available at <http://data.bioregionalassessments.gov.au/submethodology/M02>. Submethodologies might be added in the future.

Code	Proposed title	Summary of content
bioregional-assessment-methodology	<i>Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources</i>	A high-level description of the scientific and intellectual basis for a consistent approach to all bioregional assessments
M02	<i>Compiling water-dependent assets</i>	Describes the approach for determining water-dependent assets
M03	<i>Assigning receptors to water-dependent assets</i>	Describes the approach for determining receptors associated with water-dependent assets
M04	<i>Developing a coal resource development pathway</i>	Specifies the information that needs to be collected and reported about known coal and coal seam gas resources as well as current and potential resource developments
M05	<i>Developing the conceptual model of causal pathways</i>	Describes the development of the conceptual model of causal pathways, which summarises how the 'system' operates and articulates the potential links between coal resource development and changes to surface water or groundwater
M06	<i>Surface water modelling</i>	Describes the approach taken for surface water modelling
M07	<i>Groundwater modelling</i>	Describes the approach taken for groundwater modelling
M08	<i>Receptor impact modelling</i>	Describes how to develop receptor impact models for assessing potential impact to assets due to hydrological changes that might arise from coal resource development
M09	<i>Propagating uncertainty through models</i>	Describes the approach to sensitivity analysis and quantification of uncertainty in the modelled hydrological changes that might occur in response to coal resource development
M10	<i>Impacts and risks</i>	Describes the logical basis for analysing impact and risk
M11	<i>Systematic analysis of water-related hazards associated with coal resource development</i>	Describes the process to identify potential water-related hazards from coal resource development

Technical products

The outputs of the BAs include a suite of technical products presenting information about the ecology, hydrology, hydrogeology and geology of a bioregion and the potential 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 relationship of the technical products to BA components and submethodologies. 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 outlines in both Figure 2 and Table 2 indicate the information included in this technical product.

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

- unencumbered data syntheses and databases
- unencumbered tools, model code, procedures, routines and algorithms
- unencumbered forcing, boundary condition, parameter and initial condition datasets
- lineage of datasets (the origin of datasets and how they are changed as the BA progresses)
- gaps in data and modelling capability.

In this context, unencumbered material is material that can be published according to conditions in the licences or any applicable legislation. All reasonable efforts were made to provide all material under a Creative Commons Attribution 3.0 Australia Licence.

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

The Bureau of Meteorology archives a copy of all datasets used in the BAs. This archive includes datasets that are too large to be stored online and datasets that are encumbered. The community can request a copy of these archived data at <http://www.bioregionalassessments.gov.au>.

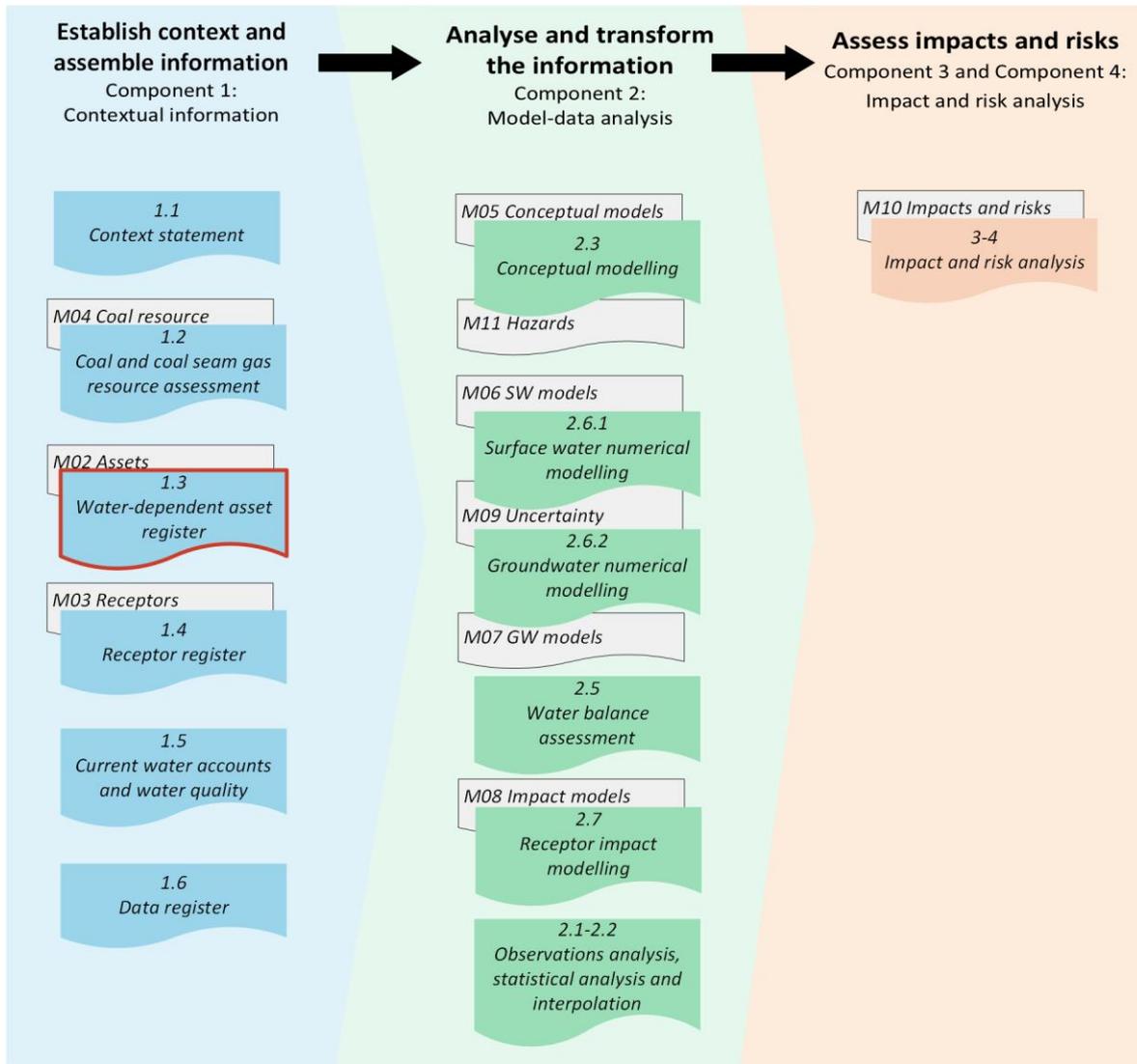


Figure 2 Technical products and submethodologies associated with each component of a bioregional assessment

In each component (Figure 1) of a bioregional assessment, a number of technical products (coloured boxes, see also Table 2) are potentially created, depending on the availability of data and models. The light grey boxes indicate submethodologies (Table 1) that specify the approach used for each technical product. The red outline indicates this technical product. The BA methodology (Barrett et al., 2013) specifies the overall approach.

Table 2 Technical products delivered for the Central West subregion

For each subregion in the Northern Inland Catchments 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. There is no product 2.4; originally this product was going to include two- and three-dimensional representations as per Section 4.2 of the BA methodology, but these are instead included in other products.

Component	Product code	Title	Section in the BA methodology ^b	Type ^a
Component 1: Contextual information for the Central West 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	Not produced
	1.5	Current water accounts and water quality	2.5.1.5	HTML-only
	1.6	Data register	2.5.1.6	Register
Component 2: Model-data analysis for the Central West 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	Not produced
	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 and Component 4: Impact and risk analysis for the Central West subregion	3-4	Impact and risk analysis	5.2.1, 2.5.4, 5.3	Not produced
Component 5: Outcome synthesis for the Central West subregion	5	Outcome synthesis	2.5.5	Not produced

^aThe types of products are as follows:

- 'PDF' indicates a PDF document that is developed by the Northern Inland Catchments Bioregional Assessment using the structure, standards and format specified by the Programme.
- 'HTML' indicates the same content as in the PDF document, but delivered as webpages.
- 'HTML-only' indicates content that is only delivered as webpages (with no accompanying PDF document). This content is developed by the Northern Inland Catchments Bioregional Assessment using the structure, standards and format specified by the Programme.
- '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).

^b*Methodology 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 151.0° East for the Northern Inland Catchments 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 4 July 2016, <http://data.bioregionalassessments.gov.au/submethodology/bioregional-assessment-methodology>.
- IESC (2015) Information guidelines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals. Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, Australia. Viewed 4 July 2016, <http://www.iesc.environment.gov.au/publications/information-guidelines-independent-expert-scientific-committee-advice-coal-seam-gas>.



1.3 Description of the water-dependent asset register for the Central West 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/NIC/CEN/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 Central West subregion. This section details the specific application to the Central West subregion of methods described in the companion submethodology M02 (as listed in Table 1) for compiling water-dependent assets (Mount et al., 2015), outlining how the register was compiled. Key concepts and terminology are also explained.

The methods covered include: the process of collecting different groups of assets and assessing their water dependency using multiple lines of evidence, the development and compilation of the water-dependent asset register, and the general determination of a preliminary assessment extent (PAE) in BAs (note that the Central West subregion does not have a PAE).

1.3.1.1 Background and context

This product presents information about the water-dependent asset register developed for the Central West subregion. The name of the dated snapshot of the asset register this description refers to is the 'Water-dependent asset register and asset list for the Central West subregion on 21 August 2015' (see O'Grady and Bruce, 2016). 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/NIC/CEN/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 Central West subregion is described in the following sections.

An *asset* is an entity having value to the community and, for BA purposes, is associated with a bioregion or subregion. 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, 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 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 are 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. The Office of Water Science liaised with Indigenous knowledge holders about Indigenous sociocultural water-dependent assets (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. The product 1.3 will not be updated or republished as part of bioregional assessments 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., 2016).

1.3.1.2 Compiling assets and developing the water-dependent asset register

The water-dependent assets register was compiled by assessing the water dependency of assets in the asset list for the Central West subregion (Bioregional Assessment Programme, Dataset 1).

1.3.1.2.1 Ecological assets

One natural resource management organisation (NRM) nominated assets through the contribution of data to the Water Asset Information Tool (WAIT) database (Australian Government Department of Environment, Dataset 2). These NRM-nominated assets were added to the asset database (Table 3). Other datasets in the asset database and their associated source organisations are listed in Table 4 together with the number of assets and elements.

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

Organisation	Description in asset database
Central West Catchment Management Authority	WAIT_Central West

Table 4 Datasets for ecological assets in the Central West subregion

Dataset ^{a,b}	Dataset citation	Elements	Assets (asset lists)
New South Wales NSW - Regional - CMA - Water Asset Information Tool - WAIT - databases	Australian Government Department of Environment (Dataset 2)	23,373	276
Collaborative Australian Protected Areas Database (CAPAD) 2010 - External RESTRICTED (Not current release) - Metadata only	Australian Government Department of the Environment (Dataset 3)	25	25
Directory of Important Wetlands in Australia (DIWA) Spatial Database (Public)	Australian Government Department of the Environment (Dataset 4)	185	1
Ramsar Wetlands of Australia	Australian Government Department of Environment (Dataset 5)	2	2
Environmental Asset Database - Commonwealth Environmental Water Office -RESTRICTED (Metadata only)	Australian Government Department of the Environment (Dataset 6)	6	6
National Groundwater Dependent Ecosystems (GDE) Atlas	Bureau of Meteorology (Dataset 7)	Subsurface: 14,355 Surface: 1,671	Subsurface: 221 Surface: 124
Communities of National Environmental Significance Database - RESTRICTED (Metadata only)	Australian Government Department of the Environment (Dataset 8)	54,778	6
Species Profile and Threats Database (SPRAT) - Australia - Species of National Environmental Significance Database (BA subset - RESTRICTED - Metadata only)	Bioregional Assessment Programme (Dataset 9)	2,516	50
Key Environmental Assets - KEA - of the Murray Darling Basin RESTRICTED (Metadata only)	Murray-Darling Basin Authority (Dataset 10)	Streams: 351 Waterbodies: 11	Streams: 5 Waterbodies: 2
Birds Australia - Important Bird Areas (IBA) 2009	Birds Australia (Dataset 11)	3	3
Climate Change Corridors (Dry Habitat) for North East NSW	Office of Environment and Heritage (OEH) NSW (Dataset 12)	4	4

Dataset ^{a,b}	Dataset citation	Elements	Assets (asset lists)
Macquarie Marshes Vegetation 1991-2008 VIS_ID 3920	Office of Environment and Heritage (OEH) NSW (Dataset 13)	1,262	8
Native Vegetation Management (NVM) - Manage Benefits	NSW Department of Environment, Climate Change and Water (DECCW) (Dataset 14)	3,460	4
Travelling Stock Route Conservation Values	NSW Department of Environment, Climate Change and Water (DECCW) (Dataset 15)	143	141
NSW Wetlands	NSW Department of Environment, Climate Change and Water (DECCW) (Dataset 16)	795	3
Great Artesian Basin and Laura Basin groundwater recharge areas	Geoscience Australia (Dataset 17)	1	1
Total		102,941	882

^aThe 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 database as boundaries may differ between databases.

^bTypology and punctuation are given as provided in the metadata for these datasets.

1.3.1.2.2 Economic assets

The datasets used in compiling the economic assets for the Central West subregion are shown in Table 5.

Table 5 Datasets for economic assets in the Central West subregion

Dataset ^a	Dataset citation	Elements	Assets (asset list)
NSW Office of Water Groundwater licences extract linked to spatial locations NIC v3 20140313	Bioregional Assessment Programme (Dataset 18)	315	19
NSW Office of Water Surface Water Licences in NIC linked to locations v1 20140422	Bioregional Assessment Programme (Dataset 19)	1442	25
NSW surface water sharing plans (groundwater and surface water)	NSW Office of Water (Dataset 20)	32	32
NSW groundwater macro plans	NSW Office of Water (Dataset 20)	16	16
NSW regulated rivers	NSW Office of Water (Dataset 20)	1	1
Total		1806	93

^aThe 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 database as boundaries may differ between databases.

1.3.1.2.3 Sociocultural assets

Indigenous sociocultural assets were sourced from existing Commonwealth heritage databases (Table 6).

Meetings have been held with Indigenous knowledge holders in the Central West 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 (available at <http://data.bioregionalassessments.gov.au/product/NIC/CEN/1.3>).

Table 6 Datasets for sociocultural assets in the Central West subregion

Dataset ^a	Dataset citation	Elements	Assets (asset list)
National Heritage List Spatial Database (NHL) (v2.1)	Australian Government Department of the Environment (Dataset 21)	2	2
Australia, Register of the National Estate (RNE) - Spatial Database (RNESDB) Internal	Australian Government Department of the Environment (Dataset 22)	55	55
Total		57	57

^aThe 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 database as boundaries may differ between databases.

1.3.1.3 Determining the preliminary assessment extent

The impacts from developing coal resources in the Central West subregion could extend beyond the subregion boundary, or might not extend as far as the subregion boundary due to its remoteness from development. The 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. It is the first step in identifying potentially impacted assets. Defining the PAE allows compilation of the asset information to occur in parallel with assessing the resource (see companion product 1.2 for the Central West subregion (Hodgkinson et al., 2014)).

Future coal mining in the subregion includes one new NSW state-owned development (Cobbora) and one expansion (Ulan). The NSW Government is in the process of selling their Cobbora interests. In light of the current low commodity prices it is unlikely that the Cobbora development will occur within the time frame of this BA. The Ulan lease straddles the Central West and Hunter subregions, and potential impacts from Ulan will be modelled with the Hunter subregion developments. There are currently neither existing nor proposed coal seam gas developments in the subregion.

As a consequence, there is no PAE for the Central West subregion and the subsequent descriptions will consider assets for the *whole* subregion to provide an initial resource should future developments occur (Figure 3).

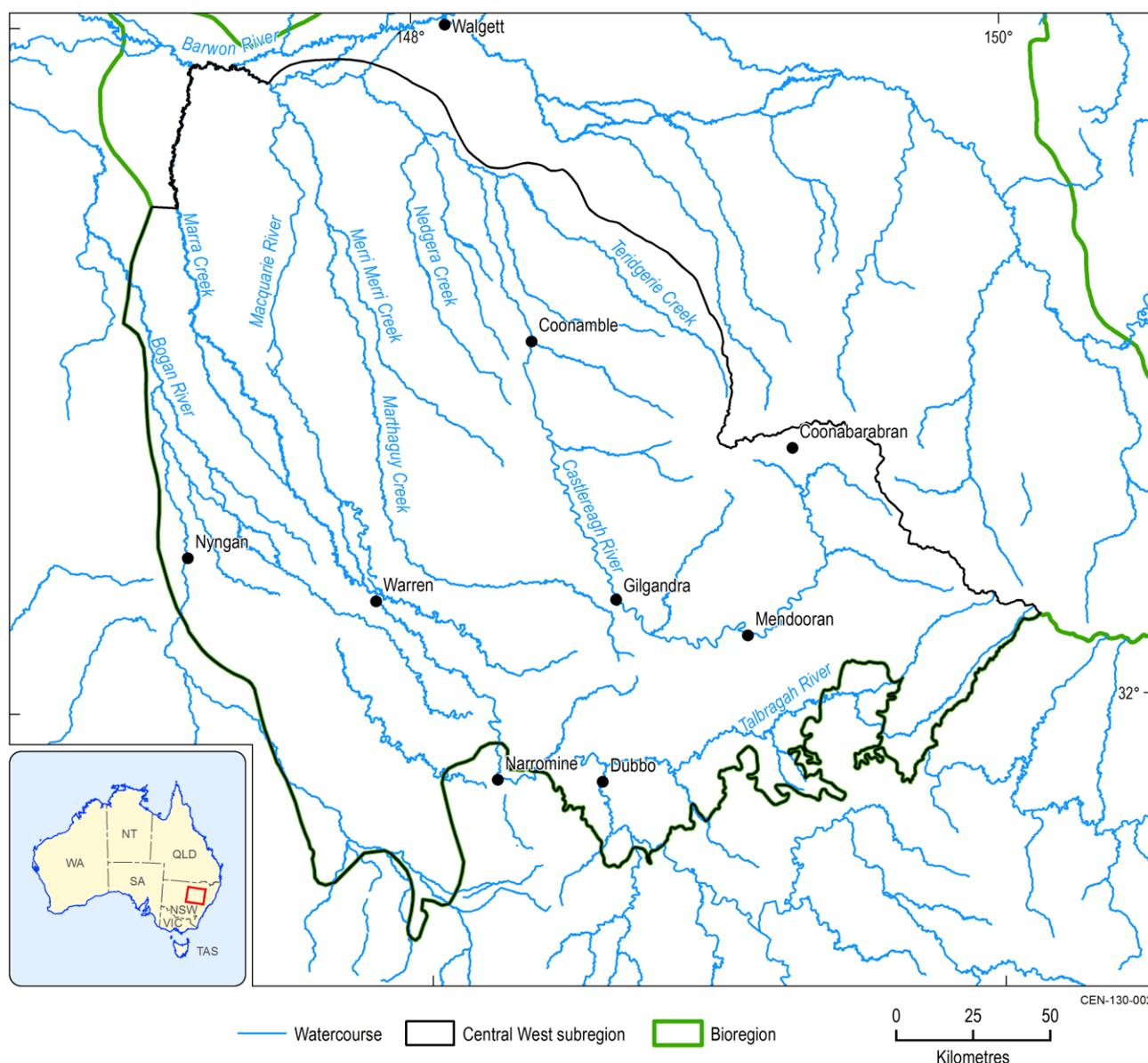


Figure 3 Central West subregion

1.3.1.4 Assessing water dependence

Following the compilation of assets into a database, water dependency of assets was assessed in a two-step procedure:

1. Only assets that intersect with the subregion were retained for a further assessment of water dependence (M1 decision).
2. For assets that intersected with the subregion, a preliminary assessment of water dependency was conducted (M2 decision).

Decisions on the preliminary water dependency (M2) were made using the following guiding principles:

1. *Efficiency*. Methods developed to assess water dependency were suitable to application to large numbers of assets and where possible used automated procedures.

2. *Transparency.* All decisions could be justified and included the rationale for inclusion, data sources, dates and responsible persons.
3. *Rigour.* Decision making was based on sound ecological, economic and sociocultural principles and clear logic.
4. *Multiple lines of evidence.* Wherever possible, multiple lines of evidence were simultaneously used to underpin decision making. Three broad groups of evidence were used including (i) naming conventions, (ii) documents describing asset profiles or management (where available) and (iii) simple spatial analysis.
5. *Precaution.* Where only part of an asset was shown to be water dependent, the entire asset was deemed to be water dependent. For example, if it was demonstrated that a nature reserve contained water-dependent assets, such as watercourses the entire nature reserve was deemed to be water dependent. Where evidence for definitive determinations of water dependence was lacking (for example descriptions of species habitat were incomplete or unclear) assets were assumed to be water dependent.

Assets classed in the ecological subgroups ‘Surface water features’ or ‘Groundwater features’, or assets with names that include the terms ‘waterhole’, ‘lake’, ‘lagoon’, ‘soak’, etc., were deemed ‘Assumed to be water dependent’. Similarly, assets sourced from the *National atlas of groundwater dependent ecosystems* (GDE atlas) (Bureau of Meteorology, Dataset 7) with a known groundwater dependency (derived from previous field work or possessing a high or moderate potential for groundwater dependency) were assumed to be water dependent (attributed as ‘likely’). Assets with a moderate potential for groundwater dependency were attributed as ‘possible’ and also included in the register. Where assets were identified as having a low probability for groundwater dependence, it was assumed that these assets were unlikely to be groundwater dependent and were not included in the water-dependent asset register.

For many of the remaining assets water dependency was not obvious. Such assets might include threatened ecological communities listed under the Commonwealth’s *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Australian Government Department of the Environment, Dataset 8) (e.g. ‘Weeping Myall Woodlands’ threatened ecological community) or assets derived from the CAPAD database such as the Warrumbungle National Park.

The water dependency of threatened species’ habitat including threatened ecological communities listed under the EPBC Act were assessed by a review of the habitat requirements for each species or community. An important caveat is that the Assessment considers the potential impact of coal resource development on the habitat of the species rather than the species *per se*. However, it is necessary to present species-based information to best reflect available data. The water dependency of the species habitat was ranked as ‘likely’, ‘possible’, ‘unlikely’ or ‘unsure’ based on profiles descriptions contained within the Species Profile and Threats Database (SPRAT; Bioregional Assessment Programme, Dataset 9). Assets listed as ‘likely’ are those with a clear and demonstrated link to aquatic ecosystems (e.g. aquatic species). Assets listed as ‘possible’ may have some overlap with habitat that may be water dependent (e.g. species that may visit riparian areas). Assets listed as ‘unlikely’ show no evidence of surface water or groundwater dependence in habitat requirements. Where assets were recorded as ‘unsure’, the precautionary principle was applied and the asset retained for inclusion in the water-dependent asset register.

For ecological and sociocultural assets such as historic buildings, nature reserves, national parks, important bird areas, etc., a spatial analysis using multiple data sources was used to assess the preliminary water dependency of the assets. Water-dependent assets were those that met at least one of the following criteria:

- intersected with existing mapping of the Murray-Darling Basin flood inundation 1 in 100 year extent (CSIRO, Dataset 23)
- occurred over shallow groundwater, where shallow groundwater is defined as regions where depth to groundwater is less than 10 m (Geoscience Australia, Dataset 24)
- occurred in regions where depth to groundwater ranged between 10 to 20 m. This criterion considered those assets that may access groundwater intermittently (Geoscience Australia, Dataset 24)
- intersected with existing wetland mapping or riparian networks (Department of Sustainability, Environment, Water, Population and Communities, Dataset 25).

In all cases, assets attributed as 'likely' or 'possible' were flagged as 'on' with respect to M2 and included in the asset register. Assets attributed as 'unlikely' were flagged as 'off' in the asset database and are not included in the preliminary water-dependent asset register.

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1.3.1 Methods

1.3.2 Ecological assets

Summary

Of the 882 ecological assets in the asset list, 772 were deemed to be water dependent for the purposes of the bioregional assessment (BA). The water-dependent assets register contains 468 assets in the 'Vegetation' subgroup, 12 in the 'Groundwater feature' subgroup and 292 in the 'Surface water feature' subgroup. Assets in the 'Vegetation' subgroup fell predominantly into two classes: groundwater-dependent ecosystems or habitat. Six communities and 26 threatened species listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were identified as water dependent in the Central West subregion.

1.3.2.1 Description

Of the 882 ecological assets in the asset list, 772 were deemed to be water dependent for the purposes of the BA. The water-dependent assets register contains 468 assets in the 'Vegetation' subgroup, 12 in the 'Groundwater feature' subgroup and 292 in the 'Surface water feature' subgroup. A more detailed summary of the distribution of assets according to asset class in the asset list is presented in Table 7.

Table 7 Summary of ecological assets within the Central West subregion

Subgroup	Asset class	Not in water-dependent asset register	In water-dependent asset register	Total assets (asset list)
Groundwater feature (subsurface)	Aquifer, geological feature, alluvium or stratum	0	12	12
	Groundwater total	0	12	12
Surface water feature	Floodplain	0	6	6
	Lake, reservoir, lagoon or estuary	0	4	4
	Marsh, sedgeland, bog, spring or soak	0	27	27
	River or stream reach, tributary, anabranch or bend	0	42	42
	Wetland, wetland complex or swamp	0	213	213
	Surface water total	0	292	292
Vegetation	Groundwater-dependent ecosystem	86	259	345
	Habitat (potential species distribution)	24	209	233
	Vegetation total	110	468	578
Total		110	772	882

Data: Bioregional Assessment Programme (Dataset 1)

1.3.2 Ecological assets

1.3.2.1.1 Groundwater features

All 12 assets listed in the 'Groundwater feature (subsurface)' subgroup were 'assumed to be water dependent' and included in the water-dependent asset register for further consideration during the Assessment (Table 7). The majority of these groundwater features were aquifers identified in the Water Asset Information Tool (WAIT) database for the Central West (Australian Government Department of the Environment, Dataset 2). One asset, the Cadna-owie – Hooray Equivalent (Pilliga Sandstone), is identified as a Great Artesian Basin recharge area (Geoscience Australia, Dataset 9).

1.3.2.1.2 Surface water features

All 292 of the assets listed in the 'Surface water feature' subgroup were assumed to be water dependent (Table 7). There are many assets in the 'Wetland, wetland complex and swamp' class distributed throughout the subregion, often covering only small areas in the eastern part, with more extensive coverage towards the north-west as the drainage nears the Barwon River and floodplains become prevalent. The Macquarie Marshes area, situated along the north-western flow of the Macquarie River is listed in several databases and has been classified in multiple ways. These include 'Marsh, sedgeland, bog, spring or soak', and as 'Floodplain' and 'Wetland, wetland complex or swamp' (Figure 4).

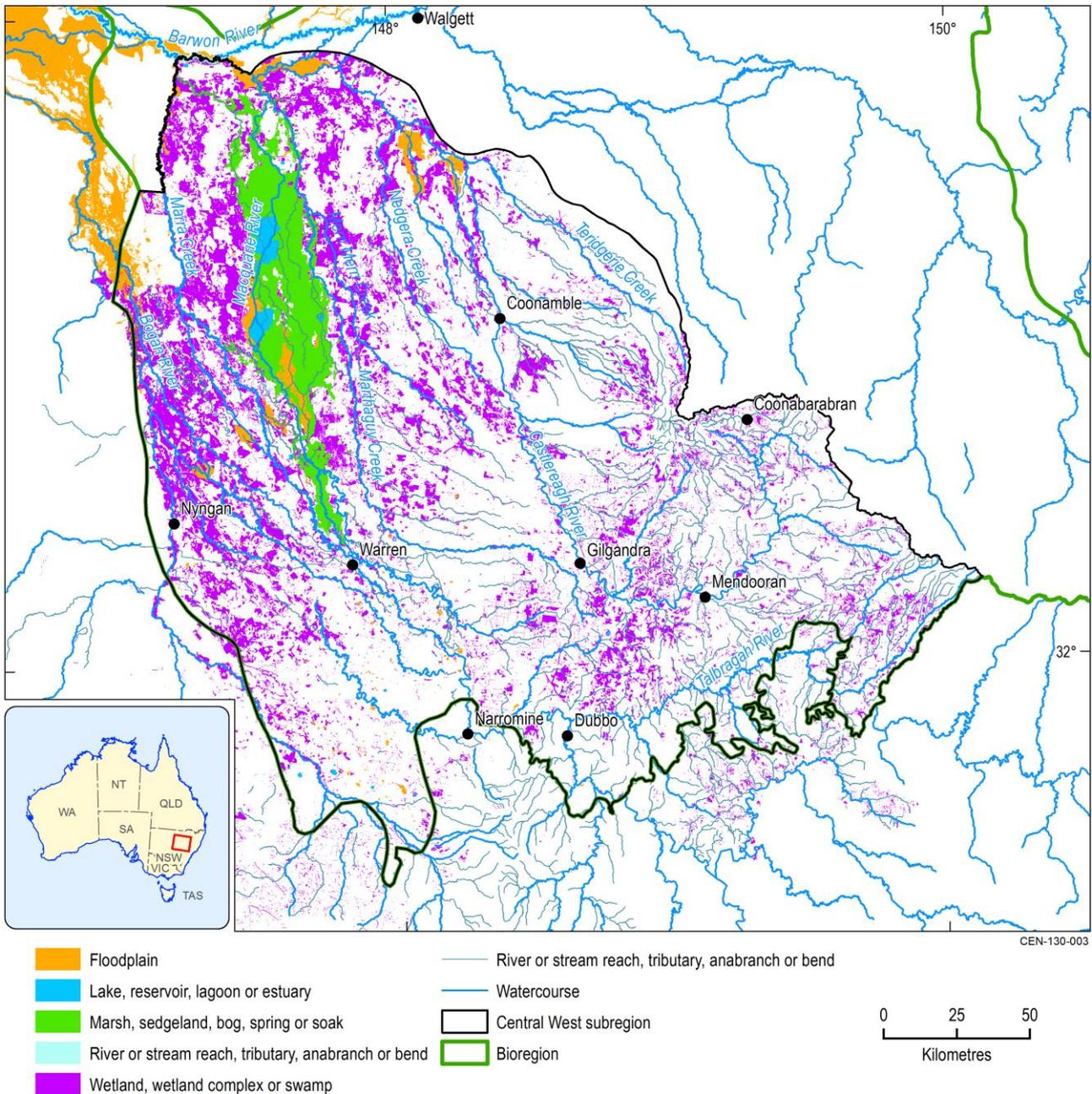


Figure 4 Surface water features in Central West subregion

Some assets are represented multiple times within the asset register. For example, the Macquarie Marshes, shown as ‘Marsh, sedgeland, bog, spring or soak’, are also classified as ‘Floodplain’ and ‘Wetland, wetland complex or swamp’.

Data: Bioregional Assessment Programme (Dataset 1); Australian Government Department of the Environment (Dataset 2, Dataset 5, Dataset 6, Dataset 8); NSW Department of Environment, Climate Change and Water (DECCW) (Dataset 3); Office of Environment and Heritage (OEH) NSW (Dataset 4); Murray-Darling Basin Authority (Dataset 7)

1.3.2.1.3 Vegetation

Assets listed in the ‘Vegetation’ subgroup consist of two classes: ‘Groundwater-dependent ecosystems’ or ‘Habitat (potential species distribution)’.

Groundwater-dependent ecosystems

All 345 assets identified as ‘Groundwater-dependent ecosystems’ were sourced from the *National atlas of groundwater dependent ecosystems* (GDE Atlas; Bureau of Meteorology, Dataset 10). A

1.3.2 Ecological assets

breakdown of the ecological assets identified as being dependent on the surface water expression of groundwater and the subsurface water expression of groundwater is given in Table 8. Figure 5 and Figure 6 show their spatial distribution, respectively. Approximately 25% of the assets were excluded from the water-dependent asset register because they were deemed to have a low likelihood of dependence on either surface or subsurface expression of groundwater (Table 8).

Table 8 Breakdown of groundwater-dependent assets in the 'Vegetation' subgroup for the Central West subregion

Subgroup	Asset class	Groundwater source	Not in water-dependent asset register	In water-dependent asset register
Vegetation	Groundwater-dependent ecosystem	Dependent on surface expression of groundwater	15	109
		Dependent on subsurface expression of groundwater	71	150
Total			86	259

Data: Bioregional Assessment Programme (Dataset 1)

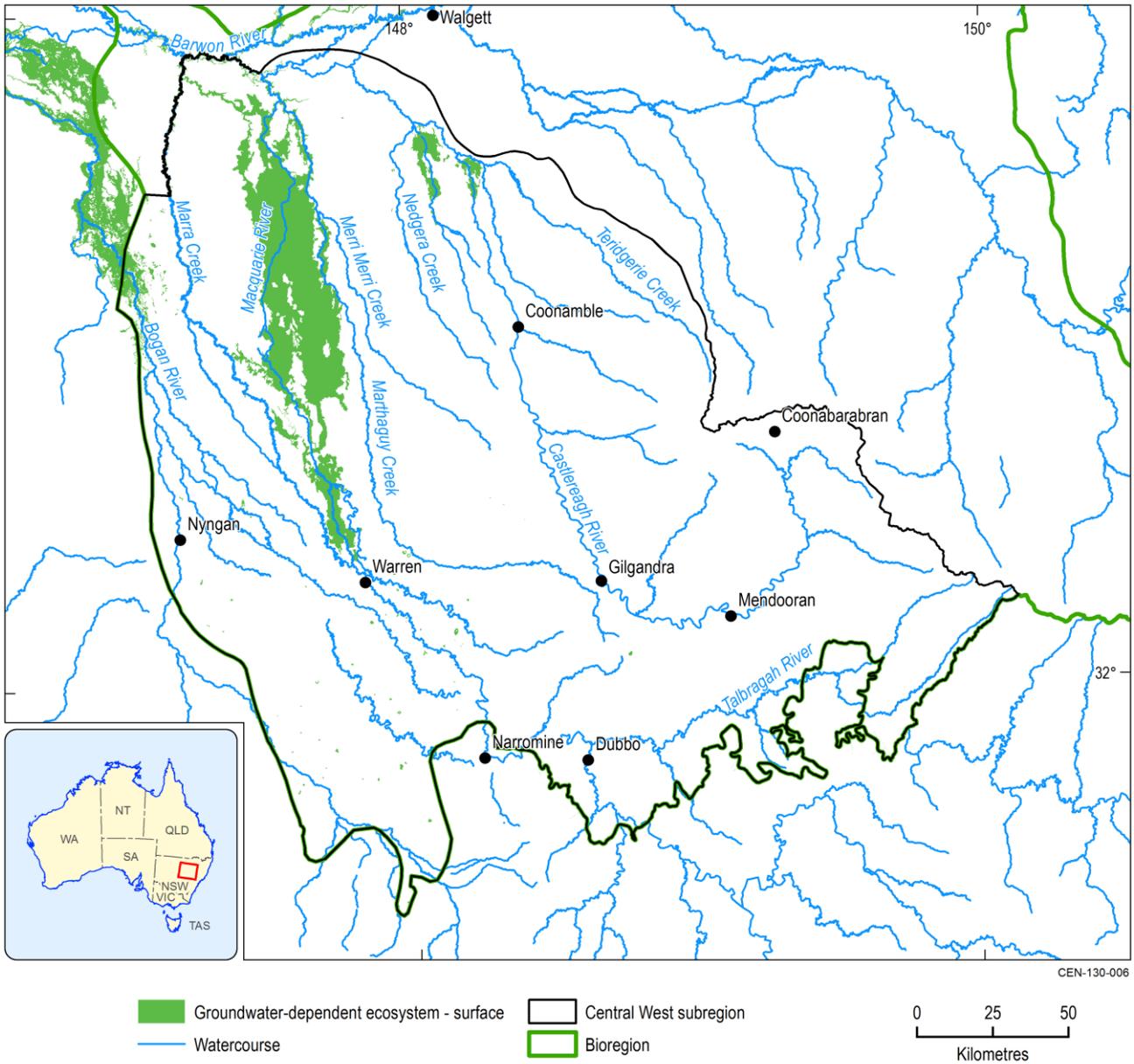


Figure 5 Groundwater-dependent ecosystems that rely on the surface expression of groundwater including surface water channels (surface line features) and vegetation communities (surface area features)

Data: Bioregional Assessment Programme (Dataset 1); Bureau of Meteorology (Dataset 10)

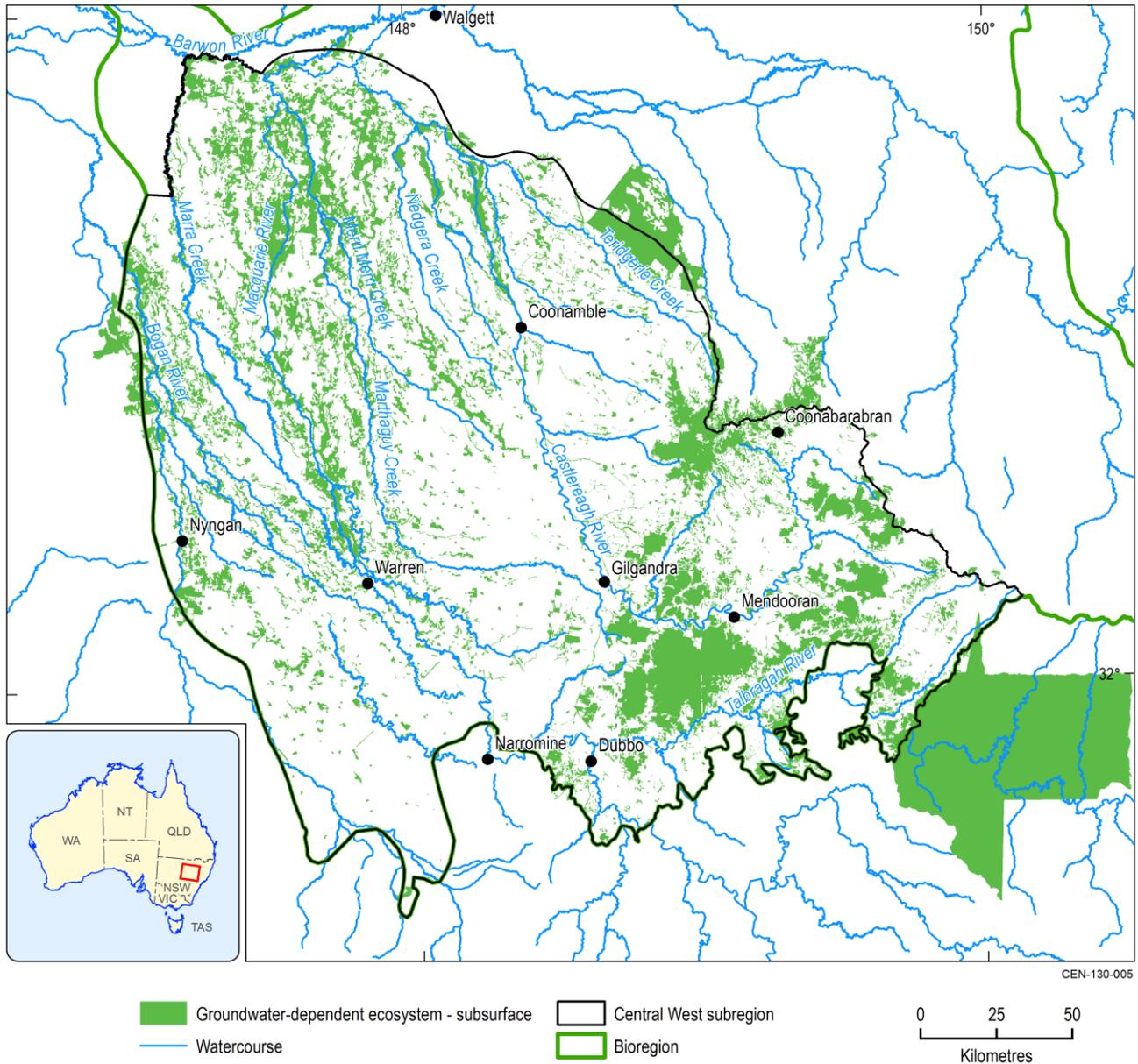


Figure 6 Groundwater-dependent ecosystems that rely on the subsurface expression of groundwater

Data: Bioregional Assessment Programme (Dataset 1); Bureau of Meteorology (Dataset 10)

Habitat (potential species distribution)

Out of a total of 235 assets, 209 assets within the ‘Habitat (potential species distribution)’ asset class were considered to be water dependent (Table 7).

All assets from the Collaborative Australian Protected Area Database (CAPAD; Australian Government Department of the Environment, Dataset 12) and the Important Bird Areas database (Birds Australia, Dataset 13) were deemed to be water dependent. Of the NSW state government assets, all assets derived from the Travelling Stock Route Conservation Values (NSW Department of Environment, Climate Change and Water (DECCW), Dataset 14), Native Vegetation Management areas (NSW Department of Environment, Climate Change and Water (DECCW), Dataset 15) and NSW Climate Change Corridors (Office of Environment and Heritage (OEH) NSW, Dataset 17) were deemed water dependent.

The remaining assets were either categorised as ‘Threatened ecological communities’, or ‘Habitat of threatened ecological species’.

Threatened ecological communities

Six communities listed under the EPBC Act occur in the Central West subregion, and all were assumed to be water dependent (Table 9). The ‘White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland’ communities are located in the east of the subregion and together with the ‘Weeping Myall Woodlands’ located more in the west cover large extents in the Central West subregion. ‘Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions’ are more prevalent in the north-west (Figure 7). The GAB spring-dependent species occur in a small area in the north-west of the subregion. ‘Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland’ only occur in a small area towards the north-east of the subregion, while ‘Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia’ are located mainly in the east throughout the subregion (Figure 7).

Table 9 Water-dependent threatened ecological communities in the Central West subregion listed under the Commonwealth’s Environment Protection and Biodiversity Conservation Act 1999

Name	Comments
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Likely to exhibit both surface water and groundwater dependence
Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Box woodlands may exhibit groundwater dependence over areas of shallow groundwater
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	On alluvial plains may exhibit surface water dependence
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin	Groundwater dependent
Weeping Myall Woodlands	Likely to be surface water dependent due to floodplain habitat
White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland	Box woodlands may be groundwater dependent over areas of shallow groundwater

Data: Bioregional Assessment Programme (Dataset 1); Australian Government Department of the Environment (Dataset 11)

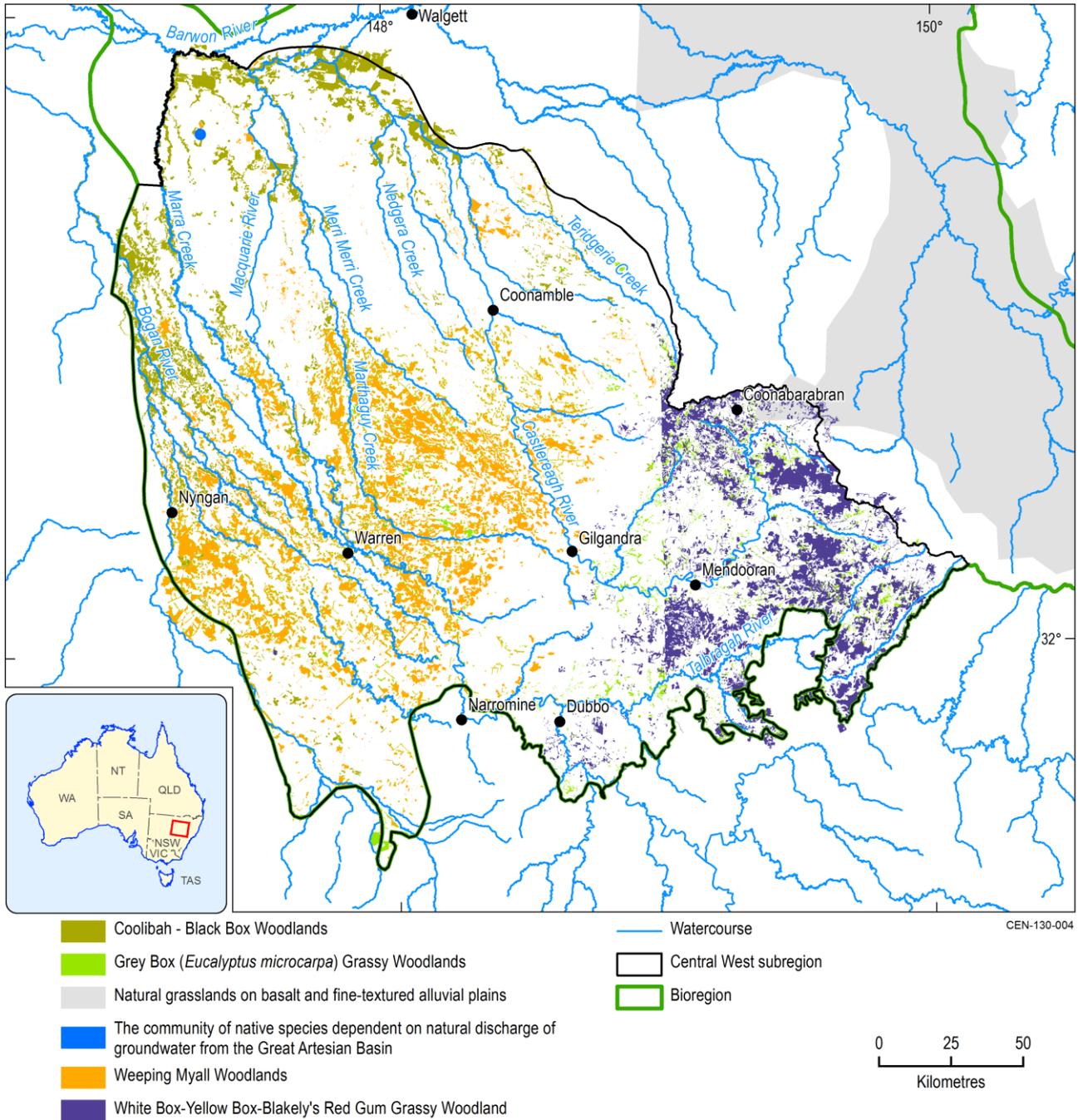


Figure 7 The six threatened ecological communities listed under the Commonwealth’s *Environment Protection and Biodiversity Conservation Act 1999* included in the water-dependent asset register

Data: Bioregional Assessment Programme (Dataset 1); Australian Government Department of the Environment (Dataset 11)
 Names in the legend have been shortened. Full names can be found in Table 9

Habitat of threatened ecological species

Fifty threatened species listed under the EPBC Act were identified in the Central West subregion (Bioregional Assessment Programme, Dataset 18). Of these, 24 were excluded from the water-dependent asset register because a demonstrated surface water or groundwater dependency of the habitat could not be established (Table 7). The excluded assets include 15 plant species, 5 bird species, 1 marsupial, 1 reptile and 2 rodents. Species included in the water-dependent asset register are listed in Table 10.

Table 10 Water-dependent threatened species in the Central West subregion listed under the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999

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

Functional group	Scientific name ^a	Common name ^a	Dependence on surface water	Dependence on groundwater	Comment
Plants	<i>Philothea ericifolia</i>	NA	Likely	Likely	Occurs in damp sites creek beds and gullies
	<i>Swainsona murrayana</i>	Slender Darling-Pea	Likely	Possible	Associated with black box communities
	<i>Lepidium aschersonii</i>	Spiny Pepper-Cress	Likely	Possible	Occurs periodically in wet sites such as gilgai and margins of freshwater and saline marshes and lakes
	<i>Eleocharis obicis</i>	A spike Rush	Likely	Unlikely	Species grow in ephemerally wet locations
	<i>Maireana cheelii</i>	Chariot Wheels	Likely	Unlikely	Often associated with floodplains or low lying areas that become water logged
	<i>Cynanchum elegans</i>	White-Flowered Wax Plant	Likely	Possible	Habitat may overlap with other water dependent habitats
Birds	<i>Botaurus poiciloptilus</i>	Australasian Bittern	Likely	Likely	Prefers permanent shallow wetlands tall dense vegetation
	<i>Rostratula australis</i>	Australian Painted Snipe	Likely	Possible	Inhabits shallow temporary and permanent wetlands
	<i>Ardea ibis</i>	Cattle Egret	Likely	Possible	Occurs in temperate grasslands woodland and wetlands
	<i>Anthochaera phrygia</i>	Regent Honeyeater	Likely	Possible	Prefers fertile sites along creek flats, riparian vegetation
	<i>Ardea alba</i>	Great Egret	Likely	Possible	Prefers wide range of habitats-inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial wetlands
	<i>Haliaeetus leucogaster</i>	White-Bellied Sea-Eagle	Likely	Possible	Coastal habitats and terrestrial wetlands
	<i>Himantopus himantopus</i>	Black-Winged Stilt	Likely	Unlikely	It inhabits most wetlands but does prefer shallow open freshwater areas
<i>Calidris ferruginea</i>	Curlew Sandpiper	Likely	Unlikely	Recorded inland, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand	

Functional group	Scientific name ^a	Common name ^a	Dependence on surface water	Dependence on groundwater	Comment
	<i>Apus pacificus</i>	Fork-tailed Swift	Likely	Possible	They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh.
	<i>Gallinago hardwickii</i>	Latham's Snipe	Likely	Likely	Occurs in permanent and ephemeral wetlands
	<i>Tringa stagnatilis</i>	Marsh Sandpiper	Likely	Likely	Lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, salt pans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats
	<i>Pandion haliaetus</i>	Osprey	Likely	Likely	Occurs in littoral and coastal habitats and terrestrial wetlands. Occasionally travel inland along major rivers. They require extensive areas of open fresh, brackish or saline water for foraging
	<i>Recurvirostra novaehollandiae</i>	Red-Necked Avocet	Likely	Possible	Freshwater and saltwater wetlands, estuaries, tidal mudflats
	<i>Calidris ruficollis</i>	Red-Necked Stint	Likely	Likely	May be seen in sewage farms, saltmarsh, shallow wetlands including lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats, flooded paddocks or damp grasslands
	<i>Calidris acuminata</i>	Sharp-Tailed Sandpiper	Likely	Likely	In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation
	<i>Philomachus pugnax</i>	Ruff	Likely	Unlikely	Found in terrestrial wetlands including swamps lakes pool, swampy field and floodplains
	<i>Myiagra cyanoleuca</i>	Satin Flycatcher	Likely	Unlikely	Mainly inhabit eucalypt forests often near wetlands or water courses

Functional group	Scientific name ^a	Common name ^a	Dependence on surface water	Dependence on groundwater	Comment
	<i>Numenius minutus</i>	Little Curlew	Likely	Unlikely	Most often found feeding in short, dry grassland and sedgeland, including dry floodplains and blacksoil plains, which have scattered, shallow freshwater pools or areas seasonally inundated
Mammals	<i>Phascolarctos cinereus</i>	Koala	Likely	Possible	May occur in riparian forests or GDE woodland
	<i>Dasyurus maculatus maculatus</i>	Spot-Tailed Quoll	Likely	Likely	Habitat includes inland riparian and river red gum forests

Data: Bioregional Assessment Programme (Dataset 1)

^aPunctuation and typography appear as used in the asset list.

NA = not available

The asset list and other details are available from the water-dependent asset register and asset list (O'Grady and Bruce, 2016) and the asset database (Bioregional Assessment Programme, Dataset 1).

1.3.2.2 Gaps

There are species listed under the NSW *Threatened Species Conservation Act 1995* and the NSW *Fisheries Management Act 1994* that are *not* listed under the EPBC Act. For example, there are 131 species and 18 ecological communities identified as assets from the NSW *Threatened Species Conservation Act 1995* (Office of Environment and Heritage, Department of Premier and Cabinet, Dataset 19). However, there was no spatial information provided with these assets, and thus their water dependencies could not be determined. As a result of this lack of spatial information these assets will not be considered in the subsequent analysis of the current BA. While it is not possible to include new asset databases into this product, further assets may be included into the asset register at a later stage (Mount et al., 2015).

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1.3.2 Ecological assets

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1.3.3 Economic assets

Summary

The water-dependent asset register for the Central West subregion has 93 economic water-dependent assets comprising 1806 elements. There are 57 economic assets within the subgroup 'Surface water management zone or area' and 36 economic assets within the subgroup 'Groundwater management zone or area'.

1.3.3.1 Description

There are 93 economic assets comprising 1806 elements within the Central West subregion and they are all considered water dependent (Table 11). The economic assets represent groupings of economic elements. Economic elements are defined as groundwater and surface water 'water access right' and 'basic water right (stock and domestic)'. Within the asset database elements are grouped by type and spatial location to create assets (see Section 1.3.1.2).

Water access rights are licensed, while basic water rights (stock and domestic) are share components included in basic landholder rights, and are both covered under water sharing plans (WSPs) (NSW Department of Primary Industries, 2015). Share components are water access entitlements that are a specified share or volume of water that can be extracted within a specified water management area.

These entitlements are represented spatially by:

- location of surface water offtake points and groundwater bores (point features)
- watercourse segments (line features)
- water access rights that do not require a works approval are included in the water-dependent asset register by assigning the water access right to the water source area (polygon features).

In the Central West subregion there are 57 assets (1474 elements) within the 'Surface water management zone or area' subgroup comprising 24 water access right and 33 basic water right (stock and domestic) entitlements (Table 11). The locations of the economic surface water assets are shown in Figure 8.

There are 36 assets (332 elements) within the 'Groundwater management zone or area' subgroup comprising 19 water access right and 17 basic water right (stock and domestic) entitlements (Table 11). The locations of the economic groundwater assets are shown in Figure 9. It shows the groundwater access rights as being concentrated in the south-west of the subregion, with a cluster around Dubbo.

The asset list and other details are available from the water-dependent asset register and asset list (O'Grady and Bruce, 2016) and the asset database (Bioregional Assessment Programme, Dataset 1).

Table 11 Summary of the economic assets within the Central West subregion

Subgroup	Asset class	Number of elements in water-dependent asset register	Number of assets in water-dependent asset register
Surface water management zone or area (surface area)	Water access right	1439	24
	Basic water right (stock and domestic)	35	33
Groundwater management zone or area (surface area)	Water access right	315	19
	Basic water right (stock and domestic)	17	17
Total		1806	93

Data: Bioregional Assessment Programme (Dataset 1)

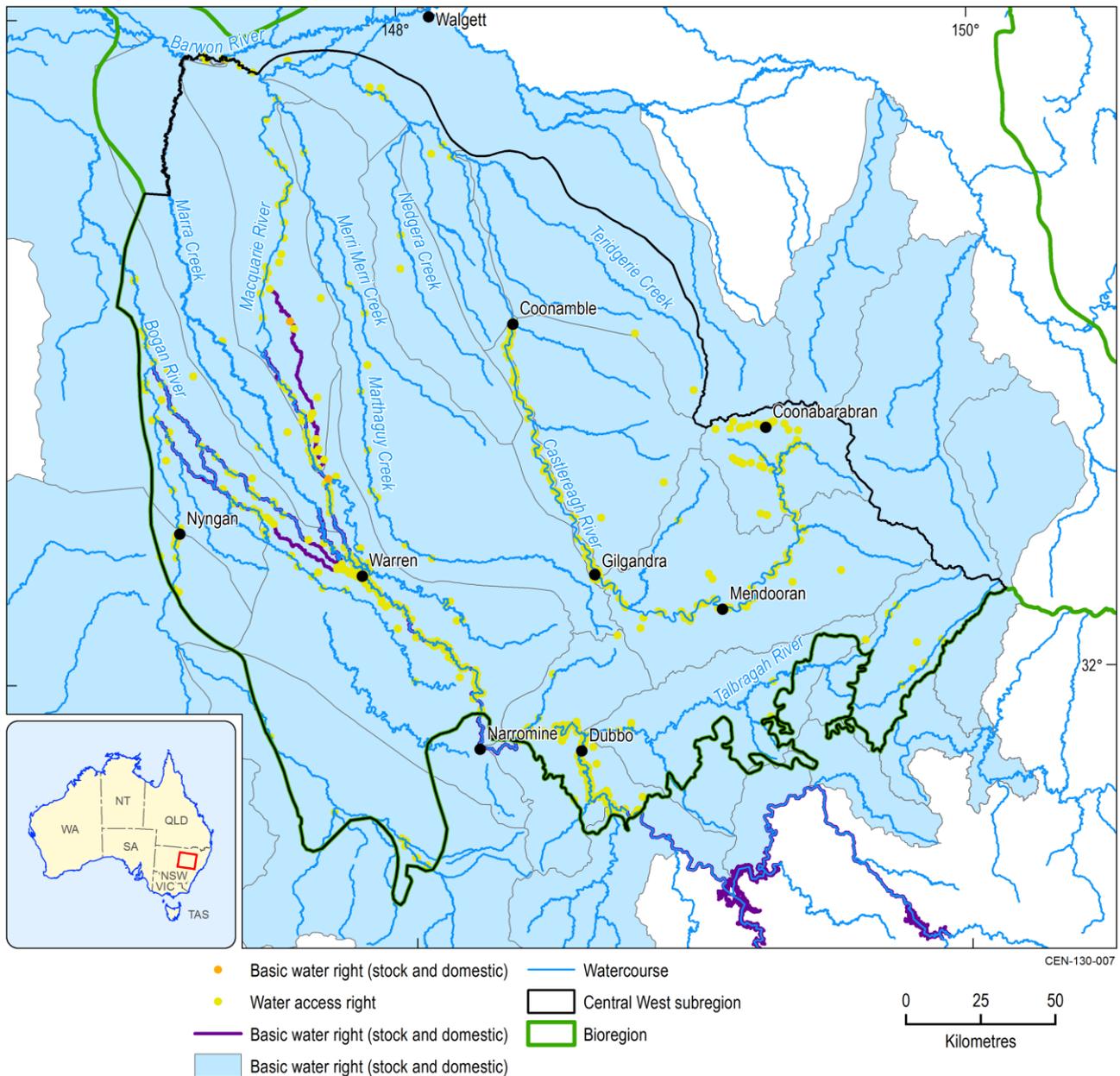


Figure 8 Location of surface water access right and basic water right (stock and domestic) assets in the Central West subregion

Basic water rights include points (depicted as yellow points), features along the streams (depicted as purple lines) and rights located within the general catchment area (blue coloured areas).

Data: Bioregional Assessment Programme (Dataset 1, Dataset 3); NSW Office of Water (Dataset 4)

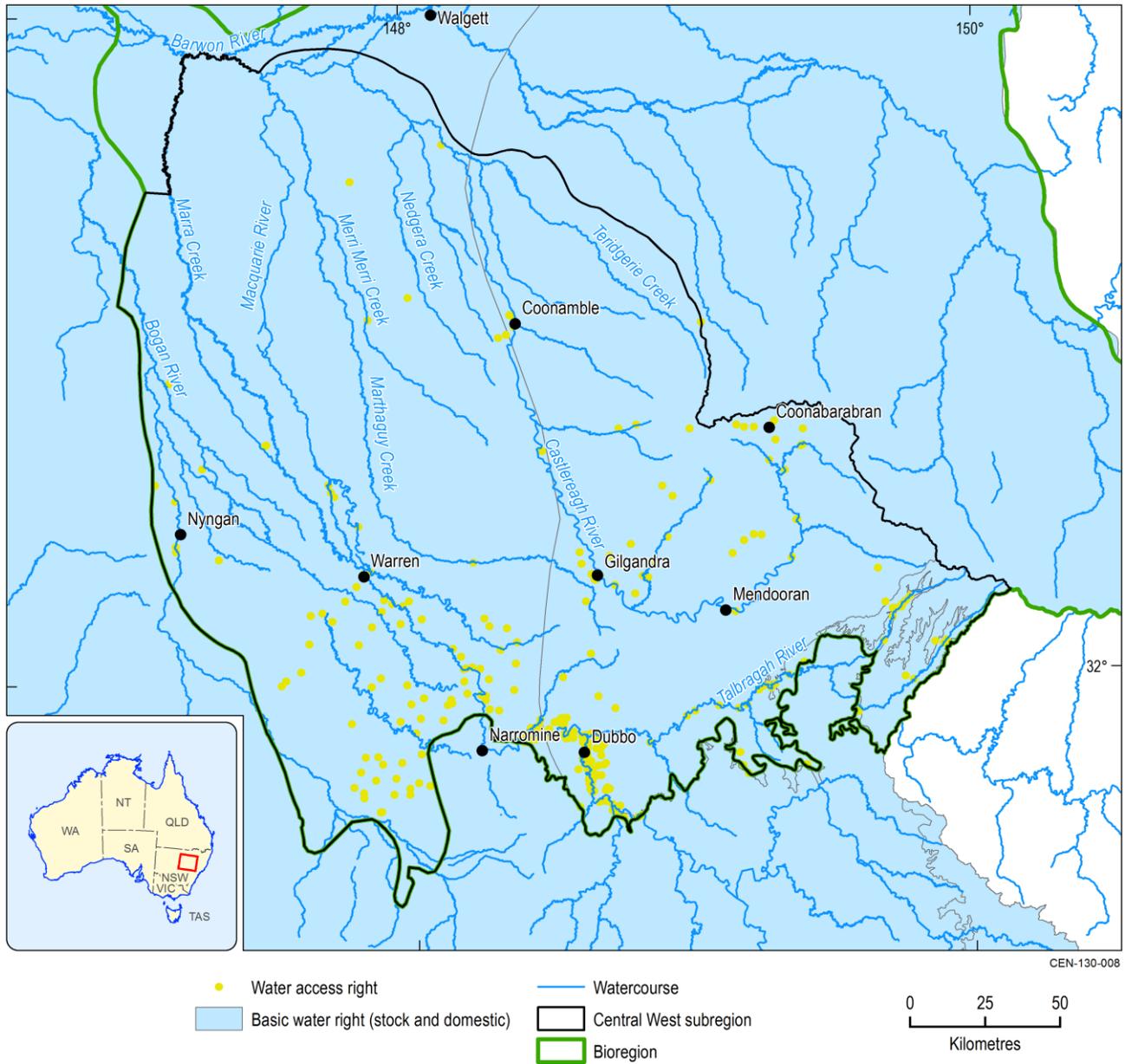


Figure 9 Location of groundwater water access right and basic water right (stock and domestic) economic assets in the Central West subregion

Data: Bioregional Assessment Programme (Dataset 1, Dataset 2); NSW Office of Water (Dataset 4)

1.3.3.2 Gaps

Many of the economic asset polygons in NSW include a negligible portion of the entire asset polygon within the subregion, which is mostly an artefact of the geographic information system (GIS) overlaying process. Therefore, many of these NSW economic assets are included in the asset database, even if only a negligible portion of a polygon overlaps within the subregion.

Floodplain harvesting has been identified in other NSW bioregions as an economic asset. Floodplain harvesting water storages are in the process of being digitised by the NSW Office of Water, but were not available for inclusion in the water-dependent asset register at this time.

The surface water access entitlement data received from NSW Office of Water do not include details of the river reach where the offtake was located; instead they include the water source and

water management zone associated with the WSP. A water source can be any set of rivers, aquifers or lakes and the like, which are defined by a gazetted WSP to be a water source. Therefore, when the elements are aggregated into the assets, water access entitlements are grouped together across the water source area (a large polygon). 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.

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1.3.3 Economic assets

1.3.4 Sociocultural assets

Summary

There are 57 sociocultural assets in the Central West subregion and 45 of these are water dependent. Eighteen of these are Indigenous assets, 16 are heritage sites and 11 are recreational areas. The Macquarie Marshes, Goonoo Forest near Dubbo and the Warrumbungle National Park cover the largest areas of all assets in the subregion.

1.3.4.1 Description

There are 57 sociocultural assets in the asset list in the Central West subregion and 45 of these are water dependent. Two of these – Warrumbungle National Park and Dundullimal – are from the National Heritage List (Australian Government Department of the Environment, Dataset 2). The remaining 43 assets are from the Register of the National Estate (RNE; Australian Government Department of the Environment, Dataset 3). Eighteen Indigenous sociocultural assets sourced from existing Commonwealth heritage databases were included for assessment. These Indigenous sites include 9 carved or scarred tree sites. There are 16 heritage sites, which include the Chalk Mountain Area, places in Dubbo, Coonable, Coonabarabran and Richard Cunningham’s grave in Burdenda. The 11 recreation areas include areas in the Macquarie Marshes, nature reserves and state forests as well as 2 geological/paleontological sites (Narangarie Quarry and Cuddie Springs). Table 12 shows the breakdown of sociocultural assets.

The largest asset in the area, Warrumbungle National Park, is listed twice, with the older and spatially slightly different 1980 boundary, listed in the RNE. The listings for Macquarie Marshes, Goonoo Forest near Dubbo and the Warrumbungle National Park are for large areas (approximately 161 km², 63 km² and 24 km², respectively) in the subregion. Other larger listed recreation areas include Binnaway, Coolbaggie and Dapper nature reserves (Figure 10).

The asset list and other details are available from the water-dependent asset register and asset list (O’Grady and Bruce, 2015) and the asset database (Bioregional Assessment Programme, Dataset 1).

Table 12 Number of sociocultural assets according to subgroup and asset class in the Central West subregion

Subgroup	Asset class	Not in water-dependent asset register	In water-dependent asset register	Total number of assets
Cultural	Heritage site	11	16	27
	Indigenous site	0	18	18
Social	Recreation area	1	11	12
Total		12	45	57

Data: Bioregional Assessment Programme (Dataset 1)

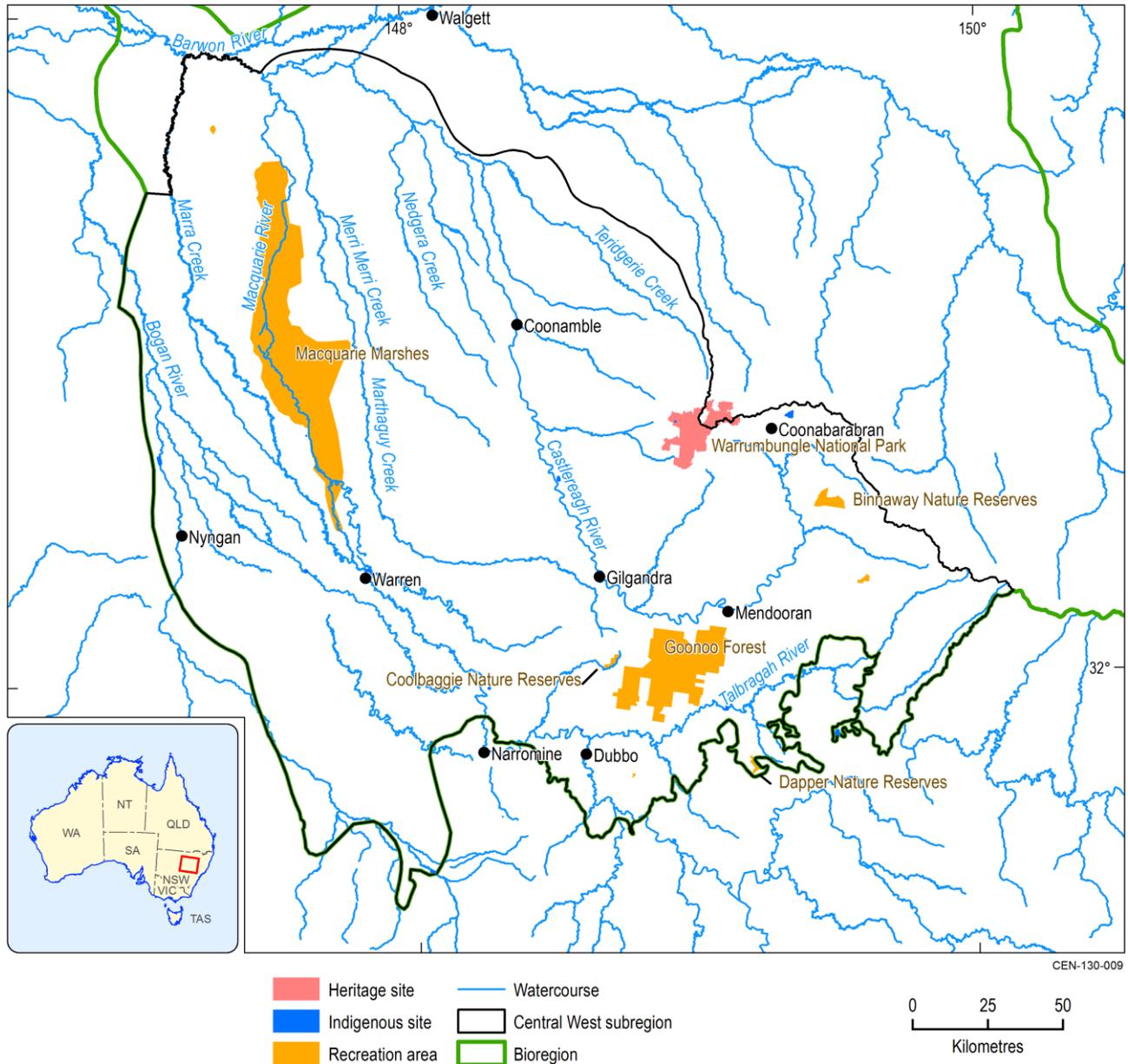


Figure 10 Location of sociocultural assets in the Central West subregion

Data: Bioregional Assessment Programme (Dataset 1), Australian Government Department of the Environment (Dataset 2 and Dataset 3)

1.3.4.2 Gaps

Meetings have been held with Indigenous knowledge holders in the Central West 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 (available at <http://data.bioregionalassessments.gov.au/product/NIC/CEN/1.3>) and/or incorporated into later technical products.

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