THE BASIN PLAN IMPLEMENTATION

NSW Murray-Darling Basin Porous Rock Water Quality Management Plan

Schedule F

Published by Department of Planning and Environment

dpie.nsw.gov.au

Series title: The Basin Plan Implementation

Title: NSW Murray–Darling Basin Porous Rock Water Quality Management Plan

Subtitle: Schedule F

First published July 2019 , updated June 2022

Department reference number: INT21/149708

More information

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www.industry.nsw.gov.au/water

Acknowledgments

NSW Department of Primary Industries —Agriculture

NSW Department of Primary Industries—Local Land Services

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Acknowledgement of Traditional Owners

The NSW Government proudly acknowledges the Aboriginal community of NSW and their rich and diverse culture and pays respect to their Elders past, present and future.

The NSW Government acknowledges Aboriginal people as Australia's First Peoples, practising the oldest living culture on earth, and as the Traditional Owners and Custodians of the lands and waters.

We acknowledge that the people of the Barapa Barapa, Barkindji/Maljangapa, Gomeroi/Kamilleroi/Gamilaroi/Gamilaraay, Maraura, Muthi Muthi, Nari Nari, Ngarabal, Ngiyampaa, Tati Tati, Wadi Wadi, Weki Weki, Wemba Wemba, Wiradjuri and Yorta Yorta Nations hold a significant connection to the lands in which the NSW Murray–Darling Basin Porous Rock Water Resource Plan area fall upon.

The land holds great areas of spiritual, cultural and economic importance to the First Nations People and the NSW Government recognises the connection of the water to the people of these nations.

We recognise the intrinsic connection of Traditional Owners to country and acknowledge their contribution to the management of the Porous Rock landscape and natural resources.

The Department of Planning and Environment understands the need for consultation and inclusion of Traditional Owner knowledge, values and uses in water quality planning to ensure we are working towards equality in objectives and outcomes.

The Department of Planning and Environment is committed to continuing future relationships and building strong partnerships with our First Nations People.

We thank the Elders, representatives of these Nations and the Aboriginal community who provided their knowledge throughout the planning process.

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1. About this plan

1.1. The Basin Plan 2012 (*Water Act 2007*)

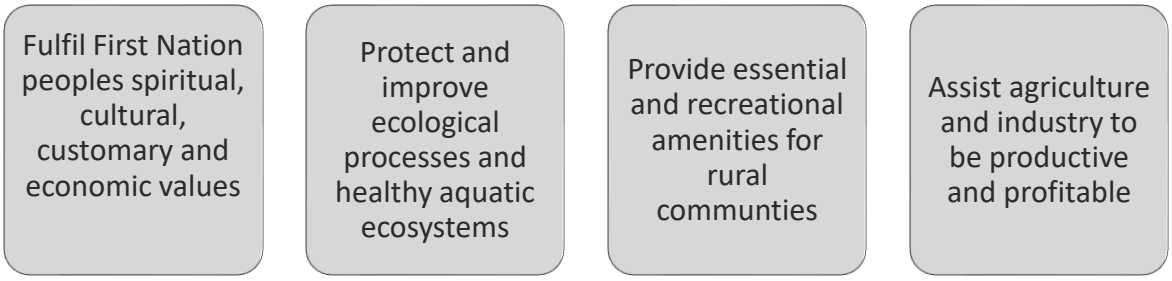
The Basin Plan provides a coordinated approach to managing the Murray–Darling Basin (MDB) water resources across Queensland, NSW, ACT, Victoria and South Australia. In NSW, the plan came into effect following the signing of Inter-governmental and National Partnership Agreements in 2014. As lead agency, the Department of Planning and Environment—Water is working with agencies including the DPE – Environment and Heritage team and NSW Department of Primary Industry—Fisheries to implement the plan.

The Basin Plan requires NSW to develop water quality management plans for each water resource plan area within the Murray–Darling Basin (10.29). The Basin Plan requires groundwater water quality management plans to identify causes, or likely causes of water quality degradation (10.35A), identify water quality target values (10.35B) and to include measures that support the maintenance of water quality within a water resource plan area (10.35C).

Basin Plan 10.29 - This water quality management plan for the NSW Murray–Darling Basin Porous Rock water resource plan area has been prepared to meet the requirements of Chapter 10, Part 7 of the Basin Plan.

1.2. Purpose

The purpose of this plan is to contribute to the sustainable and integrated management of water resources in the NSW Murray–Darling Basin Porous Rock water resource plan area for the benefit of both present and future generations. The water quality management plan aims to provide a framework to protect, enhance and restore water quality that is fit for purpose for a range of outcomes that:



This plan supports the NSW Murray–Darling Basin Porous Rock water resource plan and uses best available information to maintain, implement or develop measures to improve water quality for water resource managers.

1.3. What water sources does this plan apply to?

The NSW Murray–Darling Basin Porous Rock water quality management plan applies to all groundwater within the NSW Murray–Darling Basin Porous Rock water resource plan area (Figure 1). Detailed information about the resource is contained in the *Porous Rock water resource plan resource description* (Department of Planning, Industry and Environment—Water, 2018a).

The *Murray-Darling Basin Porous Rock water resource plan resource description* provides a description of the plan area including history of groundwater management, land use, geology and topography, groundwater dependent ecosystems (GDEs) and current management.

Figure 2 and Table 1 describes the relationship of the water quality management plan with other elements of the water resource planning process.

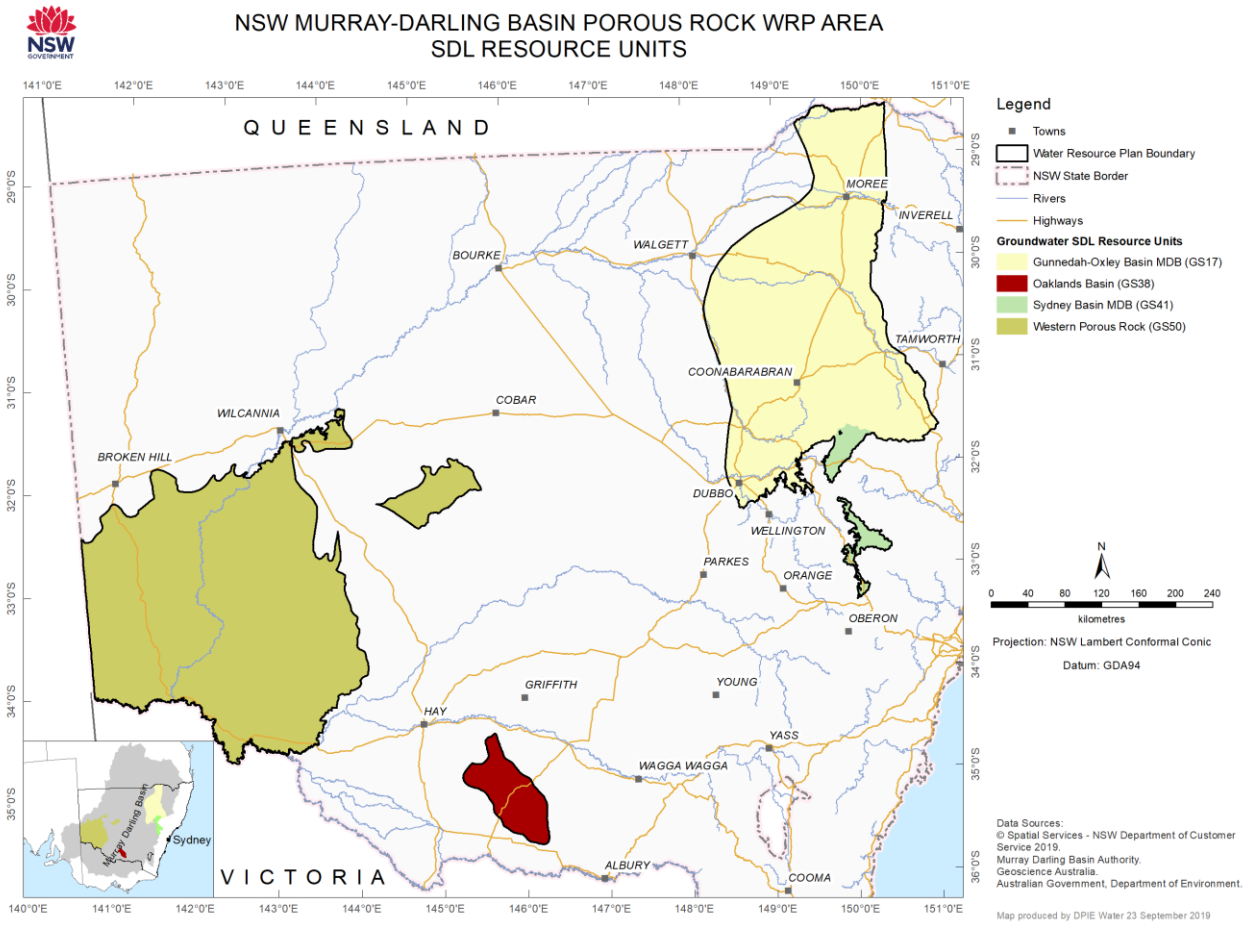


Figure 1: NSW Murray–Darling Porous Rock water resource plan area

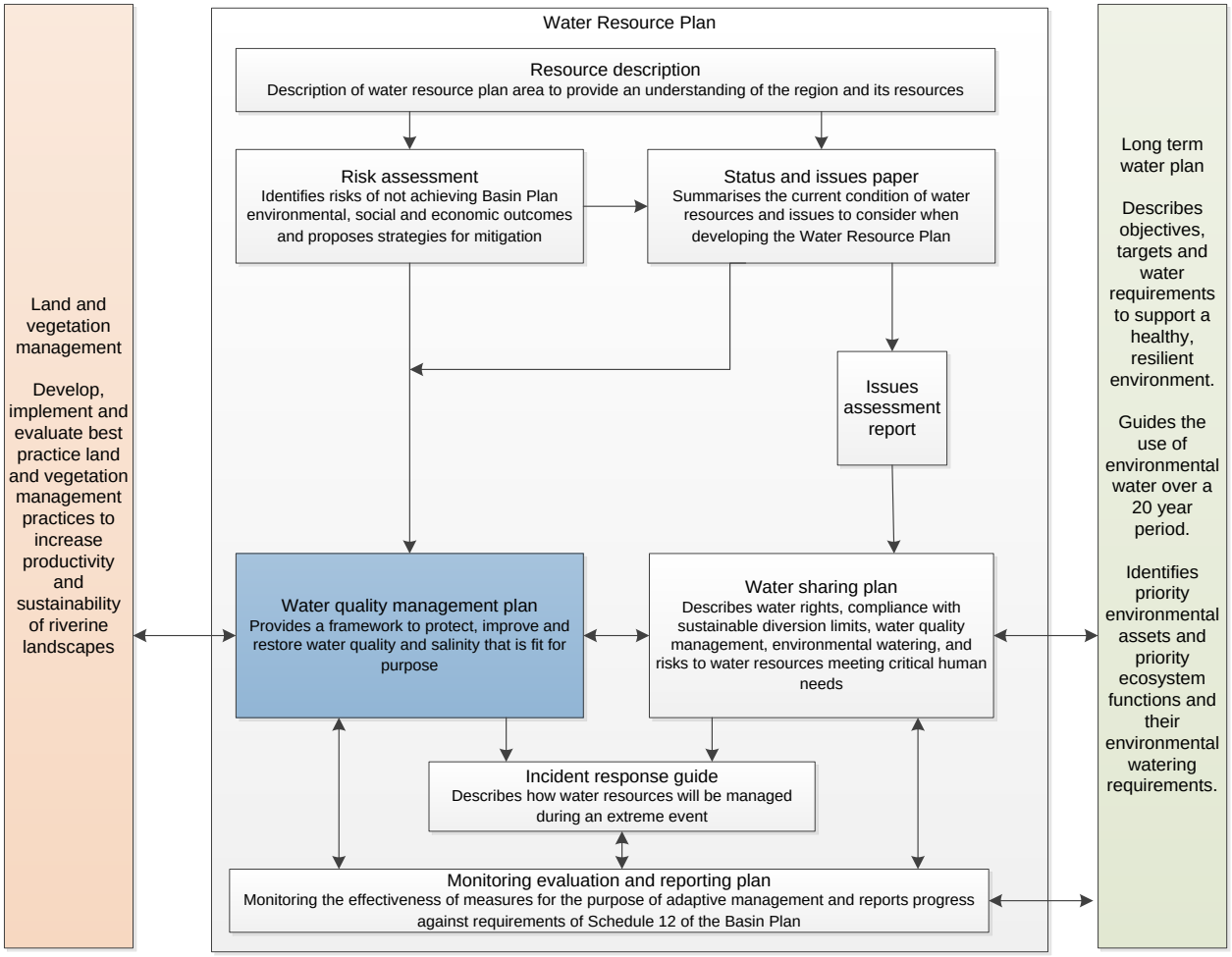


Figure 2: Flow diagram illustrating the components of the NSW Murray–Darling Porous Rock water resource plan

Table 1: Basin Plan requirements for water resource plans

Document	Basin Plan Requirement
NSW Murray–Darling Porous Rock water resource plan - resource description.	Not accredited under Basin Plan. Supplements risk assessment and status and issues paper.
NSW Murray–Darling Porous Rock water resource plan status and issues paper.	Supplements water resource plan.
NSW Murray–Darling Basin Porous Rock Risk Assessment GW6 water resource plan area.	Chapter 9 Section 9.02, 9.04 - 9.08, 9.18. Chapter 10 Section 10.35A - 10.35C, 10.41 - 10.43. Chapter 4 Section 4.02, 4.03 Supplements status and issues, Water resource plan and Water quality management plan.
Incident response guide for water resource plan areas	Chapter 10 Section 10.51. Supplements water quality management plan.
NSW Murray–Darling Basin Porous Rock water quality management plan	Chapter 9 Section 9.02, 9.04- 9.09, 9.14, 9.16 - 9.19. Chapter 10 Section 10.29 - 10.35D, 10.42, 10.43, 10.51 - 10.55. Supports Long term water plan.
Water Sharing Plan for the NSW Murray–Darling Basin	Chapter 10 Section 10.41. Chapter 5 Section 5.02. Chapter 4 Section 4.02.

Document	Basin Plan Requirement
Porous Rock Groundwater Sources 2020	
NSW Groundwater monitoring, evaluation and reporting plan	Chapter 10 Section 10.46.

1.4. NSW water quality legislative context

The management of groundwater quality in NSW is provided for across several legislative and regulatory instruments and agencies. Figure 3 summarises the objectives of each instrument and the relationship to groundwater quality management in NSW.

Water Management Act 2000
Water Management Amendment Act 2018
NSW Department of Planning, Industry and Environment, Water Group

OBJECTIVE: Sustainable and integrated management of NSW's water

This includes the protection and, where possible, enhancement of water quality of all water sources

Protection of the Environment Operations Act 1997
Protection of the Environment Legislation Amendment Act 2011
NSW Environment Protection Authority

OBJECTIVE: Protection, restoration and enhancement of the quality of NSW environment

This includes issuing licenses for activities with significant environmental impacts, enforcement of regulations and requirements of incident response management and reporting

WaterNSW Act 2014
WaterNSW

OBJECTIVE: Ensure declared catchment management areas and water management works in such areas are managed and protected to promote good water quality, the protection of public health and safety and the protection of the environment

This includes supplying water in compliance with appropriate standards of quality

Natural Resources Access Regulator Act 2017
NSW Department of Planning, Industry and Environment

OBJECTIVE: Ensure effective, efficient, transparent and accountable compliance and enforcement measures for the natural resources management legislation

This includes undertaking water management compliance activities and investigations by the independent Natural Resources Access Regulator

Environmental Planning and Assessment Act 1979
Environmental Planning and Assessment Regulation 2000
Local Government Act 1993
NSW Department of Planning Industry and Environment
NSW Local Governments

OBJECTIVE: Proper management, development and conservation of natural and artificial resources

This includes water planning approvals that may require assessment of potential water quality impacts and propose mitigation strategies

Public Health Act 2010
Public Health Regulation 2012
NSW Health

OBJECTIVE: Protection and promotion of public health and control of risks to public health

Requires water suppliers to implement and adhere to a quality management system that is consistent with the Australian Drinking Water Guidelines 2011

Local Land Services Act 2013
Local Land Services Regulation 2014
NSW Department of Primary Industries Local Land Services

OBJECTIVE: Proper management of natural resources and regional services through local decision making and priority setting

Local Land Services develop state and local strategic plans that may include water quality provisions or other non-regulatory water management issues in the region

Figure 3: Summary of major water quality legislation and regulations in NSW

2. Developing water quality management plans in NSW

2.1. Water quality

Water quality describes the condition of water within a water source and its suitability for different purposes. The water quality characteristics of a groundwater system influence how that water can be used for town water or stock and domestic supply, or for commercial purposes such as farming and irrigation. If water quality is not maintained, it can impact on the environment as well as the commercial and recreational value of a groundwater resource.

One measure of quality is the level of dissolved salts present in groundwater, or salinity. The total dissolved solids (or inorganic salts) are measured in a laboratory and is reported as milligrams per litre (mg/L). A much simpler measurement, which can be done in the field, is the electrical conductivity. The more dissolved salts in the water the higher the conductivity. Measurement of electrical conductivity can be used to give an estimate of the salinity and is generally reported in microsiemens per centimetre (µS/cm). For convenience, Total Dissolved Solids (TDS) is often estimated from electrical conductivity. An approximate conversion of electrical conductivity to total dissolved solids is: Electrical conductivity (µS/cm) x 0.67 = Total Dissolved Solids (mg/L) (ANZECC and ARMCANZ, 2000).

In NSW, groundwater salinity levels can range from that of rainwater, <100 mg/L (150 µS/cm) to greater than that of sea water (approximately 40,000 mg/L or 60,000 µS/cm). Groundwater with salinity suitable for a range of productive uses is generally found in the large unconsolidated alluvial systems associated with the major westward draining rivers.

Changes in land use, impact of industry, seasonal variations, and longer-term changes in climate as well as groundwater extraction can all affect groundwater quality.

2.1.1. Beneficial use categories

Beneficial use is a resource management tool to protect groundwater resources. It is a general categorisation of groundwater uses based on water quality and the presence or absence of contaminants. It is typically based on salinity although it can also reference other water quality parameters. The term ‘beneficial use’ is the equivalent to the ‘environmental value’ of water (ANZECC and ARMCANZ, 2000). Each designated use has its own set of water quality requirements or criteria that must be met for the use to be attained.

The NSW Groundwater Quality Protection Policy (Department of Land and Water Conservation, 1998) adopted the five beneficial use category classification recommended by the Guidelines for Groundwater Protection in Australia (ARMCANZ and ANZECC, 1995). Using the beneficial use approach, the groundwater environment is divided into segments based on the background (naturally occurring) level of total dissolved solids reported in mg/L. The groundwater segments are used to determine which segment is applicable to a beneficial use of groundwater. The protection of beneficial uses will be achieved through maintenance of the current level of water quality.

The revised Guidelines for Groundwater Protection in Australia (Department of Agriculture and Water Resource, 2013) adopted six Environmental Value categories (formerly beneficial use). Whilst acknowledging the change in nomenclature in the guidelines, the term beneficial use will continue to be used in NSW as it reflects the social and economic values of the resource in conjunction with ecological values. NSW has adopted these revised categories in this water quality management plan. This includes the addition of cultural and spiritual values.

The beneficial use categories include:

- aquatic ecosystem protection
- primary industries (irrigation and general water uses, stock drinking water, aquaculture and human consumers of aquatic foods)
- recreation and aesthetics
- drinking water
- industrial water
- cultural and spiritual values.

Groundwater quality varies spatially throughout a groundwater system reflecting the recharge sources, groundwater–rock interactions and the rate of groundwater flow in the system. In many groundwater systems the natural groundwater quality distribution will range across a number of beneficial use categories, therefore a resource may have more than one beneficial use. These uses primarily depend on groundwater quality and aquifer yield.

Table 2 lists the range of salinity thresholds for each beneficial use category. The overriding principle is that groundwater quality should be maintained within its beneficial use category. This does allow for water quality to vary; however, it should not move out of the acceptable range for each water quality criterion of its beneficial use segment. The upper limit of each category should not be seen as the limit to which the groundwater salinity can be increased. The groundwater quality should be maintained within the range of variation, both spatially and temporally, identified through the establishment of the baseline quality of the resource. If multiple beneficial use categories exist in a water resource, the most sensitive identified beneficial use should be maintained (Department of Land and Water Conservation, 1998). For example, if beneficial use categories for drinking water (A1), irrigation (B) and stock drinking water (C) have been identified, then the drinking water beneficial use segment A1 should be maintained.

NSW adopted the beneficial use categories in the earlier groundwater water sharing plans (circa 2006). It is also adopted in policies (including the Aquifer Interference Policy (NSW Office of Water, 2012)) as an objective for protecting the resource by maintaining the beneficial use categories within water sources. A change in beneficial use category may be used as an indicator of increased salinity within the water source.

Table 2: Beneficial use categories of water (based on salinity)

Beneficial use		Salinity (TDS mg/L)						
		A1	A2	A3	B	C1	C2	D
		0 – 600	601 – 900*	901 – 1200	1,201 – 3,000	3,001 – 6,000	6,001 – 10,000	>10,000
Aquatic ecosystem protection		✓	✓	✓	✓	✓	✓	✓
Primary industries	Irrigation	✓	✓	✓	✓			
	Stock drinking water	✓	✓	✓	✓	✓	✓	
Recreation and aesthetics		✓	✓	✓	✓	✓	✓	✓
Raw drinking water*		✓	✓	✓				
Industrial water		✓	✓	✓	✓	✓	✓	✓
Cultural and spiritual		✓	✓	✓	✓	✓	✓	✓

* Desirable palatability <600 mg/L(A1); acceptable palatability <900 mg/L(A2) (WHO 2004; NHMRC and NRMMC 2011).

Acceptable salinity levels must be viewed along with other water quality parameters, as other natural geogenic contaminants such as arsenic, fluoride or radionuclides may also exceed suitable limits and therefore preclude certain beneficial use categories (Department of Agriculture and Water Resources, 2013). Conversion from total dissolved solids (mg/L) to electrical conductivity (µS/cm) is presented in Table 10 (Appendix D).

2.1.2. Sodium absorption ratio (SAR)

There are a number of water quality indicators that inform the suitability of groundwater for a particular use, including the sodium absorption ratio (SAR). Sodium absorption ratio values are used to indicate a possible sodium hazard. It relates the amount of sodium relative to calcium and magnesium in water. Sodium absorption ratio should be considered in addition to salinity (which is used to define the beneficial use category) for water that is fit for purpose, as high sodium absorption ratio values may be detrimental to soil structure and plant growth.

The adverse impact of sodicity in water is not directly related to its salinity. There is a risk of both reduced infiltration and declining soil structure if the irrigation water has moderate to high sodium absorption ratio, but low salinity (NSW Department of Industry—Water, 2017).

The effects of salinity and sodicity in irrigation waters are situation-specific, making it inappropriate to set water quality trigger values for sodium absorption ratio for general application. Factors which need to be considered include: the type of crop being cultivated and its salt tolerance, the characteristics of the soil under irrigation, soil management and water management practices, climate and rainfall (ANZECC and ARMCANZ, 2000).

2.1.3. Nutrients

Nitrate occurs naturally in the environment along with ammonium and nitrite in ionic form as the most common inorganic forms of nitrogen. Data on nitrogen in Australian groundwater is very limited. Ammonium is usually converted (oxidised) to nitrite and nitrate by common aerobic bacteria when oxygen is present, even at low oxygen concentrations, so that nitrate predominates in aerobic aquatic environments (Camargo et al., 2005). Nitrate is removed from aquatic environments when taken up as an essential nutrient by plants or converted to nitrogen gas by bacteria in anaerobic situations.

Nitrate is highly soluble and very mobile, which facilitates plant uptake, but also makes it highly susceptible to leaching into groundwater. There are many sources of nitrate, both natural and anthropogenic, that can contribute to groundwater contamination. The anthropogenic sources include intensive agriculture (nitrogen-containing fertilisers), dairy and sewage effluent.

Nitrate contamination in groundwater is dependent on a combination of factors such as geology, soil, land use, land and water management practices, poor bore construction and hydrology. Previous studies have reported that nutrient concentrations vary seasonally, largely in response to changes in rainfall, stream flow and times since the application of fertiliser (Sundaram and Coram, 2009).

High levels of nitrate in the environment are a concern due to its toxicity to humans, stock animals and to aquatic invertebrates. Nitrate binds to the oxygen-carrying blood pigments (haemoglobin in humans and mammals, haemocyanin in many invertebrates), preventing these pigments from transporting oxygen to body tissues (Camargo et al., 2005).

The Australian Drinking Water Guidelines (NHMRC and NRMMC, 2011) value of 50 mg/L provides protection for bottle-fed infants under the age of three months. However, adults can safely drink water with up to 100 mg/L of nitrate. Concentrations of less than 400 mg/L nitrate in livestock drinking water should not be harmful to animal health. Stock may tolerate higher nitrate concentrations in drinking water, provided nitrate concentrations in feed are not high. Water containing more than 1,500 mg/L nitrate is likely to be toxic to animals and should be avoided. Concentrations of nitrite exceeding 30 mg/L may be hazardous to animal health.

Both nitrate and nitrite can cause toxicity to animals, with nitrite being far more toxic than nitrate (ANZECC and ARMCANZ, 2000).

Nitrate sensitive crops may be affected by concentrations greater than 22 mg/L nitrate and problems may occur with increasing concentrations up to 133 mg/L nitrate, above which severe problems could arise (ANZECC and ARMCANZ, 2000; Qld Department of Agriculture and Fisheries, 2012; NSW Department of Primary Industries, 2014).

Although not routinely monitored in all groundwater sources, nitrate concentrations should be considered as criteria for water use as the salinity levels may depict the beneficial use category but the concentration levels of nitrates and other contaminants such as sodium absorption ratio or pesticides, may deem it unsuitable for a particular use.

2.1.4. Pesticides

Pesticides include insecticides, herbicides, fungicides and defoliants. Data on pesticides found in Australian groundwater is very limited. Much of the existing groundwater pesticide data has been obtained from either short-term studies or ad hoc monitoring, therefore it is difficult to accurately determine the contamination potential in varying groundwater sources (Sundaram and Coram, 2009).

Studies in the Namoi and Gwydir catchments detected Endosulfan in surface water monitoring from 1991-2002. Where groundwater contamination has been detected in NSW, it has usually involved triazine herbicides (Australian Academy of Technological Sciences and Engineering, 2002). The most commonly detected herbicide in NSW groundwater has been Atrazine (Timms, 1997; NSW Department of Infrastructure Planning and Natural Resources, 2002). Atrazine has high water solubility and a low ability to bind to soils allowing it to leach into groundwater through soil profiles (National Registration Authority, 1997).

2.1.5. Pathogens

Waterborne diseases can spread via groundwater, often through contamination from animal faeces, sewage or septic tank leakage. Common pathogens in faeces are bacteria, viruses, protozoa, and helminths (parasitic worms). Pathogen contaminated groundwater poses significant health risks and maybe unsafe to drink.

Drinking water utilities supplying drinking water use multiple barrier treatments ensuring drinking water is safe and aesthetically pleasing to the user. Treatment processes include coagulation/flocculation, sedimentation, filtration and disinfection. Disinfectants ensure that disease causing bacteria, viruses and parasites are destroyed.

The ANZECC Guidelines (2000) provide trigger values for faecal coliforms and parasites in irrigation water applied to human food crops and animal fodder.

There is no routine monitoring for pathogens in NSW groundwater sources other than those utilised by town water suppliers or required for Environmental Protection Licence (EPL) compliance.

Groundwater used for drinking water (not supplied from a drinking water utility) should undergo a comprehensive range of chemical and physical characteristics prior to use. The water should be retested if there are any changes in water quality, such as the appearance of odours, taste or colour. Contact your local Public Health Unit for testing advice and refer to the *NSW Private Water Supply Guidelines* (NSW Department of Health, 2016) for information on groundwater, hazards and testing.

3. Water quality condition and issues in the NSW Murray–Darling Porous Rock water resource plan area

The NSW Murray–Darling Porous Rock Groundwater Water Resource Plan Area includes four sustainable diversion limit (SDL) resource units (Figure 4):

- Gunnedah-Oxley Basin MDB (GS17)
- Oaklands Basin (GS38)
- Sydney Basin MDB (GS41)
- Western Porous Rock (GS50).

The Western Porous Rock is located in the far west of the state. It extends from the south of Broken Hill and west of the Lachlan Alluvium and Murrumbidgee Alluvium WRPAs to the state borders with Victoria and South Australia.

The Gunnedah-Oxley Basin is located on the eastern side of the Murray–Darling Basin between Narrabri, Gunnedah and Dubbo. The Oaklands Basin is in the southern-central area of the state and is completely buried by the Murrumbidgee and Murray Alluviums. The Sydney Basin is in the eastern extent of the Murray–Darling Basin extending southward along the upper catchment border reaching near to Bathurst.

Groundwater monitoring bores were sampled by NSW Government for water quality upon construction, and in some areas periodically for a number of years after construction. Water quality information for the WRP areas is limited but indications are that it is extremely variable depending on location.

There is only minor development of groundwater resources for irrigated agriculture across the SDL resource units within this WRP area. This is primarily due to the low yields and variable salinity levels.

Based on data from the NSW government monitoring bore network as well as private water supply bores, the groundwater salinity in the shallowest aquifer of the Murray–Darling Basin Porous Rock is shown in Figure 4 and Figure 5 (Evans et al., 1994).

3.1. Water quality in the Gunnedah-Oxley Basin, Oaklands Basin and Sydney Basin SDL resource units

In the Gunnedah-Oxley Basin and the Sydney Basin SDL units, groundwater quality is typical of the sedimentary basins within NSW of Permian age. Salinity levels make water supplies unsuitable for potable or irrigation supplies but may be suitable for stock supply. The exception is the low salinity groundwater within a high yielding Jurassic sandstone unit in the Spring Ridge area of the Gunnedah-Oxley Basin that supports the irrigation of fodder and grain crops.

There is no information on water quality within the Oaklands Basin SDL area. There are no water licences or basic landholder rights for this unit.

3.2. Water quality in the Western Porous Rock SDL resource unit

In the Western Porous Rock SDL resource unit, groundwater quality ranges from fresh, in shallow lenses associated with the Murray River supplying domestic users, through to highly saline (the target of the salt interception schemes (i.e., greater than 50,000 µS/cm). Most of

the groundwater in the water table aquifer is highly saline. Changes to groundwater salinity are therefore not generally a threat to consumptive uses.

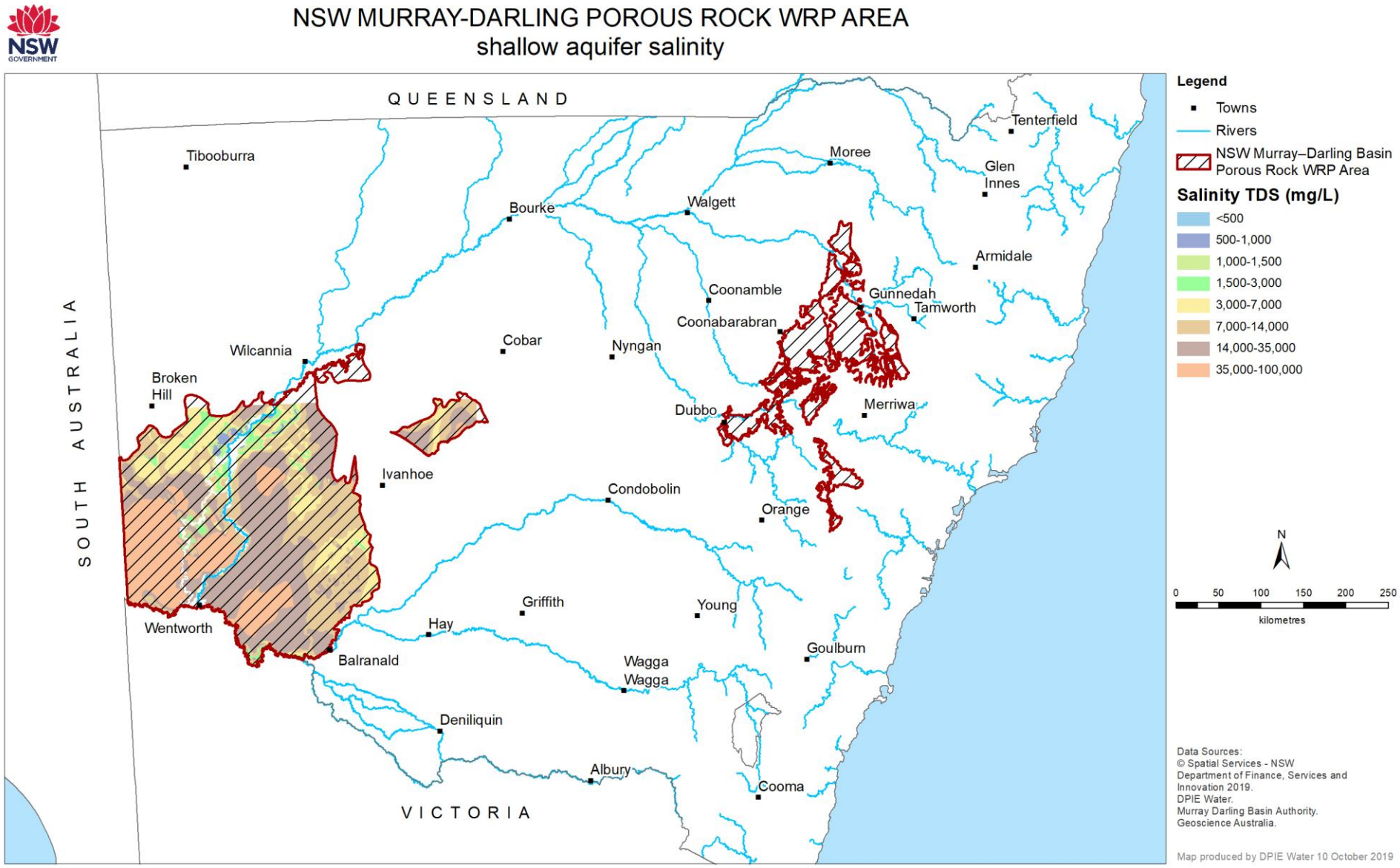


Figure 4: Groundwater salinity in the shallowest aquifer in the NSW Murray–Darling Basin Porous Rock water resource plan area

There are three salt interception schemes operating within the Western Porous Rock area: Mallee Cliffs, Buronga/Mourquong and Lake Victoria/Rufus River salt interception schemes. NSW manages the ongoing operation and maintenance of the Mallee Cliffs and Buronga/Mourquong schemes while the Lake Victoria/Rufus River scheme is operated by South Australia. These schemes involve the interception of saline groundwater through extraction from a series of bores to prevent its discharge to rivers. This interception contributes to a reduced salinity of the surface water systems as part of the Murray–Darling Basin salinity management strategy.

As the depth to the water table increases westward the water table is within the underlying Calivil Formation. Water quality (salinity) maps that correspond to the deeper geological units (Calivil Formation and Renmark Groups) are located in Appendix A (Figures 8 to 12).

3.3. Environmental assets in the NSW Murray–Darling Basin Porous Rock water resource plan areas

The Department of Planning and Environment defines groundwater-dependent ecosystems as '*ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services*' (Kuginis et al., 2016). NSW has developed a new approach for identifying the probability of an ecological community being groundwater-dependent including mapping of high probability vegetation groundwater dependent ecosystems (NSW Department of Industry – Water, 2016).

This process has identified significant groundwater dependent ecosystems of very high and high ecological value in the NSW Murray–Darling Basin Porous Rock water resource plan area. Springs are also identified as very high ecological value within these plan areas.

The NSW MDB Porous Rock WRPA groundwater resources support significant groundwater dependent ecosystems of ecological value including wetlands, springs and vegetation ecosystems. The Sydney Basin and the Gunnedah-Oxley Basin SDL resource units (Figure 6) are dominated by black tea tree and river oak riparian communities, Blakely's red gum, western grey box, yellow box, white gum, fuzzy box and river red gum woodlands, and shallow freshwater wetlands, These communities are characterised by having endangered ecological communities, basin target vegetation species (MDBA, 2014) of River Red Gums and Directory of Important Wetlands in Australia and/or Ramsar wetlands (associated with Lake Goran). The communities provide vital habitat to nesting species. Generally, the groundwater dependent ecosystem communities with high ecological value have large vegetation patches, are highly connected and have a high number of threatened species.

The Western Porous Rock SDL resource unit (Figure 7) is dominated by the vegetation groundwater dependent ecosystem communities of black blue bush shrublands, black box-lignum wetlands, black box woodland wetlands, lignum shrubland wetlands, permanent and semi-permanent wetlands and river red gum woodland wetlands. These communities are characterised by having endangered ecological communities, Directory of Important Wetlands in Australia and/or Ramsar wetlands (associated with Menindee Lakes), extensive connected riparian corridors and basin target vegetation species (Murray–Darling Basin Authority, 2014) of River Red Gums. The riparian communities provide vital habitat to nesting species and contributes to ecosystem function of instream ecosystems. Generally, the groundwater dependent ecosystem communities with high ecological value have large vegetation patches, are highly connected (such as riparian corridors) and have a moderate number of threatened species present especially in the wetland areas.

Those vegetation ecosystems that have been assessed as having a high probability of being groundwater dependent and also have a very high and high ecological value are considered to be key environmental assets which will be scheduled in groundwater water sharing plans for management purposes as 'high priority groundwater dependent ecosystems'. The identification of the groundwater dependent ecosystems in the NSW Murray–Darling Basin Porous Rock water resource plan area also aligns with those included in the NSW Border Rivers, Gwydir, Namoi, Macquarie/Castlereagh, Murrumbidgee, Murray and Lower Darling Long Term Water Plans

developed by the department's Biodiversity and Conservation team. The assigning of an ecological value has been developed using the High Ecological Value Aquatic Ecosystems (HEVAE) framework (Aquatic Ecosystems Task Group, 2012).

Terrestrial vegetation groundwater dependent ecosystems are known to have various tolerances for water quality, particularly salinity. In the Murray–Darling Basin, vegetation communities tend to be dominated by river red gums, black box, river cooba, coolabah and lignum. Each of these species tends to have varying tolerances to salinity which is also dependent on location in the landscape such as riparian or floodplain and also their flooding frequency requirements. River red gums have been recorded to have a maximum salinity tolerance of 20,000 mg/L (30,000 µS/cm) with a requirement of a flooding event every 1.5 years and are generally located within riparian areas. Black box and river cooba have a higher salinity tolerance. Although not conducive with good plant health, they have been found in areas with salinity of approximately 27,000 mg/L (40,000 µS/cm). They require a flooding event every three to five years and are generally located in flood plains (Doody and Overton, 2009).

Groundwater dependent ecosystems including terrestrial (vegetation), aquatic (wetlands, springs and baseflows) and subterranean (aquifer) are highly diverse. As a result, assigning one water quality target for all groundwater dependent ecosystems is problematic. Previous studies have reported that aquatic biota would be adversely affected when salinity exceeds 1,000 mg/L (1,500 µS/cm) (Hancock and Boulton, 2008; Nielsen et al., 2003). Groundwater dependent biota are found most commonly in fresh to brackish water, less than 3,350 mg/L or 5,000 µS/cm (Hose et al., 2015), but have also been found in very high electrical conductivities, approaching that of seawater, between 36,300 and 54,800 µS/cm. There may be a range of environmental attributes that influence the distribution of aquatic biota, including habitat, site, water quality (organic carbon, dissolved oxygen, nitrate and ammonia) and climate variables (Korbel and Hose, 2011). Water quality targets for the vegetation groundwater dependent ecosystems identified in the NSW Murray–Darling Basin Porous Rock groundwater water resource plan areas are discussed further in Section 5.

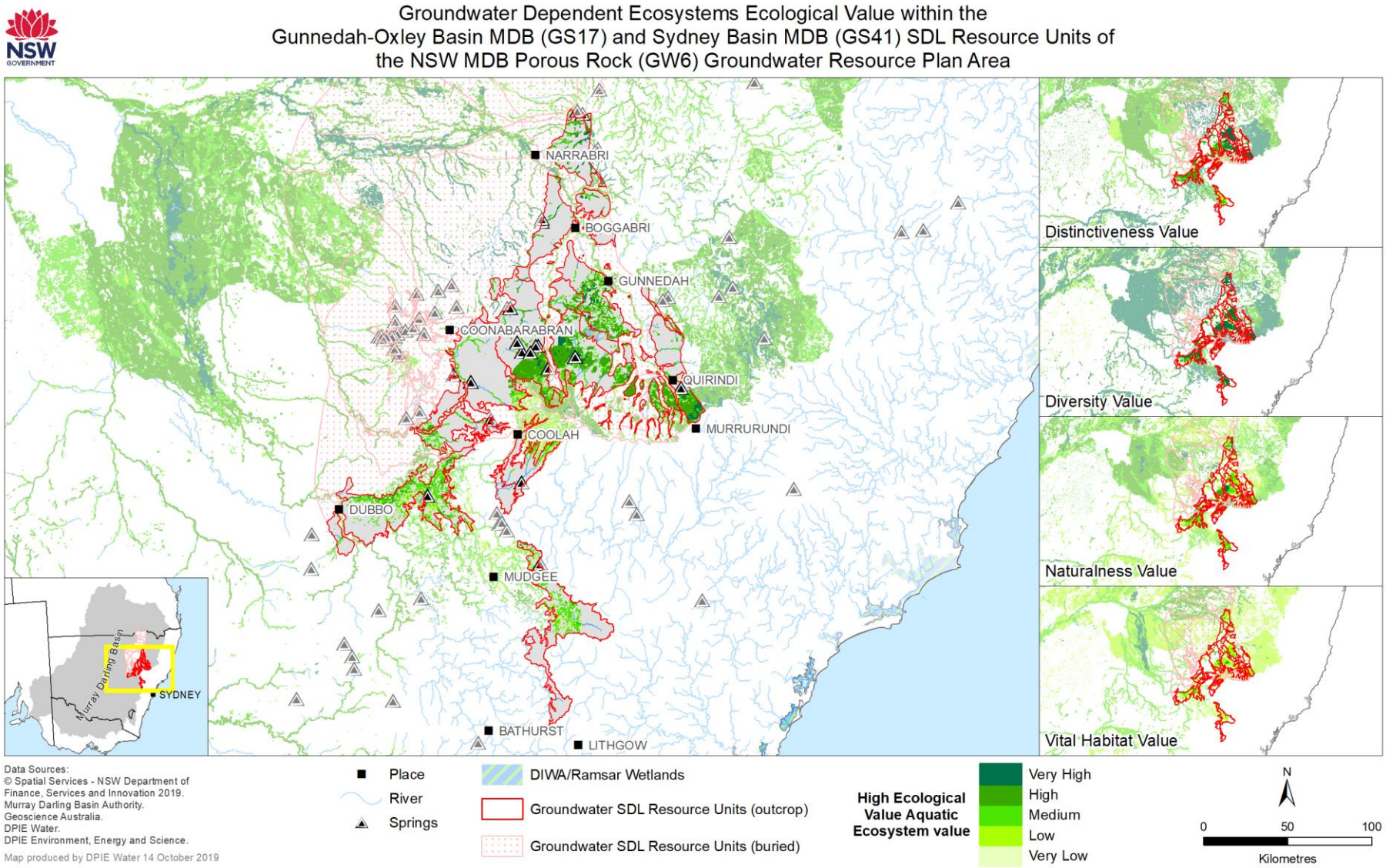


Figure 5: Groundwater dependent environmental assets within the Gunnedah-Oxley Basin and Sydney Basin MDB Porous Rick Groundwater Sources

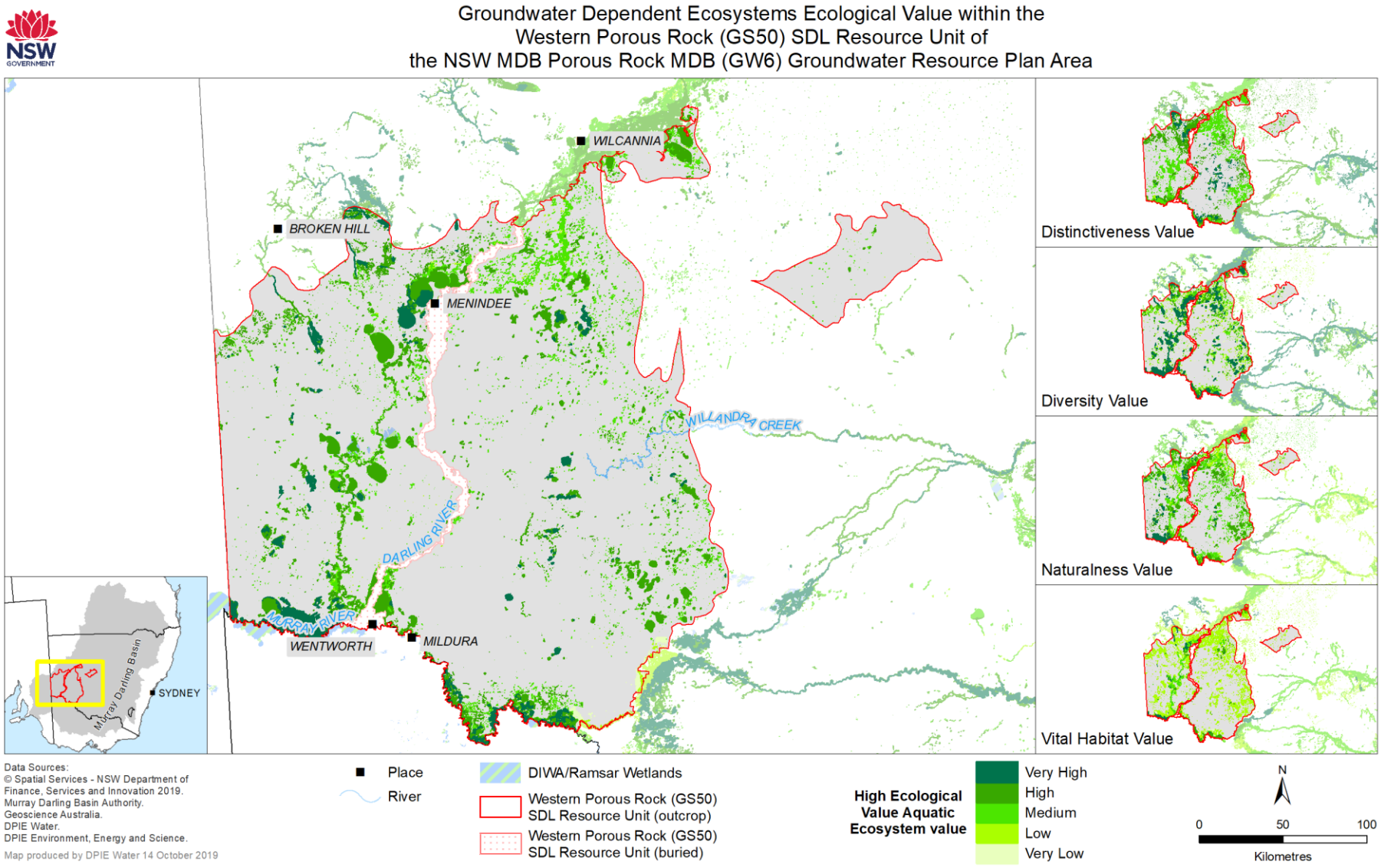


Figure 6: Groundwater dependent environmental assets within the Western Murray Porous Rick Groundwater Sources

3.4. Likely causes of water quality degradation in the NSW Murray–Darling Basin Porous Rock water resource plan area

Basin Plan 10.35A - The causes, or likely causes of water quality degradation in the NSW Murray–Darling Basin Porous Rock WRPA are presented in **Table 3**. These have been prepared having regard to the risk assessment and key causes of water quality degradation identified in Part 2 of Chapter 9 and set out in Schedule 10 of the *Basin Plan*.

Identifying and understanding why water quality degradation occurs is essential for sustainable management of water resources. Table 3 presents the causes, or likely causes of water quality degradation in the Porous Rock water resource plan area based on best available water quality data and knowledge. Table 8 (Appendix A) lists all key causes of water quality degradation as set out in Schedule 10 of the Basin Plan. Water quality degradation issues from elevated suspended sediment, cyanobacteria counts and temperature, dissolved oxygen and pH outside of natural ranges are more appropriate for surface water and are therefore not included as causes of water quality degradation in the NSW Murray–Darling Basin Porous Rock water quality management plan.

Table 3: Causes or likely causes of water quality degradation in the NSW Murray–Darling Basin Porous Rock water resource plan area based on Schedule 10 of the Basin Plan

Type of water quality degradation	Cause of water quality degradation	Where it occurs
C1. Elevated levels of salinity (s 10.41(2)(d))	Drawdown in an aquifer that is hydraulically connected to saline groundwater	Gunnedah-Oxley Basin, Sydney Basin and Western Porous Rock SDL resource areas Medium risk identified in Risk assessment (Schedule D: R2 Risk of groundwater extraction inducing connection with poor quality groundwater))
C2. Elevated levels of nutrients	Nutrients entering NSW Murray–Darling Basin Porous Rock groundwater resources through both point and diffuse sources. The key sources of nutrients are: • soil and organic matter. • animal waste. • fertilisers, and • sewage and industrial discharges.	Knowledge gap Potential risk as activities that cause water quality degradation are present in the WRP area Risk – Low - QAL (Schedule D: QL5 Risk of poor water quality to the environment (GDEs and instream ecological values)) *

Type of water quality degradation	Cause of water quality degradation	Where it occurs
C3. Elevated levels of pesticides and other contaminants	Poor management practices including the following: • Allowing pesticides or other contaminants to leach into ground water. • Inappropriate disposal of pesticides, and • Inappropriate disposal and management of industrial and other waste (including from mining and coal seam gas extraction).	Knowledge gap Refer to EPA for list of contaminated sites Potential risk as activities that cause water quality degradation are present in the WRP area Risk – Low – QAL (Schedule D: QL5 Risk of poor water quality to the environment (GDEs and instream ecological values)) *
C4. Elevated pathogen counts	Pathogens entering water resources through both point and diffuse sources. The key sources of pathogens are: • Human and animal waste, and • Sewage discharges	Knowledge gap Potential risk as activities that cause water quality degradation are present in the WRP area Risk – Low - QAL (Schedule D: QL5 Risk of poor water quality to the environment (GDEs and instream ecological values)) *

*This is a qualitative assessment of existing processes based on Department of Planning and Environment groundwater quality specialist expert opinion and available information from other NSW government agencies. As such no data has been reviewed and so a low confidence according to the criteria in Table 2-4 (Schedule D) applies. Measures that contribute to the mitigation of risk consequences are located in Table 6; explanatory text is included in Table 11.

Risks identified as low do not require a measure to address risk (s10.43 (1)). Refer to the *NSW Murray–Darling Basin Porous Rock Risk Assessment (GW6) water resource plan area* – Section 8 Risk treatment overview (Department of Planning and Environment – Water, 2022). However, measures to address risk for induced connection with poor quality water (salinity) are described in Table 6.

A summary of quantitative risk outcomes for induced connection with poor quality water (salinity) in the Porous Rock water resource plan area are presented in Table 9 (Appendix C).

4. Managing water quality in the NSW Murray–Darling Basin Porous Rock aquifers

4.1. Basin Plan water quality objectives

The water quality objectives presented in Table 4 apply to the waters of the NSW Murray–Darling Basin Porous Rock water resource plan area. They contribute to the overall objective for the Murray–Darling Basin to maintain appropriate water quality, including salinity, for environmental, social, cultural, and economic activity (BASIN PLAN 5.02 - 5.04).

BASIN PLAN 10.52, 9.03-9.06 and 9.08 - Water quality objectives for NSW Murray–Darling Basin Porous Rock water resources are listed in **Table 4**. These objectives reflect those set out for Basin water resources with the exception of recreational water as it is not relevant for the Murray–Darling Basin Porous Rock water resource plan area.

Table 4: Basin Plan Water quality objectives for the NSW Murray–Darling Basin Porous Rock water resource plan area

CODE	Basin Plan Water Quality Objectives	Basin Plan
	**Maintain water quality to protect First Nations people's water dependent values and uses** The objective is to ensure water quality is sufficient to maintain the spiritual, social, customary and economic values and uses of water by First Nations people.	**10.52**
	**Maintain water quality to protect and restore water dependent ecosystems** The objective is to ensure water quality is sufficient to: • Protect and restore ecosystems and ecosystem functions, and • Ensure ecosystems are resilient to climate change.	**9.04**
	**Maintain the quality of raw groundwater for treatment for human consumption** The objective is to minimise the risk that the quality of raw water taken for human consumption results in: • Adverse human health effects, and • The odour of drinking water being offensive to consumers. The objective also aims to maintain the palatability of rating of drinking water at the level of good as set out in the Australian Drinking Water Guidelines.	**9.05**
	**Maintain the quality of groundwater for irrigation use** The objective is to ensure the quality of groundwater, when used in accordance with the best irrigation and crop management practices and principles of ecologically sustainable development, does not result in crop yield loss or soil degradation.	**9.06**
	**Maintain good levels of water quality** The objective is to maintain the value of a water quality characteristic if it is at a level that is better than the target value set out in Section 5.	**9.08**

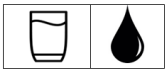
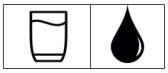
4.2. Measures that contribute to achieving Basin Plan water quality objectives in the NSW Murray–Darling Basin Porous Rock water resource plan area

Ensuring water quality remains fit for purpose and able to achieve objectives requires coordinated water and land resource management. The measures presented in Table 5 consist of plans, strategies and frameworks developed by NSW Government agencies that support the maintenance of water quality in the NSW Murray–Darling Basin Porous Rock water resource plan area against the effects of elevated levels of salinity and other types of water quality degradation identified in Table 3. These measures also contribute to achieving the Basin Plan water quality objectives (Section 4.1).

Measures contributing to Basin Plan water quality objectives are listed in **Table 5**. These measures have been prepared having regard to the causes, or likely causes of water quality degradation listed in **Table 3** and the water quality targets listed in **Table 7**.

Table 5: Measures that contribute to achieving water quality objectives in the NSW Murray–Darling Basin Porous Rock water resource plan area

Objectives	Strategic, plans and frameworks
	**Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020**
	The *Water Sharing Plan for the NSW Murray–Darling Basin Porous Rock Groundwater Sources 2020* aims to protect water resources in river and groundwater systems for the long term and provide a critical balance between water users and the environment. It establishes rules for sharing water between different types of water use such as town supply, rural domestic supply, stock watering, industry and irrigation and ensure that water is provided for the health of the system.
	**North West, Central West, Central Tablelands, Murray, Riverina and Western Local Land Services Local Strategic Plan 2016-2021**
	The *Local Land Services Local Strategic Plan* assists Local Land Services to achieve its vision of resilient communities in productive healthy landscapes. It aligns with Local Land Services' State Strategic Plan and exists as part of an overall framework that links NSW, Australian and Local Government plans and initiatives. The relevant The *Local Land Services Local Strategic Plan* for each SDL resource unit are: • Western Porous Rock (GS50) - Western • Gunnedah-Oxley Basin MDB (GS17) – Central West, North West • Sydney Basin MDB (GS41) – Central Tablelands • Oaklands Basin (GS38) – Murray, Riverina.
	**The Basin Salinity Management 2030 (BSM2030)**
	The *Basin Salinity Management 2030* builds on the successes of the Basin Salinity Management Strategy (2001-2015) to deliver a strategic, cost-efficient and streamlined program of coordinated salinity management for the next 15 years.
	NSW Safe and Secure Water Program

Objectives	Strategic, plans and frameworks
	The *NSW Safe and Secure Water* Program supports the critical needs of regional industries and communities by ensuring water security and quality of supply. It provides $1 billion funding for water and sewerage infrastructure projects in regional NSW. Eligible projects must deliver public health, environmental and/or social benefits for their communities.
	**NSW Drinking water management systems** The *Public Health Act* 2010 and Public Health Regulation 2012 require drinking water suppliers in NSW to develop and adhere to a Drinking Water Management System. The System is a quality assurance framework that identifies and manages Critical Control Points through a risk based approach. Critical Control Points are essential to prevent a water quality hazard or reduce it to an acceptable level.
	**Department of Primary Industries Agriculture – Grazing management guidelines and advisory services** The Department of Primary Industries Agriculture provides information, education and training on sustainable agriculture practices. They provide a range of guidelines for best practice grazing management including for production in wetlands, acid-sulfate soils and fertiliser or pesticide use. These assist agricultural industries minimise and mitigate potential water quality issues such as erosion and contaminants in runoff and leaching.
	**NSW Environment Protection Authority** The NSW Environment Protection Authority (EPA) is the primary environmental regulator for New South Wales. They have responsibilities and powers under a range of NSW environmental legislation. They are responsible for: • issuing environment protection licences. • requiring strict operating conditions and pollution reduction programs. • monitoring compliance with licence conditions and investigating pollution reports. • ordering the clean-up of pollution. • imposing fines or prosecuting organisations and individuals who break the law, and • respond to and manage pollution incidents involving hazardous materials (in collaboration with other government agencies).
	**NSW Aquifer Interference Policy 2012** Policy developed for the licensing and impact assessment processes for aquifer interference activities. It addresses take, minimal impact considerations on water table levels, water quality and water-dependent ecosystems.
	**NSW State Groundwater Policy Framework Document 1997** Provides an overall direction for groundwater management in NSW, with broad objectives and principles to guide decisions.
	**NSW State Groundwater Quality Protection Policy 1998** A Component Policy of the NSW State Groundwater Policy which provides a comprehensive set of policy principles for groundwater quality protection.

Objectives	Strategic, plans and frameworks
	**NSW Private Water Supply Guidelines**
	Guidance for private water suppliers on applying the *Australian Drinking Water Guidelines* and to assist in meeting the quality assurance program provisions of the NSW *Public Health Act* 2010 and Public Health Regulation 2012.

4.3. Measures that support the maintenance of water quality against the effects of elevated levels of salinity and other types of water quality degradation

The measures presented in Table 6 have been developed to support the maintenance of water quality against the effects of elevated levels of salinity and other types of water quality degradation in the NSW Murray–Darling Basin Porous Rock water resource plan area, taking into account the causes, or likely causes of water quality degradation identified in Table 3 and the target values identified in Table 7.

Based on the water quality data and information available, water quality objectives for the NSW Murray–Darling Basin Porous Rock water resource plan area have been formulated where there are 'levers' available to water managers. Where appropriate, opportunities for infrastructure, land and vegetation management have also been identified.

Basin Plan 10.35C(1) & (3) - Measures that support the maintenance of water quality against the effects of elevated levels of salinity and other types of water quality degradation in the NSW Murray–Darling Basin Porous rock water resource plan area are listed in **Table 6**.

The measures have been prepared having regard to the causes, or likely causes of water quality degradation listed in **Table 3** (s.10.35A) and the water quality target values listed in **Table 7** (s10.35B). These measures also contribute to achieving Basin Plan objectives listed in **Table 4** and align with the risks identified in the *NSW Murray–Darling Basin Porous Rock Risk Assessment (GW6) Water Resource Plan Area*.

Basin Plan 10.35C(2) (a) -(c) - Measures included in **Table 6**: WQ1 provide rules under the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* that specify locations, rates, extraction limits and restrictions that contribute to the maintenance of salinity levels and other types of water quality degradation.

Basin Plan 10.35C (2) (d) - A water quality monitoring program for NSW groundwater is proposed. Following this the Department of Planning and Environment – Water will establish a register of monitoring bores for salinity.

Note on inclusion of strategies to address risks to First Nations people's water quality dependent values and uses.

The NSW Murray–Darling Basin Porous Rock water resource plan area is located within the traditional lands of, and significant to the Barapa Barapa, Barkindji/Maljangapa, Gomeroi/Kamilleroi/Gamilaroi/Gamilaraay, Maraura, Muthi Muthi, Nari Nari, Ngarabal, Ngiyampaa, Tati Tati, Wadi Wadi, Weki Weki, Wemba Wemba, Wiradjuri and Yorta Yorta Aboriginal Nations. NSW Department of Planning and Environment has spent time engaging and consulting with Senior Traditional Owners and members of these Aboriginal Nations to identify and record objectives and outcomes in regard to Aboriginal water dependent values and uses within the NSW Border Rivers, Gwydir, Namoi, Macquarie/Castlereagh, Murrumbidgee, Murray and Lower Darling catchments. This process has also recorded a range of water quality

based issues observed by and important to First Nations people within the NSW Border Rivers, Gwydir, Namoi, Macquarie/Castlereagh, Murrumbidgee, Murray and Lower Darling catchments. A number of significant values and uses remain yet to be tabled and require additional work to be completed. Future provisioning of water quality management will need to consider this additional information as it arises.

Table 6: Measures that support the maintenance of water quality against the effects of salinity and other types of water quality degradation in the NSW Murray–Darling Basin Porous Rock water resource plan area.

Objectives	Strategies	Water management actions and mechanisms	Management plan
WQ1) Manage groundwater salinity by ensuring extraction does not result in a change in the beneficial use category Risk identified for induced connection with poor quality water (R2): ***Medium Risk*** *Gunnedah Oxley Basin, Sydney Basin and Western Porous Rock 10.41(2)(d)* *(NSW Murray–Darling Basin Porous Rock Risk Assessment (GW6) WRPA (Department of Planning, and Environment – Water 2022).* 	Limit seasonal drawdown in high risk areas.	Manage extraction at water supply works to prevent decline in groundwater levels resulting in poor water quality to maintain groundwater dependent vegetation ecosystems. Set back distance rules to limit drawdown. Set bore extraction limits on production bores in high risk areas to limit drawdown.	**A**[i] *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* Part 9 Clauses 38, 39, 40, 41, 42, 43, 44 Part 11 Clause 58. **A** *Water Management Act 2000* (s.100, s102)
		Temporarily restrict access under the Water Management Act 2000 (s.324) when there are water shortages.	**A** *Water Management Act 2000* (s.324)
	Limit total water extraction (basic rights and groundwater take) between and within each groundwater source/SDL resource unit to predetermined sustainable amounts.	Reserve all water above the long-term average annual extraction limit (LTAAEL) for the environment as Planed Environmental Water. Available Water Determinations (AWD) adjust extractive use to ensure average annual extraction is managed to the WSP extraction limit. Sustainable Diversion Limits. Require all take to be licensed except for Basic Landholder Rights or where a policy indicates otherwise. Set bore extraction limits on production bores in high risk areas to limit drawdown Compliance with individual extraction limits.	**A** *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* Part 4 Clause 17 Part 6 Clauses 25, 26, 27, 28, 29 Part 10 Clauses, 46, 47, 48, 49, 50, 51 **N** Water Take Measurement and Metering Policy. **A** *Water Management Act 2000* (s.60A, s.100, s.102)

Objectives	Strategies	Water management actions and mechanisms	Management plan
		Trade limits or prohibitions between surface water plan areas, water sources, and management zones to manage extraction. Prohibit trade between surface water and groundwater sources.	
	Ensure bore construction standards are adhered to	Manage to standards to reduce risk of cross contamination of aquifers with difference quality groundwater.	**A** *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* Part 9 Clauses 38, 40, 44 Part 11 Clauses 58 & 60
	Reduce induced flow from high salinity groundwater	Manage assessment criteria considering minimal impacts to aquifer.	**N** Aquifer Interference Policy 2012
		Temporarily restrict access under the Water Management Act 2000 (s.324) when there are water shortages, threat to public health or safety, or to manage water for environmental purposes.	**A** *Water Management Act 2000* (s.324)
	Improve knowledge used to assess risks and evaluate the effectiveness of existing strategies.	Reviews resulting from application of risk treatments will contribute to filling knowledge gaps and evaluate effectiveness of existing strategies.	**N** Groundwater Monitoring, Evaluation and Reporting Plan
WQ2) Manage salinity in connected surface waters 	Limit impact of saline groundwater discharges on surface water systems.	The Mallee Cliffs, Buronga/Mourquong and Lake Victoria/Rufus River salt interception schemes contribute to the end of basin salinity target by diverting saline groundwater before it enters the Murray River through salt interception and drainage diversion schemes.	**N** Basin Salinity Management 2030
	Improve land management practices including the planting of deep-rooted vegetation to reduce rainfall recharge displacing	No levers within scope of water planning. Natural resource management agencies provide advisory services that support and enable landholders to implement	**N** North West, Central West, Central Tablelands, Murray, Riverina and Western Local Land Services Local Strategic Plan 2016-2021.

Objectives	Strategies	Water management actions and mechanisms	Management plan
	saline groundwater to surface water systems.	improved natural resource and agricultural management practices.	
WQ3) Manage nutrients from organic matter, animal waste, fertilisers, wastewater discharges (sewage treatment facilities, septic and stormwater) entering the groundwater SDL resource unit. ***Knowledge gap*** *All areas* Risk rating: Low –QAL *(NSW Murray–Darling Basin Porous Rock Risk Assessment (GW6) WRPA: QL5* Risk of poor water quality to the environment (GDEs and instream ecological values))(Department of Planning and Environment—Water 2022). 	Reducing nutrients entering the water resource is largely related to land, vegetation and natural resource management. Strategies include best management practices for chemical handling and application, cropping practices, runoff management from agricultural land and licence assessment and conditions for onsite and sewage treatment plants	No levers within scope of water planning to reduce nutrients entering groundwater source. WSP rules have offset distances from known contamination sites and plumes to limit mobilisation of plume induced from pumping.	**A** *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* Part 9 Clause 40 Part 11 Clause 58(1)(e), 58(2), 58(3)
		Natural resource management agencies provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices.	**N** North West, Central West, Central Tablelands, Murray, Riverina and Western Local Land Services Local Strategic Plan 2016-2021.
		Manage known or potential sources of nutrients entering the groundwater source causing a decline in groundwater quality including assessments during licence approvals and licencing conditions.	**N** *Protection of the Environment Operations Act 1997* **N** *Local Government Act 1993*
WQ4) Manage pesticides and other contaminants including industrial discharges entering the groundwater SDL resource unit.  ***Knowledge gap*** *All areas* Risk rating: Low –QAL *(NSW Murray–Darling Basin Porous Rock Risk Assessment (GW6) WRPA: QL5* Risk of poor water quality to the environment (GDEs and instream ecological values)) (Department of Planning and Environment—Water, 2022).	Reducing pesticides and other contaminants from entering the water resource is largely related to land, vegetation and natural resource management. Strategies include best management practices for chemical handling, application and waste management, runoff management from agricultural land and discharges from industries and mine sites.	No levers within scope of water planning to reduce pesticides entering groundwater source. Natural resource management agencies provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices.	**N** North West, Central West, Central Tablelands, Murray, Riverina and Western Local Land Services Local Strategic Plan 2016-2021
		Manage known or potential sources of groundwater contamination to limit decline of groundwater quality.	**N** *Protection of the Environment Operations Act 1997* **N** Aquifer Interference Policy 2012
		WSP rules have offset distances from known contamination sites and plumes to limit mobilisation of plume induced from pumping.	**A** *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* Part 9 Clause 40

Objectives	Strategies	Water management actions and mechanisms	Management plan
			Part 11 Clause 58(1)(e), 58(2), 58(3)
		Temporarily restrict access under the Water Management Act 2000 (s.324) when there are water shortages, threat to public health or safety, or to manage water for environmental purposes.	**A** *Water Management Act 2000* (s.324)
WQ5) Manage contamination from pathogens entering the groundwater source  ***Knowledge gap*** *All areas* Risk rating: Low –QAL *(NSW Murray–Darling Basin Porous Rock Risk Assessment (GW6) WRPA: QL5* Risk of poor water quality to the environment (GDEs and instream ecological values)) (Department of Planning and Environment—Water, 2022).	Reduce microbial contamination to groundwater sources from animal faeces.	No levers within scope of water planning to reduce pathogens entering the groundwater source. Natural resource management agencies provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices.	**N** North West, Central West, Central Tablelands, Murray, Riverina and Western Local Land Services Local Strategic Plan 2016-2021.
	Reduce point and diffuse contamination from discharges from sewage – onsite and sewage treatment facilities.	Manage known or potential sources of groundwater contamination to limit the decline of groundwater quality including assessments during licence approvals and licencing conditions.	**N** *Protection of the Environment Operations Act 1997* **N** *Local Government Act 1993*
		WSP rules have offset distances from known contamination sites and plumes to limit mobilisation of plume induced from pumping.	**A** *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* Part 9 Clause 40 Part 11 Clause 58(1)(e), 58(2) & 58(3)

Explanatory text is provided in Table 11 showing how the measures relate to the causes and target values.

N highlights measures that will not be accredited by the MDBA during assessment of the WRP.

A highlights measures that will be accredited by the MDBA during assessment of the WRP.

5. Water quality targets

The Basin Plan sets out water quality targets and target application zones in Schedule 11. They provide a guideline for appropriate water quality required for environmental, social and economic outcomes in the Murray–Darling Basin for streams, rivers, lakes and wetlands.

Groundwater specific water quality targets are not included in Schedule 11 of the Basin Plan. The salinity target listed in Schedule 11 of the Basin Plan is a surface water salinity target for the purpose of long-term salinity planning managing (s9.19 of the Basin Plan) and not appropriate for groundwater management. Therefore, NSW has adopted alternative water quality targets to fulfil the requirements of the Basin Plan (s10.35B(3)).

The Basin Plan requires the water quality management plan to identify water quality target values ((10.35) (2) (a-c)) for:

- Freshwater-dependent ecosystems identified in the NSW Border Rivers, Gwydir, Namoi, Macquarie/Castlereagh, Murrumbidgee, Murray and Lower Darling long term water plans for surface water that are also groundwater dependent (9.16 of the Basin Plan)
- Irrigation water (salinity and sodium adsorption ratio) where an irrigation infrastructure operator is present (9.17 of the Basin Plan)
- Recreational water (9.18 of the Basin Plan).

NSW has adopted beneficial use categories outlined in *The NSW Groundwater Quality Protection Policy 1998* and determined in accordance with procedures set out in ANZECC 2000 Guidelines for:

- tolerances of plants to salinity in irrigation water,
- suitability of water for stock watering and
- the World Health Organisation (2004) for palatability drinking water guideline to fulfil the water quality objectives 9.05 - 9.08 of the Basin Plan.

The use of the beneficial use categories provides a set of environmental values that are to be protected, upper thresholds that serve as performance indicators that can be measured, evaluated and reported on. They set water quality objectives that must be met to maintain the beneficial uses of the water resource (Murray–Darling Basin Authority, 2017: Position statement 7B).

As yet, no water quality targets or thresholds have been defined for Aboriginal cultural, spiritual or ceremonial outcomes.

5.1. Water quality targets for water resource plans

Basin Plan 10.35B - The water quality targets listed in **Table 7** apply to the NSW Murray–Darling Basin Porous Rock water resource plan area.

The water quality target for fresh water-dependent ecosystems (10.35B (2) (a)) specify alternative values (10.35B (3)) to those referred to in s9.16 of the Basin Plan. The water quality parameters shown in Schedule 11 of the Basin Plan are surface water parameters and are not appropriate for gauging groundwater quality. Salinity is used to describe the water quality within the aquifer and the suitability of its use.

The salinity target listed in Schedule 11 of the Basin Plan is a surface water salinity target for the purpose of long-term salinity planning managing (s9.19). The adoption of the alternative salinity target value listed for the NSW Murray–Darling Basin Porous Rock WRPA will have no adverse impact on the End-of-Valley surface water targets for salinity as it is a groundwater resource. Progress towards these water quality targets is reported every five years in accordance with Schedule 12, Matter 12 of the Basin Plan as part of the *NSW Groundwater monitoring, evaluation and reporting (MER) plan*.

For water used for irrigation purposes (s10.35B(2)(b)), the water quality target value for irrigation water set out in s9.17 of the Basin Plan and objective s9.06 of the Basin Plan, is not required as there are no infrastructure irrigation operators that deliver services in the NSW Murray–Darling Basin Porous Rock water resource plan area.

For the purpose of Section 10.35B(2)(c) of the Basin Plan, water quality target value set out in s9.18 and objectives in s9.07 are not provided as groundwater is not used for recreational purposes in the NSW Murray–Darling Basin Porous Rock WRP area. These targets are aimed at managing surface water blue-green algal issues (Murray–Darling Basin Authority 2017: Position Statement 7A). The NSW Murray–Darling Basin Porous Rock water resource plan area is made up only of groundwater SDL resource units (s3.06).

5.1.1. Water quality targets for water-dependent ecosystems

The Basin Plan water-dependent ecosystem targets listed in Schedule 11 of the Basin Plan were developed following the methods outlined in the ANZECC Guidelines (2000) for streams, rivers, lakes and wetlands to assess the suitability of water to support healthy water-dependent ecosystems. As discussed above, as the targets were more relevant to surface water and not appropriate to groundwater, NSW has adopted an alternative salinity target that will provide a level of protection for the fresh water-dependent ecosystems identified in the NSW Murray–Darling Basin Porous Rock water resource plan area. Water is considered fresh when salinity is less than 3,000 mg/L (Nielsen et al., 2003). Fresh water-dependent ecosystems access water at a range of salinities dependent on their tolerances and accessibility to fresher water.

Table 7 shows the salinity target values for fresh water-dependent ecosystems (terrestrial vegetation). Water quality targets for all SDL units within the NSW Murray–Darling Basin Porous Rock water resource plan area (including the Gunnedah Oxley Basin MDB, Sydney Basin MDB and Western Porous Rock SDL's) have been divided into zones, as salinity levels vary within the water resources (s9.12). Groundwater dependent vegetation ecosystems associated with aquatic ecosystems that rely on surface expression of groundwater, have a water quality target of 900 mg/L and applies to the riparian zone of 100 m (Zone 1). The target value of 900 mg/L is equivalent to the Australian Drinking Water Guideline for acceptable drinking water (WHO, 2004; NHMRC and NRMMC, 2011) and the beneficial use segment A2. All remaining terrestrial groundwater dependent ecosystems accessing fresh water will have a target value of less than 3,000 mg/L (Zone 2) which is equivalent to beneficial use segment B. The water quality targets in Table 7 apply to the groundwater dependent ecosystems illustrated in Figure 5 and Figure 6.

Table 7: Water quality targets in the NSW Murray–Darling Basin Porous Rock water resource plan area

Use	Location	Target value (salinity mg/L)**		Basin Plan requirement and justification
Freshwater-dependent ecosystems	Western Porous Rock SDL Gunnedah Oxley Basin SDL Sydney Basin SDL	Zone 1	900	Alternative target value for s10.35B(2)(a) provided under s10.35B(3): Target values are consistent with objectives in Part 3 Chapter 9 and developed in accordance with ANZECC Guidelines procedures. The measures provided in Table 6 take account of the ANZECC Guidelines and the target values.
		Zone 2	<3,000	
Irrigation water	-	Not relevant for NSW Murray–Darling Basin Porous Rock WRP area		s10.35B(2)(b) s9.17 Not relevant in the NSW Murray–Darling Basin Porous Rock WRP area as there is no irrigation infrastructure operator* present.
Recreational water	-	Not relevant for NSW Murray–Darling Basin Porous Rock WRP area.		s10.35B(2)(c) s9.18 Not relevant in the NSW Murray–Darling Basin Porous Rock WRP area (MDBA 2017: Position statement 7A) as groundwater is not used for recreational purposes in this WRP area

* In NSW, irrigation infrastructure operators are defined as a separate third party that holds a water access entitlement and delivers water to shareholders. These include NSW Irrigation Corporations, Private Irrigation Districts and Private Water Trusts.

**Target values for water quality parameters other than salinity are not provided.

Section 6.6 of the NSW Murray–Darling Basin Porous Rock risk assessment (Schedule D) assesses risks to groundwater dependant ecosystems (GDEs) attributable to land and waste management practices as low-QAL.

In the absence of comprehensive monitoring, NSW considers the EPA's risk based licensing and approval system adequately manages the major causes of water quality degradation from major contaminants (other than salinity) entering the groundwater SDL source units and hence adequately mitigates likelihood. Further explanation is provided in Table 11.

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Appendices

Appendix A: Salinity mapping in the Western Porous Rock water resource plan area

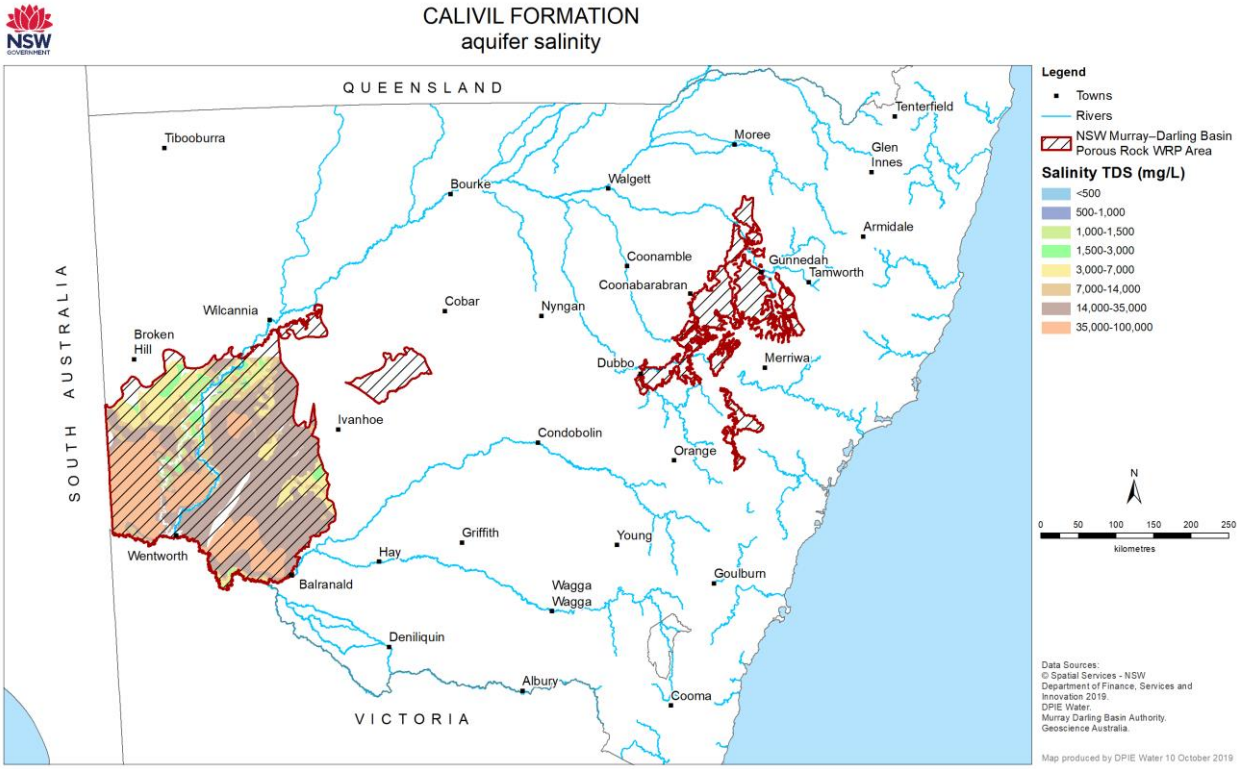

Figure 7: Groundwater salinity in the Western Porous Rock (Calivil Formation)

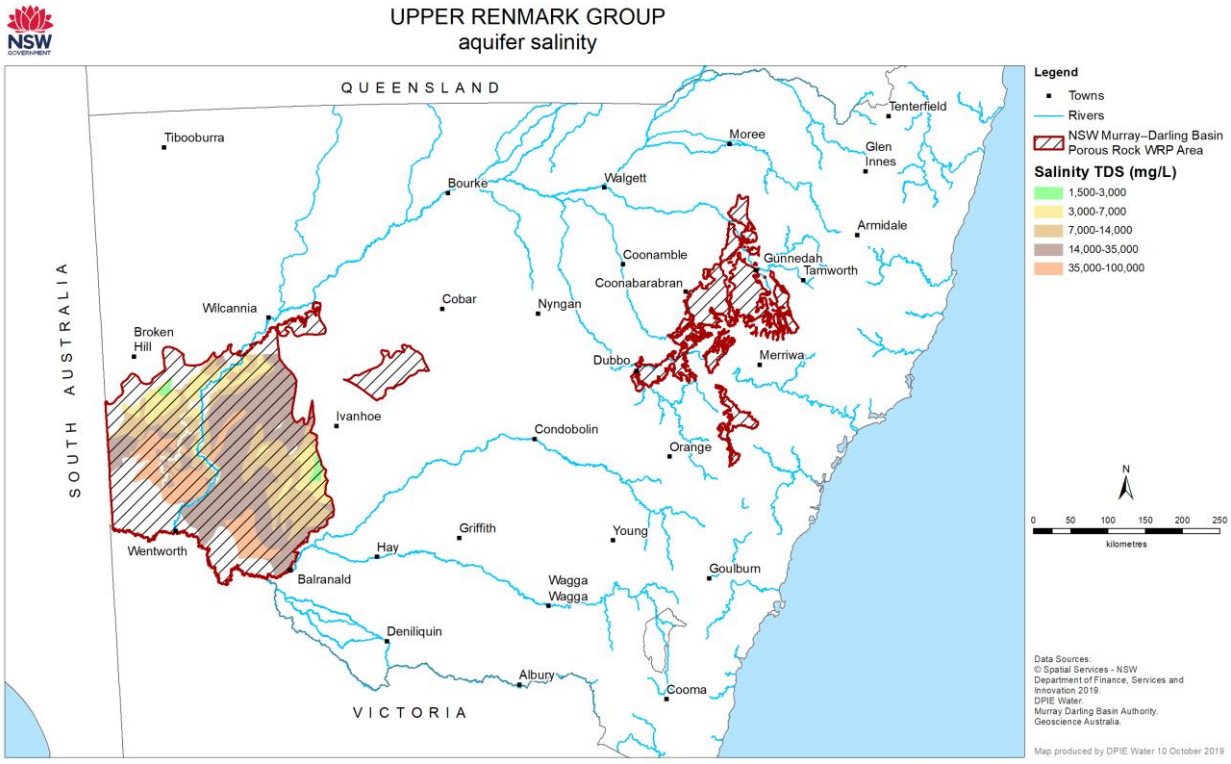

Figure 8: Groundwater salinity in the Western Porous Rock (Upper Renmark Group)

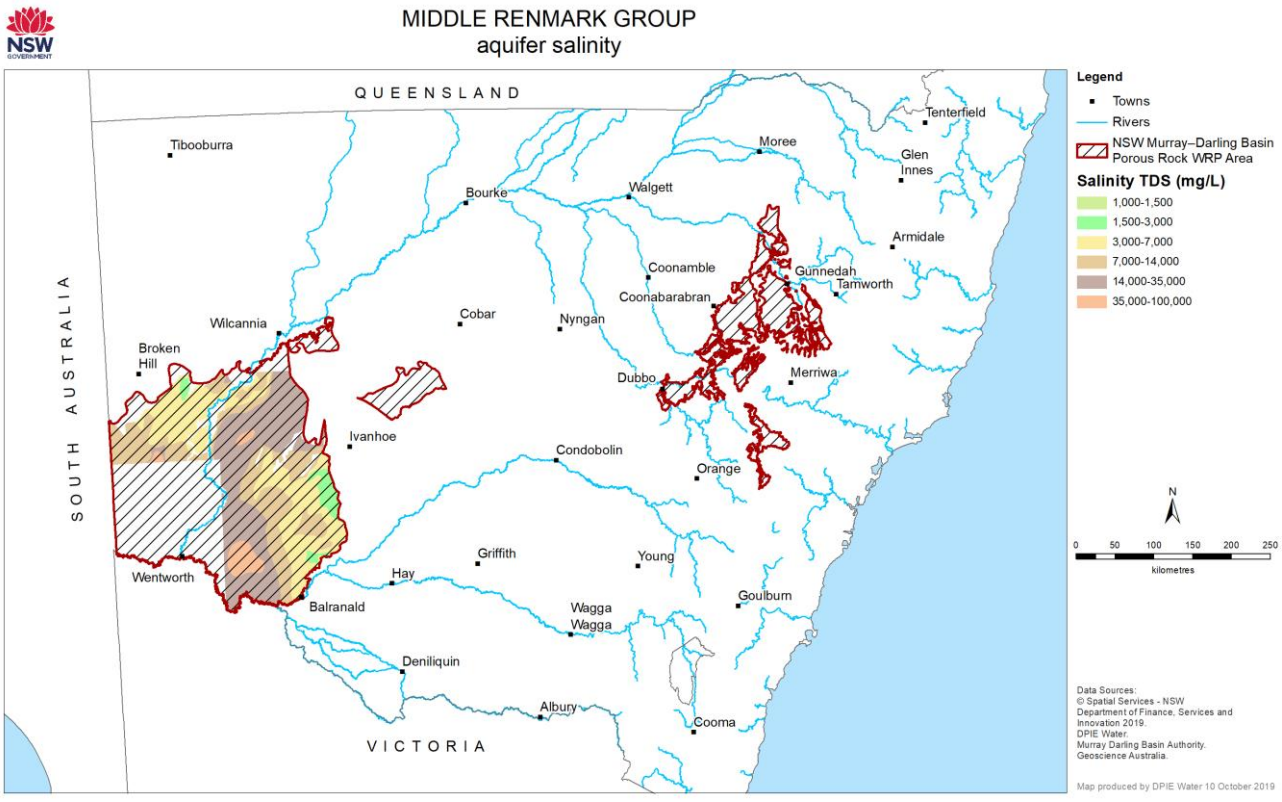

Figure 9: Groundwater salinity in the Western Porous Rock (Middle Renmark Group)

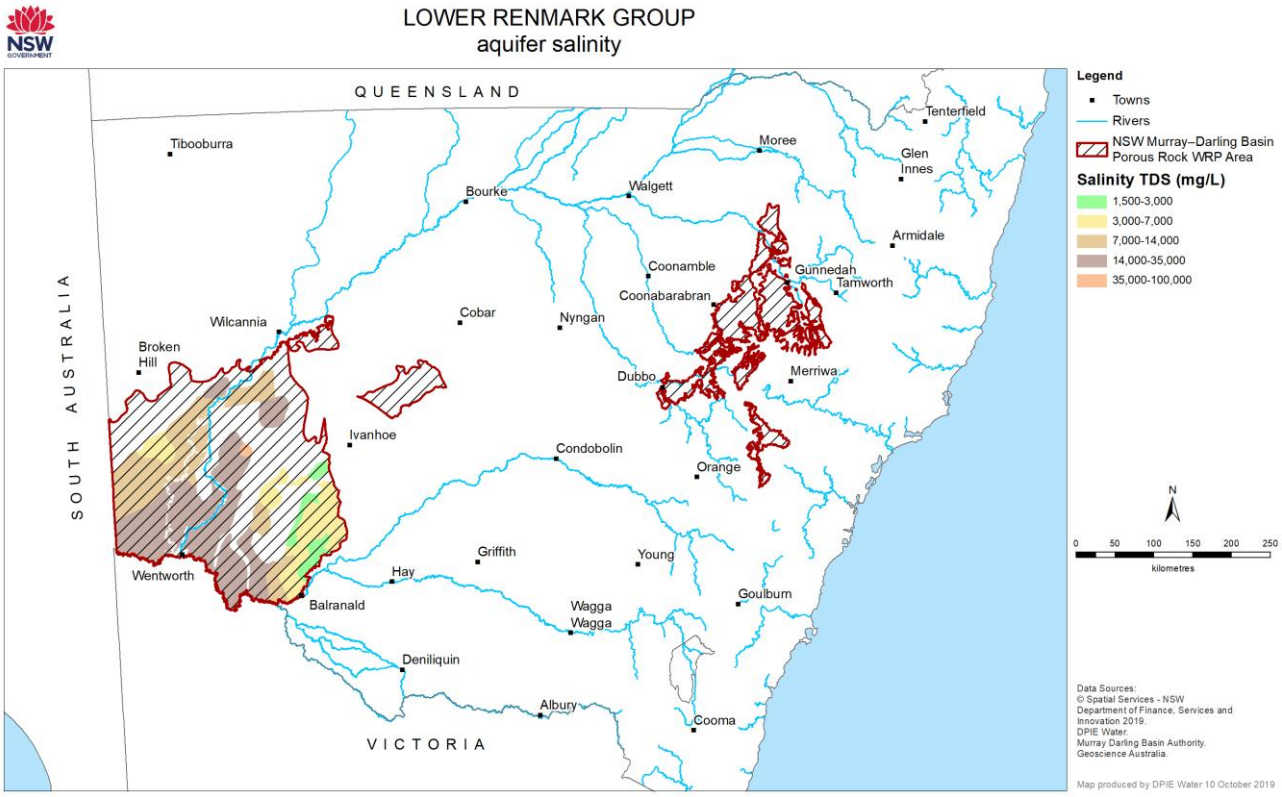

Figure 10: Groundwater salinity in the Western Porous Rock (Lower Renmark Group)

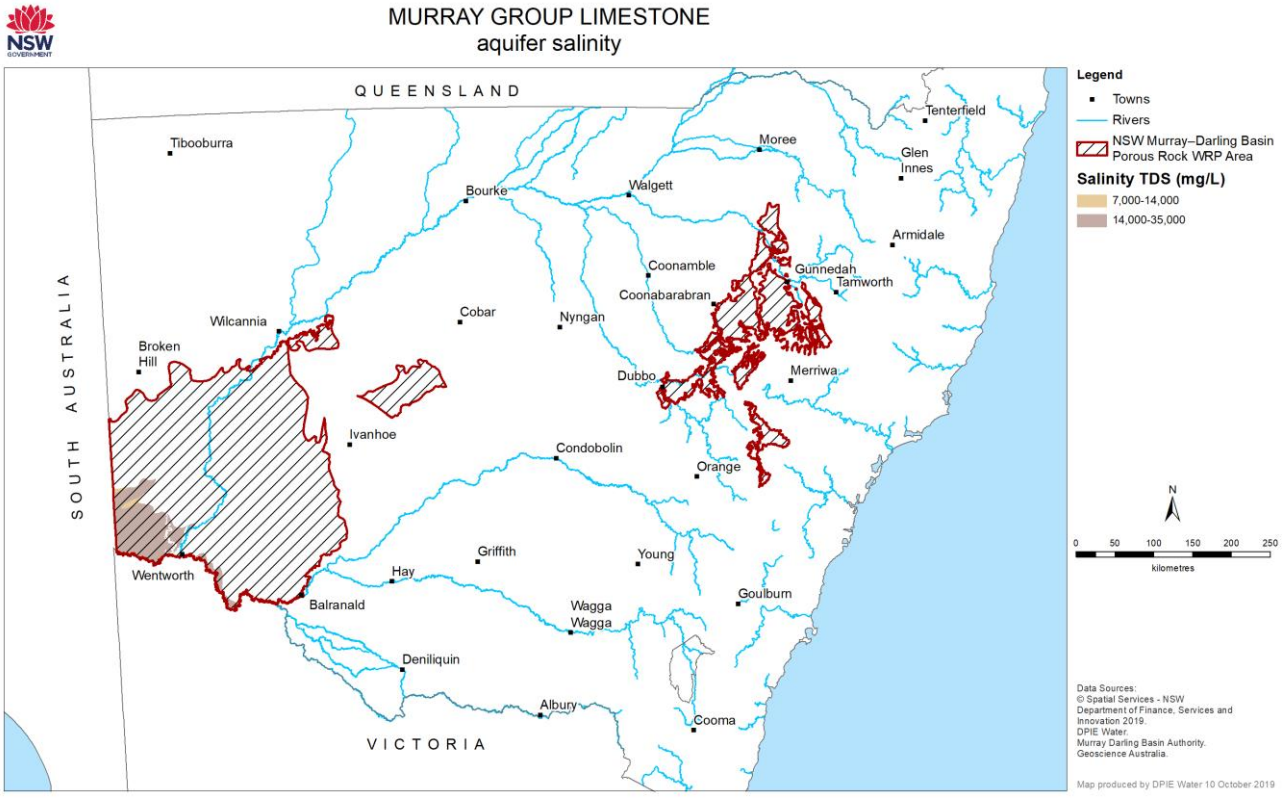

Figure 11: Groundwater salinity in the Western Porous Rock (Murray Group Limestone)

Appendix B: Key causes of water quality degradation (Schedule 10)

Table 8: Basin Plan key causes of water quality degradation

Type of water quality degradation	Cause of water quality degradation
Elevated levels of salinity	(1) The process of mobilisation of salt stores in the landscape and geological predisposition to salinity development, including by: (a) the following processes and activities relating to water flow or water management: (i) saline groundwater and surface water discharges into surface water systems. (ii) increased deep drainage below irrigated agricultural land displacing saline groundwater to surface water systems. (iii) saline surface and shallow groundwater drainage from irrigated agricultural land into surface water systems. (iv) irrigation at high salinity risk locations without adequate drainage management. Example: Locations where there is a high risk of recharge to groundwater resulting in saline discharges to surface waters. (v) de-watering of saline groundwater which mobilises salt into surface water systems. (vi) reduction in stream flows, limiting the dilution of salinity. (b) land management practices involving the replacement of deep-rooted vegetation with shallow-rooted crops and pastures, resulting in increased rainfall recharge displacing saline groundwater to surface water systems. (2) The use of groundwater for irrigation purposes at locations where highly saline upper aquifer water drains to the lower aquifer. (3) With respect to soil degradation, the use of water with a high ratio of sodium to calcium and magnesium for irrigation.
Elevated levels of suspended matter*	Sediments entering Basin water resources, which is contributed to by: (a) the following land management practices: (i) inappropriate frequency, timing and location of cultivation. (ii) overgrazing of catchments and grazing of riverbanks and floodplains. (iii) poor soil conservation practices. (iv) practices that over the long-term cause decline of stream morphology, leading to near stream processes of gully erosion, side wall cut and head migration; and (b) the following water management practices: (i) rapid drawdown of water within a surface water resource. (ii) the volume or manner of release of water, resulting in back or bed erosion; and (c) wave wash (for example, that caused by speedboats).

Type of water quality degradation	Cause of water quality degradation
Elevated levels of nutrients	Nutrients entering NSW MDB fractured Rock water resources through both point and diffuse sources. The key sources of nutrients are: (a) soil and organic matter. (b) animal waste. (c) fertilisers. (d) sewage and industrial discharges. (e) nutrients from water storages released as a result of storage management practices.
Elevated levels of cyanobacteria cell counts or biovolume and toxins and odour compounds*	The interaction of the following factors: • A water body with little or no flow • Stratification in the water body • Sunlight • The availability of phosphorus and nitrogen in the water • Seeding from upstream (although cyanobacteria blooms may occur without this factor).
Water temperature outside of natural ranges*	(1) The key cause of water temperature of Basin water resources below natural ranges is the release of stored water from below the thermocline from large water storages in spring, summer and autumn. (2) The key causes of water temperature of Basin water resources above natural ranges are the following: (a) the release of stored water from large water storages in winter. (b) the removal of shading riparian vegetation. (c) reduced flow.
Dissolved oxygen outside of natural ranges*	(1) Micro-organisms consuming organic matter and depleting oxygen at a rate faster than it can be replenished. (2) Bottom release from, or overturn within, a stratified water storage. (3) Eutrophication leading to excessive plant growth causing high diurnal variations in dissolved oxygen levels, both above and below natural ranges.
Elevated levels of pesticides and other contaminants	Poor management practices including the following: (a) pesticide spray drift. (b) allowing pesticides or other contaminants into surface water runoff. (c) allowing pesticides or other contaminants to leach into groundwater. (d) allowing erosion of contaminated soil. (e) inappropriate disposal of pesticides. (f) inappropriate disposal and management of industrial and other waste (including from mining and coal-seam gas extraction).
pH outside natural ranges*	(1) The exposure to the air of soils containing iron sulphide minerals. (2) Agricultural practices that lead to the acidification of soils. (3) Eutrophication leading to excessive plant growth causing high diurnal variation in pH.
Elevated pathogen counts	Pathogens entering Basin water resources through both point and diffuse sources. The key sources of pathogens are: • Human and animal waste • Sewage discharges

*Not applicable to groundwater – surface water quality parameters

Appendix C: Risk assessment summary

Risk assessments are the first step in the development of a water resource plan for each groundwater planning area in the Murray–Darling Basin. Risk assessments and associated water resource plans must be prepared having regard to current and future risks to the condition and continued availability of water resources in a water resource plan area, and outline strategies to manage those risks.

Impacts as a result of groundwater extraction can occur across a large expanse of a groundwater system and have the potential to affect multiple users within the system. Induced connection with an aquifer of poorer water quality through over extraction can result in degradation of groundwater quality, making it unsuitable for consumptive users.

The consequence of impacts to consumptive users was calculated in the risk assessment using the metrics of the number of users and the volume of water extracted from the groundwater source. The consequence of impacts on consumptive users would be high in the Gunnedah-Oxley Basin MDB and medium in the Western Murray Porous Rock and Sydney Basin SDL resource units. The Oaklands Basin SDL resource unit does not have any water access licences, nor are there any basic landholder rights for this SDL resource unit. There is currently no groundwater extraction and no pathway for consequences to take place.

Groundwater in this water resource plan area tends to be saline, with low salinity water rarely found. Combined drawdown and salinity gradient metrics derive an overall low likelihood of salinity migration into the Gunnedah-Oxley Basin MDB and Oaklands Basin SDL resource units and a medium likelihood for the Sydney Basin MDB and Western Murray Porous Rock.

Combining the likelihood and consequence ratings resulted in an overall risk of poor quality groundwater migration impacting aquifer users as nil in the Oaklands Basin and medium in the Western Murray Porous Rock, Sydney Basin and Gunnedah-Oxley Basin MDB SDL resource units (Table 9). A full list of risks identified in the Porous Rock water resource plan area can be found in the *NSW Murray–Darling Basin Porous Rock Risk Assessment (GW6) water resource plan area* (Department of Planning and Environment—Water, 2022).

Table 9: Summary of risk outcomes for induced connection with poor quality water (salinity)

SDL resource unit Name	Consequence	Likelihood	Overall risk
Western Porous Rock	Medium	Medium	Medium
Gunnedah-Oxley Basin MDB	High	Low	Medium
Sydney Basin	Medium	Medium	Medium
Oaklands Basin	Nil	Low	Nil

Appendix D: Conversion of electrical conductivity and total dissolved solids

An approximate conversion of electrical conductivity to total dissolved solids is:

Electrical conductivity (µS/cm) x 0.67 = Total dissolved solids (mg/L) (ANZECC and ARMCANZ, 2000)

Table 10: Conversion of total dissolved solids (mg/L) to electrical conductivity (µS/cm)

Beneficial use segment	A1	A2	A3	B	C1	C2	D
TDS (mg/L)	0 - 600	601 – 900	901 – 1,200	1,201 – 3,000	3,001 – 6,000	6,001 – 10,000	>10,000
EC (µS/cm)	0 - 896	897 – 1,343	1,344 – 1,791	1,792 – 4,478	4,479 – 8,955	8,956 – 14,925	>14,925

Appendix E: Explanation of accredited measures – how they meet Basin Plan requirements

Measures required under s10.35C of the Basin Plan are listed in Table 6. They support the maintenance of water quality within the groundwater SDL resource unit against the effects of elevated levels of salinity and other types of water quality degradation. Causes or likely causes of water quality degradation relevant to groundwater resource units are listed in Table 3, required under s10.35A of the Basin Plan. Regard has been had for the key causes of water quality degradation identified in Schedule 10 of the Basin Plan. The measures presented in Table 6 align with the strategies to address medium and high risks against induced connection with poor water quality (salinity) as identified in the NSW Murray–Darling Basin Porous Rock Risk Assessment (GW6) water resource plan area (Schedule D: Tables 4-9 and 8.7- R2 Risk of groundwater extraction inducing connection with poor quality groundwater) and likely causes of water quality degradation identified in Table 3, required under s10.35C(2)(a-c) of the *Basin Plan*.

The water quality target values required under s10.35B of the Basin Plan are listed in Table 7. The Basin Plan objectives relevant to groundwater (excluding recreation) are listed in Table 4. Each objective is represented by a symbol (also illustrated in Table 4) and highlights the Basin Plan corresponding objective. Table 5 lists measures that contribute to achieving those water quality objectives listed in Table 4 with the corresponding symbol, illustrating which objective the measure contributes to. This is also included in the first column of Table 6. A brief description of either the strategy, plan or framework that contributes to reducing the risk of water quality degradation in the SDL resource unit are listed in Table 5. These measures have been prepared having regard to the causes of water quality degradation listed in Table 3 and the water quality targets listed in Table 7.

Table 11 describes the linkage between the measure required under s10.35C and how it relates to the water quality target values (s10.35B), the causes, or likely causes of water quality degradation (s10.35A), and the alignment of the measures addressing risks assessed in the NSW Murray–Darling Basin Porous Rock Risk Assessment Schedule D (Department of Planning and Environment – Water, 2022). It also provides explanation of how water sharing plan rules limiting extraction contribute to the maintenance of salinity in the aquifer.

The water quality management plan under s10.35D must include rules or measures that are designed to ensure that the objective in s10.35C is met. Table 6 (column 4) identifies clauses in legislative instruments available to ensure the objectives in s10.35C are met. For information regarding the process of applying the measures refer to Schedule I of the NSW Murray–Darling Basin Porous Rock Water Resource Plan.

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Table 11: Relationship between the measures that support the maintenance of water quality against the likely causes of water quality degradation, and how the measures relate to water quality target values

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
WQ1	Elevated levels of salinity (Item 1)	Drawdown in an aquifer that is hydraulically connected to saline groundwater	Table 3: C1: 10.35C(2) (a-c) s10.35D	Elevated levels of salinity from the causes, or likely causes of water quality degradation identified in Table 3 (C1) are addressed by measure WQ1. Rules in the *Water Sharing Plan for NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* contribute to the maintenance of salinity levels in the SDL resource unit. Rules in the *Water Sharing Plan for the NSW Murray Darling Porous Rock groundwater sources 2020* limit extraction; set conditions for volumes and rates of extraction; provide distance rules to limit drawdown and protect GDEs; preserve water for the environment (PEW); have trade restrictions; and provide for bore construction standards that contribute to the maintenance of salinity levels in the SDL resource unit (10.35C(2)(a)). Rules are also included to manage groundwater extraction at a local scale within water sources and SDL management units to prevent or manage localised drawdown related impacts. This strategy allows consumptive groundwater extraction to be limited on a smaller scale than a water source or SDL unit to manage localised impacts. Water sharing plan rules limit consumptive water extraction thereby maintaining resource condition limits for salinity (10.35C (2) (b)). Objectives included in the WSPs include maintaining salinity within ranges that maintain beneficial use categories within the resource. The upper salinity limit (TDS) of the highest beneficial use category (e.g., segment A) for the water source is used as the resource condition limit. An elevation in salinity levels could indicate a change to the beneficial use category. Beneficial use categories (including upper thresholds) are provided in Table 2. A change in beneficial use category due to salinity levels exceeding the upper threshold of that category would trigger investigation processes consistent in the Incident Response Guide (Schedule E) to initiate a management response. Relevant clauses in the WSP that relate to rules are listed in Table 6 (column 4).

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
			Table 8-7: R2 - Risk of groundwater extraction inducing connection with poor quality groundwater (Schedule D)	Measure WQ1 addresses the risk of elevated salinity (C1). This aligns with strategies to address risk listed in Table 8-7: strategies 1, 2 & 7 to address R2 (Schedule D). Strategies for addressing risks are required if the level of risk is medium or high (10.43(1) (a)). Elevated levels of salinity from induced connection with poor water quality (R2) were assessed as a medium risk in the Gunnedah-Oxley Basin, Western Porous Rock and Sydney Basin (Schedule D of the NSW Murray–Darling Basin Porous Rock WRP). A medium or high risk result does not necessarily imply that existing water management strategies require change or are inadequate. Rules in the water sharing plan and other water management plans and policies provide measures to support the maintenance of water quality in the SDL unit (as described above). NSW has made an informed decision to accept the risk result as an acceptable or tolerable risk in line with the Basin Plan Water Resource Plan Requirements (Position Statement 9B Strategies for addressing risks). Where a risk result is considered tolerable, the Basin Plan does not require further strategies to be implemented. The risk results for induced connection with poor water quality (salinity) in the NSW Murray–Darling Basin Porous Rock WRPA are tolerable because strategies and mechanisms established in the WSP are in place to manage local drawdown impacts that could lead to elevated salinity levels. Under the Water Management Act, the Minister may also apply restrictions on extraction to maintain, protect or improve the quality of water in an aquifer (s. 324).
			Table 7	Measures were developed with regard to target values in Table 7 for fresh water-dependent ecosystems (10.35B (2) (a)). Measure WQ1 addresses the causes, or likely causes of elevated salinity that could impact fresh water-dependent ecosystems (C1). Monitoring and reporting of salinity levels will be conducted under Schedule 12 (Item 12) of the Basin Plan. Targets in Table 7 have been developed for the protection of fresh water-dependent ecosystems against elevated salinity levels. The target values in Table 7 are alternative salinity targets to those listed in Schedule 11 of the

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
				Basin Plan (10.35B(3). These targets are consistent with the water quality objectives in Part 3 of Chapter 9 of the Basin Plan. Rules in the WSP support the maintenance of water quality (salinity) and contribute to achieving the target values, as elevated salinity levels could impact GDEs. Limiting the total water extraction (basic rights and groundwater take) within each groundwater source/SDL resource unit to predetermined sustainable levels ensures a share of the water remains for the environment to protect groundwater quality and hydraulic relationships and maintains resource condition limits for salinity and other water quality degradation (10.35C(2)(b)). Rules preserve water for the environment and limit consumptive water extraction to prevent exceedance of resource condition limit (10.35C (2) (c)).
WQ2	Elevated levels of salinity (Item 1)	Displaced saline groundwater entering surface water systems	Table 3: C1	Measure WQ2 addresses the causes or likely causes of elevated salinity levels entering surface water systems (C1). As there are limited levers within scope of water planning, measures include those established by Natural Resource Management agencies to provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices. These management measures contribute to reducing saline groundwater entering the SDL resource unit. The measures included in Table 6 are not accredited as they are not mandated as part of the Basin Plan. They are denoted by N highlighting they are not accredited by the MDBA during assessment of the WRP.
WQ3	Elevated levels of nutrients (Item 3)	Nutrients entering SDL resource unit from animal waste, fertilisers and sewage discharges.	Table 3: C2:QL5 - Risk of poor water quality to the environment (GDEs and instream ecological values)	Measure WQ3 addresses the causes or likely causes of elevated levels of nutrients the SDL resource unit (C2) and aligns with risk QL5 (Schedule D of the NSW Murray–Darling Basin Porous Rock WRP: Tables 4-18). The risk of nutrients entering the SDL resource unit via onsite sewage discharges are managed under the local government management framework provided in the application for installation. A risk classification is determined by the local government during the approval phase. Under the Local Government Act 1993, local councils are responsible for regulating the installation,

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
				operation and maintenance of septic systems, conducting audits and inspections and keeping a register of systems in use in the council area. Under the Protection of the Environment Operations Act 1997 (POEO Act), the Environment Protection Authority (EPA) uses a risk-based licensing system that aims to ensure that all environment protection licensees receive an appropriate level of regulation based on the environmental risk of the activity taking into account site specific risks. Licenced industries include sewage treatment plants. Licensing conditions also include a monitoring and reporting component for compliance. Licence conditions relate to pollution prevention and monitoring. The EPA undertakes risk assessments of all licensed premises in NSW. Based on the results from these EPA risk assessments, licensees are allocated an overall environmental risk level. Licensees with a higher risk level will receive an increased level of regulatory and compliance oversight. In NSW the EPA and local councils implement a risk based approach to the management of potential point source groundwater contaminants under the Protection of the Environment Operations Act 1997, the Local Government Act 1993 and the Local Government (General) Regulation 2005. The EPA is responsible for event monitoring as a result of licence compliance issues. Data gathered during monitoring is temporally and spatially localised and not considered representative of the water quality of an SDL resource unit, groundwater source or management zone. As there is no routine water quality monitoring conducted within the WRP area for nutrients, there is insufficient data to conduct a quantitative risk assessment. In the absence of comprehensive monitoring, NSW considers the EPA's risk based licensing and approval system and local councils' regulation of onsite sewage management adequately manages the major causes of water quality degradation from nutrients entering the groundwater SDL source units and hence adequately mitigates likelihood. This is noted as a knowledge gap. Should a monitoring program or the acquisition of reliable data from an external source become available in the future, a quantitative risk assessment may be conducted using the improved knowledge which would increase the confidence in the risk outcome. A quantitative assessment of this risk has not been included in Schedule D of the NSW Murray–Darling Basin Porous Rock WRP as the available data does

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
				not adequately characterise the risk across an appropriate scale, however NSW considers there is a potential risk from these contaminants as activities contributing to contamination are present in the WRPA. A qualitative assessment of existing processes based on Department of Planning and Environment—Water groundwater quality specialist expert opinion and available information from other NSW government agencies. As such no data has been reviewed and so a low confidence according to the criteria in Table 2- 4 (Schedule D of the NSW Murray–Darling Basin Porous Rock WRP) applies. A risk rating of Low – QAL has been applied for nutrients entering the NSW Murray–Darling Basin Porous Rock SDL resource units as legislated or other risk based management is in place to reduce the likelihood of nutrients entering the groundwater sources and legislated risk based management is in place that adequately manages the raw water being of a quality unsuitable for treatment for human consumption. Local water utilities accessing water for town water supply have a Framework for Management of Drinking Water Quality. The Framework provides a structured risk-based approach to drinking water management. The WSP, WRP, WQMP and information provided from NSW Health, all advise groundwater used for drinking water (not supplied from a drinking water utility) should undergo a comprehensive range of chemical and physical tests prior to use. The water should be retested if there are any changes in water quality, such as the appearance of odours, taste or colour. Local Public Health Units provide testing advice, and the NSW Private Water Supply Guidelines provide information on groundwater, hazards and testing. The risk of consuming contaminated water is reduced by this risk based framework and community advice regarding treatment of groundwater prior to drinking. There are no accredited levers within scope of water planning in NSW to reduce nutrients entering the SDL resource unit from animal faeces and fertilisers. Natural Resource Management agencies provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices that could reduce this risk. These management measures that contribute to reducing nutrients entering the SDL resource unit (C2) include improved land management practices and best farm management practice.). These measures are not accredited as they are not mandated as part of the Basin Plan. They are denoted by N highlighting they are not accredited by the MDBA during assessment of the WRP.

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
				Measures to reduce the mobilisation of nutrients within the SDL unit are established by setting distance rules in the WSP from known contamination sites and plumes to limit mobilisation of plume induced from pumping. The relevant clauses for the WSP are included in Table 6: column 4 for accreditation. As denoted by A.
WQ4	Elevated levels of pesticides and other contaminants (Item 7)	Poor management practices – leaching of pesticides into groundwater.	Table 3: C3: QL5	Measure WQ4 addresses the causes or likely causes of elevated levels of pesticides or other contaminants entering the SDL resource unit (C3). In NSW the Environment Protection Authority (EPA) and local councils implement a risk based approach to the management of potential point source groundwater contaminants under the *Protection of the Environment Operations Act 1997,* the *Local Government Act 1993* and the *Local Government (General) Regulation 2005*. The EPA regulates the proper use of pesticides through the provisions of the Pesticides Act 1999 and Pesticides Regulation 2017. The Australian Pesticides and Veterinary Medicines Authority (APVMA) controls which pesticides are registered and sold in Australia. The EPA administers regulations, and conducts investigations and campaigns, to protect people and animals from being harmed by pesticides. Campaigns focus on educating people about the correct use of pesticides. The EPA also investigates allegations of pesticide misuse and determines whether further compliance and enforcement action is needed. Misuse includes failing to follow label or permit instructions, improper storage of pesticides, placing pesticides or empty pesticide containers in waterways and disposing of a pesticide or its container illegally. Other contaminants or toxicants are regulated under the EPA. The EPA issues environment protection licences to the owners or operators of various industrial premises under the POEO Act. Licence conditions relate to pollution prevention and monitoring. The EPA's risk-based licensing system aims to ensure that all environment protection licensees receive an appropriate level of regulation based on the level of risk they pose. The EPA undertakes risk assessments of all licensed premises in NSW. Based on the results from the risk assessments licensees are allocated an overall environmental risk level. Licensees with a higher risk level will receive an increased level of regulatory and compliance oversight. Industries such as mining may be potential sources of groundwater contamination. All exploration and mining activity in New South Wales (NSW)

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
				must be conducted under an exploration, assessment or mining title. All mining and petroleum projects and most exploration activities require environmental assessment under the Environmental Planning and Assessment Act 1979 (EP&A Act) before they can commence. Water management is considered during the approval process. This stringent regulatory approach works to ensure that all projects, including exploration, mining and petroleum activities, are thoroughly assessed and their environmental impacts are properly regulated and controlled. Potential sources of contamination from mining are mitigated by licencing conditions (EPL) and the Aquifer interference policy. In NSW the EPA implements a risk based approach to the management of potential point source groundwater contaminants under the Protection of the Environment Operations Act 1997. The EPA is responsible for event monitoring as a result of licence compliance issues. Data gathered during monitoring is temporally and spatially localised and not considered representative of the water quality of an SDL resource unit, groundwater source or management zone. As there is no routine water quality monitoring conducted within the WRP area for pesticides and other toxicants, there is insufficient data to conduct a quantitative risk assessment. Additionally, there is inadequate data to ascertain if the EPA's risk management framework is adequate to mitigate the risk of water quality degradation from nutrients entering groundwater sources across individual SDL resource units and the WRP area. In the absence of comprehensive monitoring, NSW considers the EPA's risk based licensing and approval system adequately manages the major causes of water quality degradation from major contaminants (other than salinity) entering the groundwater SDL source units and hence adequately mitigates likelihood. This is noted as a knowledge gap. Should a monitoring program or the acquisition of reliable data from an external source become available in the future, a quantitative risk assessment may be conducted using the improved knowledge which would increase the confidence in the risk outcome. Local water utilities accessing water for town water supply have a Framework for Management of Drinking Water Quality. The Framework provides a structured risk-based approach to drinking water management. The WSP, WRP, WQMP and information provided from NSW Health, all advise groundwater used for drinking water (not supplied from a drinking water utility) should undergo a comprehensive range of chemical and physical

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
				characteristics prior to use. The water should be retested if there are any changes in water quality, such as the appearance of odours, taste or colour. Contact your local Public Health Unit for testing advice and refer to the NSW Private Water Supply Guidelines for information on groundwater, hazards and testing. The risk of consuming contaminated water is reduced by this risk based framework and community advice regarding treatment of groundwater prior to drinking. A quantitative assessment of this risk has not been included in Schedule D of the NSW Murray–Darling Basin Porous Rock WRP as the available data does not adequately characterise the risk across an appropriate scale, however NSW considers there is a potential risk from these contaminants as activities contributing to contamination are present in the WRPA. A qualitative assessment of existing processes based on Department of Planning and Environment - Water groundwater quality specialist expert opinion and available information from other NSW government agencies. As such no data has been reviewed and so a low confidence according to the criteria in Table 2- 4 of the NSW Murray–Darling Basin Porous Rock WRP (Schedule D) applies. A risk rating of Low – QAL has been applied for pesticides and other contaminants entering the NSW Murray–Darling Basin Porous Rock SDL resource units as legislated or other risk based management is in place to reduce the likelihood of contaminants entering the groundwater sources and legislated risk based management is in place that adequately manages the raw water being of a quality unsuitable for treatment for human consumption. There are no accredited levers within scope of water planning to reduce pesticides entering the SDL resource unit. Natural Resource Management agencies provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices that contribute to reducing pesticides and other contaminants entering the SDL resource unit (C3). These include improved land management practices, industry best practice guidelines (e.g., Cotton Australia), improved pesticide handling, application and appropriate disposal of pesticide containers, equipment and waste that pose a risk to groundwater sources. The measures are not accredited as they are not mandated as part of the Basin Plan. They are denoted by N highlighting they are not accredited by the MDBA during assessment of the WRP. Measures to reduce the mobilisation of contaminated sites and plumes within the SDL unit by setting distance rules are established in the WSP. The

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
				distance rules limit the mobilisation of plume induced from pumping. This strategy aims to protect overlying ground and surface water sources and public health and safety by limiting exposure to and mobilisation of contamination sources. Relevant clauses in the WSP are included in Table 6: column 4 (WQMP) for accreditation. As denoted by A.
WQ5	Elevated pathogen counts (Item 9)	Pathogens entering SDL resource units from human and animal waste and sewage discharges.	Table 3: C4: QL5	Measure WQ5 addresses the causes or likely causes of elevated pathogen counts entering the SDL resource unit (C4). In NSW, the EPA and local councils implement a risk based approach to the management of potential point source groundwater contaminants under the *Protection of the Environment Operations Act 1997*, the *Local Government Act 1993* and the *Local Government (General) Regulation 2005*. The risk of pathogens entering the SDL resource unit via onsite sewage discharges is managed under the local government management framework provided in the application. A risk classification is determined by the local government during the approval phase. Under the Local Government Act 1993, local councils are responsible for regulating the installation, operation and maintenance of septic systems, conducting audits and inspections and keeping a register of systems in use in the council area. Under the *Protection of the Environment Operations Act 1997* (POEO Act), the Environment Protection Authority (EPA) uses a risk-based licensing system that aims to ensure that all environment protection licensees receive an appropriate level of regulation based on the environmental risk of the activity taking into account site specific risks. Licenced industries include sewage treatment plants. Licensing conditions also include a monitoring and reporting component for compliance. Licence conditions relate to pollution prevention and monitoring. The EPA's risk-based licensing system aims to ensure that all environment protection licensees receive an appropriate level of regulation based on the level of risk they pose. The EPA undertakes risk assessments of all licensed premises in NSW. Based on the results from these EPA risk assessments, licensees are allocated an overall environmental risk level. Licensees with a higher risk level will receive an increased level of regulatory and compliance oversight. The EPA is responsible for event monitoring as a result of licence compliance issues. Data gathered during monitoring is temporally and spatially localised and not considered representative of the water quality of an SDL resource unit,

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
				groundwater source or management zone. As there is no routine water quality monitoring conducted within the WRP area for contaminants other than salinity, there is insufficient data to conduct a quantitative risk assessment. Additionally, there is inadequate data to ascertain if the EPA's risk management framework is adequate to mitigate the risk of water quality degradation across individual SDL resource units and the WRP area. In the absence of comprehensive monitoring, NSW considers the EPA's risk based licensing and approval system and local councils' regulation of onsite sewage management adequately manages the major causes of water quality degradation from major contaminants (other than salinity) entering the groundwater SDL source units and hence adequately mitigates likelihood. This is noted as a knowledge gap. Should a monitoring program or the acquisition of reliable data from an external source become available in the future, a quantitative risk assessment may be conducted using the improved knowledge which would increase the confidence in the risk outcome. Local water utilities accessing water for town water supply have a Framework for Management of Drinking Water Quality. The Framework provides a structured risk-based approach to drinking water management. The WSP, WRP, WQMP and information provided from NSW Health, all advise groundwater used for drinking water (not supplied from a drinking water utility) should undergo a comprehensive range of chemical and physical tests prior to use. The water should be retested if there are any changes in water quality, such as the appearance of odours, taste or colour. Local Public Health Units provide testing advice, and the NSW Private Water Supply Guidelines provide information on groundwater, hazards and testing. The risk of consuming contaminated water is reduced by this risk based framework and community advice regarding treatment of groundwater prior to drinking. A quantitative assessment of this risk has not been included in Schedule D of the NSW Murray–Darling Basin Porous Rock WRP as the available data does not adequately characterise the risk across an appropriate scale, however NSW considers there is a potential risk from these contaminants as activities contributing to contamination are present in the WRPA. A qualitative assessment of existing processes based on Department of Planning and Environment - Water groundwater quality specialist expert opinion and available information from other NSW government agencies. As such no data has been reviewed and so a low confidence according to the criteria in Table

Objective	Type of WQ degradation (Schedule 10)	Cause of WQ degradation	Linkage	Explanatory note
				2- 4 of the NSW Murray–Darling Basin Porous Rock WRP (Schedule D) applies. A risk rating of Low – QAL has been applied for pathogens entering the NSW Murray–Darling Basin Porous Rock SDL resource units as there are legislated or other risk based management is in place to reduce the likelihood of contaminants entering the groundwater sources and there are legislated risk based management is in place that adequately manages the raw water being of a quality unsuitable for treatment for human consumption. There are no accredited levers within scope of water planning in NSW to reduce pathogens entering the SDL resource unit from animal waste. Natural Resource Management agencies provide advisory services that support and enable landholders to implement management measures that contribute to reducing pathogens entering the SDL resource unit (C2) from animal waste. These include improved land management practices, best farm management practice including the fencing of rivers to control stock access. Animal faeces in streams are a risk factor to groundwater in connected systems. NSW These measures are not accredited as they are not mandated as part of the Basin Plan. They are denoted by N highlighting they are not accredited by the MDBA during assessment of the WRP. Measures to reduce the mobilisation of pathogens within the SDL unit are established by setting distance rules in the WSP from known contamination sites and plumes to limit mobilisation of plume induced from pumping. The relevant clauses for the WSP are included in Table 6: column 4 for accreditation. As denoted by A.