BASIN PLAN IMPLEMENTATION

Water quality management plan for the Intersecting Streams surface water resource plan area SW13

Schedule G

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Acknowledgements

Senior Traditional Owners of the Gomeroi/Kamilaroi, Guwamu/Kooma, Budjiti, Euahlayi, Kunja, Murrawarri, Ngemba and Barkandji Nations

NSW Energy, Environment and Science – Biodiversity and Conservation

NSW Department of Primary Industries Agriculture

NSW Department of Primary Industries Fisheries

NSW Department of Primary Industries Local Land Services

Aboriginal acknowledgement

New South Wales Government proudly acknowledges the First Nations community of NSW and their rich and diverse culture and pay respect to their Elders past, present and future.

NSW acknowledges Aboriginal people as Australia's First Peoples practicing the oldest living culture on earth and as the Traditional Owners and Custodians of the lands and waters on which we rely.

We acknowledge the people of the Gomeroi/Kamilaroi, Guwamu/Kooma, Budjiti, Euahlayi, Kunja, Murrawarri, Ngemba, and Barkandji Nations hold the land and waters of the Intersecting Streams water resource plan area of spiritual, cultural, customary and economic importance.

We recognise the intrinsic connection of Traditional Owners to Country and acknowledge their contribution to the management of the Intersecting Streams landscape and natural resources.

NSW 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.

We thank the Elders, representatives of the Gomeroi, Guwamu/Kooma, Budjiti, Euahlayi, Kunja, Murrawarri, Ngemba and Barkandji Nations and Aboriginal community who provided their knowledge throughout the planning process.

Notes on Terminology

'Gomeroi', as recommended by the Gomeroi Nation Organiser and used for Native Title, is the name for the people and nation consulted during the planning process. Although this term was accepted throughout most of the nation, those in Walgett prefer 'Gamilaraay'. Historically, 'Kamillaroi' has been used.

Contents

1. About this plan

1.1. Purpose

The purpose of this plan is to contribute to the sustainable and integrated management of water resources in the Intersecting Streams surface water resource plan area (Intersecting Streams) 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;

- Fulfil First Nation peoples spiritual, cultural customary and economic values
- Protect and improve ecological processes and healthy aquatic ecosystems
- Provide essential and recreational amenities for rural communities
- Assist agricultural enterprises to be productive and profitable

This plan supports the Intersecting Streams surface water resource plan and Long term water plan. It uses best available information to maintain, implement or develop measures to improve water quality for water resource managers.

1.2. What water does this plan apply to?

The Intersecting Streams water quality management plan applies to all surface waters located in the Intersecting Streams water resource plan area (Figure 1-1). This includes the Intersecting Streams regulated and unregulated river water sources.

The *Intersecting Streams surface water resource description* (DPIE Water, 2019) provides a detailed description of the plan area including history, land use and topography, environmental assets and river operations and management.

1.3. The Basin Plan 2012 (Water Act 2007)

The Basin Plan provides a coordinated approach to managing Basin 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, Department of Planning and Environment Water are working together with agencies including Energy, Environment and Science and DPI Fisheries to implement the plan. It requires NSW to develop water quality management plans for each water resource plan area within the Murray-Darling Basin.

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

BASIN PLAN 10.29 This water quality management plan for the Intersecting Streams water resource plan area (SW13) has been prepared to meet the requirements of Chapter 10, Part 7 of The Basin Plan.

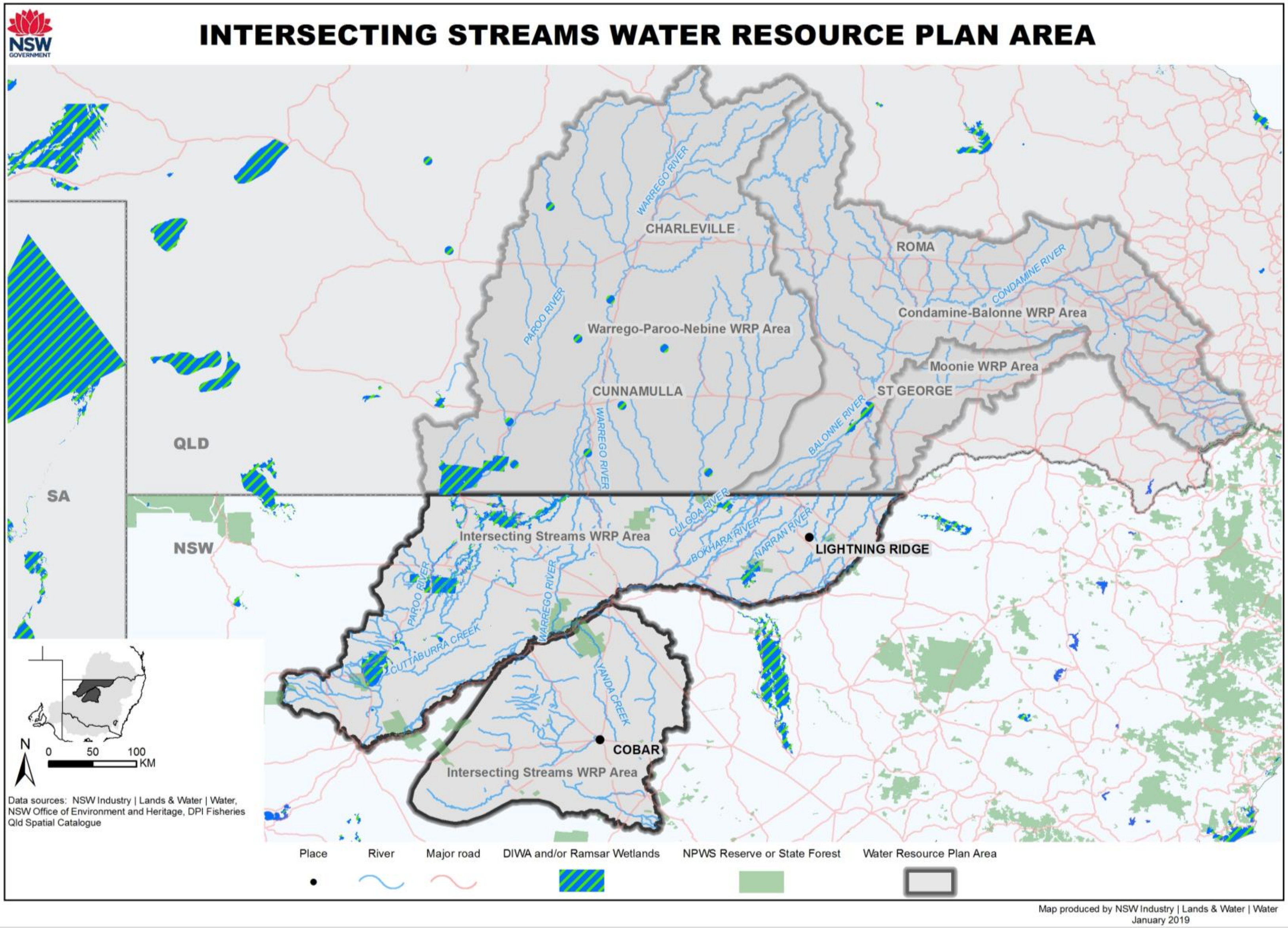


Figure 1-1: SW13 Intersecting Streams water resource plan area

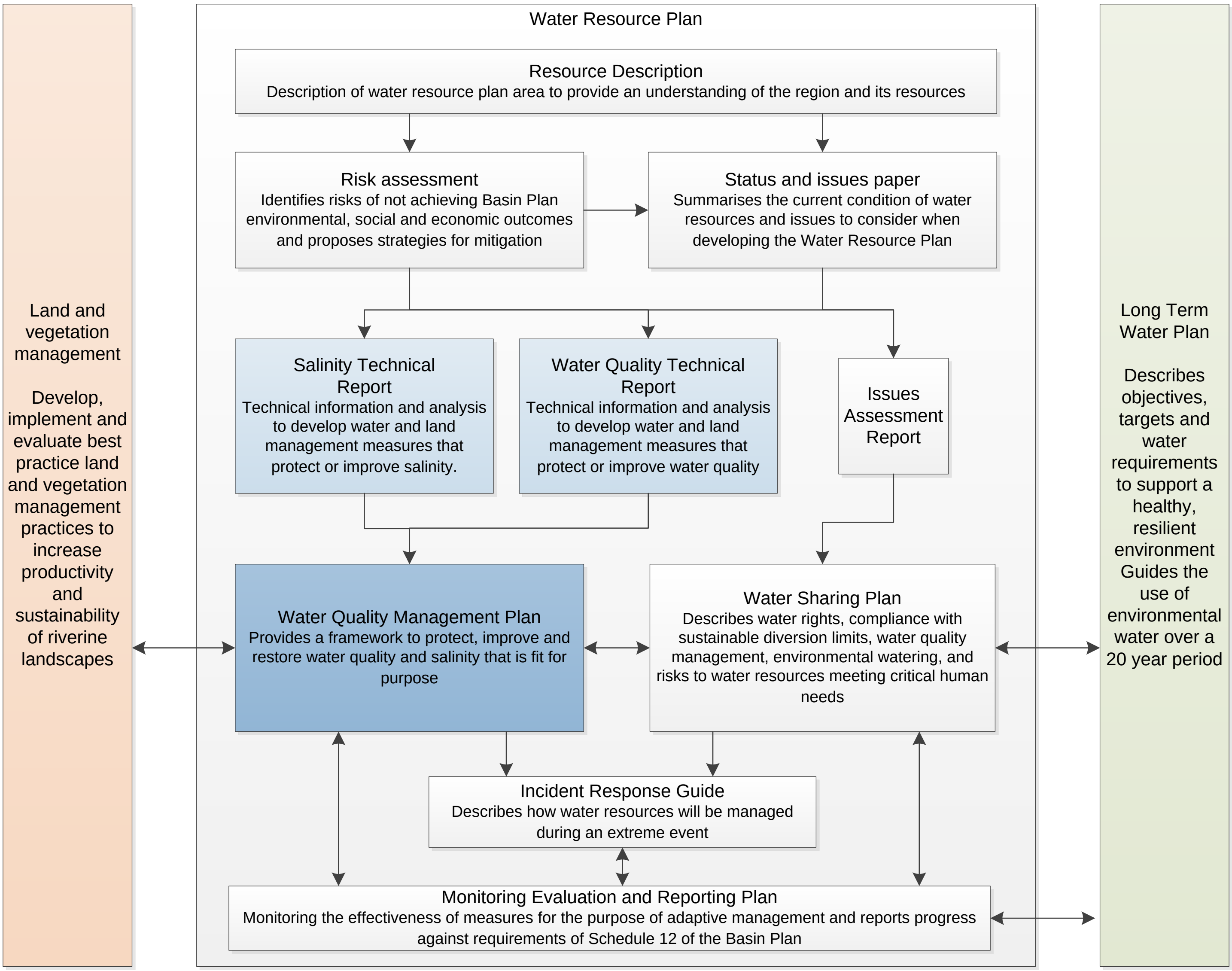


Figure 1-2: Flow diagram illustrating the components of the SW13 Intersecting Streams water resource plan

Table 1-1: Basin Plan requirements for water resource plans

Document	Basin Plan Requirement
Intersecting Streams water resource plan - surface water resource description.	Not accredited under Basin Plan. Supplements water quality technical report, salinity technical report, risk assessment and status and issues paper.
Intersecting Streams water resource plan surface water status and issues paper.	Supplements water resource plan.
Risk assessment for the Intersecting Streams surface water resource plan area.	Chapter 9 Section 9.02, 9.04 - 9.08, 9.18. Chapter 10 Section 10.30 - 10.32, 10.41 - 10.43. Chapter 4 Section 4.02, 4.03 Supplements status and issues, WRP and WQMP.
Intersecting Streams surface water incident response guide	Chapter 10 Section 10.51.Supplements WQMP describes options for managing extreme water quality events, eg blackwater
Intersecting Streams surface water salinity technical report	Chapter 9 Section 9.02. Chapter 10 Section 10.30, 10.42. Supplements the WQMP, risk assessment and status and issues paper.
Intersecting Streams surface water quality technical report	Chapter 9 Section 9.02. Chapter 10 Section 10.30, 10.42. Supplements the WQMP, risk assessment and status and issues paper.
Intersecting Streams surface water quality management plan	Chapter 9 Section 9.02, 9.04- 9.09, 9.14, 9.16 - 9.19. Chapter 10 Section 10.29 - 10.34, 10.42, 10.43, 10.51 - 10.55.Supports Long term water plan and water sharing plan.
Intersecting Streams surface water sharing plan	Chapter 10 Section 10.41. Chapter 5 Section 5.02. Chapter 4 Section 4.02.
Intersecting Streams monitoring, evaluation and reporting plan	Chapter 10 Section 10.33.

1.4. NSW water quality legislative context

The management of water quality in NSW is provided for across several legislative and regulatory instruments and agencies. Figure 1-3 summarises the objectives of each instrument and the relationship to water quality management in NSW.

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

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

Fisheries Management Act 1994
Fisheries Management (General) Regulation 2010
NSW Department of Primary Industries - Fisheries

OBJECTIVE: to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations.

This includes water quality management provisions to ensure suitable habitat for fish

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 1-3: Summary of major water quality legislation and regulations in NSW

2. Developing water quality management plans in NSW

2.1. Water quality

Water quality is defined in terms of physical, chemical and biological characteristics of water. When determining if water quality is good or bad, it is important to consider its purpose and use. Water quality may be acceptable for one purpose but not another.

For example, water may be of a suitable quality to irrigate crops, but may not be able to support a healthy population of fish.

In this plan, water quality degradation or poor water quality is defined as elevated levels of nutrients, turbidity, blue-green algae, salinity, toxicants and pathogens or temperature, pH and dissolved oxygen outside specified ranges (Appendix A).

Water quality is dynamic. It changes with time, location, climate and land use. In this plan, water quality is considered in three different ways to help determine the most appropriate management strategy.

Long term water quality	• Long term average trends over a period of months to years
Poor water quality event	• Water quality issues that are generally non ongoing such as algal blooms or blackwater events. While these events may be short lived, their effects may be long term
Ecosystem processes	• Water quality impacts fundamental ecological functions of rivers and catchments. These are less easy to define as 'good' or 'bad' and often involve complex inter-relationships.

How is water quality condition assessed?

Water quality condition and issues were assessed using a catchment stressor identification process (Figure 2-1). It considers possible causes of poor water quality, weighs best available evidence and suggests likely causes of water quality decline.

The process is intended to be iterative and uses conceptual mapping, data evaluation, literature reviews, GIS mapping and input of local and expert knowledge. The complete results of this process can be found in the *Water quality technical report for the Intersecting Streams water resource plan area (SW13)* (2018).

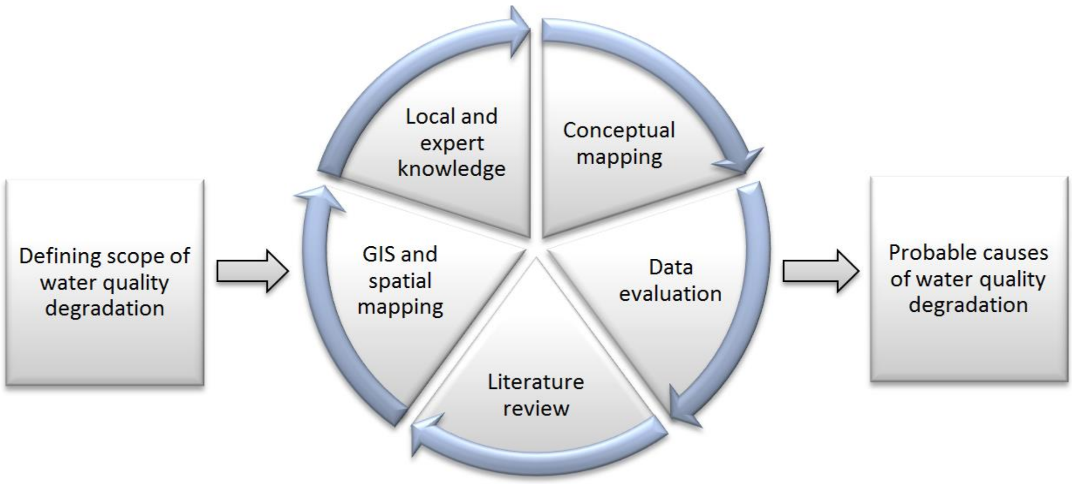


Figure 2-1: Catchment stressor identification process

2.2. Salinity

Salinity is the accumulation of salt in land and water to a level that impacts the natural and built environment. Salinity occurs naturally in many parts of the Australian landscape. However, in many cases has been exacerbated where human activities accelerate the mobilisation and accumulation of salt. Salinity is a dynamic process with the potential for change over time as a result of land use management practices.

The processes of salinity vary at different scales, such as individual sites, regions or whole catchments. Impacts can be close to or distant from the cause depending on the landscape and groundwater characteristics. Salinity impacts can be found on land, in-stream water quality (electrical conductivity) and through salt load export via streams and rivers.

How is salinity assessed?

Two approaches have been used to assess salinity hazards in the Intersecting Streams;

- Hydrogeological landscapes framework (HGL) – A hydrogeological landscapes framework considers land salinity, salt load and instream salinity (electrical conductivity) to determine the salinity hazard of an area or Hydrological landscape unit. Assessment of each unit (Figure 2-2) integrates information including geology, soils, landforms, climate and vegetation.
- Salinity modelling – Long term salinity data has been analysed incorporated into salinity models. Both discrete and continuous data sets are used to increase accuracy of the models.

Using a combined approach leads to a more informed assessment of the salinity issues in the Intersecting Streams. It also helps to identify likely causes of salinity issues and propose effective solutions.

The complete results of this process can be found in the *Salinity technical report for the Intersecting Streams water resource plan area (SW13)* (2018).

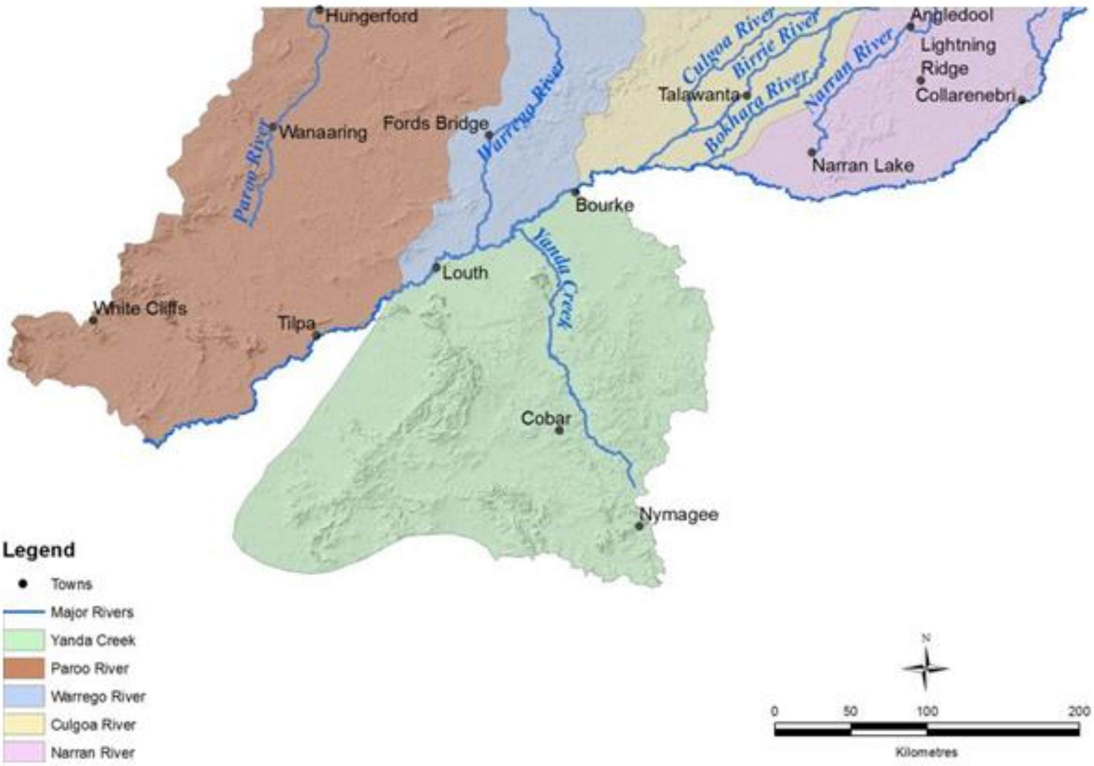


Figure 2-2 Hydrological landscape units of the Intersecting Streams water resource plan area

2.3. NSW water quality index (WaQI)

The WaQI is a water quality index developed for water quality management planning in NSW.

A water quality index is a tool to communicate complex and technical water quality data in a simple and consistent way. It is useful for presenting information with different characteristics (for example, turbidity in a montane vs lowland river) or units (for example, mg /L and % saturation) on a common scale. It is also useful as a reporting tool for showing changes in water quality over the life of a water quality management or water sharing plan.

The WaQI is a single score between 1-100 (Figure 2-3). A score can be calculated both for individual water quality parameters (salinity for irrigation, temperature and harmful algal blooms in recreational waters) and for an overall integrated score for water-dependent ecosystems (dissolved oxygen, turbidity, pH, total nitrogen and phosphorus) (Figure 3-1). The WaQI scores water quality data collected by the NSW State water quality assessment and monitoring program against appropriate water quality targets (See Section 5).

More information on how the WaQI is used in water quality management can be found in Appendix C.

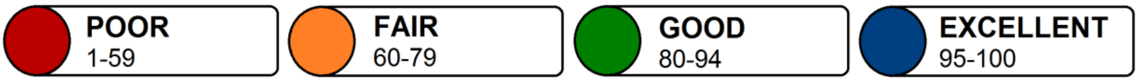


Figure 2-3: NSW Water quality index (WaQI) scoring categories

3. Water quality condition and issues in the Intersecting Streams

Water quality condition in the Intersecting Streams varies from fair to good. Figure 3-1 shows the overall water quality condition as assessed against Basin Plan targets set out in Section 6 of this plan. Figure 3-2 shows the overall salinity hazard of the Intersecting Streams as assessed using the hydrogeological framework.

Water quality degradation occurring within the catchment results from a combination of factors. These include alteration to natural flow regimes, changes to catchment conditions and land use change.

Water quality attributes in the Intersecting Streams are strongly correlated to flow. High flow from rainfall and runoff results in higher turbidity, nutrients and possibly pesticides and pathogens, but lower electrical conductivity (in stream salinity).Monitoring sites are located toward the end of each of the major river systems where results reflect the cumulative impacts of land use, soil disturbance and human activity on water quality.

In unregulated catchments, greater emphasis must be focused on preventing pollutants such as sediment and nutrients from entering waterways through land, soil and vegetation management. Sediment is a major transport mechanism for many pollutants.

Increasing groundcover, vegetated buffer strips and good agronomic practices in conjunction with the management of riparian vegetation to reduce stream bank erosion provide simple and effective means to improve water quality.

More detailed information on water quality condition and issues in the Intersecting Streams can be found in the *Water quality technical report for Intersecting Streams water resource plan area (SW13)* and *Salinity technical report for Intersecting Streams water resource plan area (SW13).*

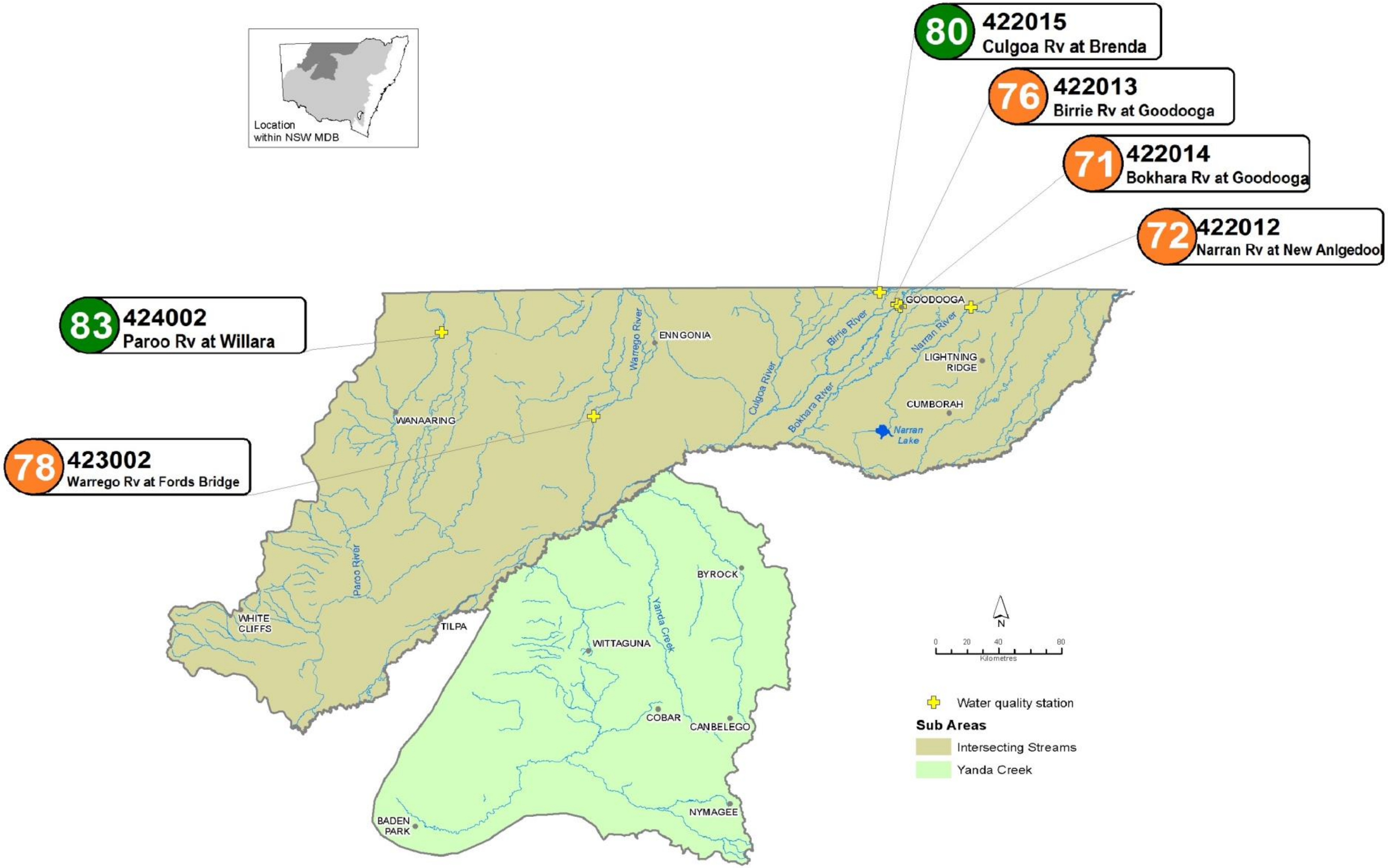


Figure 3-1: Intersecting Streams water resource plan area WaQI scores

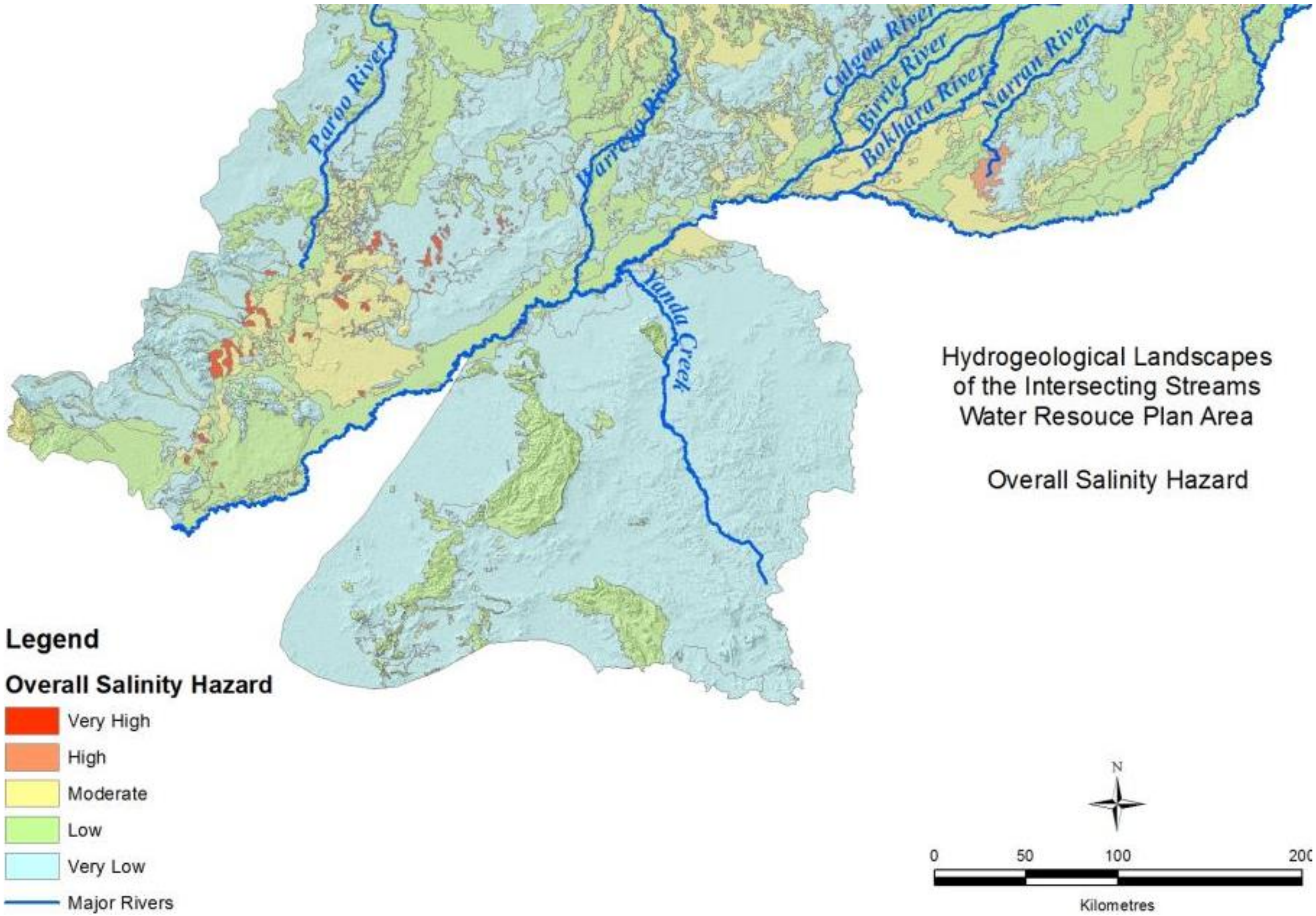


Figure 3-2 Overall salinity hazard of the Intersecting Streams using a hydrogeological landscapes (HGL) framework

3.1. Causes of water quality degradation

BASIN PLAN 10.30 The causes and likely causes of water quality degradation in the Intersecting Streams are presented in Table 3-1. These causes have been prepared having regard to the *Risk assessment for the Intersecting Streams surface water resource plan area SW13 (2019)* and key causes of water quality degradation identified in Chapter 9, Part 2 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 3-1 presents the causes and likely causes of water quality degradation in the Intersecting Streams based on best available water quality data and knowledge

Table 3-1 Causes and likely causes of water quality degradation in the Intersecting Streams 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	Risk assessment identification
Elevated levels of salinity (Electrical conductivity - EC)	The process of mobilisation of salt stores in the landscape and geological predisposition to salinity development, including by: Landscape situation • Complex geological landscape • Salt storage mechanisms in geology • High salt store in soils and regolith • Landforms conducive to salinity development • Rainfall 400-800 mm zone - risk area Land management practices that replace deep-rooted vegetation with shallow rooted crops and pastures, resulting in increased rainfall recharge displacing saline groundwater to surface water systems • Land use change – clearing and cropping • High recharge to soils The following processes and activities relating to water flow or water management:	**All areas** River salinity is generally not a major water quality issue in the Intersecting Streams. Electrical conductivity in the Narran, Culgoa and Warrego Rivers fluctuates throughout the years, with no results exceeding a level generally considered safe for agriculture and irrigation. The ephemeral nature of the Intersecting Streams can result in higher salinity readings as salts in disconnected pools become concentrated Salinity modelling is limited in this area due to intermittent flows, limited monitoring data and very limited irrigation. **Narran River** The Narran River has fresh water with low electrical conductivity and low salt load. Narran Lakes	AQUATIC ECOSYSTEMS **Risk: E(WQ-S)** **High risk** • Narran River at New Angledool 2 • Culgoa River at Brenda • Warrego River at Barringun • Cuttaburra Creek at Turra IRRIGATION **Risk: O(WQ-I)** There are no Irrigation Infrastructure Operators in the Intersecting Streams

Type of water quality degradation	Cause of water quality degradation	Where it occurs	Risk assessment identification
	• Saline groundwater and surface water discharges into surface water systems. • Increased deep drainage below irrigated agricultural land displacing saline groundwater to surface water systems • Saline surface and shallow groundwater drainage from irrigated agricultural land into surface water systems • Irrigation at high salinity risk locations without adequate drainage management • De-watering of saline groundwater which mobilises salt into surface water systems • Reduction in stream flows, limiting the dilution of salinity With respect to soil degradation, the use of water with a high a ratio of sodium to calcium and magnesium for irrigation.	concentrate local salinity with salt marsh and salt tolerant fringe vegetation naturally occurring **Culgoa River** Long periods of low rainfall can cause a drop in shallow groundwater levels causing fresher surface water and saline groundwater to disconnect. The return of wetter conditions and flooding in 2010-2011 inundated floodplain areas adjacent to the river channel, mobilising salts stored in the soil profile and recharging shallow water tables and reconnecting them with surface water. This caused an increase in electrical conductivity, particularly in the Culgoa River in 2012. These salts were then further concentrated by evaporation. The electrical conductivity then started to decline in 2013, following the return of dryer conditions. Future monitoring will show whether recent salinity observations continue to decrease as shallow saline groundwater aquifers decline during dryer conditions. **Warrego and Paroo Rivers** The Warrego and Paroo Rivers have fresh water with low electrical conductivity and low salt load. **Yanda Creek** Very low salinity impact.	

Type of water quality degradation	Cause of water quality degradation	Where it occurs	Risk assessment identification
Elevated levels of suspended sediment	Loss of vegetation in the catchment and/or riparian zones leading to increased hillslope, gully and bank erosion. Land management practices: • Inappropriate frequency, timing and location of cultivation • Overgrazing of catchments and grazing of riverbanks and floodplains • Poor soil conservation practices • 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	**All Areas** The Intersecting Streams are extensively grazed, creating low and patchy ground cover. This practice leaves soils vulnerable to increased hillslope and gully erosion. Land and vegetation management is the key cause of sediment entering waterways. The bulk of suspended solids are made up of very fine clay particles. They are able to remain in suspension in the water column, even when the river is not flowing, giving the river a muddy or turbid appearance.	AQUATIC ECOSYSTEMS **Risk: E(WQ)** **High risk** • Warrego River at Fords Bridge Bywash **Medium Risk** • Birrie River near Goodooga • Culgoa River at Brenda
	Water management practices: • Rapid drawdown of water within a surface water resource • The volume or manner of release of water, resulting in bank or bed erosion	**All areas** It is unknown if rapid drawdown of water through extraction is a cause of increased turbidity. There are no major storages in the Intersecting Streams that release water.	
	Wave wash	Potential in recreational boat use areas	
	Grazing practices, presence of feral pigs, stock trampling causing removal of groundcover, pugging, destabilising soils and erosion of stream banks.	**All areas, particularly in the floodplains.**	
	Presence of invasive noxious fish Carp (*Cyprinus carpio*)	**All areas** Carp are common throughout the area.	

Type of water quality degradation	Cause of water quality degradation	Where it occurs	Risk assessment identification
Elevated levels of nutrients [Total Nitrogen (N), Total Phosphorus (P)]	Nutrients entering Intersecting Streams water resources through both point and diffuse sources. The key sources of nutrients are: • Soil and organic matter • Animal waste • Fertilisers • Sewage and industrial discharge	**All areas** Increased nitrogen and phosphorus concentrations in the Intersecting Streams are generally caused by runoff and erosion during rainfall events when there are high flows. Wherever there is access of stock and animals to rivers and streams it is expected that animal waste will be a source of nutrients.	AQUATIC ECOSYSTEMS **Risk: E(WQ)** **High risk** • Narran River at New Angledool (N) • Bokhara River near Goodooga (N) • Culgoa River at Brenda (N) **Medium Risk** • Birrie River near Goodooga (N) and (P) • Narran River at New Angledool (P) • Bokhara River near Goodooga (P) • Culgoa River at Brenda (P)
	Nutrients from water storages released as a result of storage management practices	**Not applicable** There are no large storages that release stored water within the Intersecting Streams.	

Type of water quality degradation	Cause of water quality degradation	Where it occurs	Risk assessment identification
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)	**All areas** The Intersecting Streams is sparsely populated and has only a few water bodies that have high levels of recreational usage. Many streams in the area, particularly in the western parts, are highly turbid. This creates unfavourable conditions for algal blooms. Algal blooms can occur anywhere in this zone, but have been more commonly detected in weir pools, such as Narran River at New Angledool and Bokhara River at Goodooga. The Bohkara and Narran Rivers are monitored during periods of potential high risk. Between 2006 and 2014 only one harmful algal bloom (amber alert) has been issued for these water sources despite nutrient rich flows entering the system from the upper catchment.	RECREATIONAL **Risk: O(WQ-BGA)** **Low Risk** All areas
Water temperature outside of natural ranges	Below natural ranges (cold water pollution) The release of stored water from below the thermocline from large water storages in spring, summer and autumn	**Not applicable** There are no large storages that release stored water within the Intersecting Streams.	AQUATIC ECOSYSTEMS **E(WQ-CWP)** **E(WQ-WWP)**

Type of water quality degradation	Cause of water quality degradation	Where it occurs	Risk assessment identification
	Above natural ranges • The release of stored water from large water storages in winter • The removal of shading riparian vegetation • Reduced flow	**All areas** There are no large storages that release stored water within the Intersecting Streams. Clearing of vegetation in the riparian zone and poor geomorphic condition can lead to increased sunlight reaching the water surface, resulting in increased water temperatures. The extent and scale of this form of warm water pollution is unknown.	There are no structures that are likely to cause cold water or warm water pollution within the Intersecting Streams
Dissolved oxygen outside of natural ranges	Micro-organisms consuming organic matter and depleting oxygen at a rate faster than it can be replenished.	**All areas** The ephemeral nature of the Intersecting Streams can create a combination of low flows, turbid waters and elevated water temps which can result in lower dissolved oxygen levels. The dissolved oxygen levels at most sites were within the target range for the majority of the data period. However during low and cease to flow periods dissolved oxygen becomes unpredictable and fluctuates from very low to very high.	AQUATIC ECOSYSTEMS **Risk: E(WQ)** **Medium Risk** • Culgoa River at Brenda • Warrego River at Fords River Bywash
	Eutrophication leading to excessive plant growth causing high diurnal variations in dissolved oxygen levels, both above and below natural ranges.	**Narran River weir pool** Elevated dissolved oxygen is sometimes recorded in Narran Weir Pool at New Angledool during low flows. Runoff containing high nutrient levels into the weir may provide suitable conditions for plant growth.	
	Bottom release from, or overturn within, stratified water storage such as a dam or weir.		

Type of water quality degradation	Cause of water quality degradation	Where it occurs	Risk assessment identification
	Hypoxic low flow or blackwater events • Release of water following extended dry or low flow periods. • Less frequent flooding due to flow management allows increased organic material to accumulate on river banks and floodplains.	**All areas** The Intersecting Streams often become disconnected forming a series of standing pools. The quality of the water in these pools can be poor with very low dissolved oxygen water sitting in a layer on the bottom. Hypoxia can occur when the stagnant pools are flushed by a natural or managed flow event following an extended dry period. Blackwater events have not been recorded in the Intersecting Streams.	
pH outside of natural ranges	The exposure to the air of soils containing iron sulphide minerals. Agricultural practices that lead to the acidification of soils Eutrophication leading to excessive plant growth causing high diurnal variation in pH	**All areas** The pH is relatively consistent throughout the Intersecting Streams and should not impact on the health of aquatic ecosystems or agricultural enterprises. Soil pH is highest in the eastern water sources and on the southern floodplains adjacent to the Barwon-Darling River, where it is more alkaline than acidic. **Paroo Wetlands** There is some evidence that acid sulfate soil materials are present in the wetlands. There has not been extensive assessment of risk to pH due to priority when considering the risks to the wetlands as a whole.	AQUATIC ECOSYSTEMS **Risk: E(WQ)** **Medium Risk** • Culgoa River at Brenda

Type of water quality degradation	Cause of water quality degradation	Where it occurs	Risk assessment identification
Elevated levels of pesticides and other contaminants	Poor management practices including the following • Pesticide spray drift • Allowing pesticides or other contaminants into surface water runoff • Allowing pesticides or other contaminants to leach into ground water • Allowing erosion of contaminated soil • Inappropriate disposal of pesticides • Inappropriate disposal and management of industrial and other waste (including from mining and coal seam gas extraction).	**All areas** Department of Planning and Environment Water does not currently monitor for pesticides or contaminants in the Intersecting Streams. With chemical use increasing in the agricultural sector for the control of invasive and pest flora and fauna species, it can be expected that residues from these substances may be present in the waterways of the Intersecting Streams.	AQUATIC ECOSYSTEMS **Risk: E(WQ)** **Medium Risk** All areas

Type of water quality degradation	Cause of water quality degradation	Where it occurs	Risk assessment identification
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	**All areas** Department of Planning and Environment Water does not currently monitor for pathogens in the Intersecting Streams. Higher counts of pathogens are expected following rainfall from runoff and stormwater flushing to rivers and streams. High counts may also be experienced during low flow flows, when conditions such as warmer temperatures and point source pollution encourage pathogens to multiply. Wastewater treatment facilities occur in most towns. Discharges of treated effluent (sewage) into waterways are controlled through environment protection licences under the Protection of the Environment Operations Act 1997. Wherever there is access of stock and animals to rivers and streams it is expected that pathogens are present.	AQUATIC ECOSYSTEMS **Risk: E(WQ)** **Medium Risk** All areas

4. Managing water quality in the Intersecting Streams

4.1. Basin Plan water quality objectives

The water quality objectives presented in Table 4-1 apply to the waters of the Intersecting Streams 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**).

BASIN PLAN 10.52, 9.03-9.09 Water quality objectives for Intersecting Streams water resources are listed in Table 4-1. These objectives reflect those set out for Basin water resources.

Table 4-1 Basin Plan water quality objectives for the Intersecting Streams

CODE	Basin Plan water quality objective	Basin Plan
	Maintain water quality to protect First Nations people's water dependent values and uses	**10.52**
	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	
	Maintain water quality to protect and restore water dependent ecosystems	**9.04**
	The objective is to ensure water quality is sufficient to • Protect and restore ecosystems and ecosystem functions • Ensure ecosystems are resilient to climate change • Maintain the ecological character of Ramsar wetlands	
	Maintain the quality of raw surface water for treatment for human consumption	**9.05**
	The objective is to minimise the risk that the quality of raw water taken for human consumption results in: • Adverse human health effects • 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.	
	Maintain the quality of surface water for irrigation use	**9.06**
	The objective is to ensure the quality of surface water, 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. This objective applies at sites where water is extracted by an irrigation infrastructure operator for the purpose of irrigation (see section 5.1.3).	
	Maintain the quality of surface water for recreational use	**9.07**
	The objective ensures a low risk to human health from water quality threats posed by exposure through ingestion, inhalation or contact during recreational use of Intersecting Streams Water resources	
	Maintain good levels of water quality	**9.08**
	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 6.	

4.2. Measures that contribute to achieving Basin Plan water quality objectives

Ensuring water quality remains fit for purpose and able to achieve objectives requires coordinated water and land resource management. The measures presented in Table 4 consist of plans, strategies and frameworks developed by NSW Government agencies to contribute to achieving the water quality objectives (Section 4.1).

> **BASIN PLAN 10.33** Measures contributing to water quality objectives are listed in Table 4-2. These measures have been prepared having regard to the causes of water quality degradation listed in Table 3-1 and the water quality targets listed in Section 5.

Table 4-2 Measures that contribute to achieving Basin Plan water quality objectives in the Intersecting Streams

Objectives	Strategies, plans and frameworks
	**Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011**
	The *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* aim to protect water resources in river and groundwater systems for the long term and provide a critical balance between water users and the environment. They establish 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
	**Intersecting Streams long term water plan & Intersecting Streams annual environmental water use plan**
	The *Intersecting Streams long term water plan* draws together local, traditional and scientific knowledge to guide the management of environmental water over the longer term. It aims to improve the way water is managed to maximise river and wetland health outcomes from all available water within and between catchments. The plan sets objectives, targets and watering requirements for plants, waterbirds, fish and ecosystem functions. The Intersecting Streams annual environmental water use plan describes the key planned watering actions for the year based on resource availability scenarios.
	**Western local strategic plans 2016-2021**
	The *Western Local strategic plan* assists Local Land Services to achieve its vision of resilient communities in productive healthy landscapes. They align with the Local Land Services State Strategic Plan and exist as part of an overall framework that links NSW, Australian and Local Government plans and initiatives. The plans identify degradation in water quality as one of the key threats and challenges facing the region.
	**The Paroo River Intergovernmental Agreement 2003**
	The *Paroo River Intergovernmental Agreement 2003* between Queensland and New South Wales recognises the important social, environmental, economic and cultural values of the Paroo River system that need to be conserved, promoted or restored. The agreement provides for the development and implementation of policies and strategies concerning water resources, which affect the management of the quantity or quality of water in the river system or the aquatic ecosystems, to avoid or eliminate adverse cross-border impacts.

Objectives	Strategies, plans and frameworks
	The Basin salinity management strategy 2030 (BSMS2030)
	The *Basin salinity management strategy 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 Draft algal risk management sub plan
	The *NSW Draft algal risk management sub plan* describes the overall strategies and responsibilities to minimise the risk of harmful algal blooms in NSW water bodies. The guidelines provide a regional risk assessment framework to assist with an effective management response to algal blooms. They aim to minimise the impact of blooms by providing adequate warning to the public ensuring their safety in recreational situations and for stock and domestic use.
	NSW Safe and Secure Water Program
	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.
	National carp control plan (Cwth)
	The Fisheries Research and Development Corporation is leading The National Carp Control Plan (NCCP) on behalf of the Australian Government. The NCCP aims to help recover the health of Australian waterways and aquatic biodiversity by developing an integrated strategy for the control of carp impacts in Australia. It will use thorough and measured approaches, ensuring the benefits and risks of carp biocontrol are understood to ensure optimum outcomes for Australia.
	NSW Control plan for the noxious fish Carp (*Cyprinus carpio*)
	The NSW control plan brings the most up-to-date information about the biology and impacts of carp and outlines what is being done, or should be done, to stop further spread, control the size of populations, better understand carp and increase the understanding and involvement of the community.
	Building a fish friendly NSW - NSW Fish habitat strategy (2017 – 2027)
	The NSW Fish Habitat Strategy provides a 10 year framework for strategic investment in vital natural infrastructure to grow economic, social and environmental returns for stakeholders and regional communities.

Objectives	Strategies, plans and frameworks
	**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 the Intersecting Streams 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.

4.3. Strategies to address risks of water quality degradation

The strategies presented in Table 4-3 have been developed to address moderate and high risks and knowledge gaps identified in the *Intersecting Streams risk assessment* and *Water quality and Salinity technical reports*.

A decision tree process was used to assess risks of water quality being unsuitable for use and prioritise mitigation strategies (Appendix D). Strategies are then discussed through consultation with the DPIE - Water, the MDBA and other relevant stakeholders.

Based on the water quality data and information available, targeted water quality objectives for the Intersecting Streams have been formulated where there are flow 'levers' available to NSW water managers.

In an unregulated catchment, there are very limited opportunities to manage water quality through flow management. Under the current *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources* (2011) pumping is generally not permitted from natural pools when the water level in the pool is lower than its full capacity. The Cease-to-Pump rule ensures that additional pressure is not placed on pools by extracting water when the waterway has stopped flowing.

The Commonwealth Environmental Water Office (CEWO) has water holdings in the Queensland Condamine-Balonne catchment and NSW Warrego and Darling Rivers (Toorale) that must be managed to protect or restore environmental assets. It is not the intent of this plan to propose the use of environmental water to address water quality issues. However, the release of this environmental water for its designated purpose may provide water quality benefits for the Intersecting Streams, such as breaking up stratification in pools, diluting salts, mobilising dissolved organic carbon and making conditions less favourable for harmful algal bloom development. Holders of environmental water must also consider water quality when making flow management decisions to ensure the best possible outcomes for water dependent ecosystems are achieved.

Where appropriate, opportunities for infrastructure, land and vegetation management have been identified.

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

The Intersecting Streams water resource plan area is located within the traditional lands of, and significant to the Gomeroi/Kamilaroi, Guwamu/Kooma, Budjiti, Euahlayi, Kunja, Murrawarri, Ngemba and Barkandji Nations. NSW Department of Planning, Industry and Environment Water has spent time engaging and consulting with Senior Traditional Owners and members of the Nations to identify and record objectives and outcomes in regards to Aboriginal water dependent values and uses within the Intersecting Streams.

This process has also recorded a range of water quality based issues observed by and important to First Nations people within the Intersecting Streams. 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.

BASIN PLAN 10.31 Strategies addressing risks of water quality degradation are listed in Table 4-3. They have been prepared having regard to the causes of water quality degradation listed in Table 3-1 and the water quality targets listed in Section 6. These strategies also contribute to achieving Basin Plan objectives listed in Table 4-1.

A = Strategies for accreditation under the Basin Plan | **N** = Strategies not accredited under the Basin Plan

Table 4-3 Strategies to address risks of water quality degradation in the Intersecting Streams water resource plan area.

Targeted objectives to address risks	Strategies	Water management actions and mechanisms	Management plan
WQ1 Protect, maintain or enhance water quality to ensure it is fit for purpose  **Risk: E(WQ), E(WQ-S), E(WQ-CWP), O(WQ_BGA)**	(1) Provide a regulatory framework for the sustainable extraction and management of water resources for all water users	(a) Implement rules for water sharing, management and operations. These include but are not limited to; - Long term average annual extraction limits - Basic landholder rights - Available water determinations - Granting access licences - System operations rules - Environmental water rules	**N** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011*

Targeted objectives to address risks	Strategies	Water management actions and mechanisms	Management plan
WQ2 Manage water source salinity concentrations and salt mobilisation within Intersecting Streams end-of-valley targets **Risk: E(WQ-S)** *AQUATIC ECOSYSTEMS* ***High risk*** • *Narran River at New Angledool 2* • *Cuttaburra Creek at Turra* • *Warrego River at Barringun* • *Culgoa River at Brenda*	(1) Maintain diffuse distribution of salt load in riverine ecosystems and irrigated land from salt load generating landscapes	(a) Provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices This may include: Vegetation and land use management plan to minimise recharge by areas of salt load generating landscapes Improved water usage and reduction in deep drainage, rehabilitation of saline sites, maximise the delivery of low salinity water, not irrigating with saline or water with a high sodium absorption ratio	**N** Western Local Land Services local strategic plans **N** NSW Fish habitat strategy
		(b) Implement Basin Salinity Management Strategy actions in accordance with the agreed program under the Murray Darling Basin Agreement (Schedule 1 of the *Water Act 2007 (Cth))*	**N** Basin Salinity Management Strategy – BSMS2030
	2) Protect low flow and pool habitats to prevent accelerated rates of drying, deterioration in water quality or loss of connectivity	(a) Implement cease/commence to pump rules on unregulated rivers according to flow class conditions.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 44-46]
		(b) Prohibit new or amended water supply works on the Paroo River Water Source that are capable of taking water from between the bed and the banks of the Paroo River and its tributaries.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 49-50]

Targeted objectives to address risks	Strategies	Water management actions and mechanisms	Management plan
WQ3 Maintain turbidity (T), total nitrogen (N) and total phosphorus (P) within target ranges to minimise eutrophication in the WRP Area.  **Risk: E(WQ)** ***High risk*** • *Narran River at New Angledool (N)* • *Bokhara River at Goodooga (N)* • *Culgoa River at Brenda (N)* • *Warrego River at Fords Bridge Bywash (T)* ***Medium Risk*** • *Narran River at New Angledool (P)* • *Bokhara River at Goodooga (P)* • *Birrie River near Goodooga (T,P,N)* • *Culgoa River at Brenda (T,P)*	(1) Improve the condition of riparian zones, cropping/grazing practices, stock management, potential waste water discharges	(a) No levers within scope of water planning. Natural Resource Management agencies and Industry best management practices, Local Government. Provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices	**N** Western Local Land Services local strategic plans **N** NSW Fish Habitat Strategy **N** *Protection of the Environment Operations Act* (1997) **N** *Local Government Act* (1993)
	2) Protect low flow and pool habitats to prevent accelerated rates of drying, deterioration in water quality or loss of connectivity	(a) Implement cease/commence to pump rules on unregulated rivers according to flow class conditions.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 44-46]
		(b) Prohibit new or amended water supply works on the Paroo River Water Source that are capable of taking water from between the bed and the banks of the Paroo River and its tributaries.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 49-50]
	3) Manage turbidity effects due to high concentrations of the noxious fish carp (*Cyprinus carpio)*	(a) Targeted control activities at designated carp breeding hotspots in wetland areas	**N** NSW Control Plan for the noxious fish carp (*Cyprinus carpio*) **N** National Carp Control Plan

Targeted objectives to address risks	Strategies	Water management actions and mechanisms	Management plan
WQ4 Maintain dissolved oxygen (DO) and pH measurements within target ranges that support water dependent ecosystems.  **Risk: E(WQ)** ***Medium Risk*** • *Culgoa River at Brenda (DO,pH)* • *Warrego River at Fords Bridge Bywash (DO)*	1) Improve the condition of riparian zones, cropping/grazing practices, stock management, potential waste water discharges.	(a) No levers within scope of water planning. Natural Resource Management agencies and Industry best management practices, Local Government. Provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices	**N** Western Local Land Services Local strategic plan **N** NSW Fish habitat strategy **N** *Protection of the Environment Operations Act* (1997) **N** *Local Government Act* (1993)
	2) Protect low flow and pool habitats to prevent accelerated rates of drying, deterioration in water quality or loss of connectivity	(a) Implement cease/commence to pump rules on unregulated rivers according to flow class conditions.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 44-46]
		(b) Prohibit new or amended water supply works on the Paroo River Water Source that are capable of taking water from between the bed and the banks of the Paroo River and its tributaries.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 49-50]

Targeted objectives to address risks	Strategies	Water management actions and mechanisms	Management plan
WQ5 Maintain water temperature in the Intersecting Streams within target ranges that support water dependent ecosystems.	1) Improve the condition of riparian zones to provide shading for rivers and pools	(a) No levers within the scope of NSW water planning. Natural resource management agencies and Industry best management practices, including maintaining riparian zone vegetation cover.	**N** Western Local Land Services Local strategic plan
	2) Protect low flow and pool habitats to prevent accelerated rates of drying, stratification and deterioration in water quality or loss of connectivity.	(a) Implement cease/commence to pump rules on unregulated rivers according to flow class conditions.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 44-46]
		(b) Prohibit new or amended water supply works on the Paroo River Water Source that are capable of taking water from between the bed and the banks of the Paroo River and its tributaries.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 49-50]
WQ6 Manage the risk of harmful algal blooms in recreational use areas. **Risk: O(WQ-BGA)** *All areas are low risk*	1) Improve riparian integrity, cropping/grazing practices, stock management, potential effluent discharges to reduce nutrient inputs into rivers and weirs.	(a) No levers within the scope of NSW water planning. Natural resource management agencies and industry best management practices, including managing discharges within conditions on Environment Protection Licences. Provide advisory services that support and enable landholders and industry to implement improved natural resource and wastewater management.	**N** Western Local Strategic Plan **N** NSW Fish Habitat Strategy **N** *Protection of the Environment Operations Act* (1997) **N** *Local Government Act* (1993)

Targeted objectives to address risks	Strategies	Water management actions and mechanisms	Management plan
	2) Protect low flow and pool habitats to prevent accelerated rates of drying, deterioration in water quality or loss of connectivity	(a) Implement cease/commence to pump rules on unregulated rivers according to flow class conditions.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 44-46]
		(b) Prohibit new or amended water supply works on the Paroo River Water Source that are capable of taking water from between the bed and the banks of the Paroo River and its tributaries.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 49-50]
	3) Implement risk management framework to notify users of potential health risks and to minimise exposure.	(a) Reduce the impact of algal blooms on recreational users by monitoring algae concentrations, communicating the risks of harmful algal blooms to users and implementing incident response monitoring	**A** The draft NSW algal management sub plan (references to the NSW State Emergency Management Plan and the Energy and Utilities Supporting Plan are not for accreditation)
WQ7 Reduce the mobilisation of toxicants and pesticides.  **Risk: E(WQ)** ***Medium Risk*** *All areas*	1) Reducing mobilisation of toxicants and pesticides is largely related to land, vegetation and natural resource management. Strategies to improve the condition of riparian zones, best management practices for chemical handling and application, cropping practices, runoff from agricultural land and discharges from mine sites.	(a) No levers within the scope of NSW water planning. Natural resource management agencies and Industry best management practices, including managing discharges within conditions on Environment Protection Licences Provide advisory services that support and enable landholders to implement improved natural resource and agricultural management practices	**N** Western Local Land Services Local strategic plan **N** NSW Fish Habitat Strategy **N** *Protection of the Environment Operations Act* (1997)

Targeted objectives to address risks	Strategies	Water management actions and mechanisms	Management plan
WQ8 Reduce contamination from pathogens into water sources. **Risk: E(WQ)** ***Medium Risk*** *All areas*	1) Reducing contamination from pathogens is mostly achieved through land and industry management. Strategies to avoid animal faeces contamination include fencing to prevent stock entering waterways and runoff management from agricultural land. Reducing point and diffuse contamination from wastewater discharges – sewage treatment facilities, septic systems and stormwater	(a) No levers within the scope of NSW water planning. Natural resource management agencies and industry best management practices, including managing discharges within conditions on Environment Protection Licences Provide advisory services that support and enable landholders and industry to implement improved natural resource and wastewater management practices	**N** Western Local Land Services Local strategic plan **N** NSW Fish Habitat Strategy **N** *Protection of the Environment Operations Act* (1997) **N** *Local Government Act* (1993)
WQ9 Protect, maintain or enhance connectivity between water sources to support downstream processes including priority carbon and nutrient pathways	1) Protect low flow and pool habitats to prevent accelerated rates of drying, stratification and deterioration in water quality or loss of connectivity.	(a) Implement cease/commence to pump rules on unregulated rivers according to flow class conditions.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 44-46]
		(b) Prohibit new or amended water supply works on the Paroo River Water Source that are capable of taking water from between the bed and the banks of the Paroo River and its tributaries.	**A** *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* [Clause 49-50]

5. Water quality targets

The Basin Plan sets out water quality targets and target application zones in Schedule 10 (Figure 5-1 and Tables 5-1 to 5-3). They provide a guideline for appropriate water quality required for environmental, social and economic outcomes in the Murray-Darling Basin. As yet, no water quality targets have been defined for Aboriginal cultural, spiritual or ceremonial outcomes.

Developing regional water quality targets in NSW

The *ANZECC Guidelines* (2000) are currently under revision (Guideline document 4: Australian and New Zealand Guidelines for fresh and marine water quality 2000) as part of the broader revision of the National water quality management strategy. It is anticipated that there will be no default trigger values in the revised guidelines for Basin States as it is expected that these states have developed regional water quality targets as part of other water planning processes. Basin States may choose to use the water quality targets of the Basin Plan *in lieu* of the default trigger values of the *ANZECC Guidelines* (2000) if local water quality guidelines are not available.

The *Assessment of Murray-Darling Basin water quality targets in NSW (*2015) by DPIE – Water identified targets in some zones and zone boundaries as being inappropriate. Perceived poor water quality at a monitoring site may be due to an inappropriate target, rather than excessive pollutants. In response to these findings, NSW Department of Industry Water will develop appropriate regional water quality guidelines by 2020 for inclusion in water quality management plans.

It is anticipated the revision of the National water quality management strategy will improve the advice about comparing results from individual monitoring sites against water quality targets, with more emphasis on catchment assessments and flow-dependant trigger values.

5.1. Water quality targets for water resource plans

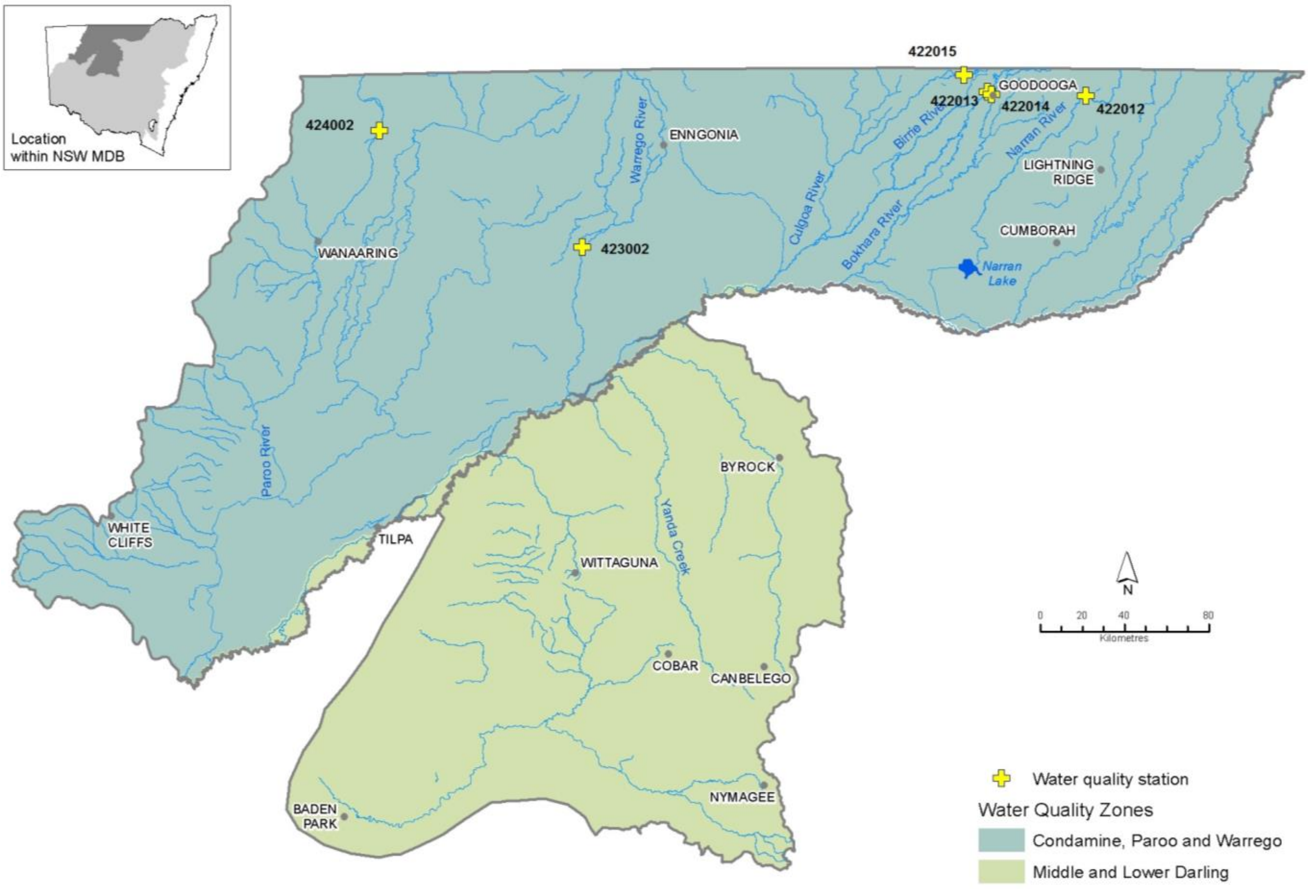
BASIN PLAN 10.32 The water quality targets listed in Table 5-1 to 5-3 apply to the Intersecting Streams water resource plan area (SW13). The water quality target values listed reflect those set out in s 10.32(2) of the Basin Plan.

Progress towards water quality targets is reported every five years in accordance with Schedule 12, Matter 12 of the Basin Plan as part of the *Intersecting Streams monitoring, evaluation and reporting (MER) plan*.

5.1.1. Water quality targets for water-dependent ecosystems

The Basin Plan water-dependent ecosystem targets listed in Table 5-1 were developed following the methods outlined in the *ANZECC Guidelines (2000).* For turbidity, salinity, total phosphorus and total nitrogen the annual median should be below the target value. For dissolved oxygen and pH the annual median should fall within the stated range. For temperature the monthly median should fall within the stated range.

The water quality targets listed in Table 5-1 are used to assess the suitability of water to support healthy water-dependent ecosystems. Water quality target application zones are shown in Figure 5-1.



<table>
<tr><th>Zone</th><th colspan="2">Water quality station</th></tr>
<tr><td rowspan="6">A1
Condamine, Paroo and Warrego valleys; Lowland zone</td><td>422012</td><td>Narran River at New Angledool</td></tr>
<tr><td>422013</td><td>Bokhara River at Goodooga</td></tr>
<tr><td>422014</td><td>Birrie River near Goodooga</td></tr>
<tr><td>422015</td><td>Culgoa River at Brenda</td></tr>
<tr><td>423002</td><td>Warrego River at Fords Bridge Bywash</td></tr>
<tr><td>424002</td><td>Paroo River at Willara</td></tr>
<tr><td>Dml
Darling valley; Middle and lower zone</td><td>-</td><td>No water quality monitoring stations</td></tr>
</table>

Figure 5-1 Water quality zones for the Intersecting Streams. The zones are based on altitude; each zone has specific water quality target indicators

Table 5-1 Water quality targets for water dependent ecosystems objective for all aquatic ecosystems.

Water Quality Zone	Ecosystem Type	Turbidity (NTU)	Total Phosphorus (µg/L)	Total Nitrogen (µg/L)	Dissolved oxygen (mg/L; or saturation (%))	pH	Salinity	Temperature	Toxicants
Other water-dependent ecosystems (not including Ramsar sites)									
A1	Streams, rivers, lakes and wetlands	700	300	1,000	>5.0 mg/L or 60-110%	6.5-8.0	End of valley targets for salinity (see section 5.1.2)	between the 20^{th} and 80^{th} percentile of natural monthly water temperature	the protection of 95% of species (must not exceed values in 3.4.1 of the ANZECC guidelines
Dml	Streams, rivers, lakes and wetlands	50	50	500	85-110%	6.5-8.0			
Declared Ramsar wetlands									
A1	Streams and rivers	450	220	890	>5.0 mg/L or 60-110%	6.5-8.0	-	between the 20^{th} and 80^{th} percentile of natural monthly water temperature	the protection of 99% of species(must not exceed values in 3.4.1 of the ANZECC guidelines
	Lakes and wetlands	100	25	1,000	90-110%	6.5-9.0	-		
Dml	Streams and rivers	50	50	500	85-110%	6.5-8.0	-		
	Lakes and wetlands	20	10	350	90-110%	6.5-8.0	-		

5.1.2. End of valley targets for long-term salinity planning and management

Electrical conductivity targets are not defined for each water quality zone of the Murray-Darling Basin. Table 5-2 shows end of valley salinity targets as described in Schedule B, Appendix 1 of the Murray Darling Agreement (Schedule 1 to the Commonwealth *Water Act 2007*), which have been incorporated into water quality targets.

Progress towards the water quality targets listed in Table 5-2 is used to measure the suitability of water to support healthy water-dependent ecosystems.

Table 5-2: Salinity targets for purposes of long term salinity planning

Water Quality Zones	Ecosystem Type	End of Valley Targets (as absolute values)		
		Salinity (EC µS/cm)		Salt Load (t/yr)
		Median (50%ile)	Peak (80%ile)	Mean
Narran River at New Angledool 2 – (422030)	Streams, rivers, lakes and wetlands	160	210	10,000
Culgoa River at Brenda	Streams, rivers, lakes and wetlands	170	210	29,000
Warrego River Barringun	Streams, rivers, lakes and wetlands	101	110	4,800
Cuttaba Creek at Turra	Streams, rivers, lakes and wetlands	100	130	5,500

5.1.3. Water quality targets for irrigation water

The target for water for irrigation is that the electrical conductivity 95th percentile of each 10 year period that ends at the end of a water accounting period is not exceeded. These targets apply at sites where water is extracted by an irrigation infrastructure operator for the purpose of irrigation.

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.

There are no irrigation infrastructure operators that deliver services in the Intersecting Streams.

5.1.4. Water quality targets for raw water for treatment for human consumption

A Drinking Water Management System is a requirement of a water provider's operating licence issued under the NSW *Public Health Act 2010* and Public Health Regulation 2012. Specific targets for raw water are listed in water providers' Drinking Water Management System. They reflect the Australian Drinking Water Guidelines (2011); the primary guidance for drinking water quality and management within Australia.

Water providers in the Intersecting Streams water resource plan area include:

- Bourke Shire Council
- Brewarrina Shire Council
- Cobar Shire Council
- Central Darling Shire Council
- Walgett Shire Council

5.1.5. Water quality targets for recreational water

The cyanobacteria and algal targets in Table 4-3 are taken from Chapter 6 of the Guidelines for Managing Risks in Recreational Waters developed in 2008 by the National Health and Medical Research Council (NHMRC).

Progress towards the water quality targets listed in Table 5-3 are used to measure the suitability of water quality for recreational use.

Table 5-3 Blue-green algae targets for recreational water

Water Quality Zone	Ecosystem Type	Guidelines
All	Recreational water bodies suitable for primary contact.	• ≤ 10 µg/L total microcystins; or ≤ 50,000 cells/mL toxic *Microcystis aeruginosa;* or biovolume equivalent of ≥ 4 mm³/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume; or • ≤ 10 mm³/L for total biovolume of all cyanobacterial material where known toxins are not present; or • Cyanobacterial scums not consistently present

6. Additional reading

Water quality management planning

Assessment of Murray-Darling Basin Plan water quality targets in New South Wales; 2007 to 2012 (2015). NSW Department of Primary Industries Water, Parramatta.

Intersecting Streams surface water description (2019). NSW Department of Primary Industries Water, Parramatta.

Intersecting Streams monitoring, evaluation and reporting plan (2018). NSW Department of Industry Water, Parramatta.

Long term water plan for the Intersecting Streams water resource plan area (2018). NSW Office of Environment and Heritage, Queanbeyan.

Risk assessment for the Intersecting Streams surface water resource plan area (SW13) (2019). NSW Department of Industry Water, Parramatta.

Salinity technical report for the Intersecting Streams water resource plan area (SW13) (2018). NSW Department of Industry Water, Parramatta.

Water quality technical report for the Intersecting Streams water resource plan area (SW13) (2018). NSW DepartmFent of Industry Water, Parramatta.

Water sharing plan for the Intersecting Streams unregulated river water sources (2012), NSW Department of Industry, Parramatta

Strategies, plans, frameworks and guidelines

ADWG: Australian drinking water guidelines (2011 and updates), National Health and Medical Research Council in collaboration with the Natural Resource Management Council.

ANZECC Guidelines: Australian and New Zealand guidelines for fresh and marine water quality (2000), Australian and New Zealand Environment and conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ)

The Basin Plan (2000). Murray-Darling Basin Authority, Canberra.

Basin salinity management 2030 (BSMS2030) (2015). Murray-Darling Basin Authority, Canberra.

Building a fish friendly NSW – NSW Fish habitat strategy (2017) NSW Fish Habitat Partnership 2017, Nelson Bay.

Western Local Strategic Plan 2016-2021(2016) Western Local Land Services

Guidelines for managing risks in recreational waters (2008), National Health and Medical Research Council (NHMRC), Canberra. ISBN 1864962720.

NSW Cold Water Pollution Strategy: Guidelines for managing cold water releases from high priority dams (2011). NSW Office of Water, Sydney.

NSW Control plan for the noxious fish Carp (*Cyprinus carpio*) (2010) NSW Industry & Investment, Orange.

NSW Guidelines for drinking water management systems (2013) NSW Ministry of Health, North Sydney

The draft NSW algal management sub plan. NSW Office of Water, Sydney.

Appendix A – List of water quality terms

Dissolved oxygen

Dissolved oxygen in water is essential for supporting fish and aquatic animals. If oxygen levels rise too high or drop too low it places stress on animals and can be fatal. Dissolved oxygen concentrations vary throughout the day and are generally lowest at night when plants and algae are not producing oxygen.

Harmful algal blooms

Most algae are safe and are a natural part of aquatic ecosystems. However, some types of blue-green algae (cyanobacteria) can produce hepatotoxins, neurotoxins and other toxins. When these species occur in bloom proportion (harmful algal blooms) they pose a serious risk to human, animal and ecosystem health. Harmful algal blooms occur when there are suitable conditions including high levels of nutrients, warm temperatures, adequate light and stable or stratified water bodies.

Hypoxic blackwater

Hypoxic blackwater events refer to periods of time when dissolved oxygen concentrations in water are very low (hypoxic). These events occur when floodwaters leach organic matter from leaf litter, plants and soil resulting in water that is very high in dissolved organic matter (blackwater). This organic matter is consumed rapidly by microbes resulting in oxygen being used faster than it can be replenished. Hypoxic conditions place high stress on aquatic biota and can lead to fish kills.

Nutrients

Nutrients such as nitrogen and phosphorus are important for sustaining growth and productivity within streams. However often inputs of nutrients to rivers has increased due to human activities. This process is known as eutrophication (meaning well-nourished). Sources of nutrients include fertilisers, discharge from sewage treatment plants or erosion. Increases in nutrients can cause nuisance algal blooms, dissolved oxygen depletion, and toxicity of aquatic organisms. In this plan we generally refer to Total Nitrogen (TN) or Total Phosphorus (TP) as a basic measure of all forms of these elements.

Pathogens

Bacteria and microorganisms occur naturally in rivers. Pathogens are certain species that have the ability to cause disease symptoms such *Enterococci* or *Giardia*. In certain concentrations pathogens can have negative impacts on public health, aquatic animals, stock watering and limit the use of water for irrigation. Human activities can increase the potential risk from pathogens including discharge of human and animal waste and sewage, stormwater runoff and access of stock and animals to rivers and water supplies.

pH

The pH value is a measure of how acidic or basic water is. The pH ranges between 0 (very acidic) to 14 (very basic) with 7 being neutral. A pH outside of natural ranges can be harmful to plants and animals. It changes the solubility and bioavailability of nutrients and carbon and the toxicity of pollutants in streams. Very high or low pH can affect the taste of water, increase corrosion in pipes and pumps and reduce the effectiveness of drinking water treatment.

Salinity

Salinity is the presence of soluble salts in water. It is generally measured as electrical conductivity (ability of dissolved salts to transmit an electric current). Increases in salinity can have harmful effects for many plants and animals, affect drinking water supplies, and cause damage and loss to cropping and horticulture sectors. The suitability of water for irrigation is often measured as a sodium adsorption ratio (SAR). SAR is a measure of the relative concentration of sodium, calcium and magnesium.

Salt land

Salt land is land that has become degraded through increased salinity and erosion. Salt land can have detrimental effects to agricultural productivity, infrastructure, vegetation, ecosystem functions and off site water quality.

Salt load export

Salt load export refers to the volume of salt that is transported by streams and rivers. It is usually transported in high volumes of water at low concentrations. Salt can be redistributed in the landscape through water flow and irrigation. The export of salt from the Murray-Darling basin to the Southern Ocean is a mechanism to prevent salt accumulation and maintain healthy rivers, wetlands and floodplains.

Temperature and thermal pollution

Temperature influences many biological and ecosystem processes. Warmer temperatures can increase growth rates and metabolism of in-stream plants, animals and algae. Temperature influences spawning, breeding and migration patterns of many aquatic animals. Higher temperatures can also result in increased solubility of salts and decreased solubility of oxygen.

Toxicants

Toxicants refer to chemical contaminants that have the potential to be toxic at certain concentrations. These include metals, inorganic and organic substances such as herbicides and pesticides. Toxicants can have public health impacts and cause stress and fatalities for plants and animals. Toxicants enter waters from many activities including agricultural, industrial and mining activities.

Turbidity and suspended sediment

Turbidity is a measure of water clarity. When turbidity in streams increases it reduces light penetration required for primary production and can contribute harmful algal blooms. Increased suspended sediments also smothers aquatic plants, fish and macroinvertebrates and provides attachment places for toxicants and pathogens.

Appendix B – Water quality index (WaQI) method

How is the WaQI calculated for water quality management plans?

For water quality management plans the WaQI is calculated as an overall integrated index (for 5-8 parameters) and for each water quality parameter individually. These calculations are performed independently.

The overall WaQI for WQMP includes turbidity, total phosphorus, total nitrogen, pH and dissolved oxygen. It is based on the exceedance of water quality targets for water dependent ecosystems as described in Schedule 11 of The Basin Plan. Harmful algal blooms, salinity and temperature are currently calculated against individual targets where sufficient data is available.

Water quality targets for the Intersecting Streams water resource plan area are listed in Section 5 of this plan.

To calculate the index a minimum of 30 samples is required across a five year period with a minimum of four samples in any one year.

The outcome provides a number between 1 and 100 that is categorised according to the following:

POOR	FAIR	GOOD	EXCELLENT
1-59	60-79	80-94	95-100

The index for both the overall score or, for an individual parameter is calculated as:

$$WaQI = \left(\frac{\sqrt{F1^2 + F2^2}}{1.41421}\right)$$

Where F1 (*frequency*), the frequency of the number of failed tests per total tests, is:

$$F1 = \left(\frac{Number\ of\ failed\ tests}{Total\ number\ of\ tests}\right) \times 100$$

And where F2 (*amplitude*), the amplitude is the amount a value exceeded he target, is:

$$F2 = (nse \div [0.01nse + 0.01])$$

Where *nse* (the normalised sum of excursions) is:

$$nse = \left(\frac{\sum_{i=1}^{n} excursion\ i}{number\ of\ tests}\right)$$

And where the excursion is:

$$Excursion = \left(\frac{Failed\ test\ value\ i}{Test\ objective}\right)$$

or

$$Excursion = \left(\frac{Test\ objective}{Failed\ test\ value\ i}\right)$$

Appendix C - Risk assessment summary

Table C-1: Summary of risk outcomes for water dependent ecosystems from poor water quality [E(WQ)], [E(WQ-S)]

Site ID	Site Name	Turbidity	Total Phosphorus	Total Nitrogen	pH	Dissolved Oxygen	Salinity
422012	Narran River at New Angledool	Low	Medium	High	Low	Low	
422030	Narran River at New Angledool 2						High
422013	Bokhara River at Goodooga	Medium	Medium	Medium	Low	Low	
422014	Birrie River near Goodooga	Low	Medium	High	Low	Low	
422015	Culgoa River at Brenda	Medium	Medium	High	Medium	Medium	High
423002	Warrego River at Fords Bridge Bywash	High	Low	Low	Low	Medium	
423004	Warrego River at Barringun						High
421002	Paroo River at Willara Crossing	Low	Low	Low	Low	Low	
423005	Cuttaburra Creekat Turra						High

Site Name	Pathogens	Pesticides
All Areas	Medium	Medium

Table C-2: Summary of risk outcomes for recreational water quality with algal response in place [O(WQ-BGA)].

Site Name	Blue-green algae**
All areas	Low

**Risk rating after implementing algal management protocols.

Appendix D – Strategy decision tree logic

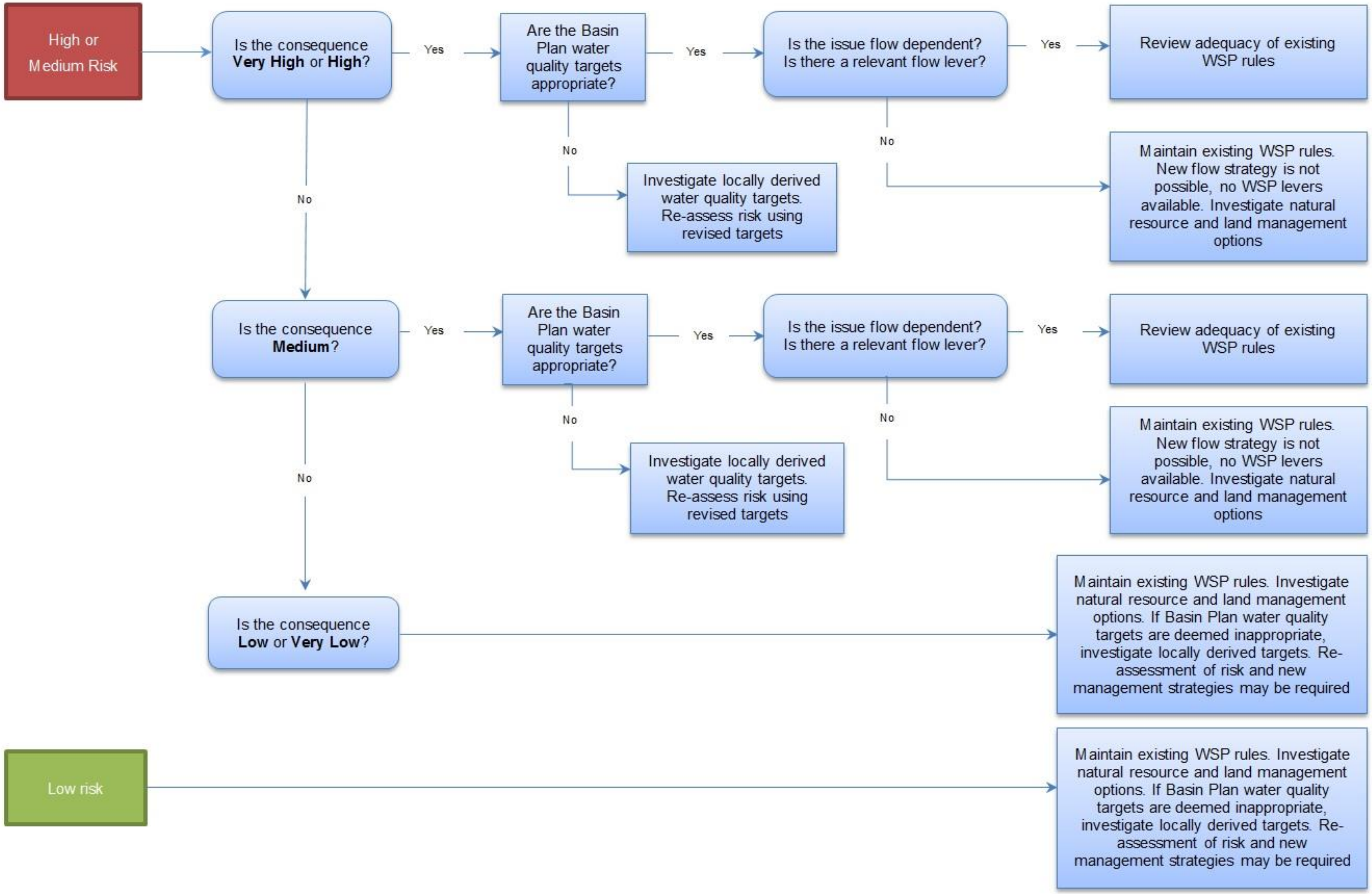


Figure D-1 Decision tree logic used as a guide to develop strategies for water quality risks