Drinking Water Management System

Warrumbungle Shire Council

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Revision – 17-Oct-2014
Prepared for – NSW Health – ABN: 45 100 538 161

Drinking Water Management System

Warrumbungle Shire Council

Prepared for

Warrumbungle Shire Council

Prepared by

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Reviewed by Kate Miles, Cornelia Wiebels, Michelle Phoenix, Mark Nave, Bruce Lamont

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
0.1	1-Aug-2014	Internal Draft	Kate Miles Project Manager	
0.2	15-Sep-2014	Draft for Review	Kate Miles Project Manager	
1.0	17-Oct-2014	Final for Issue	Kate Miles Project Manager	

Executive Summary

NSW Health has provided funding to assist Warrumbungle Shire Council (Council) in meeting its obligations under the NSW *Public Health Act 2010.* This is being achieved by developing a Drinking Water Management System (DWMS) that is consistent with the Framework for Management of Drinking Water Quality (the Framework) as documented in the Australian Drinking Water Guidelines (ADWG) (NHMRC/NRMMC, 2011).

This report documents the development of this DWMS, describes Council's existing management systems and contains an implementation plan to ensure that the system can be updated to comply with all the requirements of the ADWG.

Central to the DWMS development was the delivery of a risk assessment workshop to identify hazards and existing preventative measures pertaining to Council's drinking water supply system. A total of 56 hazards were identified as part of this assessment, with 30 of these being considered as a significant unmitigated risk – i.e. those that received a *High* or *Very High* rating.

Generally, the unmitigated significant risks related to potential management issues resulting in the contamination of the water supply system. For example:

- Poor catchment management (e.g. agricultural hazards, unsewered properties in township, algal blooms)
- Poor system maintenance (e.g. not replacing filter media, incorrect filter media)
- Poor treatment processes (e.g. inadequate filter backwashing, overdosing of chemicals)
- Management systems (e.g. lack of real-time water quality monitoring, lack of operating procedures)
- Inadequate treatment processes (e.g. sedimentation/clarification failure leading to high turbidity)
- Inadequate infrastructure security (e.g. inadequate netting, unlockable hatches).

After considering Council's existing control measures the significant risk total was reduced to 23. This highlighted that Council's management systems are addressing some of these risks, however there are still further actions required to manage some of the remaining risks.

To decrease the residual risks the following actions were identified and are summarised as follows:

- Formally documenting operational protocols
- Installing online monitoring equipment with interlocks (e.g. turbidity analyser, chlorine analyser)
- Additional monitoring (e.g. pesticide monitoring, chlorine strength monitoring)
- Upgrading treatment processes or equipment
- Developing a DWMS that is understood by all staff and implemented appropriately.

The importance of a current and effective DWMS to manage water quality risks was demonstrated through this process.

Part of the DWMS development process, as specified by ADWG, requires water utilities to identify Critical Control Points (CCP) in the water supply systems to allow effective management of deviations from recommended water parameter guidelines. A summary of the CCPs identified for Council's water supply systems are shown in Figures E.1 to E.8.

The CCPs are monitored and controlled using a 'traffic light' alert levels system. Planned corrective actions are provided in the instance of breach of alert limits and critical limits. Actions are centred on returning the system back to acceptable limits and notifying relevant stakeholders/authorises as required. Actions may also include the activation of Standard Operating or Incident Management Procedures. The Standard Operating Procedures (SOPs) are detailed in Appendix E, with SOPs relating to corrective actions for CCPs provided in Appendix C.

The DWMS is a working system document and will require Council to action all the Implementation Plan actions within the recommended time frames. Not having an effective and current DWMS was identified as one of the key risks to the water supply systems. As such, continued development, implementation and review of this system is critical to the effective management of water quality in the water supply systems.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Baradine	BDN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BDN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	1.2 mg/L	<1.0 mg/L
	BDN3	Fluoridation	Fluoride	Fluoride	1 mg/L (leaving WFP, leaving reservoir and throughout distribution system)	<0.9 mg/L or >1.1 mg/L (calculated daily concentration) OR 1.2 – 1.5 mg/L (concentration leaving reservoir) OR >1.5 mg/L (concentration leaving WFP)	>1.5 mg/L (calculated daily concentration) OR >1.4 mg/L (concentration leaving reservoir)
	BDN4	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BDN5	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure E.1 Critical Control Points Reference Guide (Baradine)

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Bugaldie	BUG1	Disinfection (Hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	< 1.3 mg/L	< 1.0 mg/L
	BUG2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BUG3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure E.2 Critical Control Points Reference Guide (Bugaldie)

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Binnaway	BWY1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BWY2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 mg/L	<1.5 mg/L	<1.2 mg/L
	BWY3	Fluoridation	Fluoride	Fluoride	1 mg/L (leaving WFP, leaving reservoir and throughout distribution system)	<0.9 mg/L or >1.1 mg/L (calculated daily concentration) OR 1.2 – 1.5 mg/L (concentration leaving reservoir) OR >1.5 mg/L (concentration leaving WFP)	>1.5 mg/L (calculated daily concentration) OR >1.4 mg/L (concentration leaving reservoir)
	BWY4	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BWY5	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure E.3 Critical Control Points Reference Guide (Binnaway)

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coonabarabran	CBN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	CBN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 – 5.0 mg/L	<1.8 mg/L	<1.5 mg/L
	CBN3	Fluoridation	Fluoride	Fluoride	1 mg/L (leaving WFP, leaving reservoir and throughout distribution system)	<0.9 mg/L or >1.1 mg/L (calculated daily concentration) OR 1.2 – 1.5 mg/L (concentration leaving reservoir) OR >1.5 mg/L (concentration leaving WFP)	>1.5 mg/L (calculated daily concentration) OR >1.4 mg/L (concentration leaving reservoir)
	CBN4	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CBN5	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure E.4 Critical Control Points Reference Guide (Coonabarabran)

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coolah	CLH1	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	CLH2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CLH3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	≤1.0 mg/L	0.8 mg/L

Figure E.5 Critical Control Points Reference Guide (Coolah)

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Dunedoo	DDO1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.2 mg/L	<1.0 mg/L
	DDO2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	DDO3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	≤1.0 mg/L	0.8 mg/L

Figure E.6 Critical Control Points Reference Guide (Dunedoo)

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Kenebri	KBI1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	KBI2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	KBI3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure E.7 Critical Control Points Reference Guide (Kenebri)

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Mendooran	MDN1	Filtration	All pathogens	Turbidity	<0.5 NTU	>0.8 NTU	>1.0 NTU
	MDN2	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.6 mg/L	<1.2 mg/L	≤1.0 mg/L
	MDN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	MDN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	>0.5 mg/L	<0.3 mg/L	0.1 mg/L

Figure E.8 Critical Control Points Reference Guide (Mendooran)

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

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Glossary

Abbreviation	Definition
ADWG	Australian Drinking Water Guidelines
AWA	Australian Water Association
BDN	Baradine
BUG	Bugaldie
BWY	Binnaway
CBN	Coonabarabran
CCP	Critical Control Point
CLH	Coolah
CMA	Catchment Management Authority
CT	Chlorine Contact Time
DAL	Division of Analytical Laboratories
DDO	Dunedoo
DBP	Disinfection by-products
DWMS	Drinking Water Management System
EPA	Environment Protection Authority
ERP	Emergency Response Plans
FASS	Forensic and Analytical Science Services
HACCP	Hazard Analysis and Critical Control Points
L	Litre
KBI	Kenebri
LMWUA	Lower Macquarie Water Utilities Alliance
MDN	Mendooran
mg	milligram
min	minute
MoU	Memorandum of Understanding
NATA	National Association of Testing Authorities
NHMRC	National Health and Medical Research Council
NOW	NSW Office of Water
NRMMC	Natural Resource Management Ministerial Council
NSW	New South Wales
NTU	Nephelometric Turbidity Unit
PAC	Powdered Activated Carbon
PHU	Public Health Unit
SOE	State of the Environment
SOP	Standard Operating Procedure
STP	Sewage Treatment Plant
TBC	To be confirmed
TDS	Total dissolved solids
WIOA	Water Industry Operators Association
WSC	Warrumbungle Shire Council
WTP	Water Treatment Plant

Introduction to the Drinking Water Management System

Purpose of the DWMS

NSW Parliament recently passed the NSW *Public Health Act 2010* and the *Public Health Regulation 2012*. Under this legislation, drinking water suppliers are required to establish and maintain a risk-based quality assurance program for the management of drinking water supplied to consumers.

NSW Health has provided funding to assist Warrumbungle Shire Council (Council, or WSC) in meeting their obligations under the Act, by developing a Drinking Water Management System (DWMS) that is consistent with the Framework for Management of Drinking Water Quality (the Framework) as documented in the Australian Drinking Water Guidelines (ADWG) (NHMRC/NRMMC, 2011).

A DWMS developed in accordance with the ADWG provides a basis to manage drinking water supplies to ensure safety at the point of use. In essence, a DWMS requires a drinking water supplier to identify, document and manage risks to drinking water quality. In turn, this requires the supplier to understand where and how contamination of the water supply may occur and how it may make its way to customers.

This document follows the structure provided in the ADWG and aims to provide Council with the tools to manage their water effectively. It is an auditable document that may be used to demonstrate that the water supplies are being effectively managed.

The ADWG Framework

As stated in the ADWG (NHMRC, 2011), these guidelines were developed utilising the best available scientific evidence and provides an authoritative reference on what defines safe, good quality water, how it can be achieved and how it can be assured. The ADWG also states that these guidelines are concerned with safety from a health point of view and also with aesthetic quality.

The core of the ADWG is the Framework for Management of Drinking Water Quality (the Framework). The Framework is a holistic risk-based approach to drinking water management, and can be seen as a quality management system that has been specifically developed for the water industry to manage drinking water quality.

Process for Developing the DWMS

This DWMS was developed in partnership with Warrumbungle Shire Council and involved input from NSW Health and NSW Office of Water. The drinking water quality risk assessment and Hazard Analysis and Critical Control Point components of this DWMS were developed in a three day workshop. The workshop involved a range of staff from Council, representatives from NSW Health (Public Health Unit and Water Unit) and NSW Office of Water and was facilitated by AECOM. This workshop comprised of a system and water quality performance analysis undertaken by AECOM, using data available publicly, data provided by Council and water quality data from the NSW Drinking Water Database. The outcomes of this analysis were documented in the *Water Quality Risk Assessment Briefing Paper*, which was circulated to attendees prior to the workshop. The purpose of the workshop was to identify, evaluate and document risks to water quality and the existing control measures that Council had in place, as well as prioritising actions identified by the workshop participants. The output of this workshop was:

- A water quality risk assessment
- Identification of the critical points of the water supply system for control of water quality
- Current water quality risk control measures and their efficacy, and
- Additional actions required to manage water quality as identified by the workshop attendees.

These outputs inform this DWMS and are documented in the *Water Quality Risk Assessment Report* in Appendix A. The *Water Quality Risk Assessment Report* was circulated to and reviewed by all attendees in June 2014. Some of the content provided in that report has since been updated. For example, the water quality risk assessment and the critical control point summary tables. Any information which has been superseded has been labelled accordingly.

A gap analysis of Council's current water quality management practises against the ADWG Framework was undertaken. Current practises are documented in this DWMS along with actions that may assist Council in

meeting the requirements of the Framework. All identified actions have been prioritised and documented in the DWMS Implementation Plan in Section 13.0 of this DWMS, along with actions identified in the water quality risk assessment workshop. Documentation developed, as per the actions in the DWMS Implementation Plan, will ultimately form part of this DWMS. A summary of the key documents that constitute the DWMS include:

- Drinking water quality policy
- Legal and formal requirements register
- Water quality risk assessment and Critical Control Point (CCP) plan
- Operational procedures
- Water quality monitoring plan
- Emergency and incident management protocols
- Document control and records management procedure
- Performance evaluation protocols (evaluation of water quality performance, auditing and senior executive review processes).

This DWMS has been reviewed by NSW Health, NSW Office of Water and Council. It is anticipated that this DWMS will be formally adopted by Council, at which point Council will adopt responsibility for implementation and further development in accordance with the actions identified.

Understanding this document

The structure of this document reflects the structure of the Framework for the Management of Drinking Water Quality (Framework), as set out in the ADWG.

The Framework specifies 12 elements, 32 components and 76 subsequent requirements that are considered good practice for management of drinking water supplies.

The DWMS is therefore divided into 12 sections, such that each section addresses each element of the Framework in turn. The components that sit under each of the 12 elements are addressed as separate subsections (refer to Table 1). The specific requirements of the Framework are documented under each component. The purpose of this is to clearly communicate Council's obligations under the Framework and also to set the scene for what should be addressed by this DWMS.

Table 1 Framework for DWMS

Element		DWMS Section	ADWG Component
1	Commitment to drinking water quality management	1.1	Drinking Water Quality Policy
		1.2	Regulatory and Formal Requirements
		1.3	Engaging Stakeholders
2	Assessment of the drinking water supply system	2.1	Water Supply System Analysis
		2.2	Assessment of Water Quality Data
		2.3	Hazard Identification and Risk Assessment
3	Preventive measures for drinking water quality management	3.1	Preventive Measures and Multiple Barriers
		3.2	Critical Control Points
4	Operational Procedures and process control	4.1	Operational Procedures
		4.2	Operational Monitoring
		4.3	Corrective Action
		4.4	Equipment Capability and Maintenance
		4.5	Materials and Chemicals

5	Verification of drinking water quality	5.1	Drinking Water Quality Monitoring
		5.2	Consumer Satisfaction
		5.3	Short-term Evaluation of Results
		5.4	Corrective Action
6	Management of incidents and emergencies	6.1	Communication
		6.2	Incident and Emergency Response Protocols
7	Employee awareness and training	7.1	Employee Awareness and Involvement
		7.2	Employee Training
8	Community Involvement and awareness	8.1	Community Consultation
		8.2	Communication
9	Research and Development	9.1	Investigative Studies and Research Monitoring
		9.2	Validation of Processes
		9.3	Design of Equipment
10	Documentation and Reporting	10.1	Management of Documentation and Records
		10.2	Reporting
11	Evaluation and audit	11.1	Long-Term Evaluation of Results
		11.2	Audit of Drinking Water Quality
12	Review and continual improvement	12.1	Review by senior executive
		12.2	Drinking Water Quality Management Improvement Plan

Document Control

Where key information exists as part of another management system or document, it has been summarised and included within this DWMS under the relevant sections. The intention is to allow this DWMS to be read as a stand-alone document. A supporting MS Excel based document register detailing all documents that support this DWMS has been developed and can be found in Appendix D. The document register is also located in the following folder on Council's local network:

DWMS Document Register: <insert link to folder>

This DWMS and the document register will be updated as the DWMS supporting information is updated or developed.

How to use this Document

Within each subsection of the DWMS, the specific requirements of the relevant component are documented.

Following the statement of requirements is text that describes what activities and processes Council currently has in place to address these requirements. Where Council's current activities do not fully address the requirements of the Framework, further actions are detailed in the Implementation Plan.

These actions have been organised in priority and form part of the continuing implementation process for the DWMS.

The DWMS is not static. It is envisaged that the document will be a "living document" and will be regularly reviewed and updated as actions are completed, or when new risks are identified, and other risks mitigated or eliminated.

Once Council has undertaken the identified actions, the actions should be removed from this document and the text describing Council's activities and processes updated to reflect how Council addresses the requirements of the Framework. Similarly, as new actions are identified, they should be added to the document.

A diagram depicting this process is shown in Figure 1.

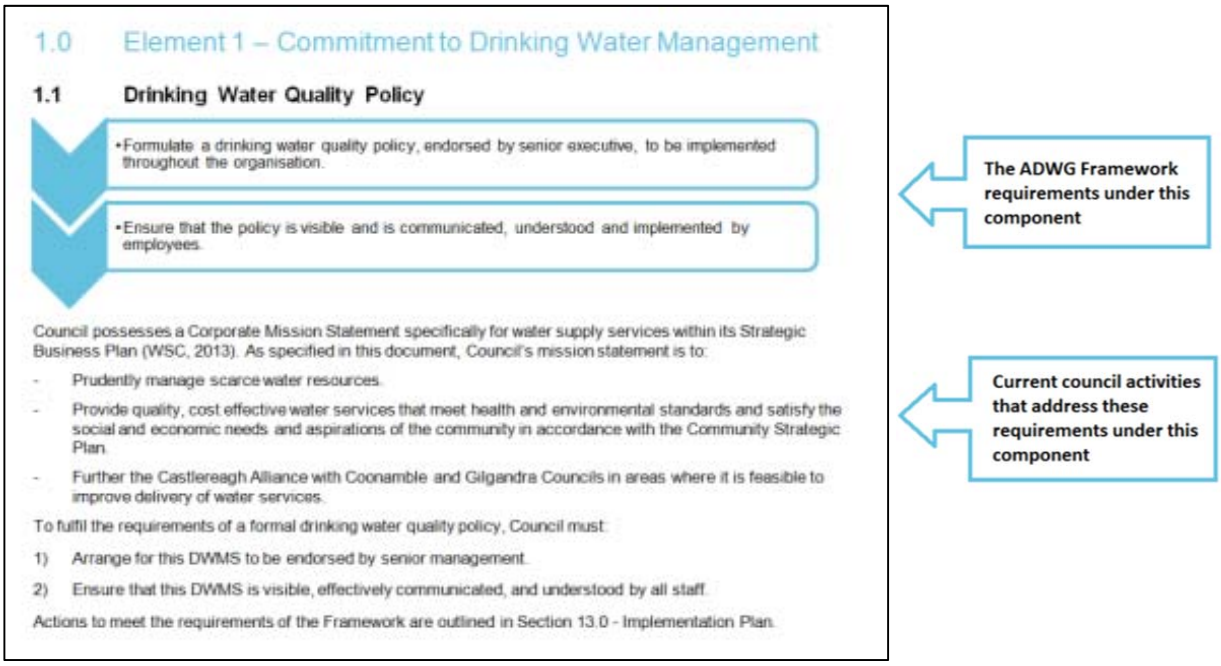


Figure 1 How this document should be used

Implementation Plan

A consolidated list of actions required to be undertaken to meet the obligations under the Framework are detailed in the Implementation Plan in Section 13.0. These actions have been prioritised to ensure that critical actions are implemented expediently, while allowing more time for Council to address actions that are less fundamental, or may take time to develop. Due dates and responsibilities have also been assigned to these actions.

In developing the DWMS, it was found that many procedures and protocols were in place and functioning effectively; however they were not formally documented. Council is able to address many outstanding actions by formally documenting these existing procedures.

A number of actions were also identified during the drinking water quality risk assessment workshop. These have also been included in the Implementation Plan.

Plan Review

This DWMS and the Implementation Plan should be reviewed and updated at least annually, as part of the annual planning cycle. This should be undertaken in conjunction with an annual review of CCP monitoring data. This process should be undertaken in consultation with the local Public Health Unit.

Council should undertake a facilitated review of the risk assessment every five years (at minimum) or when significant changes to the water supply system or treatment process are made (e.g. upgrade of control system, or new treatment process unit installed, etc.). This workshop should include an update to the hazards identified, the corresponding risk scores, mitigation measures, CCP identification and CCP target, alert and critical limits.

1.0 Element 1 – Commitment to Drinking Water Management

1.1 Drinking Water Quality Policy

- Formulate a drinking water quality policy, endorsed by senior executive, to be implemented throughout the organisation.
- Ensure that the policy is visible and is communicated, understood and implemented by employees.

Council has a Corporate Mission Statement specifically for water supply services within its Strategic Business Plan (WSC, 2013). As specified in that document, Council's mission statement is to:

- Prudently manage scarce water resources.
- Provide quality, cost effective water services that meet health and environmental standards and satisfy the social and economic needs and aspirations of the community in accordance with the Community Strategic Plan.
- Further the Castlereagh Alliance with Coonamble and Gilgandra Councils in areas where it is feasible to improve delivery of water services.

To fulfil the requirements of a formal drinking water quality policy, Council must also:

1) Arrange for this DWMS to be endorsed by senior management.

2) Ensure that this DWMS is visible, effectively communicated, and understood by all staff.

Actions to meet the requirements of the Framework are outlined in Section 13.0 - Implementation Plan.

1.2 Regulatory and Formal Requirements

- Identify and document all relevant regulatory and formal requirements.
- Ensure responsibilities are understood and communicated to employees.
- Review requirements periodically to reflect any changes

Council has identified and documented its regulatory and formal requirements for the delivery of water supply services in its Strategic Business Plan (WSC, 2013).

It is suggested that a formal requirements register covering all water and wastewater related activities, including requirements for the management of water quality, be maintained within this DWMS. This register is detailed in Table 2. This table also includes the legislative requirements that have been identified in Council's Strategic Business Plan.

Table 2 Formal Requirements

Legislation / Formal Requirements
NSW Public Health Act 2010
Public Health Regulation 2012
Local Government Act 1993 (NSW)
Local Government (General) Regulation 2005 (NSW)
NSW Health Drinking Water Monitoring Program
NSW Best-Practice Management of Water Supply and Sewerage Guidelines 2007 (NSW Office of Water) (including the various guidelines Strategic Business Planning, Integrated Water Cycle Management, pricing, water conservation, drought management and performance monitoring and reporting)
AS/NZS 3500.1:2003 Plumbing and drainage – Water services
Environmental Planning and Assessment Act (1979)
Water Management Act (2000)
Work Health and Safety Act and Regulations (2011)
Protection of the Environment Operations Act (1997), including provisions of: - Clean Air Act (1961) - Clean Waters Act (1970) - Pollution Control Act (1970) - Noise Control Act (1975)
Catchment Management Act (1989)
Independent Pricing and Regulatory Tribunal Act (1992)
Water Industry Competition Act (2006)
Fluoridation of Public Water Supplies Act (1957) No 58
Soil Conservation Act (1938)
Dams Safety Act (1978)

It is recommended that the regulatory and formal requirements be reviewed every 12 months (minimum), and whenever there are significant changes to any of the legislation or formal requirements.

Council communicates employees' roles and responsibilities through open dialogue between staff, including up and down communication between management and operations staff. To fulfil the requirements of the Framework, Council must formally document and communicate roles and responsibilities of staff relating to management of drinking water quality.

Refer to the detailed actions to meet the requirements of the Framework outlined in Section 13.0 - Implementation Plan.

1.3 Engaging Stakeholders

- Identify all stakeholders who could affect, or be affected by, decisions or activities of the drinking water supplier.
- Develop appropriate mechanisms and documentation for stakeholder commitment and involvement.
- Regularly update the list of relevant agencies

The following details the external stakeholders currently involved in drinking water management for the Warrumbungle Shire Council water supply systems. This list was last updated in September 2014.

Table 3 Stakeholder List

Name	Position	Affiliation	Responsibilities	Contact Details
Mark Nave	Environmental Health Officer Western NSW Local Health District	NSW Health	Water quality advice, regulatory oversight, NSW Drinking Water Monitoring Program	P: (02) 6841-2339 M: 0407 551 548 Mark.Nave@health.nsw.gov.au
Bruce Lamont	Regional Inspector	NSW Office of Water	Technical and strategic advice, assistance on project development, water & sewer funding programs, regulatory oversight, inspection of water supply systems.	M: 0458 268 453 bruce.lamont@water.nsw.gov.au
Matt Parmeter	Senior Urban Water Manager	NSW Office of Water	Water & sewer funding programs, regulatory oversight.	P: (02) 6841 7410 matt.parmeter@water.nsw.gov.au

Supplier contact details are currently documented in the Operation and Maintenance (O&M) manuals for Baradine Water Treatment Plant (WTP), Binnaway WTP and Coonabarabran WTP. Council also maintains a list of contact names and numbers of relevant staff in their 'Front Counter and Telephone Contacts Database" <insert location>.

Council should also consider developing a list of key industrial, commercial and essential use customers for each water supply system. Similarly contact details for customers who are immunocompromised or on dialysis should also be recorded for easy contact.

Council should also formalise how it intends to engage stakeholders and customers with respect to issues such as water restrictions, drought management and service levels, as well as in any other decision making processes for the water supply systems. This should include a communication procedure and engagement processes.

Refer to the detailed actions to meet the requirements of the Framework outlined in Section 13.0 - Implementation Plan.

2.0 Element 2 – Assessment of the Drinking Water Supply System

2.1 Water Supply System Analysis

- Assemble a team with appropriate knowledge and expertise.
- Construct a flow diagram of the water supply system from catchment to tap.
- Assemble pertinent information and document key characteristics of the water supply system to be considered.
- Periodically review the water supply system analysis.

In May 2014, Council hosted a drinking water quality risk assessment workshop, which included a review of its drinking water supply systems, from catchment to consumer, and identified hazards and risks to drinking water quality. The first three of the above actions were completed and documented in the report *Drinking Water Quality Risk Assessment* (AECOM, 2014a), which is provided in Appendix A.

The team included staff from Council, NSW Health, NSW Office of Water (NOW) as well as input from the facilitators and independent technical specialists from AECOM. The flow charts were reviewed by workshop participants, as were the catchment and water supply system characteristics, prior to issuing the final report. The Warrumbungle Shire catchment boundary is detailed in Figure 2. The water supply system flow diagrams for Council's water supply systems, Baradine, Binnaway, Bugaldie, Coolah, Coonabarabran, Dunedoo, Kenebri and Mendooran, are detailed in Figure 3 to Figure 10 respectively.

Council will need to maintain the currency of this system analysis to ensure it accurately reflects the system and its performance over time. The flow diagrams are current as of May 2014; Council is required to update the flow diagrams as the system changes, in this report and in reference documents detailed in Appendix D.

Refer to the detailed actions to meet the requirements of the Framework outlined in Section 13.0 - Implementation Plan.

2.1.1 Catchment Summary

Warrumbungle Shire is situated within the Central West Catchment, with the exception of a small section in the north-eastern corner which drains into the Namoi Catchment. Warrumbungle Shire utilises both river water and groundwater for the delivery of drinking water within the region. The bore systems draw water from artesian and sub-artesian basins across the region.

Timor Dam is located 13 km west of Coonabarabran and is one the major surface water sources in the region. From the dam, the Castlereagh River meanders through Coonabarabran, Binnaway and Mendooran before heading west into Gilgandra Shire. This river is also a major source of surface water for the region.

Figure 2 below details the Council areas and catchment boundaries of the Central West Catchment.

Figure 2 Central West Catchment (CWCMA, 2012)

2.1.2 Baradine System Flow Diagram

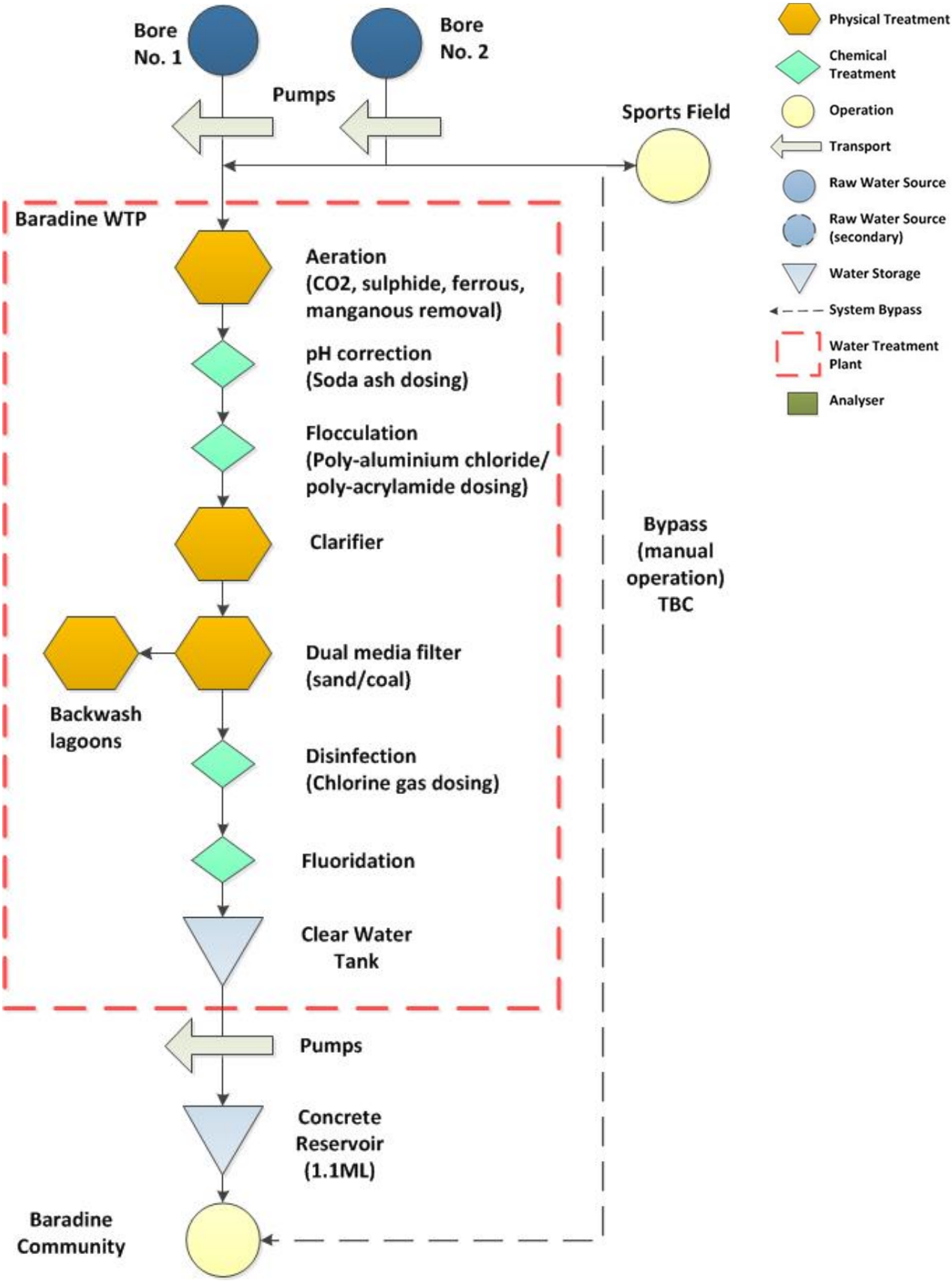


Figure 3 Baradine Water Supply System

2.1.3 Binnaway System Flow Diagram

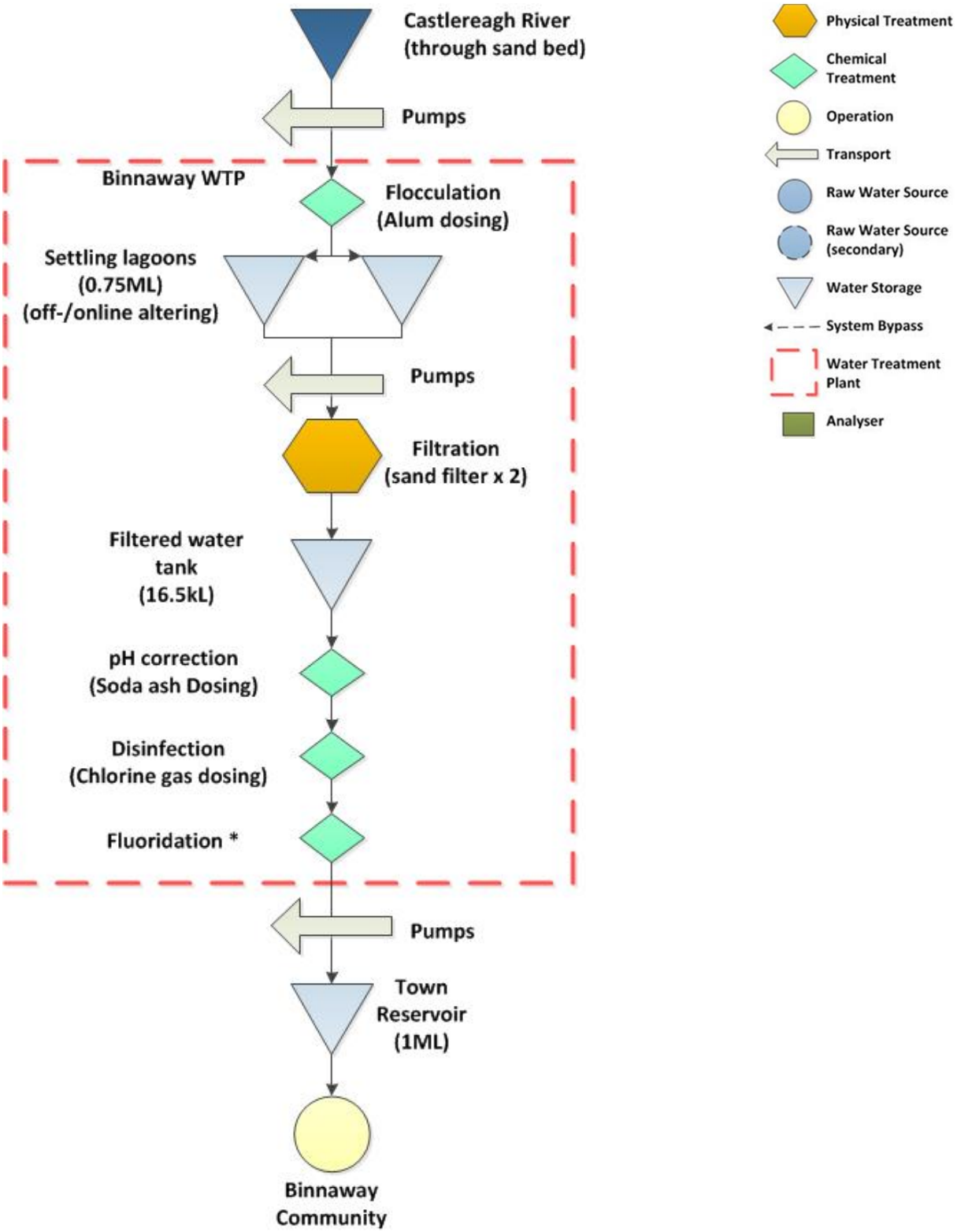


Figure 4 Binnaway Water Supply System

*** NOTE:** Fluoridation system has been commissioned following the 2014 Risk Assessment and therefore has not been considered in this assessment.

2.1.4 Bugaldie System Flow Diagram

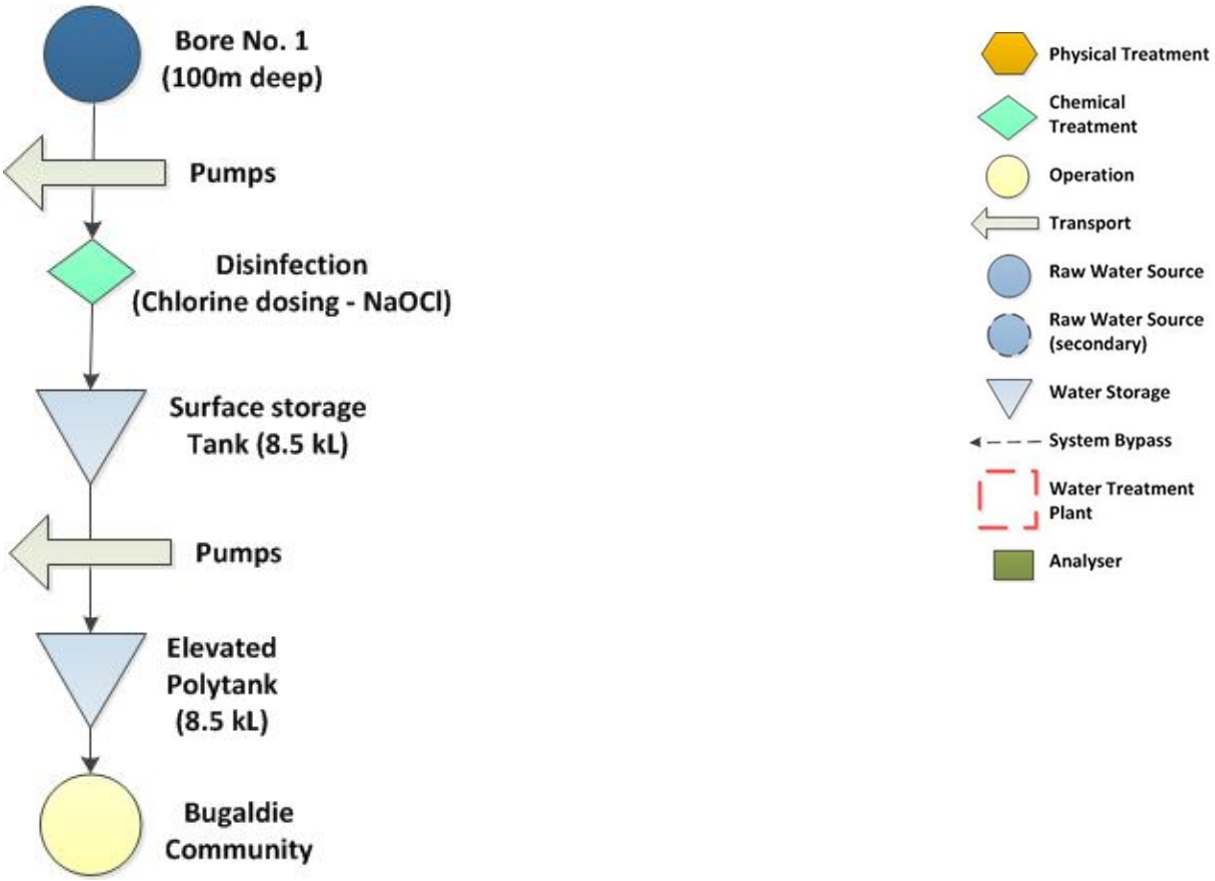


Figure 5 Bugaldie Water Supply System

2.1.5 Coolah System Flow Diagram

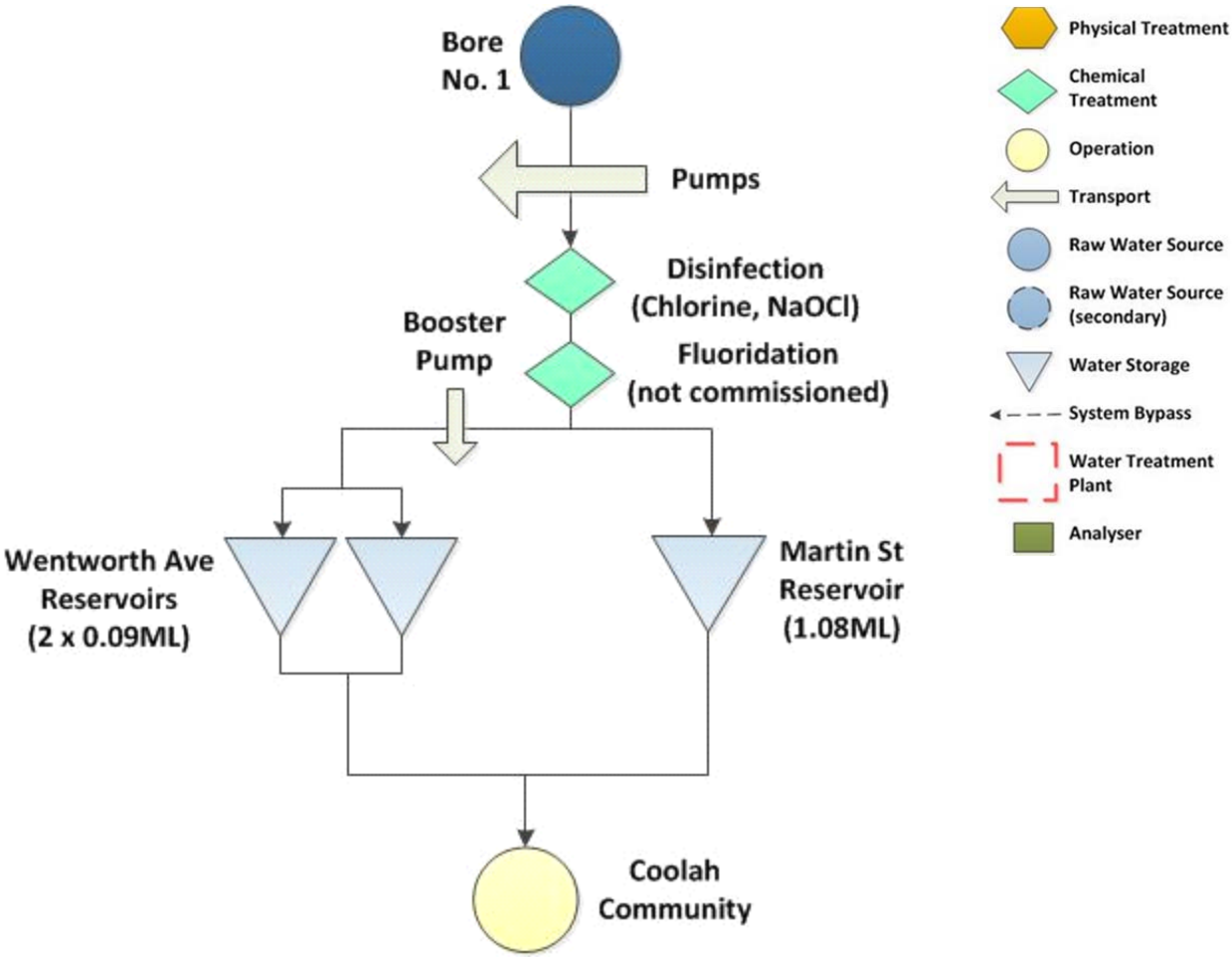


Figure 6 Coolah Water Supply System

2.1.6 Coonabarabran System Flow Diagram

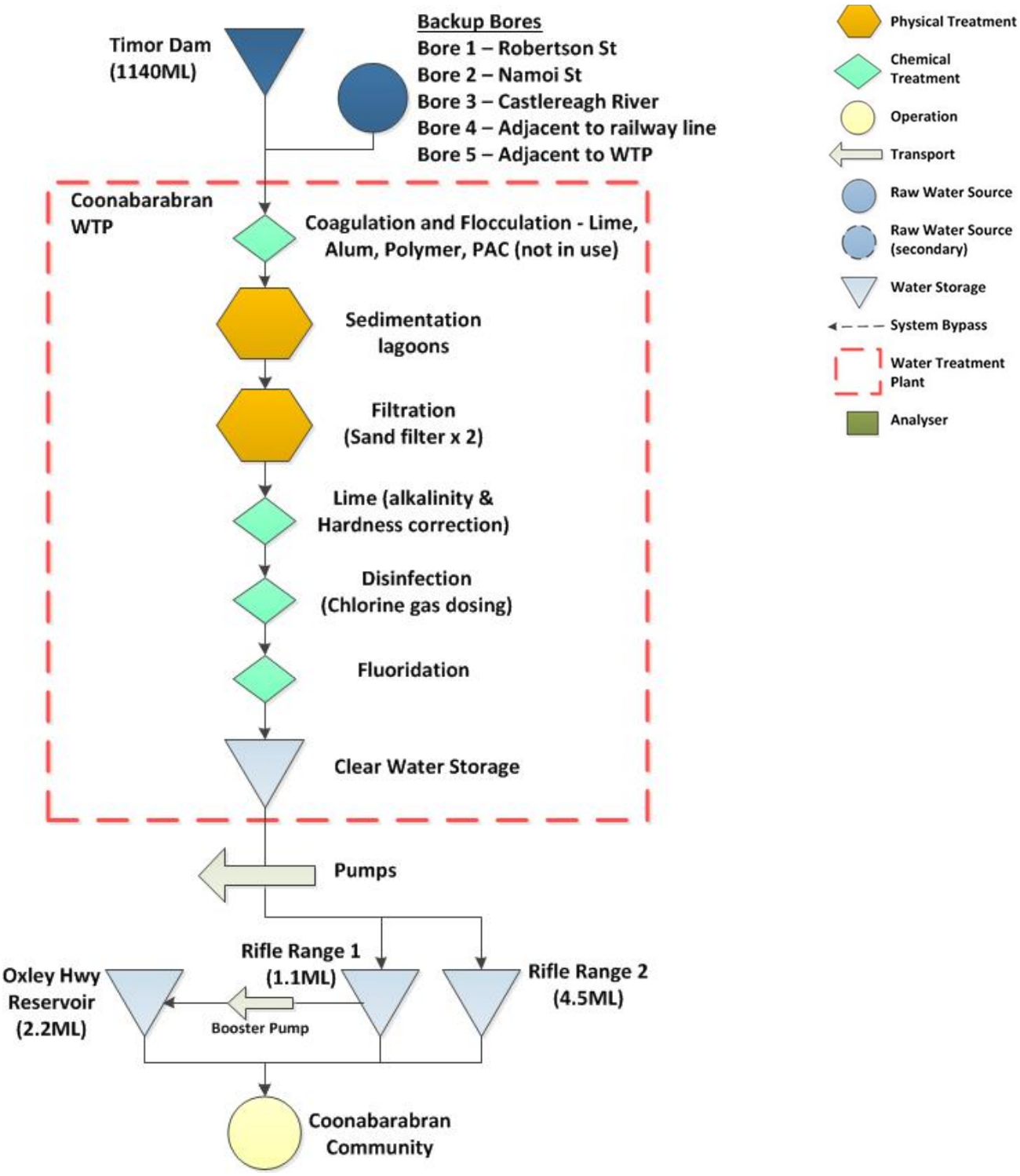


Figure 7 Coonabarabran Water Supply System

2.1.7 Dunedoo System Flow Diagram

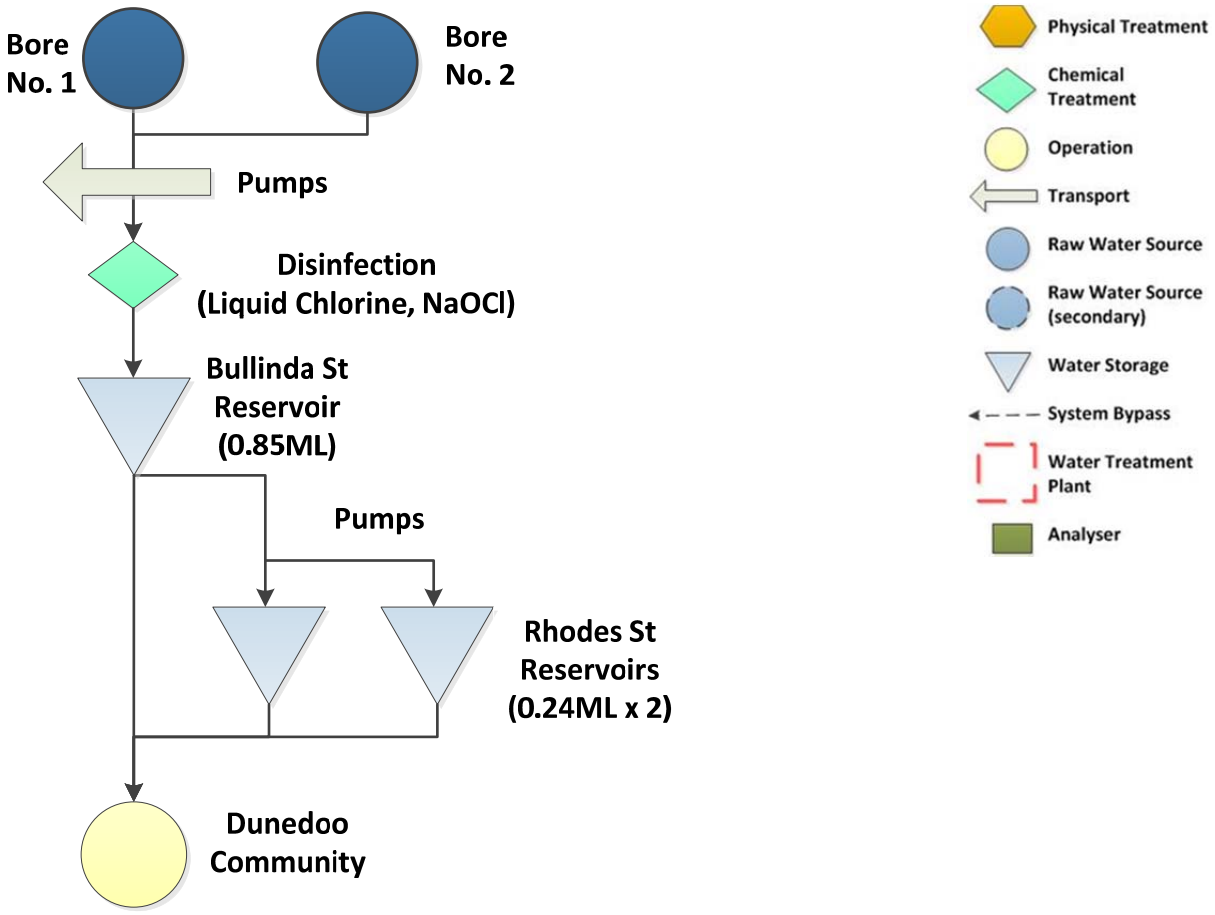


Figure 8 Dunedoo Water Supply System

2.1.8 Kenebri System Flow Diagram

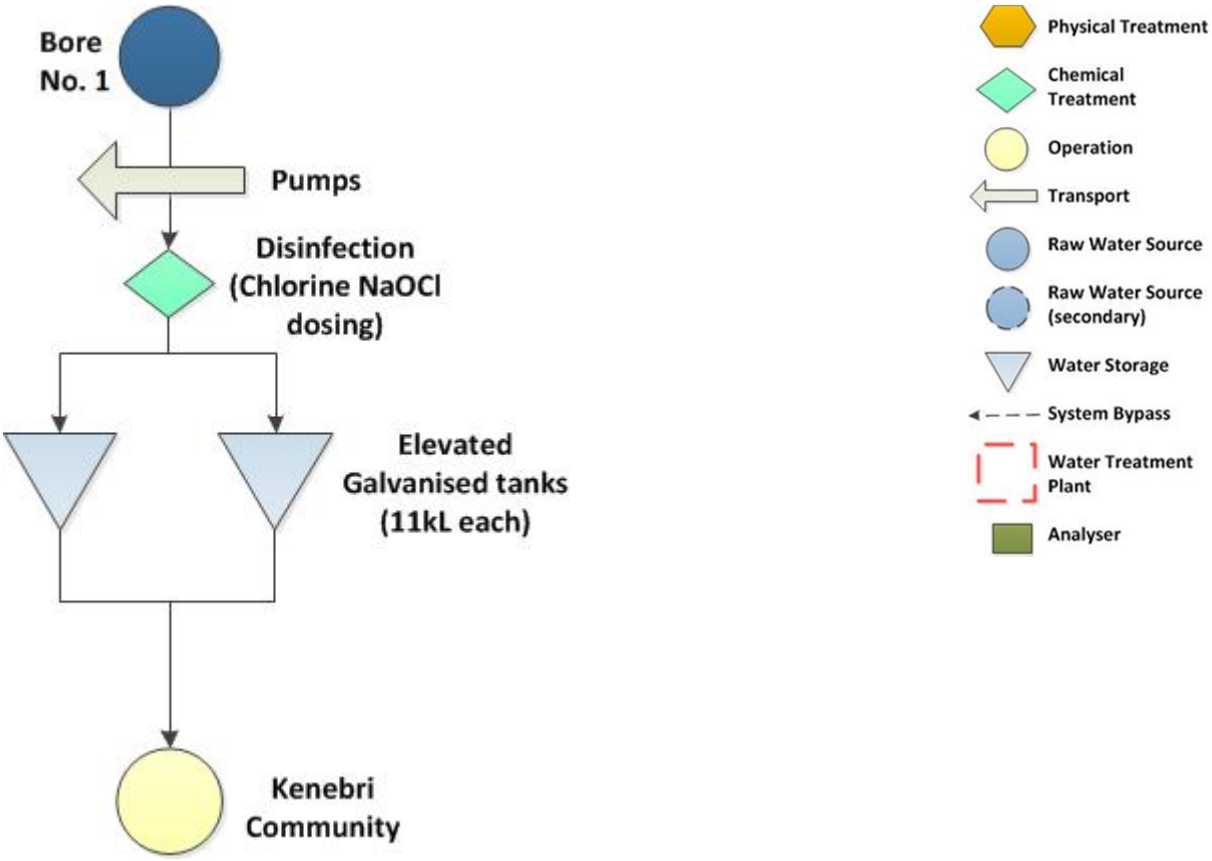


Figure 9 Kenebri Water Supply System

2.1.9 Mendooran System Flow Diagram

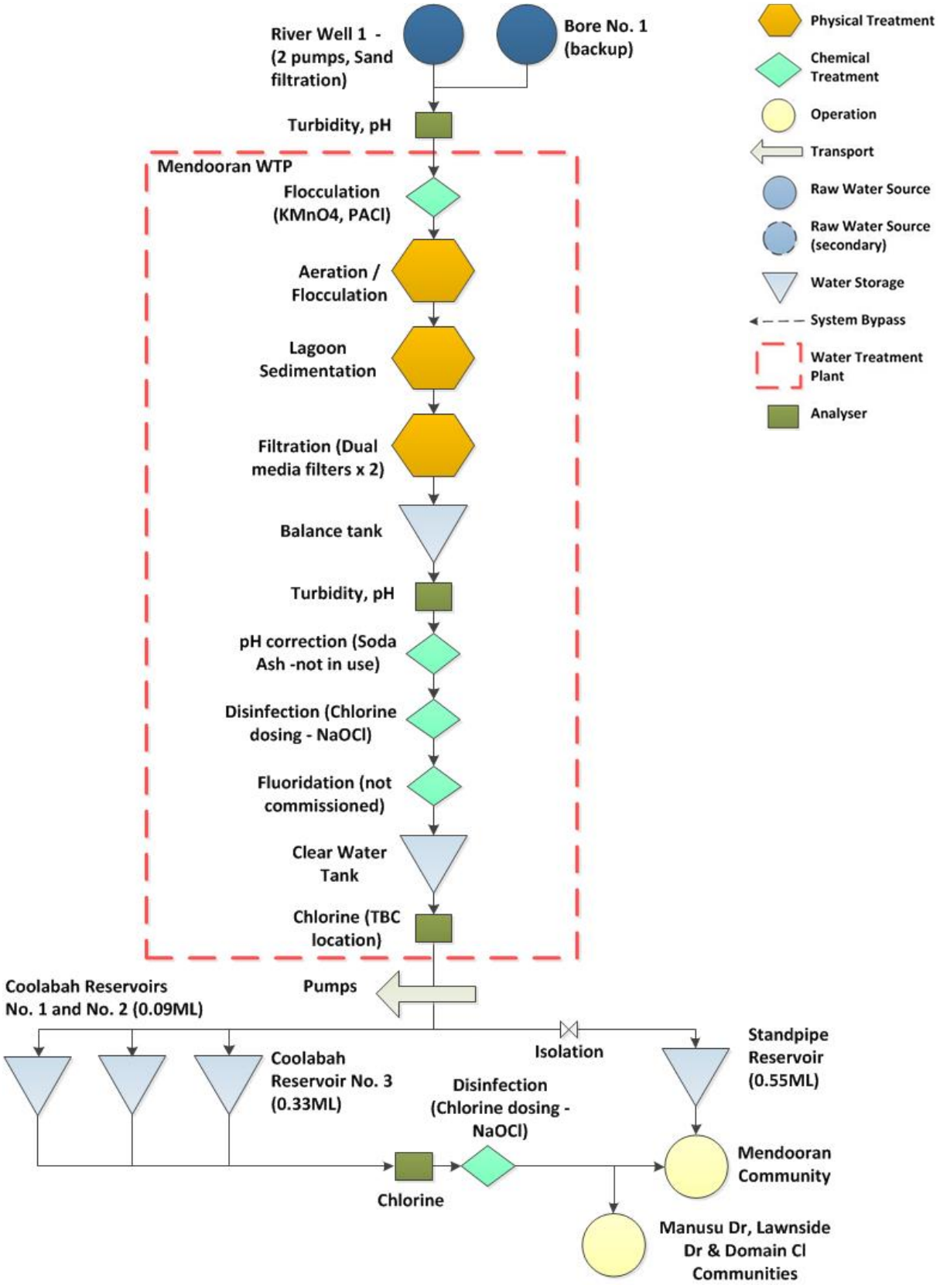


Figure 10 Mendooran Water Supply System

2.2 Assessment of Water Quality Data

- Assemble historical data from source waters, treatment plants and finished water supplied to consumers (over time and following specific events).
- List and examine exceedances.
- Assess data using tools such as control charts and trends analysis to identify trends and potential problems.

Historical data was analysed in preparation for the 2014 risk assessment workshop. Most of the data analysed was sourced from the NSW Health Drinking Water Database.

Data from 55 sampling sites has been collected from the Database covering the eight drinking water systems. All sample locations are post-treatment. A five year date range was selected to identify trends and assess the system as it is currently functioning. The specific dates of this five year range were between 10 March 2009 and 10 March 2014.

A comprehensive review of water quality data should also include source water data, as well as data from operational treatment processes. It is recommended that Council includes this water quality data in this DWMS upon next review.

The *Drinking Water Quality Risk Assessment* (AECOM, 2014a) report includes results of the analysis of the available water quality data, which included statistical analysis and graphing to identify trends. The statistical analysis undertaken as part of the 2014 risk assessment workshop is detailed in Table 4 and Table 5.

Council will need to maintain the currency of this drinking water quality assessment to maintain an understanding of how the water supply system is actually performing. This is particularly relevant where there has been a change to the water supply system, or there is an emerging performance issue.

Refer to the detailed actions to meet the requirements of the Framework outlined in Section 13.0 - Implementation Plan.

Table 4 Statistical Analysis of ADWG Health Characteristics (2008 to 2013)

	Microbiological ADWG Health		Chemical ADWG Health (mg/L if not otherwise stated)																				
	E. Coli (cfu/ 100mL)	Total Coliforms (cfu/ 100mL)	Turbidity (NTU)	pH (pH)	Antimony	Arsenic	Barium	Boron	Cad-mium	Free Chlorine	Total Chlorine	Chromium	Copper	Fluoride	Iodide	Lead	Manganese	Mercury	Molyb-denum	Nickel	Nitrate	Nitrite	Sele-nium	Silver	Sul-fate
ADWG Health Guideline Value	0	0	<5 (aesthetic) <1 (effective disinfection)	6.5 - 8.5	0.003	0.01	2	4	0.002	5	-	0.05	2	1.5 (max)	0.5	0.01	0.5	0.001	0.05	0.02	50	3	0.01	0.1	500
Baradine																									
No. Exceedences	1	7	0	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Number of samples	240	240	15	199	8	8	8	8	8	195	122	8	8	8	-	8	8	8	8	8	8	8	8	8	8
Max Value	**4**	**43**	0.98	**8.63**	0.0005	0.0005	0.112	0.05	0.00025	2.92	2.93	0.0025	0.056	0.22	-	0.002	0.0025	0.00005	0.0025	0.005	0.5	0.6	0.001	0.001	5
Mean Value	0.51	0.78	0.29	7.87	0.001	0.001	0.09	0.05	0.0003	0.96	1.10	0.0025	0.01	0.18	-	0.001	0.003	0.0001	0.003	0.01	0.50	0.12	0.001	0.001	4.13
StdDev of Values	0.23	2.86	0.37	0.27	0	0	0.02	9.96E-10	0	0.43	0.47	3.11E-11	0.02	0.04	-	3.5E-4	3.11E-11	0	3.1E-11	6.2E-11	0	0.19	0	0	0.35
Bugaldie																									
No. Exceedences	1	4	2	1	0	0	0	0	0	1	0	0	0	0	-	2	0	0	0	0	0	0	0	0	0
Number of samples	59	59	13	60	10	10	10	10	10	49	31	10	10	10	-	10	10	10	10	10	10	10	10	10	10
Max Value	**1**	**400**	**25.3**	**8.11**	0.0005	0.001	0.096	0.05	0.00025	**6.46**	2.2	0.0025	0.037	0.42	-	**0.036**	0.0025	0.00005	0.0025	0.005	1.2	0.05	0.001	0.001	3
Mean Value	0.51	7.40	3.11	6.87	0.001	0.001	0.08	0.050	0.00025	0.70	0.76	0.0025	0.02	0.34	-	0.01	0.003	0.0001	0.003	0.01	1.03	0.05	0.001	0.001	2.10
StdDev of Values	0.07	52.00	7.32	0.95	0	0	0.01	1.24E-09	0	0.96	0.56	5.49E-11	0.01	0.04	-	0.01	5.49E-11	0	5.5E-11	1.1E-10	0.07	1.2E-9	0	0	0.32
Binnaway																									
No. Exceedences	0	16	0	1	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Number of samples	120	120	11	104	7	7	7	7	7	97	60	7	7	7	-	7	7	7	7	7	7	7	7	7	7
Max Value	0.5	**41**	1.8	**8.21**	0.0005	0.001	0.167	0.05	0.00025	1.76	**7**	0.0025	0.129	0.26	-	0.003	0.037	0.00005	0.0025	0.005	1.6	0.05	0.004	0.001	67
Mean Value	0.50	1.68	0.41	7.55	0.001	0.001	0.12	0.05	0.00025	0.42	0.79	0.0025	0.03	0.18	-	0.001	0.01	0.0001	0.0025	0.01	0.73	0.05	0.001	0.001	52.6
StdDev of Values	0	5.39	0.54	0.79	0	0	0.03	7.6E-10	0	0.43	0.97		0.05	0.08	-	7.6E-4	0.01				0.43	7.6E-10	1.13E-3		11.7
Coolah																									
No. Exceedences	2	36	0	1	0	0	0	0	0	1	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Number of samples	244	244	19	210	9	9	9	9	9	199	123	9	9	9	-	9	9	9	9	9	9	9	9	9	9
Max Value	**3**	**400**	2.2	**8.3**	0.0005	0.001	0.018	0.05	0.00025	**7.53**	2.97	0.005	0.174	0.14	-	0.01	0.0025	0.0001	0.0025	0.005	5.1	0.05	0.002	0.001	6
Mean Value	0.51	7.47	0.47	7.48	0.0005	0.001	0.017	0.050	0.0003	0.90	1.24	0.003	0.06	0.09	-	0.0027	0.0025	0.0001	0.0025	0.01	4.80	0.05	0.001	0.001	5.11
StdDev of Values	0.16	45.47	0.57	0.48	0	0	0.001	1.14E-09	0	0.86	0.70	0.001	0.06	0.04	-	0.0029	4.12E-11	1.67E-05	4.1E-11	8.2E-11	0.46	1.14E-9	3.33E-4	0	0.60
Coonabarabran																									
No. Exceedences	4	27	2	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Number of samples	253	253	19	211	10	10	10	10	10	202	125	10	10	12	-	10	10	10	10	10	10	10	10	10	10
Max Value	**3**	**130**	**29**	**8.7**	0.0005	0.001	0.059	0.05	0.00025	2.02	2.16	0.0025	0.042	1.24	-	0.001	0.191	0.00005	0.0025	0.005	3.6	0.1	0.001	0.001	49
Mean Value	0.52	2.16	2.30	7.60	0.0005	0.0006	0.02	0.0500	0.0003	0.49	0.72	0.0025	0.01	0.46	-	0.00	0.03	0.00005	0.0025	0.01	1.45	0.06	0.001	0.001	33.2
StdDev of Values	0.17	10.55	6.67	0.42	0	0.0002	0.01	1.24E-09	0	0.49	0.57	5.49E-11	0.01	0.50	-	0.00	0.06		5.5E-11	1.1E-10	1.42	0.02	0	0	9.25
Dunedoo																									
No. Exceedences	1	7	1	1	0	0	0	0	0	1	0	0	0	0	-	1	0	0	0	0	0	0	0	0	0
Number of samples	241	241	17	205	8	8	8	8	8	197	123	8	8	8	-	8	8	8	8	8	8	8	8	8	8
Max Value	**1**	**62**	**7.41**	**8.01**	0.0005	0.004	0.089	0.1	0.00025	**7.38**	3.23	0.008	0.276	0.75	-	**0.013**	0.007	0.00005	0.0025	0.005	2	0.05	0.005	0.001	23
Mean Value	0.50	0.80	0.91	7.40	0.001	0.002	0.086	0.09	0.0003	1.10	1.69	0.004	0.06	0.66	-	0.0028	0.0031	0.0001	0.0025	0.01	1.14	0.05	0.002	0.001	21.7
StdDev of Values	0.03	3.98	1.72	0.55	0	0.001	0.002	0.02	0	0.94	0.63	0.002	0.09	0.06	-	0.0042	0.0016	0	3.1E-11	6.2E-11	0.35	9.9E-10	0.001	0	1.04

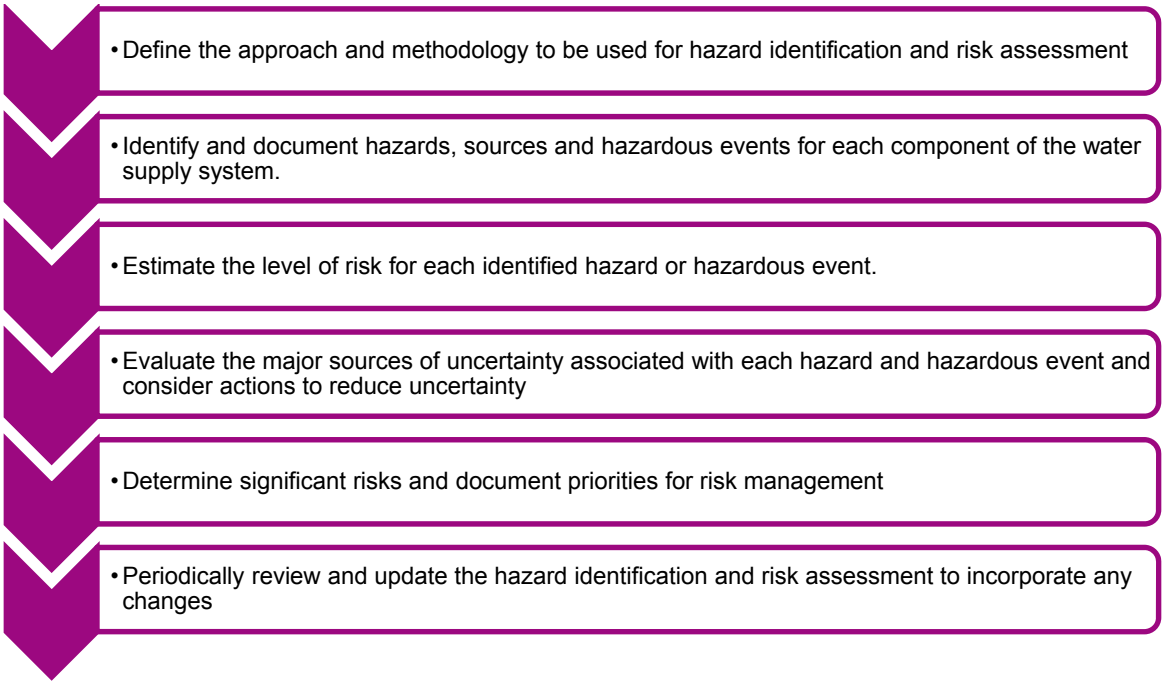
	Microbiological ADWG Health		Chemical ADWG Health (mg/L if not otherwise stated)																				
	E. Coli (cfu/ 100mL)	Total Coliforms (cfu/ 100mL)	Turbidity (NTU)	pH (pH)	Antimony	Arsenic	Barium	Boron	Cad-mium	Free Chlorine	Total Chlorine	Chromium	Copper	Fluoride	Iodide	Lead	Manganese	Mercury	Molyb-denum	Nickel	Nitrate	Nitrite	Sele-nium	Silver	Sul-fate
ADWG Health Guideline Value	0	0	<5 (aesthetic) <1 (effective disinfection)	6.5-8.5	0.003	0.01	2	4	0.002	5	-	0.05	2	1.5	0.5	0.01	0.5	0.001	0.05	0.02	50	3	0.01	0.1	500
Kenebri																									
No. Exceedences	1	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of samples	61	61	11	57	8	8	8	8	8	45	28	8	8	8	5	8	8	8	8	8	8	8	8	8	8
Max Value	**6**	**400**	1.7	**8.85**	0.001	0.003	0.237	0.1	0.00025	1.6	2.2	0.0025	0.016	0.32	0.01	0.002	0.0025	0.00005	0.0025	0.005	1.7	0.05	0.003	0.001	13
Mean Value	0.59	8.74	0.49	7.25	0.001	0.002	0.21	0.09	0.00025	0.51	0.64	0.0025	0.01	0.28	0.01	0.001	0.003	0.000	0.003	0.01	1.13	0.05	0.001	0.001	12.00
StdDev of Values	0.70	51.48	0.50	0.39	0	0.001	0.02	0.02	0	0.43	0.55	3.11E-11	4.3E-03	0.03		4.6E-4	3.11E-11		3.1E-11	6.2E-11	0.25	9.9E-10	0.001		0.53
Mendooran																									
No. Exceedences	11	36	2	1	0	0	0	0	0	0	0	0	0	0	-	0	2	0	0	0	0	0	0	0	0
Number of samples	132	132	13	112	9	9	9	9	9	100	61	9	9	9	-	9	9	9	9	9	9	9	9	9	9
Max Value	**3**	**400**	**2.2**	**8.3**	0.0005	0.001	0.018	0.05	0.00025	7.53	2.97	0.005	0.174	0.14	-	0.01	**0.616**	0.0001	0.0025	0.005	5.1	0.05	0.002	0.001	6
Mean Value	0.51	7.47	0.47	7.48	0.0005	0.0009	0.02	0.05	0.00	0.90	1.24	0.003	0.06	0.09	-	0.0027	0.13	0.0001	0.0025	0.01	4.80	0.05	0.001	0.001	5.11
StdDev of Values	0.16	45.47	0.57	0.48	0	0.0002	0.001	1.14E-09	0	0.86	0.70	0.001	0.06	0.04	-	0.0029	0.25	1.7E-05	4.1E-11	8.2E-11	0.46	1.14E-9	3.33E-4	0	0.60

Table 5 Statistical Analysis of ADWG Aesthetic Characteristics (2008 to 2013)

	Chemical ADWG Aesthetic (mg/L if not otherwise stated)										
	Aluminium (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Iodine	Iron	Magnesium (mg/L)	Sodium	TDS	Total Hardness as CaCO3	True Colour (HU)	Zinc
ADWG Aesthetic Guideline Value	0.2	N/A	250	0.15	0.3	-	180	600	200	15	3
Baradine											
No. Exceedences	0	0	0	0	0	0	0	0	0	0	0
Number of samples	8	8	8	8	8	8	8	8	8	8	8
Max Value	0.12	8.3	39	0.03	0.12	6.14	62	184	46	0.5	0.04
Mean Value	0.02	6.89	32.50	0.02	0.03	4.77	55.13	175.25	36.85	0.50	0.02
StdDev of Values	0.04	1.04	2.83	0.01	0.04	0.78	4.70	5.85	5.70	0	0.01
Bugaldie											
No. Exceedences	0	0	0	0	2	0	0	0	0	0	0
Number of samples	10	10	10	10	10	10	10	10	10	10	10
Max Value	0.005	20	44	0.03	**2.28**	13.6	38	187	98.7	1	0.5
Mean Value	0.01	16.24	38.80	0.02	0.29	10.95	33.70	174.50	85.65	0.55	0.12
StdDev of Values	1.10E-10	2.21	2.62	4.83E-03	0.71	1.10	3.13	5.93	7.12	0.16	0.14
Binnaway											
No. Exceedences	0	0	0	0	0	0	0	0	2	0	0
Number of samples	7	7	7	7	7	7	7	7	7	7	7
Max Value	0.15	44.5	152	0.03	0.1	32.41	85	522	**244.6**	1	0.05
Mean Value	0.04	34.31	84.57	0.02	0.04	21.54	63.57	348.57	174.40	0.71	0.02
StdDev of Values	0.05	8.71	39.42	0.01	0.04	6.68	19.89	109.48	48.27	0.27	0.02
Coolah											
No. Exceedences	0	0	0	0	0	0	0	0	9	0	0
Number of samples	9	9	9	9	9	9	9	9	9	9	9
Max Value	0.01	75	62	0.01	0.18	64.04	39	487	**451**	1	0.08
Mean Value	0.01	70.61	59.44	0.01	0.04	60.05	36.67	479.11	423.62	0.56	0.04
StdDev of Values	1.67E-03	3.46	1.59	1.65E-10	0.06	2.25	1.80	4.88	16.69	0.17	0.02
Coonabarabran											
No. Exceedences	1	0	0	0	3	0	0	0	0	0	0
Number of samples	10	10	10	10	10	10	10	10	10	10	10
Max Value	**0.5**	37.6	10	0.02	**7.62**	4.14	8	140	110.9	3	0.07
Mean Value	0.11	23.01	7.80	0.01	0.96	2.04	6.80	91.20	65.87	1.05	0.02
StdDev of Values	0.15	7.89	1.93	4.22E-03	2.37	1.15	1.40	23.16	24.08	0.72	0.02
Dunedoo											
No. Exceedences	0	0	0	0	0	0	0	4	8	0	0
Number of samples	8	8	8	8	8	8	8	8	8	8	8
Max Value	0.005	75.8	173	0.08	0.22	55.25	114	**630**	**406.8**	1	0.07
Mean Value	0.01	66.06	165.50	0.07	0.04	51.12	105.25	560.63	375.49	0.56	0.02
StdDev of Values	6.22E-11	5.35	4.81	0.01	0.07	2.64	5.47	137.41	18.96	0.18	0.02

	Chemical ADWG Aesthetic (mg/L if not otherwise stated)										
	Aluminium	Calcium	Chloride	Iodine	Iron	Magnesium	Sodium	TDS	Total Hardness as CaCO3	True Colour (HU)	Zinc
ADWG Aesthetic Guideline Value	0.2	N/A	250	0.15	0.3	-	180	600	200	15	3
Kenebri											
No. Exceedences	0	0	0	0	0	0	1	0	0	0	0
Number of samples	8	8	8	8	8	8	8	8	8	8	8
Max Value	0.005	19.2	172	0.15	0.24	10.49	**221**	485	77.6	1	0.13
Mean Value	0.01	13.76	165.50	0.13	0.06	7.84	157.38	468.00	66.60	0.63	0.04
StdDev of Values	6.22E-11	3.13	6.57	0.01	0.08	1.14	27.88	10.97	8.46	0.23	0.04
Mendooran											
No. Exceedences	0	0	0	0	2	0	0	1	3	0	0
Number of samples	9	9	9	9	9	9	9	9	9	9	9
Max Value	0.01	75	62	0.01	**0.18**	64.04	39	**487**	**451**	1	0.08
Mean Value	0.01	70.61	59.44	0.01	0.04	60.05	36.67	479.11	423.62	0.56	0.04
StdDev of Values	1.67E-03	3.46	1.59	1.65E-10	0.06	2.25	1.80	4.88	16.69	0.17	0.02

2.3 Hazard Identification and Risk Assessment



The hazardous events and hazard identification were recorded in a risk assessment spreadsheet, during the 2014 risk assessment workshop. This was undertaken for each component of all the drinking water supply systems. Once hazards had been identified, risk scores associated with the likelihood and consequences of each hazard were applied, resulting in an overall risk score. This risk score allowed participants to identify where the risk management priorities lie (this was later used to ensure appropriate potential CCPs were identified). Definitions associated with the risk assessment scores were drawn from the ADWG and are provided in the *Drinking Water Quality Risk Assessment* report, which is provided in Appendix A.

A total of 56 hazards were identified as part of this risk assessment, with 30 of these having what was considered as a significant unmitigated risk – i.e. *High* or *Very High* rating. By applying Council's existing control measures the number of significant risks was reduced to 23. A summary of the significant residual risks identified by the workshop attendees is provided in Table 6 below.

Where uncertainty existed, this was noted in the basis of scoring (including the source of the uncertainty) and a conservative approach to scoring was employed. Uncertainty was not scored. Where appropriate, actions to reduce uncertainty were identified and included in the Implementation Plan, which is provided in Section 13.0.

Council will need to maintain the currency of this water quality risk assessment to ensure it reflects the water quality risks in the drinking water supply system and the relevant management practises at the time. It is recommended the water supply system hazard identification and risk assessment be reviewed internally in 12 months, and with a qualified risk assessment facilitator upon any significant changes to any of the water supply systems.

The current (as of May 2014) risk assessment spreadsheet is provided in Appendix B.

For detailed actions to meet the requirements of the Framework refer to Section 13.0 - Implementation Plan.

Table 6 Significant Residual Risks (May 2014 Risk Assessment)

Hazardous Event Code	System Code	Hazardous Event	Hazard	Hazard Category	Description of Consequences	Unmitigated Risk Evaluation			Existing Control Measures & Monitoring	Residual Risk Evaluation		
						Consequence	Likelihood	Risk Band Label		Consequence	Likelihood	Risk Band Label
1	**Catchment and Abstraction**											
1.02	BWY CBN MDN CLH DDO (surface)	- Pathogens from agricultural inputs due to surface water ingress. {significant agricultural activities not present within Timor Dam catchment} [AGRICULTURAL HAZARDS]	*Cryptosporidium*	Pathogens (Chlorine resistant e.g. *Crypto*)	Acute health impact	4	C	Very High	- Filtration (MDN, CBN, BWY) - Backup supply, bores (MDN) - Sand bed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	4	D	High
1.03	BUG KBI BDN (ground)	- Pathogens from agricultural inputs due to surface water ingress. [AGRICULTURAL HAZARDS]	*Cryptosporidium*	Pathogens (Chlorine resistant e.g. *Crypto*)	Acute health impact	4	C	Very High	- Filtration (BDN) - Bore casing and bore depth (>50m)	4	C	Very High
1.04	BUG BWY CBN KBI MDN DDO	- Pathogens from septics - Unsewered properties in township (septic systems - BUG, KBI, MDN, BWY) - CBN STP upstream MDN, BWY - High rainfall events leading to *E.Coli* presence (MDN back-up bore) {significant agricultural activities not present within Timor Dam catchment} [RURAL SEPTICS]	*Cryptosporidium*	Pathogens (Chlorine resistant e.g. *Crypto*)	Acute health impact	5	C	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Sand bed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	5	D	Very High
1.05	BUG BWY CBN KBI MDN	- Pathogens from agricultural inputs due to surface water ingress. - Wildlife in catchment - High rainfall events/flood leading to *E.Coli* events (MDN back-up bore) [AGRICULTURAL]	Chlorine sensitive pathogens	Pathogens (Chlorine sensitive e.g. Bacteria and viruses), Nutrients	Acute health impact	5	A	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Chlorine dosing - Coagulation (MDN, CBN, BWY, BDN) - Sand bed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	4	D	High
1.06	ALL	- Pathogens from septics - Unsewered properties in township (septic systems - BUG, KBI, MDN, BWY) - CBN STP upstream MDN, BWY - High rainfall events leading to E.Coli presence (MDN back-up bore) [RURAL]	Chlorine sensitive pathogens	Pathogens (Chlorine sensitive e.g. Bacteria and viruses), Nutrients	Acute health impact	5	A	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Chlorine dosing - Coagulation (MDN, CBN, BWY, BDN) - Sand bed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	5	D	Very High
1.07	ALL	- Coal seam gas industry within area	All chemicals	Chemical	Chronic health impact	4	D	High	None	4	D	High

1.10	CBN	- Algal blooms	Taste and odour	-	Aesthetic impact	3	C	High	- Dam aeration - Weekly algal count and identification - Council notifications - PAC dosing - Algaecide dosing (when required)	3	C	High
3	**Coagulation and Flocculation**											
3.02	MDN BWY CBN BDN	- Incorrect dosing of coagulant: - Highly turbid water - incorrect pH (underdosing/overdosing soda ash/lime/coagulant) - loss of control - alum pump failure	Pathogens	-	Acute health impact	5	C	Very High	- Daily testing (drop tests) and inspections - Jar testing (as required) - Operator training and experience - pH and turbidity monitoring - visual inspection - duty standby pumps - chlorine dosing - filtration/sedimentation/clarification	5	E	High
4	**Clarification/Sedimentation**											
4.02	MDN BWY CBN BDN	- Wildlife cross-contamination - Clarification failure (BDN) - sedimentation failure (BWY, MDN, CBN)	All pathogens	-	Acute health impact	5	C	Very High	- Daily testing on turbidity/pH/colour - Operator training and experience - Jar testing for coagulant - Chlorine dosing - Filtration (BDN, CBN, MDN, BWY)	5	E	High
5	**Filtration**											
5.01	MDN CBN BDN	- Incorrect filter media - Failed pressure transducer, incorrect headloss set point - incorrect backwashing, failed level sensors - not replacing filter media when required - Operator error or vandalism via dropping material into the filters blocking outlet, inhibiting backwash (leads to ineffective treatment) - Compressor failure leading to insufficient pressure to wash - Sedimentation/clarification failure leading to high turbidity	All pathogens	-	Acute health impact	5	A	Very High	- Time/head loss backwash (MDN/CBN) - Routine backwash x2 week (summer), x1 (winter) (BWY) - High turbidity from filtered water leading to manual backwash. Continual high turbidity will result in filter replacement - Daily backwash, timer and head loss backup (BDN) - Maintenance procedures (i.e. backwash blowers, cleaning instruments - not documented) - Operator experience and training - Flow meter on air line for blowers - Annual calibration of the pressure gauges - Routine inspection of equipment (i.e. checking for breakthrough, blockages of nozzles) - chlorine dosing - Online turbidity meter (CBN) on outlet of filters	4	D	High
5.02	BWY	- Incorrect filter media - Failed pressure transducer, incorrect headloss set point - incorrect backwashing, failed level sensors - not replacing filter media when required - Operator error or vandalism via dropping material into the filters blocking outlet, inhibiting backwash (leads to ineffective treatment) - Compressor failure leading to insufficient pressure to wash - Sedimentation/clarification failure leading to high turbidity	All pathogens	-	Acute health impact	5	A	Very High	- Time/head loss backwash (MDN/CBN) - Visual inspection to identify low level in balance tank indicate (BWY) - Routine backwash x2 week (summer), x1 (winter) (BWY) - High turbidity from filtered water leading to manual backwash. Continual high turbidity will result in filter replacement - Maintenance procedures (i.e. backwash blowers, cleaning instruments - not documented) - Operator experience and training - Flow meter on air line for blowers - Annual calibration of the pressure gauges - Routine inspection of equipment (i.e. checking for breakthrough, blockages of nozzles) - chlorine dosing - Online turbidity meter (CBN) on outlet of filters	5	D	Very High

6	**pH Correction**											
6.02	CBN BWY BDN	- Overdosing of Lime or soda ash creating operational issues. Caused by high pH as a result of: - pump calibration failure - blocked pipe - incorrect calibration of pH meters - raw water source quality - incorrect batching This leads to less efficient treatment from disinfection due to reduced presence of hypochlorite.	All Pathogens	High pH	Acute health impact	4	C	Very High	- pH meters regularly calibrated - drop test - visual inspections - pH meters - daily sampling and testing - operator training and experience - disinfection	4	E	High
7	**Disinfection (Chlorine Dosing and Contact Vessels)**											
7.01	ALL	Under dosing from: - incorrect chlorine set point - operator error - instrumentation/equipment failure/incorrect calibration or running out of Chlorine Gas resulting in inadequate disinfection to control pathogens (system is not interlocked with chlorine pumps) - Air lock in the NaOCl or blockage from crystallisation - varying water quality i.e. turbidity, pH (due to manual water quality monitoring) - poor quality/incorrect concentration of chlorine - incorrect pH may affect chlorine residual - dilution batching (BUG, KBI, MDN)	Chlorine sensitive pathogens	Pathogens (Chlorine sensitive)	Acute health impact	5	A	Very High	- Operator training and experience - Daily chlorine residual testing after 20-30mins detention time (leaving plant and in reticulation) - Calibration of instruments	5	C	Very High
9	**Reservoirs**											
9.01	ALL	Vermin and stormwater ingress: - unlocked hatches/poorly fitting hatches - inadequate netting - poor integrity of the roof - damage due to storm events - access via scour lines/overflow - Stormwater ingress leading to contamination from faecal matter from birds. - Malicious contamination or access to reservoir by unauthorised personnel leading to water contamination. - Malicious contamination or access to reservoir by unauthorised personnel leading to water contamination. BDN: - Holes in floor of plant allowing vermin ingress to clear water tank	All pathogens and all chemicals	-	Acute health impact	5	A	Very High	- Currently a tender process soon to commence (planned joint project with LMWUA) for reservoir inspection and cleaning - Ad hoc reservoir inspections - Lockable hatches, netting, roofing - Lockable ladders and removable ladders - Security fencing around reservoirs - Community notification	5	B	Very High
9.02	CBN MDN BDN	- Stratification of reservoir leading to low chlorine	All pathogens	-	Acute health impact	5	C	Very High	- Staff experience and training - Chlorine residual monitoring within reticulation system	5	C	Very High
9.03	ALL	Disturbance of sediments due to: - low volumes and then refilling - Inadequate/infrequent cleaning of tanks - Incorrect filling design	Turbidity, suspended material, Taste and Odour	Pathogens	Aesthetic impact	3	C	High	- Aqualift inspection and report (in the past, not ongoing) - Reservoir cleaning program (not currently in place; currently a tender process, soon to commence planned joint project with LMWUA for reservoir inspection and cleaning)	3	C	High

10	**Distribution**											
10.01	ALL	- Ingress of contaminants due to back flow or cross connections (including property illegal connections) - Illegal connection to standpipes - Improper practices by water carters - Backflow from tankers filling from inappropriate locations on the system	All pathogens and all chemicals	Various	Acute health impact	4	C	Very High	- Locks on standpipes - Backflow prevention devices on standpipes - Community notification of illegal connections, illegal water carter filling - Hydrant (and stop valve) maintenance in place	4	D	High
10.02	ALL	- Mains breaks or unsanitary repairs leading to WQ issues including cross contamination of main repair equipment e.g. Sewer/Water. - Not chlorinating after a main break - Incorrect flushing procedures after a main break - Inappropriate storage of new pipework prior to installation. - Incorrect valve operation or valve failures leading to ingress of contaminates due to loss of pressure. - Unsanitary commissioning of a new main - Lack of flushing leading to high turbidity resulting in high chlorine take up - Oxidation of infrastructure inside reservoir leading to low chlorine residual	All pathogens and all chemicals	Various	Acute health impact	4	A	Very High	- Operator training and experience - Separation of water and sewer tools - Developing SWMS - Flushing of mains after repair - Maintaining chlorine residuals and monitoring	4	C	Very High
11	**Whole of System**											
11.02	ALL	- Entry of unauthorised persons leading to accidental or deliberate sabotage - Contractors/unauthorised staff have unsupervised access to treatment plants and reservoir	Various	Various	Exceedence of ADWG health guideline	5	C	Very High	- Security fencing - Lockable buildings - Community notifying council of any security breaches - Contractor entry under supervision	5	E	High
11.04	ALL	- Extreme weather events: e.g. bushfire, flood	Various	-	Exceedence of ADWG health guideline	5	D	Very High	- Secondary supply - Water carting - Double treating in high turbidity events (CBN) - Water treatment processes - Borehead integrity (BDN)	5	E	High
11.05	ALL	- Incorrect chemical delivery (quality assurance, type) - Tank filled with incorrect chemical	All chemicals	-	Exceedence of ADWG health guideline	5	C	Very High	- Staff need to be onsite to accept delivery - Labelling of containers/walls - Sighting delivery docket	5	D	Very High
11.06	MDN BWY BDN	Staff management: - Loss of skilled staff - Other responsibilities pulling operators away from key water management duties - Reporting structure creates confusion for staff and limits the ability of the manager to the direct staff to perform water/wastewater duties - Communication is inhibited by current structure which may pose risk during emergency events	ALL	-	ALL	5	A	Very High	- Agreement between water manager and urban services around staff management	5	A	Very High
11.07	ALL	- There is not enough water for consumption and hygiene needs, continuously, seasonally or in parts of distribution systems.	Various	-	Illness from harmful microorganisms due to poor hygiene or use of alternative lower-quality supplies, Dehydration	5	D	Very High	- Drought management plan - Accredited water carters - Water restrictions	5	E	High

12	**Monitoring and Management System**												
12.01	ALL	Lack of DWMS including: - SOPs - Operator training - Maintenance practices - Location of water quality monitoring sample points not being representative of whole of system. - Succession planning - Calibration of instrumentation - Qualified contactors and consultants - emergency response procedure - chemical delivery procedures	Various	-	Exceedence of ADWG health guideline	5	A	Very High	- Development of DWMS and implementation of the DWMS - All of the above	5	C	Very High

3.0 Element 3 – Preventive Measures for Drinking Water Quality Management

3.1 Preventive Measures and Multiple Barriers

- Identify existing preventive measures from catchment to consumer for each significant hazard or hazardous event and estimate the residual risk.
- Evaluate alternative or additional preventive measures where improvement is required.
- Document the preventive measures and strategies into a plan addressing each significant risk

Existing preventive measures were identified for all hazards during the 2014 risk assessment workshop, not just those presenting a significant level of risk. A total of 56 hazards were identified as part of the risk assessment process. Significant risks were determined as those with a *High* or *Very High* risk score. The number of raw risks (i.e. risks assessed without consideration of barriers/preventive strategies) identified as significant was 30. This figure was reduced to 23 once existing controls were applied.

During the risk assessment, follow up actions were identified for the remaining significant risks, as required. These actions are detailed in the Implementation Plan in Section 13.0.

The preventive measures for addressing the significant health related risks were also addressed as part of the CCP identification process. A summary of some of the general preventive measures and barriers employed by Council to manage hazards to water quality includes:

- Disinfection (see Table 11 for CT calculation)
- Online/physical monitoring – turbidity, chlorine, pH
- Treatment plant processes – aeration, filtration, disinfection, pH correction, Powdered Activated Carbon (PAC) dosing, algaecide dosing
- Natural treatment processes – e.g. sand-bed filtration
- Standby dosing pumps
- Interlocks
- Maintenance, calibration and cleaning procedures – e.g. filter backwashing, dosing pump maintenance
- Operator checks and visual inspections
- Alternative supply – e.g. backup bores
- Physical barriers – e.g. bore casing, locks on stand pipes
- Staff experience and training.

Council should continue to maintain existing control measures and ensure that all relevant control measures are formally documented as part of this review process.

For detailed actions to meet the requirements of the Framework refer to Section 13.0 - Implementation Plan.

3.2 Critical Control Points

- Assess preventive measures from catchment to consumer to identify CCPs.
- Establish mechanisms for operational control.
- Document the CCPs, Critical Limits and target criteria.

The Hazard Assessment and Critical Control Point (HACCP) methodology was used to assist the 2014 risk assessment workshop participants in identifying the CCPs. This process was described to workshop participants in the *Workshop Briefing Paper* (AECOM, 2014b) and is also documented in the *Drinking Water Quality Risk Assessment*. Target, Alert and Critical Limits were identified for each CCP, and the response protocols in the event of breach of Alert or Critical Limits were recorded. A summary of the current CCPs for Baradine, Binnaway, Bugaldie, Coolah, Coonabarabran, Dunedoo, Kenebri and Mendooran are provided in Figure 11 to Figure 18 respectively. The Standard Operating Procedures (SOP) are collated in Appendix E. The SOPs specifically relating to the CCPs are in Appendix C for quick reference and printing.

It is important that the critical control points and their associated limits and target criteria are well understood by all water supply staff, particularly those responsible for operation of the water treatment and distribution systems. To ensure maximum visibility and support a safe drinking water culture, CCP summary pages should be posted on noticeboards at the treatment plants, kept in work vehicles and displayed at other normal workplaces.

Council need to maintain currency of CCP information and ensure staff members understand what is required of them with regard to operational control.

For detailed actions to meet the requirements of the Framework refer to Section 13.0 - Implementation Plan.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Baradine	BDN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BDN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	1.2 mg/L	<1.0 mg/L
	BDN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BDN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure 11 Critical Control Points Reference Guide (Baradine)

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Binnaway	BWY1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BWY2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 mg/L	<1.5 mg/L	<1.2 mg/L
	BWY3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BWY4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure 12 Critical Control Points Reference Guide (Binnaway)

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Bugaldie	BUG1	Disinfection (Hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	< 1.3 mg/L	< 1.0 mg/L
	BUG2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BUG3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure 13 Critical Control Points Reference Guide (Bugaldie)

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coolah	CLH1	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	CLH2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CLH3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	<1.0 mg/L	0.8 mg/L

Figure 14 Critical Control Points Reference Guide (Coolah)

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coonabarabran	CBN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	CBN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 – 5.0 mg/L	<1.8 mg/L	<1.5 mg/L
	CBN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CBN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure 15 Critical Control Points Reference Guide (Coonabarabran)

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Dunedoo	DDO1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.2 mg/L	<1.0 mg/L
	DDO2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	DDO3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	<1.0 mg/L	0.8 mg/L

Figure 16 Critical Control Points Reference Guide (Dunedoo)

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Kenebri	KBI1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	KBI2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	KBI3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Figure 17 Critical Control Points Reference Guide (Kenebri)

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Mendooran	MDN1	Filtration	All pathogens	Turbidity	<0.5 NTU	>0.8 NTU	>1.0 NTU
	MDN2	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.6 mg/L	<1.2 mg/L	≤1.0 mg/L
	MDN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	MDN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	>0.5 mg/L	<0.3 mg/L	0.1 mg/L

Figure 18 Critical Control Points Reference Guide (Mendooran)

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

4.0 Element 4 – Operational Procedures and Process Control

4.1 Operational Procedures

- Identify procedures required for processes and activities from catchment to consumer.
- Document all procedures and compile into an operations manual.

Council currently has some operational procedures for their water supply systems documented in O&M manuals and Safe Work Method Statements (SWMS). The electronic and hard copy location of documents outlining operational procedures is detailed in Table 7. These manuals are accessible by engineering staff in the council office. Hard copies are also kept at the respective council offices.

Table 7 Operational Procedures

System	Operation Procedures Document Location	Last Updated
Baradine WTP O&M Manual	Electronic LOCATION: <insert location> Hard copy LOCATION: <insert location>	<insert date>
Binnaway WTP O&M Manual	Electronic LOCATION: <insert location> Hard copy LOCATION: <insert location>	<insert date>
Coonabarabran WTP O&M Manual	Electronic LOCATION: <insert location> Hard copy LOCATION: <insert location>	<insert date>
<insert relevant SWMS>	Electronic LOCATION: <insert location> Hard copy LOCATION: <insert location>	<insert date>
<insert other operational procedures>		

During the risk assessment process, a number of additional operational procedures were identified as being required to effectively manage water quality risks. These procedures have been captured in Section 13.0 - Implementation Plan to be actioned. As outlined in the ADWG, “Procedures are most effective when operations staff members are involved in their development, documentation and verification”. Council is encouraged to develop these new procedures and review existing operational procedures in a team which includes operational staff. This shall include activities such as water quality sampling, maintenance schedules and records.

While summarised procedures for managing CCPs are documented in the CCP summary sheets provided in the *Drinking Water Quality Risk Assessment* (AECOM, 2014a), these procedures are abbreviated, and more detailed procedures should be developed.

These operational procedures are to be relevant and current to the existing system and a review process shall be developed to capture any changes, modifications since the last review.

Council should compile all SOPs into a single operations manual, to be kept on site at the WTPs. This will ensure that all operational staff have access to the procedures and they are kept in a centralised (and recognisable) location.

Actions addressing the above requirements are detailed in Section 13.0 - Implementation Plan.

4.2 Operational Monitoring

- Develop monitoring protocols for operational performance of the water supply system, including the selection of operational parameters and criteria, and the routine analysis of results.
- Document monitoring protocols into an operational monitoring plan.

Operators sample and test the pre and post treated water in Warrumbungle Shire. Test results are recorded on run sheets. This includes manual sampling and real time monitoring using an inline probe. Table 8 summarises the parameters monitored, the monitoring location and the frequency of monitoring is recorded below.

Table 8 Monitoring Parameters

System	Parameters	Monitoring Location	Monitoring Frequency
Baradine	Chlorine residual	Leaving WTP	Daily
		Sampling point in the distribution system	Monthly
	Turbidity	Outlet of filter	Daily
	<Parameter>	<Location>	<Frequency>
Binnaway	Chlorine residual	Leaving WTP	Daily
		Sampling point in the distribution system	Fortnightly
	Turbidity	Outlet of filter	Daily
	<Parameter>	<Location>	<Frequency>
Bugaldie	Chlorine residual	Off elevated reservoir outlet	Daily
		Sampling point in the distribution system	Monthly
	Turbidity	<Location>	<Frequency>
	pH	<Location>	<Frequency>
	<Parameter>	<Location>	<Frequency>
Coolah	Chlorine residual	Wentworth and Martin St reservoirs	Daily
		Sampling point in the distribution system	Daily
	Turbidity	<Location>	<Frequency>
	pH	<Location>	<Frequency>
	<Parameter>	<Location>	<Frequency>
Coonabarabran	Chlorine residual	Leaving WTP	Daily
		Sampling point in the distribution system	Monthly
	Turbidity	Outlet of filter	Online
	<Parameter>	<Location>	<Frequency>
Dunedoo	Chlorine residual	Outlet of Bullindah St reservoir and Rhodes St reservoir	Daily
		Sampling points in the	Daily

System	Parameters	Monitoring Location	Monitoring Frequency
		distribution system (at dead ends)	
	<Parameter>	<Location>	<Frequency>
Kenebri	Chlorine residual	Outlet of reservoir	Daily
		Sampling point in the distribution system	Monthly
	<Parameter>	<Location>	<Frequency>
Mendooran	Chlorine residual	Leaving Coolabah reservoir and the plant	Daily
		Sampling points in the distribution system	Weekly
	Turbidity	Outlet of filter	Online
	<Parameter>	<Location>	<Frequency>

Short term water quality results are communicated internally from the operators directly to the Manager Warrumbungle Water, when appropriate (i.e. exceedence measured). External communication of daily results is limited to gross and/or consistent exceedences. These tasks are carried out as appropriate. Currently there is no written procedure.

Monitoring practices were discussed in detail in the risk assessment workshop and it is clear that the operations staff understand the monitoring requirements for each system.

Operational monitoring documents include:

- Daily run sheets at the water treatment sites
- <insert names of any other monitoring documentation (if any)>

These documents are included in the DWMS Document Register.

While the above documentation already exists, the next step is to develop monitoring protocols and combine this with the existing documentation into a formal Operational Monitoring Plan. The monitoring protocols in the Operational Monitoring Plan should include responsibilities, authorities and communication protocols. This plan shall contain monitoring protocols for monitoring of CCPs against the defined criteria.

Outstanding actions to address the above requirements are detailed in Section 13.0.

4.3 Corrective Action

- Establish and document procedures for corrective action to control excursions in operational parameters.
- Establish rapid communication systems to deal with unexpected events.

Corrective actions to be implemented in the event of excursions from health related water quality targets were discussed and documented as part of the CCP identification process during the drinking water quality risk assessment workshop held in May 2014. These actions have been documented in the Implementation Plan in Section 13.0. The CCP Reference Guide can be referenced in Section 3.2 of this report.

It is important that the critical control points and their associated limits and target criteria are well understood by all water supply staff, particularly those responsible for operation of the water treatment and distribution systems. To ensure maximum visibility and support a safe drinking water culture, CCP summary tables should be posted on noticeboards at the treatment plants, kept in work vehicles and displayed at other normal workplaces.

Council observes the guidance provided in the NSW Health Response Protocols on microbial quality and physical and chemical quality.

Response protocols can be found at:

http://www.health.nsw.gov.au/environment/water/Pages/nswhrp-chemical.aspx

http://www.health.nsw.gov.au/environment/water/Pages/nswhrp-microbiological.aspx

A summary of who to contact in the event of triggering these protocols and a list of emergency contacts are provided in Section 6.1.

A rapid communication system has not been formalised and agreed, however, operators contact the Manager Warrumbungle Water for unexpected events.

Outstanding actions to address the above requirements are detailed in Section 13.0.

4.4 Equipment Capability and Maintenance

- Ensure that equipment performs adequately and provides sufficient flexibility and process control.
- Establish a program for regular inspection and maintenance of all equipment, including monitoring equipment.

Through the Drinking Water Quality Risk Assessment (refer to Appendix A for the report) the adequacy of the existing process equipment was assessed in relation to its ability to effectively manage water quality hazards. This included:

- Reliability of the systems (i.e. availability of backup generators, system redundancy)
- Stability of systems (i.e. ability to withstand flood/fire events)
- Capacity to deliver drinking water in line with ADWG health limits

In the risk assessment workshop, areas lacking in capability were identified and follow up actions have been captured in Section 13.0 - Implementation Plan.

A comprehensive inventory of equipment, including details such as maintenance history, ensures equipment is functioning optimally and within the bounds it was designed for. Council's existing asset register (including details on asset life) is located here: <insert location>.

It is recommended Council build on its existing asset register and ensure all of the following details are captured within this register. This should include (but not be limited to) details such as: maintenance history, last service date, maintenance frequency, who is responsible for maintaining each piece of equipment and any recorded failures. This database should also include any water quality monitoring equipment, such as online monitoring equipment and bench top laboratory equipment.

An inspection and maintenance program should be developed in conjunction with this database. The purpose is to ensure the database notifies when there is a need for maintenance, and ensure that any inspections and/or maintenance work is appropriately recorded in this database.

Condition based maintenance is currently carried out when regular inspections/measurements indicate maintenance intervention is required (e.g. vibration levels in pumps, paint condition, oil levels). The SOPs council currently have in place for this are detailed in Appendix E.

Outstanding actions to address the above requirements are detailed in Section 13.0.

4.5 Materials and Chemicals

- Ensure that only approved materials and chemicals are used.
- Establish documented procedures for evaluating chemicals, materials and suppliers.

Council requires conformance with the following plumbing codes, regulations and standards, which guide product selection and installation:

- AS/NZS 3500.1:2003 Plumbing and drainage – Water services
- AUS-SPEC 0071 Water Supply – Reticulation and pump stations (Design)
- AUS-SPEC 1341 Water – Reticulation and pump stations (Construction)

Council currently does not have a formalised procedure for chemical deliveries, and does not undertake acceptance tests upon receipt of chemicals. However, there are long standing contracts in place with chemical suppliers for water treatment chemicals and chemicals are delivered with a statement of chemical quality. Council is currently undertaking a review of its chemical procurement procedures.

The following chemicals are used by Council's water treatment systems:

- Alum at <insert systems> for flocculation supplied by <insert supplier>
- PAC at <insert systems> for algae treatment supplied by <insert supplier>
- Lime at <insert systems> for pH correction supplied by <insert supplier>
- Soda ash <insert systems> for pH correction supplied by <insert supplier>
- Chlorine gas at <insert systems> for disinfection supplied by <insert supplier>
- Sodium hypochlorite at <insert systems> for chlorination supplied by <insert supplier>
- Fluoride at <insert systems> for fluoridation supplied by <insert supplier>
- <Chemical> <insert systems> for <x> supplied by <insert supplier>

The use of unverified chemicals remains a hazard within the drinking water systems. Contracts with the chemical suppliers should be reviewed to ensure tolerances around chemical quality are sufficiently addressed and treatment/delivery of the product is appropriately controlled. Verification procedures and documentation should be developed to address this, including the need for an operator to be on site at the time of chemical delivery. Council should consider developing a procedure for undertaking spot checks for chemical quality compliance.

Outstanding actions to address the above requirements are detailed in Section 13.0.

5.0 Element 5 - Verification of Drinking Water Quality

5.1 Drinking Water Quality Monitoring

- Determine the characteristics to be monitored in the distribution system and in water as supplied to the consumer.
- Establish and document a sampling plan for each characteristic, including the location and frequency of sampling.
- Ensure monitoring data are representative and reliable.

Council participates in NSW Health's Drinking Water Monitoring Program, with results recorded in the NSW Drinking Water Database. Council tests drinking water for 36 health and aesthetic characteristics. These samples are taken from 55 sample sites covering the eight drinking water systems, all of which are post-treatment. These results input into an ongoing verification process of the quality of drinking water supplied by Council. The water quality characteristics that are monitored as part of this program are specified by NSW Health and were detailed in Appendix G of the *Drinking Water Quality Risk Assessment* report.

Pesticides, radiological characteristics and Disinfection By-Products (DBPs) have not been measured in Warrumbungle Shire in the last 5 years. As discussed in the risk assessment workshop, NSW Health provides a funding allocation for specific project investigations consistent with NSW Health and/or NHMRC monitoring recommendations. Council should consider applying for this by contacting the Public Health Unit, to get an improved understanding of whether these characteristics are present within their catchments which could pose a potential risk to drinking water quality.

Water samples collected as part of the Drinking Water Monitoring Program are sent to the Forensic and Analytical Science Service (FASS), NSW Health's NATA accredited laboratory for testing, and Council is informed of any non-compliant test results. Samples are collected in accordance with the *Guide to Submitting Water Samples to the Division of Analytical Service* (DAL, 2010). Additional information on the NSW Drinking Water Monitoring Program, as well as a link to the drinking water database and may be found here:

http://www.health.nsw.gov.au/environment/water/Pages/drinkwater-nsw.aspx

In addition to monitoring undertaken as part of NSW Health's Drinking Water Monitoring Program, Council also independently monitors water quality parameters pre and post treatment at their water supply systems, including:

- *E.coli*
- Total coliforms
- Chlorine residual
- pH
- Turbidity
- Iron
- Aluminium
- Lead
- Total Dissolved Solids (TDS)
- Total hardness
- Sodium
- Manganese

Results of drinking water quality monitoring by Council are recorded in spreadsheets. The electronic locations of spreadsheets are provided in Table 9. This data should be included in this DWMS as it is assists in understanding system performance, and allows for identifying aspects of the drinking water system that may need improvement.

Table 9 Drinking Water Quality Monitoring Spreadsheets

System	Operation Procedures Document Location
Baradine	Electronic LOCATION: <insert location>
Binnaway	Electronic LOCATION: <insert location>
Bugaldie	Electronic LOCATION: <insert location>
Coolah	Electronic LOCATION: <insert location>
Coonabarabran	Electronic LOCATION: <insert location>
Dunedoo	Electronic LOCATION: <insert location>
Kenebri	Electronic LOCATION: <insert location>
Mendooran	Electronic LOCATION: <insert location>

While the above activities are currently being undertaken, these practices are not formally documented. The next step is to develop verification monitoring protocols and combine this with existing documentation into a formal Water Quality Verification Plan. The Verification Plan should include current information on sampling locations, parameters, frequencies, links to sampling and handling procedures and protocols, information regarding how the results are communicated by the lab, internal data review requirements and information on how to respond in the event of a non-compliance.

Council may insert these Water Quality Verification Plans into this section of the DWMS or maintain the links to the verification plans. It is advisable to maintain only one primary source of information and to limit the number of documents that contain the live version to one.

Water quality data was reviewed and subsequently determined to be representative of Council's catchments during the Drinking Water Quality Risk Assessment. Data will continue to be reviewed through the annual DWMS review process.

Outstanding actions in this regard have been detailed in the Implementation Plan in Section 13.0.

5.2 Consumer Satisfaction

- Establish a consumer complaint and response program, including appropriate training of employees.

It is a requirement of Council to manage and record any customer complaints and/or feedback from the community. Customer complaints are managed through reception. Customer complaints are directed to the Manager Warrumbungle Water who delegates responsibilities as appropriate.

As specified in the Strategic Business Plan (WSC, 2013), Council conducts customer surveys at least once every three years. Council sets performance targets for these surveys to achieve 90% satisfaction level.

A register of these complaints is submitted annually to NSW Office of Water for inclusion in the *NSW Water Supply and Sewerage – NSW Benchmarking Reports*. The following provides a summary of complaints from NOW *NSW Benchmarking Report 2009 – 2012*:

- 2011/12 – 3 per 1,000 properties
- 2010/11 – 14 per 1,000 properties
- 2009/10 – <1 per 1,000 properties
- 2008/09 – <1 per 1,000 properties

Council should continue to undertake these activities. No additional actions are required to meet the requirements of this component under the framework.

5.3 Short-term Evaluation of Results

- Establish procedures for the daily review of drinking water quality monitoring data and consumer satisfaction.
- Develop reporting mechanisms internally, and externally, where required.

Water quality verification data is recorded in NSW Health's Drinking Water Database and may be accessed by Council at any time. The Drinking Water Database shows compliance against the ADWG requirements and may be accessed by authorised Council users from the following link:

http://www.health.nsw.gov.au/environment/water/Pages/drinking-water-databse.aspx

Council undertakes daily monitoring of water quality results at their supply systems. Council is in the process of adopting a central electronic spreadsheet to capture daily water quality data. It is critical that this is kept up-to-date to allow for simple and ongoing evaluation of results. Council may want to consider providing water quality data in water rate notices to customers.

Council's <insert personnel> is notified of non-conforming results and provides advice as the appropriate response actions. The local PHU should also be contacted by Council's <insert personnel> in the event of an ADWG exceedence. Review of the water quality data is undertaken by Council's <insert personnel> on a regular basis (<insert frequency>). The <insert personnel> also reviews this information against the operational monitoring that is undertaken. Council acknowledges that water quality data recorded in the NSW Drinking Water Database should be reviewed more frequently to identify potential trends in water quality and this has been noted in the Implementation Plan in Section 13.0.

Where samples analysed by FASS are found to be above guidelines, Council is notified.

Council also records customer complaints in daily water quality monitoring spreadsheets for Baradine, Binnaway, Coolah, Coonabarabran, Dunedoo and Mendooran water supply systems. Council should also apply these procedures to Bugaldie and Kenebri water supply systems.

Outstanding actions to address the above requirements are detailed in Section 13.0.

5.4 Corrective Action

- Establish and document procedures for corrective action in response to non-conformance or consumer feedback.
- Establish rapid communication systems to deal with unexpected events.

Customer complaints and feedback are received and delegated as per the procedures outlined in Section 5.2. Non-conforming water quality verification and monitoring results trigger the operational staff or operators to notify the Manager Warrumbungle Water.

As identified in Section 4.3, Council adheres to the response protocols established by NSW Health, which can be found at:

http://www.health.nsw.gov.au/environment/water/Pages/drinking-water.aspx

It is recommended that the rapid communication system be established as part of an Emergency Response Plan (ERP). This is addressed in Section 6.1. Additional actions to be implemented to improve compliance with the above requirements are documented in the Implementation Plan in Section 13.0.

6.0 Element 6 - Management of Incidents and Emergencies

6.1 Communication

- Define communication protocols with the involvement of relevant agencies and prepare a contact list of key people, agencies and businesses.
- Develop a public and media communications strategy.

Council currently holds general meetings that are open for the public to attend. At these meeting general council issues are discussed and can include water related issues. The public can also contact Council via email or telephone for more information on water quality issues.

Community consultation strategies have been defined in Council's Strategic Business Plan (WSC, 2013). Information on major projects is included in local newsletters. The local high school and TAFE have expressed interest in organising excursions to the dam, WTP and STP. This initiative could help further educate the community about water related issues.

Council follows the guidance from NSW Health in responding to public health risks and maintains communication with NSW Health's Public Health Unit and NOW when responding to emergencies.

It is recommended that communication protocols be documented as part of an ERP and a contact list be pinned up at the water treatment sites. As well as including contact details for emergency services, government stakeholders and media, the ERP should also include a contact register for customers sensitive to minor changes in water quality (e.g. dialysis patients). Council should consider implementing a procedure to communicate with the relevant Renal Dialysis Co-ordinators if high chlorine concentrations are found or expected in the distribution system. This will be more reliable than trying to keep an up to date list of dialysis patients.

The contact list in Table 10 is a draft that should be reviewed and updated by Council.

Table 10 Contact List

Role	Name	Contact Details	
		Phone	Email
Manager Warrumbungle Water	Cornelia Wiebels	P: (02) 6378 5000 M: 0409 896 452	cornelia.wiebels@warrumbungle.nsw.gov.au
Public Health Unit (PHU)	Mark Nave	P: (02) 6841-2339 M: 0407 551 548	Mark.Nave@health.nsw.gov.au
NSW Office of Water	Bruce Lamont	M: 0458 268 453	bruce.lamont@water.nsw.gov.au
NSW Office of Water	Matt Parmeter	P: (02) 6841 7410	matt.parmeter@water.nsw.gov.au
FASS	General Enquiries	Ph: (02) 9646 0322	-
After Hours Courier	Council staff as directed.	-	-
Emergency Services	-	000	-

Outstanding actions to address the above requirements are detailed in Section 13.0.

6.2 Incident and Emergency Response Protocols

- Define potential incidents and emergencies and document procedures and response plans with the involvement of relevant agencies.
- Train employees and regularly test emergency response plans.
- Investigate any incidents or emergencies and revise protocols as necessary.

Council does not currently have formally documented *Incident Response and Management Plans* for incidents and emergencies. The *Drinking Water Quality Risk Assessment* workshop attendees identified various tasks that will need to be integrated into an Incident and Emergency Response Plan (for example, response procedures for contaminants such as pathogens, other algal blooms, chemical spills etc.). Council is required to develop a comprehensive Incident and Emergency Response Plan for all water supply services which defines these potential incidents in relation to water quality and provides guidance in responding to these water quality incidents. Emergency contact details must be referenced in the ERP. Response protocols should be practiced, with all staff needing to be trained in the procedures.

Council does not currently undertake regular follow up investigations following incidents. These investigations should include an analysis of the cause and effects of the incident, the effectiveness of the response procedures and corrective actions required. These reviews should feed into regular updates to the ERP, as appropriate.

NSW Health provides guidance on how to respond to water quality incidents through the following protocols. Flow charts depicting the appropriate response protocols are detailed below in Appendix F. Most of the below information can be reached via NSW Health's Drinking Water website.

- Microbiological failure or threat, including treatment and disinfection failure
  - NSW Health Response Protocol - Microbiological Quality
  - NSW Health Response Protocol – Treatment Failure, Cryptosporidium and Giardia
- Physical and Chemical Contamination
  - NSW Health Response Protocol - Physical and Chemical Quality
- Cyanobacterial (Blue-green algae) bloom/toxins
  - Regional Algal Coordinating Committee Contingency Plans
  - NSW Water Directorate Blue Green Algae Management Protocols
- Business interruption
  - NSW Water Directorate Business Continuity Management Guidelines

Additional guidance is also available for issuance of boil water alerts:

- Special Considerations During a Boil Water Alert
  - Precautions for schools and child care centres
  - Precautions for swimming pools and spas
  - Precautions for commercial establishments serving food or drinks
  - Using water header tanks
- Boil Water Alerts
  - Example Boil water alert *E. Coli* contamination
  - Example Boil water alert for Cryptosporidium and or Giardia contamination

Council needs to plan for water quality incident response reviews to be undertaken. Outstanding actions to address the above requirements are detailed in Section 13.0.

7.0 Element 7 - Employee awareness and training

7.1 Employee Awareness and Involvement

- Develop mechanisms and communication procedures to increase employees' awareness of and participation in drinking water quality management.

Council demonstrates their commitment to open two-way dialogue between operators and managers that allows for any concerns to be raised. Toolbox meetings are held regularly (<insert frequency>) to inform the team of workplace health and safety issues. This is also an opportunity for staff to raise any concerns or feedback in relation to any water quality management issues.

All water management stakeholders must read and agree to abide by the principles of this DWMS. This includes adding this requirement to the role descriptions for Council employees moving forward.

Council should continue to undertake these activities and may consider developing a procedure for operator communication.

Outstanding actions to address the above requirements are detailed in Section 13.0.

7.2 Employee Training

- Ensure that employees, including contractors, maintain the appropriate experience and qualifications.
- Identify training needs and ensure resources are available to support training programs.
- Document training and maintain records of all employee training.

Operational staff are managed by the Manager Warrumbungle Water, whose role with respect to employee training is to:

- ensure these employees hold sufficient experience
- ensure employees have the appropriate qualifications for their roles
- coordinate training courses for staff (where required)
- manage financial resourcing for training

As detailed in their Strategic Business Plan, Council has a Workforce Management Strategy Plan (2013-2017) that covers all aspects of workforce management. The strategy includes (but is not limited to) the following:

- Work force planning
- Recruitment
- Personnel management (motivation, communication, performance appraisal etc.)
- Training
- Succession planning

Council's Human Resources team maintains records of all staff training including: licenses, ticket numbers and expiry dates. Examples of training include:

- NOW training courses (i.e. WTP Processes – Part 1 and 2, Certificate 2 and 3)
- Construction Green Card
- Occupational Health and Safety Induction
- Fluoride training courses

Council undertakes various internal training courses for its staff. Council is required to formalise internal on the job training processes – documenting the training content, processes and attendance.

Council should continue to undertake these activities, however no additional actions need to be undertaken to address the requirements of this component of the Framework.

8.0 Element 8 - Community Involvement and Awareness

8.1 Community Consultation

- Assess requirements for effective community involvement.
- Develop a comprehensive strategy for community consultation.

Council engages with the local community to communicate issues around water management proactively through:

- Regular (<insert frequency>) consultative meetings
- Community surveys
- Local newsletters
- Council website (http://www.Warrumbungle.nsw.gov.au/)

As outlined in Council's Strategic Business Plan (WSC, 2013), "Council is committed to consulting with the community on a regular basis with significant decisions being made in a totally transparent manner". Council's strategy for community consultation is detailed in Section 6.6.2 of their Strategic Business Plan.

Council should continue to undertake these activities, however no additional actions need to be undertaken to address the requirements of this component of the Framework.

8.2 Communication

- Develop an active two-way communication program to inform consumers and promote awareness of drinking water quality issues.

As discussed in section 5.2 the community are welcome to provide feedback by contacting Council through email or telephone. Council communicates water quality issues to the public and media on their website and through local media.

Council may consider providing water quality data on residents rates notices and/or publishing some of this data on their website.

Outstanding actions to address the above requirements are detailed in Section 13.0.

9.0 Element 9 - Research and Development

9.1 Investigative Studies and Research Monitoring

- Establish programs to increase understanding of the water supply system.
- Use information to improve management of the water supply system.

In May 2014 Council held a drinking water quality risk assessment workshop to better understand their system and the risks that affect water quality. Through open dialogue between plant operators and the Manager Warrumbungle Water there is continuous feedback regarding the systems and how they behave.

Council have access to the NSW Health Drinking Water Database to facilitate analysis of water quality information in the distribution system/network. Council predominantly rely on manual sampling and testing for operational control. Council should strongly consider investing in online monitoring at all CCPs. This would provide greater process control, as immediate notification would be provided in the event an alert limit is exceeded. Importantly, it would also provide the opportunity of an immediate response in the event a critical limit is exceeded (such as triggering a plant shut down). Online monitoring would also provide useful data for analysis of performance of processes used to control hazards at CCPs and would improve understanding of the treatment effectiveness more generally.

Council is part of the Lower Macquarie Water Utilities Alliance (LMWUA) bringing together 12 councils across the region, governed by a common strategic plan. The driver for the alliance is to share resources and combine service delivery where possible. This has included research reports and community awareness programs spanning across a number of councils boundaries.

Other investigative studies that Council has undertaken or participated in include:

- Implementation of corrective actions outlined in NOW inspector reports
- Water quality sampling and testing in response to water quality complaints
- Valuation of Water Supply and Sewerage Assets (WSC, 2012)
- Strategic Business Plan (WSC, 2013)

Project specific water quality sampling for source water monitoring (e.g. pesticides, DBPs, baseline raw water monitoring), designed to increase understanding of water quality characteristics and fill gaps in knowledge, may be undertaken by Council in consultation with the PHU. Council should review and analyse water quality performance using available water quality data as discussed in Section 5.3.

Outstanding actions to address the above requirements are detailed in Section 13.0.

9.2 Validation of Processes

- Validate processes and procedures to ensure that they are effective in controlling hazards.
- Revalidate processes periodically or when variations in conditions occur.

Validation is the process of objectively checking the performance of the processes, procedures and controls in place to ensure they are effective and so that drinking water remains safe.

With respect to existing processes and procedures, the drinking water quality risk assessment workshop included a review of the existing control measures and their effectiveness was assessed for each hazard.

Validation is particularly important when changes are made to the operation of a water supply system or WTP, or when system components are upgraded. Validation should also be undertaken for new systems. This should involve reviewing existing processes and procedures to ensure they adequately address the changes being made, and if they don't, updating them.

Chlorine contact time (CT) is an indicator used to determine the effectiveness of the chlorine disinfection process. CT is calculated using Equation 1:

$$\text{CT}\left(\frac{\text{mg.min}}{\text{L}}\right) = \text{Chlorine residual}\left(\frac{\text{mg}}{\text{L}}\right) \times \text{Time (mins)}$$

Equation 1 – Chlorine contact time

where chlorine residual (mg/L) is measured as final water (leaving the WTP) and time is the estimated time to nearest customer (including reservoir turnover time).

According to ADWG, "in clean water, a combined available residual chlorine level of 0.5 mg/L after a contact time of 30 minutes should be sufficient to ensure microbial control, given to a clean distribution system and no significant recontamination"; this equates to a CT value of 15 mg.min/L.

Council currently does not have a good understanding of the CT in its water supply systems, nor does it have sufficient design information to accurately calculate it. Most systems have tanks following the chlorine dosing point. At some systems there are no online analysers appropriately placed to operationally verify CT. Council will have to action installing online analysers and gathering parameters to calculate CT for each system.

A CT calculation table is provided below in Table 11. Council will need to confirm the various gaps in data including: distance to nearest customer, diameter of supply pipeline, maximum flow rate, volume of reservoirs, minimum reservoir depth to confirm the CT values for specific supply systems.

Council has engaged an external contractor to validate their fluoride processes and procedures.

Council should continue to undertake validation of performance of new or upgraded water infrastructure. Council should revalidate existing processes as part of regular reviews of the DWMS risk assessment. These tasks have been captured in Section 13.0 - Implementation Plan.

Table 11 CT calculator table

		Tank						Pipeline to nearest customer					Total Ct
		Flow rate (max)	**Volume**	**Min Depth in Res**	**Min Volume**	**Chlorine residual[1] (min)**	**Tank CT (min)**	**Diameter supply pipe**	**Cross-sectional area pipe**	**Distance**	**Chlorine residual[2] (min)**	**Pipe CT (min)**	**Total Ct (min)**
	Units	L/min	L	%	L	mg/L	(mg.min)/L	m	m^2	m	mg/L	(mg.min)/L	(mg.min)/L
	Reference	a	b	c	d	e	f	g	h	i	j	k	l
	Equation	**INPUT**	**INPUT**	**INPUT**	= b × c	INPUT	= (d × e) / a	**INPUT**	= π × (g / 2)^2	**INPUT**	**INPUT**	= (h × i) / a × (1/1000)	= k + f
Supply System	**Reservoir**												
Baradine	Clear Water Tank	TBC	<Volume>	TBC	-	1.5	-	TBC	-	TBC	0.6	-	-
	Reservoir	TBC	1,100,000	TBC	-	1.5	-	TBC	-	TBC	0.6	-	
Binnaway	Town Reservoir	TBC	1,000,000	TBC	-	2.0	-	TBC	-	TBC	0.6	-	-
Bugaldie	Surface Storage Tank	TBC	<Volume>	TBC	-	1.5	-	TBC	-	TBC	0.6	-	-
	Elevated Tank	TBC	20,000	TBC	-	1.5	-	TBC	-	TBC	0.6	-	-
Coolah	Wentworth Ave Reservoirs (2 x 0.1ML)	TBC	200,000	TBC	-	1.5	-	TBC	-	TBC	1.0	-	-
	Martin St Reservoir	TBC	1,080,000	TBC	-	1.5	-	TBC	-	TBC	1.0	-	-
Coonabarabran	Clear Water Storage	TBC	<Volume>	TBC	-	2.0	-	TBC	-	TBC	0.6	-	-
	Oxley Hwy Reservoir	TBC	2,200,00	TBC	-	2.0	-	TBC	-	TBC	0.6	-	-
	Rifle Range 1	TBC	1,100,000	TBC	-	2.0	-	TBC	-	TBC	0.6	-	-
	Rifle Range 2	TBC	4,500,000	TBC	-	2.0	-	TBC	-	TBC	0.6	-	-
Dunedoo	Bullinda St Reservoir	TBC	850,000	TBC	-	1.5	-	TBC	-	TBC	1.0	-	-
	Rhodes St Reservoirs (2 x 0.24ML)	TBC	480,000	TBC	-	1.5	-	TBC	-	TBC	1.0	-	-
Kenebri	Tanks (2 x 13kL)	TBC	26,000	TBC	-	1.5	-	TBC	-	TBC	0.6	-	-
Mendooran	Clear Water Tank	TBC	<Volume>	TBC	-	1.6	-	TBC	-	TBC	0.5	-	-
	Coolabah Reservoirs	TBC	1,400,000	TBC	-	1.6	-	TBC	-	TBC	0.5	-	-
	Standpipe Reservoir	TBC	<Volume>	TBC	-	1.6	-	TBC	-	TBC	0.5	-	-

NOTES:

[1] Values are based on CCP targets for chlorine residual leaving the WTP agreed in the May 2014 Risk Assessment.
[2] Values are based on CCP targets for chlorine residual at sampling points in the distribution system agreed in the May 2014 Risk Assessment.

9.3 Design of Equipment

- Validate the selection and design of new equipment and infrastructure to ensure continuing reliability.

A validation process does not currently exist for new equipment installation. For significant changes to the drinking water systems Council may consider engaging external consultants to review the effectiveness of new equipment design and/or installation.

Council is required to develop a validation process. Validation may be undertaken by reviewing external research and information, manufacturer's guarantees, and by using witness, commissioning and demonstration periods to validate process performance and reliability of water quality compliance.

Design of new equipment shall consider the systems' ability to withstand impact from natural disasters. Supplementing a system with elements for contingencies can help ensure the reliability of a system and reduce the risk of down time and/or potential contamination. All new infrastructure must be approved by the Office of Water in accordance with Section 60 of the *Local Government Act 1993*.

Actions relating to this requirement have been captured in Section 13.0 - Implementation Plan.

10.0 Element 10 - Documentation and Reporting

10.1 Management of Documentation and Records

- Document information pertinent to all aspects of drinking water quality management.
- Develop a document control system to ensure current versions are in use.
- Establish a records management system and ensure that employees are trained to fill out records.
- Periodically review documentation and revise as necessary.

As of May 2014, Council had documented some aspects of its management of drinking water; however this documentation is not comprehensive. In developing this DWMS, areas lacking in documentation have been identified and are documented in Section 13.0.

Council maintains a central document control system on their T drive (Technical Services) that encompasses all Council documents. This drive has restricted access and is only accessible to approved staff members.

Council shall develop a regular review process for all water management related documents, outlining review frequency, date and document responsibility to ensure these documents are current and relevant. Council is also required to train staff in how to access and manage water management documents on this system.

Actions to address this requirement have been captured in Section 13.0 - Implementation Plan.

10.2 Reporting

- Establish procedures for effective internal and external reporting.
- Produce an annual report to be made available to consumers, regulatory authorities and stakeholders.

Council has informal communication lines between plant operators and the Manager Warrumbungle Water. Any water quality exceedences and/or issues with the plant will be communicated directly to the <insert personnel>.

The plant operator also communicates upwardly to the <insert personnel> on a minimum <insert frequency> basis (and/or as-needs basis). This reporting includes a summary of <insert water quality related information reported up – e.g. complaints, successes, failures, training undertaken>.

Information is reported through the various NOW requirements under the NSW *Water Supply and Sewerage Strategic Business Planning Guidelines*.

Water quality data results are communicated to external parties through the annual *State of Environment (SOE)* reports and reported to NOW for the purpose of the *NSW Water Supply and Sewerage – Performance Monitoring* reports and the *Water Supply and Sewerage – NSW Benchmarking* reports. The NOW reports are available for members of the public to download, as are the SOE reports.

Council should continue to undertake these activities.

11.0 Element 11 - Evaluation and Audit

11.1 Long-Term Evaluation of Results

- Collect and evaluate long-term data to assess performance and identify problems.
- Document and report results.

As mentioned previously, long term water quality data collected for the NSW Drinking Water Monitoring Program is available through the NSW Health Drinking Water Database. This data was used as part of the drinking water risk assessment workshop in May 2014, which analysed water quality data from 2008 to 2013. Council documents and reports water quality monitoring results to NSW Office of Water as described in Section 10.2.

Council is currently in the process of capturing handwritten water quality data into electronic spreadsheets.

Council may consider developing in-house evaluation procedures for the assessment of long-term data. This is particularly important when required to demonstrate the need for new equipment and/or infrastructure funding.

Actions relating to addressing these requirements have been captured in Section 13.0 - Implementation Plan.

11.2 Audit of Drinking Water Quality

- Establish processes for internal and external audits.
- Document and communicate audit results.

A gap analysis of Councils' water quality management procedures against the requirements of the ADWG was completed in April 2014. The results of this gap analysis were used in the development of this DWMS and are a form of internal audit.

Informal inspections of the system are carried out by operators and external inspections are performed by NOW inspectors, with inspection reports used to target improvements.

Internal audit frequency is at the discretion of Council. External audit frequency requirements will be determined in consultation with the NSW Health PHU. For external audits, Council will be required to engage an independent auditor approved by NSW Health. It is also noted that NSW Health can, in the meantime, audit the DWMS at any time. NOW inspectors and local PHU Environmental Health Officers will also undertake external audits on various areas of the DWMS and will record the results. Hence it is essential that Council maintains this document and continue to address outstanding actions in the Implementation Plan.

Actions to address this requirement have been captured in Section 13.0 - Implementation Plan.

12.0 Element 12 - Review and Continual Improvement

12.1 Review by senior executive

- Senior executive review of the effectiveness of the management system.
- Evaluate the need for change.

As this is a new document, Council does not currently have a process in place for senior executive to review the DWMS. Council is required to instigate a process by which the effectiveness of the DWMS will be reviewed and updated when required improvements are identified. Notwithstanding the agreed internal review dates, the DWMS should be reviewed and updated in the event of significant changes to the water supply or management systems, with a formal review by Council occurring annually.

Actions relating to this requirement have been captured in Section 13.0 - Implementation Plan.

12.2 Drinking Water Quality Management Improvement Plan

- Develop a drinking water quality management improvement plan.
- Ensure that the plan is communicated and implemented, and that improvements are monitored for effectiveness.

The Implementation Plan in Section 13.0 of this document captures the recommended improvements identified through the system and risk assessment and noted throughout this document. Additional actions have been identified in the drinking water quality risk assessment workshop, and have also been included in the Implementation Plan.

Corrective actions issued by NOW inspectors and local PHU Environmental Health Officers that relate to drinking water quality should also be included in the Implementation Plan.

The Implementation Plan includes priorities, indicative dates for task completion and the nominated responsible party for each action. The Implementation Plan should be periodically reviewed to ensure actions implemented are removed from the plan, and new actions added to it. The completion of actions should also be documented under the relevant section of this DWMS.

Actions relating to this requirement have been captured in Section 13.0 - Implementation Plan.

13.0 Implementation Plan

Actions arising from the gap analysis and the drinking water quality risk assessment workshop are outlined in the table below. Council should continue to develop this Implementation Plan, removing items as actions are implemented, and adding items as additional actions are identified. As each action is completed, the relevant section(s) should be updated to reflect this.

Each action has been prioritised as *Very High*, *High*, *Medium* or *Low*. *Very High* and *High* risks should be addressed urgently, and as such, these actions should be addressed first. The due dates allocated correspond to this. The alternating components of each element are highlighted for readability only.

Table 12 Implementation Plan

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
1.1	*Drinking Water Quality Policy*	-	- Gain formal endorsement and support of the policy from senior executive, including ensuring that organisation activities support effective water quality management such as providing appropriate staffing, financial and training resources and reporting performance to the board or chief executive.	High	Manager Warrumbungle Water	1-Mar-15
1.1	*Drinking Water Quality Policy*	-	- Develop and implement a staff awareness program for the DWMS and make the DWMS visible to all employees.	High	Manager Warrumbungle Water	1-Mar-15
1.2	*Regulatory and Formal Requirements*	-	- Develop, document and implement a process for reviewing formal requirements every 12 months or where there are any changes to Council's activities or formal requirements.	Medium	Manager Warrumbungle Water	1-Sep-15
1.2	*Regulatory and Formal Requirements*	-	- Develop and implement a staff awareness program for relevant water quality obligations relating to their areas of responsibility.	Medium	Manager Warrumbungle Water	1-Sep-15
1.2	*Regulatory and Formal Requirements*	-	- Formally document and communicate roles and responsibilities of staff relating to management of drinking water quality.	Medium	Manager Warrumbungle Water	1-Sep-15
1.3	*Engaging Stakeholders*	-	- Update stakeholder/relevant agencies list to comprehensively identify all stakeholders who could affect, or be affected by, decisions or activities of the drinking water supplier. Where possible, this list should also identify the accountabilities and responsibilities of relevant agencies in support of the water supplier. This list will be included in this DWMS (in the main body) and maintained as a separate document referenced in Appendix D. It is also recommended that the contact register be inserted on a separate page so that it may be easily printed and posted on workplace walls.	High	Manager Warrumbungle Water	1-Mar-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
1.3	*Engaging Stakeholders*	-	- Develop appropriate mechanisms for stakeholder commitment and involvement. Document the planned approach including partnership agreements or Memorandum of Understanding (MoU).	Medium	Manager Warrumbungle Water	1-Sep-15
1.3	*Engaging Stakeholders*	-	- Develop a regular review process to update the list of stakeholders. Ensure contact details are current and all relevant parties are involved in engagement processes.	Low	Manager Warrumbungle Water	1-Sep-16
2.1	*Water Supply System Analysis*	-	- Enter all water quality monitoring data into electronic spreadsheets on a weekly basis. Allows for ease of data processing.	High	Manager Warrumbungle Water	1-Mar-15
2.1	*Water Supply System Analysis*	-	- The water supply system analysis, including the flow charts and catchment characteristics, will be reviewed internally in 12 months, and upon any significant changes to any of the water supply systems. The review process and records of the outcomes of these reviews should be documented.	Medium	Manager Warrumbungle Water	1-Sep-15
2.2	*Assessment of Water Quality Data*	-	- Develop a central electronic spreadsheet to record results of operational sampling and testing to allow these results to be easily reviewed and analysed.	High	Manager Warrumbungle Water	1-Mar-15
2.2	*Assessment of Water Quality Data*	-	- The assessment of the water quality performance data should be reviewed every 12 months, and upon any significant changes to any of the water supply systems. Review will assess any seasonal trends, consistent exceedences or other potential water quality issues. The formal review process and records of the outcomes of these reviews should be documented.	Medium	Manager Warrumbungle Water	1-Sep-15
2.2	*Assessment of Water Quality Data*	-	- Council to include new operational data prior to review of the DWMS.	Medium	Manager Warrumbungle Water	1-Sep-15
2.3	*Hazard Identification & Risk Assessment*	-	- The hazard identification and risk assessment should be internally reviewed 12 months. Every five years (or upon any significant changes to any of the water supply systems) Council should undertake a comprehensive review. The review process and records of the outcomes of these reviews should be documented.	Medium	Manager Warrumbungle Water	1-Sep-15
3.1	*Preventive Measures and Multiple Barriers*	-	- The identification and evaluation of preventive measures should be internally reviewed 12 months. Every five years (or upon any significant changes to any of the water supply systems) Council should undertake a comprehensive review. The review should also consider whether existing control measures are being undertaken, their effectiveness and whether they are appropriately documented and formalised. The review process and records of the outcomes of these reviews should be documented.	Low	Manager Warrumbungle Water	1-Sep-16

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
3.1	*Preventive Measures and Multiple Barriers*	Location: BUG, KBI, BDN (ground) Process Step: Catchment & Abstraction Haz ID: 1.03 Hazard Category: Pathogens (chlorine resistant e.g. *Cryptosporidium*)	- Bore investigations (integrity, capping, geology, exclusion zones - fencing)	High	Manager Warrumbungle Water	1-Mar-15
3.1	*Preventive Measures and Multiple Barriers*	Location: BUG, KBI, BDN (ground) Process Step: Catchment & Abstraction Haz ID: 1.03 Hazard Category: Pathogens (chlorine resistant e.g. *Cryptosporidium*)	- Private water bore inspections, bore register	High	Manager Warrumbungle Water	1-Mar-15
3.1	*Preventive Measures and Multiple Barriers*	Location: BDN, DDO Process Step: Catchment & Abstraction Haz ID: 1.03 Hazard Category: Pathogens (chlorine resistant e.g. *Cryptosporidium*)	- Concrete capping of bores	High	Manager Warrumbungle Water	1-Mar-15
3.1	*Preventive Measures and Multiple Barriers*	Location: BUG, BWY, CBN, KBI, MDN Process Step: Catchment & Abstraction Haz ID: 1.05 Hazard Category: Pathogens (Chlorine sensitive e.g. Bacteria and viruses), Nutrients	- Timor Dam fence was damaged during the bushfires. Animal ingress is possible, fence to be replaced. Follow up with Council engineer the status of the fence replacement program. Some funding is available from insurance claim.	High	Manager Warrumbungle Water	1-Mar-15
3.1	*Preventive Measures and Multiple Barriers*	Location: MDN, BWY, CBN, BDN Process Step: Coagulation & Flocculation Haz ID: 3.02 Hazard Category: -	- Online interlocks for pH and turbidity on outlet for filters	High	Manager Warrumbungle Water	1-Mar-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
3.1	*Preventive Measures and Multiple Barriers*	Location: All Process Step: Distribution Haz ID: 10.01 Hazard Category: Various	- Identify high risk areas for backflow prevention (i.e. STP)	High	Manager Warrumbungle Water	1-Mar-15
3.1	*Preventive Measures and Multiple Barriers*	Location: All Process Step: Whole of System Haz ID: 11.02 Hazard Category: Various	- Electronic key system currently being investigated	Medium	Manager Warrumbungle Water	1-Sep-15
3.2	*CCPs*	-	- The identification of CCPs and Critical Limits should be reviewed every year, and upon any significant changes to any of the water supply systems. The formal review process and records of the outcomes of these reviews should be documented. The DWMS documentation should also be updated accordingly.	Medium	Manager Warrumbungle Water	1-Sep-15
3.2	*CCPs*	-	- The HACCP Summary Tables should be made readily accessible to operators (e.g. pinned up at the treatment plants and Council offices).	High	Manager Warrumbungle Water	1-Mar-15
3.2	*CCPs*	-	- Council to include a fluoride CCP at Binnaway, Baradine and Coonabarabran, upon next review of DWMS.	Medium	Manager Warrumbungle Water	1-Sep-15
3.2	*CCPs*	-	- Relevant staff members must be trained to ensure they understand what the CCPs are and why they are important. This training should include use of the HACCP Summary Tables, associated target, Alert and Critical Limits, as well as the monitoring requirements to ensure the CCPs remain in control.	High	Manager Warrumbungle Water	1-Mar-15
3.2	*CCPs*	Location: BWY, CBN, MDN, CLH, DDO (surface) Process Step: Catchment & Abstraction Haz ID: 1.02 Hazard Category: Pathogens (chlorine resistant e.g. *Cryptosporidium*)	- If sand bed demonstrates effective filtration consider making this a CCP	Medium	Manager Warrumbungle Water	1-Sep-15
4.1	*Operational Procedures*	-	- Insert location of and quality information (i.e. version, last review date, Document owner) for existing operational procedures into the DWMS Document Register (Include review date, date created, responsible person, etc.) found in Appendix D of the DWMS.	High	Manager Warrumbungle Water	1-Mar-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
4.1	*Operational Procedures*	-	-Review operational procedures to determine what other procedures need to be developed in relation to managing drinking water quality (e.g. operational and maintenance processes for main breaks)	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	-	- Formally document any procedure related to existing control measures identified in the risk assessment that are not currently documented. Involve relevant staff in the development of these procedures.	Medium	Manager Warrumbungle Water	1-Sep-15
4.1	*Operational Procedures*	-	- Compile all SOPs into an operations manual	Medium	Manager Warrumbungle Water	1-Sep-15
4.1	*Operational Procedures*	Location: MDN Process Step: Aeration & Oxidation Haz ID: 2.02 Hazard Category: -	- Implement SOP for batching and dosing	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	Location: BDN Process Step: Clarification/ Sedimentation Haz ID: 4.01 Hazard Category: -	- Strategy needs to be developed for continued supply during times of significant maintenance (e.g. utilising the lagoons temporarily)	Medium	Manager Warrumbungle Water	1-Sep-15
4.1	*Operational Procedures*	Location: MDN, BWY, CBN, BDN Process Step: Filtration Haz ID: 5.01 Hazard Category: -	- Develop SOP for filter maintenance	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	Location: MDN, BWY, CBN, BDN Process Step: Filtration Haz ID: 5.01 Hazard Category: -	- Consider periodic inspection on filter media	Medium	Manager Warrumbungle Water	1-Sep-15
4.1	*Operational Procedures*	Location: CLH Process Step: Disinfection (Chlorine Dosing and Contact Vessels) Haz ID: 7.01 Hazard Category: Pathogens (chlorine sensitive)	- Implement process to identify when gas bottle is empty	High	Manager Warrumbungle Water	1-Mar-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
4.1	*Operational Procedures*	Location: All Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Consider a routine reservoir inspection (checking locks etc.)	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	Location: All Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Develop SOP for the access of reservoirs	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	Location: All Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Assess compliance regarding reservoir access with Australian Standards and common sense	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	Location: All Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Consider reviewing mixing options for reservoirs with common inlet/outlet	Medium	Manager Warrumbungle Water	1-Sep-15
4.1	*Operational Procedures*	Location: All Process Step: Distribution Haz ID: 10.01 Hazard Category: Various	- Develop a communication protocol around monitoring data (i.e. distribution data feeding back to WTP)	Medium	Manager Warrumbungle Water	1-Sep-15
4.1	*Operational Procedures*	Location: All Process Step: Distribution Haz ID: 10.01 Hazard Category: Various	- Consider sampling and testing program following mains repairs	Medium	Manager Warrumbungle Water	1-Sep-15
4.1	*Operational Procedures*	Location: All Process Step: Distribution Haz ID: 10.02 Hazard Category: Various	- Develop SOP around distribution failures such as main breaks, sufficient flushing, cleaning of tools	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	Location: All Process Step: Distribution Haz ID: 10.02 Hazard Category: Various	- Consider developing a notification procedure for mains breaks	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	Location: All Process Step: Distribution Haz ID: 10.02 Hazard Category: Various	- Consider closing household property meters prior to recommissioning mains	High	Manager Warrumbungle Water	1-Mar-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
4.1	*Operational Procedures*	Location: CLH, DDO Process Step: Distribution Haz ID: 10.03 Hazard Category: Various	- Finalise flushing schedule for remaining systems (CLH, DDO nothing currently in place)	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	Location: All Process Step: Distribution Haz ID: 10.03 Hazard Category: Various	- Consider scouring program, including prioritisation of mains to be scoured	High	Manager Warrumbungle Water	1-Mar-15
4.1	*Operational Procedures*	Location: All Process Step: Distribution Haz ID: 10.03 Hazard Category: Various	- Consider tanker filling from dead ends (if backflow prevention available)	Medium	Manager Warrumbungle Water	1-Sep-15
4.2	*Operational Monitoring*	-	- Develop formal monitoring protocols which identify target criteria for each of the preventive measures being monitored (including CCPs), monitoring records to be kept, responsibilities, authorities and required communication protocols. Combine documented protocols into a formal Operational Monitoring Plan.	Medium	Manager Warrumbungle Water	1-Sep-15
4.2	*Operational Monitoring*	-	- Ensure all operational procedures are documented and referenced in the DWMS document register	Medium	Manager Warrumbungle Water	1-Sep-15
4.2	*Operational Monitoring*	Location: CLH, DDO Process Step: Catchment & Abstraction Haz ID: 1.02 Hazard Category: Pathogens (chlorine resistant e.g. *Cryptosporidium*)	- Consider turbidity monitoring of infiltration well water and river water on event basis to determine effectiveness of filtration	Medium	Manager Warrumbungle Water	1-Sep-15
4.2	*Operational Monitoring*	Location: BUG, BWY, CBN, KBI, MDN, DDO Process Step: Catchment & Abstraction Haz ID: 1.04 Hazard Category: Pathogens (chlorine resistant e.g. *Cryptosporidium*)	- Consider testing for *E. coli* in raw water	Medium	Manager Warrumbungle Water	1-Sep-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
4.2	*Operational Monitoring*	Location: CBN, BDN Process Step: Reservoirs Haz ID: 9.02 Hazard Category: -	- Consider implementing sampling regime for CBN, BDN for chlorine residual in the reservoirs	Medium	Manager Warrumbungle Water	1-Sep-15
4.2	*Operational Monitoring*	Location: All Process Step: Whole of System Haz ID: 11.01 Hazard Category: Various	- Consider online monitoring where CCPs have been identified	Medium	Manager Warrumbungle Water	1-Sep-15
4.3	*Corrective Action*	-	- Develop detailed procedures for corrective actions regarding control of CCPs (using the corrective actions identified in the workshop as a starting point). These procedures need to include details such as required adjustments, additional monitoring, recording, reporting and responsibilities and authorities (relating to things such as notifications within the organisation and externally).	High	Manager Warrumbungle Water	1-Mar-15
4.3	*Corrective Action*	-	- Establish a rapid communication system to deal with unexpected events.	High	Manager Warrumbungle Water	1-Mar-15
4.3	*Corrective Action*	-	- Train relevant staff in these procedures and maintain a record of training.	High	Manager Warrumbungle Water	1-Mar-15
4.4	*Equipment Capability & Maintenance*	-	- Continue developing the existing asset registers to develop an electronic database that includes details such as; age of infrastructure; expected life; last service date; maintenance frequency; manufacturer; recorded failures; responsibility for maintenance; operational procedures; and records for maintenance of equipment (including calibration). This should include any monitoring instrumentation.	Low	Manager Warrumbungle Water	1-Sep-16
4.4	*Equipment Capability & Maintenance*	Location: BWY Process Step: Filtration Haz ID: 5.01 Hazard Category: -	- Check filter media depth against design requirements	High	Manager Warrumbungle Water	1-Mar-15
4.4	*Equipment Capability & Maintenance*	Location: MDN, BWY, CBN, BDN Process Step: Filtration Haz ID: 5.01 Hazard Category: -	- Consider maintenance program for the filters	Medium	Manager Warrumbungle Water	1-Sep-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
4.4	*Equipment Capability & Maintenance*	Location: MDN, BWY, CBN, BDN Process Step: Filtration Haz ID: 5.01 Hazard Category: -	- Consider online turbidity meter with interlocks at BWY, BDN - Consider interlocks for meters at CBN and MDN	Medium	Manager Warrumbungle Water	1-Sep-15
4.4	*Equipment Capability & Maintenance*	Location: All Process Step: Disinfection (Chlorine Dosing and Contact Vessels) Haz ID: 7.01 Hazard Category: Pathogens (chlorine sensitive)	- Consider program of analyser calibration	Medium	Manager Warrumbungle Water	1-Sep-15
4.4	*Equipment Capability & Maintenance*	Location: MDN Process Step: Disinfection (Chlorine Dosing and Contact Vessels) Haz ID: 7.01 Hazard Category: Pathogens (chlorine sensitive)	- Investigate installation of chlorine mixer for batching or replacement with chlorine gas	Medium	Manager Warrumbungle Water	1-Sep-15
4.4	*Equipment Capability & Maintenance*	Location: DDO Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Bullindah reservoir roof replacement (currently planned)	High	Manager Warrumbungle Water	1-Mar-15
4.4	*Equipment Capability & Maintenance*	Location: MDN Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Coolabah requires vermin proofing	High	Manager Warrumbungle Water	1-Mar-15
4.4	*Equipment Capability & Maintenance*	Location: CLH Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Wentworth Ave and Martin St Reservoirs requires vermin proofing	High	Manager Warrumbungle Water	1-Mar-15
4.4	*Equipment Capability & Maintenance*	Location: CLH Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Wentworth Ave Reservoir requires sealing	High	Manager Warrumbungle Water	1-Mar-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
4.4	*Equipment Capability & Maintenance*	Location: BDN Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Clear water tank requires vermin proofing	High	Manager Warrumbungle Water	1-Mar-15
4.4	*Equipment Capability & Maintenance*	Location: MDN, BDN, CBN Process Step: Reservoirs Haz ID: 9.02 Hazard Category: -	- Consider investigating the status of other reservoirs (MDN, BDN, CBN)	Medium	Manager Warrumbungle Water	1-Sep-15
4.4	*Equipment Capability & Maintenance*	Location: All Process Step: Distribution Haz ID: 10.01 Hazard Category: Various	- Replace old water meters with new water meters including backflow prevention devices	Medium	Manager Warrumbungle Water	1-Sep-15
4.5	*Materials & Chemicals*	-	- Confirm whether Council's supplier contracts include chemical quality compliance. - Review of its chemical procurement procedures	Medium	Manager Warrumbungle Water	1-Sep-15
4.5	*Materials & Chemicals*	-	- Develop a program to undertake spot checks for chemical quality compliance.	Medium	Manager Warrumbungle Water	1-Sep-15
4.5	*Materials & Chemicals*	Location: All Process Step: Disinfection (Chlorine Dosing and Contact Vessels) Haz ID: 7.01 Hazard Category: Pathogens (chlorine sensitive)	- Consider testing of hypochlorite strength	Medium	Manager Warrumbungle Water	1-Sep-15
5.1	*Drinking Water Quality Monitoring*	-	- Formally document all drinking water quality monitoring protocols and combine into a formal Water Quality Verification Plan.	High	Manager Warrumbungle Water	1-Mar-15
5.1	*Drinking Water Quality Monitoring*	Location: CBN, BDN, BWY Process Step: Fluoride Haz ID: 8.01 Hazard Category: Pathogens (chlorine sensitive)	- Confirm process on extracting data from NSW Health Water Quality Database	High	Manager Warrumbungle Water	1-Mar-15
5.3	*Short-term evaluation of results*	-	- Consider providing water quality data in water rate notices to customers	Low	Manager Warrumbungle Water	1-Sep-16

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
5.3	*Short-term evaluation of results*	-	- Implement regime of regular (daily) review of raw and treated water quality results, and input operational data into an electronic spread sheet to facilitate analysis and reporting.	High	Manager Warrumbungle Water	1-Mar-15
5.3	*Short-term evaluation of results*	-	- Record customer complaints in water quality monitoring spreadsheets for Bugaldie and Kenebri water supply systems.	Medium	Manager Warrumbungle Water	1-Sep-15
5.4	*Corrective Action*	-	- Establish a rapid communication system (for internal and external communication) to deal with unexpected events. It is recommended this be included in the Emergency Response Plan that is addressed below.	Extreme	Manager Warrumbungle Water	1-Sep-14
6.1	*Communication*	-	- Define communication protocols with the involvement of relevant agencies and include in the protocols a contact list of relevant agencies and businesses and their relevant key people.	Medium	Manager Warrumbungle Water	1-Sep-15
6.1	*Communication*	-	- Review and update contact details listed in Table 10.	Medium	Manager Warrumbungle Water	1-Jun-15
6.1	*Communication*	-	- Consider implementing a procedure in consultation with local hospitals to ensure dialysis patient details remain up-to-date.	Low	Manager Warrumbungle Water	1-Jun-16
6.1	*Communication*	-	- Develop a comprehensive public and media communications strategy and include draft public and media notifications.	Medium	Manager Warrumbungle Water	1-Jun-15
6.1	*Communication*	-	- Identify an appropriate person to handle all incident and emergency communications and ensure they are appropriately trained.	Medium	Manager Warrumbungle Water	1-Jun-15
6.1	*Communication*	Location: All Process Step: Distribution Haz ID: 10.02 Hazard Category: Various	- Obtain list of dialysis patients for each system	High	Manager Warrumbungle Water	1-Mar-15
6.2	*Incident & Emergency Response Protocols*	-	- Identify possible water quality related incidents and emergency scenarios (the risk assessment should be used as a basis) and document these potential scenarios in an *Incident and Emergency Response Plan*. Document procedures and response plans to address these incidents (can refer to guideline protocols from NSW Health as provided in the DWMS). Add to the ERP particular processes that are required to address severe hazard / emergency scenarios, such as algal blooms, fuel spills, bushfire etc. The development of these protocols should involve relevant agencies.	High	Manager Warrumbungle Water	1-Mar-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
6.2	*Incident & Emergency Response Protocols*	-	- Develop a process for investigation following incidents and emergencies and document this process. Include in this process a mechanism for revision of any emergency protocols, where an investigation demonstrates it is required.	High	Manager Warrumbungle Water	1-Mar-15
6.2	*Incident & Emergency Response Protocols*	-	- Develop a process for documenting and reporting of an incident or emergency.	High	Manager Warrumbungle Water	1-Mar-15
6.2	*Incident & Emergency Response Protocols*	-	- Employees should be trained and protocols regularly tested in the emergency response plans. The requirement for this should be included in the ERP.	High	Manager Warrumbungle Water	1-Mar-15
7.1	*Employee Awareness and Involvement*	-	- All water management stakeholders must read and agree to abide by the principles of this DWMS. This includes adding this requirement to the role descriptions for Council employees moving forward.	Medium	Manager Warrumbungle Water	1-Jun-15
7.1	*Employee Awareness and Involvement*	-	- Consider developing operators communication strategy	Medium	Manager Warrumbungle Water	1-Jun-15
7.2	*Employee Training*	-	- Formalise internal on-the-job training processes, documenting the training content, processes and attendance.	Medium	Manager Warrumbungle Water	1-Jun-15
7.2	*Employee Training*	Location: MDN Process Step: Reservoirs Haz ID: 9.01 Hazard Category: -	- Consider working at heights training for staff	Medium	Manager Warrumbungle Water	1-Sep-15
7.2	*Employee Training*	Location: MDN, BWY, BDN Process Step: Whole of System Haz ID: 11.06 Hazard Category: -	- Review staff structure of water services team, PHU and NOW to provide support	Medium	Manager Warrumbungle Water	1-Sep-15
8.2	*Communication*	-	- Council may consider providing water quality data on residents rates notices and/or publishing some of this data on their website and in Council's Annual Report	Low	Manager Warrumbungle Water	1-Sep-16

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
8.2	*Communication*	-	- Develop a consumer information program providing details on the DWMS, Emergency Response Plan, consumer responsibilities, how drinking water quality may be affected in household distribution and drinking water uses etc.	Medium	Manager Warrumbungle Water	1-Sep-15
9.1	*Investigative Studies & Research Monitoring*	-	- Increase review of water quality performance and utilisation of water quality data to improve understanding of the effectiveness of treatment and to identify water quality trends and patterns.	Low	Manager Warrumbungle Water	1-Sep-16
9.1	*Investigative Studies & Research Monitoring*	-	- Council should strongly consider investing in online monitoring at all CCPs. This would provide greater process control, as immediate notification would be provided in the event an alert limit is exceeded. Importantly, it would also provide the opportunity of an immediate response in the event a critical limit is exceeded (such as triggering a plant shut down). Online monitoring would also provide useful data for analysis of performance of processes used to control hazards at CCPs and would improve understanding of the WTP's effectiveness more generally.	High	Manager Warrumbungle Water	1-Mar-15
9.1	*Investigative Studies & Research Monitoring*	Location: All Process Step: Catchment & Abstraction Haz ID: 1.01 Hazard Category: Chemical (pesticides)	- Consider instigating a pesticide monitoring program	Medium	Manager Warrumbungle Water	1-Sep-15
9.1	*Investigative Studies & Research Monitoring*	Location: BUG, BWY, CBN, KBI, MDN, DDO Process Step: Catchment & Abstraction Haz ID: 1.04 Hazard Category: Pathogens (chlorine resistant, e.g. *Cryptosporidium*)	- STP effluent review (i.e. quality, quantity from EPA report) to determine typical characteristics in effluent and the quality of treatment. Consider testing for *E.Coli* in raw water.	Medium	Manager Warrumbungle Water	1-Sep-15
9.1	*Investigative Studies & Research Monitoring*	Location: All Process Step: Catchment & Abstraction Haz ID: 1.07 Hazard Category: Chemical	- Consider undertaking chemical testing on groundwater supplies to establish baseline water quality	Medium	Manager Warrumbungle Water	1-Sep-15

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
9.1	*Investigative Studies & Research Monitoring*	Location: All Process Step: Catchment & Abstraction Haz ID: 1.07 Hazard Category: Chemical	- Review of existing coal seam gas investigations in the area (i.e. EPA)	Medium	Manager Warrumbungle Water	1-Sep-15
9.1	*Investigative Studies & Research Monitoring*	Location: CBN Process Step: Catchment & Abstraction Haz ID: 1.12 Hazard Category: -	- Results to be followed up	High	Manager Warrumbungle Water	1-Mar-15
9.1	*Investigative Studies & Research Monitoring*	Location: MDN Process Step: Disinfection (Chlorine Dosing & Contact Vessels) Haz ID: 7.01 Hazard Category: Pathogens (chlorine sensitive)	- Monitor the strength of the chlorine over a period of 6 months	Medium	Manager Warrumbungle Water	1-Sep-15
9.2	*Validation of Processes*	-	- As part of Council's review of the DWMS risk assessment, review and discuss the effectiveness of existing processes and procedures in managing water quality. The review should draw on external research and information, the risk assessment, water quality analysis and organisational experience. With any changes in conditions, processes and procedures should be revalidated.	Low	Manager Warrumbungle Water	1-Sep-16
9.2	*Validation of Processes*	-	- Review and confirm the various data gaps in Table 11 to calculate CT for all supply systems.	High	Manager Warrumbungle Water	1-Mar-15
9.2	*Validation of Processes*	Location: CBN Process Step: Catchment & Abstraction Haz ID: 1.10 Hazard Category: -	- Review PAC dosing effectiveness. Detention time for PAC limiting factor	Medium	Manager Warrumbungle Water	1-Sep-15
9.3	*Design of Equipment*	-	- Develop a policy on validation of new or upgraded water supply infrastructure. This should include witness, demonstration and commissioning requirements that are designed to ensure the infrastructure delivers the expected water quality results.	Low	Manager Warrumbungle Water	1-Sep-16

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
10.1	*Management of Documentation & Records*	-	- Continue to document information pertinent to all aspects of drinking water quality management.	Medium	Manager Warrumbungle Water	1-Sep-15
10.1	*Management of Documentation & Records*	-	- Develop a procedure that manages document control for all DWMS documentation (i.e. ensure the currency, accessibility and appropriate review DWMS documents).	Medium	Manager Warrumbungle Water	1-Sep-15
10.1	*Management of Documentation & Records*	-	- Develop a records management process to ensure appropriate storage and accessibility of DWMS related records.	Medium	Manager Warrumbungle Water	1-Sep-15
10.1	*Management of Documentation & Records*	-	- Review existing documentation on the water supply systems and ensure all are captured on Council's document management system. Verify documents are up-to-date.	Low	Manager Warrumbungle Water	1-Sep-16
10.1	*Management of Documentation & Records*	-	- Update details for existing documentation in the DWMS document register.	Medium	Manager Warrumbungle Water	1-Sep-15
11.1	*Long-Term Evaluation of Results*	-	- Develop in-house evaluation of long-term water quality performance procedures (outside external monitoring requirements) and implement these procedures. These procedures could be incorporated into the preparation process for the annual management review or as part of the internal audit process.	Medium	Manager Warrumbungle Water	1-Sep-15
11.1	*Long-Term Evaluation of Results*	-	- Ensure all handwritten water quality data is captured in electronic spreadsheets.	High	Manager Warrumbungle Water	1-Mar-15
11.2	*Audit of Drinking Water Quality Management*	-	- Develop internal audit procedures and schedules appropriate to functionality of council and the water supply systems.	Low	Manager Warrumbungle Water	1-Sep-16
11.2	*Audit of Drinking Water Quality Management*	-	- Identify appropriate personal to undertake the internal audit and provide training in auditing.	Low	Manager Warrumbungle Water	1-Sep-16
11.2	*Audit of Drinking Water Quality Management*	-	- Document and report results of CCP exceedences in annual report for Council	Low	Manager Warrumbungle Water	1-Sep-16

ADWG Element		Risk Assessment Ref. (process step & Hazard ID number)	Action	Priority	Action Owner	Date
11.2	*Audit of Drinking Water Quality Management*	-	- Develop external audit procedures in consultation with NSW Public Health Unit.	Low	Manager Warrumbungle Water	1-Sep-16
12.1	*Review by senior executive*	-	- Develop and implement a process (including a schedule) for senior executive review of the effectiveness of the management system. The review process should include aspects such as; reports from audits, water quality performance, previous reviews, concerns from consumers and regulators and impacts of changes to internal or external conditions (e.g. regulatory, technology, organisational activities).	High	Manager Warrumbungle Water	1-Mar-15
12.1	*Review by senior executive*	-	- Amend/update the DWMS where it is evaluated that there is a need for change.	Medium	Manager Warrumbungle Water	1-Sep-15
12.2	*Drinking Water Quality Management Improvement Plan*	-	- Update and review Implementation Plan when necessary. Follow up actions to ensure deadlines are met and responsible parties are capable to undertake these actions.	Medium	Manager Warrumbungle Water	1-Sep-15

14.0 References

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Appendix A

Drinking Water Quality Risk Assessment Report

Drinking Water Management System
Warrumbungle Shire Council
28-Aug-2014
Doc No. 60301752

Drinking Water Quality Risk Assessment

Workshop Summary Paper

Warrumbungle Shire Council

Drinking Water Quality Risk Assessment

Warrumbungle Shire Council

Client: Warrumbungle Shire Council

ABN: 45 100 538 161

Prepared by

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In association with

NSW Health

28-Aug-2014

Job No.: 60301752

AECOM in Australia and New Zealand is certified to the latest version of ISO9001, ISO14001, AS/NZS4801 and OHSAS18001.

Quality Information

Document Drinking Water Quality Risk Assessment

Ref 60301752

Date 28-Aug-2014

Prepared by Matthew Oliver

Reviewed by Kate Miles

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
0.1	13-June-2014	Internal draft	Kate Miles Project Manager	
0.2	27-June-2014	Issued for review	Kate Miles Project Manager	
1.0	28-August-2014	Final for issue	Kate Miles Project Manager	

Table of Contents

Executive Summary

Background

The Public Health Act 2010 was passed by NSW Parliament in December 2010 and commenced in September 2012, along with the Public Health Regulations 2012. The objectives of the Regulations are to support the implementation of the Act (NSW Health, 2012). NSW Health has provided funding to assist Warrumbungle Shire Council (Council) in meeting its obligations under the Act, by developing a Drinking Water Management System (DWMS) that is consistent with the Framework for Management of Drinking Water Quality as documented in the Australian Drinking Water Guidelines (ADWG) (NHMRC/NRMMC, 2011).

The ADWG adopts a preventive risk management approach to ensure the protection of public health by providing safe drinking water to consumers (NHMRC/NRMMC, 2011). A significant part of this process is to understand and manage risks to drinking water quality, which involves an appreciation of where and how contamination may occur and how it may make its way to customers.

This process includes the following tasks:

- Description of the water supply system, including development of system flow diagrams
- Assessment of existing water quality data
- Identification of water quality hazards and a risk assessment
- Identification of Critical Control Points (CCPs), as well as operating targets, Alert Levels (ALs) and Critical Limits (CLs) for parameters associated with each CCP

Risk Assessment Workshop

A workshop was held with Warrumbungle Shire Council, NSW Office of Water (NOW) and NSW Health personnel on 13th to 15th May 2014 to identify system risks and CCPs. The drinking water quality risk assessment workshop included the following activities:

- Confirmation of system flow diagrams for the current systems
- Presentation of what is known about the water quality hazards relating to the current water supplies
- Documentation of workshop input from the participants on hazardous events and the hazards that may arise from those events
- Assessment of the unmitigated risks presented by each hazard
- Assessment of the residual risks (factoring in existing control measures) presented by each hazard
- Identification of any residual risks that required additional preventive measures
- Identification of CCPs in the system and the corresponding parameters that should be monitored to determine if the critical process step is operating within design limits
- Development of operating targets, ALs and CLs for CCPs
- Development of corrective actions in response to a breach of ALs and CLs
- Development of an action list for the safe management of Council's drinking water supply

Risk Assessment Summary

The risk assessment workshop team identified the hazards which had a *High* or *Very High* unmitigated risk (before existing control measures had been factored). Existing control measures were identified and a residual risk was defined. Additional corrective actions were identified that will help to further address some of these risks and will be carried over into the action plan in the broader DWMS.

CCP Summary

CCPs identified for Council's drinking water system are summarised in Section 3.2.3, alongside the parameters to be measured to maintain control of the drinking water quality.

1.0 Introduction

1.1 Background

This report documents the development of a Drinking Water Management System (DWMS) for Warrumbungle Shire Council (Council) in accordance with the Australian Drinking Water Guidelines (ADWG) (NHMRC/ NRMMC, 2011).

The core of the ADWG is the Framework for Management of Drinking Water Quality (the Framework). The Framework is a holistic risk-based approach to drinking water management that addresses four general areas:

- commitment to drinking water quality management
- system analysis and management
- supporting requirements, and
- review.

The Framework is a quality management system that has been specifically developed for the water industry. The structure of the Framework is provided in Figure 1.

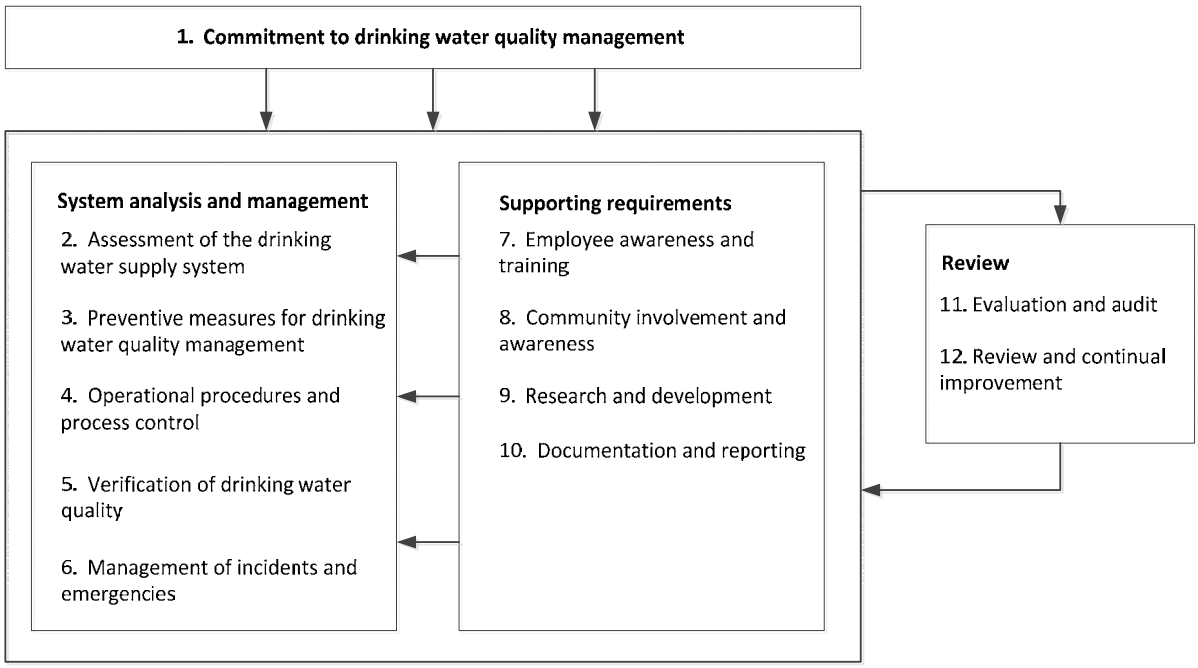

Figure 1 The framework for management of drinking water quality (adapted from NHMRC/NRMMC, 2011)

In developing this DWMS, a risk assessment workshop was undertaken to identify, understand, assess and determine the management responses to the risks to Council's current drinking water supply system. This report forms part of the DWMS and covers two of the twelve elements of the ADWG: Element 2 – assessment of the drinking water supply system, and Element 3 – preventive measures for drinking water quality management.

1.2 Scope

Council provides drinking water to the district via eight potable water supply systems. These systems are as follows:

- Bugaldie (BUG)
- Binnaway (BWY)
- Coolah (CLH)
- Kenebri (KBI)
- Baradine (BDN)
- Coonabarabran (CBN)
- Dunedoo (DDO)
- Mendooran (MDN)

Detailed descriptions of the configuration and treatment processes for each of the water supply systems are provided in Section 2.1.2.

1.3 Structure of the Document

Element 2 of the ADWG Framework outlines the risk assessment process. Element 3 addresses the assessment of preventive measures, multiple barriers and identification of Critical Control Points (CCPs).

Section 2.0 of this report has been structured to mirror Element 2 from the Framework, with a subsection for each component. The components under Element 2 are described below. The actions under each component will be described and addressed within each subsection.

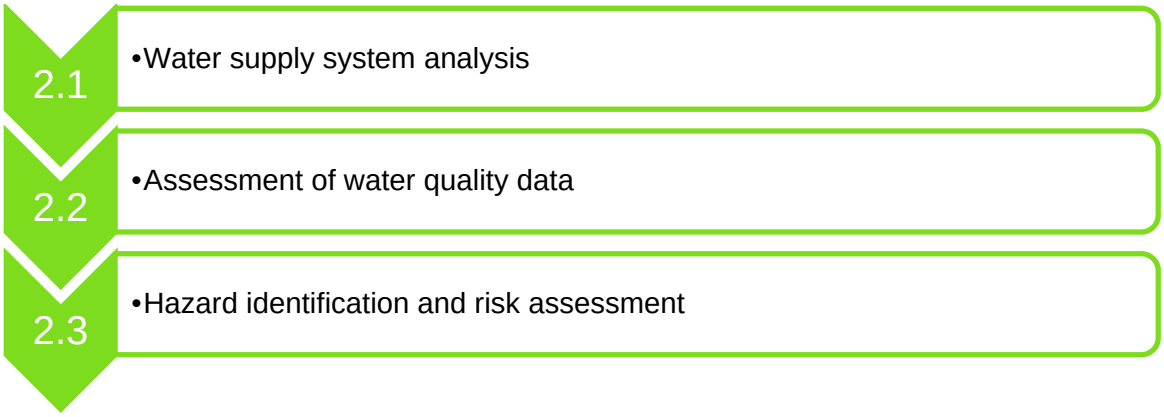

Figure 2 Components of Element 2 - Assessment of the drinking water supply system [ADWG, Chapter 3.2]

Section 3.0 of this report addresses Element 3 of the Framework. The components under Element 3 are described below. The actions under each component will be described and addressed in Section 3.0.

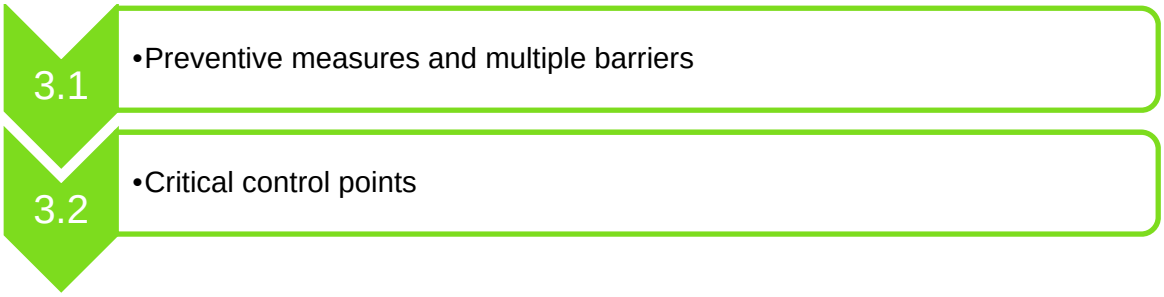

Figure 3 Components of Element 3 - Preventive measures for drinking water quality management [ADWG, Chapter 3.3]

2.0 Element 2 – Assessment of the Drinking Water Supply System

2.1 Water supply system analysis

This section collates information regarding Council's drinking water system. The information collated in this section originates from background research, information provided by Council and NSW Health, and input obtained at the workshop.

Figure 4 outlines the actions as specified by ADWG. The following sub-sections will address each of these actions.

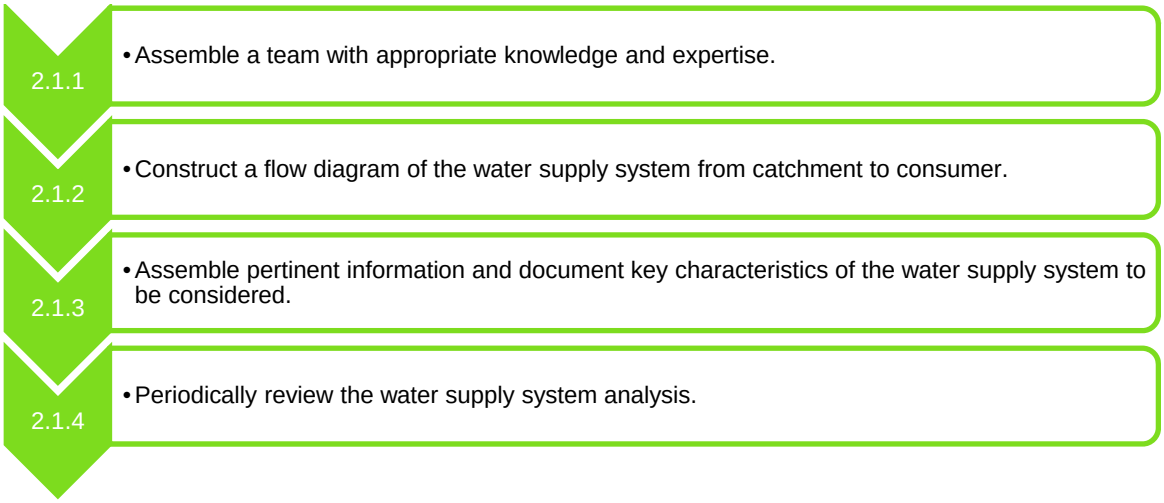

Figure 4 Water supply system analysis actions [ADWG, Chapter 3.2.1]

2.1.1 Assemble a team with appropriate knowledge and expertise

On Tuesday 13th to Thursday 15th May 2014, a drinking water quality risk assessment workshop was held at Council's offices in Coonabarabran, NSW. This workshop included representatives from Council (including operations staff), NSW Office of Water (NOW) and NSW Health (including Public Health Unit (PHU)). This risk assessment was facilitated by AECOM. A full list of the workshop participants is detailed in Table 1. A copy of the signed participant attendance register is provided in **Appendix F**.

Table 1 Workshop participants

Team Member	Role	Affiliation	Attendance		
			Tuesday 13th May 2014	Wednesday 14th May 2014	Thursday 15th May 2014
Ben Smith	Supervisor Warrumbungle Water Treatment Plants North	Council	Yes	Yes	Yes
Marty Gordon	Supervisor Warrumbungle Water Mains North	Council	Yes	Yes	Yes
Brad Condon	Environmental & Health Officer	Council	Yes	Yes	-
Noel Gilbert	Recycling & Waste Compliance Officer	Council	Yes	Yes	Yes
Andrew Milford	Water & Wastewater Operations, Coonabarabran	Council	Yes	Yes	Yes
Sam Dunn	Supervisor Warrumbungle Water South	Council	Yes	Yes	Yes
Phillip Paul	Sewer Operator, Coolah/Dunedoo	Council	Yes	Yes	Yes
Geoff Averillo	Supervisor Urban Services, Mendooran	Council	Yes	Yes	Yes
Phil Hensby	Urban Services - Truck Operator Baradine	Council	Yes	Yes	Yes
Paul Whipper	Urban Services, Binnaway	Council	Yes	Yes	Yes
Craig Whitty	Urban Services - Tractor Operator Binnaway	Council	Yes	Yes	Yes
Cornelia Wiebels	Manager, Warrumbungle Water	Council	Yes	Yes	Yes
Kevin Tighe	Director of Technical Services	Council	-	Yes	-
Mark Nave	Public Health Unit officer	NSW Health	Yes	Yes	Yes
Bruce Lamont	Regional Inspector	NSW Office of Water	Yes	Yes	Yes
Sandy Leask	NSW Health Water Unit representative	NSW Health	Yes	Yes	Yes
Kate Miles	Project manager and workshop facilitator	AECOM	Yes	Yes	Yes
Ryan Signor	Workshop facilitator	AECOM	Yes	Yes	-
Matthew Oliver	Project engineer and workshop note taker	AECOM	Yes	Yes	Yes

2.1.2 Water Supply System Descriptions

The following sections provide an overview of the water supply systems in Baradine, Binnaway, Bugaldie, Coolah, Coonabarabran, Dunedoo, Kenebri and Mendooran. The system detail and diagrams that follow were verified during the workshop process as correct as of the time of writing this report. These diagrams should be reviewed annually in line with the review of the DWMS, and as required, to maintain an effective DWMS.

Warrumbungle Shire Council sits within the Central West Catchment, with the exception of a small section in the north-eastern corner which drains into the Namoi Catchment. Warrumbungle Shire Council utilises both river water and groundwater for the delivery of potable water within the region. The bore systems draw water from artesian and sub-artesian basins across the region.

Timor Dam is located 13 km west of Coonabarabran and is one the major surface water sources in the region. From the dam, the Castlereagh River passes through Coonabarabran, Binnaway and Mendooran before flowing west into Gilgandra Shire. This river is a major source of surface water for the Warrambungle region.

2.1.2.1 Baradine Water Supply System

Baradine is located 45 km north of Coonabarabran with a population of around 680. Council has 349 registered connections to their potable water network in this township.

Abstraction

Baradine water is sourced from two artesian bores. The main bore in use is at the site of the water treatment plant at the corner of Walker and Narren Streets. A second bore is located adjacent to the park at Wellington Street. It is used primarily to irrigate the sports field but is also used as a backup for town water supply. It is unconfirmed whether the treatment plant can be manually bypassed; the pipework configuration needs to be confirmed.

Treatment

The water treatment plant (WTP) has an operating capacity of approximately 1.5 ML/day. In 2001, the plant was upgraded to improve its treated water quality output.

The bore water is aerated to remove carbon dioxide and oxidise sulphide, ferrous and manganous compounds. The aerated water is dosed with sodium carbonate (soda ash) to assist with the oxidation of the iron, manganese and sulphur compounds by increasing the pH. This removes sulphur, iron and manganese as insoluble salts from the water. Carbon dioxide is released to the atmosphere as a gas.

Polyaluminium chloride and polyacrylamide are added to the aerated water in order to coagulate and flocculate the fine insoluble salts which settle in the clarifier. This by-product is discharged to a lagoon as sludge. The water is then filtered through a dual media filter (anthracite and sand). The filtered water is disinfected with chlorine gas and dosed with fluoride. The fluoridation system was commissioned in May 2014. The water is then stored in the clean water tank located underneath the floor slab of the main building. The holes in the floor slab/roof of the clear water tank pose a significant risk for this supply. From here the water is pumped approximately 2 km to a concrete reservoir.

Distribution

The town's water storage is a single reinforced concrete reservoir, located on elevated ground outside the township of Baradine (on Gulargambone Rd). It has a storage capacity of 1.1 ML. Water is supplied to the township by gravity mains. The reticulation network consists mostly of asbestos cement (AC) pipework.

Baradine System Flow Diagram

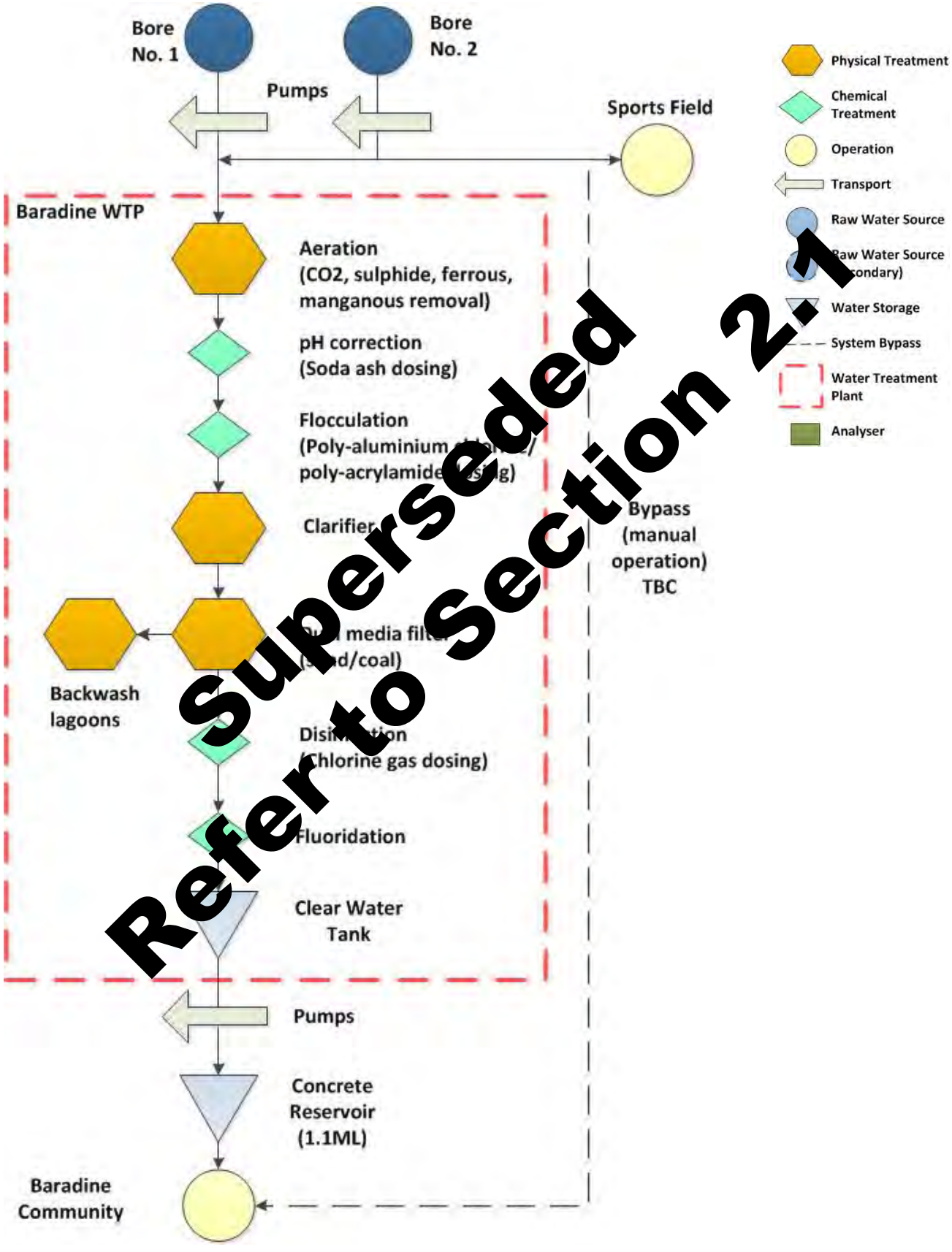

Figure 5 Baradine system flow diagram

Figure 6 Bore with bore extraction tower

Figure 7 Aeration unit

Figure 8 Clarifier

Figure 9 Filter unit

Figure 10 Balance tank

Figure 11 Clear water tank and pumps

Figure 12 Poly-aluminium chloride tank

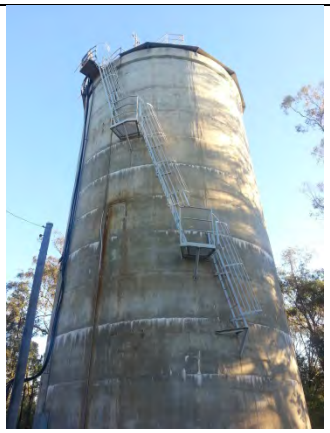

Figure 13 Concrete reservoir (1.1ML)

Figure 14 Baradine WTP

2.1.2.2 Binnaway Water Supply System

Binnaway is located 35 km south of Coonabarabran with a population of around 400. Council has 287 registered connections to their potable water network in this township.

Source Water

Water is drawn from the Castlereagh River via a bore buried in the river bed. This bore is downstream from a considerable part of the town. The town of Binnaway is unsewered, relying instead on septic tanks. The onsite wastewater systems for Binnaway should have a high priority for inspection, as the risks from discharges from poorly maintained on site systems are high. Raw water is pumped through 200 mm diameter pipework via a pump station by the river to the Binnaway WTP.

Treatment

Raw water enters into an inlet mixing tank which discharges to a settled water lagoon. The WTP has two lagoons, allowing for one to be taken offline for maintenance whilst maintaining operation. Each of the two lagoons holds 0.75 ML of raw water. The plant has a capacity of 1.3 ML/day of treated water production.

Aluminium sulphate is added as the water enters the lagoon to aid the flocculation process, with incoming suspended solids settling to the bottom of the lagoon. The clarified water is then pumped from the lagoon to the filters at a rate of 16.5 L/s. Two filters operate in parallel, enabling one filter cell to be used whilst the other is backwashed. The filtered water enters the underdrain at a rate of 16.5 L/s. The filtered water then flows to a 16.5 kL filtered water tank.

After the water is adjusted for pH and disinfected (using chlorine gas), two centrifugal pumps transfer the clean water to the town reservoir. The treatment plant has a fluoridation dosing skid installed, however it is yet to be commissioned into the treatment process.

The treatment plant currently does not have any online monitoring equipment installed.

Distribution

Clear water from the treatment plant is pumped to the 1 ML Town Reservoir (located on Cypress St), from which water distributes to the community via gravity reticulation.

Binnaway System Flow Diagram

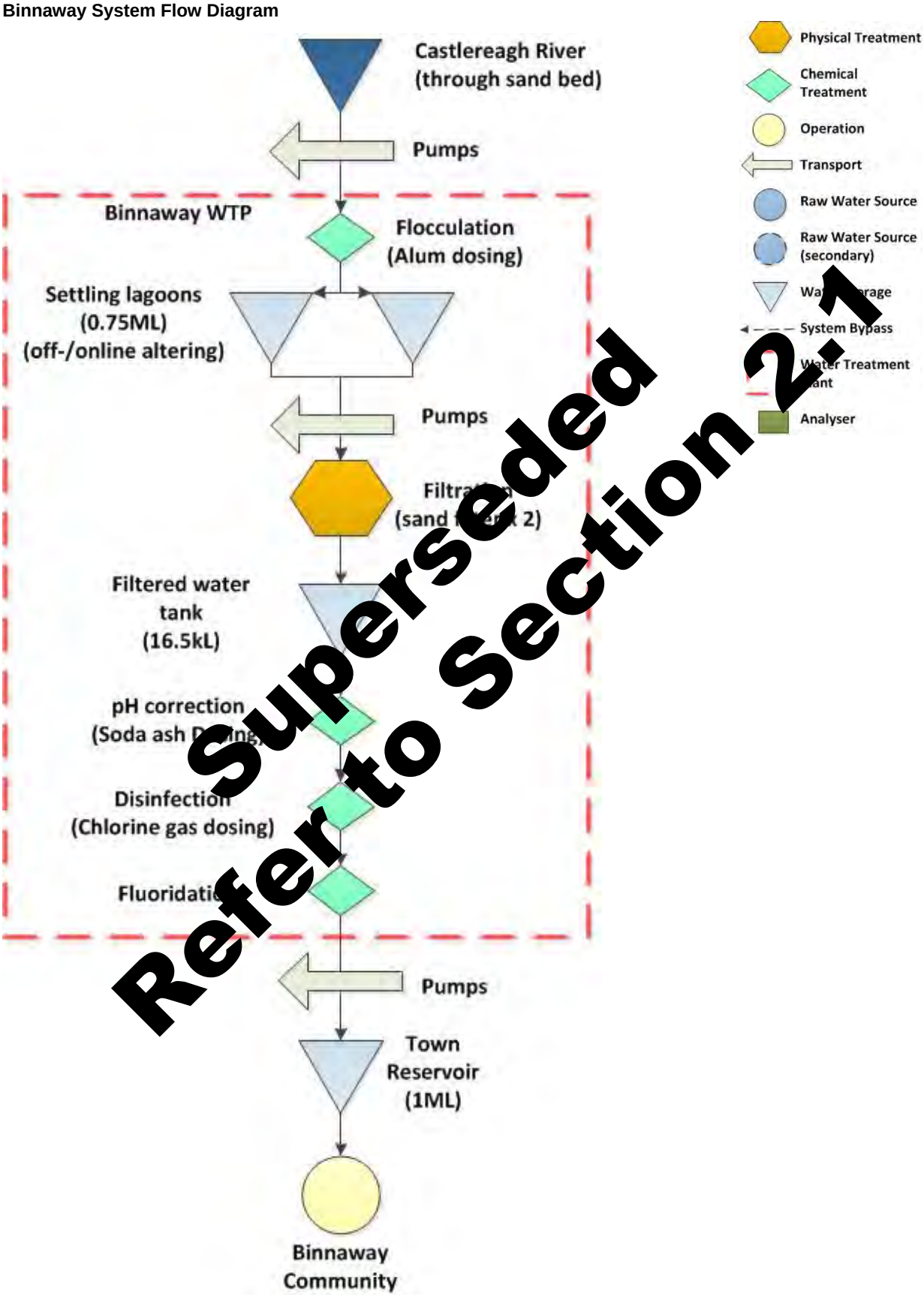

Figure 15 Binnaway system flow diagram

Figure 16 Castlereagh River

Figure 17 River intake

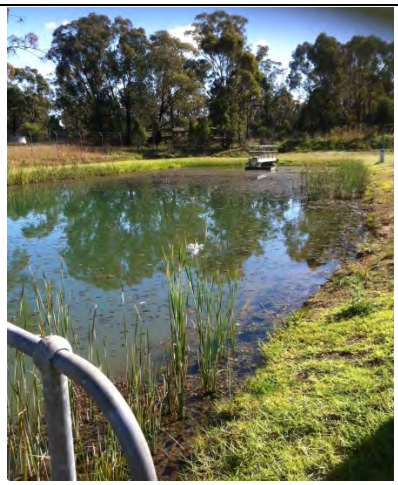

Figure 18 Settling lagoon

Figure 19 Sand filter

Figure 20 Filtered water tank

Figure 21 Chlorine gas cylinder

Figure 22 Chlorine dosing point

Figure 23 Alum tank

Figure 24 Town reservoir

2.1.2.3 Bugaldie Water Supply System

Bugaldie is located 27 km north of Coonabarabran with a population of 236, according to the 2011 census. Council has 14 registered connections to their potable water network, with many properties on private bore water and/or rainwater systems.

Source water

The Bugaldie supply system draws water from a sub-artesian bore which is approximately 100 m deep. The bore surround is concrete encased at ground level.

Treatment

This system utilises chlorine dosing for disinfection. No further treatment is given. Chlorinated water sits in the 8.5 kL surface storage tank before being pumped to the 8.5 kL elevated reservoir. This reservoir is a HDPE tank.

Distribution

Treated water is distributed to the community via a single 75 mm AC main. The 8.5 kL elevated reservoir provides the gravity head required to distribute the water to the township.

Bugaldie System Flow Diagram

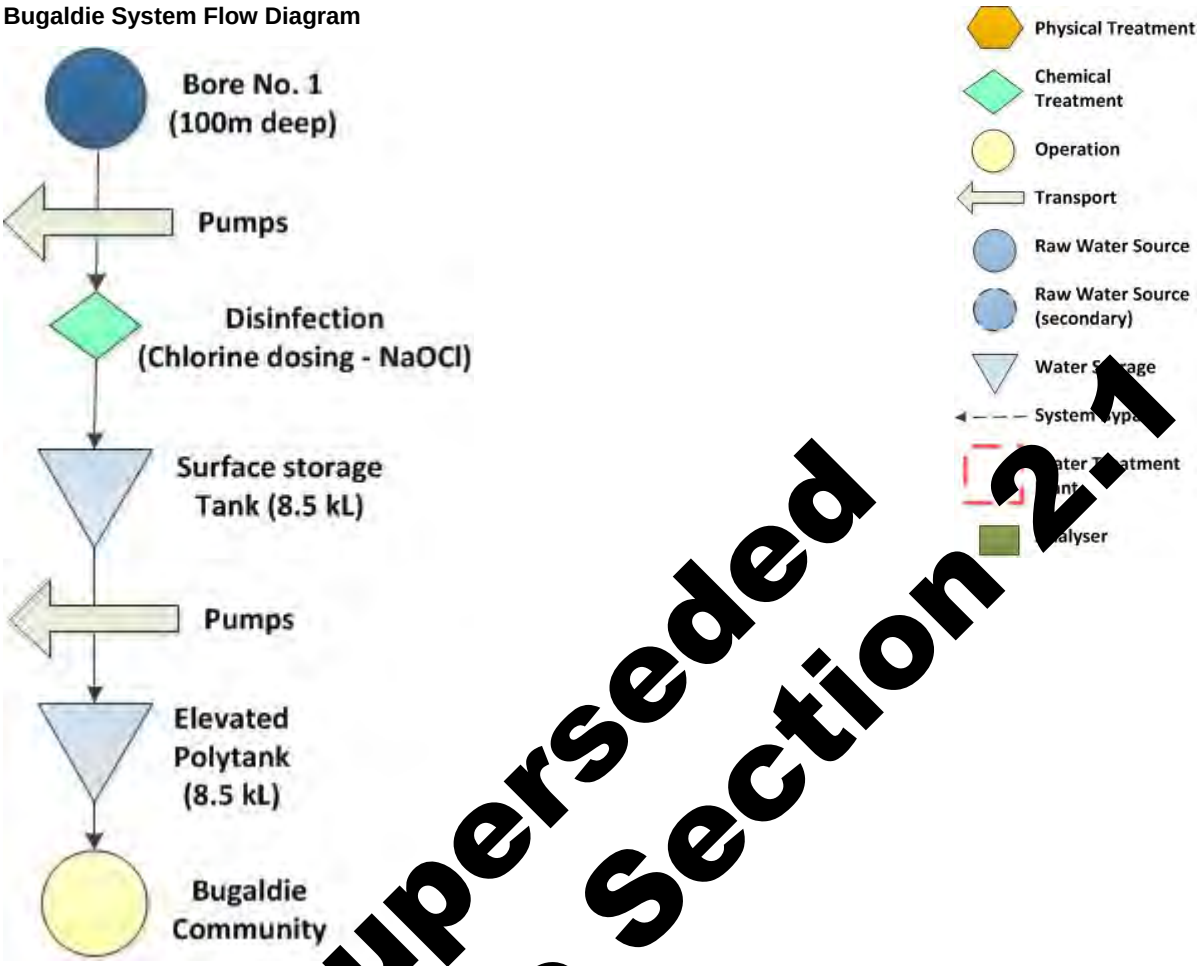

Figure 25 Bugaldie system flow diag

Figure 26 Bugaldie bore

Figure 27 Elevated tank

Figure 28 Bore casing

Figure 29 Locality of the bore

2.1.2.4 Coolah Water Supply System

Coolah is located 86 km south-east of Coonabarabran with a population of around 910. Council has 440 registered connections to their potable water network.

Source water

The Coolah water supply system draws water from a bore located outside the township next to the Coolaburragundy River.

Treatment

Water is pumped from the bore and dosed with liquid sodium hypochlorite (NaOCl), for disinfection. A fluoridation dosing skid has been installed, however it is yet to be commissioned. No further treatment is given.

Distribution

Treated water is stored in three reservoirs: two 90 kL reservoirs located at Wentworth Ave, and one 1.08 ML reservoir on Martin St, Coolah. A booster pump from Wentworth Ave delivers water to the community. The water stored in the Martin St Reservoir gravitates to the township.

Coolah System Flow Diagram

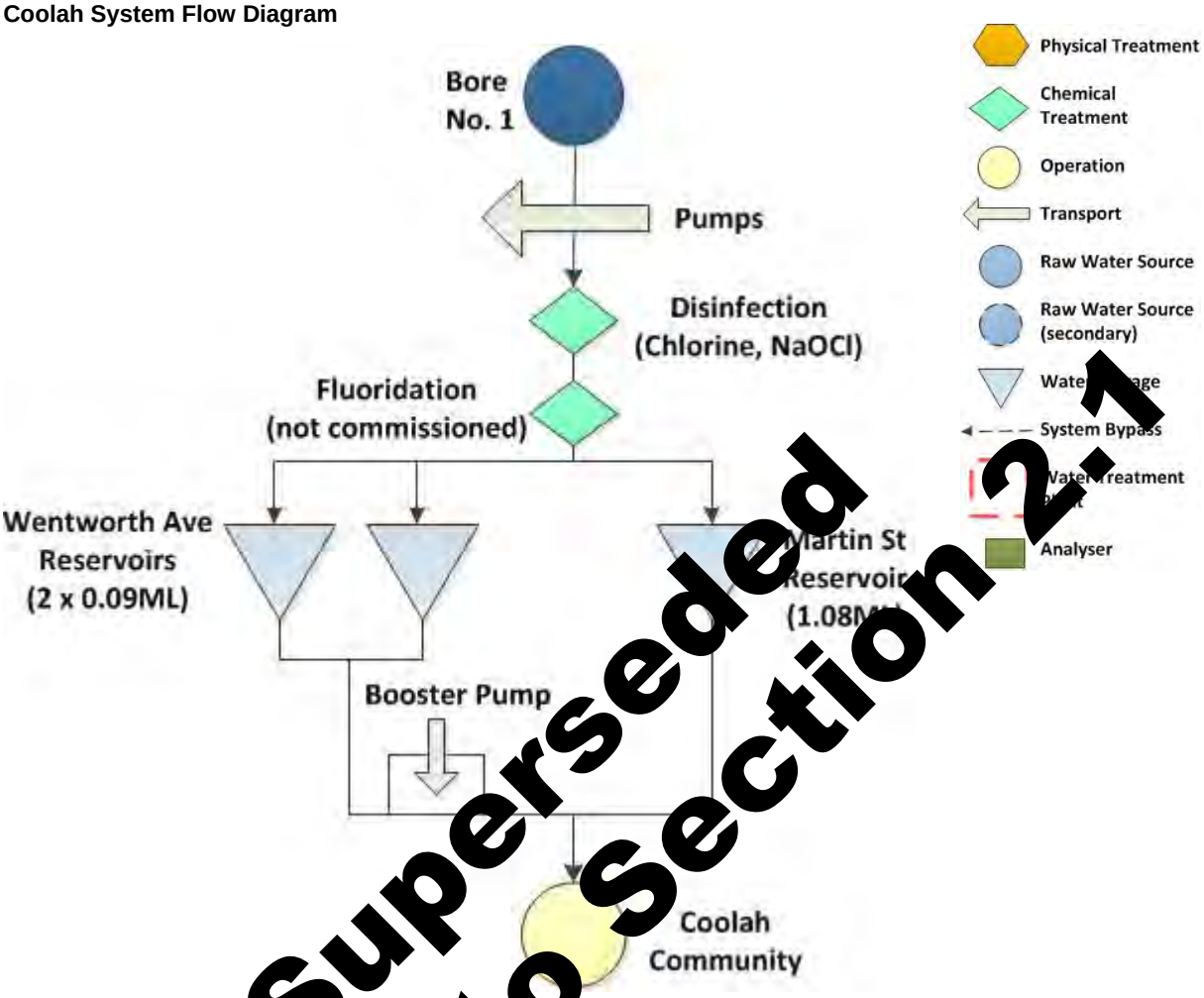

Figure 30 Coolah system flow diagram

2.1.2.5 Coonabarabran Supply System

Coonabarabran is the main township in Warrumbungle Shire Council and has a population of approximately 2,500 residents. Council has 1,320 registered connections to their potable water network in this township.

Source water

Timor Dam is the main source of water for the township, located 12 km west of Coonabarabran on the Castlereagh River (off Timor Rd). Built in 1961, the dam consists of a 19.5 m concrete arch structure with a storage capacity of approximately 1,140 ML.

Coonabarabran has five back-up bores which, when in use, Council typically blends with the dam water in a ratio 60:40 (dam water to bore water). During periods of drought (resulting in low dam levels) Council relies heavily on these bores. Water drawn from these bores can be utilised to top up the storage volume in the dam. These bores are located near the Castlereagh River include:

- Bore 1 – Robertson St
- Bore 2 – Namoi St
- Bore 3 – Immediately north of Castlereagh River Weir
- Bore 4 – Namoi St adjacent to railway line
- Bore 5 – Adjacent to Water Treatment Plant

Treatment

The water arriving at the WTP firstly passes through a coagulation and flocculation stage, where is it dosed with lime, alum and polymer. A powdered activated carbon (PAC) dosing unit has been installed, but is currently not operational. From here it drains into one of two sedimentation lagoons. The lagoons are configured to allow one to be offline (for cleaning) whilst the other maintains all the flow through the plant. At the inlet to the lagoons, each has horseshoe baffle walls to increase the flow path and slow down the velocity of the entering water. This assists in sediment dropping out of the incoming water.

Following this stage the water passes through a sand filter to remove any further suspended solids before being dosing with lime for alkalinity and hardness correction.

The water is disinfected with chlorine gas before being dosed with fluoride. From the plant the water drains into an in-ground clear water storage tank.

Distribution

The customers closest to the WTP typically receive water with free chlorine levels around 3-4 mg/L, whilst the extremities of the network receive very little free chlorine. A program of mains flushing has been recommended.

Water is pumped from the WTP to two reservoirs; Rifle Range 1 and 2 reservoirs, respectively 1.1 ML and 4.5 ML in capacity. A third reservoir, Oxley Hwy Reservoir (2.2 ML), is filled from the Rifle Range reservoirs via a booster pump.

The three reservoirs supply water to the Coonabarabran community via the gravity reticulation network.

Coonabarabran System Flow Diagram

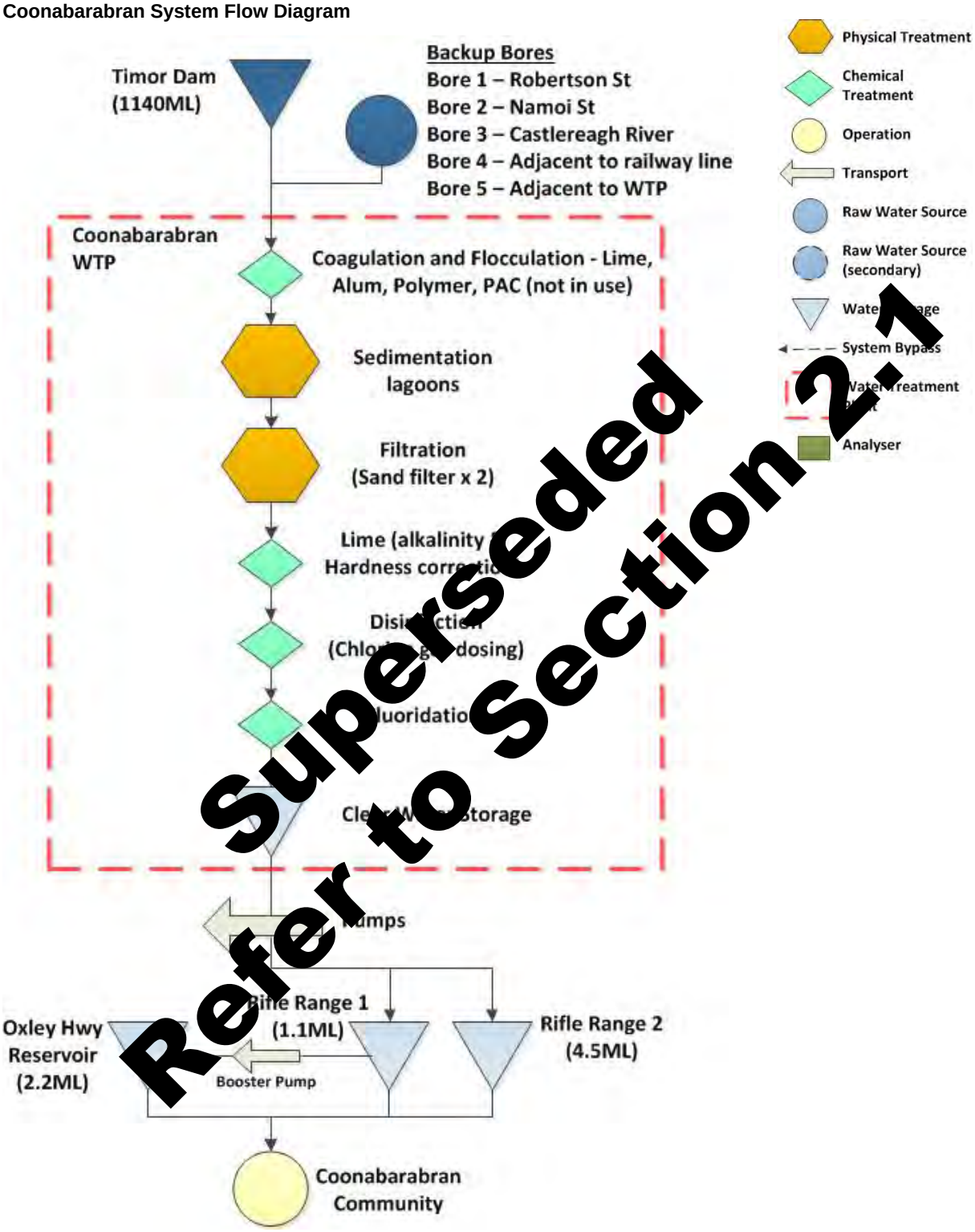

Figure 31 Coonabarabran system flow diagram

Figure 32 Sedimentation lagoons

Figure 33 Sedimentation lagoon

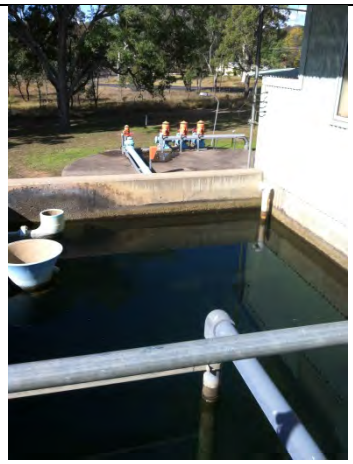

Figure 34 Sand filter

Figure 35 Polymer tank

Figure 36 Lime mixer

Figure 37 In-ground clear water tank

Figure 38 Chlorine gas cylinders

Figure 39 Oxley Hwy reservoir hatch

Figure 40 Oxley Hwy reservoir roof

2.1.2.6 Dunedoo Water Supply System

Dunedoo is located 110 km south of Coonabarabran with a population of around 840. Council has 450 registered connections to their potable water network in this township.

Source water

The water supply draws from Bore 1 located on the Talbragar River. A secondary source (Bore 2) can also supply water for the Dunedoo water supply system. An irrigation tank has been built to draw off this raw water line, however it has not been commissioned. There is no backflow prevention device on this tank.

Treatment

Water is dosed with sodium hypochlorite (NaOCl) for disinfection. The groundwater at this site contains a naturally high level of fluoride, and as such, fluoride dosing is not required. No further treatment is given.

Distribution

Water is pumped from the bores to one of two reservoir sites across Dunedoo. Site one is at Bullinda St and has a 0.85 ML reservoir. Site two is at a higher elevation at Rhodes St, and has a pair of 0.24 ML reservoirs. Bullinda Street reservoir fills first followed by the Rhodes Street Reservoirs. A Telstra telemetry line links the reservoir in Bullinda Street to the bore pump. Water is pumped to the reservoirs when the water level reaches a low water level limit. No further pumping is required and the treated water gravitates to the community via the reticulation system.

Dunedoo System Flow Diagram

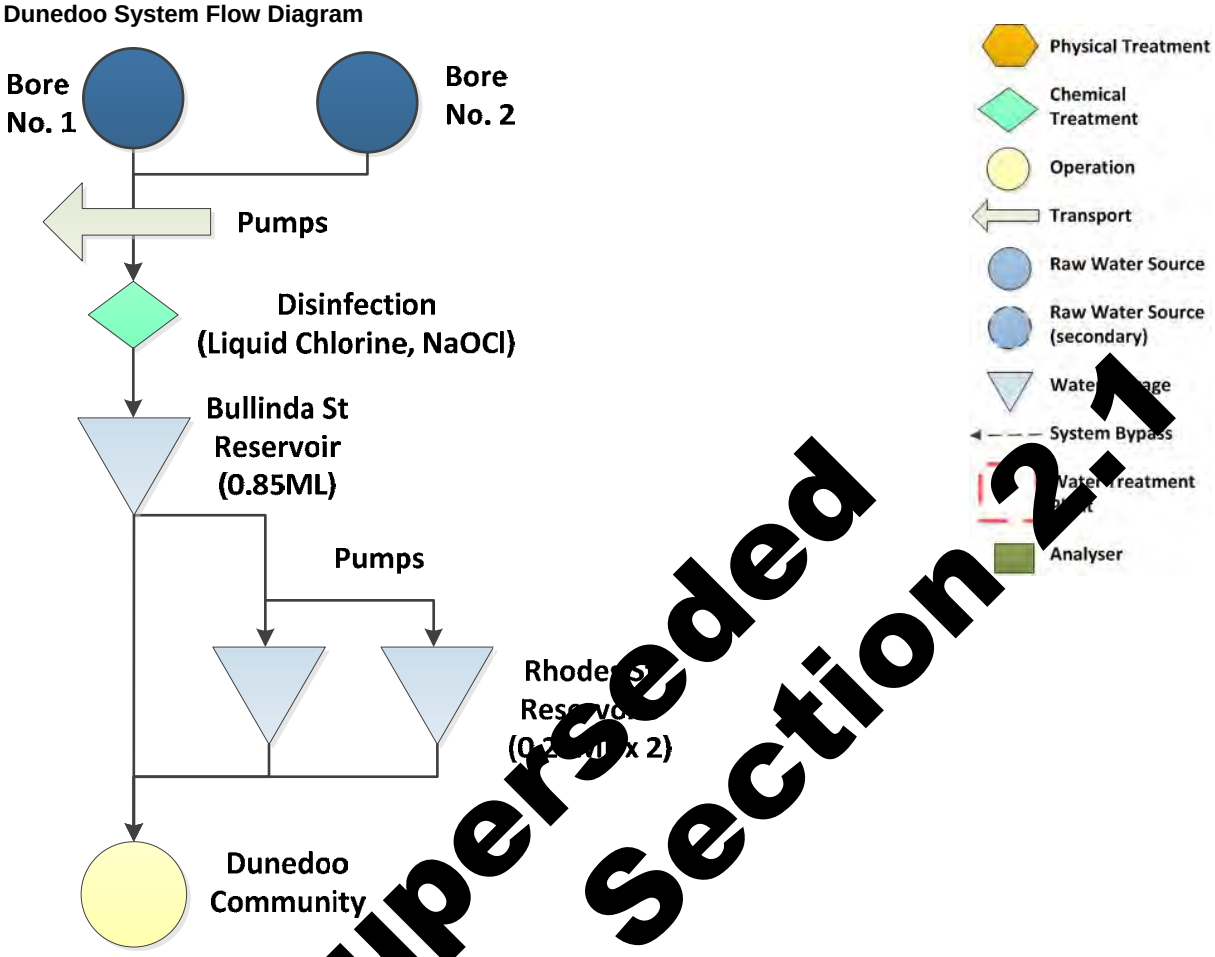

Figure 41 Dunedoo system flow diag

2.1.2.7 Kenebri Supply System

Kenebri is located 110 km north of Coonabarabran with a population of 170 (according to the 2011 ABS census). Council has 13 registered connections to their potable water network, with many properties on private bore water and/or rainwater systems.

Source water

This water supply system draws water from a single artesian bore approximately 30 m deep.

Treatment

This system utilises liquid chlorine dosing (NaOCl) for disinfection. No further treatment is given.

Distribution

Water is pumped from the bore site to two 11 kL elevated galvanised tanks (located on Gwabegar Baradine Rd) supported by a timber structure. Water gravitates via a 75 mm AC distribution main into the township.

Kenebri System Flow Diagram

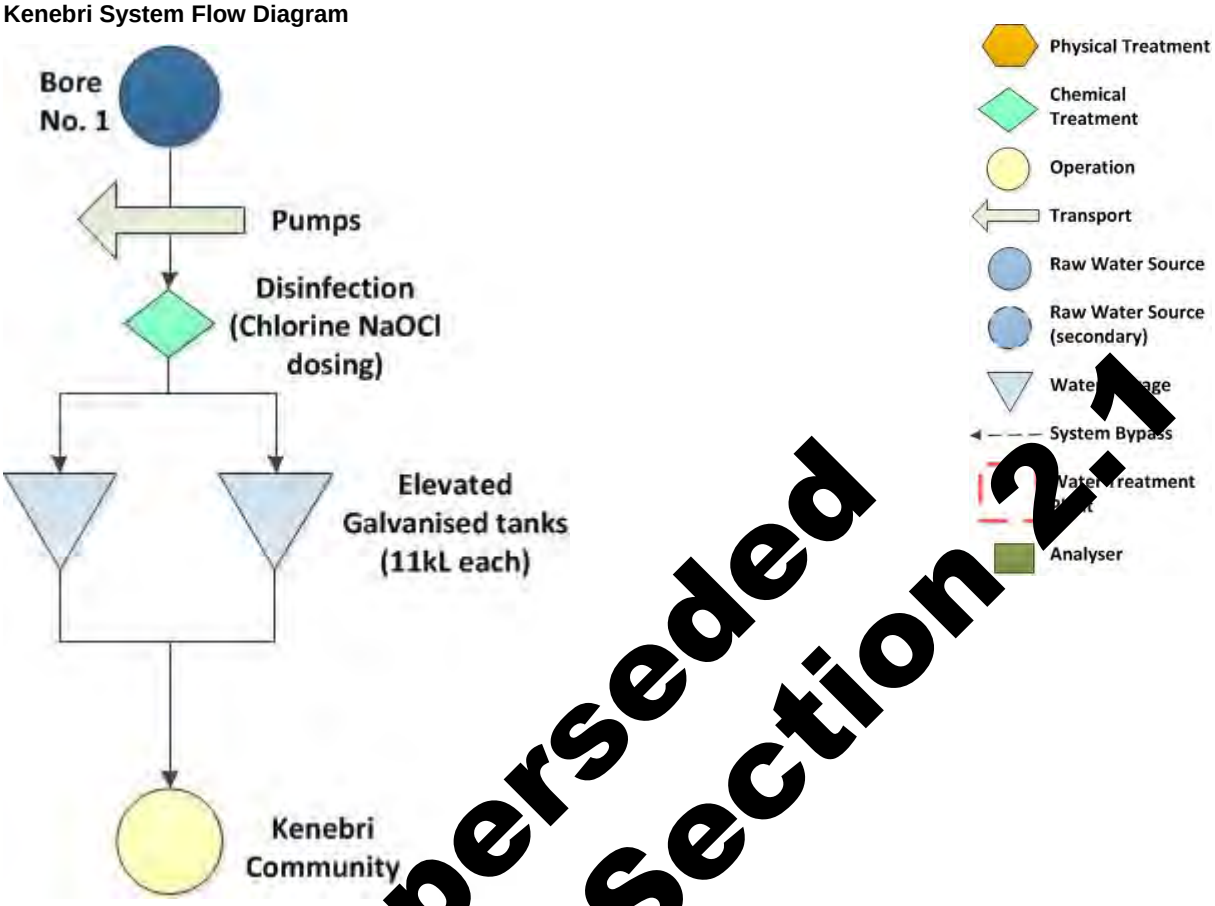

Figure 42 **Kenebri system flow diagra**

2.1.2.8 Mendooran Supply System

Mendooran is located 71 km south of Coonabarabran with a population of around 400. Council has 225 registered connections to their potable water network in this township.

Source water

Mendooran's water is sourced from a well (River Well 1) in the Castlereagh River near River and Dalglish Streets. During periods of low water levels in River Well 1, the system can utilise water drawn from a bore located downstream on the Castlereagh River, designated Bore No.1.

Treatment

A new WTP has been constructed adjacent to the Council Depot on the corner of Dalglish Street and Benewa Streets. The capacity of the plant is 1.0 ML/day. The water is pumped from the river to a cascade aerator where it is dosed with potassium permanganate and polyaluminium chloride (PACl) to create a floc. This is primarily designed to remove the iron and manganese that is typically present in the source water. Water then passes through a series of baffles before discharging into the sediment lagoons. Following the sedimentation process the water is filtered through dual media filters before entering a balance tank.

On the outlet of the balance tank, turbidity and pH is measured via online monitoring. The soda ash dosing unit is currently not in use and the fluoridation system has not been commissioned yet. The water is dosed with sodium hypochlorite (NaOCl) for disinfection before entering the clear water tank.

Distribution

Treated water is pumped to one of four reservoirs; three Coolabah Reservoirs and one Standpipe Reservoir. These reservoirs have a combined capacity of 1.06 ML. The Mendooran Standpipe Reservoir is located on the corner of Brambil St and Cobra St and has a capacity of 0.55 ML. The three Coolabah Reservoirs are located on Manusu Drive; two of which have capacities of 0.09 ML and the third has a capacity of 0.33 ML. Following the Coolabah reservoirs, there is an online chlorine monitor with a small dosing unit to allow for additional chlorine dosing within the reticulation system.

The water is supplied to the township of Mendooran and nearby Coolabah Estate. The reticulation system consists of 13 km of rising mains, 9 km of mains for Mendooran, and 4 km of mains for Coolabah Estate.

Mendooran System Flow Diagram

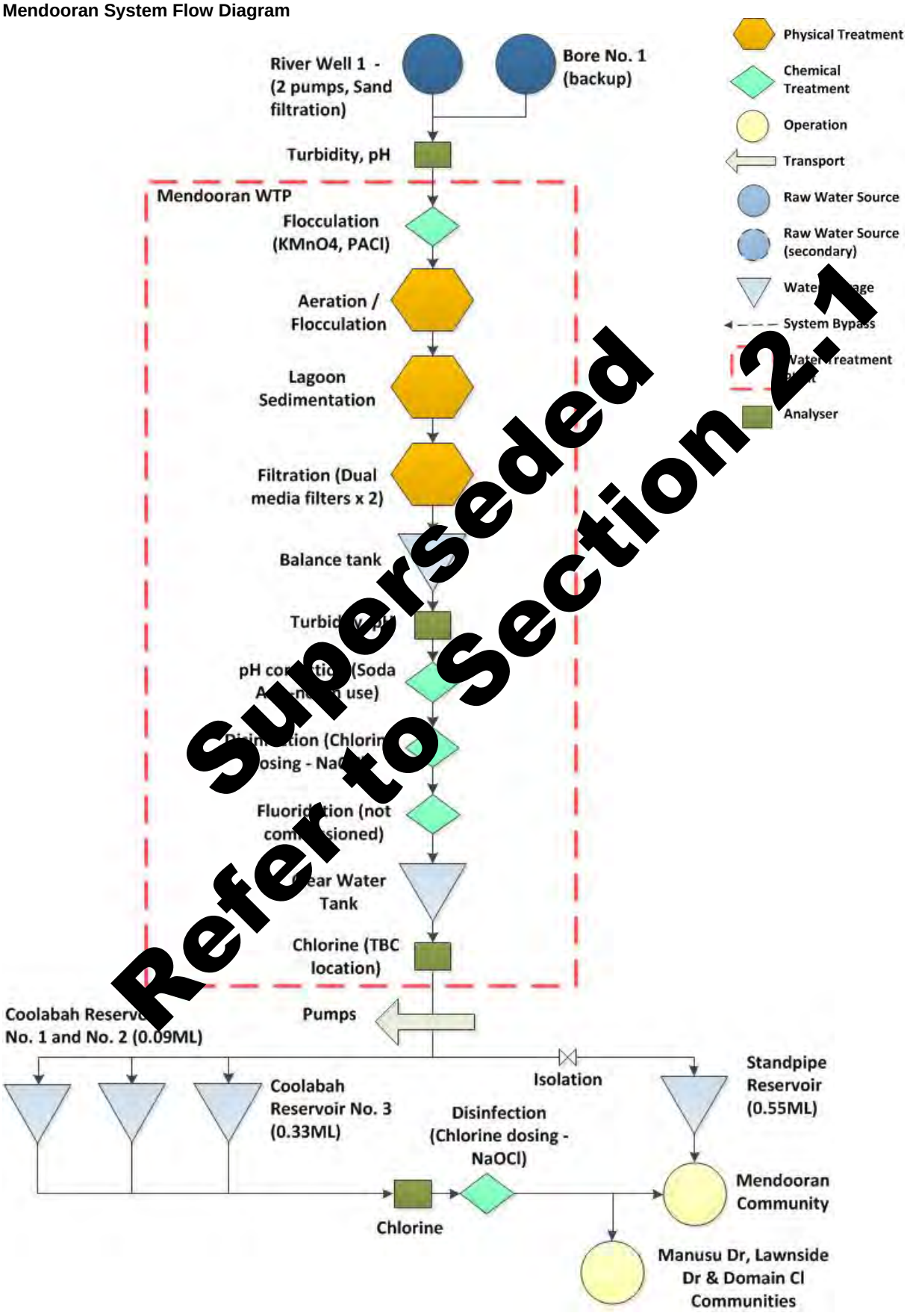

Figure 43 Mendooran system flow diagram

Figure 44 River well 1

Figure 45 Cascade aerator

Figure 46 Baffles leading to sedimentation lagoons

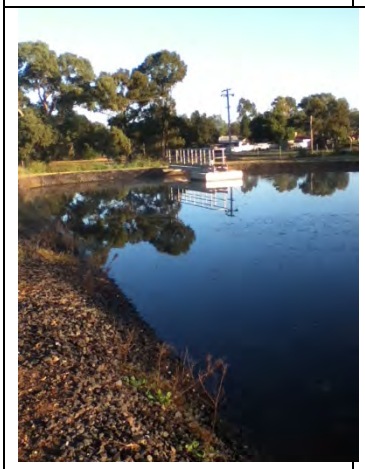

Figure 47 Sedimentation lagoons

Figure 48 Sand filters

Figure 49 Potassium permanganate tank

Figure 50 Coolabah reservoirs

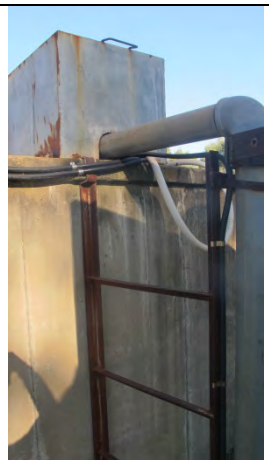

Figure 51 Coolabah reservoirs hatch

Figure 52 Standpipe reservoir

2.1.3 Periodic Review

The information contained within this document is current at the time of writing. The information will need to be periodically reviewed and updated. The information should be formally reviewed annually and will be updated in response to significant system changes.

2.2 Assessment of water quality data

This section summarises the assessment of water quality data undertaken for Council's drinking water supply systems. The information collated in this section was accessed through the NSW Drinking Water Database, and was supplemented by information provided by Council. Figure 53 outlines the actions recommended by the ADWG.

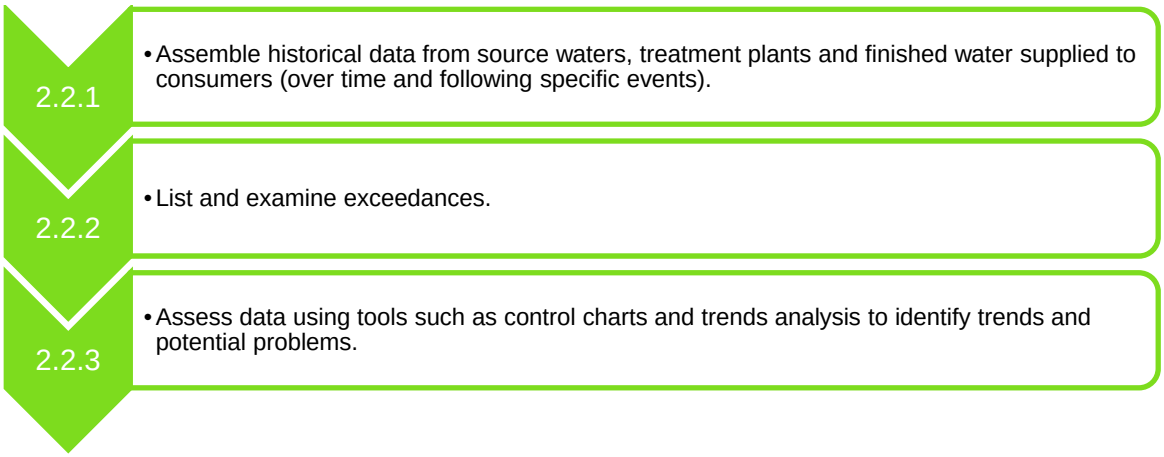

Figure 53 Assessment of water quality data actions [ADWG, Chapter 3.2.2]

2.2.1 Historical data from source waters, treatment plants and finished water supplied to customers

The ADWG provides guideline values for 223 microbial, chemical and physical characteristics in drinking water. Council routinely monitors 32 of these characteristics in their drinking water supply systems. Most chemicals, including pesticides and other trace organics, do not warrant the same level of monitoring attention as microbial pathogens or the chemicals of main concern, which are currently being monitored by Council, unless there is evidence or reasonable inference of their potential presence, as determined through site-specific investigation and analysis of the water supply system. Pesticide and DBP monitoring have been conducted for the Coonabarabran supply system as part of the NSW Aboriginal Communities Water and Sewerage Program.

Data from 55 sampling sites has been collected from the Database covering the eight drinking water systems. All sample locations are post-treatment. A five year date range was selected to identify trends and assess the system as it is currently functioning. The specific dates of this five year range were between 10 March 2009 and 10 March 2014.

The list of parameters for which Council monitor and their associated ADWG values are provided in **Appendix C**.

2.2.2 List and examine exceedances

Water supplied to consumers is sampled and tested under the NSW Health Drinking Water Monitoring Program.

A review of the available water quality data has identified that there are current data gaps. Table 2 outlines the issues identified through uncertainties and gaps in the available dataset.

Table 2 Uncertainties and gaps in data

Issue	Why	Comments
Chlorine residual – frequency of monitoring	Frequency of chlorine residual monitoring i.e. monthly grab sampling for some systems.	Limited on-line analysis undertaken. Council should consider installing online monitoring at the clear water tank outlets. This will assist in the calculation of CT.
Pesticides	Significant amount of agricultural activities within the catchments.	No pesticide monitoring data recorded between 2008 to 2013 (not applicable to Coonabarabran; pesticide monitoring data recorded for Coonabarabran between 2010 and 2014). The need to monitor any of these parameters should be determined through exercises such as catchment sanitary surveys.
Turbidity (at plant)	Turbidity levels directly affect the effectiveness of disinfection. High reliance on chlorine disinfection requires low turbidity to ensure adequate disinfection.	Council should consider installing online monitoring on filter outlets that feeds into their SCADA system. Otherwise, twice daily manual test results should be recorded in a spreadsheet to allow review and analysis.

A review of the water quality data from the NSW Drinking Water Database also identified issues that have been present within the drinking water systems over the past five years. Table 3 to Table 10 illustrate the specific issues identified through the water quality analyses (described in further detail in section 2.2.3) by summarising characteristics that exceeded the ADWG guidelines.

Table 3 Water quality issues for Baradine water supply (post-treatment)

Issue	ADWG guideline value	Frequency	Comments
E. coli (health)	No detections	Rare	One detection in 240 samples.
Total coliforms[1]	-	Infrequent	7 detections in 240 samples.
pH (aesthetic)	pH 6.5 - 8.5	Rare	One reading in 199 samples outside the guideline range for pH.
Free chlorine[2]	0.2 - 0.6 mg/L	Occasional	14 readings of 195 were below 0.2 mg/L.

Table 4 Water quality issues for Binnaway water supply (post-treatment)

Issue	ADWG guideline value	Frequency	Comments
Total Coliforms[1]	-	Occasional	16 detections in 120 samples.
pH (aesthetic)	pH 6.5 - 8.5	Rare	One reading in 104 samples outside the guideline range for pH.
Total Hardness (aesthetic)	200 mg/L	Occasional	2 exceedences in 7 samples.
Free chlorine[2]	0.2 - 0.6 mg/L	Frequent	50 readings of 97 were below 0.2 mg/L.

Table 5 Water quality issues for Bugaldie water supply (post-treatment)

Issue	ADWG guideline value	Frequency	Comments
E. coli (health)	No detections	Rare	One detection in 59 samples.
Total coliforms[1]	-	Occasional	4 detections in 59 samples.
Turbidity (aesthetic)	5 NTU	Occasional	2 readings in 13 samples greater than 1 NTU (both of which were greater than 5 NTU).
pH (aesthetic)	pH 6.5 - 8.5	Rare	One reading in 60 samples outside the guideline range for pH.
Lead (health)	0.01 mg/L	Occasional	2 exceedences in 10 samples.
Iron (aesthetic)	0.3 mg/L	Occasional	2 exceedences in 10 samples.
Free chlorine[2]	0.2 - 0.6 mg/L	Frequent	11 readings of 49 were below 0.2 mg/L.

Table 6 Water quality issues for Coolah water supply (post-treatment)

Issue	ADWG guideline value	Frequency	Comments
E. coli (health)	No detections	Rare	2 detections in 244 samples.
Total coliforms[1]	-	Frequent	36 detections in 244 samples.
pH (aesthetic)	pH 6.5 - 8.5	Rare	One reading in 120 samples outside the guideline range for pH.
Total Hardness (aesthetic)	200 mg/L	Constant	Of the 9 samples all exceeded the ADWG aesthetic guidelines.
Free chlorine[2]	0.2 - 0.6 mg/L	Frequent	57 readings of 199 were below 0.2 mg/L.

Table 7 Water quality issues for Coonabarabran water supply (post-treatment)

Issue	ADWG guideline value	Frequency	Comments
E. coli (health)	No detections	Infrequent	4 detections in 253 samples.
Total coliforms[1]	-	Frequent	27 detections in 253 samples.
Turbidity (aesthetic)	5 NTU	Occasional	4 readings in 19 samples greater than 1 NTU (2 were greater than 5 NTU). High turbidity inhibits effectiveness of disinfection.
pH (aesthetic)	pH 6.5 - 8.5	Rare	One reading in 211 samples outside the guideline range for pH.
Aluminium (aesthetic)	0.2 mg/L	Infrequent	One exceedence in 10 samples.
Iron (aesthetic)	0.3 mg/L	Occasional	3 exceedences in 10 samples.
Free chlorine[2]	0.2 - 0.6 mg/L	Frequent	91 readings of 202 were below 0.2mg/L.

Table 8 Water quality issues for Dunedoo water supply (post-treatment)

Issue	ADWG guideline value	Frequency	Comments
E. coli (health)	No detections	Rare	One detection in 241 samples.
Total coliforms[1]	-	Infrequent	7 detections in 241 samples.
Turbidity (aesthetic)	5 NTU	Infrequent	3 readings in 17 samples greater than 1 NTU (one was greater than 5 NTU). High turbidity inhibits effectiveness of disinfection.
pH (aesthetic)	pH 6.5 - 8.5	Rare	One reading in 205 samples outside the guideline range for pH.
Lead (health)	0.01 mg/L	Occasional	One exceedence in 8 samples.
Total Hardness (aesthetic)	200 mg/L	Frequent	4 exceedences in 8 samples.
TDS (aesthetic)	600 mg/L	Constant	Of the 8 samples all exceeded the ADWG aesthetic guidelines.
Free chlorine[2]	0.2 - 0.6 mg/L	Frequent	49 readings of 197 were below 0.2 mg/L.

Table 9 Water quality issues for Kenebri water supply (post-treatment)

Issue	ADWG guideline value	Frequency	Comments
E. coli (health)	No detections	Rare	One detection in 61 samples.
Total coliforms[1]	-	Occasional	7 detections in 61 samples.
Turbidity (aesthetic)	5 NTU	Occasional	One reading in 11 samples was greater than 1 NTU. High turbidity inhibits effectiveness of disinfection.
pH (aesthetic)	pH 6.5 - 8.5	Rare	One reading in 57 samples outside the guideline range for pH.
Sodium (aesthetic)	180 mg/L	Infrequent	One exceedence in 10 samples.
Free chlorine[2]	0.2 - 0.6 mg/L	Frequent	15 readings of 45 were below 0.2 mg/L.

Table 10 Water quality issues for Mendooran water supply (post-treatment)

Issue	ADWG guideline value	Frequency	Comments
E. coli (health)	No detections	Occasional	11 detections in 132 samples.
Total coliforms[1]	-	Frequent	36 detections in 132 samples.
Turbidity (aesthetic)	5 NTU	Occasional	3 readings in 13 samples greater than 1 NTU (2 were greater than 5 NTU). High turbidity inhibits effectiveness of disinfection.
pH (aesthetic)	pH 6.5 - 8.5	Rare	One reading in 112 samples outside the guideline range for pH.
Manganese (health)	0.5 mg/L	Occasional	2 exceedences in 9 samples.
Iron (aesthetic)	0.3 mg/L	Occasional	2 exceedences in 9 samples.
Total Hardness (aesthetic)	200 mg/L	Occasional	One exceedence in 9 samples.
TDS (aesthetic)	600 mg/L	Occasional	3 exceedences in 9 samples.
Free chlorine[2]	0.2 - 0.6 mg/L	Occasional	37 readings of 100 were below 0.2 mg/L.

NOTES:

[1] No guideline value has been set for total coliforms in drinking water. If used as an indicator, numbers should be established on a system-specific basis. Increased concentrations should be investigated.

[2] ADWG recommends a free chlorine residual between 0.2 - 0.6 mg/L for adequate disinfection, whilst still meeting aesthetic requirements.

2.2.3 Assessment of data using tools such as control charts and trend analysis to identify trends and potential hazards

Statistical analysis of the water quality results from the NSW Drinking Water Database was undertaken to assess any trends and potential hazards. The results of these analyses are provided in **Appendix A**.

For right-censored data (data for which the true value lies above the upper limit of quantification or reporting of the assay used) twice the upper limit of quantification was substituted for the recorded value. For example, for a sample that returned a value of > 5, a value of 10 was applied.

For left-censored data (data for which the true value lies below the lower limit of detection or reporting of the assay used) one half the detection limit was substituted for the recorded value. For example, for a sample that returned a value of < 5, a value of 2.5 was applied. The raw data was also checked visually in order to identify likely erroneous results and remove obvious outliers.

For microbiological data, convention requires a non-detection to be reported as <1 Colony-forming Units (CFU) per 100 mL. These values were converted to zero for statistical analyses.

2.3 Hazard Identification and Risk Assessment

This section documents the drinking water risk assessment process and results. Figure 54 outlines the actions as specified in the ADWG.

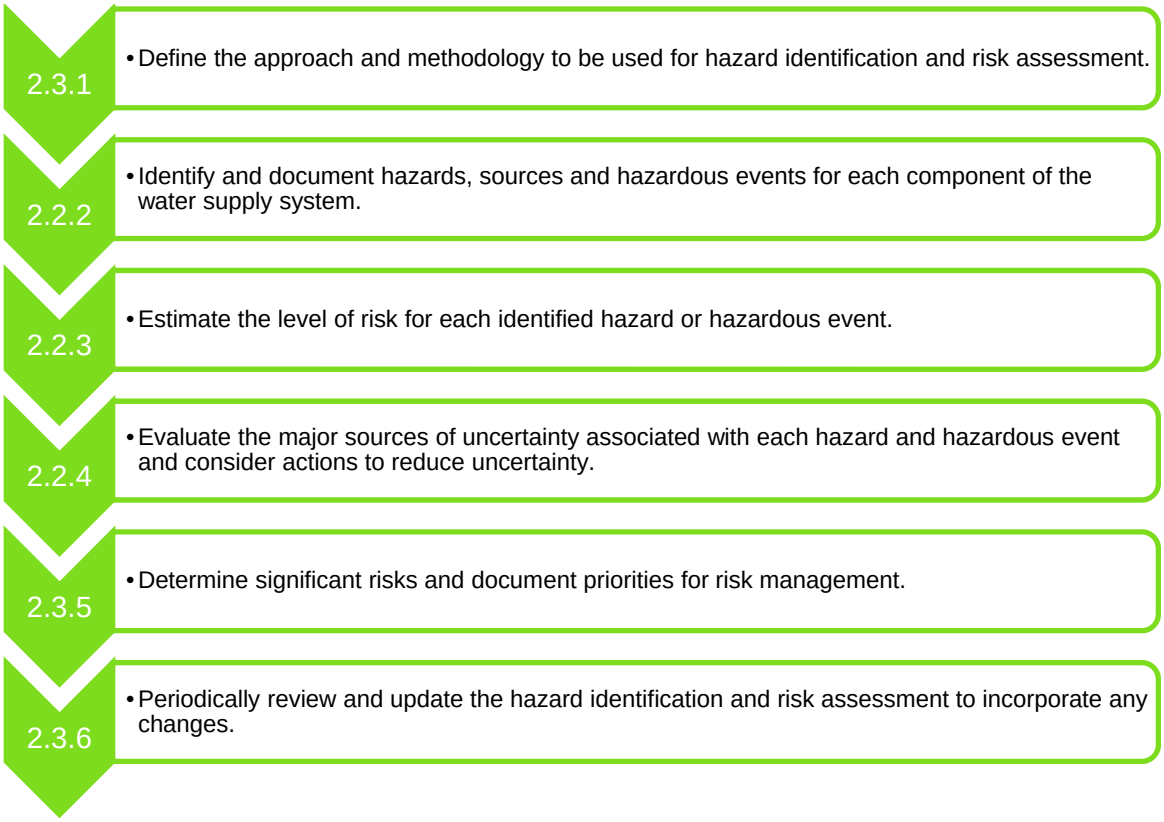

Figure 54 Hazard identification and risk assessment actions [ADWG, Chapter 3.2.3]

2.3.1 Define the approach and methodology for hazard identification and risk assessment

The risk assessment was undertaken using a workshop format. Prior to the workshop, a *Drinking Water Quality Risk Assessment Workshop Briefing Paper* (AECOM 2014) was developed. This briefing paper was issued to the participants two weeks prior to the workshop. The briefing paper included an overview of the methodology and agenda, the catchment characteristics, as well as the analyses of water quality data.

For the workshop itself, a qualitative risk assessment process was adapted from the procedure outlined in the ADWG. The workshop followed the *Decision Tree to Identify Critical Control Points* process (taken from ADWG, 2011) as the CCP identification methodology.

At the start of the workshop the Warrumbungle Water manager provided an overview of their respective water supply system from catchment to consumer. These descriptions included a high level overview of the key features of the catchment, abstraction points and the treatment and distribution systems. This process was used to update and gain consensus on the process flow diagrams.

A site visit was also conducted prior to the workshop to verify the system flow diagrams. The infrastructure of Baradine, Bugaldie, Binnaway, Coonabarabran and Mendooran was inspected during the site visit.

2.3.2 Identify and document hazards and hazardous events

The AECOM team initially reviewed existing information to identify potential sources of hazards relating to Council's water supply systems. This was done by reviewing background information and water quality data provided by Council, including their Draft Strategic Business Plan and State of the Environment reports.

Additional sources of hazards were identified by examining the characteristics of the catchment and the historic water quality performance. This was done by reviewing publicly available information, including: State of the Environment reports, State of the Catchment reports, natural disaster declarations, Central West Catchment

Management Authority (CMA) reports, and historical water quality data from the NSW Health Drinking Water Database.

A summary of the potential hazards initially identified was included in the *Workshop Briefing Paper* (AECOM 2014). This summary was used as a discussion point for the identification of hazardous events and hazards during the workshop.

A **hazard** is a biological, chemical, physical or radiological agent that has the potential to cause harm. An example of a hazard is increased turbidity after a rainfall event.

A **hazardous event** is an incident or situation that can lead to the presence of a hazard (what can happen and how). An example of a hazardous event is a large rainfall event, which may lead to increased turbidity and other types of contamination that may cause harm.

Preventive measures are actions, activities and processes used to prevent hazards from occurring or to reduce them to an acceptable level.

A systematic approach was taken to the hazard identification. The group stepped through the hazard identification by activity/process step (considering systems simultaneously) starting at the catchment and working through the treatment process to distribution. Where the hazards were applicable only to one system, this was noted during the workshop.

The group discussed and recorded the hazardous events at each step, the subsequent hazards associated with each hazardous event (see above for definitions), as well as the existing controls in place to prevent or control the hazard.

The outcomes of the hazard identification are provided in **Appendix D**.

2.3.3 Estimate the level of risk

Once participants were satisfied that all the hazards had been identified, the group then undertook the risk assessment for each hazard (see below for risk definitions). The risk assessment included firstly assessing the unmitigated likelihood and consequence scores of a hazardous event, then addressing the residual likelihood and consequence scores for that same hazardous event, factoring in existing controls. The definitions used to guide scoring of the consequences and likelihoods are provided in Table 11 and Table 12.

The risk score for a particular hazard was then calculated using the likelihood and consequence scores and the matrix provided in Table 13. The spread sheet was automatically populated with the matrix results based on the likelihood and consequence.

Risk is the likelihood of identified hazards causing harm in exposed populations in a specified timeframe, including the severity of the consequences.

Unmitigated risk is risk assessed in the absence of preventive measures.

Residual risk is risk assessed after consideration of existing preventive measures.

Table 11 Qualitative measures of consequence

Level	Descriptor	Description
1	Insignificant	Isolated exceedance of aesthetic parameter with little or no disruption to normal operation
2	Minor	Potential local aesthetic impact, isolated exceedance of chronic health parameter
3	Moderate	Potential widespread aesthetic impact or repeated breach of chronic health parameter
4	Major	Potential acute health impact, no declared outbreak expected
5	Catastrophic	Potential acute health impact, declared outbreak expected

Table 12 Qualitative measures of likelihood

Level	Descriptor	Description
A	Almost Certain	Occurs more often than once per week (or more often than 52 times per year)
B	Likely	Occurs more often than once per month (or more often than 12 times per year) and up to once per week (up to 52 times per year)
C	Possible	Occurs more often than once per year and up to once per month (up to 12 times per year)
D	Unlikely	Occurs more often than once every 5 years and up to once per year
E	Rare	Occurs less than or equal to once every 5 years

Table 13 Qualitative risk analysis matrix

Likelihood	Consequences				
	1	2	3	4	5
A	Moderate	High	Very High	Very High	Very High
B	Moderate	High	High	Very High	Very High
C	Low	Moderate	High	Very High	Very High
D	Low	Low	Moderate	High	Very High
E	Low	Low	Moderate	High	High

The final scores provided the team with the unmitigated and residual risk score for each hazard. These results were reviewed for inconsistency and accuracy, and scoring was appropriately modified where required.

The full risk assessment results are shown in **Appendix D**.

2.3.4 Evaluate the major sources of uncertainty

Uncertainty scores were not explicitly allocated to each hazard; however, where relevant, uncertainty was discussed and recorded as part of the basis for scoring. Generally, where uncertainty was present, a precautionary approach was adopted when scoring the risk. That is, hazards with a high level of uncertainty were assessed conservatively.

Follow up actions were identified and recorded to alleviate this uncertainty and provide better information on the performance of the system. These notes are also available in **Appendix D**.

2.3.5 Determine significant risks and document priorities

A total of 56 risk scenarios were identified as part of the risk assessment process. Table 14 summarises the unmitigated risk scores, while Table 15 provides a summary of the residual risk scores. Significant risks were determined as unmitigated risks with either a *High* or *Very High* risk score. A total of 30 unmitigated risks were deemed significant (as shown in Table 14). This figure was reduced to 23 once controls were applied (as shown in Table 15).

Table 16 provides an overview of the significant unmitigated risks, and their existing control measures. The hazards presented in Table 14 were considered to be “risk management priorities” and were subsequently identified as being necessary for CCP evaluation (discussed in further detail in section 3.2).

Table 14 Unmitigated risk distribution

Process	Very High	High	Medium	Low	Sub-Total
Catchment and abstraction	7	2	4	-	13
Aeration and oxidation	-	1	1	-	2
Coagulation and flocculation	1	-	1	-	2
Clarification/sedimentation	1	1	-	-	2
Filtration	1	-	-	-	1
pH correction	1	-	1	-	2
Disinfection (Chlorine Dosing and Contact Vessels)	1	1	1	-	3
Fluoride	-	1	-	-	1
Reservoirs	2	1	-	-	3
Distribution	2	1	1	-	4
Whole of System	5	-	1	-	6
Monitoring & Management Systems	1	-	-	-	1
Subtotal	22	8	10	0	**40**

Table 15 Residual risk distribution

Process	Very High	High	Medium	Low	Sub-Total
Catchment and abstraction	3	4	4	2	13
Aeration and oxidation	-	-	2	-	2
Coagulation and flocculation	-	1	1	-	2
Clarification/sedimentation	-	1	1	-	2
Filtration	1	-	-	-	1
pH correction	-	1	-	1	2
Disinfection (Chlorine Dosing and Contact Vessels)	1	-	2	-	3
Fluoride	-	-	1	-	1
Reservoirs	2	1	-	-	3
Distribution	1	1	2	-	4
Whole of System	2	3	1	-	6
Monitoring & Management Systems	1	-	-	-	1
Subtotal	11	12	14	3	**40**

Table 16 Hazards assessed as having a significant unmitigated risk score and their existing control measures

Process Step	System Code	Hazard	Hazardous Event	Unmitigated Risk Score	Existing Control Measures	Residual Risk Score
Catchment and Abstraction	BWY CBN MDN CLH DDO (surface)	Cryptosporidium	- Pathogens from agricultural inputs due to surface water ingress {significant agricultural activities not present within Timor Dam catchment} [AGRICULTURAL HAZARDS]	Very High	- Filtration (MDN, CBN, BWY) - Backup supply, bores (MDN) - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	High
Catchment and Abstraction	BUG KEN BDN (ground)	Cryptosporidium	- Pathogens from agricultural inputs due to surface water ingress [AGRICULTURAL HAZARDS]	Very High	- Filtration (BDN) - Bore casing and bore depth (>50m)	Very High
Catchment and Abstraction	BUG BWY CBN KEN MDN DDO	Cryptosporidium	- Pathogens from septic - Unsewered properties in township (septic systems - BUG, KEN, MDN, BWY) - CBN STP upstream MDN, BWY - High rainfall events leading to E.Coli presence (MDN back-up bore) {significant agricultural activities not present within Timor Dam catchment} [RURAL SEPTICS]	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	Very High
Catchment and Abstraction	BUG BWY CBN KEN MDN	Chlorine sensitive pathogens	- Pathogens from agricultural inputs due to surface water ingress. Wildlife in catchment High rainfall events/flood leading to E.Coli events (MDN back-up bore) [AGRICULTURAL]	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Chlorine dosing - Coagulation (MDN, CBN, BWY, BDN) - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	High

Catchment and Abstraction	ALL	Chlorine sensitive pathogens	- Pathogens from septics - Unsewered properties in township (septic systems - BUG, KEN, MDN, BWY) - CBN STP upstream MDN, BWY - High rainfall events leading to E.Coli presence (MDN back-up bore) [RURAL]	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register and inspection program and risk rating (BWY, MDN) [not functioning] - Chlorine dosing - Coagulation (MDN, CBN, BWY, BDN) - Sand filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam retention (CBN)	Very High
Catchment and Abstraction	MDN BDN BUG CBN	Iron and manganese	- Groundwater can contain naturally occurring iron and manganese	Very High	- Aeration (Timor Dam, CBN) - Aeration (cascade) /Oxidation (KMNO4) (MDN) - Aeration (BDN) - Coagulation and sedimentation	Moderate
Catchment and Abstraction	ALL	All chemicals	- Coal seam gas industry within	High		High
Catchment and Abstraction	CBN	Taste and odour	- Algal bloom	High	- Dam aeration - Weekly algal count and identification - Council notifications - PAC dosing - Algaecide dosing (when required)	High
Catchment and Abstraction	BDN	Taste and odour	- Naturally occurring sulphide	Very High	- Aeration - Detection by operators during normal operation	Low

Aeration and oxidation	MDN	Manganese	- Overdosing KMNO4 (pink water) - Lack of SOP for batching - Incorrect dosing adjustment on SCADA	High	- Operator trai[illegible]xperience - Daily monitorin[illegible] - Interlocks with raw water pumps	Moderate
Coagulation and Flocculation	MDN BWY CBN BDN	Pathogens	Incorrect dosing of coagulant: - Highly turbid water - incorrect pH (underdosing/overdosing soda ash/lime/[illegible]lant) - loss of control - alum pump failure	Very High	- D[illegible]y testing (drop tests) and inspections - Jar t[illegible]ing (as required) - O[illegible]rator training and experience - pH and turbidity monitoring - visual inspection - duty standby pumps - chlorine dosing - filtration/sedimentation/clarification	High
Clarification/ Sedimentation	BDN CBN MDN BWY	Turbidity/Colour	BDN - Clarifier CBN/MDN/BWY - Sedimentation processes - incorrect coagulant dosing - flooding - short circuiting - wildlife access may lead to remobilisation of sediments	High	- Alternating lagoons when turbidity increases above set point - Operator training and experience - Visual inspections - Jar testing for coagulant - established vegetation to resist lagoon erosion - Daily testing turbidity/colour/pH - Filtration (BDN, CBN, MDN, BWY)	Moderate
Clarification/ Sedimentation	MDN BWY CBN BDN	All pathogens	- Wildlife cross contamination - Clarification failure (BDN) - sedimentation failure (BWY, MDN, CBN)	Very High	- Daily testing on turbidity/pH/colour - Operator training and experience - Jar testing for coagulant - Chlorine dosing - Filtration (BDN, CBN, MDN, BWY)	High

Filtration	MDN CBN BDN	All pathogens	- Incorrect filter media - Failed pressure transducer, incorrect headloss set point - incorrect backwashing, failed level sensors - not replacing filter media when required - Operator error or vandalism via dropping material into the filters blocking outlet, inhibiting backwash (leads to ineffective treatment) - Compressor failure leading to insufficient pressure to wash - Sedimentation/clarification failure leading to high turbidity	Very High	- Time/head loss backwash (MDN/CBN) - Routine backwash x2 week (summer), x1 (winter) (BWY) - High turbidity from filtered water leading to manual backwash. Continual high turbidity will result in filter replacement - Daily backwash, timer and head loss backup (BDN) - Maintenance procedures (i.e. backwash blowers, cleaning instruments - not documented) - Operator experience and training - Flow meter on air line for blowers - Annual calibration of the pressure gauges - Routine inspection of equipment (i.e. checking for breakthrough, blockages of nozzles) - chlorine dosing - Online turbidity meter (CBN) on outlet of filters	High
Filtration	BWY	All pathogens	- Incorrect filter media - Failed pressure transducer, incorrect headloss set point - incorrect backwashing, failed level sensors - not replacing filter media when required - Operator error or vandalism via dropping material into the filters blocking outlet, inhibiting backwash (leads to ineffective treatment) - Compressor failure leading to insufficient pressure to wash - Sedimentation/clarification failure leading to high turbidity	Very High	- Time/head loss backwash (MDN/CBN) - Visual inspection to identify low level in balance tank indicate (BWY) - Routine backwash x2 week (summer), x1 (winter) (BWY) - High turbidity from filtered water leading to manual backwash. Continual high turbidity will result in filter replacement - Maintenance procedures (i.e. backwash blowers, cleaning instruments - not documented) - Operator experience and training - Flow meter on air line for blowers - Annual calibration of the pressure gauges - Routine inspection of equipment (i.e. checking for breakthrough, blockages of nozzles) - chlorine dosing - Online turbidity meter (CBN) on outlet of filters	Very High
pH correction	CBN BWY BDN	All Pathogens	Overdosing of lime or soda ash creating operational issues. Caused by high pH as a result of: - pH calibration failure - broken pipe - incorrect calibration of pH meters - raw water source quality - incorrect batching This leads to less efficient treatment from disinfection due to reduced presence of hypochlorite.	Very High	- pH meters regularly calibrated - drop test - visual inspections - pH meters - daily sampling and testing - operator training and experience - disinfection	High

Disinfection (Chlorine Dosing and Contact Vessels)	ALL	Chlorine sensitive pathogens	Under dosing from: - incorrect chlorine set point - operator error - instrumentation/equipment failure/incorrect calibration or running out of Chlorine Gas resulting in inadequate disinfection to control pathogens (system is not interlocked with chlorine pumps) - Air lock in the NaOCl or blockage from crystalisation - varying water quality i.e. turbidity, pH (due to manual water quality monitoring) - poor quality/incorrect concentration of chlorine - incorrect pH may affect chlorine residual - dilution batching (BUG, KBI, MDN)	Very High	- Operator training and experience - Daily chlorine residual testing after 20-30mins detention time (leaving plant and in reticulation) - Calibration of instruments	Very High
Disinfection (Chlorine Dosing and Contact Vessels)	ALL	Taste & Odour	Operating systems to achieve adequate chlorine through system. Overdosing of chlorine from: - incorrect chlorine set point - operator error - instrumentation/equipment fai - varying water quality i.e. t pH (due to ual w quality monitoring) - new hyperchlorite b h, incorrect set poin - poor mixing or s t c iting - incorrect on tration of chlorine	High	- Operator training and experience - Daily chlorine residual testing after 20-30mins detention time (leaving plant and in reticulation) - Calibration of instruments - Injection into the line prior to clear water tank (except CBN)	Moderate
Fluoride	CBN BDN	Fluoride	Overdosing o oride from: - incorrect set point - operator error - complex water qua sting - instrumenta e/e nt failure - poor mixing, t circuiting - incorrect entration of chemicals - fluoride filter breakthrough ities in fluoride	High	- Operator training and experience - Fluoride ticket required - x2 trained operators required per system, min. x3 between 2 towns/systems - Monthly sampling sent to lab (retic) - Daily plant sampling - Weekly retic sampling - Daily calibration - If lab samples results differ +/- 20% from councils results, NSW Health/PHU notified. NSW Health will notify council - Council has access to NSW Drinking Water Database	Moderate

Reservoirs	ALL	All pathogens and all chemicals	Vermin and stormwater ingress: - unlocked hatches/poorly fitting hatches - inadequate netting - poor integrity of the roof - damage due to storm events - access via scour lines/overflow - Stormwater ingress leading to contamination from faecal matter from birds. - Malicious contamination or access to reservoir by unauthorised personnel leading to water contamination. - Malicious contamination or access to reservoir by unauthorised personnel leading to water contamination. BDN: - Holes in floor of plant allowing vermin ingress to clear water tank	Very High	- Current tender process soon to commence (planned joint project with LMWUA) for reservoir inspection and cleaning and future reservoir inspections - Lockable hatches, netting, roofing - Lockable ladders and removable ladders - Security fencing around reservoirs - Community notification	Very High
Reservoirs	CBN MDN BDN	All pathogens	- Stratification of reservoirs leading to low chlorine	Very High	- Staff experience and training - Chlorine residual monitoring within reticulation system	Very High
Reservoirs	ALL	Turbidity, suspended material, Taste and Odour	Disturbance of sediments due to: - low volumes and then refilling - Inadequate/infrequent cleaning of tanks - Incorrect filling sequence	High	- Aqualift inspection and report (in the past, not ongoing) - Reservoir cleaning program (not currently in place; currently a tender process, soon to commence planned joint project with LMWUA for reservoir inspection and cleaning)	High
Distribution	ALL	All pathogens and all chemicals	- Ingress of contaminates due to back flow or cross connections (including property illegal connections) - Illegal connection to standpipes - Improper practices by water carters - Backflow from tankers filling from inappropriate locations on the system	Very High	- Locks on standpipes - Backflow prevention devices on standpipes - Community notification of illegal connections, illegal water carter filling - Hydrant (and stop valve) maintenance in place	High

Distribution	ALL	All pathogens and all chemicals	- Mains breaks or unsanitary repairs leading to WQ issues including cross contamination of main repair equipment e.g. Sewer/Water. - Not chlorinating after a main break - Incorrect flushing procedures after a main break - Inappropriate storage of new pipework prior to installation. - Incorrect valve operation or valve failures leading to ingress of contaminates due to loss of pressure. - Unsanitary commissioning of a new main - Lack of flushing leading to high turbidity resulting in hig[illegible] take up - Oxidation of infrastructure inside reservoir leadin[illegible] chlorine residual	Very High	- Operator training and experience - Sepa[illegible] water and sewer tools - D[illegible]g SWMS - Flus[illegible]g of mains after repair - M[illegible]taining chlorine residuals and monitoring	Very High
Distribution	ALL	Turbidity	- Dead ends in reticulation - Incorrect/lack of flushing	High	- Operator training and experience - Flushing program (CBN, currently on hold) - Reactive flushing to customer compliants - Developing flushing schedule - Mains replacement	Moderate
Whole of system	ALL	Various	- Entry of unauthorised persons leading to accidental or deliberate sabotage - Contractors/unauthorised staff have unsupervised access to treatment plants and reservoirs	Very High	- Security fencing - Lockable buildings - Community notifying council of any security breaches - Contractor entry under supervision	High
Whole of system	ALL	Various	- Extreme weather events: e.g. bushfire, flood	Very High	- Secondary supply - Water carting - Double treating in high turbidity events (CBN) - Water treatment processes - Borehead integrity (BDN)	High
Whole of system	ALL	All chemicals	- Incorrect chemical delivery (quality assurance, type) - Tank filled with incorrect chemical	Very High	- Staff need to be onsite to accept delivery - Labelling of containers/walls - Sighting delivery docket	Very High

Whole of system	MDN BWY BDN	ALL	Staff management: - Loss of skilled staff - Other responsibilities pulling operators away from key water management duties - Reporting structure creates confusion for staff and limits the ability of the manager to the direct staff to perform water/wastewater duties - Communication is inhibited by current structure which may pose risk during emergency events	Very High	- Agreement between water manager and urban services around staff management	Very High
Whole of system	ALL	Various	- There is not enough water for consumption and household needs, continuously, seasonally or in parts of distribution systems.	Very High	- Drought management plan - Accredited water carters - Water restrictions	High
Monitoring and Management System	ALL	Various	Lack of DWMS including: - SOPs - Operator training - Maintenance practices - Location of water quality monitoring sample points not being representative of whole of system. - Succession planning - Calibration of instrumentation - Qualified contractors and consultants - emergency response procedure - chemical delivery procedures	Very High	- Development of DWMS and implementation of the DWMS - All of the above	Very High

2.3.6 Periodically review and update

This document was accurate at time of writing and has been verified by all workshop participants. This document will need to be periodically reviewed and updated. An annual internal review should be undertaken, with any significant system changes captured in the new review.

A formal review and audit program should be developed in consultation with NSW Health.

3.0 Element 3 – Preventive Measures for Drinking Water Quality Management

This section documents the process for assessing the existing preventive measures in place and additional required preventive measures to mitigate drinking water quality risks. Figure 55 outlines the actions as specified in the ADWG.

3.1 Preventive measures and multiple barriers

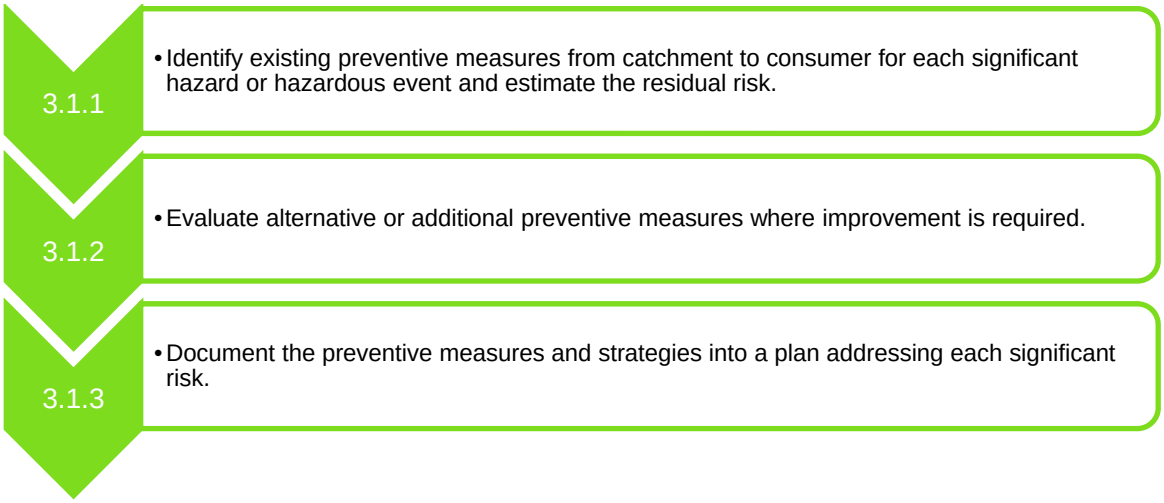

Figure 55 Preventive Measures and Multiple Barriers Actions [ADWG 3.3.1]

3.1.1 Identify existing preventive measures for each significant hazard or hazardous event and estimate the residual risk

Council currently has various preventive measures in place to control or reduce the risks to water quality within its water supply system. These measures were identified during the risk assessment workshop and have been recorded in **Appendix D**. The risk assessment considered these preventive measures when evaluating the residual risk.

3.1.2 Evaluate alternative or additional preventive measures where improvement is required

Council has developed preventive measures to address particular hazards within the water supply systems. Risk management is a process of continual improvement and adaptation. Through the workshop discussion additional preventive measures that may assist in more effectively managing the risk to the systems were identified and recorded. These additional preventive measures are provided in the risk assessment worksheet in **Appendix D**. Some of these additional preventive measures require immediate action.

3.1.3 Document the preventive measures and strategies into a plan addressing each significant risk

The preventive measures for addressing the significant health related risks were addressed as part of the CCP identification process (refer to section 3.2 for further details).

3.2 Critical control points

This section documents the CCPs identified for the water supply systems and the mechanisms for their operational control, including: monitoring systems, operating targets, Alert Levels (ALs) and Critical Limits (CLs) applied. Corrective actions to respond to a breach of AL or CL will also be discussed. Figure 56 outlines the actions as specified in the ADWG.

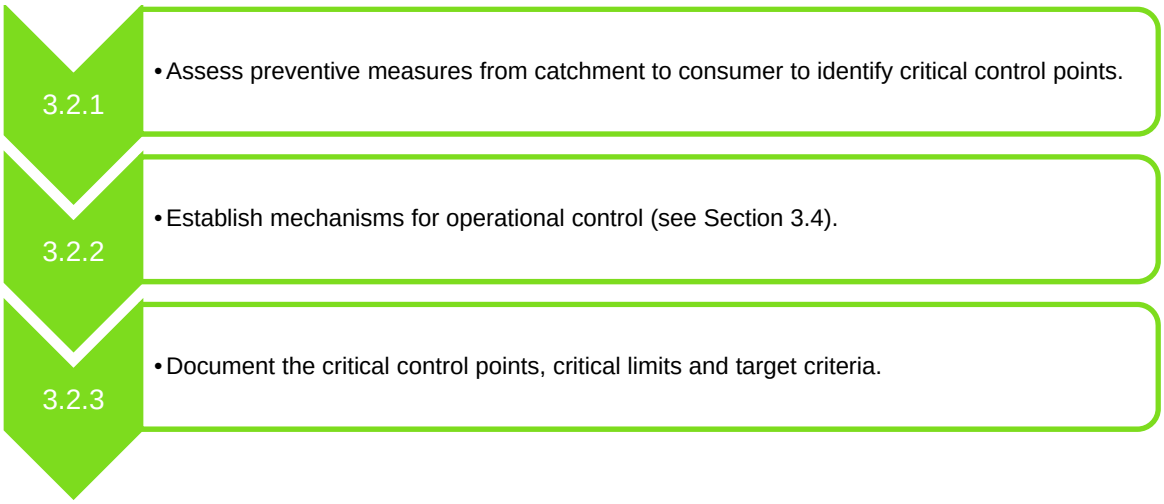

Figure 56 Critical control point actions [ADWG, Chapter 3.3.2]

3.2.1 Assess preventive measures from catchment to consumer to identify critical control points

Unmitigated risks found to be significant (i.e. rated *High* or *Very High*), were carried through to the CCP evaluation process.

A **critical control point** is defined as an activity, procedure or process at which control can be applied and which is essential to prevent a hazard or reduce it to an acceptable level.

A critical control point has several operational requirements, including:

- Operational parameters that can be measured and for which critical limits can be set to define the operational effectiveness of the activity (e.g. chlorine residuals for disinfection)
- Operational parameters that can be monitored frequently enough to reveal any failures in a timely manner (online and continuous monitoring is preferable)
- Procedures for corrective action that can be implemented in response to deviation from critical limits.

The *Decision Tree to Identify Critical Control Points* taken from the ADWG, 2011 (shown in Figure 57) was used to determine which activities or process steps may be considered a CCP. The group collectively assessed each risk using this flowchart to determine the CCPs in the systems.

Following this identification process, controls and/or parameters were identified to manage each CCP. Appropriate operating targets, ALs and CLs were then discussed and agreed upon.

Critical control limits are performance criteria that separate acceptability from unacceptability in terms of hazard control and water safety.

'Targets' are performance goals from which any deviation can be regarded as a trend towards loss of control. Setting target criteria that are more stringent than critical limits will enable corrective actions to be implemented before an unacceptable health risk occurs

'Alert levels' are levels that trigger corrective action. Setting alert levels should ensure that target performance is maintained.

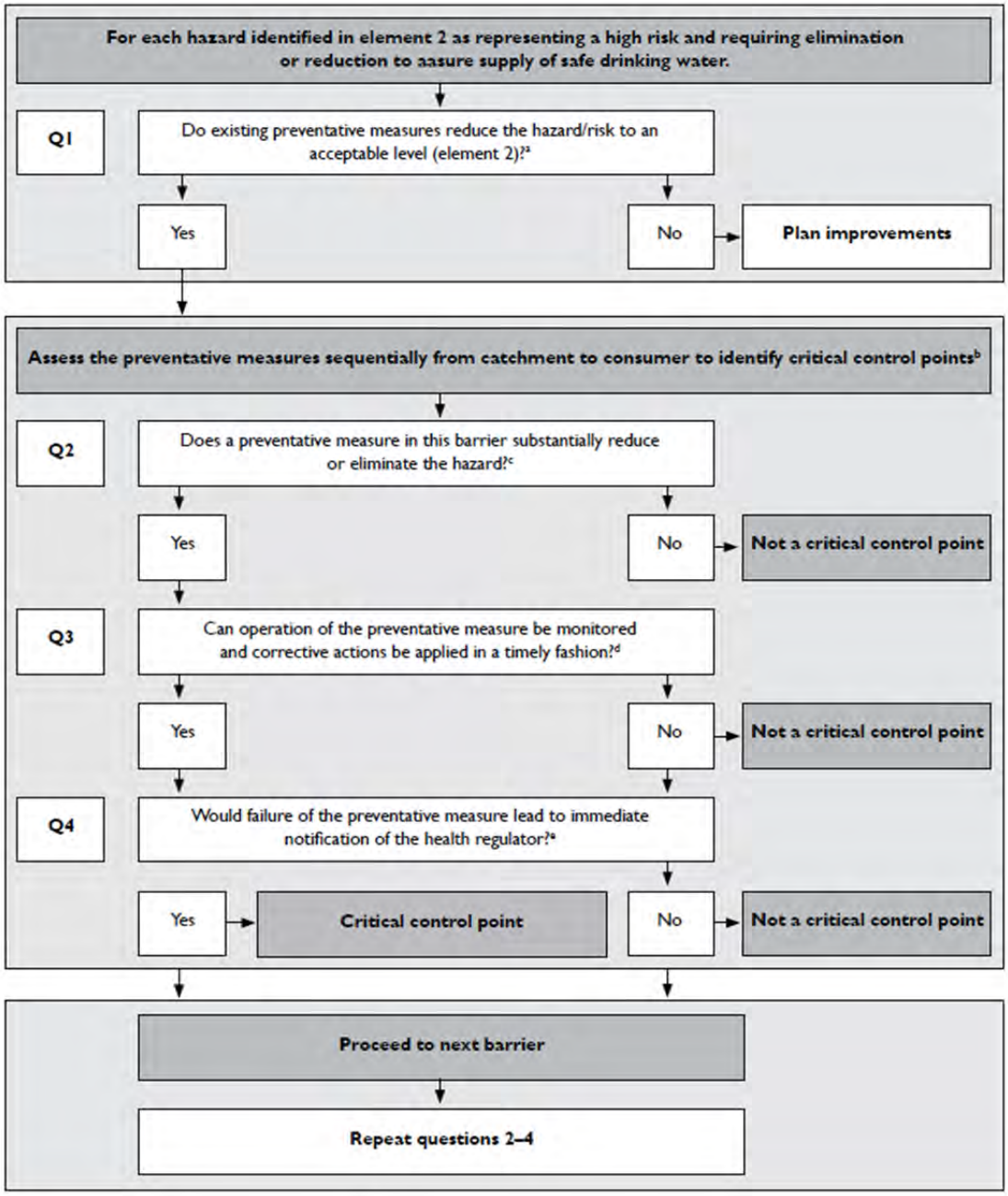

Figure 57 ADWG (2011) Decision Tree to Identify Critical Control Points (Figure A1.2)

3.2.2 Establish mechanisms for operational control

During the workshop, corrective actions were identified for each CCP. These actions were based on a breach of an AL or CL. This was recorded in the risk assessment spreadsheet, and has been documented as part of the worksheet developed for each CCP (refer to **Appendix E**).

3.2.3 Document the critical control points, critical limits and target criteria

Table 17 provides an overview of the CCPs and their operating targets, ALs and CLs. These limits were developed during the workshop, and are also included against response actions (provided in **Appendix E**).

Table 17 CCPs and associated parameters and limits

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Baradine	BDN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BDN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	1.2 mg/L	<1.0 mg/L
	BDN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BDN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and rectify immediate problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Bugaldie	BUG1	Disinfection (Hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	< 1.3 mg/L	< 1.0 mg/L
	BUG2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in netting)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BUG3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to rectify problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Binnaway	BWY1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BWY2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 mg/L	1.5 mg/L	<1.2 mg/L
	BWY3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatch is closed, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BWY4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain level equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coonabarabran	CBN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	CBN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 – 5.0 mg/L	1.8 mg/L	<1.5 mg/L
	CBN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatch is closed, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CBN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain level equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coolah	CLH1	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	CLH2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in netting)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CLH3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	≤1.0 mg/L	0.8 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to rectify problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Dunedoo	DDO1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.2 mg/L	<1.0 mg/L
	DDO2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in netting)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	DDO3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	≤1.0 mg/L	0.8 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to rectify problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Kenebri	KBI1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	KBI2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in netting)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	KBI3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to rectify problem.

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Mendooran	MDN1	Filtration	All pathogens	Turbidity	<0.5 NTU	>0.8 NTU	>1.0 NTU
	MDN2	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.6 mg/L	1.2 mg/L	≤1.0 mg/L
	MDN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatch is closed, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	MDN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	>0.5 mg/L	<0.3 mg/L	0.1 mg/L

Target	This is where you want your system to be operating. Try to maintain level equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

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Appendix A

Water Quality Compliance Table

Appendix A – Water Quality Compliance Table

Table A1 **Water Quality Compliance for ADWG Health Characteristics**

		Microbiological ADWG Health			Chemical ADWG Health																					
	YEAR	E. Coli	Total Coliforms	Turbidity	pH	Antimony	Arsenic	Barium	Boron	Cad-mium	Free Chlorine (<5mg/L)	Free Chlorine (>0.2mg/L)	Total Chlorine	Chromium	Copper	Fluoride	Iodide	Lead	Manganese	Mercury	Molybdenum	Nickel	Nitrate	Nitrite	Selenium	Silver	Sulfate
Baradine	2009	100% (39)	97% (39)	100% (1)	100% (17)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (16)	88% (16)	-	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	100% (47)	100% (47)	100% (3)	100% (47)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (46)	96% (46)	-	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	100% (50)	94% (50)	100% (4)	98% (46)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (45)	91% (45)	100% (36)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2012	98% (50)	96% (50)	100% (1)	100% (40)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (42)	93% (42)	100% (40)	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (45)	98% (45)	100% (6)	100% (40)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (37)	92% (37)	100% (37)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2014	100% (9)	100% (9)	-	100% (9)	-	-	-	-	-	100% (9)	100% (9)	100% (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bugaldie	2009	90% (10)	90% (10)	100% (1)	75% (4)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	67% (3)	100% (3)	-	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	100% (12)	100% (12)	100% (2)	100% (14)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (12)	75% (12)	-	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	100% (11)	100% (11)	60% (5)	100% (15)	100% (4)	100% (4)	100% (4)	100% (4)	100% (4)	100% (11)	82% (11)	100% (8)	100% (4)	100% (4)	100% (4)	-	50% (4)	100% (4)	100% (4)	100% (4)	100% (4)	100% (4)	100% (4)	100% (4)	100% (4)	100% (4)
	2012	100% (12)	75% (12)	100% (1)	100% (13)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (12)	75% (12)	100% (11)	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (12)	100% (12)	100% (4)	100% (12)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (9)	67% (9)	100% (10)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2014	100% (2)	100% (2)	-	100% (2)	-	-	-	-	-	100% (2)	100% (2)	100% (2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Binnaway	2009	100% (20)	80% (20)	100% (1)	100% (11)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (10)	30% (10)	-	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	100% (24)	75% (24)	100% (2)	100% (25)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (23)	35% (23)	-	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	100% (26)	85% (26)	100% (3)	100% (26)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (24)	46% (24)	100% (19)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2012	100% (23)	96% (23)	-	100% (19)	-	-	-	-	-	100% (19)	47% (19)	100% (19)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2013	100% (22)	95% (22)	100% (5)	94% (18)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (16)	69% (16)	94% (17)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2014	100% (5)	100% (5)	-	100% (5)	-	-	-	-	-	100% (5)	100% (5)	100% (5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coolah	2009	97% (39)	77% (39)	100% (1)	100% (21)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (20)	65% (20)	-	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	98% (47)	60% (47)	100% (4)	100% (49)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (46)	33% (46)	-	100% (3)	100% (3)	100% (3)	-	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)
	2011	100% (50)	98% (50)	100% (4)	98% (48)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	98% (46)	87% (46)	100% (37)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2012	100% (52)	88% (52)	100% (1)	100% (42)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (40)	85% (40)	100% (38)	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (47)	98% (47)	100% (9)	100% (41)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (38)	82% (38)	100% (39)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2014	100% (9)	100% (9)	-	100% (9)	-	-	-	-	-	100% (9)	100% (9)	100% (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

		Microbiological ADWG Health			Chemical ADWG Health																				
	YEAR	E. Coli	Total Coliforms	Turbidity	pH	Antimony	Arsenic	Barium	Boron	Cad-mium	Free Chlorine (<5mg/L)	Free Chlorine (<0.2mg/L)	Total Chlorine	Chromium	Copper	Fluoride	Iodide	Lead	Man-ganese	Mercury	Moly-bdenum	Nickel	Nitrate	Nitrite	Selenium	Silver	Sulfate
Coonabara-bran	2009	100% (40)	83% (40)	100% (1)	100% (17)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (16)	6% (16)	-	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	94% (51)	80% (51)	100% (2)	100% (49)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (49)	49% (49)	-	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	98% (57)	96% (57)	100% (5)	98% (54)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (51)	55% (51)	100% (41)	100% (3)	100% (3)	100% (3)	-	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)
	2012	100% (50)	92% (50)	100% (1)	100% (40)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (40)	60% (40)	100% (38)	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (46)	91% (46)	80% (10)	100% (42)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (37)	70% (37)	100% (37)	100% (3)	100% (3)	100% (4)	-	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)
	2014	100% (9)	100% (9)	-	100% (9)	-	-	-	-	-	100% (9)	89% (9)	100% (9)	-	-	100% (1)	-	-	-	-	-	-	-	-	-	-	-
Dunedoo	2009	100% (39)	100% (39)	100% (1)	95% (20)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	94% (18)	39% (18)	-	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	98% (47)	89% (47)	100% (3)	100% (48)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (45)	24% (45)	-	100% (3)	100% (3)	100% (3)	-	67% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)
	2011	100% (50)	100% (50)	100% (4)	100% (48)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (46)	98% (46)	100% (37)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2012	100% (50)	98% (50)	50% (2)	100% (42)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (42)	95% (42)	100% (40)	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (46)	98% (46)	100% (7)	100% (38)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (37)	97% (37)	100% (37)	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2014	100% (9)	100% (9)	-	100% (9)	-	-	-	-	-	100% (9)	100% (9)	100% (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kenebri	2009	100% (10)	100% (10)	100% (1)	100% (5)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (4)	50% (4)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	100% (12)	75% (12)	100% (2)	93% (14)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (12)	58% (12)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	100% (12)	83% (12)	100% (4)	100% (13)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (11)	64% (11)	100% (7)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2012	92% (13)	85% (13)	100% (1)	100% (11)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (9)	78% (9)	100% (9)	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (12)	100% (12)	100% (3)	100% (12)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (7)	71% (7)	100% (10)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2014	100% (2)	100% (2)	-	100% (2)	-	-	-	-	-	100% (2)	100% (2)	100% (2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mendooran	2009	85% (20)	25% (20)	0% (1)	100% (11)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (8)	25% (8)	-	100% (1)	100% (1)	100% (1)	-	100% (1)	0% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	86% (29)	72% (29)	67% (3)	100% (29)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (26)	46% (26)	-	100% (3)	100% (3)	100% (3)	-	100% (3)	67% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)
	2011	89% (27)	74% (27)	100% (3)	100% (25)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (23)	57% (23)	100% (19)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2012	96% (27)	89% (27)	100% (1)	100% (21)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (20)	75% (20)	100% (19)	100% (1)	100% (1)	100% (1)	-	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (25)	88% (25)	100% (5)	96% (23)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (20)	90% (20)	100% (20)	100% (2)	100% (2)	100% (2)	-	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2014	100% (4)	100% (4)	-	100% (3)	-	-	-	-	-	100% (3)	100% (3)	100% (3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A2 Water Quality Compliance for ADWG Aesthetic Characteristics

		Chemical ADWG Aesthetic										
	YEAR	Aluminium	Calcium	Chloride	Iodine	Iron	Magnesium	Sodium	Total Dissolved Solids (TDS)	Total Hardness as CaCO3	True Colour	Zinc
Baradine	2009	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2012	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2014	-	-	-	-	-	-	-	-	-	-	-
Bugaldie	2009	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	100% (4)	100% (4)	100% (4)	100% (4)	50% (4)	100% (4)	100% (4)	100% (4)	100% (4)	100% (4)	100% (4)
	2012	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2014	-	-	-	-	-	-	-	-	-	-	-
Binnaway	2009	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	50% (2)	100% (2)	100% (2)
	2012	-	-	-	-	-	-	-	-	-	-	-
	2013	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	50% (2)	100% (2)	100% (2)
	2014	-	-	-	-	-	-	-	-	-	-	-
Coolah	2009	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	0% (1)	100% (1)	100% (1)
	2010	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	0% (3)	100% (3)	100% (3)
	2011	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	0% (2)	100% (2)	100% (2)
	2012	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	0% (1)	100% (1)	100% (1)
	2013	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	0% (2)	100% (2)	100% (2)
	2014	-	-	-	-	-	-	-	-	-	-	-

Table A3 – Compliance Legend

Compliance	Colour
100%	
75-99%	
51-74%	
0-50%	
No limiting value	
No of samples	-
Percentage of passing samples, X Number of samples, Y	X % (Y)

		Chemical ADWG Aesthetic										
	YEAR	Aluminium	Calcium	Chloride	Iodine	Iron	Magnesium	Sodium	Total Dissolved Solids (TDS)	Total Hardness as CaCO3	True Colour	Zinc
Coonabarabran	2009	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	100% (3)	100% (3)	100% (3)	100% (3)	67% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)
	2012	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	67% (3)	100% (3)	100% (3)	100% (3)	33% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)
	2014	-	-	-	-	-	-	-	-	-	-	-
Dunedoo	2009	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	0% (1)	0% (1)	100% (1)	100% (1)
	2010	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	67% (3)	0% (3)	100% (3)	100% (3)
	2011	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	0% (2)	0% (2)	100% (2)	100% (2)
	2012	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	0% (1)	100% (1)	100% (1)
	2013	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	0% (1)	100% (1)	100% (1)
	2014	-	-	-	-	-	-	-	-	-	-	-
Kenebri	2009	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2010	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2011	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	50% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2012	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)
	2014	-	-	-	-	-	-	-	-	-	-	-
Mendooran	2009	100% (1)	100% (1)	100% (1)	100% (1)	0% (1)	100% (1)	100% (1)	100% (1)	0% (1)	100% (1)	100% (1)
	2010	100% (3)	100% (3)	100% (3)	100% (3)	67% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)	100% (3)
	2011	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	50% (2)	100% (2)	100% (2)
	2012	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)	100% (1)
	2013	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	100% (2)	50% (2)	50% (2)	100% (2)	100% (2)
	2014	-	-	-	-	-	-	-	-	-	-	-

Appendix B

Statistical Analysis

Appendix B – Statistical Analysis

Table B1 Statistical Analysis of ADWG Health Characteristics (2008 to 2013)

	Microbiological ADWG Health		Chemical ADWG Health																				
	E. Coli	Total Coliforms	Turbidity	pH	Antimony	Arsenic	Barium	Boron	Cad-mium	Free Chlori ne	Total Chlorine	Chromium	Copper	Fluoride	Iodide	Lead	Manganese	Mercury	Molyb-denum	Nickel	Nitrate	Nitrite	Sele-nium	Silver	Sul-fate
Baradine																									
Number of Exceedences	1	7	0	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Number of samples	240	240	15	199	8	8	8	8	8	195	122	8	8	8	-	8	8	8	8	8	8	8	8	8	8
Max Value	4	43	0.98	8.63	0.0005	0.0005	0.112	0.05	0.00025	2.92	2.93	0.0025	0.056	0.22	-	0.002	0.0025	0.00005	0.0025	0.005	0.5	0.6	0.001	0.001	5
Mean Value	0.51	0.78	0.29	7.87	0.001	0.001	0.09	0.05	0.0003	0.96	1.10	0.0025	0.01	0.18	-	0.001	0.003	0.0001	0.003	0.01	0.50	0.12	0.001	0.001	4.13
StdDev of Values	0.23	2.86	0.37	0.27	0	0	0.02	9.96E-10	0	0.43	0.47	3.11E-11	0.02	0.04	-	3.5E-4	3.11E-11	0	3.1E-11	6.2E-11	0	0.19	0	0	0.35
Bugaldie																									
Number of Exceedences	1	4	2	1	0	0	0	0	0	1	0	0	0	0	-	2	0	0	0	0	0	0	0	0	0
Number of samples	59	59	13	60	10	10	10	10	10	49	31	10	10	10	-	10	10	10	10	10	10	10	10	10	10
Max Value	1	400	25.3	8.11	0.0005	0.001	0.096	0.05	0.00025	6.46	2.2	0.0025	0.037	0.42	-	0.036	0.0025	0.00005	0.0025	0.005	1.2	0.05	0.001	0.001	3
Mean Value	0.51	7.40	3.11	6.87	0.001	0.001	0.08	0.050	0.00025	0.70	0.76	0.0025	0.02	0.34	-	0.01	0.003	0.0001	0.003	0.01	1.03	0.05	0.001	0.001	2.10
StdDev of Values	0.07	52.00	7.32	0.95	0	0	0.01	1.24E-09	0	0.96	0.56	5.49E-11	0.01	0.04	-	0.01	5.49E-11	0	5.5E-11	1.1E-10	0.07	1.2E-9	0	0	0.32
Binnaway																									
Number of Exceedences	0	16	0	1	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Number of samples	120	120	11	104	7	7	7	7	7	97	60	7	7	7	-	7	7	7	7	7	7	7	7	7	7
Max Value	0.5	41	1.8	768	0.0005	0.001	0.167	0.05	0.00025	1.76	7	0.0025	0.129	0.26	-	0.003	0.037	0.00005	0.0025	0.005	1.6	0.05	0.004	0.001	67
Mean Value	0.50	1.68	0.41	14.94	0.001	0.001	0.12	0.05	0.00025	0.42	0.79	0.0025	0.03	0.18	-	0.001	0.01	0.0001	0.0025	0.01	0.73	0.05	0.001	0.001	52.6
StdDev of Values	0	5.39	0.54	74.56	0	0	0.03	7.6E-10	0	0.43	0.97		0.05	0.08	-	7.6E-4	0.01				0.43	7.6E-10	1.13E-3		11.7
Coolah																									
Number of Exceedences	2	36	0	1	0	0	0	0	0	1	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Number of samples	244	244	19	210	9	9	9	9	9	199	123	9	9	9	-	9	9	9	9	9	9	9	9	9	9
Max Value	3	400	2.2	8.3	0.0005	0.001	0.018	0.05	0.00025	7.53	2.97	0.005	0.174	0.14	-	0.01	0.0025	0.0001	0.0025	0.005	5.1	0.05	0.002	0.001	6
Mean Value	0.51	7.47	0.47	7.48	0.0005	0.001	0.017	0.050	0.0003	0.90	1.24	0.003	0.06	0.09	-	0.0027	0.0025	0.0001	0.0025	0.01	4.80	0.05	0.001	0.001	5.11
StdDev of Values	0.16	45.47	0.57	0.48	0	0	0.001	1.14E-09	0	0.86	0.70	0.001	0.06	0.04	-	0.0029	4.12E-11	1.67E-05	4.1E-11	8.2E-11	0.46	1.14E-9	3.33E-4	0	0.60
Coonabarabran																									
Number of Exceedences	4	27	2	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Number of samples	253	253	19	211	10	10	10	10	10	202	125	10	10	12	-	10	10	10	10	10	10	10	10	10	10
Max Value	3	130	29	8.7	0.0005	0.001	0.059	0.05	0.00025	2.02	2.16	0.0025	0.042	1.24	-	0.001	0.191	0.00005	0.0025	0.005	3.6	0.1	0.001	0.001	49
Mean Value	0.52	2.16	2.30	7.60	0.0005	0.0006	0.02	0.0500	0.0003	0.49	0.72	0.0025	0.01	0.46	-	0.00	0.03	0.00005	0.0025	0.01	1.45	0.06	0.001	0.001	33.2
StdDev of Values	0.17	10.55	6.67	0.42	0	0.0002	0.01	1.24E-09	0	0.49	0.57	5.49E-11	0.01	0.50	-	0.00	0.06		5.5E-11	1.1E-10	1.42	0.02	0	0	9.25
Dunedoo																									
Number of Exceedences	1	7	1	1	0	0	0	0	0	1	0	0	0	0	-	1	0	0	0	0	0	0	0	0	0
Number of samples	241	241	17	205	8	8	8	8	8	197	123	8	8	8	-	8	8	8	8	8	8	8	8	8	8
Max Value	1	62	7.41	8.01	0.0005	0.004	0.089	0.1	0.00025	7.38	3.23	0.008	0.276	0.75	-	0.013	0.007	0.00005	0.0025	0.005	2	0.05	0.005	0.001	23
Mean Value	0.50	0.80	0.91	7.40	0.001	0.002	0.086	0.09	0.0003	1.10	1.69	0.004	0.06	0.66	-	0.0028	0.0031	0.0001	0.0025	0.01	1.14	0.05	0.002	0.001	21.7
StdDev of Values	0.03	3.98	1.72	0.55	0	0.001	0.002	0.02	0	0.94	0.63	0.002	0.09	0.06	-	0.0042	0.0016	0	3.1E-11	6.2E-11	0.35	9.9E-10	0.001	0	1.04

	Microbiological ADWG Health		Chemical ADWG Health																					
	E. Coli	Total Coliforms	Turbidity	pH	Antimony	Arsenic	Barium	Boron	Cad-mium	Free Chlorine	Total Chlorine	Chromium	Copper	Fluoride	Iodide	Lead	Manganese	Mercury	Molyb-denum	Nickel	Nitrate	Nitrite	Sele-nium	Silver	Sul-fate
Kenebri																									
Number of Exceedences	1	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of samples	61	61	11	57	8	8	8	8	8	45	28	8	8	8	5	8	8	8	8	8	8	8	8	8	8
Max Value	6	400	1.7	8.85	0.001	0.003	0.237	0.1	0.00025	1.6	2.2	0.0025	0.016	0.32	0.01	0.002	0.0025	0.00005	0.0025	0.005	1.7	0.05	0.003	0.001	13
Mean Value	0.59	8.74	0.49	7.25	0.001	0.002	0.21	0.09	0.00025	0.51	0.64	0.0025	0.01	0.28	0.01	0.001	0.003	0.000	0.003	0.01	1.13	0.05	0.001	0.001	12.00
StdDev of Values	0.70	51.48	0.50	0.39	0	0.001	0.02	0.02	0	0.43	0.55	3.11E-11	4.3E-03	0.03		4.6E-4	3.11E-11		3.1E-11	6.2E-11	0.25	9.9E-10	0.001		0.53
Mendooran																									
Number of Exceedences	11	36	2	1	0	0	0	0	0	0	0	0	0	0	-	0	2	0	0	0	0	0	0	0	0
Number of samples	132	132	13	112	9	9	9	9	9	100	61	9	9	9	-	9	9	9	9	9	9	9	9	9	9
Max Value	3	400	2.2	8.3	0.0005	0.001	0.018	0.05	0.00025	7.53	2.97	0.005	0.174	0.14	-	0.01	0.0025	0.0001	0.0025	0.005	5.1	0.05	0.002	0.001	6
Mean Value	0.51	7.47	0.47	7.48	0.0005	0.0009	0.02	0.05	0.00	0.90	1.24	0.003	0.06	0.09	-	0.0027	0.0025	0.0001	0.0025	0.01	4.80	0.05	0.001	0.001	5.11
StdDev of Values	0.16	45.47	0.57	0.48	0	0.0002	0.001	1.14E-09	0	0.86	0.70	0.001	0.06	0.04	-	0.0029	4.1E-11	1.7E-05	4.1E-11	8.2E-11	0.46	1.14E-9	3.33E-4	0	0.60

Table B2 Statistical Analysis of ADWG Aesthetic Characteristics (2008 to 2013)

	Chemical ADWG Aesthetic										
	Aluminium	Calcium	Chloride	Iodine	Iron	Magnesium	Sodium	Total Dissolved Solids (TDS)	Total Hardness as CaCO3	True Colour	Zinc
Baradine											
Number of Exceedences	0	0	0	0	0	0	0	0	0	0	0
Number of samples	8	8	8	8	8	8	8	8	8	8	8
Max Value	0.12	8.3	39	0.03	0.12	6.14	62	184	46	0.5	0.04
Mean Value	0.02	6.89	32.50	0.02	0.03	4.77	55.13	175.25	36.85	0.50	0.02
StdDev of Values	0.04	1.04	2.83	0.01	0.04	0.78	4.70	5.85	5.70	0	0.01
Bugaldie											
Number of Exceedences	0	0	0	0	2	0	0	0	0	0	0
Number of samples	10	10	10	10	10	10	10	10	10	10	10
Max Value	0.005	20	44	0.03	2.28	13.6	38	187	98.7	1	0.5
Mean Value	0.01	16.24	38.80	0.02	0.29	10.95	33.70	174.50	85.65	0.55	0.12
StdDev of Values	1.10E-10	2.21	2.62	4.83E-03	0.71	1.10	3.13	5.93	7.12	0.16	0.14
Binnaway											
Number of Exceedences	0	0	0	0	0	0	0	0	2	0	0
Number of samples	7	7	7	7	7	7	7	7	7	7	7
Max Value	0.15	44.5	152	0.03	0.1	32.41	85	522	244.6	1	0.05
Mean Value	0.04	34.31	84.57	0.02	0.04	21.54	63.57	348.57	174.40	0.71	0.02
StdDev of Values	0.05	8.71	39.42	0.01	0.04	6.68	19.89	109.48	48.27	0.27	0.02
Coolah											
Number of Exceedences	0	0	0	0	0	0	0	0	9	0	0
Number of samples	9	9	9	9	9	9	9	9	9	9	9
Max Value	0.01	75	62	0.01	0.18	64.04	39	487	451	1	0.08
Mean Value	0.01	70.61	59.44	0.01	0.04	60.05	36.67	479.11	423.62	0.56	0.04
StdDev of Values	1.67E-03	3.46	1.59	1.65E-10	0.06	2.25	1.80	4.88	16.69	0.17	0.02
Coonabarabran											
Number of Exceedences	1	0	0	0	3	0	0	0	0	0	0
Number of samples	10	10	10	10	10	10	10	10	10	10	10
Max Value	0.5	37.6	10	0.02	7.62	4.14	8	140	110.9	3	0.07
Mean Value	0.11	23.01	7.80	0.01	0.96	2.04	6.80	91.20	65.87	1.05	0.02
StdDev of Values	0.15	7.89	1.93	4.22E-03	2.37	1.15	1.40	23.16	24.08	0.72	0.02
Dunedoo											
Number of Exceedences	0	0	0	0	0	0	0	4	8	0	0
Number of samples	8	8	8	8	8	8	8	8	8	8	8
Max Value	0.005	75.8	173	0.08	0.22	55.25	114	630	406.8	1	0.07
Mean Value	0.01	66.06	165.50	0.07	0.04	51.12	105.25	560.63	375.49	0.56	0.02
StdDev of Values	6.22E-11	5.35	4.81	0.01	0.07	2.64	5.47	137.41	18.96	0.18	0.02

	Chemical ADWG Aesthetic										
	Aluminium	Calcium	Chloride	Iodine	Iron	Magnesium	Sodium	Total Dissolved Solids (TDS)	Total Hardness as CaCO3	True Colour	Zinc
Kenebri											
Number of Exceedences	0	0	0	0	0	0	1	0	0	0	0
Number of samples	8	8	8	8	8	8	8	8	8	8	8
Max Value	0.005	19.2	172	0.15	0.24	10.49	221	485	77.6	1	0.13
Mean Value	0.01	13.76	165.50	0.13	0.06	7.84	157.38	468.00	66.60	0.63	0.04
StdDev of Values	6.22E-11	3.13	6.57	0.01	0.08	1.14	27.88	10.97	8.46	0.23	0.04
Mendooran											
Number of Exceedences	0	0	0	0	2	0	0	1	3	0	0
Number of samples	9	9	9	9	9	9	9	9	9	9	9
Max Value	0.01	75	62	0.01	0.18	64.04	39	487	451	1	0.08
Mean Value	0.01	70.61	59.44	0.01	0.04	60.05	36.67	479.11	423.62	0.56	0.04
StdDev of Values	1.67E-03	3.46	1.59	1.65E-10	0.06	2.25	1.80	4.88	16.69	0.17	0.02

Appendix C

Warrumbungle Shire Council Water Quality Monitoring

Table 18 Council water quality monitoring (sourced from NSW Health database)

	Warrumbungle Shire Council		ADWG Guidelines 2011		
	Is Council Monitoring Characteristic?	If NO, does it have a health Guideline value?	Health	Aesthetic	Units
1,1,1-Trichloroethane	NO	NO	c		mg/L
1,1,1-trichloropropanone	NO	NO	c		mg/L
1,1,3-trichloropropanone	NO	NO	c		mg/L
1,1-dichloroethane	NO	NO	c		mg/L
1,1-dichloroethene	NO	YES	0.03		mg/L
1,1-dichloropropanone	NO	NO	c		mg/L
1,2-dichlorobenzene	NO	YES	1.5	0.001	mg/L
1,2-dichloroethane	NO	YES	0.003		mg/L
1,2-dichloroethene	NO	YES	0.06		mg/L
1,3-dichlorobenzene	NO	NO	c	0.02	mg/L
1,3-dichloropropanone	NO	NO	c		mg/L
1,3-Dichloropropene	NO	YES	0.1		mg/L
1,4-dichlorobenzene	NO	YES	0.04	0.0003	mg/L
2,2-DPA	NO	YES	0.5		mg/L
2,4,5-T	NO	YES	0.1		mg/L
2,4,6-trichlorophenol	NO	YES	0.02	0.002	mg/L
2,4-D	NO	YES	0.03		mg/L
2,4-dichlorophenol	NO	YES	0.2	0.0003	mg/L
2-chlorophenol	NO	YES	0.3	0.0001	mg/L
Acephate	NO	YES	0.008		mg/L
Acrylamide	NO	YES	0.0002		mg/L
Aldicarb	NO	YES	0.004		mg/L
Aldrin & Dieldrin	NO	YES	0.0003		mg/L
Aluminium	YES	N/A	c	0.2	mg/L
Ametryn	NO	YES	0.07		mg/L
Amitraz	NO	YES	0.009		mg/L
Amitrole	NO	YES	0.009		mg/L
Ammonia	NO	NO	c	0.5	mg/L
Antimony	YES	N/A	0.003	-	mg/L
Arsenic	YES	N/A	0.01	-	mg/L
Asbestos	NO	NO	c		mg/L
Asulam	NO	YES	0.07		mg/L
Atrazine	NO	YES	0.02		mg/L
Azinphos-methyl	NO	YES	0.03		mg/L
Barium	YES	N/A	2	-	mg/L
Benomyl	NO	YES	0.09		mg/L
Bentazone	NO	YES	0.4		mg/L
Benzene	NO	YES	0.001		mg/L
Beryllium	NO	YES	0.06		mg/L
Bioresmethrin	NO	YES	0.1		mg/L
Boron	YES	N/A	4	-	mg/L
Bromacil	NO	YES	0.4		mg/L
Bromate	NO	YES	0.02		mg/L
bromochloroacetonitrile	NO	NO	c		mg/L
Bromophos-ethyl	NO	YES	0.01		mg/L
Bromoxynil	NO	YES	0.01		mg/L
Cadmium	YES	N/A	0.002	-	mg/L

	Warrumbungle Shire Council		ADWG Guidelines 2011		
	Is Council Monitoring Characteristic?	If NO, does it have a health Guideline value?	Health	Aesthetic	Units
Calcium	YES	N/A	N/A	N/A	mg/L
Captan	NO	YES	0.4		mg/L
Carbaryl	NO	YES	0.03		mg/L
Carbendazim	NO	YES	0.09		mg/L
Carbofuran	NO	YES	0.01		mg/L
Carbon tetrachloride	NO	YES	0.003		mg/L
Carbophenothion	NO	YES	0.0005		mg/L
Carboxin	NO	YES	0.3		mg/L
Carfentrazone-ethyl	NO	YES	0.1		mg/L
Chlorantraniliprole	NO	YES	6		mg/L
Chlorate	NO	NO	c e		mg/L
Chlordane	NO	YES	0.002		mg/L
Chlorfenvinphos	NO	YES	0.002		mg/L
Chloride	YES	N/A	c	250	mg/L
Chlorinated furanones	NO	NO	c e		
Chlorine dioxide	NO	NO	c	0.4	mg/L
Chlorite	NO	YES	0.8		mg/L
chloroacetic acid	NO	YES	0.15		mg/L
Chloroacetic acids	NO	NO	e		mg/L
Chlorobenzene	NO	YES	0.3	0.01	mg/L
Chloroketones	NO	NO	e		mg/L
Chlorophenols	NO	NO	e		mg/L
Chloropicrin	NO	NO	c		mg/L
Chlorothalonil	NO	YES	0.05		mg/L
Chloroxuron	NO	YES	0.01		mg/L
Chlorpyrifos	NO	YES	0.01		mg/L
Chlorsulfuron	NO	YES	0.2		mg/L
Chromium	YES	N/A	0.05	-	mg/L
Clopyralid	NO	YES	2		mg/L
Copper	YES	N/A	2	1	mg/L
Cyanide	NO	YES	0.08		mg/L
Cyanogen chloride	NO	YES	0.08		mg/L
Cyfluthrin, Beta-cyfluthrin	NO	YES	0.05		mg/L
Cypermethrin isomers	NO	YES	0.2		mg/L
Cyprodinil	NO	YES	0.09		mg/L
DDT	NO	YES	0.009		mg/L
Deltamethrin	NO	YES	0.04		mg/L
di(2-ethylhexyl) adipate	NO	NO	c		mg/L
di(2-ethylhexyl) phthalate	NO	YES	0.01		mg/L
dialkyltins	NO	NO	c		mg/L
Diazinon	NO	YES	0.004		mg/L
dibromoacetonitrile	NO	NO	c		mg/L
Dicamba	NO	YES	0.1		mg/L
Dichlobenil	NO	YES	0.01		mg/L
dichloroacetonitrile	NO	NO	c		mg/L
Dichlorobenzenes	NO	NO			
Dichloroethanes	NO	NO			
Dichloroethenes	NO	NO			

	Warrumbungle Shire Council		ADWG Guidelines 2011		
	Is Council Monitoring Characteristic?	If NO, does it have a health Guideline value?	Health	Aesthetic	Units
Dichloromethane	NO	YES	0.004		mg/L
Dichloroprop / Dichlorprop-P	NO	YES	0.1		mg/L
Dichlorvos	NO	YES	0.005		mg/L
dicholoroacetic acid	NO	YES	0.1		mg/L
Diclofop-methyl	NO	YES	0.005		mg/L
Dicofol	NO	YES	0.004		mg/L
Difenzoquat	NO	YES	0.1		mg/L
Diflubenzuron	NO	YES	0.07		mg/L
Dimethoate	NO	YES	0.007		mg/L
Diphenamid	NO	YES	0.3		mg/L
Diquat	NO	YES	0.007		mg/L
Dissolved oxygen	NO	NO	N/A	<85	%
Disulfoton	NO	YES	0.004		mg/L
Disulfoton	NO	YES	0.02		mg/L
EDB	NO	YES	0.001		mg/L
EDTA	NO	YES	0.25		mg/L
Endosulfan	NO	YES	0.02		mg/L
Endothal	NO	YES	0.1		mg/L
Epichlorohydrin	NO	YES	0.0005	d	mg/L
EPTC	NO	YES	0.3		mg/L
Esfenvalerate	NO	YES	0.03		mg/L
Ethion	NO	YES	0.004		mg/L
Ethoprophos	NO	YES	0.001		mg/L
Ethylbenzene	NO	YES	0.3	0.003	mg/L
Etridiazole	NO	YES	0.1		mg/L
Fenamiphos	NO	YES	0.0005		mg/L
Fenarimol	NO	YES	0.04		mg/L
Fenchlorphos	NO	NO	c		mg/L
Fenchlorphos	NO	YES	0.007		mg/L
Fenoprop	NO	YES	0.01		mg/L
Fensulfothion	NO	YES	0.01		mg/L
Fenthion	NO	YES	0.007		mg/L
Fenvalerate	NO	YES	0.06		mg/L
Fipronil	NO	YES	0.0007		mg/L
Flamprop-methyl	NO	YES	0.004		mg/L
Fluometuron	NO	YES	0.07		mg/L
Fluoride	YES	N/A	1.5	-	mg/L
Fluproponate	NO	YES	0.009		mg/L
Formaldehyde	NO	YES	0.5		mg/L
Formothion	NO	YES	0.05		mg/L
Fosamine	NO	YES	0.03		mg/L
Free Chlorine	YES	N/A	5	0.6	mg/L
Glyphosate	NO	YES	1		mg/L
Haloacetonitriles	NO	NO	e		mg/L
Haloxyfop	NO	YES	0.001		mg/L
Heptachlor	NO	YES	0.0003		mg/L
Hexachlorobutadiene	NO	YES	0.0007		mg/L
Hexaflurate	NO	YES	0.03		mg/L

	Warrumbungle Shire Council		ADWG Guidelines 2011		
	Is Council Monitoring Characteristic?	If NO, does it have a health Guideline value?	Health	Aesthetic	Units
Hexazinone	NO	YES	0.4		mg/L
Hydrogen sulfide	NO	NO	c	0.05	mg/L
Imazapyr	NO	YES	9		mg/L
Iodide	YES	N/A	0.5		mg/L
Iodine	YES	N/A	c	0.15	mg/L
Iprodione	NO	YES	0.1		mg/L
Iron	YES	N/A	c	0.3	mg/L
Lead	YES	N/A	0.01	-	mg/L
Lindane	NO	YES	0.01		mg/L
Maldison (Malathion)	NO	YES	0.07		mg/L
Mancozeb	NO	YES	0.009		mg/L
Manganese	YES	N/A	0.5	0.1	mg/L
MCPA	NO	YES	0.04		mg/L
Mercury	YES	N/A	0.001	-	mg/L
Metaldehyde	NO	YES	0.02		mg/L
Metham	NO	YES	0.001		mg/L
Methidathion	NO	YES	0.006		mg/L
Methiocarb	NO	YES	0.007		mg/L
Methomyl	NO	YES	0.02		mg/L
Methoxychlor	NO	YES	0.3		mg/L
Methyl bromide	NO	YES	0.001		mg/L
Metiram	NO	YES	0.009		mg/L
Metolachlor / s-Metolachlor	NO	YES	0.3		mg/L
Metribuzin	NO	YES	0.07		mg/L
Metsulfuron-methyl	NO	YES	0.04		mg/L
Mevinphos	NO	YES	0.005		mg/L
Microcystins	NO	YES	1.3		µg/L
Molinate	NO	YES	0.004		mg/L
Molybdenum	YES	N/A	0.05	-	mg/L
Monochloramine	NO	YES	3		mg/L
Monocrotophos	NO	YES	0.002		mg/L
Naphthalophos	NO	NO	c		mg/L
Napropamide	NO	YES	0.4		mg/L
NDMA	NO	YES	0.0001		mg/L
Nicarbazin	NO	YES	1		mg/L
Nickel	YES	N/A	0.02	-	mg/L
Nitralin	NO	YES	0.5		mg/L
Nitrate	YES	N/A	50	-	mg/L
Nitrilotriacetic acid 0.2	NO	YES	0.2		mg/L
Nitrite	YES	N/A	3	-	mg/L
Norflurazon	NO	YES	0.05		mg/L
Omethoate	NO	YES	0.001		mg/L
Organotins	NO	NO			
Oryzalin	NO	YES	0.4		mg/L
Oxamyl	NO	YES	0.007		mg/L
Ozone	NO	NO			
PAHs	NO	YES	0.00001		mg/L

	Warrumbungle Shire Council		ADWG Guidelines 2011		
	Is Council Monitoring Characteristic?	If NO, does it have a health Guideline value?	Health	Aesthetic	Units
Paraquat	NO	YES	0.02		mg/L
Parathion	NO	YES	0.02		mg/L
Parathion-methyl	NO	YES	0.0007		mg/L
Pebulate	NO	YES	0.03		mg/L
Pendimethalin	NO	YES	0.4		mg/L
Pentachlorophenol	NO	YES	0.01		mg/L
Permethrin	NO	YES	0.2		mg/L
pH	YES	NO	c	6.5-8.5	
Picloram	NO	YES	0.3		mg/L
Piperonyl butoxide	NO	YES	0.6		mg/L
Pirimicarb	NO	YES	0.007		mg/L
Pirimiphos methyl	NO	YES	0.09		mg/L
Pirimiphos-ethyl	NO	YES	0.0005		mg/L
Plasticisers	NO	NO			mg/L
Polihexanide	NO	YES	0.7		mg/L
Profenofos	NO	YES	0.0003		mg/L
Promecarb	NO	NO	c		mg/L
Propachlor	NO	YES	0.07		mg/L
Propanil	NO	YES	0.7		mg/L
Propargite	NO	YES	0.007		mg/L
Propazine	NO	YES	0.05		mg/L
Propiconazole	NO	YES	0.1		mg/L
Propyzamide	NO	YES	0.07		mg/L
Pyrasulfotole	NO	YES	0.04		mg/L
Pyrazophos	NO	YES	0.02		mg/L
Pyroxsulam	NO	YES	4		mg/L
Quintozene	NO	YES	0.03		mg/L
Selenium	YES	N/A	0.01	-	mg/L
Silica	NO	NO		80	mg/L
Silver	YES	N/A	0.1	-	mg/L
Simazine	NO	YES	0.02		mg/L
Sodium	YES	N/A	N/A	180	mg/L
Spirotetramat	NO	YES	0.2		mg/L
Styrene	NO	YES	0.03	0.004	mg/L
Sulfate	YES	N/A	500	250	mg/L
Sulprofos	NO	YES	0.01		mg/L
Taste and odour	NO	NO	N/A	Not offensive to most people	
Temephos	NO	YES	0.4		mg/L
Temperature	NO	NO	N/A	No value set	
Terbacil	NO	YES	0.2		mg/L
Terbufos	NO	YES	0.0009		mg/L
Terbuthylazine	NO	YES	0.01		mg/L
Terbutryn	NO	YES	0.4		mg/L
Tetrachloroethene	NO	YES	0.05		mg/L
Tetrachlorvinphos	NO	YES	0.1		mg/L

	Warrumbungle Shire Council		ADWG Guidelines 2011		
	Is Council Monitoring Characteristic?	If NO, does it have a health Guideline value?	Health	Aesthetic	Units
Thiobencarb	NO	YES	0.04		mg/L
Thiometon	NO	YES	0.004		mg/L
Thiophanate	NO	YES	0.005		mg/L
Thiram	NO	YES	0.007		mg/L
Tin	NO	NO	N/A		
Toltrazuril	NO	YES	0.004		mg/L
Toluene	NO	YES	0.8	0.025	mg/L
Total Chlorine	YES	N/A	5	0.6	mg/L
Total Dissolved Solids (TDS)	YES	N/A	N/A	600	mg/L
Total Hardness as CaCO3	YES	N/A	N/A	200	mg/L
tributyltin oxide	NO	YES	0.001		mg/L
Trichlorfon	NO	YES	0.09		mg/L
Trichlorfon	NO	YES	0.007		mg/L
Trichloroacetaldehyde	NO	YES	0.02	e	mg/L
trichloroacetic acid	NO	YES	0.1		mg/L
trichloroacetonitrile	NO	NO	c		mg/L
Trichlorobenzenes	NO	YES	0.03	0.005	mg/L
Trichloroethylene	NO	NO	c		mg/L
Triclopyr	NO	YES	0.02		mg/L
Trifluralin	NO	YES	0.09		mg/L
Trihalomethanes	NO	YES	0.25	e	mg/L
True Colour	YES	N/A	N/A	15	HU
Turbidity	YES	N/A	c	5	NTU
Uranium	NO	YES	0.017		mg/L
Vernolate	NO	YES	0.04		mg/L
Vinyl chloride	NO	YES	0.0003		mg/L
Xylene	NO	YES	0.6	0.02	mg/L
Zinc	YES	N/A	c	3	mg/L

Notes:

HU = Hazen Units; NTU = Nephelometric Turbidity Units, THMs = Trihalomethanes

a Aesthetic values are not listed if the compound does not cause aesthetic problems, or if the value determined from health considerations is the same or lower.

b If present at all in Australian drinking waters, concentrations of all organic compounds other than disinfection by-products are likely to be very low relative to the guideline value.

c Insufficient data to set a guideline value based on health considerations.

d The guideline value is below the limit of quantitation. Improved analytical procedures are required for this compound.

e The concentration of all chlorination by-products can be minimised by removing naturally occurring organic matter from the source water, reducing the amount of chlorine added, or using an alternative disinfectant (which may produce other by-products). Action to reduce trihalomethanes and other by-products is encouraged, but most not compromise disinfection.

Appendix D

Risk Assessment Worksheet

Hazardous Event Code	System Code	Hazardous Event	Hazard	Hazard Category	Description of Consequences	Unmitigated Risk Evaluation			Existing Control Measures	Residual Risk Evaluation			Agreed Additional Preventive Measures	Proposed Follow Up Actions	Notes on basis of scoring (e.g. uncertainty)
						C	L	R		C	L	R			
1.00	**Catchment & Abstraction**														
1.01	ALL	- Chemicals from agricultural runoff near bores. - Spraying as a result of a pest plague. - Pest control - Illegal dumping/washing of drums - Spillage/leakage of chemical drums/tankers	Pesticides	Chemical (pesticides)	Chronic health impact	3	D	Moderate	- Drum muster program - Chemical training program for pesticide customers (Chemical certification process) - Media releases regarding spraying program - NSW Health testing program for pesticides (no detections above ADWG, 2011) - Spraying exclusion zones	3	D	Moderate		- Consider instigating a pesticide monitoring program	
1.02	BWY CBN MDN CLH DDO (surface)	- Pathogens from agricultural inputs due to surface water ingress. {significant agricultural activities not present within Timor Dam catchment} **[AGRICULTURAL HAZARDS]**	Cryptosporidium	Pathogens (Chlorine resistant e.g. *Crypto*)	Acute health impact	4	C	Very High	- Filtration (MDN, CBN, BWY) - Backup supply, bores (MDN) - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	4	D	High		- Consider turbidity monitoring of infiltration well water and river water on event basis at CLH, DDO to determine effectiveness of filtration - If sand bed demonstrates effective filtration consider making this a CCP	- High rainfall events/flood leading to E.Coli presence (MDN back-up bore) - Turbidity off filters average 0.5NTU
1.03	BUG KEN BDN (ground)	- Pathogens from agricultural inputs due to surface water ingress. **[AGRICULTURAL HAZARDS]**	Cryptosporidium	Pathogens (Chlorine resistant e.g. *Crypto*)	Acute health impact	4	C	Very High	- Filtration (BDN) - Bore casing and bore depth (>50m)	4	C	Very High		- Bore investigations (integrity, capping, geology, exclusion zones - fencing) - Private water bore inspections, bore register - Concrete capping of bore at BDN and DDO	- Based on worst case systems i.e without filtration - Open bore at BDN - Some private bores at KBI, BUG
1.04	BUG BWY CBN KEN MDN DDO	- Pathogens from septics - Unsewered properties in township (septic systems - BUG, KEN, MDN, BWY) - CBN STP upstream MDN, BWY - High rainfall events leading to E.Coli presence (MDN back-up bore) {significant agricultural activities not present within Timor Dam catchment} **[RURAL SEPTICS]**	Cryptosporidium	Pathogens (Chlorine resistant e.g. *Crypto*)	Acute health impact	5	C	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	5	D	Very High		- STP effluent review (i.e. quality, quantity from EPA report) to determine typical characteristics in effluent and the quality of treatment - Consider testing for E.Coli in raw water	
1.05	BUG BWY CBN KEN MDN	- Pathogens from agricultural inputs due to surface water ingress. - Wildlife in catchment - High rainfall events/flood leading to E.Coli events (MDN back-up bore) **[AGRICULTURAL]**	Chlorine sensitive pathogens	Pathogens (Chlorine sensitive e.g. Bacteria and viruses) Nutrients	Acute health impact	5	A	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Chlorine dosing - Coagulation (MDN, CBN, BWY, BDN) - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	4	D	High		- Timor Dam fence was damaged during the bushfires. Animal ingress is possible, fence to be replaced. Follow up with council engineer the status of the fence replacement program. Funding is available from insurance claim.	

1.06	ALL	- Pathogens from septics - Unsewered properties in township (septic systems - BUG, KEN, MDN, BWY) - CBN STP upstream MDN, BWY - High rainfall events leading to E.Coli presence (MDN back-up bore) **[RURAL]**	Chlorine sensitive pathogens	Pathogens (Chlorine sensitive e.g. Bacteria and viruses) Nutrients	Acute health impact	5	A	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Chlorine dosing - Coagulation (MDN, CBN, BWY, BDN) - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	5	D	Very High			
1.06	MDN BDN BUG CBN	- Groundwater can contain naturally occuring iron and manganese	Iron and manganese	Chemicals (Fe & Mn) Radiological	Chemical chronic health impact (Mn ONLY) and aesthetic impacts	3	A	Very High	- Aeration (Timor Dam, CBN) - Aeration (cascade) /Oxidation (KMNO4) (MDN) - Aeration (BDN) - Coagulation and sedimentation	2	C	Moderate			- BDN, MDN raw water (Mn) detection - BDN (Fe) 6mg/L raw water
1.07	ALL	- Coal seam gas industry within area	All chemicals	Chemical	Chronic health impact	4	D	High				High		-Consider undertaking chemical testing on groundwater supplies to establish baseline WQ - Review of existing coal seam gas investigations in the area (i.e. EPA)	
1.08	ALL	- Illegal dumping - Recreational activities (boating) - vehicle spills/accident - private/public underground/aboveground fuel storages (petrol stations)	Hydrocarbons		Chronic health impact	3	D	Moderate	- Council are removing own[illegible]ground storages - CLH depot, CBN depot, DDO depot hydrocarbon testing - Some locations of [illegible]ground tanks k[illegible] - Monitoring and [illegible]ediation by supp[illegible]	3	D	Moderate			
1.09	CBN	- Algal blooms	Cyanotoxins		Acute health impact	3	D	Moderate	- Dam aeration - Weekly algal count and identification - Council notifications - PAC dosing - Algaecide dosing (when required)	2	E	Low			- Never had a detection of toxic algae
1.10	CBN	- Algal blooms	Taste and odour		Aesthetic impact	3	C	High	- Dam aeration - Weekly algal count and identification - Council notifications - PAC dosing - Algaecide dosing (when required)	3	C	High		- Review PAC dosing effectiveness. Detention time for PAC limiting factor	
1.11	BDN	- Naturally occurring sulphide	Taste and odour		Aesthetic impact	3	A	Very High	- Aeration - Detection by operators during normal operation	2	D	Low			
1.12	ALL	- Naturally occuring	Radiological		Chronic health impact	3	E	Moderate	- DDO tested prior to new bore installed	3	E	Moderate		- CBN results to be followed up	- Testing at Gunnedah Hill

2.00	**Aeration and oxidation**															
2.01	BDN MDN	- Poor maintenance practises - Blower failure (BDN) - Dosing system failure (running out of KMNO4) - Hydrogen sulphide breakthrough	Iron and manganese and sulphide		Aesthetic impact	3	D	Moderate	- Daily inspections of blowers and dosing systems - Weekly chemical testing - Retention volume of the clarifier - Community notification	3	E	Moderate			
2.02	MDN	- Overdosing KMNO4 (pink water) - Lack of SOP for batching - Incorrect dosing adjustment on SCADA	Manganese		Aesthetic impact	3	C	High	- Operator training and experience - Daily monitoring - Interlocks with raw water pumps	3	E	Moderate		- Implement SOP for batching and dosing	
3.00	**Coagulation and Flocculation**															
3.01	MDN BWY CBN BDN	Overdosing coagulant: - operator error - instrumentation failure - incorrect interlocks - equipment failure - resulting in low pH and subsequently dissolving of copper and lead into drinking water	Copper and Lead		Chronic health impact	3	D	Moderate	- Daily testing (drop tests) and inspections - Jar testing (as required) - Operator training and experience - pH correction (CBN, BWY)	3		Moderate			
3.02	MDN BWY CBN BDN	Incorrect dosing of coagulant: - Highly turbid water - incorrect pH (underdosing/overdosing soda ash/lime/coagulant) - loss of control - alum pump failure	Pathogens		Acute health impact	5	C	Very High	- Daily testing (drop tests) and inspections - Jar testing (as required) - Operator training and experience - pH and turbidity monitoring - visual inspections - duty standby pumps - chlorine dosing - filtration (sedimentation/clarification	5	E	High		- Online interlocks for pH and turbidity on outlet for filters	
4.00	**Clarification/sedimentation**															
4.01	BDN CBN MDN BWY	BDN - Clarifier CBN/MDN/BWY - Sedimentation processes - incorrect coagulant dosing - flooding - short circuiting - wildlife access may lead to remobilisation of sediments	Turbidity/Colour		Aesthetic impact	3	C	High	- Alternating lagoons when turbidity increases above set point - Operator training and experience - Visual inspections - Jar testing for coagulant - Established vegetation to resist lagoon erosion - Daily testing turbidity/colour/pH - Filtration (BDN, CBN, MDN, BWY)	3	D	Moderate		BDN - Strategy needs to be developed for continued supply during times of significant maintenance (e.g. utilising the lagoons temporarily)	
4.02	MDN BWY CBN BDN	- Wildlife cross-contamination - Clarification failure (BDN) - sedimentation failure (BWY, MDN, CBN)	All pathogens		Acute health impact	5	C	Very High	- Daily testing on turbidity/pH/colour - Operator training and experience - Jar testing for coagulant - Chlorine dosing - Filtration (BDN, CBN, MDN, BWY)	5	E	High			

5.00	Filtration														
5.01	MDN CBN BDN	- Incorrect filter media - Failed pressure transducer, incorrect headloss set point - incorrect backwashing, failed level sensors - not replacing filter media when required - Operator error or vandalism via dropping material into the filters blocking outlet, inhibiting backwash (leads to ineffective treatment) - Compressor failure leading to insufficient pressure to wash - Sedimentation/clarification failure leading to high turbidity	All pathogens		Acute health impact	5	A	Very High	- Time/head loss backwash (MDN/CBN) - Routine backwash x2 week (summer), x1 (winter) (BWY) - High turbidity from filtered water leading to manual backwash. Continual high turbidity will result in filter replacement - Daily backwash, timer and head loss backup (BDN) - Maintenance procedures (i.e. backwash blowers, cleaning instruments - not documented) - Operator experience and training - Flow meter on air line for blowers - Annual calibration of the pressure gauges - Routine inspection of equipment (i.e. checking for breakthrough, blockages of nozzles) - chlorine dosing - Online turbidity meter (CBN) on outlet of filters	4	D	High		- Develop SOP for filter maintenance - Consider online turbidity meter with interlocks at BDN. Consider interlocks for meters at CBN and MDN - Consider periodic inspection on filter media - Consider maintenance program for the filters	
5.02	BWY	- Incorrect filter media - Failed pressure transducer, incorrect headloss set point - incorrect backwashing, failed level sensors - not replacing filter media when required - Operator error or vandalism via dropping material into the filters blocking outlet, inhibiting backwash (leads to ineffective treatment) - Compressor failure leading to insufficient pressure to wash - Sedimentation/clarification failure leading to high turbidity	All pathogens		Acute health impact	5	A	Very High	- Time/head loss backwash (MDN/CBN) - Visual inspection to identify low level in balance tank indicate (BWY) - Routine backwash x2 week (summer), x1 (winter) (BWY) - High turbidity from filtered water leading to manual backwash. Continual high turbidity will result in filter replacement - Maintenance procedures (i.e. backwash blowers, cleaning instruments - not documented) - Operator experience and training - Flow meter on air line for blowers - Annual calibration of the pressure gauges - Routine inspection of equipment (i.e. checking for breakthrough, blockages of nozzles) - chlorine dosing - Online turbidity meter (CBN) on outlet of filters	5	D	Very High		- Develop SOP for filter maintenance - Consider online turbidity meter with interlocks at BWY. - Consider periodic inspection on filter media - Check filter media depth against design requirements at BWY - Consider maintenance program for the filters	

6.00	**pH correction**														
6.01	CBN BWY BDN	Loss of control of Lime (CBN) or soda ash (BWY, BDN) caused by: - pump failure - blocked piping - screw feeder failure - poor quality lime or soda ash - incorrect batching of soda ash - moisture in lime bin or hopper - hoppers haven't been filled - incorrect calibration of pH meters - raw water source quality	High or Low pH	Low pH	Aesthetic impact.	2	C	Moderate	- pH meters regularly calibrated - drop test - visual inspections - pH meters - daily sampling and testing - operator training and experience - maintenance of lime and soda ash systems and injection points	2	E	Low			pH >8.5 causes build-up of calcium carbonate. • pH > 10 also corrodes pipes, exposing users to health-related chemicals. • pH > 11 can cause irritation of eyes and, in sensitive populations, gastrointestinal irritation.
6.02	CBN BWY BDN	Overdosing of Lime or soda ash creating operational issues. Caused by high pH as a result of: - pump calibration failure - blocked pipe - incorrect calibration of pH meters - raw water source quality - incorrect batching This leads to less efficient treatment from disinfection due to reduced presence of hypochlorite.	All Pathogens	High pH	Acute health imact.	4	C	Very High	- pH meters regularly calibrated - drop test - visual inspections - pH meters - daily sampling and testing - operator training and experience - disinfection	4	E	High			pH >8.5 causes build-up of calcium carbonate and makes treatment and disinfection less effective. • pH > 10 also corrodes pipes, exposing users to health-related chemicals. • pH > 11 can cause irritation of eyes and, in sensitive populations, gastrointestinal irritation.
7.00	**Disinfection (Chlorine Dosing and Contact Vessels)**														
7.01	ALL	Under dosing from: - incorrect chlorine set point - operator error - instrumentation/equipment failure/incorrect calibration or running out of Chlorine Gas resulting in inadequate disinfection to control pathogens (system is not interlocked with chlorine pumps) - Air lock in the NaOCl or blockage from crystalisation - varying water quality i.e. turbidity, pH (due to manual water quality monitoring) - poor quality/incorrect concentration of chlorine - incorrect pH may affect chlorine residual - dillution batching (BUG, KBI, MDN)	Chlorine sensitive pathogens	Pathogens (Chlorine sensitive)	Acute health impact	5	A	Very High	- Operator training and experience - Daily chlorine residual testing after 20-30mins detention time (leaving plant and in reticulation) - Calibration of instruments	5	C	Very High		- Consider testing of hypochlorite strength - Consider program of analyser calibration - CLH implement process to identify when gas bottle is empty - Monitor the strength of the chlorine over a period of 6 months (MDN) - Investigate installation of chlorine mixer for batching or replacement with chlorine gas (MDN)	

7.02	ALL	Inherent issue as a result of chlorine dosing	DBPs	T &O, Chlorine, DBP's.	Chronic health impact	3	D	Moderate	- THM, chloracidic acids testing results below guideline levels, PHU - Upstream process (clarification, filtration) to remove organic material	3	E	Moderate			
7.03	ALL	Operating systems to achieve adequate chlorine through system. Overdosing of chlorine from: - incorrect chlorine set point - operator error - instrumentation/equipment failure - varying water quality i.e. turbidity, pH (due to manual water quality monitoring) - new hyperchlorite batch, with incorrect set point - poor mixing or short circuiting - incorrect concentration of chlorine	Taste & Odour	T &O, Chlorine, DBP's.	Aesthetic impact	3	C	High	- Operator training and experience - Daily chlorine residual testing after 20-30mins detention time (leaving plant and in reticulation) - Calibration of instruments - Injection into the line prior to clear water tank (except CBN)	3	D	Moderate			
8.00	**Fluoride**														
8.01	CBN BDN	Overdosing of fluoride from: - incorrect set point - operator error - complex water quality testing - instrumentation/equipment failure - poor mixing, short circuiting - incorrect concentration of chemicals - fluoride granual breakthrough - impurities in fluoride	Fluoride		Chronic health impact	3	C	High	- Operator training and experien - Fluoride ticket required - x2 trained operators requ r system, mi between 2 towns/systems - Monthly sampling ent lab (retic) - Daily plant sampl - Weekly ret sampling - Daily calibra - If lab m es results diff + % rom councils results, NS Hea /PHU notified. N V Health will notify council Council has access NSW Drinking Water Database	3	D	Moderate		- Confirm process of extracting data from NSW Health Water Quality Database	CHL, MDN - to be commissioned shortly (BWY commissioned now)

9.00	**Reservoirs**														
9.01	ALL	Vermin and stormwater ingress: - unlocked hatches/poorly fitting hatches - inadequate netting - poor integrity of the roof - damage due to storm events - access via scour lines/overflow - Stormwater ingress leading to contamination from faecal matter from birds. - Malicious contamination or access to reservoir by unauthorised personnel leading to water contamination. - Malicious contamination or access to reservoir by unauthorised personnel leading to water contamination. BDN: - Holes in floor of plant allowing vermin ingress to clear water tank	All pathogens and all chemicals		Acute health impact	5	A	Very High	- Currently a tender process soon to commence (planned joint project with LMWUA) for reservoir inspection and cleaning - Ad hoc reservoir inspections - Lockable hatches, netting, roofing - Lockable ladders and removable ladders - Security fencing around reservoirs - Community notification	5	B	Very High		- Consider a routine reservoir inspection (checking locks etc) DDO: - Bullindah reservoir roof replacement (currently planned) MDN: - Coolabah requires vermin proofing CLH: - Wentworth/Martin St Res requires vermin proofing - Wentworth requires sealing BDN: - Clear water tank requires vermin proofing - Develop SOP for the access of reservoirs - Assess compliance regarding reservoir access with Australian standards and common sense - Consider working at heights training for staff (MDN)	
9.02	CBN MDN BDN	- Stratification of reservoir leading to low chlorine	All pathogens		Acute health impact	5	C	Very High	- Staff experience and training - Routine residual monitoring within reticulation system	5	C	Very High		- Consider investigation the status of other reservoirs (MDN, BDN, CBN) - Consider reviewing mixing options for reservoirs with common inlet/outlet - Consider implementing sampling regime for CBN, BDN for chlorine residual in the surface water for CT calculation	
9.03	ALL	Disturbance of sediments due to: - low volumes and then refilling - Inadequate/infrequent cleaning of tanks - Incorrect filling design	Turbidity, suspended material, Taste and Odour	Pathogens	Aesthetic impact	3	C	High	- Aqualift inspection and report (in the past, not ongoing) - Reservoir cleaning program (not currently in place; currently a tender process, soon to commence planned joint project with LMWUA for reservoir inspection and cleaning)	3	C	High		- Investigate options to clean BDN reservoir - Instigate reservoir cleaning program	BDN - last inspected 2008, not cleaned because sediment depth was too great (1.5m)

10.00	Distribution													
10.01	ALL	- Ingress of contaminates due to back flow or cross connections (including property illegal connections) - Illegal connection to standpipes - Improper practices by water carters - Backflow from tankers filling from inappropriate locations on the system	All pathogens and all chemicals	Various	Acute health impact	4	C	Very High	- Locks on standpipes - Backflow prevention devices on standpipes - Community notification of illegal connections, illegal water carter filling - Hydrant (and stop valve) maintenance in place	4	D	High		- Identify high risk areas for backflow prevention (i.e. STP) - Replace old water meters with new water meters including backflow prevention devices - Develop a communication protocol around monitoring data (i.e. distribution data feeding back to WTP) - Consider sampling and testing program following mains repairs	
10.02	ALL	- Mains breaks or unsanitary repairs leading to WQ issues including cross contamination of main repair equipment e.g. Sewer/Water. - Not chlorinating after a main break - Incorrect flushing procedures after a main break - Inappropriate storage of new pipework prior to installation. - Incorrect valve operation or valve failures leading to ingress of contaminates due to loss of pressure. - Unsanitary commissioning of a new main - Lack of flushing leading to high turbidity resulting in high chlorine take up - Oxidation of infrastructure inside reservoir leading to low chlorine residual	All pathogens and all chemicals	Various	Acute health impact	4	A	Very High	- Operator training and experience - Separation of water and sewer tools - Developing SWMS - Flushing of mains after repair - Maintaining chlorine residuals a[illegible]onitoring	2	C	Very High		- Develop SOP - Consider closing household property meters prior to recommissioning mains - Obtain list of dialysis patients for each system - SEE 10.03 re: flushing schedule to improve chlorine residual in the distribution	- Same crews water/sewers but separate tools - Water and sewer mains within same easement
10.03	ALL	- Dead ends in reticulation - Incorrect/lack of flushing	Turbidity	Various	Aesthetic impact	2	A	High	- Operator training and experience - Flushing program (CBN, currently on hold) - Reactive flushing to customer compliants - Developing flushing schedule - Mains replacement	2	C	Moderate		- Finalise flushing schedule for remaining systems (CLH, DOO nothing currently in place) - Consider scouring program, including prioritisation of mains to be scoured - Consider tanker filling from dead ends (if backflow prevention available)	

10.04	ALL	Sloughing of biofilm leading to WQ complaints. May be caused by: - flushing of mains following a repair or replacement - reverse flow during a main break - excessive chlorine dose - Use of fire hydrants disturbing sediments in system. May be exacerbated by: - Dead ends in reticulation. - Incorrect/lack of flushing.	Taste & Odour	Pathogens Turbidity Taste & Odour	Aesthetic impact	2	C	Moderate	- Operator training and experience - Flushing program (CBN, currently on hold) - Reactive flushing to customer compliants - Developing flushing schedule - Mains replacement	2	C	Moderate			
11.00	**Whole of system**															
11.01	ALL	- Lack of online monitoring - Failure of telemetry (telemetry at Timor Dam for aeration)	Various	Various	Exceedence of ADWG health guideline	-	-	'	- Manual inspections required	-	-			- Consider online monitoring where CCPs have been identified	
11.02	ALL	- Entry of unauthorised persons leading to accidental or deliberate sabotage - Contractors/unauthorised staff have unsupervised access to treatment plants and reservoirs	Various	Various	Exceedence of ADWG health guideline	5	C	Very High	- Security fencing - Lockable buildings - Community notifying council of any security breaches - Contractor entry under supervision	5		High		- Electronic key system currently being investigated	
11.03	ALL	- Loss of power/brown outs at treatment plants due to inadequate power supply, storm events or planned outages resulting in loss of treatment control.	Various	Various	Exceedence of ADWG health guideline	1	B	Moderate	- Pumps need to be manually reset after blackout - CBN plant resets - Interlocks with system - Surge protection on equipment	1	B	Moderate			
11.04	ALL	- Extreme weather events: e.g. bushfire, flood	Various		Exceedence of ADWG health guideline	5	D	Very High	- Secondary supply - Water carting - Double treatment in high turbidity events (CBN) - Water treatment processes - Borehead integrity (BDN)	5	E	High			- Fire retardants are generally at safe levels
11.05	ALL	- Incorrect chemical delivery (quality assurance, type) - Tank filled with incorrect chemical	All chemicals		Exceedence of ADWG health guideline	5	C	Very High	- Staff needed to be onsite to accept delivery - Labelling of containers/walls - Sighting delivery docket	5	D	Very High			

11.06	MDN BWY BDN	Staff management: - Loss of skilled staff - Other responsibilities pulling operators away from key water management duties - Reporting structure creates confusion for staff and limits the ability of the manager to the direct staff to perform water/wastewater duties - Communication is inhibited by current structure which may pose risk during emergency events	ALL		ALL	5	A	Very High	- Agreement between water manager and urban services around staff management	5	A	Very High		- Review staff structure of water services team, PHU and NOW to provide support	
11.07	ALL	- There is not enough water for consumption and hygiene needs, continuously, seasonally or in parts of distribution systems.	Various		- Illness from harmful microorganisms due to poor hygiene or use of alternative lower-quality supplies. - Dehydration	5	D	Very High	- Drought management plan - Accredited water carters - Water restrictions	5	E	High			
12.00	**Monitoring & Management System**														
12.01	ALL	Lack of DWMS including: - SOPs - Operator training - Maintenance practices - Location of water quality monitoring sample points not being representative of whole of system. - Succession planning - Calibration of instrumentation - Qualified contactors and consultants - emergency response procedure - chemical delivery procedures	Various		Exceedence of ADWG health guideline	5	A	Very High	- Development of DWMS and implementation of the DWMS - All of the above	5	C	Very High			

Appendix E

CCPs and Operational Information

Critical Control Points Reference Guide – Warrumbungle Shire Council

Baradine

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Baradine	BDN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BDN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	1.2 mg/L	<1.0 mg/L
	BDN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in netting)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BDN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Aim to maintain level equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Baradine
CCP ID	BDN1
What is the control point?	Filtration
What are the hazards?	All pathogens
What is being monitored?	Turbidity
What will initiate response?	High turbidity reading (online or from grab sample)

Target <0.8 NTU	**Alert Level** >0.9 NTU	**Critical Limit** >1.0 NTU
Monitoring Systems Monitoring parameter: Turbidity Monitoring location: Outlet of filter Monitoring frequency: Daily grab sample - Calibration of instruments - Visual inspection of filters - Routine monitoring program - Backwashing filters (time based/on high turbidity read) - Testing raw water - Coagulation/sedimentation/clarification monitoring (daily sampling) - Hose down filter whilst backwashing - Pressure cleaning of filters annually - Check media annually - Visual inspection of clarifier floc and inspection of the blowers	**Corrective actions** - Check settled water turbidity * check dosing * jar tests * adjust dose accordingly - Check filter operation * check headloss * check time since last backwash - Instigate backwash * recheck headloss * resample and test	**Corrective actions** - Follow HACCP corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 89[illegible]52 - Dump clarifier water - Reduce flow rate through filters - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Check reticulation for chlorine residual and turbidity - Microbiological sampling and testing - Dose with chlorine - Consider instigating a boil water alert

Water Supply System	Baradine
CCP ID	BDN2
What is the control point?	Disinfection (gas)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** 1.2 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Leaving WTP Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and in reticulation) - Calibration of instruments - Check rotameter - Check auto changer over - Check bottles aren't empty **NOTE:** Standby bottles available	**Corrective actions** - Check rotameter - Check for gas line leaks - Check bottles aren't empty * manual change over * order new bottle - Check injector - Check service water and head unit - Increase chlorine dose - Check upstream processes - Visual inspection of clear water tank/ reservoir - Reduce flow rate to plant	**Corrective actions** - Follow HACCP corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 89[illegible]52) - Shut down plant - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Baradine
CCP ID	BDN3
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Notify PHO (Ph. 0407 551 548) and NOW (Ph. 1800 368 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Baradine
CCP ID	BDN4
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (Monthly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residual (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Bugaldie

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Bugaldie	BUG1	Disinfection (Hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	< 1.3 mg/L	< 1.0 mg/L
	BUG2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BUG3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Bugaldie
CCP ID	BUG1
What is the control point?	Disinfection (hypo)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** <1.3 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Off elevated reservoir outlet Monitoring frequency: Daily - Daily chlorine residual testing (off elevated reservoir outlet and in reticulation) - Calibration of instruments - Check batch tanks - Check pumps	**Corrective actions** - Check chlorine batch tank - Check pumps and dosing lines - Check injector - Check strength of hypo * Order new hypo if strength is too low - Increase chlorine dose - Visual inspection clear water tank/reservoir	**Corrective actions** - Follow alert level corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 [illegible] 2) - Shutdown bore pump - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Bugaldie
CCP ID	BUG2
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Notify DPHU (Ph. 0407 551 548) and NOW (Ph. 1300 368 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Bugaldie
CCP ID	BUG3
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (monthly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residual (refer to chlorination CCP) - Check for line breaks - Flush location of low chlorine residual - Sample and re-test	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0429 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Binnaway

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Binnaway	BWY1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BWY2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 mg/L	<1.5 mg/L	<1.2 mg/L
	BWY3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BWY4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Binnaway
CCP ID	BWY1
What is the control point?	Filtration
What are the hazards?	All pathogens
What is being monitored?	Turbidity
What will initiate response?	High turbidity reading (online or from grab sample)

Target <0.8 NTU	**Alert Level** >0.9 NTU	**Critical Limit** >1.0 NTU
Monitoring Systems Monitoring parameter: Turbidity Monitoring location: Outlet of filter Monitoring frequency: Daily grab sample - Calibration of instruments - Visual inspection of filters - Routine monitoring program - Backwashing filters (time based/on high turbidity read) - Testing raw water - Coagulation/sedimentation/clarification monitoring (daily sampling) - Hose down filter whilst backwashing - Pressure cleaning of filters annually - Check media annually	**Corrective actions** - Check settled water turbidity * check dosing * jar tests * adjust dose accordingly - Check filter operation * check headloss * check time since last backwash - Instigate backwash * recheck headloss * resample and test	**Corrective actions** - Follow ALERT corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 89[illegible]52) - Recirculate settled water through to front of plant (i.e. through lagoons) - Undertake jar test and adjust dose - Sample and retest after ~12 hours (plant will have come back into equilibrium) - Reduce flow rate through filters - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Check reticulation for chlorine residual and turbidity - Microbiological sampling and testing - Dose with chlorine - Consider instigating a boil water alert

Water Supply System	Binnaway
CCP ID	BWY2
What is the control point?	Disinfection (gas)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 2.0 mg/L	**Alert Level** <1.5 mg/L	**Critical Limit** <1.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Leaving WTP Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and in reticulation, sample is rested for 20mins before testing) - Calibration of instruments - Check rotameter - Check auto changer over - Check bottles aren't empty **NOTE:** Standby bottles available	**Corrective actions** - Check rotameter - Check for gas line leaks - Check bottles aren't empty * manual change over * order new bottle - Check injector - Check service water and head unit - Increase chlorine dose - Check upstream processes - Visual inspection of clear water tank/ reservoir - Reduce flow rate to plant	**Corrective actions** - Follow ICA corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 89[illegible]52) - Shut down plant - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Binnaway
CCP ID	BWY3
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Contact PHO (Ph. 0407 551 548) and NOW (Ph. 1800 368 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Binnaway
CCP ID	BWY4
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (fortnightly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residual (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0429 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Coonabarabran

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coonabarabran	CBN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	CBN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 – 5.0 mg/L	<1.8 mg/L	<1.5 mg/L
	CBN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CBN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Coonabarabran
CCP ID	CBN1
What is the control point?	Filtration
What are the hazards?	All pathogens
What is being monitored?	Turbidity
What will initiate response?	High turbidity reading (online or from grab sample)

Target <0.8 NTU	**Alert Level** >0.9 NTU	**Critical Limit** >1.0 NTU
Monitoring Systems Monitoring parameter: Turbidity Monitoring location: Outlet of filter Monitoring frequency: Online - Calibration of instruments - Visual inspection of filters - Routine monitoring program - Backwashing filters (time based/on high turbidity read) - Testing raw water - Coagulation/sedimentation/clarification monitoring (daily sampling) - Hose down filter whilst backwashing - Pressure cleaning of filters annually - Check media annually	**Corrective actions** - Check settled water turbidity * check dosing * jar tests * adjust dose accordingly - Check filter operation * check headloss * check time since last backwash - Instigate backwash * recheck headloss * resample and test - Consider source water option depending on situation	**Corrective actions** - Follow HACCP corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 89[illegible]52) - Recirculate settled water through to front of plant (i.e. through lagoons) - Undertake jar test and adjust dose - Sample and retest after ~12 hours (plant will have come back into equilibrium) - Reduce flow rate through filters - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Check reticulation for chlorine residual and turbidity - Microbiological sampling and testing - Dose with chlorine - Consider instigating a boil water alert

Water Supply System	Coonabarabran
CCP ID	CBN2
What is the control point?	Disinfection (gas)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 2.0 – 5.0 mg/L	**Alert Level** <1.8 mg/L	**Critical Limit** <1.5 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Leaving WTP Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and in reticulation) - Calibration of instruments - Check rotameter - Check auto changer over - Check bottles aren't empty **NOTE:** Standby bottles available	**Corrective actions** - Check rotameter - Check for gas line leaks - Check bottles aren't empty * manual change over * order new bottle - Check injector - Check service water and head unit - Increase chlorine dose - Check upstream processes - Visual inspection of clear water tank/reservoir - Reduce flow rate to plant	**Corrective actions** - Follow HACCP corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 89[illegible]52) - Shut down plant - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Coonabarabran
CCP ID	CBN3
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Notify PHU (Ph. 0407 551 548) and NOW (Ph. 1800 368 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Coonabarabran
CCP ID	CBN4
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (monthly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residual (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0429 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Coolah

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coolah	CLH1	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	CLH2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CLH3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	1.0 mg/L	0.8 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Coolah
CCP ID	CLH1
What is the control point?	Disinfection (gas)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** <1.3 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Wentworth and Martin St reservoirs Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and in reticulation) - Calibration of instruments - Check rotameter - Check bottles aren't empty **NOTE:** Spare bottles available	**Corrective actions** - Check rotameter - Check for gas line leaks - Check bottles aren't empty * manual change over * order new bottle - Check injector - Check service water and head unit - Increase chlorine dose - Check upstream processes - Visual inspection of clear water tank/reservoir - Reduce flow rate to plant	**Corrective actions** - Follow HACCP corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 89[illegible]52) - Shut down bore pump - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Coolah
CCP ID	CLH2
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Notify PHO (Ph. 0407 551 548) and NOW (Ph. 1800 368 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Coolah
CCP ID	CLH3
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 1.0 – 1.5 mg/L	**Alert Level** ≤1.0 mg/L	**Critical Limit** 0.8 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (Daily) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residual (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0429 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Dunedoo

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Dunedoo	DDO1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.2 mg/L	<1.0 mg/L
	DDO2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	DDO3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	1.0 mg/L	0.8 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Dunedoo
CCP ID	DDO1
What is the control point?	Disinfection (hypo)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** <1.2 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Outlet of Bullindah St reservoir and Rhodes St reservoir Monitoring frequency: Daily - Daily chlorine residual testing (leaving reservoirs and in reticulation) - Calibration of instruments - Check batch tanks - Check pumps	**Corrective actions** - Check chlorine batch tank - Check pumps and dosing lines - Check injector - Check strength of hypo * Order new hypo if strength is low - Increase chlorine dose - Visual inspection clean water tank/reser	**Corrective actions** - Follow [illegible] corrective actions - Not[illegible] Manager Warrumbungle Water (Ph. 0409 89[illegible]52 - Shut down bore pump - Shot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Dunedoo
CCP ID	DDO2
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Notify DPIW (Ph. 0407 551 548) and NOW (Ph. 1800 368 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Dunedoo
CCP ID	DDO3
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 1.0 – 1.5 mg/L	**Alert Level** ≤1.0 mg/L	**Critical Limit** 0.8 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system (at dead ends) Monitoring frequency: Manual water quality testing (Daily) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residual (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0429 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Kenebri

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Kenebri	KBI1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	KBI2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	KBI3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Kenebri
CCP ID	KBI1
What is the control point?	Disinfection (hypo)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** <1.3 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Outlet of reservoir Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant or reservoir and in reticulation) - Calibration of instruments - Check batch tanks - Check pumps	**Corrective actions** - Check chlorine batch tank - Check pumps and dosing lines - Check injector - Check strength of hypo * Order new hypo if strength is low - Increase chlorine dose - Visual inspection clean water tank/reser	**Corrective actions** - Follow CAP corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 89[illegible]52 - Shut down bore pump - Shot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Kenebri
CCP ID	KBI2
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Notify PHO (Ph. 0407 551 548) and NOW (Ph. 1800 368 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Kenebri
CCP ID	KBI3
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (monthly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual until - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0499 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Mendooran

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Mendooran	MDN1	Filtration	All pathogens	Turbidity	<0.5 NTU	>0.8 NTU	>1.0 NTU
	MDN2	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.6 mg/L	<1.2 mg/L	≤1.0 mg/L
	MDN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	MDN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	>0.5 mg/L	<0.3 mg/L	0.1 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Mendooran
CCP ID	MDN1
What is the control point?	Filtration
What are the hazards?	All pathogens
What is being monitored?	Turbidity
What will initiate response?	High turbidity reading (online or from grab sample)

Target <0.5 NTU	**Alert Level** >0.8 NTU	**Critical Limit** >1.0 NTU
Monitoring Systems Monitoring parameter: Turbidity Monitoring location: Outlet of filter Monitoring frequency: Online - Calibration of instruments - Visual inspection of filters - Routine monitoring program - Backwashing filters (time based/on high turbidity read) - Testing raw water - Coagulation/sedimentation/clarification monitoring (daily sampling) - Hose down filter whilst backwashing - Pressure cleaning of filters annually - Check media annually	**Corrective actions** - Check settled water turbidity * check dosing * jar tests * adjust dose accordingly - Check filter operation * check headloss * check time since last backwash - Instigate backwash * check headloss * resample and test	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Recirculate settled water through to front of plant (i.e. through lagoons) - Undertake jar test and adjust dose - Sample and retest after ~12 hours (plant will have come back into equilibrium) - Reduce flow rate through filters - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Check reticulation for chlorine residual and turbidity - Microbiological sampling and testing - Dose with chlorine - Consider instigating a boil water alert

Water Supply System	Mendooran
CCP ID	MDN2
What is the control point?	Disinfection (hypo)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.6 mg/L	**Alert Level** <1.2 mg/L	**Critical Limit** ≤1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Leaving Coolabah reservoir and the plant Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and reservoir and in reticulation) - Calibration of instruments - Check batch tanks - Check pumps - Bleed pumps and clean injection point	**Corrective actions** - Check chlorine batch tank - Check pumps and dosing lines - Check injector - Check strength of hypo * Order new hypo if strength is too low - Increase chlorine dose - Check upstream processes - Visual inspection clear water tank/reservoir - Reduce flow rate of plant	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Consider isolating Standpipe Reservoir and supply from Coolabah Reservoir - Shutdown plant and/or bore pump - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Mendooran
CCP ID	MDN3
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity br[illegible]	**Critical Limit** [illegible]ce of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamin[illegible] - Rectify integrity breach (e.g. [illegible]atch) - Notify Manager Warrumbu[illegible] Water (Ph. 0409 896 452) - Check chlorine res[illegible]al in reservoir a[illegible] upstream - Spot dose if n[illegible]essary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Mendooran
CCP ID	MDN4
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target >0.5 mg/L	**Alert Level** <0.3 mg/L	**Critical Limit** 0.1 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (weekly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual result - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Appendix F

Workshop Attendance List

Water Quality Risk Assessment Workshop - Attendance Register

Warrumbungles Shire Council (WSC)

Team Member	Role	Affiliation	Water Quality Experience	TUES 13-May-2014	WED 14-May-2014	THURS 15-May-2014
Ben Smith	Supervisor Warrumbungle Water (WW) Treatment Plants North	WSC				
Jarvis Watton	Technical Officer WW	WSC		sick		
Marty Gordon	Supervisor WW Mains North	WSC				
Brad Condon	Environmental & Health Officer	WSC	Coonted.			
Noel Gilbert	Recycling & Waste Compliance Officer	WSC	DWM Officer 15 Yrs			
Andrew Milford	Water & Wastewater Operators Coonabarabran	WSC	4 Yrs			
Sam Dunn	Supervisor WW South	WSC	Coolah & Dunedoo WTP			
Phillip Paul	Sewer Operator Coolah/Dunedoo.	WSC	WASTEWATER OPERATOR CLH/DDO			
Geoff Averillo	Supervisor Urban Services Mendooran	WSC	Mendooran WTP 18 months			
~~Dean Hartley~~	Urban Services Tractor Operator Mendooran	WSC				
Phil Hensby	Urban Services Truck Operator Baradine	WSC	Relief Operator 1 year, Fluoride Operation			
~~Fred Magann~~ PAUL WHITTAKER	~~Supervisor~~ Urban Services Binnaway	WSC	RELIEF OPERATOR 3YRS			
Craig Whitty	Urban Services Tractor Operator Binnaway	WSC	Relief Operater 18yrs			
Cornelia Wiebels	Manager Warrumbungles Water	WSC	since 04/2013 in current role, prior: 3.5 year with Siemens Water Techn.			
Kevin Tighe	~~Technical officer~~ DTS	WSC	Management > 20 years			
Ingo Steppat	Public Health Unit officer	NSW Health				
Mark Nave	Public Health Unit officer	NSW Health	EHO - 14 YEARS			
Bruce Lamont	Regional Inspector	NSW Office of Water		BSL	BSL	BSL

Team Member	Role	Affiliation	Water Quality Experience	TUES 13-May-2014	WED 14-May-2014	THURS 15-May-2014
Matt Parameter	Regional Inspector	NSW Office of Water				
Sandy Leask	NSW Health Water Unit representative	NSW Health				
Kate Miles	Project manager and workshop facilitator	AECOM	12 years w/WW + Risk Mgmt consulting			
Ryan Signor	Independent technical consultant (water engineering)	AECOM	" "	RJ	YES	
Matthew Oliver	Project engineer and workshop note taker	AECOM	Civil Engineer - 5 yrs water/wastewater	M.O.	M. Oliver	M. Oliver

Appendix B

Risk Assessment

Hazardous Event Code	System Code	Hazardous Event	Hazard	Hazard Category	Description of Consequences	Unmitigated Risk Evaluation			Existing Control Measures	Residual Risk Evaluation			Agreed Additional Preventive Measures	Proposed Follow Up Actions	Notes on basis of scoring (e.g. uncertainty)
						C	L	R		C	L	R			
1.00	**Catchment & Abstraction**														
1.01	ALL	- Chemicals from agricultural runoff near bores. - Spraying as a result of a pest plague. - Pest control - Illegal dumping/washing of drums - Spillage/leakage of chemical drums/tankers	Pesticides	Chemical (pesticides)	Chronic health impact	3	D	Moderate	- Drum muster program - Chemical training program for pesticide customers (Chemical certification process) - Media releases regarding spraying program - NSW Health testing program for pesticides (no detections above ADWG, 2011) - Spraying exclusion zones	3	D	Moderate		- Consider instigating a pesticide monitoring program	
1.02	BWY CBN MDN CLH DDO (surface)	- Pathogens from agricultural inputs due to surface water ingress. {significant agricultural activities not present within Timor Dam catchment} **[AGRICULTURAL HAZARDS]**	Cryptosporidium	Pathogens (Chlorine resistant e.g. *Crypto*)	Acute health impact	4	C	Very High	- Filtration (MDN, CBN, BWY) - Backup supply, bores (MDN) - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	4	D	High		- Consider turbidity monitoring of infiltration well water and river water on event basis at CLH, DDO to determine effectiveness of filtration - If sand bed demonstrates effective filtration consider making this a CCP	- High rainfall events/flood leading to E.Coli presence (MDN back-up bore) - Turbidity off filters average 0.5NTU
1.03	BUG KEN BDN (ground)	- Pathogens from agricultural inputs due to surface water ingress. **[AGRICULTURAL HAZARDS]**	Cryptosporidium	Pathogens (Chlorine resistant e.g. *Crypto*)	Acute health impact	4	C	Very High	- Filtration (BDN) - Bore casing and bore depth (>50m)	4	C	Very High		- Bore investigations (integrity, capping, geology, exclusion zones - fencing) - Private water bore inspections, bore register - Concrete capping of bore at BDN and DDO	- Based on worst case systems i.e without filtration - Open bore at BDN - Some private bores at KBI, BUG
1.04	BUG BWY CBN KEN MDN DDO	- Pathogens from septics - Unsewered properties in township (septic systems - BUG, KEN, MDN, BWY) - CBN STP upstream MDN, BWY - High rainfall events leading to E.Coli presence (MDN back-up bore) {significant agricultural activities not present within Timor Dam catchment} **[RURAL SEPTICS]**	Cryptosporidium	Pathogens (Chlorine resistant e.g. *Crypto*)	Acute health impact	5	C	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	5	D	Very High		- STP effluent review (i.e. quality, quantity from EPA report) to determine typical characteristics in effluent and the quality of treatment - Consider testing for E.Coli in raw water	
1.05	BUG BWY CBN KEN MDN	- Pathogens from agricultural inputs due to surface water ingress. - Wildlife in catchment - High rainfall events/flood leading to E.Coli events (MDN back-up bore) **[AGRICULTURAL]**	Chlorine sensitive pathogens	Pathogens (Chlorine sensitive e.g. Bacteria and viruses) Nutrients	Acute health impact	5	A	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Chlorine dosing - Coagulation (MDN, CBN, BWY, BDN) - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	4	D	High		- Timor Dam fence was damaged during the bushfires. Animal ingress is possible, fence to be replaced. Follow up with council engineer the status of the fence replacement program. Funding is available from insurance claim.	

1.06	ALL	- Pathogens from septics - Unsewered properties in township (septic systems - BUG, KEN, MDN, BWY) - CBN STP upstream MDN, BWY - High rainfall events leading to E.Coli presence (MDN back-up bore) **[RURAL]**	Chlorine sensitive pathogens	Pathogens (Chlorine sensitive e.g. Bacteria and viruses) Nutrients	Acute health impact	5	A	Very High	- Filtration (MDN, CBN, BWY, BDN) - Septic register, inspection program and risk rating (BWY, MDN) [not functioning yet] - Chlorine dosing - Coagulation (MDN, CBN, BWY, BDN) - Sandbed filtration (BWY, MDN, DDO, CLH) - Sedimentation and UV exposure (BWY, MDN, CBN) - Dam detention (CBN)	5	D	Very High			
1.06	MDN BDN BUG CBN	- Groundwater can contain naturally occuring iron and manganese	Iron and manganese	Chemicals (Fe & Mn) Radiological	Chemical chronic health impact (Mn ONLY) and aesthetic impacts	3	A	Very High	- Aeration (Timor Dam, CBN) - Aeration (cascade) /Oxidation (KMNO4) (MDN) - Aeration (BDN) - Coagulation and sedimentation	2	C	Moderate			- BDN, MDN raw water (Mn) detection - BDN (Fe) 6mg/L raw water
1.07	ALL	- Coal seam gas industry within area	All chemicals	Chemical	Chronic health impact	4	D	High		4	D	High		-Consider undertaking chemical testing on groundwater supplies to establish baseline WQ - Review of existing coal seam gas investigations in the area (i.e. EPA)	
1.08	ALL	- Illegal dumping - Recreational activities (boating) - vehicle spills/accident - private/public underground/aboveground fuel storages (petrol stations)	Hydrocarbons		Chronic health impact	3	D	Moderate	- Council are removing own underground storages - CLH depot, CBN depot, DDO depot hydrocarbon testing - Some locations of underground tanks known - Monitoring and remediation by suppliers	3	D	Moderate			
1.09	CBN	- Algal blooms	Cyanotoxins		Acute health impact	3	D	Moderate	- Dam aeration - Weekly algal count and identification - Council notifications - PAC dosing - Algaecide dosing (when required)	2	E	Low			- Never had a detection of toxic algae
1.10	CBN	- Algal blooms	Taste and odour		Aesthetic impact	3	C	High	- Dam aeration - Weekly algal count and identification - Council notifications - PAC dosing - Algaecide dosing (when required)	3	C	High		- Review PAC dosing effectiveness. Detention time for PAC limiting factor	
1.11	BDN	- Naturally occurring sulphide	Taste and odour		Aesthetic impact	3	A	Very High	- Aeration - Detection by operators during normal operation	2	D	Low			
1.12	ALL	- Naturally occuring	Radiological		Chronic health impact	3	E	Moderate	- DDO tested prior to new bore installed	3	E	Moderate		- CBN results to be followed up	- Testing at Gunnedah Hill

2.00	**Aeration and oxidation**														
2.01	BDN MDN	- Poor maintenance practises - Blower failure (BDN) - Dosing system failure (running out of KMNO4) - Hydrogen sulphide breakthrough	Iron and manganese and sulphide		Aesthetic impact	3	D	Moderate	- Daily inspections of blowers and dosing systems - Weekly chemical testing - Retention volume of the clarifier - Community notification	3	E	Moderate			
2.02	MDN	- Overdosing KMNO4 (pink water) - Lack of SOP for batching - Incorrect dosing adjustment on SCADA	Manganese		Aesthetic impact	3	C	High	- Operator training and experience - Daily monitoring - Interlocks with raw water pumps	3	E	Moderate		- Implement SOP for batching and dosing	
3.00	**Coagulation and Flocculation**														
3.01	MDN BWY CBN BDN	Overdosing coagulant: - operator error - instrumentation failure - incorrect interlocks - equipment failure - resulting in low pH and subsequently dissolving of copper and lead into drinking water	Copper and Lead		Chronic health impact	3	D	Moderate	- Daily testing (drop tests) and inspections - Jar testing (as required) - Operator training and experience - pH correction (CBN, BWY)	3	E	Moderate			
3.02	MDN BWY CBN BDN	Incorrect dosing of coagulant: - Highly turbid water - incorrect pH (underdosing/overdosing soda ash/lime/coagulant) - loss of control - alum pump failure	Pathogens		Acute health impact	5	C	Very High	- Daily testing (drop tests) and inspections - Jar testing (as required) - Operator training and experience - pH and turbidity monitoring - visual inspection - duty standby pumps - chlorine dosing - filtration/sedimentation/clarification	5	E	High		- Online interlocks for pH and turbidity on outlet for filters	
4.00	**Clarification/sedimentation**														
4.01	BDN CBN MDN BWY	BDN - Clarifier CBN/MDN/BWY - Sedimentation processes - incorrect coagulant dosing - flooding - short circuiting - wildlife access may lead to remobilisation of sediments	Turbidity/Colour		Aesthetic impact	3	C	High	- Alternating lagoons when turbidity increases above set point - Operator training and experience - Visual inspections - Jar testing for coagulant - established vegetation to resist lagoon erosion - Daily testing turbidity/colour/pH - Filtration (BDN, CBN, MDN, BWY)	3	D	Moderate		BDN - Strategy needs to be developed for continued supply during times of significant maintenance (e.g. utilising the lagoons temporarily)	
4.02	MDN BWY CBN BDN	- Wildlife cross-contamination - Clarification failure (BDN) - sedimentation failure (BWY, MDN, CBN)	All pathogens		Acute health impact	5	C	Very High	- Daily testing on turbidity/pH/colour - Operator training and experience - Jar testing for coagulant - Chlorine dosing - Filtration (BDN, CBN, MDN, BWY)	5	E	High			

5.00	Filtration														
5.01	MDN CBN BDN	- Incorrect filter media - Failed pressure transducer, incorrect headloss set point - incorrect backwashing, failed level sensors - not replacing filter media when required - Operator error or vandalism via dropping material into the filters blocking outlet, inhibiting backwash (leads to ineffective treatment) - Compressor failure leading to insufficient pressure to wash - Sedimentation/clarification failure leading to high turbidity	All pathogens		Acute health impact	5	A	Very High	- Time/head loss backwash (MDN/CBN) - Routine backwash x2 week (summer), x1 (winter) (BWY) - High turbidity from filtered water leading to manual backwash. Continual high turbidity will result in filter replacement - Daily backwash, timer and head loss backup (BDN) - Maintenance procedures (i.e. backwash blowers, cleaning instruments - not documented) - Operator experience and training - Flow meter on air line for blowers - Annual calibration of the pressure gauges - Routine inspection of equipment (i.e. checking for breakthrough, blockages of nozzles) - chlorine dosing - Online turbidity meter (CBN) on outlet of filters	4	D	High		- Develop SOP for filter maintenance - Consider online turbidity meter with interlocks at BDN. Consider interlocks for meters at CBN and MDN - Consider periodic inspection on filter media - Consider maintenance program for the filters	
5.02	BWY	- Incorrect filter media - Failed pressure transducer, incorrect headloss set point - incorrect backwashing, failed level sensors - not replacing filter media when required - Operator error or vandalism via dropping material into the filters blocking outlet, inhibiting backwash (leads to ineffective treatment) - Compressor failure leading to insufficient pressure to wash - Sedimentation/clarification failure leading to high turbidity	All pathogens		Acute health impact	5	A	Very High	- Time/head loss backwash (MDN/CBN) - Visual inspection to identify low level in balance tank indicate (BWY) - Routine backwash x2 week (summer), x1 (winter) (BWY) - High turbidity from filtered water leading to manual backwash. Continual high turbidity will result in filter replacement - Maintenance procedures (i.e. backwash blowers, cleaning instruments - not documented) - Operator experience and training - Flow meter on air line for blowers - Annual calibration of the pressure gauges - Routine inspection of equipment (i.e. checking for breakthrough, blockages of nozzles) - chlorine dosing - Online turbidity meter (CBN) on outlet of filters	5	D	Very High		- Develop SOP for filter maintenance - Consider online turbidity meter with interlocks at BWY. - Consider periodic inspection on filter media - Check filter media depth against design requirements at BWY - Consider maintenance program for the filters	

6.00	**pH correction**														
6.01	CBN BWY BDN	Loss of control of Lime (CBN) or soda ash (BWY, BDN) caused by: - pump failure - blocked piping - screw feeder failure - poor quality lime or soda ash - incorrect batching of soda ash - moisture in lime bin or hopper - hoppers haven't been filled - incorrect calibration of pH meters - raw water source quality	High or Low pH	Low pH	Aesthetic impact.	2	C	Moderate	- pH meters regularly calibrated - drop test - visual inspections - pH meters - daily sampling and testing - operator training and experience - maintenance of lime and soda ash systems and injection points	2	E	Low			pH >8.5 causes build-up of calcium carbonate. • pH > 10 also corrodes pipes, exposing users to health-related chemicals. • pH > 11 can cause irritation of eyes and, in sensitive populations, gastrointestinal irritation.
6.02	CBN BWY BDN	Overdosing of Lime or soda ash creating operational issues. Caused by high pH as a result of: - pump calibration failure - blocked pipe - incorrect calibration of pH meters - raw water source quality - incorrect batching This leads to less efficient treatment from disinfection due to reduced presence of hypochlorite.	All Pathogens	High pH	Acute health imact.	4	C	Very High	- pH meters regularly calibrated - drop test - visual inspections - pH meters - daily sampling and testing - operator training and experience - disinfection	4	E	High			pH >8.5 causes build-up of calcium carbonate and makes treatment and disinfection less effective. • pH > 10 also corrodes pipes, exposing users to health-related chemicals. • pH > 11 can cause irritation of eyes and, in sensitive populations, gastrointestinal irritation.
7.00	**Disinfection (Chlorine Dosing and Contact Vessels)**														
7.01	ALL	Under dosing from: - incorrect chlorine set point - operator error - instrumentation/equipment failure/incorrect calibration or running out of Chlorine Gas resulting in inadequate disinfection to control pathogens (system is not interlocked with chlorine pumps) - Air lock in the NaOCl or blockage from crystalisation - varying water quality i.e. turbidity, pH (due to manual water quality monitoring) - poor quality/incorrect concentration of chlorine - incorrect pH may affect chlorine residual - dillution batching (BUG, KBI, MDN)	Chlorine sensitive pathogens	Pathogens (Chlorine sensitive)	Acute health impact	5	A	Very High	- Operator training and experience - Daily chlorine residual testing after 20-30mins detention time (leaving plant and in reticulation) - Calibration of instruments	5	C	Very High		- Consider testing of hypochlorite strength - Consider program of analyser calibration - CLH implement process to identify when gas bottle is empty - Monitor the strength of the chlorine over a period of 6 months (MDN) - Investigate installation of chlorine mixer for batching or replacement with chlorine gas (MDN)	

7.02	ALL	Inherent issue as a result of chlorine dosing	DBPs	T &O, Chlorine, DBP's.	Chronic health impact	3	D	Moderate	- THM, chloracidic acids testing results below guideline levels, PHU - Upstream process (clarification, filtration) to remove organic material	3	E	Moderate			
7.03	ALL	Operating systems to achieve adequate chlorine through system. Overdosing of chlorine from: - incorrect chlorine set point - operator error - instrumentation/equipment failure - varying water quality i.e. turbidity, pH (due to manual water quality monitoring) - new hyperchlorite batch, with incorrect set point - poor mixing or short circuiting - incorrect concentration of chlorine	Taste & Odour	T &O, Chlorine, DBP's.	Aesthetic impact	3	C	High	- Operator training and experience - Daily chlorine residual testing after 20-30mins detention time (leaving plant and in reticulation) - Calibration of instruments - Injection into the line prior to clear water tank (except CBN)	3	D	Moderate			
8.00	**Fluoride**															
8.01	CBN BDN	Overdosing of fluoride from: - incorrect set point - operator error - complex water quality testing - instrumentation/equipment failure - poor mixing, short circuiting - incorrect concentration of chemicals - fluoride granual breakthrough - impurities in fluoride	Fluoride		Chronic health impact	3	C	High	- Operator training and experience - Fluoride ticket required - x2 trained operators required per system, min. x3 between 2 towns/systems - Monthly sampling sent to lab (retic) - Daily plant sampling - Weekly retic sampling - Daily calibration - If lab samples results differ +/- 20% from councils results, NSW Health/PHU notified. NSW Health will notify council - Council has access to NSW Drinking Water Database	3	D	Moderate		- Confirm process of extracting data from NSW Health Water Quality Database	CHL, MDN - to be commissioned shortly (BWY commissioned now)

9.00	Reservoirs														
9.01	ALL	Vermin and stormwater ingress: - unlocked hatches/poorly fitting hatches - inadequate netting - poor integrity of the roof - damage due to storm events - access via scour lines/overflow - Stormwater ingress leading to contamination from faecal matter from birds. - Malicious contamination or access to reservoir by unauthorised personnel leading to water contamination. - Malicious contamination or access to reservoir by unauthorised personnel leading to water contamination. BDN: - Holes in floor of plant allowing vermin ingress to clear water tank	All pathogens and all chemicals		Acute health impact	5	A	Very High	- Currently a tender process soon to commence (planned joint project with LMWUA) for reservoir inspection and cleaning - Ad hoc reservoir inspections - Lockable hatches, netting, roofing - Lockable ladders and removable ladders - Security fencing around reservoirs - Community notification	5	B	Very High		- Consider a routine reservoir inspection (checking locks etc) DDO: - Bullindah reservoir roof replacement (currently planned) MDN: - Coolabah requires vermin proofing CLH: - Wentworth/Martin St Res requires vermin proofing - Wentworth requires sealing BDN: - Clear water tank requires vermin proofing - Develop SOP for the access of reservoirs - Assess compliance regarding reservoir access with Australian standards and common sense - Consider working at heights training for staff (MDN)	
9.02	CBN MDN BDN	- Stratification of reservoir leading to low chlorine	All pathogens		Acute health impact	5	C	Very High	- Staff experience and training - Chlorine residual monitoring within reticulation system	5	C	Very High		- Consider investigation the status of other reservoirs (MDN, BDN, CBN) - Consider reviewing mixing options for reservoirs with common inlet/outlet - Consider implementing sampling regime for CBN, BDN for chlorine residual in the surface water for CT calculation	
9.03	ALL	Disturbance of sediments due to: - low volumes and then refilling - Inadequate/infrequent cleaning of tanks - Incorrect filling design	Turbidity, suspended material, Taste and Odour	Pathogens	Aesthetic impact	3	C	High	- Aqualift inspection and report (in the past, not ongoing) - Reservoir cleaning program (not currently in place; currently a tender process, soon to commence planned joint project with LMWUA for reservoir inspection and cleaning)	3	C	High		- Investigate options to clean BDN reservoir - Instigate reservoir cleaning program	BDN - last inspected 2008, not cleaned because sediment depth was too great (1.5m)

10.00	Distribution													
10.01	ALL	- Ingress of contaminates due to back flow or cross connections (including property illegal connections) - Illegal connection to standpipes - Improper practices by water carters - Backflow from tankers filling from inappropriate locations on the system	All pathogens and all chemicals	Various	Acute health impact	4	C	Very High	- Locks on standpipes - Backflow prevention devices on standpipes - Community notification of illegal connections, illegal water carter filling - Hydrant (and stop valve) maintenance in place	4	D	High		- Identify high risk areas for backflow prevention (i.e. STP) - Replace old water meters with new water meters including backflow prevention devices - Develop a communication protocol around monitoring data (i.e. distribution data feeding back to WTP) - Consider sampling and testing program following mains repairs	
10.02	ALL	- Mains breaks or unsanitary repairs leading to WQ issues including cross contamination of main repair equipment e.g. Sewer/Water. - Not chlorinating after a main break - Incorrect flushing procedures after a main break - Inappropriate storage of new pipework prior to installation. - Incorrect valve operation or valve failures leading to ingress of contaminates due to loss of pressure. - Unsanitary commissioning of a new main - Lack of flushing leading to high turbidity resulting in high chlorine take up - Oxidation of infrastructure inside reservoir leading to low chlorine residual	All pathogens and all chemicals	Various	Acute health impact	4	A	Very High	- Operator training and experience - Separation of water and sewer tools - Developing SWMS - Flushing of mains after repair - Maintaining chlorine residuals and monitoring	4	C	Very High		- Develop SOP around distribution failures such as main breaks, sufficient flushing, cleaning of tools - Consider developing a notification procedure main breaks - Consider closing household property meters prior to recommissioning mains - Obtain list of dialysis patients for each system - SEE 10.03 re: flushing schedule to improve chlorine residual in the distribution	- Same crews water/sewers but separate tools - Water and sewer mains within same easement
10.03	ALL	- Dead ends in reticulation - Incorrect/lack of flushing	Turbidity	Various	Aesthetic impact	2	A	High	- Operator training and experience - Flushing program (CBN, currently on hold) - Reactive flushing to customer compliants - Developing flushing schedule - Mains replacement	2	C	Moderate		- Finalise flushing schedule for remaining systems (CLH, DOO nothing currently in place) - Consider scouring program, including prioritisation of mains to be scoured - Consider tanker filling from dead ends (if backflow prevention available)	

10.04	ALL	Sloughing of biofilm leading to WQ complaints. May be caused by: - flushing of mains following a repair or replacement - reverse flow during a main break - excessive chlorine dose - Use of fire hydrants disturbing sediments in system. May be exacerbated by: - Dead ends in reticulation. - Incorrect/lack of flushing.	Taste & Odour	Pathogens Turbidity Taste & Odour	Aesthetic impact	2	C	Moderate	- Operator training and experience - Flushing program (CBN, currently on hold) - Reactive flushing to customer compliants - Developing flushing schedule - Mains replacement	2	C	Moderate			
11.00	**Whole of system**															
11.01	ALL	- Lack of online monitoring - Failure of telemetry (telemetry at Timor Dam for aeration)	Various	Various	Exceedence of ADWG health guideline	-	-	'	- Manual inspections required	-	-	'		- Consider online monitoring where CCPs have been identified	
11.02	ALL	- Entry of unauthorised persons leading to accidental or deliberate sabotage - Contractors/unauthorised staff have unsupervised access to treatment plants and reservoirs	Various	Various	Exceedence of ADWG health guideline	5	C	Very High	- Security fencing - Lockable buildings - Community notifying council of any security breaches - Contractor entry under supervision	5	E	High		- Electronic key system currently being investigated	
11.03	ALL	- Loss of power/brown outs at treatment plants due to inadequate power supply, storm events or planned outages resulting in loss of treatment control.	Various	Various	Exceedence of ADWG health guideline	1	B	Moderate	- Pumps need to be manually reset after blackout - CBN plant resets - Interlocks within system - Surge protection on equipment	1	B	Moderate			
11.04	ALL	- Extreme weather events: e.g. bushfire, flood	Various		Exceedence of ADWG health guideline	5	D	Very High	- Secondary supply - Water carting - Double treating in high turbidity events (CBN) - Water treatment processes - Borehead integrity (BDN)	5	E	High			- Fire retardants are generally at safe levels
11.05	ALL	- Incorrect chemical delivery (quality assurance, type) - Tank filled with incorrect chemical	All chemicals		Exceedence of ADWG health guideline	5	C	Very High	- Staff need to be onsite to accept delivery - Labelling of containers/walls - Sighting delivery docket	5	D	Very High			

11.06	MDN BWY BDN	Staff management: - Loss of skilled staff - Other responsibilities pulling operators away from key water management duties - Reporting structure creates confusion for staff and limits the ability of the manager to the direct staff to perform water/wastewater duties - Communication is inhibited by current structure which may pose risk during emergency events	ALL		ALL	5	A	Very High	- Agreement between water manager and urban services around staff management	5	A	Very High		- Review staff structure of water services team, PHU and NOW to provide support	
11.07	ALL	- There is not enough water for consumption and hygiene needs, continuously, seasonally or in parts of distribution systems.	Various		- Illness from harmful microorganisms due to poor hygiene or use of alternative lower-quality supplies. - Dehydration	5	D	Very High	- Drought management plan - Accredited water carters - Water restrictions	5	E	High			
12.00	**Monitoring & Management System**														
12.01	ALL	Lack of DWMS including: - SOPs - Operator training - Maintenance practices - Location of water quality monitoring sample points not being representative of whole of system. - Succession planning - Calibration of instrumentation - Qualified contactors and consultants - emergency response procedure - chemical delivery procedures	Various		Exceedence of ADWG health guideline	5	A	Very High	- Development of DWMS and implementation of the DWMS - All of the above	5	C	Very High			

Appendix C

HACCP Summary Tables

Critical Control Points Reference Guide – Warrumbungle Shire Council

Baradine

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Baradine	BDN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BDN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	1.2 mg/L	<1.0 mg/L
	BDN3	Fluoridation	Fluoride	Fluoride	1 mg/L (leaving WFP, leaving reservoir and throughout distribution system)	<0.9 mg/L or >1.1 mg/L (calculated daily concentration) OR 1.2 – 1.5 mg/L (concentration leaving reservoir) OR >1.5 mg/L (concentration leaving WFP)	>1.5 mg/L (calculated daily concentration) OR >1.4 mg/L (concentration leaving reservoir)
	BDN4	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BDN5	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Baradine
CCP ID	BDN1
What is the control point?	Filtration
What are the hazards?	All pathogens
What is being monitored?	Turbidity
What will initiate response?	High turbidity reading (online or from grab sample)

Target <0.8 NTU	**Alert Level** >0.9 NTU	**Critical Limit** >1.0 NTU
Monitoring Systems Monitoring parameter: Turbidity Monitoring location: Outlet of filter Monitoring frequency: Daily grab sample - Calibration of instruments - Visual inspection of filters - Routine monitoring program - Backwashing filters (time based/on high turbidity read) - Testing raw water - Coagulation/sedimentation/clarification monitoring (daily sampling) - Hose down filter whilst backwashing - Pressure cleaning of filters annually - Check media annually - Visual inspection of clarifier floc and inspection of the blowers	**Corrective actions** - Check settled water turbidity * check dosing * jar tests * adjust dose accordingly - Check filter operation * check headloss * check time since last backwash - Instigate backwash * recheck headloss * resample and test	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Dump clarifier water - Reduce flow rate through filters - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Check reticulation for chlorine residual and turbidity - Microbiological sampling and testing - Dose with chlorine - Consider instigating a boil water alert

Water Supply System	Baradine
CCP ID	BDN2
What is the control point?	Disinfection (gas)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** 1.2 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Leaving WTP Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and in reticulation) - Calibration of instruments - Check rotameter - Check auto changer over - Check bottles aren't empty **NOTE:** Standby bottles available	**Corrective actions** - Check rotameter - Check for gas line leaks - Check bottles aren't empty * manual change over * order new bottle - Check injector - Check service water and head unit - Increase chlorine dose - Check upstream processes - Visual inspection clear water tank/reservoir - Reduce flow rate of plant	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Shutdown plant - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Baradine
CCP ID	BDN3
What is the control point?	Fluoridation
What are the hazards?	Over or under-dose of fluoride
What is being monitored?	Fluoride concentration (daily sampling at WFP and reservoir, daily concentration calculation)
What will initiate response?	In response to low or high fluoride concentration

Target Leaving WFP, leaving reservoir and throughout distribution system 1.0 mg/L	**Alert Level** Calculated daily concentration 0.9 or 1.1 mg/L OR Concentration leaving reservoir 1.2 mg/L OR concentration leaving WFP > 1.5 mg/L	**Critical Limit** Calculated daily concentration >1.5 mg/L OR Concentration leaving reservoir >1.4 mg/L
Monitoring Systems Monitoring parameter: Fluoride Monitoring location: Monitoring out of the plant, out of the reservoir and throughout distribution system Monitoring frequency: Daily/weekly - Visual inspection of the system - Raw water testing as required - Daily measurement of volume treated and weight fluoride dosed with calculation of average daily fluoride concentration - Daily testing at outlet to water filtration plant and outlet from clear water storage reservoir - Weekly testing in distribution system	**Corrective actions** - Confirm calculations or resample and test - Conduct screw feeder and pump drop tests - Confirm current WTP flow rate and fluoride dosing rate - Adjust fluoride powder screw feeder - Test concentration leaving WFP more frequently - Consider temporarily shutting down fluoride dosing system	**Corrective actions** - Shutdown fluoride dosing system. - Test fluoride in reservoirs and reticulation - Identify cause & rectify problem - Consider contacting the following for advice: - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Refer to Fluoride Response Plan

Water Supply System	Baradine
CCP ID	BDN3
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Baradine
CCP ID	BDN4
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (Monthly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual result - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Bugaldie

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Bugaldie	BUG1	Disinfection (Hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	< 1.3 mg/L	< 1.0 mg/L
	BUG2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BUG3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Bugaldie
CCP ID	BUG1
What is the control point?	Disinfection (hypo)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** <1.3 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Off elevated reservoir outlet Monitoring frequency: Daily - Daily chlorine residual testing (off elevated reservoir outlet and in reticulation) - Calibration of instruments - Check batch tanks - Check pumps	**Corrective actions** - Check chlorine batch tank - Check pumps and dosing lines - Check injector - Check strength of hypo * Order new hypo if strength is too low - Increase chlorine dose - Visual inspection clear water tank/reservoir	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Shutdown bore pump - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Bugaldie
CCP ID	BUG2
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Bugaldie
CCP ID	BUG3
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (monthly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - Check for line breaks - Flush location of low chlorine residual result - Sample and re-test	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Binnaway

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Binnaway	BWY1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	BWY2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 mg/L	<1.5 mg/L	<1.2 mg/L
	BWY3	Fluoridation	Fluoride	Fluoride	1 mg/L (leaving WFP, leaving reservoir and throughout distribution system)	<0.9 mg/L or >1.1 mg/L (calculated daily concentration) OR 1.2 – 1.5 mg/L (concentration leaving reservoir) OR >1.5 mg/L (concentration leaving WFP)	>1.5 mg/L (calculated daily concentration) OR >1.4 mg/L (concentration leaving reservoir)
	BWY4	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	BWY5	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Binnaway
CCP ID	BWY1
What is the control point?	Filtration
What are the hazards?	All pathogens
What is being monitored?	Turbidity
What will initiate response?	High turbidity reading (online or from grab sample)

Target <0.8 NTU	**Alert Level** >0.9 NTU	**Critical Limit** >1.0 NTU
Monitoring Systems Monitoring parameter: Turbidity Monitoring location: Outlet of filter Monitoring frequency: Daily grab sample - Calibration of instruments - Visual inspection of filters - Routine monitoring program - Backwashing filters (time based/on high turbidity read) - Testing raw water - Coagulation/sedimentation/clarification monitoring (daily sampling) - Hose down filter whilst backwashing - Pressure cleaning of filters annually - Check media annually	**Corrective actions** - Check settled water turbidity * check dosing * jar tests * adjust dose accordingly - Check filter operation * check headloss * check time since last backwash - Instigate backwash * recheck headloss * resample and test	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Recirculate settled water through to front of plant (i.e. through lagoons) - Undertake jar test and adjust dose - Sample and retest after ~12 hours (plant will have come back into equilibrium) - Reduce flow rate through filters - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Check reticulation for chlorine residual and turbidity - Microbiological sampling and testing - Dose with chlorine - Consider instigating a boil water alert

Water Supply System	Binnaway
CCP ID	BWY2
What is the control point?	Disinfection (gas)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 2.0 mg/L	**Alert Level** <1.5 mg/L	**Critical Limit** <1.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Leaving WTP Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and in reticulation, sample is rested for 20mins before testing) - Calibration of instruments - Check rotameter - Check auto changer over - Check bottles aren't empty **NOTE:** Standby bottles available	**Corrective actions** - Check rotameter - Check for gas line leaks - Check bottles aren't empty * manual change over * order new bottle - Check injector - Check service water and head unit - Increase chlorine dose - Check upstream processes - Visual inspection clear water tank/reservoir - Reduce flow rate of plant	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Shutdown plant - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Binnaway
CCP ID	BWY3
What is the control point?	Fluoridation
What are the hazards?	Over or under-dose of fluoride
What is being monitored?	Fluoride concentration (daily sampling at WFP and reservoir, daily concentration calculation)
What will initiate response?	In response to low or high fluoride concentration

Target Leaving WFP, leaving reservoir and throughout distribution system 1.0 mg/L	**Alert Level** Calculated daily concentration 0.9 or 1.1 mg/L OR Concentration leaving reservoir 1.2 mg/L OR concentration leaving WFP > 1.5 mg/L	**Critical Limit** Calculated daily concentration >1.5 mg/L OR Concentration leaving reservoir >1.4 mg/L
Monitoring Systems Monitoring parameter: Fluoride Monitoring location: Monitoring out of the plant, out of the reservoir and throughout distribution system Monitoring frequency: Daily/weekly - Visual inspection of the system - Raw water testing as required - Daily measurement of volume treated and weight fluoride dosed with calculation of average daily fluoride concentration - Daily testing at outlet to water filtration plant and outlet from clear water storage reservoir - Weekly testing in distribution system	**Corrective actions** - Confirm calculations or resample and test - Conduct screw feeder and pump drop tests - Confirm current WTP flow rate and fluoride dosing rate - Adjust fluoride powder screw feeder - Test concentration leaving WFP more frequently - Consider temporarily shutting down fluoride dosing system	**Corrective actions** - Shutdown fluoride dosing system. - Test fluoride in reservoirs and reticulation - Identify cause & rectify problem - Consider contacting the following for advice: - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Refer to Fluoride Response Plan

Water Supply System	Binnaway
CCP ID	BWY3
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Binnaway
CCP ID	BWY4
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (fortnightly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual result - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Coonabarabran

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coonabarabran	CBN1	Filtration	All pathogens	Turbidity	<0.8 NTU	>0.9 NTU	>1.0 NTU
	CBN2	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	2.0 – 5.0 mg/L	<1.8 mg/L	<1.5 mg/L
	CBN3	Fluoridation	Fluoride	Fluoride	1 mg/L (leaving WFP, leaving reservoir and throughout distribution system)	<0.9 mg/L or >1.1 mg/L (calculated daily concentration) OR 1.2 – 1.5 mg/L (concentration leaving reservoir) OR >1.5 mg/L (concentration leaving WFP)	>1.5 mg/L (calculated daily concentration) OR >1.4 mg/L (concentration leaving reservoir)
	CBN4	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CBN5	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Coonabarabran
CCP ID	CBN1
What is the control point?	Filtration
What are the hazards?	All pathogens
What is being monitored?	Turbidity
What will initiate response?	High turbidity reading (online or from grab sample)

Target <0.8 NTU	**Alert Level** >0.9 NTU	**Critical Limit** >1.0 NTU
Monitoring Systems Monitoring parameter: Turbidity Monitoring location: Outlet of filter Monitoring frequency: Online - Calibration of instruments - Visual inspection of filters - Routine monitoring program - Backwashing filters (time based/on high turbidity read) - Testing raw water - Coagulation/sedimentation/clarification monitoring (daily sampling) - Hose down filter whilst backwashing - Pressure cleaning of filters annually - Check media annually	**Corrective actions** - Check settled water turbidity * check dosing * jar tests * adjust dose accordingly - Check filter operation * check headloss * check time since last backwash - Instigate backwash * recheck headloss * resample and test - Consider source water option depending on situation	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Recirculate settled water through to front of plant (i.e. through lagoons) - Undertake jar test and adjust dose - Sample and retest after ~12 hours (plant will have come back into equilibrium) - Reduce flow rate through filters - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Check reticulation for chlorine residual and turbidity - Microbiological sampling and testing - Dose with chlorine - Consider instigating a boil water alert

Water Supply System	Coonabarabran
CCP ID	CBN2
What is the control point?	Disinfection (gas)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 2.0 – 5.0 mg/L	**Alert Level** <1.8 mg/L	**Critical Limit** <1.5 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Leaving WTP Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and in reticulation) - Calibration of instruments - Check rotameter - Check auto changer over - Check bottles aren't empty **NOTE:** Standby bottles available	**Corrective actions** - Check rotameter - Check for gas line leaks - Check bottles aren't empty * manual change over * order new bottle - Check injector - Check service water and head unit - Increase chlorine dose - Check upstream processes - Visual inspection clear water tank/reservoir - Reduce flow rate of plant	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Shutdown plant - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Coonabarabran
CCP ID	CBN3
What is the control point?	Fluoridation
What are the hazards?	Over or under-dose of fluoride
What is being monitored?	Fluoride concentration (daily sampling at WFP and reservoir, daily concentration calculation)
What will initiate response?	In response to low or high fluoride concentration

Target Leaving WFP, leaving reservoir and throughout distribution system 1.0 mg/L	**Alert Level** Calculated daily concentration 0.9 or 1.1 mg/L OR Concentration leaving reservoir 1.2 mg/L OR concentration leaving WFP > 1.5 mg/L	**Critical Limit** Calculated daily concentration >1.5 mg/L OR Concentration leaving reservoir >1.4 mg/L
Monitoring Systems Monitoring parameter: Fluoride Monitoring location: Monitoring out of the plant, out of the reservoir and throughout distribution system Monitoring frequency: Daily/weekly - Visual inspection of the system - Raw water testing as required - Daily measurement of volume treated and weight fluoride dosed with calculation of average daily fluoride concentration - Daily testing at outlet to water filtration plant and outlet from clear water storage reservoir - Weekly testing in distribution system	**Corrective actions** - Confirm calculations or resample and test - Conduct screw feeder and pump drop tests - Confirm current WTP flow rate and fluoride dosing rate - Adjust fluoride powder screw feeder - Test concentration leaving WFP more frequently - Consider temporarily shutting down fluoride dosing system	**Corrective actions** - Shutdown fluoride dosing system. - Test fluoride in reservoirs and reticulation - Identify cause & rectify problem - Consider contacting the following for advice: - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Refer to Fluoride Response Plan

Water Supply System	Coonabarabran
CCP ID	CBN4
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Coonabarabran
CCP ID	CBN5
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (monthly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual result - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Coolah

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Coolah	CLH1	Disinfection (gas)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	CLH2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	CLH3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	<1.0 mg/L	0.8 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Coolah
CCP ID	CLH1
What is the control point?	Disinfection (gas)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** <1.3 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Wentworth and Martin St reservoirs Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and in reticulation) - Calibration of instruments - Check rotameter - Check bottles aren't empty **NOTE:** Spare bottles available	**Corrective actions** - Check rotameter - Check for gas line leaks - Check bottles aren't empty * manual change over * order new bottle - Check injector - Check service water and head unit - Increase chlorine dose - Check upstream processes - Visual inspection clear water tank/reservoir - Reduce flow rate of plant	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Shutdown bore pump - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Coolah
CCP ID	CLH2
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Coolah
CCP ID	CLH3
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 1.0 – 1.5 mg/L	**Alert Level** <1.0 mg/L	**Critical Limit** 0.8 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (Daily) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual result - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Dunedoo

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Dunedoo	DDO1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.2 mg/L	<1.0 mg/L
	DDO2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	DDO3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	1.0 – 1.5 mg/L	<1.0 mg/L	0.8 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Dunedoo
CCP ID	DDO1
What is the control point?	Disinfection (hypo)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** <1.2 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Outlet of Bullindah St reservoir and Rhodes St reservoir Monitoring frequency: Daily - Daily chlorine residual testing (leaving reservoirs and in reticulation) - Calibration of instruments - Check batch tanks - Check pumps	**Corrective actions** - Check chlorine batch tank - Check pumps and dosing lines - Check injector - Check strength of hypo * Order new hypo if strength is too low - Increase chlorine dose - Visual inspection clear water tank/reservoir	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Shutdown bore pump - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Dunedoo
CCP ID	DDO2
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Dunedoo
CCP ID	DDO3
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 1.0 – 1.5 mg/L	**Alert Level** <1.0 mg/L	**Critical Limit** 0.8 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system (at dead ends) Monitoring frequency: Manual water quality testing (Daily) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual result - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Kenebri

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Kenebri	KBI1	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.5 mg/L	<1.3 mg/L	<1.0 mg/L
	KBI2	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	KBI3	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	0.6 mg/L	0.5 mg/L	0.2 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Kenebri
CCP ID	KBI1
What is the control point?	Disinfection (hypo)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.5 mg/L	**Alert Level** <1.3 mg/L	**Critical Limit** <1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Outlet of reservoir Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant or reservoir and in reticulation) - Calibration of instruments - Check batch tanks - Check pumps	**Corrective actions** - Check chlorine batch tank - Check pumps and dosing lines - Check injector - Check strength of hypo * Order new hypo if strength is too low - Increase chlorine dose - Visual inspection clear water tank/reservoir	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Shutdown bore pump - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Kenebri
CCP ID	KBI2
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Kenebri
CCP ID	KBI3
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target 0.6 mg/L	**Alert Level** 0.5 mg/L	**Critical Limit** 0.2 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (monthly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual result - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Mendooran

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Mendooran	MDN1	Filtration	All pathogens	Turbidity	<0.5 NTU	>0.8 NTU	>1.0 NTU
	MDN2	Disinfection (hypo)	Chlorine sensitive pathogens	Chlorine	1.6 mg/L	<1.2 mg/L	≤1.0 mg/L
	MDN3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity (hatches locked, no holes in meshing)	Detection of breach of integrity (i.e. open hatch, hole in netting)	Evidence of contamination (hazard identified, i.e. vermin in reservoir, illegal access)
	MDN4	Distribution	Chlorine sensitive pathogens and all chemicals	Chlorine	>0.5 mg/L	<0.3 mg/L	0.1 mg/L

Target	This is where you want your system to be operating. Try to maintain levels equal to or greater quality the required value.
Alert Level	First indication your system may have a problem or a potential problem. Increase monitoring and refer to CCP management plans.
Critical Limit	At this limit you have lost control of your system. As a matter of urgency refer to CCP management plans and try to remediate problem.

Water Supply System	Mendooran
CCP ID	MDN1
What is the control point?	Filtration
What are the hazards?	All pathogens
What is being monitored?	Turbidity
What will initiate response?	High turbidity reading (online or from grab sample)

Target <0.5 NTU	**Alert Level** >0.8 NTU	**Critical Limit** >1.0 NTU
Monitoring Systems Monitoring parameter: Turbidity Monitoring location: Outlet of filter Monitoring frequency: Online - Calibration of instruments - Visual inspection of filters - Routine monitoring program - Backwashing filters (time based/on high turbidity read) - Testing raw water - Coagulation/sedimentation/clarification monitoring (daily sampling) - Hose down filter whilst backwashing - Pressure cleaning of filters annually - Check media annually	**Corrective actions** - Check settled water turbidity * check dosing * jar tests * adjust dose accordingly - Check filter operation * check headloss * check time since last backwash - Instigate backwash * recheck headloss * resample and test	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Recirculate settled water through to front of plant (i.e. through lagoons) - Undertake jar test and adjust dose - Sample and retest after ~12 hours (plant will have come back into equilibrium) - Reduce flow rate through filters - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Check reticulation for chlorine residual and turbidity - Microbiological sampling and testing - Dose with chlorine - Consider instigating a boil water alert

Water Supply System	Mendooran
CCP ID	MDN2
What is the control point?	Disinfection (hypo)
What are the hazards?	All pathogens
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low chlorine residual

Target 1.6 mg/L	**Alert Level** <1.2 mg/L	**Critical Limit** ≤1.0 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Leaving Coolabah reservoir and the plant Monitoring frequency: Daily - Daily chlorine residual testing (leaving plant and reservoir and in reticulation) - Calibration of instruments - Check batch tanks - Check pumps - Bleed pumps and clean injection point	**Corrective actions** - Check chlorine batch tank - Check pumps and dosing lines - Check injector - Check strength of hypo * Order new hypo if strength is too low - Increase chlorine dose - Check upstream processes - Visual inspection clear water tank/reservoir - Reduce flow rate of plant	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Consider isolating Standpipe Reservoir and supply from Coolabah Reservoir - Shutdown plant and/or bore pump - Spot dose and resample - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Microbiological sampling and testing - Consider instigating a boil water alert

Water Supply System	Mendooran
CCP ID	MDN3
What is the control point?	Reservoirs
What are the hazards?	All pathogens and All chemicals
What is being monitored?	Reservoir integrity
What will initiate response?	Any sign of reservoir integrity breach

Target No breach of reservoir integrity	**Alert Level** Any sign of integrity breach	**Critical Limit** Evidence of a breach of reservoir integrity
Monitoring Systems Monitoring parameter: Reservoir integrity Monitoring location: At reservoirs Monitoring frequency: Ad-hoc visual inspection by operators - Ad-hoc visual inspection (checking perimeter fencing/gates/hatches/locks/netting/roofing) **NOTE:** Routine inspection is to be implemented	**Corrective actions** - Check for evidence of contamination - Rectify integrity breach (e.g. patch) - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Check chlorine residual in reservoir and upstream - Spot dose if necessary	**Corrective actions** - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Consider instigating a boil water alert - Remove contamination source * restore integrity - Dump water if appropriate * clean reservoir - Spot dose and resample - Fill reservoir and check for chlorine residual - Microbiological sampling and testing

Water Supply System	Mendooran
CCP ID	MDN4
What is the control point?	Distribution
What are the hazards?	All pathogens and all chemicals
What is being monitored?	Free chlorine residual
What will initiate response?	In response to low free chlorine residual

Target >0.5 mg/L	**Alert Level** <0.3 mg/L	**Critical Limit** 0.1 mg/L
Monitoring Systems Monitoring parameter: Free chlorine residual Monitoring location: Sampling points in the distribution system Monitoring frequency: Manual water quality testing (weekly) - Routine monitoring program - WQ testing officer to provide results to manager - Entered into data spreadsheet - Main repair documentation	**Corrective actions** - Check reservoir chlorine residual (if low refer to CCP for reservoirs) * inspect reservoir * spot dosing * check plant chlorine residuals (refer to chlorination CCP) - check for line breaks - Flush location of low chlorine residual result - Sample and retest	**Corrective actions** - Follow all AL corrective actions - Notify Manager Warrumbungle Water (Ph. 0409 896 452) - Call PHU (Ph. 0407 551 548) and NOW (Ph. 0458 268 453) - Sampling and testing within reticulation for chlorine residual - Consider instigating a boil water alert - Microbiological sampling and testing

Appendix D

Document Register

DWMS Document Register - Warrumbungle Shire Council

Last Date Updated	17/10/2014
Updated by (Name)	e.g. Cornelia Wiebels
Updated by (Title)	e.g. Water and Wastewater Manager
Version Number	0.1

Element		Component		Document Name	Author	Document Number	Date Updated	Responsible Person	Electronic File Location	Hard Copy Document Location(s)	Comments
1	Commitment to drinking water quality management	1.1	Drinking Water Quality Policy								
		1.2	Regulatory and Formal Requirements								
		1.3	Engaging Stakeholders								
2	Assessment of the drinking water supply system	2.1	Water Supply System Analysis								
		2.2	Assessment of Water Quality Data								
		2.3	Hazard Identification and Risk Assessment								
3	Preventive measures for drinking water quality management	3.1	Preventive Measures and Multiple Barriers								
		3.2	Critical Control Points								
4	Operational Procedures and process control	4.1	Operational Procedures								
		4.2	Operational Monitoring								
		4.3	Corrective Action								
		4.4	Equipment Capability and Maintenance								
		4.5	Materials and Equipment								
5	Verification of drinking water quality	5.1	Drinking Water Quality Monitoring								
		5.2	Consumer satisfaction								
		5.3	Short-term evaluation of results								
		5.4	Corrective Action								

6	**Management of incidents and emergencies**	**6.1**	Communication								
		6.2	Incident and Emergency Response Protocols								
7	**Employee awareness and training**	**7.1**	Employee Awareness and Involvement								
		7.2	Employee Training								
8	**Community Involvement and awareness**	**8.1**	Community Consultation								
		8.2	Communication								
9	**Research and Development**	**9.1**	Investigative Studies and Research Monitoring								
		9.2	Validation of Processes								
		9.3	Design of Equipment								
10	**Documentation and Reporting**	**10.1**	Management of Documentation and Records								
		10.2	Reporting								
11	**Evaluation and audit**	**11.1**	Long-Term Evaluation of Results								
		11.2	Audit of Drinking Water Quality Management								
12	**Review and continual improvement**	**12.1**	Review by senior executive								
		12.2	Drinking Water Quality Mangement Improvement Plan								

Appendix E

Standard Operating Procedures

Appendix F

Response Protocols for Water Quality Incidents

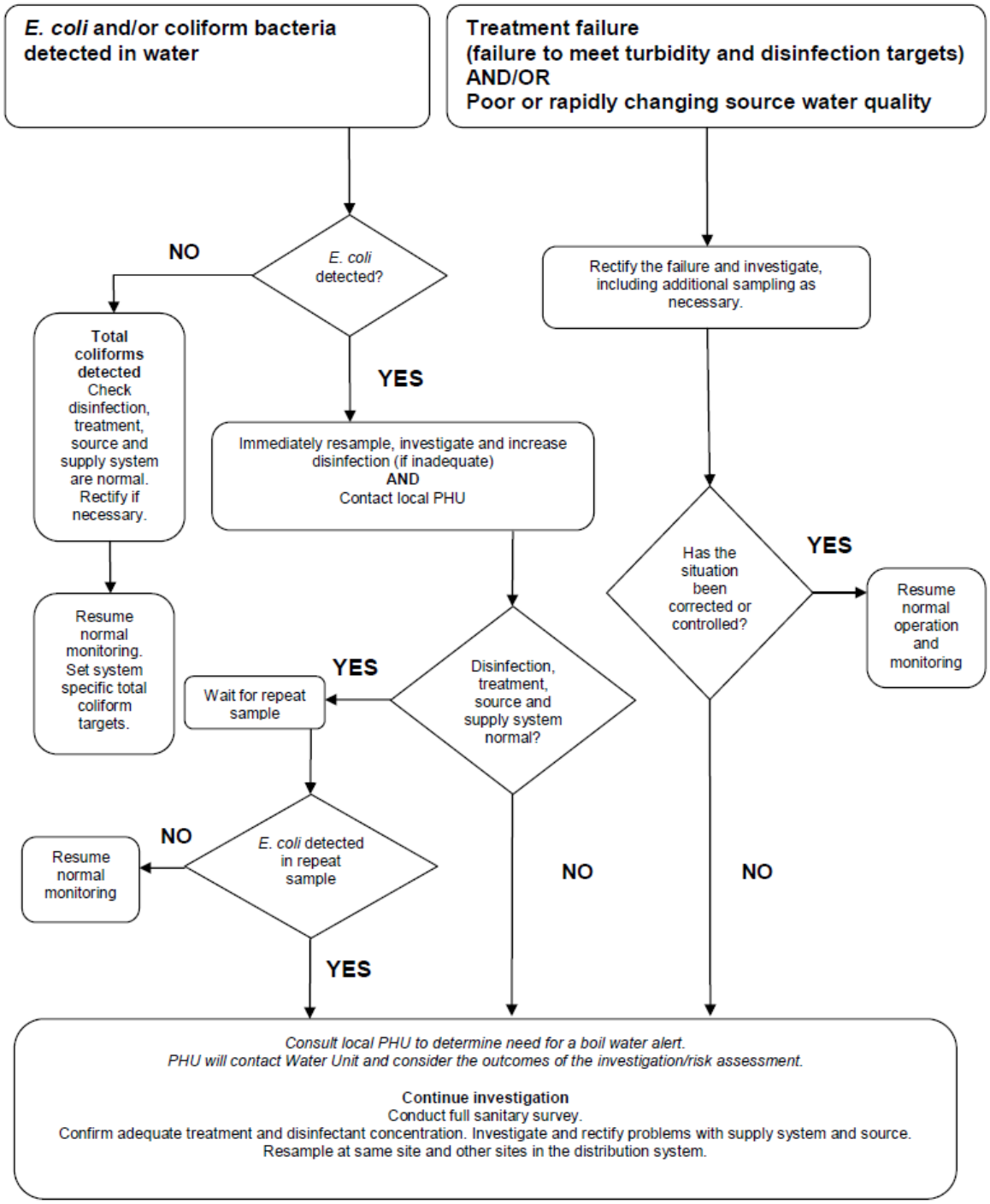

Figure 19 Response protocol for microbiological quality incident (NSW Health, 2013a)

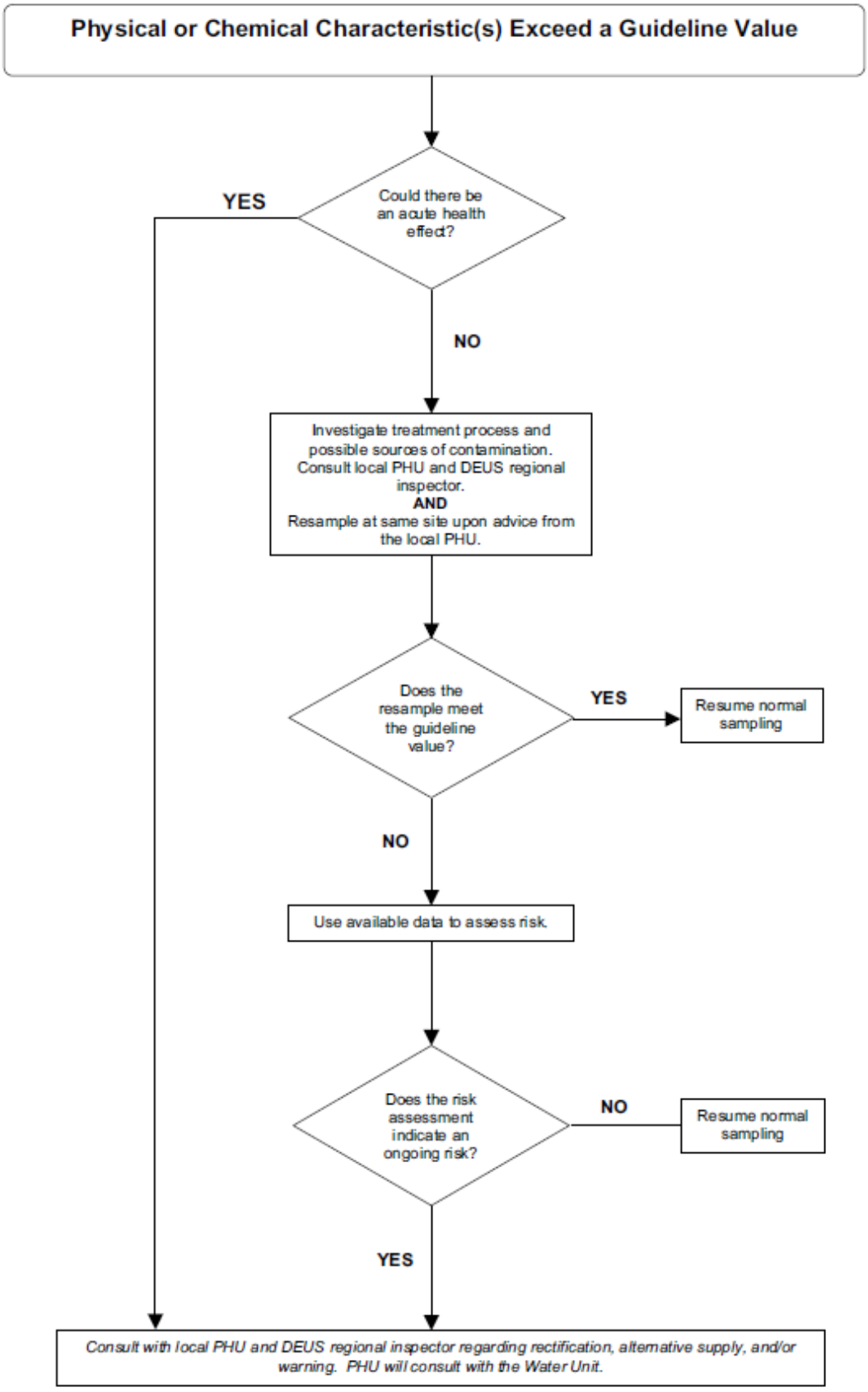

Figure 20 Response protocol for physical and chemical quality incidents (NSW Health, 2013b)