CENTRAL DARLING SHIRE COUNCIL

CENTRAL DARLING SHIRE COUNCIL DRINKING WATER MANAGEMENT SYSTEM

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DOCUMENT CONTROL SHEET

DOCUMENT

Central Darling Shire Council Drinking Water Management System

LOCAL WATER UTILITY

Central Darling Shire Council

UTILITY CONTACT

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CENTRAL DARLING SHIRE COUNCIL

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GLOSSARY

Term	Definition
ABS	Australian Bureau of Statistics
ADWG	Australian Drinking Water Guidelines 2011 published by the National Health and Medical Research Council (NHMRC). Primary guidance for drinking water quality and management within Australia
catchment	area of land that collects rainfall and contributes to surface water (streams, rivers, wetlands) or to groundwater
coagulation	clumping together of very fine particles into larger particles using chemicals (coagulants) that neutralise the electrical charges of the fine particles and destabilise the particles
critical control point (CCP)	An activity, procedure or process at which control can be applied and which is essential to prevent or eliminate a hazard or reduce it to an acceptable level
critical limit	a prescribed tolerance that must be met to ensure that a critical control point effectively controls a potential health hazard; a criterion that separates acceptability from unacceptability
Cryptosporidium	microorganism commonly found in lakes and rivers that is highly resistant to disinfection
C.t.	the product of residual disinfectant concentration (C) in milligrams per litre determined before or at taps providing water for human consumption, and the corresponding disinfectant contact time (t) in minutes
cyanobacteria	bacteria containing chlorophyll and phycobilins, commonly known as 'blue-green algae'
DBP	Disinfection By-Product
DISPLAN	Local Disaster Management Plans, often prepared by Councils in compliance with the State Emergency and Rescue Management Act, 1989.
DWMS	Drinking Water Management System
DWSS	Drinking Water Supply System
disinfection	an oxidising agent (e.g. chlorine, chlorine dioxide, chloramines and ozone) that is added to water in any part of the treatment or distribution process and is intended to kill or inactivate pathogenic (disease-causing) microorganisms
distribution system	a network of pipes, pumps and reservoirs leading from a treatment plant to customers' plumbing system
EPA	Environment Protection Authority
Escherichia coli (*E. coli*)	bacterium found in the gut, used as an indicator of faecal contamination of water
filtration	process in which particulate matter in water is removed by passage through porous media
flocculation	process in which small particles are agglomerated into larger particles (which can settle more easily) through gentle stirring by hydraulic or mechanical means
GL	Gigalitres
groundwater	water contained in rocks or subsoil

guideline value	the concentration or measure of a water quality characteristic that, based on present knowledge, either does not result in any significant risk to the health of the consumer (health-related guideline value), or is associated with good quality of water (aesthetic guideline value).
HU	Hazen Unit (colour)
hazard	a biological, chemical, physical or radiological agent that has the potential to cause harm
hazardous event	an incident or situation that can lead to the presence of a hazard (what can happen and how)
Improvement Plan	A Drinking Water Quality Management Improvement Plan as required under Element 12 of the Framework
L/s	litres per second
LEP	Local Environment Plan
mg/L	milligrams per litre
ML	megalitre
ML/d	megalitres per day
maximum risk	a risk in the absence of preventive measures
multiple barriers	use of more than one preventive measures as a barrier against hazards
NTU	Nephelometric Turbidity Units
OSSM	On-site sewage management
operational monitoring	the planned sequence of measurements and observations used to assess and confirm that individual barriers and preventative strategies for controlling hazards are functioning properly and effectively
PAC	Powdered Activated Carbon
pathogen	an organism capable of eliciting disease symptoms in another organism
pH	value taken to represent acidity or alkalinity of an aqueous solution; expressed as a logarithm of the reciprocal of the hydrogen ion activity in moles per litre at a given temperature
preventive measure	any planned action, activity or process that is used to prevent hazards from occurring or reduce them to acceptable levels
quality assurance program	all the planned and systematic activities implemented within the quality system, and demonstrated as needed, to provide adequate confidence that an entity will fulfil requirements for quality (AS/NZS ISO 8402:1994)
raw water	the water entering the first treatment process of a water treatment plant; water in its natural state, prior to any treatment
reservoir	any natural or artificial holding area used to store, regulate or control water
residual risk	the risk remaining after consideration of existing preventive measures
risk	the likelihood of a hazard causing harm in exposed populations in a specified time frame, including the magnitude of that harm
SBP	Strategic Business Plan: A 20 to 30 year strategic business plan and financial plan is a utility's peak planning document for water supply and sewerage in accordance with the NSW Water and Sewerage Strategic Business Planning Guidelines 2011 (www.water.nsw.gov.au)

SCADA	Supervisory Control and Data Acquisition system used to monitor, control and alarm water treatment plants
STP	Sewage Treatment Plant
service reservoir	a storage for drinking water, generally within the distribution system, used to meet fluctuating demands, accommodate emergency requirements and/or equalise operating pressures
source water	water in its natural state, before any treatment to make it suitable for drinking
surface water	all water naturally open to the atmosphere (eg rivers, streams, lakes and reservoirs)
target criteria	quantitative or qualitative parameters established for preventive measures to indicate performance
turbidity	the cloudiness of water caused by the presence of fine suspended matter
validation of processes	the substantiation by scientific evidence (investigative or experimental studies) of existing or new processes and the operational criteria to ensure capability to effectively control hazards
verification of drinking water quality	an assessment of the overall performance of the water supply system and the ultimate quality of drinking water being supplied to consumers; incorporates both drinking water quality monitoring and monitoring of consumer satisfaction
WTP	Water Treatment Plant
WU	Water Utility

1 INTRODUCTION

1.1 Overview

Central Darling Shire Council (CDSC), in partnership with NSW Health, has developed a risk-based Drinking Water Management System (DWMS) consistent with the Australian Drinking Water Guidelines (ADWG) (NHMRC, NRMMC, 2011).

NSW Health has provided funding to support CDSC to fulfil its obligations under Division 1 Section 25 of the Public Health Act 2010 (NSW) (PH Act) and Part 5 Section 34 of the Public Health Regulation 2012. The PH Act sets out the requirement for drinking water suppliers to develop and adhere to a quality assurance program or Drinking Water Management System.

The ADWG provides the framework for the good management of drinking water supplies that, when implemented, assures safety at point of use. The framework was developed to guide a structured and systematic approach for the management of drinking water quality from catchment to consumer. It incorporates a preventive risk approach or quality assurance program developed specifically for the water industry, and includes elements of HACCP, AS/NZS ISO 9000 and AS/NZS ISO31000:2009.

1.2 Objective

This document aims to support both the CDSC to provide, and the Central Darling community to access, a safe quality drinking water supply. Access to safe water is a basic need and is one of the most important contributors to public health.

The overall approach is to provide water treatment plant (WTP) Operators and Managers with a user-friendly document that supports Council in its management of a safe drinking water supply. It provides an overview of the system and a summary of all relevant documentation and supporting requirements.

This DWMS and its supporting documentation are living documents. They should be reviewed and updated in line with Council's monitoring and reporting procedures and when new processes or changes are introduced.

2 COMMITMENT TO DRINKING WATER QUALITY

2.1 Commitment

Council is committed to managing its drinking water supply systems to provide a safe, high quality drinking water which consistently meets the ADWG, consumer expectations and regulatory requirements.

The development and implementation of the DWMS formalises and demonstrates Council commitment to drinking water quality management throughout the organisation by:

- Formally adopting drinking water quality as a Council priority
- Defining Council's role and responsibility in regard to providing safe drinking water
- Identifying and assessing risks associated with the drinking water system and introducing controls, preventive measures, appropriate training, procedures and emergency response plans to protect drinking water quality and public health
- Adopting a measurable Improvement Plan that will increase the integrity of the Drinking Water Management System
- Reinforcing the ongoing and active involvement of all staff and supporting senior management to ensure actions and policies support the management of drinking water quality

A draft Drinking Water Policy was provided as part of the development of this DWMS for Council to review, endorse and adopt. The policy further confirms Council's commitment to supply high quality drinking water and to manage the risks to drinking water quality.

2.1.1 Regulatory and Formal Requirements

The regulatory and formal requirements relating to drinking water quality in the Central Darling Shire have been identified and reviewed. Table 4 provides a summary of the most relevant legislative and formal requirements for the supply of safe drinking water at CDSC.

Table 1 Regulatory and Formal Requirements for Supply of Drinking Water

Regulatory or Formal Requirement	Relevance to Drinking Water Quality	Agency
Commonwealth Legislation		
Water Act 2007	Provides for the management of the ground and surface water resources of the Murray-Darling Basin, with particular focus on managing extractions to "protect, restore and provide for the ecological values and ecosystem services of the Murray-Darling Basin".	Murray Darling Basin Authority
Competition and Consumer Act 2010	Replaces the Trade Practices Act 1974 and incorporates Schedule 2 - The Australian Consumer Law. As a "seller" of water, the local council is subject to provisions of Consumer transactions and Consumer guarantees, which guarantees that the goods supplied are reasonably fit for purpose.	Australian Competition and Consumer Commission
NSW Legislation		
Aboriginal Land Rights Act 1983	Establishes Local Aboriginal Land Councils, which are responsible for managing land for the benefit of local Aboriginal people.	NSW Education and Communities: Aboriginal Affairs

Regulatory or Formal Requirement	Relevance to Drinking Water Quality	Agency
Catchment Management Authorities Act 2003	Natural resource management, from planning to operations, is to be undertaken at the catchment level. State-wide standards are to be applied. Catchment Action Plans are used to define key themes for each catchment, each with specific catchment and management targets.	Western and Lachlan Catchment Management Authorities (CMA) Natural Resources Commission
Environmental Planning & Assessment Act 1979	Requires that the environmental impacts of projects be studied at all stages on the basis of scale, location and performance. Under Part 3 of the Act, Local Environmental Plans (LEPs) are developed to establish what forms of development and land use are permissible and/or prohibited. LEPs ensure that drinking water quality is considered when assessing development applications. The Central Darling LEP (2012) applies to all lands within Wilcannia, Ivanhoe and White Cliffs towns.	NSW Department of Planning, Industry and Environment (DPIE)
Fluoridation of Public Water Supplies Act 1957 Regulation and Code of Practice	Requirements for testing and reporting where water supplies are fluoridated.	NSW Health NHMRC
Local Government Act 1993	Local councils have the responsibility for the provision of water supply to consumers, in accordance to the NSW Best-Practice Management of Water Supply and Sewerage Guidelines.	NSW Government Division of Local Government
NSW Groundwater Quality Protection Policy 1998	Manages groundwater resources for sustainable economic, social and environmental uses, with a specific principle to protect town water supplies against contamination. A key recommendation is to develop wellhead protection plans.	NSW DPIE (Water)
Protection of the Environment (Operations) Act 1997	Requires licences for activities with potentially significant environmental impacts. Prosecution may be carried out under this act for any chemical leakage, spill, and disposal of wastes or similar.	NSW EPA
Public Health Act 2010 Public Health Regulation 2012	Requires all water authorities to develop Drinking Water Management Systems. Bestows certain powers on NSW Health with respect to provision of safe drinking water, including ability to enter treatment facilities, order mandatory testing or obtain information about the drinking water and powers to close a water supply. Council is required to issue public advice regarding the water supply when directed by the Chief Health Officer of NSW Health.	NSW Health
Water Act 1912	Licences to extract water outside of areas covered by water-sharing plans. Affecting alterations to the quantity or quality of water in certain circumstances is an offence. Water Act 1912 is being progressively phased out and replaced by Water Management Act 2000.	NSW DPIE (Water)
Water Management Act 2000	Provides the basis for water planning, the allocation of water resources and water access entitlements. Licences for extraction for the three systems are governed by the provisions of this Act.	NSW DPIE (Water)

Regulatory or Formal Requirement	Relevance to Drinking Water Quality	Agency
Work, Health & Safety Act 2011	Specifies conditions for storage and handling of chemicals on-site at water treatment plants.	WorkCover Authority of NSW
Guidelines and Programs		
Australian Drinking Water Guidelines 2011	Ensures the accountability of drinking water managers and operators and health authorities and auditors for the supply of safe, good quality drinking water to consumers.	NSW Health
NSW Best-Practice Management of Water Supply and Sewerage Guidelines 2007	Provides for appropriate, affordable and cost- effective services to meet community needs while protecting public health and the environment and making best use of regional resources. Requires a Strategic Business Plan (SBP), including a Financial Plan and associated asset management plans, reviewed and updated every four years; a 30-year Integrated Water Cycle Management Plan (IWCMP).	NSW DPIE (Water)
NSW Health Drinking Water Monitoring Program 2005	NSW Health provides analysis of drinking water samples for water utilities, providing an independent analysis of water at point of supply.	NSW Health
NSW Health Managing pathogen risks in drinking water: Response protocol for water utilities and public health units 2018	Guides Public Health Units and water utilities in their joint response to rapidly changing source water quality, treatment failure or microbial contamination.	NSW Health
NSW Health Response Protocol for management of physical and chemical quality	Guides Public Health Units and water utilities in their joint response following the detection of physical and chemical water characteristics that exceed the Guidelines. Aesthetic and health related guideline values are considered.	NSW Health
National Partnership Agreement on Water for the Future	The COAG Strategy on Water and Wastewater Services in Remote Communities in New South Wales aims to provide water infrastructure and build the capacity of the Council to improve the management and overall security of water in remote communities.	Australian Government NSW DPIE (Water)
Aboriginal Communities Water and Sewerage Program	Provides funds for maintenance, operations and repairs to water systems in discrete Aboriginal communities, covering Warrali and Mallee communities. Council has also entered into a five year service agreement with DPI Water and the Local Aboriginal Land Council under which it provides routine operational, maintenance and monitoring activities to the Aboriginal communities of Mallee and Warrali Mission.	NSW and Local Aboriginal Land Council NSW DPIE (Water)
AS/NZS 3500 – Plumbing and Drainage set	Largely for management of the distribution system including standards for plumbing and drainage issues	Standards Australia
Plumbing Code of Australia	Specifications for plumbing in drinking water systems, to be complied with by administrators, plumbing Licensees, developers and property owners/occupiers.	Office of Fair Trading

2.1.2 Engaging Stakeholders

Stakeholders involved in the provision of a safe reliable drinking water supply have been identified and are listed in Table 2. NSW Health Water Unit, Local Public Health Unit and NSW Department of Planning, Industry and Environment (Water) participated in the development of this DWMS.

Table 2 Stakeholders in Drinking Water Quality Management

Stakeholder	Role	Participation
NSW Health	Provides expert advice and support to Council in achieving their regulatory requirements	Provides water analysis through the NSW Health Drinking Water Monitoring Program. NSW Health response protocol to microbial and physical and chemical exceedances Representatives from the Local Public Health Unit and NSW Health Water Unit participated in site visits and the Risk Assessment Workshop as part of the development of the DWMS, and again in the 2021 review.
NSW Department of Industry (Water)	Technical support on investigations, design, construction, operation, maintenance and management	Inspector visits and assesses WTPs compliance at a risk-based frequency. Technical support on investigations, design, construction, operation, maintenance and management Annual Reporting on Water Supply performance Participated in Site Visits and Risk Assessment Workshops Far West Regional Algal Coordinating Committee (RACC) provides algal alerts
Western CMA Lachlan CMA	Catchment Management Coordinates action plans and funding in the drinking water catchment	It is recommended that Council liaises with CMAs regarding the management of water quality in the drinking water catchment
Murray Darling Basin Authority	Catchment Management	Assists in management of algal blooms through varying flows
Mallee and Warrali Aboriginal Communities	Aboriginal Water and Sewage Interim Management Plans	Report incidents. The roles and responsibilities of the Aboriginal communities of Mallee & Warrali Mission, the Local Aboriginal Land Council Chief Executive Officer, Council, the Department of Primary Industries Water and NSW Health are listed in Appendix C.

3 DRINKING WATER SUPPLY SYSTEMS

3.1 Overview

Central Darling Shire Council operates two DWSS and one non potable water supply. A summary of these drinking water systems is detailed below.

Table 3 Overview of Oberon Water Supply System

Component	Wilcannia	Ivanhoe	White Cliffs
Water Supply	Potable	Potable	Non – Potable
WTP	Wilcannia WTP	Ivanhoe WTP	White Cliffs WTP
Catchment	Western Catchment	Lachlan Catchment	Western Catchment
Source Water	Darling River Wilcannia Borefields	Willandra Creek / or Lachlan River Ivanhoe Borefields	Wannara Creek Raw water is stored in large ground tanks
Key Barriers	**Borewater only:** ▪ Aeration ▪ Sodium hypochlorite **Surface and borewater:** ▪ PAC Dosing (optional) ▪ Coagulation ▪ Flocculation ▪ Sedimentation ▪ Sand Filtration ▪ pH correction ▪ Disinfection (chlorine)	**Borewater only:** ▪ Aeration **Surface water only:** ▪ Settling (in a series of three storage tanks) ▪ PAC (optional) ▪ Coagulation ▪ Flocculation ▪ Sedimentation ▪ Filtration ▪ Disinfection (chlorine)	▪ Settling (in one of two ground storage tanks) ▪ PAC (optional) ▪ Clarification ▪ Filtration ▪ Disinfection (chlorine)
Reservoirs	2 ML raw water reservoir 0.5 ML treated water reservoir	0.5 ML raw water reservoir 0.5 ML treated water reservoir	White Cliffs raw water reservoir (Not Applicable) 650,000L storage 2 treated water reservoirs
Points of Supply	Wilcannia Township Mallee and Warrali Aboriginal Communities	Ivanhoe Township	White Cliffs Township Water is reticulated via gravity to individual header tanks at each property.
Population Serviced	880	250	200

3.2 Wilcannia Drinking Water Supply System Analysis

3.2.1 Description

The Wilcannia WTP is located on Hood Street. At Wilcannia the raw water undergoes full treatment with chlorination for disinfection. A description of the Wilcannia DWSS is described in the following sections. Figure 2 provides a process flow diagram of the Wilcannia DWSS.

Wilcannia has a dual reticulated water supply scheme. The township receives both treated drinking water and untreated raw water. Only the drinking water supply system is addressed in this document.

3.2.1.1 Catchment

The Darling River is part of the Barwon-Darling catchment, which flows in a south-westerly direction from the north-east region of the NSW-QLD border, as shown in Figure 1. The catchment collects water from several rivers covering an area of 45,510 km^2. The catchment is a prime agricultural area for NSW.

Barwon Darling is an unprotected catchment: including pastoral activities, grazing (sheep, cattle and goats) and mining. Saline groundwater intrusions on surface water may occur during low flow with some areas affected by dryland salinity.

Runoff from the catchment area can reduce the quality of water available for extraction. Turbidity can change rapidly, reaching over 1000 NTU on occasions. The reduction of flows and reduced frequency of freshes due to upstream abstraction can result in blue-green algae outbreaks.

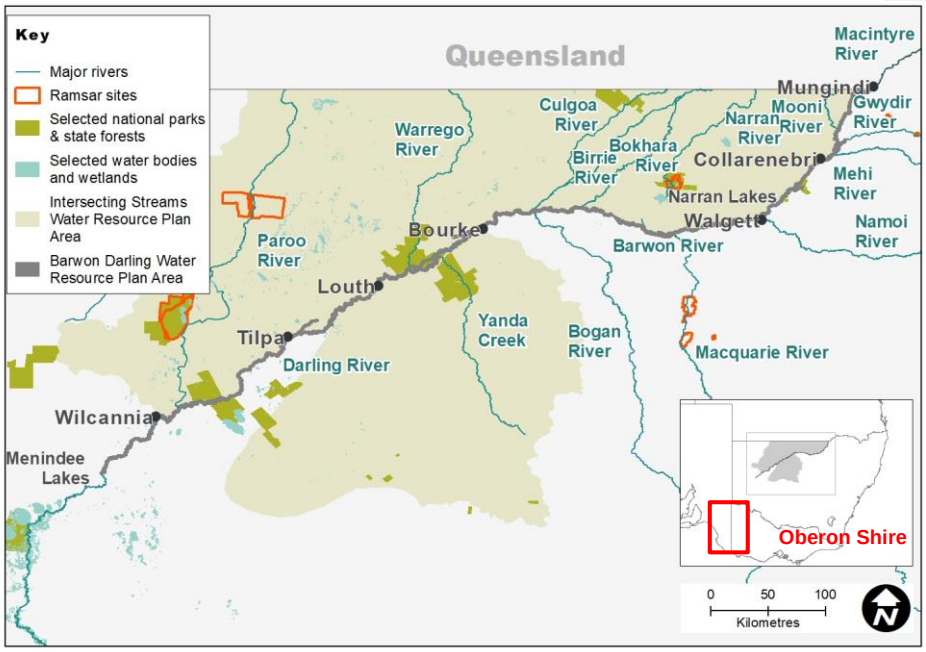

Figure 1 Barwon Darling Catchment

(https://www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/water-for-environment-outcomes-2019-20/barwon-darling [accessed 1/06/2021])

3.2.1.2 Source Water

Raw water for the Wilcannia drinking water supply is sourced from the Wilcannia Weir on the Darling River.

The weir at Wilcannia is 3.5 m high on the Darling River. There are two relatively independent ponds behind the weir separated by a rock bar, 5 km and 22 km long. Water is extracted from the first weir pool in normal conditions. Water may only be accessed to a depth of 1.0 m below the weir crest due to siltation issues. When water levels drop below 2.5 m, CDSC can access the second weir pool via pumps. The Darling River Weir has a yield of 0.55 ML/day.

During times of no or low flow in the river, raw water is sourced from the Wilcannia Borefield, which consists of three bores, in which currently only one is operational. This was constructed in 2003 and is situated approximately 5 kms south of the WTP. An additional borefield with two bores has recently been constructed approximately 2.5 km from WTP. There is no information about the size or extent of the aquifer. Water is supplied from the bore at 0.48 ML/day.

3.2.1.3 Water Treatment

The Wilcannia WTP is a conventional filtration plant with chlorination for disinfection. Fluoridation facilities exist although the facility has never been commissioned.

Raw water is pumped from the Wilcannia Weir to the WTP. In times of no / low flow the raw water is pumped from the Wilcannia Borefield. The Wilcannia WTP does not operate with blended river and groundwater.

The WTP is operated manually by two CDCS staff. The plant runs for approximately 5 hours per day.

For surface water, the treatment process is:

- The raw water is dosed with aluminium sulphate (alum) and soda ash at the inlet to the WTP. Alum is dosed to coagulate and flocculate the water. Soda Ash is dosed for pH correction
- Powered Activated Carbon (PAC) is added if required. PAC is dosed into the raw water for the treatment of blue green algae
- Dosed water is then directed to a mixer to ensure uniformed dosing
- Following mixing, the dosed water flows through a sedimentation tank. Settled floc is manually removed by opening the outlet valves at the bottom of the sedimentation tank
- Following sedimentation the water is chlorinated to help oxidise soluble manganese for its subsequent removal through filtration
- The chlorinated water is filtered through a sand medium for final polishing
- Filters are backwashed up to three times daily due to high turbidity of the source water
- The filtered water is then dosed with soda ash for pH correction
- Chlorine gas is added to the filtered water prior to discharge into the clearwater well and then into the treated water reservoir
- The sludge from the sedimentation process and the supernatant is disposed of into the evaporation ponds

For groundwater, treatment is:

- Raw water is pumped directly from the bore to the aerator, to remove volatile gases and to oxidise dissolved iron
- The water is then dosed with chlorine gas to oxidise manganese for removal by filtration
- The water then enters the treatment train as for surface water

3.2.1.4 Water Distribution

Treated water is reticulated from the Wilcannia WTP treated water reservoir via gravity. In addition to the Wilcannia Township, drinking water is distributed to two Aboriginal Communities: the Warrali and Mallee.

Raw water is also reticulated through the township. Council is actively working to prevent cross-contamination between the two water supply systems and private sewage systems through installation of back-flow prevention devices.

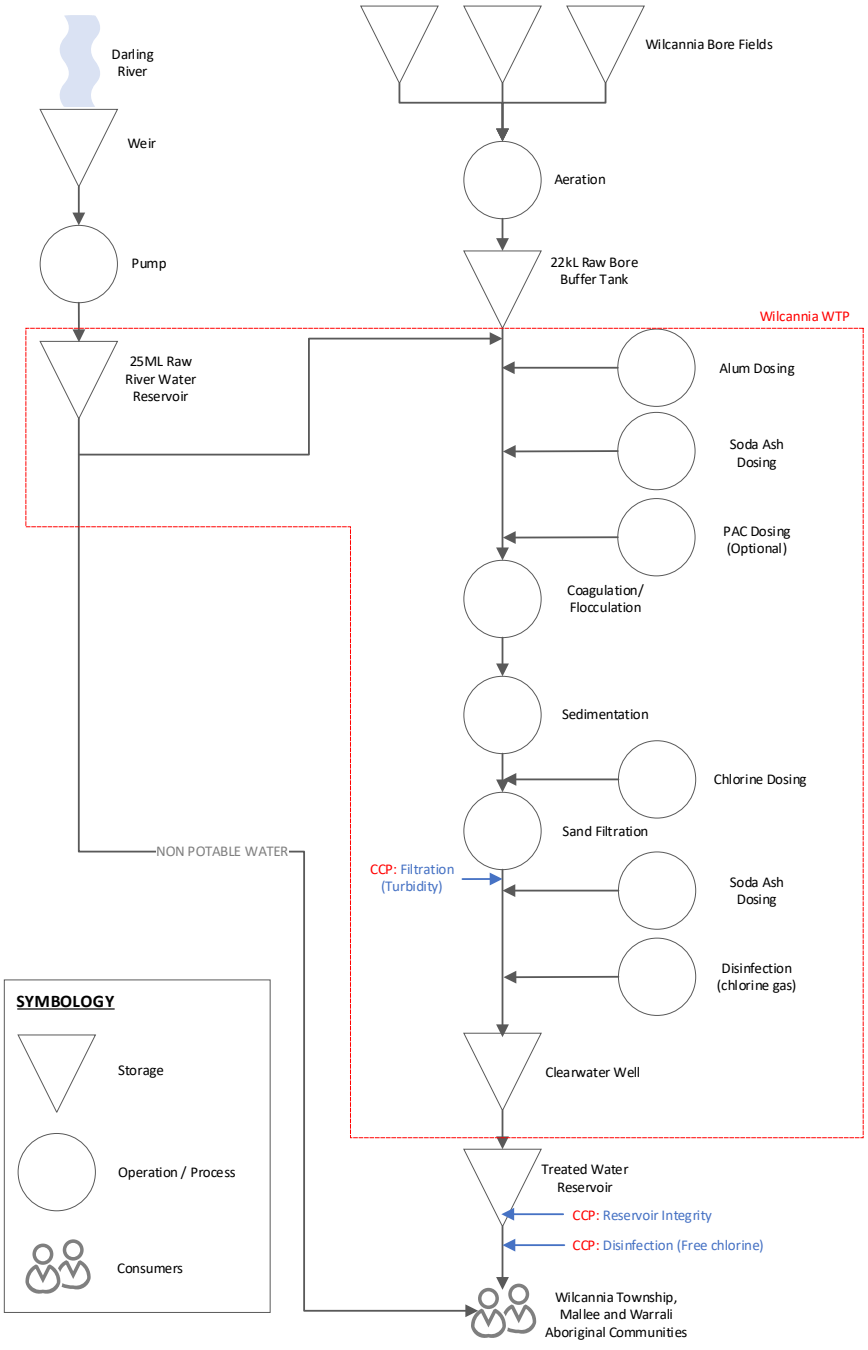

Figure 2 Wilcannia DWSS Process Flow Diagram

3.2.2 Assessment of Water Quality

Water quality was assessed to inform the 2012 Risk Assessment Workshop process and identify issues within the supply. This historical assessment of water quality is in Appendix D, retained as a historical reference. A similar water quality assessment exercise was undertaken in preparation for the 2021 risk assessment review. This assessment is provided in Appendix B.

CDSC does not currently undertake water quality monitoring in the drinking water catchment. Nevertheless raw water is monitored at the inlet to the Wilcannia WTP. The available raw water quality data was assessed as part of the development of the DWMS.

At the inlet to the Wilcannia WTP, surface water monitoring often shows elevated turbidity, true colour as well as iron and manganese. According to the operational data analysed, the treatment processes are effectively reducing the elevated parameters to within the ADWG health and aesthetic guidelines.

The Wilcannia WTP is currently unable to reliably meet best practice guidance for *Cryptosporidium* removal, i.e., it cannot regularly achieve a filtered water turbidity <0.2NTU at most times with a critical limit of 0.5NTU. This is because the treatment plant was not designed to meet this relatively recent specification, and CDSC is attempting to achieve the best water quality with the existing infrastructure. Prior to 2021, the filtered water turbidity requirement (as per the CCP) was <1NTU. This was generally met, as shown in Table 4.

According to the operational data provided, adequate disinfection is generally achieved within the treated water reservoir.

Ten years (from 2011 – 2021) of NSW Health Drinking Water Monitoring Program data from samples collected at the point of supply as well as within the water distribution system was assessed and this is summarised in Table 5.

An overview of water quality performance in water supplied to Wilcannia is provided in Table 6.

Table 4 CCP critical limit exceedances by year, Wilcannia WTP

Year	Number of CCP Exceedances per year*		
	Filtration	Disinfection	Reservoir Integrity
2017	0	2	0
2018	2	1	0
2019	2	0	0
2020	6	2	0

*note these are based on previous CCP critical limits, i.e. filtered water turbidity <1.0NTU and reservoir free chlorine >0.5mg/L

Table 5 NSW Drinking Water Monitoring Program Data, Wilcannia (2011-2021)

Parameter*	Units	Count	Min.	Average	Max	Comment
Aluminium	mg/L	42	0.005	0.40	**4.1**	Multiple results >0.2mg/L
Antimony	mg/L	42	0.00005	0.0005	0.001	
Arsenic	mg/L	42	0.0005	0.001	0.003	
Barium	mg/L	42	0.05	0.11	0.18	
Boron	mg/L	42	0.05	0.16	0.9	
Cadmium	mg/L	42	0.00005	0.00024	0.00025	
Calcium	mg/L	42	10	31	91	
Chloride	mg/L	42	0.5	150	**558**	
Chromium	mg/L	42	0.0005	0.003	0.006	
Copper	mg/L	42	0.0025	0.019	0.116	
E. coli	mpn/100mL	636	0	0	**3**	4 detects in 2014, 1 in 2018, 2 in 2019
Fluoride	mg/L	42	0.05	0.12	0.33	
Free Chlorine	mg/L	622	0	1.7	**7.1**	18 results >5mg/L, distributed evenly over time
Iodine	mg/L	42	0.01	0.05	0.11	
Iron	mg/L	42	0.005	0.14	**1.05**	6 results >0.3mg/L, only 1 post 2015
Lead	mg/L	42	0.001	0.001	0.002	
Magnesium	mg/L	42	4	16	70	
Manganese	mg/L	42	0.0002	0.011	**0.15**	1 result >0.1mg/L in 2015
Mercury	mg/L	42	0.00005	0.00007	0.0004	
Molybdenum	mg/L	42	0.0007	0.002	0.0025	
Nickel	mg/L	42	0.0002	0.005	0.005	
Nitrate	mg/L	42	0.5	1.2	5	
Nitrite	mg/L	42	0.05	0.07	0.9	
pH		649	6.3	7.6	**10.0**	11 results >8.5. 1 result <6.5
Selenium	mg/L	42	0.001	0.002	**0.018**	
Silver	mg/L	42	0.0001	0.001	0.002	
Sodium	mg/L	42	18	118	**369**	
Sulfate	mg/L	42	2	72	126	
Temperature	°C	204	7.1	21.0	30.5	
Total Chlorine	mg/L	609	0.01	2.0	**8.8**	31 results >5mg/L
Total Coliforms	mpn/100mL	636	0	4	**>200**	33 detects, majority pre-2016
TDS	mg/L	42	93	456	**1152**	11 results >600mg/L
Total Hardness	mg/L as $CaCO_3$	42	41	144	**515**	Only 1 result >200mg/L
True Colour	HU	42	0.5	1.7	9	
Turbidity	NTU	435	0	1.9	**77**	34 results >5NTU, 127 >1NTU
Uranium	mg/L	12	0.00005	0.002	0.0025	
Zinc	mg/L	42	0.005	0.04	0.28	

Table 6 Wilcannia Water Quality Overview

Parameter(s)	Comments
Microbial hazards	The Wilcannia WFP draws water primarily from the Darling River, which can experience dramatic changes in raw water turbidity and runs through an unprotected catchment. The catchment has been rated as a Medium risk for *Cryptosporidium* by NSW Health, with the recommendation that filtration be optimised to achieve filtered water turbidity of <0.2NTU. This is rarely met, with typical filtered water turbidity values of 0.5-0.6NTU. *E. coli* is not routinely tested in raw water, however is periodically detected in the distribution system. The frequency of detections has dropped over time. Disinfection effectiveness can be impacted by occasional elevated turbidity (see below).
Turbidity	Aside from filtration performance, turbidity of supplied water has frequently exceeded 1NTU which is the target to ensure effective disinfection. 127 of 435 distribution system samples collected between 2011 and 2021 returned results of >1NTU. 34 of 435 results also exceeded 5NTU which is the aesthetic guideline. It is possible that this turbidity reflects ongoing metals oxidation and/or sediment up in the pipe network, and may not be reflective of compromised primary disinfection.
Chlorine	Chlorine demand in treated surface water can be high, requiring a high chlorine dose at the WTP (to maintain a residual through the network). Accordingly, total chlorine results >5mg/L at the WTP treated water site are not uncommon. Incidences of low chlorine in the distribution system are relatively rare, but do occur.
Organic carbon & disinfection by-products	Total organic carbon has been measured in raw water at concentrations ranging from 13mg/L to 19mg/L. Following coagulation, this level drops to between 6mg/L and 12mg/L. At these levels, following pre-chlorination and final disinfection, trihalomethanes can form at high levels (above health guidelines). Haloacetic acids have also been measured above health guideline levels.
Iron & manganese	Iron and manganese are present in surface water (infrequent measurements, iron is commonly ~2mg/L and manganese 0.2 – 1.5mg/L) Although the supplied water dataset shows results above aesthetic guideline limits for both, none of these exceedances have occurred after 2015.
Aluminium	There have been multiple results above the ADWG aesthetic limit of 0.2mg/L suggesting overdose or carryover from the coagulation process.
Heavy metals	Aside from one selenium result of 0.018mg/L in 2020 (currently being investigated), there have been no exceedances of ADWG health guideline values.
Radiological	Radiological baseline assessments in the form of alpha and beta radiation were undertaken on 19 April 2011 at the Mallee Community. Radiological quality of the drinking water was within the ADWG criteria. Bore 2 & 3 raw water was just over the screening threshold of 0.5Bq/L gross alpha (0.55 Bq/L: Nov-2019). WTP was found to reduce gross alpha activity.

3.3 Ivanhoe Drinking Water Supply System Analysis

3.3.1 Description

The Ivanhoe WTP is located on the Cobb Highway, southeast of the Ivanhoe Township. At Ivanhoe the water undergoes full treatment with chlorination for disinfection. A description of the Ivanhoe DWSS is detailed in the following sections. Figure 3 provides a process flow diagram of the Ivanhoe DWSS.

Ivanhoe has a dual reticulated water supply scheme. The township receives both treated drinking water and untreated raw water. Only the potable drinking water supply system is addressed in this system.

3.3.1.1 Catchment

Willandra Creek is part of the Lachlan Catchment, which is essentially a terminal system with the Lachlan River ending in the extensive wetlands of the Great Cumbung Swamp. The catchment area is 86,554 km^2. The Lachlan catchment is regulated by the two major water storages of Wyangala Dam (capacity 1,220 GL) and Carcoar Dam (capacity around 36 GL), and other regulating weirs such as Booberoi and Lake Brewster.

Lachlan is an unprotected catchment with pastoral activities, grazing (sheep, cattle and goats) and mining being undertaken across the catchment. Saline groundwater intrusions on surface water during low flow may occur. Some areas are affected by dryland salinity. Runoff from parts of the catchment, particularly during periods of high rainfall can reduce the quality of water at Willandra Creek, particularly increasing turbidity.

3.3.1.2 Source Water

Ivanhoe's water supply is sourced from either the Willandra Creek or the Ivanhoe Borefield. There is no baseline water quality data for either surface or groundwater.

Raw water is extracted from the Willandra weir where it is diverted to two ground storage tanks where progressive settling occurs. The water is then pumped to a final ground storage tank at Ivanhoe WTP.

Fencing around ground storage tanks require repairs, currently allowing unrestricted access by humans and livestock. The Willandra weir is approximately 33 km from the WTP.

Water can also be diverted from the Lachlan River in wet weather when Willandra Creek is affected by high turbidity.

During times of low / no flow in the Willandra Creek, the drinking water is sourced from Ivanhoe borefield. The bores were constructed in 2005. Bore water is pumped directly from one of two (2) bores into the raw water reservoir (25 ML) at Ivanhoe WTP (NSW Public Works, 2012).

The Ivanhoe WTP does not operate with blended river and groundwater sources. Currently the primary source is Willandra Creek.

3.3.1.3 Water Treatment

The Ivanhoe WTP is a conventional filtration plant which was constructed in 1985. The plant is operated manually by one Council staff. The plant does not run continually, it runs for approximately 3 - 4 hours winter and 4 - 6 hours during summer.

The treatment process for surface water includes:

- Raw water is pumped from the Willandra Creek through two ground storage tanks for settling
- The raw water is pumped through 30 kms of pipeline to the groundwater storage tank at the Ivanhoe WTP

- The raw water is pumped to the Raw Water Reservoir where it is reticulated to the town for non-potable use or through the treatment plant
- The raw water is dosed with aluminium chlorohydrate (alchlor) as it leaves the raw water tank for treatment. Alum is dosed for coagulation and flocculation
- The dosed water is then directed to a clarifier for coagulation and flocculation
- The clarified water flows through a sedimentation tank. Settled floc is manually removed by opening the outlet valves at the bottom of the sedimentation tank and scour for up to 5 minutes
- Following sedimentation the water is filtered through a sand medium
- Filters are backwashed up to three times a week due to high turbidity of the source water when extracted from Willandra Creek and virtually nil when utilising bore water
- The filtered water is then dosed with soda ash for pH correction
- Chlorine is added to the filtered water prior to discharge into the treated water reservoir
- The sludge from the sedimentation process and the supernatant is disposed of into the evaporation ponds

The treatment process for groundwater includes:

- The raw water is pumped through 30 kms of pipeline to the groundwater storage tank at the Ivanhoe WTP
- The raw water is pumped from the ground storage tank to the Raw Water Reservoir where it is reticulated to the town for non-potable use or through the water treatment plant
- The raw water is aerated to help oxidise soluble iron and manganese for its subsequent removal through filtration
- Following aeration the water is filtered through a sand medium for final polishing
- The water then enters the treatment train as for surface water

3.3.1.4 Water Distribution

Treated water from the Ivanhoe WTP is reticulated by gravity from the treated water reservoir to the Township of Ivanhoe.

Ivanhoe has a dual reticulation system for raw and treated drinking water. Some individual properties also have water tanks and on-site sewage systems.

Council is actively working to prevent cross-contamination between the two systems and private systems through installation of back-flow prevention devices. Additional actions are recommended to prevent cross-contamination between the raw and drinking water reticulation systems.

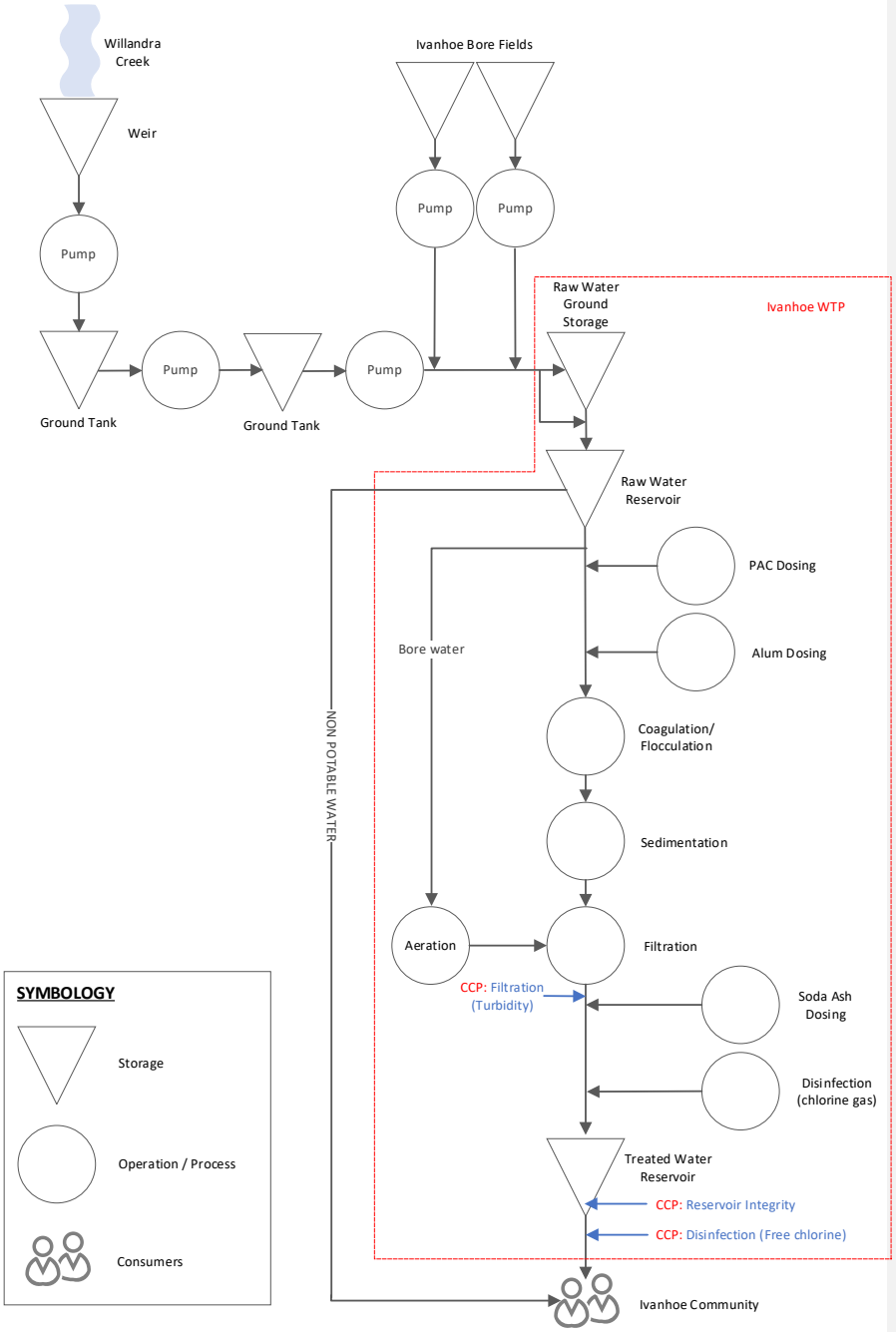

Figure 3 Ivanhoe DWSS Process Flow Diagram

3.3.2 Assessment of Water Quality

Water quality was assessed to inform the 2012 Risk Assessment Workshop process and identify issues within the supply. This historical assessment of water quality is in Appendix D, retained as a historical reference. A similar water quality assessment exercise was undertaken in preparation for the 2021 risk assessment review. This assessment is provided in Appendix B.

CDSC does not currently undertake water quality monitoring in the drinking water catchment. Nevertheless raw water is monitored at the inlet to the Ivanhoe WTP. The available raw water quality data was assessed as part of the development of the DWMS.

At the inlet to the Ivanhoe WTP, raw surface water monitoring typically shows low turbidity (usually <5NTU, occasionally up to 30NTU), high pH and salinity, and low iron. Low turbidity is expected given the settling tanks prior to the WTP.

Operational monitoring data shows that in 2018, there were significant issues with filtration performance. Around 10% of daily readings failed the filtered water turbidity critical limit of 1NTU. However this improved dramatically in 2019 and 2020. Disinfection CCP failures were rare.

Chlorine residuals are maintained throughout the distribution network as a partial barrier against recontamination of the system. Additional procedures are recommended in the Improvement Actions to ensure ongoing service and maintenance works in the system do not result in recontamination.

Regular maintenance and servicing works to ensure integrity of the system, particularly of water reservoirs, are recommended to prevent re-contamination of source or treated waters.

Ten years (from 2011 – 2021) of NSW Health Drinking Water Monitoring Program data from samples collected at the point of supply as well as within the water distribution system was assessed and this is summarised in Table 8.

An overview of water quality performance in water supplied to Ivanhoe is provided in Table 9.

Table 7 CCP critical limit exceedances by year, Ivanhoe WTP

Year	Number of CCP Exceedances per year*		
	Filtration	Disinfection	Reservoir Integrity
2018	25	2	0
2019	0	0	0
2020	1	0	0

*note these are based on previous CCP critical limits, i.e. filtered water turbidity <1.0NTU and reservoir free chlorine >0.5mg/L

Table 8 NSW Drinking Water Monitoring Program Data, Ivanhoe (2011-2021)

Parameter*	Units	Count	Min.	Average	Max	Comment
Aluminium	mg/L	16	0.01	0.06	**0.31**	1 result >0.2mg/L in 2013
Antimony	mg/L	16	0.0002	0.0005	0.0005	
Arsenic	mg/L	16	0.001	0.003	0.009	
Barium	mg/L	16	0.10	0.17	0.24	
Boron	mg/L	16	0.19	0.29	0.5	
Cadmium	mg/L	16	0.00005	0.0002	0.0003	
Calcium	mg/L	16	25	41	54	
Chloride	mg/L	16	138	196	**290**	
Chromium	mg/L	16	0.0005	0.002	0.003	
Copper	mg/L	16	0.0025	0.02	0.12	
E. coli	mpn/100mL	246	0	0	0	
Fluoride	mg/L	16	0.15	0.32	0.57	
Free Chlorine	mg/L	89	0.02	0.97	**6.1**	2 results >5mg/L in 2012
Iodine	mg/L	16	0.07	0.19	0.38	
Iron	mg/L	16	0.005	0.03	0.2	
Lead	mg/L	16	0.0003	0.0009	0.001	
Magnesium	mg/L	16	22	31	39	
Manganese	mg/L	16	0.0011	0.0134	0.096	
Mercury	mg/L	16	0.00005	0.0001	0.0004	
Molybdenum	mg/L	16	0.0011	0.0024	0.0025	
Nickel	mg/L	16	0.0007	0.0045	0.005	
Nitrate	mg/L	16	0.5	1.1	3.5	
Nitrite	mg/L	16	0.05	0.05	0.05	
pH		111	7.1	7.5	8.5	
Selenium	mg/L	16	0.001	0.002	0.01	
Silver	mg/L	16	0.0001	0.0009	0.001	
Sodium	mg/L	16	85	141	**277**	
Sulfate	mg/L	16	77	119	231	
Temperature	°C	53	14.6	22.0	30	
Total Chlorine	mg/L	84	0.17	1.6	**6.5**	4 results >5mg/L in 2011 and 2012
Total Coliforms	mpn/100mL	246	0	5	**>200**	37 detects, only 3 after 2017
TDS	mg/L	16	2.5	561	**949**	4 results >600mg/L
Total Hardness	mg/L as $CaCO_3$	16	187	**228**	**287**	14 of 16 results >200mg/L
True Colour	HU	16	0.5	1.7	6	
Turbidity	NTU	92	0.05	8.2	**700**	
Uranium	mg/L	8	0.00005	0.002	0.0025	
Zinc	mg/L	16	0.02	0.075	0.23	

Table 9 Ivanhoe Water Quality Overview

Parameter(s)	Comments
Microbial hazards	The Ivanhoe WTP draws water primarily from Willandra Creek, which runs through an unprotected catchment. The catchment has been rated as a Medium risk for *Cryptosporidium* by NSW Health, with the recommendation that filtration be optimised to achieve filtered water turbidity of <0.2NTU. In 2020, around 50% of daily filtered water samples returned results of <0.2NTU, and around 5% of results were >0.5NTU. *E. coli* is not routinely tested in raw water, but has not been detected in the distribution system in around 400 samples collected over almost 20 years of monitoring.
Turbidity	Turbidity of supplied water is generally low with the exception of one result of 700NTU recorded in September 2011. This result is a significant outlier and should be viewed with suspicion. Aside from this result, the average turbidity from 91 distribution system samples was 0.6NTU.
Chlorine	In recent years, maintenance of free chlorine in the WTP reservoir has improved. There are occasional low (<0.2mg/L) and high (>5mg/L) chlorine results in supplied water.
Organic carbon & disinfection by-products	Total organic carbon has been measured in raw water at concentrations ranging from 22mg/L to 30mg/L. Following coagulation, this level drops to between 12mg/L and 16mg/L. At these levels, following pre-chlorination and final disinfection, trihalomethanes can form at very high levels (above health guidelines). Haloacetic acids have also been measured above health guideline levels.
Iron & manganese	Iron and manganese have not been detected at significant levels either in raw water or in the network (i.e., no breaches of ADWG aesthetic guidelines).
Aluminium	There was only a single result above the ADWG aesthetic limit of 0.2mg/L, which occurred in 2013.
Heavy metals	An arsenic result of 0.009mg/L was recorded in 2019, which represents an exceedance of the old ADWG health limit of 0.007mg/L, but not the updated health limit of 0.01mg/L. Investigations led staff to conclude that the source of arsenic was Morrisons Lake. Alum coagulation may have reduced arsenic levels from the raw water, i.e., raw water arsenic concentration may have been higher.
Radiological	No known records of radiological testing. This has been recommended as an improvement action.

3.1 White Cliffs Non Potable Water Supply System

3.1.1 Description

The White Cliffs water supply system is classified as non-potable. CDSC notifies all residents and visitors to White Cliffs that the water supply is non-potable.

The White Cliffs water supply is extracted from the Barwon Darling Catchment. The water supply is sourced from the Wannara Creek via a diversion weir. Raw water flows via gravitation from the weir to a 100 ML off - stream groundwater tank. The raw water is then pumped approximately 6 km to one of two groundwater tanks (Wakefields Tanks) at White Cliffs.

The White Cliffs water supply undergoes filtration and chlorination. The treated non-potable water is pumped to 2 reservoirs and is reticulated through the town via gravity in agricultural-class polyethylene pipes.

Most residents rely on rainwater for drinking and cooking.

CDSC has a responsibility to ensure residents and visitors are completely aware of the quality and use of the tap water as a non-potable source only.

This section is included only as a placeholder in the DWMS for a future point in time when the White Cliffs WTP is upgraded and the scheme is declared potable.

4 RISK MANAGEMENT AND CONTROLS

4.1 Risk Assessment and Preventive Measures

The original DWMS risk assessment was undertaken in October 2012 with participation from NSW Health, DPIE Water, CDSC, and external consultants.

A risk review was undertaken in February 2021, facilitated by Bligh Tanner.

CDSC uses the ADWG 2011 (NHMRC, NRMMC, 2011) risk assessment methodology. The definitions are summarised in Table 10 and Table 11 below.

Table 10 Risk assessment methodology - likelihood

Descriptor	Definition
Almost Certain	Expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Possible	Might occur or should occur at some time
Unlikely	Could occur at some time
Rare	May occur in exceptional circumstances

Table 11 Risk assessment methodology - consequence

Descriptor	Definition
Catastrophic	Major impact for a large population, complete failure of systems
Major	Major impact for a small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required
Moderate	Minor impact for a large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring
Minor	Minor impact for a small population, some manageable operational disruption, some increase in operating costs
Insignificant	Insignificant impact, little disruption to normal operation, low increase in normal operational costs

The resultant risk matrix is shown in Table 12.

Table 12 Risk Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	**Moderate**	**High**	**Very High**	**Very High**	**Very High**
Likely	**Moderate**	**High**	**High**	**Very High**	**Very High**
Possible	**Low**	**Moderate**	**High**	**Very High**	**Very High**
Unlikely	**Low**	**Low**	**Moderate**	**High**	**Very High**
Rare	**Low**	**Low**	**Moderate**	**High**	**High**

Both maximum and residual risks were assessed within the system.

- Maximum risk: risk that is present without preventive measures and controls (Table 14).
- Residual risks: risk that is present after implementing the system's preventive measures and controls (Table 14).
- Preventive measures and controls: are those actions, activities and processes used to prevent the identified hazards or reduce them to acceptable levels.

The ADWG note that protection of water sources is of paramount importance in reducing risks. Catchments can be protected by limiting access by humans and animals, limiting land uses to non-polluting types that will not contribute to risk and the use of buffer zones. Development controls can be used to ensure that development is appropriate. Planning Instruments such as Local Environmental Plans (LEPs) may be used to help protect catchment integrity, for example inclusion of local provisions which restrict land use within catchments to types that will not pose a risk to water quality. Water catchment areas can be declared under the Local Government Act 1993 section 128 which may provide a layer of protection against land uses that pose risks to water quality.

The Wilcannia and Ivanhoe DWSS support a multi-barrier approach for the protection of the drinking water, as promoted by ADWG. The key barriers are extraction management through the use of both surface and groundwaters, flocculation, filtration and disinfection. Ivanhoe also uses staged settling in groundwater tanks to minimise the concentration of hazards arriving at the consumer. The strength of this approach is that a failure in one barrier may be compensated by effective operation of the remaining barriers, minimising the likelihood of contaminants passing through to consumers.

The risk assessment team for the 2021 risk review is summarised in Table 13.

Table 13 CDSC risk assessment team, 2021

Name	Position	Organisation
Reece Wilson	Director Shire Services	Central Darling Shire Council
Darren Scotti	Projects Engineer	Central Darling Shire Council
Jared Cattermole	WTP Operator Wilcannia	Central Darling Shire Council
Tim Gageler	WTP Operator Ivanhoe	Central Darling Shire Council
Peter Catalotti	External Consultant to CDSC	Catalotti Consulting
Bruce Lamont	Water & Sewerage Inspector	Department of Industry (Water)
Wendy Henderson	Senior Project Officer	NSW Health Water Unit
Jason Harwood	Environmental Health Officer	Western NSW LHD PHU
Sean Hinton	Facilitator	Bligh Tanner

The risk registers are presented in Table 14 and Table 15 below. Not all risks were revisited in 2021, the focus of the team was toward reviewing the significant risks apparent from the water quality data and site visits.

Table 14 Drinking Water Risk Register - Wilcannia

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
Catchment	Pathogens from rural residential, agricultural and wildlife reaching the consumer.	Pathogens - chlorine sensitive (e.g. Bacteria and Viruses)	Filtration Disinfection	Local Environmental Plan (LEP), government approvals for developments, WTP process control (i.e. flocculation, coagulation, filtration, disinfection)	Almost Certain	Major	Very High	Unlikely	Major	High	NSW Health monitoring	Discussions with Western Catchment Management Authority (WCMA) re catchment activities are ongoing, but no coordination is underway; no fencing along river to keep livestock/wildlife out, banks are quite steep so access is limited; multiple river systems and catchments contribute to Barwon Darling River system.	
Catchment	Pathogens from STP and collection system overflows/ leaks contaminating source water	Pathogens (chlorine resistant e.g. Protozoa - Cryptosporidium), Nutrients	Filtration	STP SOPs and maintenance, emergency procedures, alternate water source, WTP process control	Unlikely	Major	High	Rare	Major	High	CDSC asset management and reactive maintenance of sewerage assets. NSW Health monitoring	STP has an overflow to the surrounding land; old oxidation ponds are back-up storage; wet weather events can fill these ponds. Sewage pumps at each property - runoff from stormwater at each household (HH). Common effluent drainage system for septic tank supernatant - CDSC responsibility for management of CED.	
Catchment	Pathogens from Onsite Sewage Management System discharges/ failures contaminating source water	Pathogens (chlorine sensitive e.g. bacteria, virus)	Filtration Disinfection	Alternate water source, WTP process control	Likely	Major	Very High	Rare	Major	High	NSW Health monitoring	CDSC OSSM system? (details to be confirmed), Concrete sewage holding - HH manages solids tank (HH responsibility to dispose); soak/rubble pits at each station, hospital; community education/ awareness strategies. RECOMMENDATION: 1. Inspection and maintenance of HH pumps and solids tanks. 2. Confirm management system for hospital sewage.	
Catchment	Pathogens from Onsite Sewage Management System discharges/ failures contaminating source water	Pathogens (chlorine resistant e.g. Protozoa - *Cryptosporidium*)	Filtration	Alternate water source, WTP process control	Likely	Major	Very High	Unlikely	Major	High	NSW Health monitoring	CDSC OSSM system (details to be confirmed), Concrete sewage holding - HH manages solids tank (HH responsibility to dispose); soak/rubble pits at each station, hospital; community education/ awareness strategies. RECOMMENDATION: 1. Inspection and maintenance of HH pumps and solids tanks. 2. Confirm management system for hospital sewage.	
Catchment	Chemical spill in catchment contaminating raw water	Chemicals, pesticides, herbicides, fertilisers, Hydrocarbons	Filtration	Dilution, WTP process control, PAC, alternate water source	Rare	Moderate	Mod	Rare	Minor	Low	NSW Health monitoring	(2-3 hours to transfer to bore water)	
Catchment	Farming practices leading to pesticides in source water above ADWG	Pesticides	Filtration	PAC, WTP process control, alternate water source	Unlikely	Minor	Low	Rare	Insignificant	Low	NSW Health monitoring	Cropping is very distant to source water. Rare minor events at WTP associated with weed control and poor sampling processes.	
Catchment	Flooding leading to increased pollutant loading from catchment runoff	All pollutants	Disinfection, Filtration	Upstream alerts (several weeks ahead of expected arrival of contaminated water); additional water quality monitoring, alternate water source, WTP process control	Unlikely	Major	High	Rare	Major	High	No monitoring/ control at catchment level NSW Health monitoring	Some river catchments (e.g. Castlereagh) bring in "black water" from overflow from crops - crops retain silt, water washes pesticides in, reduced oxygen in water; some fish kills have occurred in the past due to reduced oxygen.	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
Weir	Cyanobacterial outbreak bloom in source water leading to toxins above ADWG	Toxins	Disinfection, filtration	BGA Task Force Western Division monitoring & alerts PAC, reactive sampling program (CDSC EH unit), WTP process control, alternate water source	Unlikely	Major	**High**	Rare	Minor	**Low**	Visual Inspection by Operators	RECOMMENDATION: Consider developing algal response framework including toxin testing through NSW Health FASS lab (potentially low/no cost)	
Weir	Swimming and primary contact introducing pathogens in source water	Pathogens	Disinfection	Sign posted warnings, informal community education programs, dilution, WTP process control, alternate water source	Almost Certain	Major	**Very High**	Unlikely	Minor	**Low**	Visual Inspection by Operators NSW Health monitoring		
Weir	Cyanobacterial outbreak in source water leading to taste and odour issues	MIB, Geosmin etc	Filtration	PAC, radio announcements, personal communications with operators	Unlikely	Minor	**Low**	Rare	Insignificant	**Low**	Visual Inspection by Operators	Community education/awareness strategies	
Weir	Dead livestock/ wildlife in weir introducing pathogens into source water	Pathogens	Disinfection	community awareness, WTP process control	Rare	Major	**High**	Rare	Insignificant	**Low**	Visual Inspection by OperatorsNSW Health monitoring		
Weir	Relocation of weir to downstream of the town (currently upstream of most potential pathogen inputs associated with township)	Pathogens, algal toxins	Disinfection, filtration, PAC	Coagulation & Sedimentation	Almost Certain	Catastrophic	**Very High**	Possible	Catastrophic	**Very High**	Visual Inspection by Operators NSW Health monitoring	Timeline uncertain. Long history of sewage overflows, however switchboards have recently been upgraded RECOMMENDATION: 1. Enhance bunding at sewer pump stations to minimise overflow risk 2. Resolve telemetry issues which are preventing alarms on high sewer pump station level being generated/sent out 3. Feed back risks to Town Water Risk Reduction program, Jim Bentley (direct) & works program for sewerage system upgrades 4. Ensure Operators have all necessary tools for bypass arrangements if pump station overflows can't be resolved in a short timeframe. 5. Ensure weir relocation risks are addressed in new WTP design - **Review tender documentation to check what treatment specs are required.**	
Inlet	Coarse screen (on pump inlet) failure/ blockage at river inlet	Debris	Inlet works	Blowers	Unlikely	Minor	**Low**	Rare	Minor	**Low**	Visual Inspection by Operators		
Inlet	Heavy debris at pump inlet damaging/ destroying inlet	Turbidity, Organic Matter	Inlet works	physical removal, alternate source	Unlikely	Minor	**Low**	Rare	Insignificant	**Low**	Visual Inspection by Operators		
Borefield	Limited access during wet weather events preventing pump operation	All pollutants	Filtration Disinfection	4WD, boat, pedestrian access	Possible	Minor	**Mod**	Rare	Minor	**Low**	Weather Observations	Bore water is alternate option for several hazardous events associated with wet weather, therefore access is essential.	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
Borefield	Pathogens from residential/ agricultural/industrial inputs due to surface water ingress	Pathogens - chlorine sensitive, chlorine resistant	Filtration Disinfection	WTP process control, LEP, government approvals for developments.	Rare	Major	**High**	Rare	Minor	**Low**	Visual Inspection by Operators NSW Health monitoring	Bore construction: 1.5m earth mound, concrete tank and stainless steel hatch; pumping tests completed (NSW Office of Water, Public Works approval for operation); CDSC bore logs; data logger installed but not used. No knowledge of aquifer. RECOMMENDATION: 1. Extents of aquifer to be defined. 2. Preventative maintenance/cleaning of bore to be undertaken. 3. Review borehead sealing/integrity	
Borefield	Spills occurring in recharge area	Chemicals (various)	Disinfection	PAC, appropriate bore construction, alternate water source, WTP process control	Rare	Minor	**Low**	Rare	Minor	**Low**		Recharge areas unknown. RECOMMENDATION: 1. Recharge areas to be defined.	
Borefield	Aquifer contamination due to seepage from septic tanks, STP or landfills	Chemicals, pathogens	Disinfection	Alternate sources, LEPs and government approvals for developments, alternative water source, WTP process control.	Possible	Major	**Very High**	Unlikely	Major	**High**	NSW Health monitoring	Nearest house approximately 2kms. RECOMMENDATIONS: 1. Programmed inspections of household septic tanks. 2. Recharge areas to be defined.	
Borefield	Surface water short- circuiting of contaminants due to well-casing failure	Pathogens	Disinfection Filtration	Visual inspection and reactive maintenance, alternate water source, WTP process control	Rare	Major	**High**	Rare	Major	**High**	NSW Health monitoring	PVC casing, stainless steel screens. RECOMMENDATION: Install fencing around bores to prevent access and bore damage by livestock/wildlife	
Borefield	Radiological hazard from bore 2 & 3	Radiological	Blending of bores and WTP process (general)		Likely	Minor	**High**	Rare	Minor	**Low**		WTP Process found to reduce gross alpha activity. Bore 2 & 3 raw water was just over the screening threshold of 0.5Bq/L gross alpha (0.55 Bq/L: Nov-2019). RECOMMENDATION: Test bores every 2 years for gross alpha and beta activity in line with ADWG.	
WTP	Alum dose - Under dosing	Turbidity, Pathogens,	Clarifiers	Jar test daily; pre-dose soda ash; drop tests; river level monitoring, WTP process control	Likely	Major	**Very High**	Possible	Major	**Very High**	WTP process control , weather observations; Monitoring daily at raw water intake and clarifiers	Pump failure, blocked line, rising river waters, jar test, different source rivers. Council is under-resourced, undertaking reactive maintenance works in both sewerage and water systems as well as plant operation RECOMMENDATIONS: 1. Online monitoring. 2. Increasing resourcing.	
WTP	Alum dose - Over dosing	Aluminium, turbidity, pathogens	Clarifiers	Jar test daily; pre-dose soda ash; drop tests; increased monitoring, river level monitoring;	Likely	Major	**Very High**	Possible	Major	**Very High**	Monitoring daily at raw water intake and clarifiers, weather observations;	RECOMMENDATIONS: 1. Online monitoring. 2. Increased resourcing	
WTP	PAC dose - underdosing allowing contaminants	Toxins, Taste and Odour	Clarifiers	Jar test daily; pre-dose soda ash; drop tests; increased monitoring, river level monitoring; alternate source	Unlikely	Moderate	**Mod**	Rare	Minor	**Low**	Monitoring daily at raw water intake and clarifiers, weather observations;	PAC not used regularly; used only for algal blooms in the river.	
WTP	PAC dose - over - dosing	PAC	Clarifiers	Backwashing, jar testing	Unlikely	Minor	**Low**	Rare	Minor	**Low**		Overdose can clog the filter	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
WTP	Failure at clarifier	Pathogens, turbidity	Clarifiers	Spare parts for paddle, programmed maintenance, de-slime, WTP process control	Likely	Major	Very High	Possible	Major	Very High	Visual inspections, Daily NTU monitoring at clarifier	RECOMMENDATION: Install online monitoring	
WTP	Filters - Ineffective pollutant removal due to blockage of media/inadequate maintenance, breakthrough (or expectation of plant to operate above its design)	Pathogens (chlorine resistant e.g. Protozoa - Cryptosporidium)	Filters	Coagulation & Sedimentation Regular backwashing every morning as a minimum (more frequent if raw water quality worsens) Manual observation of filter outlet valve position (opens further as flow rate decreases) Ability to change to bore water if unable to effectively treat	Likely	Major	Very High	Possible	Major	Very High	Turbidity at clarifier and after sand filter,	No real ripening peak evident at present (turbidity does not spike and then decrease). Filtered water turbidity often at 0.5 - 0.6 NTU. Plant cannot reliably meet 0.5NTU. Bores are shallow and unprotected. Community dislike bore water source. DPIE has some concerns re salinity if bores are used more frequently. River water quality has changed significantly over the years NSW Health Crypto risk assessment rating for Wilcannia - medium RECOMMENDATION: 1. On-line monitoring (new plant) 2. Check filter media, top up if necessary 3. Review potential for river and bore water mixture	
WTP	pH correction - soda ash underdosing (pre- dose)	Low pH, Pathogens	Filters	Backup dosing pumps, river height etc monitoring, SOPs for batching soda ash	Possible	Major	Very High	Unlikely	Major	High	Monitoring pH daily through treatment process	Pump failure; rapid change in river conditions; incorrect dose due to manual testing. RECOMMENDATION: On-line monitoring.	
WTP	pH correction - soda ash overdosing (post- dose only)	Loss of chlorination efficiency	Filters	Long contact time in service reservoir, daily pH checks	Possible	Major	Very High	Unlikely	Major	High	Monitoring pH daily through treatment process	Pump failure; rapid change in river conditions; incorrect dose due to manual testing. RECOMMENDATION: On-line monitoring.	
WTP	Disinfection - Chlorine overdosing	Chemicals	Disinfection	Daily WTP checks, adjust dose as necessary	Likely	Minor	Mod	Possible	Minor	Low	Monitoring, chlorine residual after filter at end of supply, clear well, reservoir	RECOMMENDATION: Online monitoring	
WTP	Disinfection - Chlorine dose failure causing underdosing	Pathogens	Disinfection		Likely	Catastrophic	Very High	Unlikely	Catastrophic	Very High	Daily Monitoring, chlorine residual after filter at end of supply, clear well, reservoir NSW Health monitoring	RECOMMENDATION: Online monitoring	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
WTP	Disinfection - turbidity >1NTU at point of disinfection (shielding of pathogens)	Pathogens (bacteria and virus)	Filtration	Coagulation & Sedimentation Regular backwashing every morning as a minimum (more frequent if raw water quality worsens) Manual observation of filter outlet valve position (opens further as flow rate decreases)	Almost Certain	Major	**Very High**	Possible	Major	**Very High**		Filter media was replaced in 2017 RECOMMENDATION: 1. Top up filter media. 2. Empty sludge ponds	
WTP	Disinfection - Shortage of chlorine supply, cylinder runs out (failure of disinfection, pathogens reaching the community)	Pathogens	Disinfection	Dual cylinder auto-changeover, cylinder indicator for empty Daily WTP checks	Likely	Catastrophic	**Very High**	Unlikely	Catastrophic	**Very High**	Chlorine residual testing, NSW Health monitoring	RECOMMENDATION: 1. Obtain a new chlorine dosing line booster pump (existing spare pump to be modified to be able to plug in and use) 2. Get quotes for chlorine cylinder scales and request approval to buy (aim to have scales re-used at the pool) 3. Supervisor to monitor chlorine usage patterns to assist Operators 4. New plant to have chlorine scales, alarms on low cylinder weight	
WTP	Infrastructure (pipe work, linings of valves, pump, oils) leach components of materials due to chemical reaction	Chemicals		Reactive maintenance program.	Possible	Insignificant	**Low**	Possible	Insignificant	**Low**		Shafts on clear water well pumps corrode – current program to change over to PVC; black AC asbestos pipe - current replacement program.	
WTP	Power failure leading to equipment failure	All contaminants			Likely	Moderate	**High**	Likely	Moderate	**High**		Filtered water storage - 24-36 hours in summer; no back-up power supply. Water is not delivered to community during power failures. RECOMMENDATION: Provide back-up generator/alternative power supply.	
WTP	Loss/unavailability of skilled/ trained operators due to sickness, leave etc	All contaminants	WTP Process	2 trained and 1 untrained (trainee) operators in town.	Possible	Major	**Very High**	Possible	Major	**Very High**		RECOMMENDATION: 1. Trained operators from other plants to learn system (ongoing); 2. Other trained people in town. 3. Complete trainee training	
WTP	Aerator contamination	Pathogens	Filtration Disinfection	WTP process control	Possible	Major	**Very High**	Possible	Minor	**Mod**	Visual Inspection NSW Health monitoring	RECOMMENDATION: Provide access for maintenance/cleaning; repair top seal	
Service Reservoir	Faecal contamination (access by birds, rats)	Pathogens	Disinfection	Reactive maintenance schedule	Possible	Major	**Very High**	Rare	Major	**High**	Chlorine residual at supply, Visual Inspection NSW Health monitoring	Vermin proofing completed late 2020	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
Distribution	Loss of chlorine residual with heat/ materials/diam eter /biofilms etc of reticulation	Pathogens	Disinfection	Monitor and adjust chlorine levels, flush mains	Almost Certain	Major	Very High	Possible	Major	Very High	Chlorine residual at supply NSW Health monitoring	Steel pipe crossing bridge to Warrali - planned replacement program. (50, 80, 100, 200mm mains in town). 8 flushing points and 2 hydrants	
Distribution	Dead end in reticulation system leading to stagnation and loss of chlorine residual	Taste and Odour	Disinfection	Flushing mains, reactive maintenance	Almost Certain	Moderate	Very High	Possible	Minor	Mod	Chlorine residual at supply NSW Health monitoring	Steel pipe crossing bridge to Warrali - planned replacement program. (50, 80, 100, 200mm mains in town). 8 flushing points and 2 hydrants	
Distribution	Pathogens, chemicals, debris and soil entering the treated water supply through repairs, maintenance and new mains	All pollutants	Disinfection	SOPs (e.g. flushing), high pressures maintained in distribution network	Possible	Major	Very High	Unlikely	Major	High		Contractors undertake works within private properties; dual reticulation for potable and non-potable systems; same tools for water and sewage. RECOMMENDATIONS: 1. Chlorine residual testing after repair. 2.Separate equipment for water/ sewage/raw water systems	
Distribution	Pathogens contaminating the treated water due to back flow & cross connection (e.g. hydrant for water carter at depot, raw water dual reticulation, rainwater tanks)	Pathogens, Chemicals	Disinfection	Household checks by CDSC for cross- connections; WTP process control; backflow prevention on meters (not currently on all property lines). RPZ on hospital. Smart meters	Possible	Major	Very High	Unlikely	Major	High	household check on septic tanks	(e.g. hydrant for water carter at depot, raw water dual reticulation); school, hospital etc have their own plumbers; concerns around inadequate backflow prevention, inadequate documentation of dual reticulation layout. RECOMMENDATION: 1. Upgrade backflow prevention to each property (ongoing). 2. Documentation of water distribution network to be kept-up-to-date. 3. SOPs and appropriate management for non-Council works to be undertaken. 4. Improve backflow prevention in non-Council managed properties (i.e. outstanding connections without smart meters) Council to do household checks for cross connections	
Distribution	Dislodgement of biofilms, sludge causing degradation of water quality	"Dirty water", operational impacts	Disinfection	Flushing mains	Possible	Minor	Mod	Unlikely	Minor	Low	NSW Health monitoring		
Distribution	Public use of non- potable water system in public areas	All pollutants		Signs, removal of taps, designated public potable taps	Likely	Moderate	High	Unlikely	Moderate	Mod		e.g. caravans, tourists	
Whole of System	Malicious/ deliberate contamination	Various - chemicals, fertilisers, herbicides, pesticides, toxins, pathogens	Disinfection	WTP process control, public condemnation, locked gates, fences and ladder hatch at service reservoir	Rare	Moderate	Mod	Rare	Moderate	Mod	Visual Inspection		

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
Whole of System	Cybersecurity	All pollutants		No online monitoring or control	Rare	Insignificant	**Low**	Rare	Insignificant	**Low**		Needs consideration for new WTPs	
WTP	Fluoride - to cover in next revision post WTP construction	Fluoride, dental health		No fluoridation								Needs consideration for new WTPs	
WTP	Disinfection by-product formation due to high organic load in raw surface water and reaction with chlorine	Trihalomethanes, Haloacetic acids, other DBPs	PAC dosing, coagulation/ sedimentation	Ability to change water source to bores	Almost Certain	Moderate	**Very High**	Almost Certain	Moderate	**Very High**		Needs consideration for new WTPs - PAC contact time	
WTP	Disinfection by-product formation due to organics present in bore water and reaction with chlorine	Trihalomethanes, Haloacetic acids, other DBPs	PAC dosing, coagulation/ sedimentation		Unlikely	Moderate	**Mod**	Unlikely	Moderate	**Mod**		Needs consideration for new WTPs - PAC contact time RECOMMENDATION: Undertake TOC/THM study with assistance from NSW Health	
WTP	Capacity of new WTPs - Wilcannia WTP designed to **0.7**ML/day based on 22hrs operation. No real ability to downrate plant in response to poor water quality	Pathogens	Filtration Disinfection	Coagulation/sedimentation. Maintain reservoir as full as possible (in anticipation) Plant automation	Almost Certain	Major	**Very High**	Possible	Major	**Very High**		22hr operation would mean plant is operating for long periods while unmanned. High usage period combined with a power outage is worst case scenario	
WTP	Capacity of new WTPs - Wilcannia WTP designed to **1.2**ML/day based on 22hrs operation.	Pathogens	Filtration Disinfection	Coagulation/sedimentation. Maintain reservoir as full as possible (in anticipation) Plant automation	Almost Certain	Major	**Very High**	Unlikely	Major	**High**		22hr operation would mean plant is operating for long periods while unmanned. High usage period combined with a power outage is worst case scenario	
WTP	Limited oversight of operational data, and possibly low awareness of CCP limits mean health risks are not reported	Pathogens	Filtration Disinfection	trained Operators	Possible	Major	**Very High**	Unlikely	Major	**High**		RECOMMENDATION: 1) Training on CCPs and reporting requirements to new Project Engineer 2) Implementation of new spreadsheet for operational monitoring data record keeping	
WTP	Security of WTP site - vandalism impacts plant processes	All contaminants		Locked gates, locked building (chlorine)	Possible	Major	**Very High**	Unlikely	Major	**High**		RECOMMENDATION: 1) Repair fence, 2) Consider security lights and/or security cameras	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
WTP	Switchboard - confusion with old & new. Risk of impact on treatment processes.	Pathogens	Filtration Disinfection	trained Operators	Possible	Major	Very High	Possible	Major	Very High		RECOMMENDATION: 1) Progress with new WTP, 2) consider removing redundant wiring, 3) If new WTP delayed significantly, further actions will be required to address this risk.	
Whole of System	Warm water temperatures	Naegleria	Disinfection (30mg.min/L)	Aim to keep chlorine residual through network	Possible	Major	Very High	Rare	Major	High			

Table 15 Drinking Water Risk Register - Ivanhoe

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
Catchment	Pathogens from rural residential, agricultural and wildlife reaching the consumer.	Pathogens - chlorine sensitive (eg. Bacteria and Viruses)	Disinfection	Ground tanks to settle turbidity before plant, Jar testing, WTP process control (i.e. flocculation, coagulation, filtration, disinfection)	Almost Certain	Major	**Very High**	Unlikely	Major	**High**	Turbidity meters (no online monitoring), NSW Health monitoring	Lower Lachlan Catchment Management Authority (CMA). (no online monitoring), RECOMMENDATION: 1. Chlorine testing at lab sink.	
Catchment	Pathogens from Onsite Sewage Management System discharges / failures contaminating source water	Pathogens (chlorine resistant e.g. Protozoa - *Cryptosporidium*)	Filtration	Ground tanks to settle turbidity before plant, Jar testing, WTP process control (i.e. flocculation, coagulation, filtration, disinfection)	Likely	Major	**Very High**	Unlikely	Major	**High**	Turbidity meters NSW Health monitoring	Risk unknown; Lower Lachlan CMA; RECOMMENDATION: 1. Determine number/ location of systems within the catchment. 2. Chlorine testing at lab sink.	
Catchment	Pathogens from unrestricted livestock access to water supply entering raw water	Pathogens (chlorine resistant e.g. Protozoa - *Cryptosporidium*)	Filtration	Ground tanks to settle turbidity before plant, Jar testing at plant dam, WTP process control (i.e. flocculation, coagulation, filtration, disinfection)	Likely	Major	**Very High**	Unlikely	Major	**High**	Turbidity meters NSW Health monitoring	No online monitoring	
Catchment	Chemical spill in catchment contaminating raw water	Chemicals, Pesticides, Herbicides, Fertilisers, Petrol	Filtration	Ground tanks to settle turbidity before plant,	Rare	Major	**High**	Rare	Minor	**Low**	NSW Health monitoring	2 fuel tankers come to Ivanhoe a week and they cross Willandra Creek. Fertilisers, pesticides are all trucked in.	
Catchment	Grass fires	Turbidity, debris, ash	Filtration	Alternate water supply, staged settling ponds, WTP process control	Unlikely	Moderate	**Mod**	Unlikely	Insignificant	**Low**	NSW Health monitoring		
Catchment	Flooding leading to increased pollutant loading from catchment runoff	All pollutants	Disinfection, Filtration	1 month timeframe warning on flood waters, coagulation, filtration, jar testing is increased, raw water storages - Ground tanks to settle turbidity before plant, alternate water source	Unlikely	Moderate	**Mod**	Unlikely	Minor	**Low**	Weather observations, river heights are monitored (Willandra National Park weir - web based),	First flush is a big issue. Flood warnings come at least one month ahead through word of mouth.	
Catchment	Arsenic above ADWG in source water arriving at the point of supply	Arsenic	Coagulation, flocculation, filtration	coagulation, flocculation, filtration	Almost Certain	Minor	**High**	Rare	Minor	**Low**	NSW Health monitoring Source water monitoring	Guideline value = 0.1 mg/L; results are 0.11 mg/L; consequence is public perception/loss of service; baseline sampling results to be provided to HSC. Historical higher As sample results from Morrisons Lake.	
Weir	Cyanobacterial (blue green algae) outbreak leading to toxins above health guidelines reaching the consumer	Cyanotoxins,	Disinfection, filtration	BGA Task Force Western Division monitoring & alerts, PAC, Chlorination, Filtration, Alternate water supply (bores)	Unlikely	Major	**High**	Rare	Minor	**High**		RECOMMENDATION: Consider developing algal response framework including toxin testing through NSW Health FASS lab (potentially low/no cost)	

Commented [SH1]:

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
Weir	Cyanobacterial (blue green algae) outbreak leading to taste and odour issues	MIB, Geosmin etc	Filtration	PAC, Alternate water supply (bores)	Unlikely	Minor	**Low**	Rare	Minor	**Low**	Visual inspection,	no cell counts	
Weir	Storm events leading to increased pollutants in raw water	Turbidity, Colour, Pathogens, Fertilisers, Herbicides, Pesticides.	Filtration	WTP process control, Jar testing and enhanced coagulation, Alternate water supply (bores)	Possible	Major	**Very High**	Rare	Major	**High**	Turbidity 2-3/wk NSW Health monitoring		
Weir	Elevated turbidity outside storm events reaching the consumer	Turbidity, pathogens	Filtration	WTP process control, jar testing and enhanced coagulation, alternate water supply	Almost Certain	Major	**Very High**	Unlikely	Major	**High**	Turbidity 2-3/wk, NSW Health monitoring	Lower Lachlan Catchment Management Authority (CMA). RECOMMENDATION: 1. Chlorine testing at lab sink.	
Weir	Negligent / accidental contamination	Pesticides, Herbicide		Operators are trained in the handling of chemicals	Possible	Minor	**Mod**	Rare	Minor	**Low**	NSW Health monitoring		
Inlet	Coarse screen (on pump inlet) failure / blockage at ground storage tanks	Debris	Inlet works	Vegetation control in dam area, built-in silt trap, de-silting of dam, pump servicing (cleaning of screen)	Unlikely	Minor	**Low**	Rare	Minor	**Low**	Visual Inspection		
Inlet	Build-up of sediment and slimes at pump inlet	Turbidity, Organic Matter		Vegetation control in dam area, built-in silt trap, de-silting of dam, pump servicing (cleaning of screen)	Unlikely	Minor	**Low**	Rare	Minor	**Low**	Visual Inspection		
Ground tank	Stock access (including death of animal)	Pathogens, turbidity	Disinfection	Coagulation, filtration, WTP process control, regular pipeline inspections, fencing	Almost Certain	Major	**Very High**	Rare	Major	**High**	Visual Inspection NSW Health monitoring	Fencing repaired since original 2013 risk assessment	
Ground tank	Swimming and primary contact	Pathogens	Disinfection	Coagulation, filtration, WTP process control, Fencing, signs, dilution	Possible	Minor	**Mod**	Rare	Minor	**Low**	Visual Inspection NSW Health monitoring		
Borefield	Pathogens from residential/ agricultural/ industrial inputs due to surface water ingress	Pathogens - chlorine sensitive, chlorine resistant	Disinfection, Filtration,	Fenced bores, WTP process control	Possible	Major	**Very High**	Rare	Major	**High**	Turbidity meters fortnightly NSW Health monitoring	Bore depth: 58 meters. CDSC to confirm bore logs RECOMMENDATION: Construct concrete bore heads (activity already planned by CDSC); and review borehead sealing/integrity	
Borefield	Spills occurring in recharge area on roads or properties	Chemicals (various)		Hazardous material controls on transport vehicles, dilution, filtration through the aquifer	Rare	Minor	**Low**	Rare	Minor	**Low**	NSW Health monitoring	CDSC to provide baseline groundwater quality data to HSC/NSW Health	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
Borefield	Aquifer contamination due to seepage from septic tanks or landfills	Chemicals, pathogens	Disinfection	Chlorination, appropriate bore construction (steel cased bore etc).	Unlikely	Major	**High**	Rare	Major	**High**	NSW Health monitoring	Risk unknown. Details of aquifer, recharge areas are unknown. Concentration of septic tanks is low. Register of septic tanks?? RECOMMENDATION: 1. Extent of aquifer and recharge area to be determined. 2. Confirm location/ details/ management system of septic tanks	
Borefield	Surface water short- circuiting of contaminants due to well-casing failure	Pathogens	Disinfection	Chlorination, appropriate bore construction (including elevated well head, steel cased bore etc)	Unlikely	Major	**High**	Rare	Major	**High**	NSW Health monitoring	PVC casing, stainless steel screen. RECOMMENDED ACTIONS: 1. Planned inspections (including using cameras) of bores	
Borefield	Connections to stock watering (one bore only) - potential for contamination through backflow	Pathogens	Disinfection	Black flow prevention, 2 stop valves on line, disinfection	Possible	Major	**Very High**	Rare	Major	**High**		Regular level testing of bores is now undertaken. RECOMMENDATION: 1. Monitor groundwater quality in conjunction with level testing.	
Borefield	Radiological hazard present in aquifer	Radiological	Blending of bores and WTP process (general)		Possible	Minor	**Mod**	Possible	Minor	**Mod**		RECOMMENDATION: Test bores every 2 years for gross alpha and beta activity in line with ADWG.	
WTP	Alum dose - Over dosing	Aluminium, Turbidity, Pathogens	Clarifiers	Jar testing carried out irregularly, no alarms on plant	Unlikely	Major	**High**	Rare	Major	**High**		Overdosing may cause filter to block, floc may not form	
WTP	PAC dose - underdosing allowing contaminants	Toxins, Taste and Odour	Clarifiers	Alternative supply, visual inspection of storage dams	Possible	Moderate	**High**	Unlikely	Moderate	**Mod**		Standard PAC dose without prior testing. Toxins rarely present in system. Consequence is based on taste and odour. NSW Office of Water to be consulted regarding appropriate dose. Confirm shelf life of PAC. Confirm new WTP design allows sufficient contact time.	
WTP	PAC dose - over - dosing	PAC	Clarifiers	Alternative supply, visual inspection of storage dams	Unlikely	Insignificant	**Low**	Unlikely	Insignificant	**Low**			
WTP	Failure at clarifier	Pathogens, turbidity	Filtration	chemical dosing controls, jar testing to adjust coagulation dose, filtration, alternate water supply, multiple settling ponds, chlorination, automatic sludge removal	Likely	Major	**Very High**	Unlikely	Major	**High**	Operator observations, visual inspection of floc,	RECOMMENDATION: 1. Turbidity monitoring at clarifier (new plant)	
WTP	Clarification - floc blanket failure (e.g. loss of blanket, rising blanket etc	Pathogens	Clarifiers	chemical dosing controls; jar testing to adjust coagulation dose; filtration; alternate water supply, automatic sludge removal	Likely	Major	**Very High**	Unlikely	Major	**High**	Operator observations;		
WTP	Filters - Ineffective pollutant removal due to blockage of media/inadequate maintenance	Pathogens (chlorine resistant eg. Protozoa - *Cryptosporidium*)	Filters	DPIE & consultant inspections of filters, chlorination, routine filter maintenance	Likely	Major	**Very High**	Unlikely	Major	**High**	Sampling point at bottom of filter - regular sampling, Operators observation,	Backwash is water only, no air scouring. RECOMMENDATION: 1. Online monitoring, alarms (new plant) 2. Top up filter media, 3. Installation of prefilter chlorination	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
WTP	Filters - Disposal of backwash supernatant	Alum sludge, pathogens	Filters	WTP process control, no alarms on pumps, ponds, dilution	Possible	Major	**Very High**	Unlikely	Minor	**Low**	Visual inspection of pumps,	Small volumes for bore water and evaporation is all that is required to dispose of supernatant; larger volume for surface water treatment. Standby and duty sludge lagoons. RECOMMENDATION: New plant to consider sludge lagoon cleaning with respect to nearby power line, and reuse of pond supernatant (<10% recycle is considered best practice if returning supernatant).	
WTP	Loss of process control due to pH correction - soda ash underdosing	Low pH, pathogens		Can pre-dose if required;	Possible	Major	**Very High**	Unlikely	Major	**High**	Daily pH monitoring	Post dose after filter before disinfection; pre-dose possible at soda-dosing point (although soda-ash dosing would have to drop out!) Alarms would reduce; Clarifier has to be within pH range 6 - 7. Can lose the process if pH is out of this range. RECOMMENDATION: Additional pre- dosing point.	
WTP	pH correction - soda ash overdosing (post- dose only)	Pathogens		Long contact time in service reservoir.	Possible	Major	**Very High**	Unlikely	Minor	**Low**	Daily pH monitoring	Incorrect dosing – loss of chlorination efficiency	
WTP	Disinfection - Chlorine overdosing	Elevated Chlorine	Disinfection,		Likely	Minor	**High**	Unlikely	Minor	**Low**	Daily pH monitoringNSW Health Monitoring	Taste only	
WTP	Disinfection - Chlorine dose failure causing underdosing	Pathogens	Disinfection	Dual cylinders, automatic switch over at chlorine supply, cylinders are dated by online date. Booster pump could be sourced from the pool if required.	Likely	Catastrophic	**Very High**	Unlikely	Catastrophic	**Very High**	NSW Health monitoring,	RECOMMENDATION: Source a new booster pump for use either at WTP or pool in case of pump failure	
WTP	Disinfection - Shortage of chlorine supply	Pathogens	Disinfection	Back up supply at pool. 2 months' supply at treatment plant.	Likely	Catastrophic	**Very High**	Rare	Catastrophic	**High**	Operator inspections	Wet weather may prevent road supply of chlorine.	
WTP	Infrastructure (pipe work, linings of valves, pump, oils) leach components of materials due to chemical reaction	Chemicals	Filtration	Dilution due to volume of water	Rare	Minor	**Low**	Rare	Insignificant	**Low**	NSW Health monitoring	Cement lined ductile piping, PVC, plastic hosing for chemical lines.	
WTP	Power failure leading to equipment failure	Pathogens, Physical			Possible	Insignificant	**Low**	Possible	Insignificant	**Low**		Has happened, sometimes in excess of 24 hours. If there is no power, water does not get to reservoirs and therefore not supplied. No back-up generators/ power supply. 2 days storage	
WTP	Plant layout, wind- blown dust, chemicals etc	Dust, chemicals			Possible	Minor	**Mod**	Possible	Minor	**Mod**		RECOMMENDATION: Improve chemical storage, upgrade doors/ windows etc	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
WTP	Loss/ unavailability of skilled/ trained operators due to sickness, leave etc	All hazards			Likely	Major	**Very High**	Likely	Major	**Very High**		A back-up person is available but not fully trained. RECOMMENDATION: Identifying and training for additional operator(s) (current Operator leaving for 12 months in late 2021)	
Service Reservoir	Faecal contamination (access by birds, rats)	Pathogens	Disinfection, Inspections	Chlorine residual	Almost Certain	Major	**Very High**	Rare	Major	**High**	Visual Inspection	Vermin proofing completed late 2020	
Distribution	Dead end in retic system leading to stagnation and loss of chlorine residual	Taste and Odour	Disinfection	Fortnightly flushing	Almost Certain	Minor	**High**	Possible	Minor	**Mod**	Chlorine residual testing NSW Health monitoring	RECOMMENDATIONS: 1. Hydrants to be installed on bigger mains for improved flushing	
Distribution	Pathogens, chemicals, debris and soil entering the treated water supply through repairs, maintenance and new mains	Pathogens	Disinfection, filtration	Pump the hole and keep the water lower than the main; flush the system after works; SOPs	Almost Certain	Major	**Very High**	Possible	Major	**Very High**	Chlorine residual testing NSW Health monitoring	RECOMMENDATION: 1. Hydrants to be installed on bigger mains for improved flushing; 2. increased monitoring after the repair in the area.	
Distribution	Pathogens contaminating the treated water due to back flow & cross connection (water carters, stock connections, raw water dual reticulation, Bush Fire Brigade)	Pathogens, Chemicals	Disinfection	Meters on treated water lines with double checks (smart meter replacements); pressure in water reticulation	Almost Certain	Major	**Very High**	Possible	Major	**Very High**	Chlorine residual testingNSW Health monitoring	Raw water at similar pressure than treated water; no differentiation between raw and treated plumbing; treated water network is all PVC, raw water network is AC; Raw water unlikely to be palatable (strong organic smell).RECOMMENDATION: 1. Council to do household checks for cross connections; rainwater tanks are not checked. 2. Back flow prevention to be reviewed at Fire Station tap in shed	
Distribution	Growth of biofilms, sludge causing degradation of water quality	"Dirty water", operational impacts	Disinfection	Disinfection, flushing mains	Almost Certain	Insignificant	**Mod**	Likely	Insignificant	**Mod**	NSW Health monitoring	RECOMMENDATION: Install hydrants for improved flushing	
Whole of System	Malicious/deliberate contamination of whole system (including reservoirs, tanks)	Various - Chemical, Fertilisers, Herbicides, Pesticides		Alternate water source (bores), locked fences, locked hatches at reservoir, flocculation, coagulation, disinfection	Rare	Major	**High**	Rare	Major	**High**			

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
WTP	Security of WTP site - vandalism impacts plant processes	All contaminants		Locked gates, locked building (chlorine), WTP is ~2km out of town	Possible	Major	**Very High**	Rare	Major	**High**		RECOMMENDATION: 1. Consider security lights and/or security cameras	
Whole of System	Warm water temperatures	Naegleria	Disinfection (30mg.min/L)	Aim to keep chlorine residual through network	Possible	Major	**Very High**	Rare	Major	**High**			
WTP	Capacity of new WTPs - Ivanhoe WTP designed to **0.3**ML/day based on 22hrs operation. No real ability to downrate plant in response to poor water quality	Pathogens	Filtration Disinfection	Coagulation/ sedimentation. Maintain reservoir as full as possible (in anticipation) Plant automation	Almost Certain	Major	**Very High**	Possible	Major	**Very High**		22hr operation would mean plant is operating for long periods while unmanned. High usage period combined with a power outage is worst case scenario RECOMMENDATION: 1. Confirm CWT recommendation for WTP size remains suitable given future use of old prison site	
WTP	Capacity of new WTPs - Ivanhoe WTP designed to **0.4**ML/day based on 22hrs operation.	Pathogens	Filtration Disinfection	Coagulation/sedimentation. Maintain reservoir as full as possible (in anticipation) Plant automation	Almost Certain	Major	**Very High**	Unlikely	Major	**High**		22hr operation would mean plant is operating for long periods while unmanned. High usage period combined with a power outage is worst case scenario RECOMMENDATION: 1. Confirm CWT recommendation for WTP size remains suitable given future use of old prison site	
WTP	Failure of air compressor - impacts on WTP (air actuated sludge removal and raw water bypass valves)	Pathogens		Daily WTP inspections Manual sludge drain valve; Ability to take compressor from depot	Possible	Major	**Very High**	Rare	Major	**High**		RECOMMENDATION: 1. Buy a standby compressor	
WTP	Switchboard - messy and confusing. Potential impacts for treatment processes	Pathogens	Filtration Disinfection	Trained Operators	Possible	Major	**Very High**	Possible	Major	**Very High**		RECOMMENDATION: 1. Progress with new WTP, 2. If new WTP delayed significantly, further actions will be required to address this risk.	
Catchment	Pathogens from rural residential, agricultural and wildlife reaching the consumer.	Pathogens - chlorine sensitive (eg. Bacteria and Viruses)	Disinfection	Ground tanks to settle turbidity before plant, Jar testing, WTP process control (i.e. flocculation, coagulation, filtration, disinfection)	Almost Certain	Major	**Very High**	Unlikely	Major	**High**	Turbidity meters (no online monitoring), NSW Health monitoring	Lower Lachlan Catchment Management Authority (CMA). (no online monitoring), RECOMMENDATION: 1. Chlorine testing at lab sink.	
Catchment	Pathogens from Onsite Sewage Management System discharges / failures contaminating source water	Pathogens (chlorine resistant eg. Protozoa - *Cryptosporidium*)	Filtration	Ground tanks to settle turbidity before plant, Jar testing, WTP process control (i.e. flocculation, coagulation, filtration, disinfection)	Likely	Major	**Very High**	Unlikely	Major	**High**	Turbidity meters NSW Health monitoring	Risk unknown; Lower Lachlan CMA; RECOMMENDATION: 1. Determine number/ location of systems within the catchment. 2. Chlorine testing at lab sink.	

Process Step	Source of Hazard/Event	Hazards	Control Point	Preventative Measures	Maximum Risk			Residual Risk			Monitoring	Comments	Improvement Plan reference
					Likelihood	Conseq.	Risk Level	Likelihood	Conseq.	Risk Level			
Catchment	Pathogens from unrestricted livestock access to water supply entering raw water	Pathogens (chlorine resistant eg. Protozoa - *Cryptosporidium*)	Filtration	Ground tanks to settle turbidity before plant, Jar testing at plant dam, WTP process control (i.e. flocculation, coagulation, filtration, disinfection)	Likely	Major	**Very High**	Unlikely	Major	**High**	Turbidity meters NSW Health monitoring	No online monitoring	
Catchment	Chemical spill in catchment contaminating raw water	Chemicals, Pesticides, Herbicides, Fertilisers, Petrol	Filtration	Ground tanks to settle turbidity before plant,	Rare	Major	**High**	Rare	Minor	**Low**	NSW Health monitoring	2 fuel tankers come to Ivanhoe a week and they cross Willandra Creek. Fertilisers, pesticides are all trucked in.	

4.2 Key barriers

The NSW DPIE (Water) issued Circular LWU 18 'Assuring the safety of drinking water supplies', (4 June 2014) with corresponding protocols that are to be implemented by all local water utilities providing a drinking water supply. The Circular is attached in Appendix A. Council must meet the minimum requirements in order to achieve the three key barriers outlined below (NSW Department of Industry (Water), 2014):

- Effective disinfection to kill or remove pathogens in the raw water
- Ensure distribution system integrity to prevent contamination
- Maintenance of free chlorine residual in the reticulation system

Council is required to ensure the SOPs meet the minimum requirement for each key barrier as outlined by NSW DPIE (Water).

4.3 Critical Control Points

Critical Control Points (CCPs) are activities, procedures or processes where the operator can apply control, and are essential processes in reducing risks to an acceptable level.

In order to define acceptable from unacceptable performance at each point, target levels, alert levels and critical limits have been identified for Council's drinking water supply systems.

Critical Control Points were identified in 2012, and reviewed in 2021. This was undertaken in consultation with CDSC, NSW Health and NSW DPIE (Water) and the resultant CCP procedures are documented below.

Table 16 and Table 17 summarise the CCPs for the Wilcannia and Ivanhoe drinking water supply schemes.

Three different limits have been set for each CCP within Council's drinking water supply systems:

1. Target Limit: Representing day to day operational limits and procedures. This is what the WTP aims to achieve.
2. Alert Limit: Deviation from the Alert Limit indicates a trend towards loss of control and corrective actions should be immediately taken to resolve the problem and restore control to the Drinking Water Supply System.
3. Critical Limit: Deviation from the Critical Limit indicates loss of control and the potential of unacceptable health risks. If the critical limit is exceeded, incident and emergency plans should be immediately activated.

Table 16 Wilcannia drinking water supply scheme CCPs - summary

Parameter	Frequency	Target Limit	Adjustment Limit	Critical Limits
CCP 1 Filtration				
Turbidity (NTU)	Daily	<0.5	>0.5	>1
CCP 2 Disinfection				
Free chlorine (mg/L)	Daily	2.0 – 4.0	<1.0	<0.6 or >5.0
CCP 3 Integrity of Reservoirs				
System integrity (sealed and secure)	Monthly	No breaches in structure or vermin proofing	Reservoir integrity breach	Evidence of contamination, or serious breach of integrity / unable to be fixed immediately

Table 17 Ivanhoe drinking water supply scheme CCPs - summary

Parameter	Frequency	Target Limit	Adjustment Limit	Critical Limits
CCP 1 Membrane Filtration				
Turbidity (NTU)	Daily	<0.1	>0.1	≥0.5
CCP 2 Disinfection				
Free chlorine (mg/L)	Daily	1.5 – 2.0	<1.5	<1.0 or >5.0
CCP 3 Integrity of Reservoirs				
System integrity (sealed and secure)	Monthly	No breaches in structure or vermin proofing	Reservoir integrity breach	Evidence of contamination, or serious breach of integrity / unable to be fixed immediately

The six CCP wall charts are provided below.

Wilcannia Water Treatment Plant
Filtration Critical Control Point Procedure

What is measured	Where or how is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Turbidity	Grab sample of filtered water	Daily	Filter	Pathogens, turbidity	Results stored on Daily Log Sheet. Adjustment and critical limit response actions to be recorded in the plant diary

Critical Limit
>1 NTU

- Alert supervisor
- Decrease flow through plant
- Consider alternate supply (bore water)
- Contact Public Health Unit on (08) 8080 1486 or 0409 746 311
- Contact DPIE Water Inspector on (02) 6841 7402 or 0458 268 453
- Stop pump to clearwater well and flush if required
- Increase frequency of backwash
- Process controls - investigate operational activities
- Increase monitoring frequency to determine effectiveness of corrective actions

Adjustment Limit
>0.5 NTU

- Alert supervisor
- Visual inspection of clarifier (refer to Coagulation OCP)
- Increase backwash
- Increase monitoring
- Stop flow to clearwater well
- Inspect clearwater well - if water has flowed in, flush clearwater well
- Recommence flow when turbidity meets target

Target
<0.5 NTU

- Daily backwash
- Daily Monitoring at Filters - Turbidity
- Inspect media for mud balls - monthly; remove as appropriate and backwash until clear
- Replenish media when required (19 " from central drain)

Wilcannia Water Treatment Plant
Disinfection Critical Control Point Procedure

What is measured	Where or how is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Free chlorine	Grab sample of treated water from reservoir	Daily	Chlorine dosing system	Chlorine sensitive pathogens	Results stored on Daily Log Sheet. Adjustment and critical limit response actions to be recorded in the plant diary

Critical Limits
<0.6 mg/L OR >5.0 mg/L

- Alert supervisor
- Contact Public Health Unit on (08) 8080 1486 or 0409 746 311
- Contact DPIE Water Inspector on (02) 6841 7402 or 0458 268 453
- Verify dosing system operation & chlorine available
- If <0.6mg/L, increase chlorine dose
- If >5mg/L, decrease chlorine dose
- Flush water mains if required
- Consider alternative source if required (e.g. if chlorine demand excessive)
- Increase monitoring frequency until resolved

Adjustment Limit
<1.0 mg/L

- Verify dosing system operation & chlorine available
- Review raw and filtered water quality, consider whether chlorine demand has changed
- Increase dose carefully until reservoir reaches target
- Increase monitoring frequency to ensure modified dose rate does not result in overdose

Target
2.0 – 4.0 mg/L

- Daily WTP inspection
- Daily treated water quality monitoring (complete Daily Log Sheets)
- Instrument maintenance and calibrations as required
- Order chlorine cylinders as required

Wilcannia Reservoir Integrity Critical Control Point Procedure

What is measured	Where or how is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Reservoir integrity	Observation at the reservoir including the roof	Monthly	Reservoir storage	Pathogens	Adjustment and critical limit response actions to be recorded in the plant diary

Critical Limit
Evidence of contamination, or serious breach of integrity / unable to be fixed immediately

- Alert supervisor
- Contact Public Health Unit on (08) 8080 1486 or 0409 746 311
- Contact DPIE Water Inspector on (02) 6841 7402 or 0458 268 453
- Take samples and send away for microbiological analysis
- Consider increasing free chlorine through adjustment to dosing rate (discuss with Public Health)
- Increase chlorine monitoring frequency until resolved
- Follow advice from Public Health regarding any need for a boil water alert
- Urgently plan and implement contaminant removal / longer term solution to integrity breach
- Regular communications and updates provided to Public Health Unit

Adjustment Limit
Reservoir integrity breach

- Alert supervisor
- Rectify breach / reinstate vermin proofing
- Check free chlorine at reservoir outlet and follow Disinfection CCP
- Discuss e.g. need for capital works with Supervisor (e.g. if cause of breach is due to asset degradation)

Target
No breaches in structure or vermin proofing

- Monthly reservoir inspections
- Daily treated water quality monitoring (complete Daily Log Sheets)
- Preventative & corrective maintenance as required to avoid integrity breaches

Ivanhoe Water Treatment Plant
Filtration Critical Control Point Procedure

What is measured	Where or how is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Turbidity	Grab sample of filtered water	Daily	Filter	Pathogens, turbidity	Results stored on Daily Log Sheet. Adjustment and critical limit response actions to be recorded in the plant diary

Critical Limit
>0.5 NTU

- Alert supervisor
- Decrease flow through plant
- Consider alternate supply (bore water)
- Contact Public Health Unit on (08) 8080 1486 or 0409 746 311
- Contact DPIE Water Inspector on (02) 6841 7402 or 0458 268 453
- Stop flow to treated water reservoir and flush if required
- Increase frequency of backwash
- Process controls - investigate coagulation
- Increase chlorine dose
- Increase monitoring frequency to determine effectiveness of corrective actions

Adjustment Limit
>0.3 NTU

- Alert supervisor
- Visual inspection of clarifier (refer to Coagulation OCP)
- Initiate backwash
- Stop flow to treated water reservoir
- Inspect treated water reservoir, if turbid water has flowed in, flush well
- Recommence flow when turbidity meets target
- Increase monitoring

Target
<0.2 NTU

- Daily backwash
- Daily Monitoring at Filters - Turbidity
- Inspect media for mud balls - monthly; remove as appropriate and backwash until clear
- Replenish media as appropriate

Ivanhoe Water Treatment Plant
Disinfection Critical Control Point Procedure

What is measured	Where or how is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Free chlorine	Grab sample of treated water from reservoir	Daily	Chlorine dosing system	Chlorine sensitive pathogens	Results stored on Daily Log Sheet. Adjustment and critical limit response actions to be recorded in the plant diary

Critical Limits
<1mg/L OR >5mg/L

- Alert supervisor
- Contact Public Health Unit on (08) 8080 1486 or 0409 746 311
- Contact DPIE Water Inspector on (02) 6841 7402 or 0458 268 453
- Verify dosing system operation & chlorine available
- If <1mg/L, increase chlorine dose
- If >5mg/L, decrease chlorine dose
- Flush water mains if required
- Consider alternative source if required (e.g. if chlorine demand excessive)
- Increase monitoring frequency until resolved

Adjustment Limit
<1.5mg/L

- Verify dosing system operation & chlorine available
- Review raw and filtered water quality, consider whether chlorine demand has changed
- Increase dose carefully until reservoir reaches target
- Increase monitoring frequency to ensure modified dose rate does not result in overdose

Target
1.5 – 2.0 mg/L

- Daily WTP inspection
- Daily treated water quality monitoring (complete Daily Log Sheets)
- Instrument maintenance and calibrations as required
- Order chlorine cylinders as required

Ivanhoe Reservoir Integrity Critical Control Point Procedure

What is measured	Where or how is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Reservoir integrity	Observation at the reservoir including the roof	Monthly	Reservoir storage	Pathogens	Adjustment and critical limit response actions to be recorded in the plant diary

Critical Limit
Evidence of contamination, or serious breach of integrity / unable to be fixed immediately

- Alert supervisor
- Contact Public Health Unit on (08) 8080 1486 or 0409 746 311
- Contact DPIE Water Inspector on (02) 6841 7402 or 0458 268 453
- Take samples and send away for microbiological analysis
- Consider increasing free chlorine through adjustment to dosing rate (discuss with Public Health)
- Increase chlorine monitoring frequency until resolved
- Follow advice from Public Health regarding any need for a boil water alert
- Urgently plan and implement contaminant removal / longer term solution to integrity breach
- Regular communications and updates provided to Public Health Unit

Adjustment Limit
Reservoir integrity breach

- Alert supervisor
- Rectify breach / reinstate vermin proofing
- Check free chlorine at reservoir outlet and follow Disinfection CCP
- Discuss e.g. need for capital works with Supervisor (e.g. if cause of breach is due to asset degradation)

Target
No breaches in structure or vermin proofing

- Monthly reservoir inspections
- Daily treated water quality monitoring (complete Daily Log Sheets)
- Preventative & corrective maintenance as required to avoid integrity breaches

5 MONITORING OF DRINKING WATER SYSTEMS

The sections below outline the operational and verification monitoring for the CDSC drinking water supply systems. Operational monitoring includes the planned sequence of measurements and observations to assess and confirm the performance of preventive measures. Verification monitoring assesses the overall performance of the system and the quality of the drinking water being supplied to the consumer. Council undertakes both operational and verification monitoring.

5.1 Operational Monitoring

Operational monitoring of water quality is undertaken manually by CDSC Operators. All records are documented in worksheets on site. Council intends to develop a centralised system to electronically record all water quality data and observe trends over time.

Operational Monitoring regimes have been developed for both Wilcannia and Ivanhoe DWSSs as part of the development of the DWMS. Table 18and Table 19 summarise the regimes for both Wilcannia and Ivanhoe.

Table 18 Operational Monitoring Program – Wilcannia WTP

Monitoring Point	Parameters	Trigger Levels	Frequency	Sampling Method
Catchment	Rainfall Darling River Weir Level Standing Water Level (SWL) at bores		Daily/weekly Event based	Visual
	Algal Bloom (RACC)	Algae Alerts	Monthly/ fortnightly	
Source Water: Darling River	Fencing, security, algae	Signs of ingress by people and livestock, algal blooms occurring	Weekly	Visual
Source Water: Wilcannia Bores	Fencing, security	Signs of unauthorised access, points of potential ingress/ contamination	Weekly	Visual
WTP – Raw water	pH	<6 or >8	Daily	Grab sample
	Turbidity	>1000NTU		
	Colour			
	Salinity			
	Iron	>0.3mg/L		
	Manganese	>0.1mg/L		
	Temperature			
WTP – Clarifier outlet	Turbidity	>5NTU	Daily	Grab sample
	pH	<6 or >7		
	Temperature			
	Colour			

Monitoring Point	Parameters	Trigger Levels	Frequency	Sampling Method
WTP – Filtration	Turbidity	>0.5NTU	Daily	Grab sample
	Colour			
	Free chlorine	<3 or >5mg/L		
	Number of backwashes	>3		
WTP – Clearwater well	Free chlorine	<3 or >5mg/L	Daily	Grab sample
	Total chlorine			
	Turbidity	>1NTU		
	pH	<7 or >8		
	Colour			
	Temperature			
	Aluminium	>0.2mg/L	Daily to Weekly	
	Iron	>0.3mg/L		
	Manganese	>0.1mg/L		
Treated water reservoir	Free chlorine	<1.0 or >5.0mg/L	Daily	Grab sample
	Total chlorine	>5.0mg/L		
	Turbidity	>1NTU		
	pH	<7 or >8		
	Colour			
	Temperature			
	Aluminium	>0.2mg/L		
	Iron	>0.3mg/L		
	Manganese	>0.1mg/L		
	Salinity			
	Hardness		Weekly	
	Tank integrity	Integrity breach	Daily (ground level); Monthly (climb to top)	Visual
Reticulation	Free chlorine	<0.2 or >5.0mg/L	Weekly	Grab samples
	Total chlorine	>5.0mg/L		
	Turbidity	>5NTU		
	pH	<7 or >8		
	Colour			
	Temperature			

Table 19 Operational Monitoring Program – Ivanhoe WTP

Monitoring Point	Parameters	Trigger Levels	Frequency	Sampling Method
Catchment	Rainfall Willandra Creek Flow SWL at bores		Event; changing from bore to surface water use	Visual
Source water: Willandra Creek	Fencing, security, signs, ingress by people and livestock, algal blooms		Twice weekly	Visual
Source water: Ivanhoe Bores	Fencing, security, signs, ingress by people and livestock		Twice weekly	Visual
WTP – Raw water	pH		Daily	Grab sample
	Turbidity	>30NTU		
	Colour			
	Salinity			
	Iron	>0.3mg/L		
	Manganese	>0.1mg/L		
	Temperature			
WTP – Clarifier outlet	Turbidity	>5NTU	Daily	Grab sample
	pH	<6 or >7		
	Temperature			
WTP – Filtration	Turbidity	>0.5NTU	Daily	Grab sample
WTP – Clearwater	Free chlorine	<3 or >6mg/L	Daily	Grab sample
	Turbidity	>1NTU		
	pH	<7 or >8		
	Colour			
	Temperature			
	Salinity			
	Aluminium	>0.2mg/L	Daily to Weekly	
	Iron	>0.3mg/L		
	Manganese	>0.1mg/L		
Treated water reservoir	Free chlorine	<0.5 or >5.0mg/L	Daily	Grab sample
	Total chlorine	>5.0mg/L		
	Turbidity	>1NTU		
	pH	<7 or >8		
	Colour			
	Temperature			
	Salinity			

Monitoring Point	Parameters	Trigger Levels	Frequency	Sampling Method
	Aluminium	>0.2mg/L	Weekly	Grab sample
	Iron	>0.3mg/L		
	Manganese	>0.1mg/L		
	Hardness			
	Tank integrity	Integrity breach	Daily (ground level); Monthly (climb to top)	Visual
Reticulation	Free chlorine	<0.2 or >5.0mg/L	Weekly	Grab samples
	Total chlorine	>5.0mg/L		
	Turbidity	>5NTU		
	pH	<7 or >8		
	Colour			
	Temperature			

5.2 Verification of Drinking Water Management

The verification of drinking water quality supplied to the consumer assesses the overall performance of the system. Verification provides an important link back to the operation of the water supply system and additional assurance that the preventive measures and treatment barriers have worked and are supplying safe quality water.

WTP Operators monitor water quality at the point of supply as part of the NSW Health Drinking Water Monitoring Program which provides ongoing independent verification of the treatment process. Frequency of sampling is based on population. The Program assesses 36 parameters for microbial, physical and chemical properties of the water as detailed in Table 20. The results can be accessed at:

https://www.webapp.health.nsw.gov.au/

Table 21 lists the sites for verification monitoring, including: five sites in the Wilcannia reticulation, with one to two samples scheduled weekly (sites rotated); seven sites in the Ivanhoe reticulation, with one sample scheduled fortnightly (sites rotated); and two sites in the White Cliffs reticulation, with one sample scheduled fortnightly (sites alternated).

Council's Manager of Environmental Services is responsible for the collection of samples for the NSW Health Drinking water Monitoring Program. Samples are submitted in accordance with the "Guide for Submitting Water Samples to FASS for Analysis" (Sydney West Area Health Service, 2010) and the Council water procedures for samples.

In addition to the NSW Health Drinking Water Monitoring Program, Council undertakes daily and weekly operational monitoring at point of supply as part of the Council's operating procedures.

Table 20 NSW Health Drinking Water Monitoring Program Analytes

Parameters		
Microbial		
E. coli	Total coliforms	
Disinfection		
Free chlorine	Total chlorine	
Physical		
pH	Total Dissolved Solids	True Colour
Temperature	Total Hardness	Turbidity
Chemical		
Aluminium	Copper	Nickel
Antimony	Fluoride	Nitrate
Arsenic	Iodine	Nitrite
Barium	Iron	Selenium
Boron	Lead	Silver
Cadmium	Magnesium	Sodium
Calcium	Manganese	Sulphate
Chloride	Mercury	Uranium
Chromium	Molybdenum	Zinc

Table 21 NSW Health Drinking Water Monitoring Program Sites

NSW Health Drinking Water Monitoring Program Sites			
Wilcannia			
4	Water Filtration Plant Wilcannia	12	20 Warrali Avenue Wilcannia
6	Shire Depot Wilcannia	15	Ross Street Wilcannia
11	Mallee Wilcannia		
Ivanhoe			
1	Hospital Ivanhoe	6	Leichardt Ivanhoe
2	Police Station Ivanhoe	7	Columbus Street Ivanhoe
4	Water Filtration Plant Ivanhoe	9	Bourke Street Ivanhoe
5	33 Mitchell Street Ivanhoe		
White Cliffs			
2	Caravan Park White Cliffs	4	Water Filtration Plant White Cliffs

5.3 Consumer Satisfaction

Council has a customer service for complaints and requests. The call centre records all requests, which are forwarded to the Engineering Section for action. Straightforward requests are

forwarded directly to the relevant Town Ganger. Other more complex matters are referred to the Manager Technical and Engineering Services (MTES) and delegated to the Projects Engineer should the MTES be absent. All water and sewer issues are registered as a complaint or issue for action.

Personal and urgent complaints are responded to within two hours. Written (and non-urgent) complaints are responded to within five (5) working days.

5.4 Short Term Evaluation of Results and Corrective Action

Council evaluates water quality data on receipt of monitoring results. Water quality results from NSW Health are reported to Council's Manager of Environmental Services (MES) and delegated to the Manager Technical and Engineering Services (MTES) when MES is absent. Any exceedances are immediately reported to Council's Projects Engineer. The Projects Engineer liaises with the relevant Water Treatment Plant Operator and Council's Environmental Health Officer in evaluating and resolving the issue. Compliance is assessed against the ADWG.

Drinking water quality exceedances from NSW Health Drinking Water Monitoring Program triggers a notification by the laboratory to Council's Manager of Engineering Services (MES) who immediately notifies the Manager Technical and Engineering Services (MTES) where the investigation and resolution of the particular exceedance is delegated to the Projects Engineer. The Projects Engineer liaises with the relevant Water Treatment Plant Operator and Council's Environmental Health Officer. A response is prepared by the Projects Engineer for concurrence and reporting by the Manager of Environmental Services.

Any exceedances are recorded and acted upon immediately with the appropriate regulatory authorities notified. All test results are recorded in the NSW Health Drinking Water Database which is completely independent of Council. The NSW Health Drinking Water Monitoring Program provides the following response protocols, accessible to CDSC:

- Managing pathogen risks in drinking water: Response protocol for water utilities and public health units (March 2018)
- NSW Health Response Protocol: for the management of physical and chemical quality (September 2015)
- In future, when fluoridation is implemented - NSW Code of Practice for Fluoridation of Public Water Supplies (April 2018)

E. coli exceedances require immediate re-testing (using the "Form for urgent sample submission to FASS") as stipulated in the NSW Health response protocol for the management of microbiological quality of drinking water. Council should immediately discuss any *E. coli* exceedances with NSW Health, which may result in a boil water alert. This protocol also includes actions in response to failure of treatment, disinfection or poor or rapidly changing source water quality.

6 OPERATIONAL PROCEDURES AND PROCESS CONTROL

6.1 Operational procedures

As part of the development of the DWMS, key operating procedures and corrective actions were established for each CCP within the Wilcannia and Ivanhoe DWSS. These included operational procedures required to achieve the target criteria and corrective actions when alert levels or critical levels are reached.

- Wilcannia – Filtration, Disinfection and Reservoir Integrity
- Ivanhoe – Filtration, Disinfection and Reservoir Integrity

The CCPs have documented operational procedures that support Council to achieve the target criteria and corrective actions when alert levels or critical levels are reached. Refer to the CCP's under Risk Management and Controls. CCP signs have been developed and are attached in section 4.3.

Council has a hard copy of the Operation and Maintenance Manual for both the Wilcannia and Ivanhoe Water Treatment Plants located at each WTP and within the Wilcannia Engineering Office, Meyers Street, Wilcannia.

6.2 Equipment Capability and Maintenance

Council's objective is to ensure all equipment purchased performs adequately and provides sufficient flexibility and process control.

The risk assessment identified areas of concern in relation to the capability of existing equipment including the calibration of monitoring utensils, to adequately support operators in their day to day activities. Council must ensure that water treatment assets and equipment are maintained to the highest standards.

Council has prepared an Asset Management Plan for water infrastructure to manage water assets and the services they provide in Ivanhoe and Wilcannia. The Water Asset Management Plan includes a water asset register. The Water Asset Management Plan guides maintenance generally and specifically defines criteria for reactive and planned maintenance of water assets.

Hard copies of Council's Infrastructure Asset Management Plans are located within the Engineering Office in Meyers Street, Wilcannia and electronic copies are stored within Council's Document Management System.

6.3 Materials and Chemicals

Council conforms to the NSW Code of Practice Plumbing and Drainage (CUPDR, 2006) and the AUS-SPEC 0071 water supply – Reticulation and pump stations (Design) (NATSPEC in the purchasing of materials and chemicals). The Plumbing Code of Australia has now been adopted in NSW.

Council purchases water treatment chemicals through reputable suppliers. Orica supply Council's chlorine products and REDOX supply soda ash and aluminium phosphate.

The following procedures are recommended by NSW Health:

- Chemical deliveries are attended by trained water treatment plant operators
- A certificate of analysis is provided by the supplier at the time of delivery for each batch of chemical supplied and that the chemical satisfies the criteria specified in Chapter 8 of the Australian Drinking Water Guidelines, prior to the commencement of unloading

- The correct chemical is being delivered into the appropriate storage
- If relevant, check that the correct concentration has been supplied

Delivery of water treatment chemicals to the CDSC may encounter delays due to distances. Chlorine supply from Adelaide has previously been delivered after extended storage in a warehouse and had lost its strength.

Preferred suppliers identified through government contracts are used for the supply of some chemicals, including alum and lime. Public tender processes or sole sourced contracts in the case of a limited market are used for the remainder of chemicals, including chlorine.

The use, including transport and storage, of chemicals listed as “Dangerous Goods” under the Work, Health and Safety Act 2011 (NSW) (WH&S Act). This includes chlorine, is dictated by the provisions of the WH&S Act and Work Cover. Storages and trucks are licensed according to the WH&S Act.

Council conforms to the requirements of individual Material Safety Data Sheet (MSDS) with regards to personal protective equipment (PPE) requirements, safety precautions first aid treatment for chemical spills. Relevant MSDS are appropriately located at each WTP in vicinity of chemical storage areas.

Chemicals used in the supply of drinking water at Wilcannia and Ivanhoe are listed in Table 22 and Table 23.

Table 22 List of Chemicals used in Wilcannia Drinking Water Supply System

Chemical	Purpose	Dosing Concentration (typical)
Powdered Activated Carbon	Organics removal	TBC
Aluminium chlorohydrate	Coagulation	TBC
Chlorine gas	Disinfection	6.0 – 7.0mg/L
Sodium carbonate	pH adjustment	100-300 mg/L

Table 23 List of Chemicals used in Ivanhoe Drinking Water Supply System

Chemical	Purpose	Dosing Concentration (typical)
Powdered Activated Carbon	Organics removal	TBC
Aluminium chlorohydrate	Coagulation	TBC
Chlorine gas	Disinfection	6.0 – 7.0mg/L
Sodium carbonate	pH adjustment	100-300 mg/L

7 MANAGEMENT OF INCIDENTS AND EMERGENCIES

7.1 Overview

Council classifies drinking water incidents according to a three-tiered framework as illustrated in Table 24. The responsibility for incident management is also shown in the table.

Table 24 Drinking water incident classification levels

Level	Description	Primary Responsibility
Level 3 Incident	High risk or confirmed impact to the community, e.g. disease outbreak or natural disaster.	General Manager
Level 2 Incident	Elevated risk, e.g. water treatment processes are not operating at the level required to remove or inactive contaminants (should they be present in the raw water).	Utilities Engineer
Level 1 Incident	Potential for elevated risk unless action is taken, or minor (e.g. aesthetic) impacts to customers.	WTP Operator

7.2 Communication

Any Council staff member becoming aware of an incident must communicate this to the appropriate level. In most cases it is likely to be the Water Treatment Operators who become aware of Level 1 and 2 incidents, through operational issues or detection of a parameter through operational or verification monitoring.

Council refers to the NSW Health Response Protocols for communication strategies to manage water quality incidents. Council's primary contact is the Manager of Environmental Services (MES) on 08 8083 8900. The Manager Technical and Engineering Services (MTES) is the secondary contact on 08 8083 8800.

Council's Media department distributes warnings and notifications to the community as required and in accordance with Council's Media Policy.

7.3 Incident and Emergency Response Protocols

Council responds to water quality incidents according to the following NSW Response Protocols:

- Managing pathogen risks in drinking water: Response protocol for water utilities and public health units (March 2018)
- NSW Health Response Protocol: for the management of physical and chemical quality (September 2015)

E. coli detections require immediate re-testing as stipulated in the NSW Health response protocol. Council should immediately discuss any *E. coli* notification with NSW Health, to determine appropriate public health response (including the need for a boiled water alert).

For physical and chemical exceedances, Council follows the NSW Health Response Protocol: for the management of physical and chemical quality.

Council has participated in the development and has representation on the committee for the Far West District Emergency Disaster Plan (Far West DEMC, 2006). This defines the responsibility of Council in mitigation/prevention strategies and in supporting disaster response. The Far West

Plan also identifies the roles of key responsible agencies, and in particular of NSW Fire Brigade relating to spills or hazardous materials incidents affecting waterways.

8 SUPPORTING REQUIREMENTS

8.1 Employee Awareness and Training

Council's Water Treatment Operators have all undertaken training (water treatment plant operation, theory and practice) provided by DPIE Water in conjunction with TAFE NSW. Wilcannia water treatment operators have completed or have commenced their training to Cert 3 – Water Operations.

Staff meetings are held on a weekly basis, generally Monday, to plan and schedule work tasks for the coming week. This opportunity is often utilised to disseminate technical information.

Council has developed a draft Workforce Management Plan 2012 – 2015 (CDSC, 2012). It provides the details of the positions and workforce gaps in the Technical and Engineering Services team, required competencies and existing gaps in competencies, succession strategies and an action plan with strategies and a timeframe to meet the gaps.

The Workforce Management Plan is available for public consultation in hardcopy at the Council office and electronically.

8.2 Community Involvement and Awareness

Council has a Community Consultation Policy, allowing the public to address Council meetings personally or through written submissions. Standing committees such as the Works Committee and Water Advisory Committee provide avenues for members of the public to participate in the development of Council policy and their functions. Community forums allow for public participation at the monthly meetings and regular open community forums throughout the year.

Ordinary meetings of Council are normally held on the third Tuesday of the month. The meeting is rotated between Wilcannia Council Chambers, Menindee Civic Hall, Sunset Strip Community Hall, Ivanhoe RSL and Darnick Community Hall. The schedule and minutes from the meetings are available on the Council website.

The Central Darling Shire Community Strategic Plan (CDSC, 2012) identifies the main priorities and expectations of the community for the next ten years. It has a specific strategy of "Safe and reliable water supply for Shire communities" and a corresponding performance target and defined actions until 2022/23. It is available on Council's website.

CDSC's website has a page for water and sewerage, with information on water conservation only. With regards to the Aboriginal communities of Mallee & Warrali Mission, the CEO of the Local Aboriginal Land Council will, in consultation with Council, be responsible for all community consultation and communication and be the 'First Point of Contact" for the community. Upon receipt of an issue, the CEO will notify Council which will record and respond to the issues within its area of responsibility.

The Local Aboriginal Land Council - CEO will obtain a list of recent issues from Council and present the list for review at the 4–monthly meetings. A list of contacts for the Aboriginal community is in Appendix C.

No further details on water quality in the Wilcannia or Ivanhoe DWSSs are available on the website. It is recommended that Council develop the website to provide information to consumers regarding their drinking water supply. The website should be updated on a regular basis.

The CDSC Publication Guide provides details on:

- Ways to access information, both formal and informal releases
- Avenues for public participation; and
- Documents available to the public

8.3 Research and Development

8.3.1 Investigative Studies and Research Monitoring

The following items have been identified as requiring investigative research projects:

- Ongoing research into raw water quality, pre-treatment, and chlorine dosing in order to reduce the development of DBPs.
- Optimisation of filtration performance to manage *Cryptosporidium* risk insofar as is possible with the existing infrastructure.

8.3.2 Validation of Processes and Equipment

Validation requires the evaluation of system processes and equipment to prove the performance under all conditions expected to be encountered during operations. Validation should be undertaken on new processes and equipment, when upgrades occur and on a regular basis to ensure continual performance.

Validation should be undertaken when there is a:

- Change in raw water quality
- Modification to the water treatment processes
- Change to the delivery, storage and distribution systems of treated and untreated water
- Change in the use of treated water
- Change in water quality standards
- New research or understanding of water quality issues
- Receipt of information that indicates a health risk associated with the quality of the drinking water

Validation of new or upgraded processes and equipment is undertaken by qualified, experienced engineers and operators through:

- System design according to industry guidelines and standards
- Individual process and equipment specification against CCP target limits
- Procurement of equipment/chemicals from approved suppliers
- Market pre-validation by suppliers, particularly associated with water treatment chemicals

Ongoing validation processes to ensure safe and acceptable drinking water is supplied to the customer are:

- Review of scientific literature on treatment processes and industry best practice
- Evaluation of the effectiveness of CCPs in eliminating or controlling risks
- Assessment of research and development work to ensure CCP limits remain appropriate

8.3.2.1 Primary Disinfection Contact Time

In treated water, a combined available residual chlorine level of 0.5 mg/L after a contact time of 30 minutes is considered sufficient to ensure microbial control, given a clean distribution system and no significant recontamination. C.t is a measure of free chlorine residual concentration (C) and contact time (t). A primary disinfection contact time greater than 30mg.min/L has been set to mitigate against the risk of *Naegleria fowleri*. because of the elevated temperatures in Central Darling Shire

Chlorine C.t for the CDSC drinking water supplies has been calculated as shown in Table 25 and Table 26. In both systems, 'reasonable worst case' conditions have been used, i.e. reservoirs at their lowest normal level with highest flow rates under normal conditions (i.e. not a firefighting or mains break scenario). Baffle factors of 0.1 have been applied in both, as well as the low critical limit for the Disinfection CCP each system.

Table 25 Wilcannia Ct calculations

Factor	Unit of measure	Value
Reservoir capacity	ML	1
Baffle Factor	-	0.1
Min. Reservoir Level	%	50
Flow rate out	L/sec	15
Contact time	mins	55.5
Free chlorine (leaving reservoir)	mg/L	0.6
C.t	mg.min/L	33.3

Table 26 Ivanhoe Ct calculations

Factor	Unit of measure	Value
Reservoir capacity	ML	0.5
Baffle Factor	-	0.1
Min. Reservoir Level	%	60
Flow rate out	L/sec	15
Contact time	mins	33.3
Free chlorine (leaving reservoir)	mg/L	1.0
C.t	mg.min/L	33.3

These calculations justify the Disinfection CCP critical limits that have been adopted as of 2021.

8.4 Documentation and Reporting

8.4.1 Management of Documentation and Records

Council does not have an effective document control process. Notwithstanding an electronic file has been created within the Engineering Section of Council document / data storage system to store relevant information and data.

The DWMS documents information pertinent to all aspects of drinking water quality management for the Wilcannia and Ivanhoe DWSS.

The DWMS is a living document and should be maintained in-line with actual operations and management. Any changes to the DWSS should be updated and documented within this DWMS.

For more information on data management see Table 3 -11 'Data Management Obligations', NSW Guidelines for Drinking Water Management Systems. It is recommended that Council review their obligations and develop a system to effectively manage Council documents and records.

8.4.2 Reporting

Daily water quality monitoring results are located at Engineering/Water Sewer/Wilcannia Water/Testing Results and Engineering/Water Sewer/Ivanhoe Water/Testing Results for Wilcannia and Ivanhoe respectively. Drinking water quality results are not generally reported to Council.

Council undertakes reporting as required by NSW Health and DPIE Water. In line with Council's responsibilities the following reports are produced:

- Council Annual Report: available in hardcopy at the Council office and electronically on Council's website
- NSW Health compliance reporting for drinking water quality monitoring: The drinking water quality is monitored and the results are recorded in the NSW Drinking Water Database. Water quality reports can be produced from the NSW Drinking Water Database. https://www.webapp.health.nsw.gov.au/
- Water Supply and Sewerage NSW Performance Reporting: Council's water supply service performance is detailed in the NSW Water Supply and sewerage performance monitoring report annually. This report is available for public access from the DPIE Water
- CDSC Strategic Business Plan for Water Supply

9 REVIEW AND AUDIT

9.1 Evaluation and Audit

Water quality results will in future be recorded in electronic format so Council may analyse and observe trends in water quality over time. This will allow Council to optimise treatment processes across seasonal variations and continually improve the quality of the drinking water system.

The DWMS is reviewed annually by Council or external contractors.

Annual reviews examine Council's performance in relation to:

- CCPs and their exceedances
- Improvement Plan
- Record keeping
- NSW Performance Monitoring

The DPIE Water Inspector carries out external assessment of the WTP on quarterly basis. DPIE Water and the NSW Health Public Health Unit may check key elements of the DWMS (e.g. whether critical control points are implemented correctly, Improvement plan actions). The NSW Health Regulation allows NSW Health to review a DWMS at any time.

In future, audits of DWMS adherence may be implemented by NSW Health.

9.2 Review by Senior Management

As part of the requirements of Council's reporting procedures, as detailed above, the Manager Technical and Engineering Services will review the effectiveness of the management system and the underlying policies. This review will be undertaken annually and will focus on reviewing of effectiveness and implementation of the DWMS.

A complete review of the DWMS will ideally take place every 4 years in line with the review of the Strategic Business Plan.

10 DRINKING WATER QUALITY MANAGEMENT IMPROVEMENT PLAN

Improvement actions for the CDSC water supply systems are listed in Table 27. Priorities have been determined based on the risks as identified through the workshop process.

Council's Utilities Engineer is responsible for delegating and tracking the improvements. The Improvement Plan is used by the Council to monitor the implementation of the drinking water management system. The Improvement Plan is subject to an annual review.

Table 27 Improvement Plan

Priority	Number	Action
Very High	1	Progress with construction of new WTPs
	2	New plants to have online monitoring and ability to shut down on CCP failure
	3	Top up filter media, both WTPs
	4	Review potential for river and bore water mixture at Wilcannia
	5	Empty Wilcannia sludge ponds
	6	Obtain a new chlorine dosing line booster pump for Wilcannia (existing spare pump to be modified to be able to plug in and use)
	7	Get quotes for chlorine cylinder scales and request approval to buy for Wilcannia (aim to have scales re-used at the pool)
	8	Supervisor to monitor chlorine usage patterns to assist Operators (Wilcannia and Ivanhoe)
	9	New plants to have chlorine scales, alarms on low cylinder weight (all schemes)
	10	Complete staff/trainee training
	11	Consider removing redundant wiring at Wilcannia WTP (switchboard)
	12	Source a new booster pump (disinfection line) for use either at Ivanhoe WTP or pool in case of pump failure
	13	Identifying and training for additional Ivanhoe operator(s) (current Operator leaving for 12 months in late 2021)
	14	Install hydrants on bigger mains for improved flushing (all schemes)
	15	Undertake chlorine residual testing after maintenance, repairs, new works in distribution system
	16	
	17	Back flow prevention to be reviewed at Ivanhoe Fire Station tap in shed
	18	Confirm CWT recommendation for Ivanhoe WTP size remains suitable given future use of old prison site
	19	Enhance bunding at Wilcannia sewer pump stations to minimise overflow risk (higher risk when weir relocated)
	20	Resolve telemetry issues which are preventing alarms on high sewer pump station level being generated/sent out
	21	Feed back risks to Town Water Risk Reduction program, Jim Bentley (direct) & works program for sewerage system upgrades

Priority	Number	Action
	22	Ensure Operators have all necessary tools for bypass arrangements if pump station overflows can't be resolved in a short timeframe.
	23	Ensure weir relocation risks are addressed in new WTP design - Review tender documentation to check what treatment specs are required.
High	24	Confirm location /details/management systems of septic tanks and OSSM
	25	Undertake programmed inspection and maintenance of household sewage pumps and solid tanks
	26	Confirm management systems for hospital sewage and other private on-site sewage management systems
	27	Regular inspections (including using cameras) of bores
	28	Undertake a study of the groundwater aquifer to identify recharge areas
	29	Prepare and implement backup emergency power supply strategy
	30	Use separate equipment for drinking water, sewage and raw water systems
	31	Install/upgrade backflow prevention to each property (ongoing)
	32	Maintain up-to-date documentation of dual-reticulation water supply system.
	33	Update and implement SOPs for non-council works to water and sewerage systems
	34	Improve backflow prevention in non-Council managed properties (i.e. outstanding connections without smart meters)
	35	Training on CCPs and reporting requirements to new Project Engineer
	36	Implementation of new spreadsheet for operational monitoring data record keeping
	37	Repair site fence
	38	Consider security lights and/or security cameras
	39	Confirm new WTP design allows sufficient PAC contact time
	40	Buy a standby compressor
	41	Develop Emergency Response Procedures
	42	Maintain and review a register to provide incident priority notification to customers who require water for specialised purposes such as renal dialysis or specific industrial usage
Moderate	43	Undertake TOC/THM study with assistance from NSW Health
	44	Confirm new WTP design allows sufficient PAC contact time
	45	Install turbidity monitoring at clarifier (new plants)
	46	Installation of prefilter chlorination at Ivanhoe
	47	New plant to consider Ivanhoe sludge lagoon cleaning with respect to nearby power line, and reuse of pond supernatant (<10% recycle is considered best practice if returning supernatant).
	48	Undertake a baseline assessment of source water for microbial, physical characteristics in the (surface and ground) in line with ADWG 2011

Priority	Number	Action
	49	Develop and implement a monthly catchment water quality monitoring program
	50	Consider additional measures to protect catchments (e.g. through a Local Environmental Plan)
	51	Liaise with Lachlan and Western CMAs for catchment improvement initiatives e.g. agricultural practices, riparian vegetation, land clearing
Low	52	Update Council website with information on Drinking Water Quality
	53	Document a system to ensure appropriate operator training and education
	54	To maintain records of documents and data, Council is required to develop a documentation and records control process
	55	Consider developing algal response framework including toxin testing through NSW Health FASS lab (potentially low/no cost)
	56	Test bores every 2 years for gross alpha and beta activity in line with ADWG.

11 REFERENCES

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APPENDIX A
CIRCULAR LWU 18

CENTRAL DARLING
SHIRE COUNCIL

APPENDIX B
RISK ASSESSMENT BRIEFING DOCUMENT, 2021

CENTRAL DARLING
SHIRE COUNCIL

APPENDIX C
ABORIGINAL COMMUNITIES STAKEHOLDER REGISTER

CENTRAL DARLING
SHIRE COUNCIL

Agency or Business	Person	Phone
Emergency	000	000
Ambulance, Police & Fire	000	000
Local Aboriginal Land Council	Jennifer Thwaites (Acting CEO)	T: (08) 8091 5828 M: 0419 967 960
Central Darling Shire Council	Service Desk	T: (08) 8083 8900 (WH & AH)
	Jared Cattermole (WTP Operator)	M: 0429 915 984
	John Pearson	T: (08) 8083 8800
	Reece Wilson	T: (08) 8083 8800 M: 0429 915992
DPIE Water	Bruce Lamont - Operations	M: 0458 268 453
	Bala - Policy & Approvals	T: 02 9842 8487 M: 0428 201 446
NSW Health	David Ferrall	T: (08) 8080 1504 M: 0409 462 137
	Jason Harwood	T: (08) 8080 1486 M: 0409 746 311
NSW Aboriginal Land Council	Chloe Bennett (Broken Hill)	M: 0476 809 376

Stakeholder	Roles and Responsibilities
Aboriginal Community	Report issues asap to Central Darling Shire Council.
LALC	Be the 1st point of contact for all other community matter. Participate in 4-monthly review meetings.
Council	Maintain an Issues Register (using current system). Diagnose problems & Repair. Provide water and sewerage services to the same standard as Wilcannia, except as specifically varied. Maintain regular communication and consultation with the community via LALC, Administrator, DPI Water and NSW Health. Participate in 4-monthly review meetings. Recommend updates for this Management Plan to DPI Water. Obtain financial approvals from DPI Water before proceeding. Send Mthly Report to NSW Health.
DPIE Water	Provide Program Management and Financial approvals. Provide technical support on investigation, design, construction, operation, maintenance and management. Conduct and minute 4–monthly meetings
NSW Health	Provide technical support on health issues. Participate in 4–monthly reviews by either attendance or prior written advice to the other attendees.

APPENDIX D
HISTORICAL WATER QUALITY ASSESSMENT

CENTRAL DARLING
SHIRE COUNCIL

Central Darling Shire Council Drinking Water Management System
4 June 2021

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