Goldenfields Water

Drinking Water Management System

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5 EXECUTIVE SUMMARY

5.1 Document Purpose

This document and the supporting systems demonstrate Goldenfields Water County Council (GWCC) compliance with the requirement of s25 *Public Health Act 2010* to develop a Quality Assurance Program in line with the Framework for Drinking Water Quality Management in the Australian Drinking Water Guidelines 2011 v3.4 (NHMRC 2017). This document acts as a roadmap of the activities that Council undertakes to ensure the provision of safe drinking water to its customers.

5.2 Critical Control Points

The day to day safety of the water is maintained at critical control points (CCP) and it is a requirement of Drinking Water Management System (DWMS) development that CCPs are developed and critical limits assigned.

CCPs for the each of GWCC water supply systems are shown in appendix B.

5.3 Action and Improvement Plan

A number of actions were identified through the risk assessment and plan development. These have been added to action and improvement plan and assigned to staff members and contractors/consultants to follow-up. The Action and Improvement Plan is reviewed regularly as actions are completed and as part of the annual planning cycle.

The action and improvement plan is included in appendix C.

5.4 System Review

The Drinking Water Management System should be reviewed internally on an annual basis, and by an independent party every 5 years (or as advised by NSW Health).

6 INTRODUCTION

The NSW *Public Health Act 2010* (the Act) was passed by Parliament at the end of 2010. The Act includes the requirement for water suppliers to produce a *Quality Assurance Program* (QAP). This document forms Goldenfields Water County Council (GWCC) response to the development of a QAP for its water supply schemes, and is based on the 12 Elements, 32 Components and 76 Actions of the Framework for Drinking Water Quality Management in the Australian Drinking Water Guidelines 2011 v3.4 (NHMRC 2017).

7 PURPOSE

This document acts as a roadmap for the activities that Council undertakes to ensure the provision of safe drinking water to its customers.

The document is supported by a range of procedures, registers, data management systems, flow diagrams and process and instrumentation diagrams which are all referenced at the appropriate points in this document.

This plan and the supporting documentation are living documents that should be reviewed and updated in a timely manner.

8 ELEMENT ROADMAP

8.1 Element 1: Commitment to Drinking Water Quality Management

8.1.1 Drinking Water Quality Policy

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

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

The development and implementation of the DWMS formalises and demonstrates Goldenfields Water's commitment to drinking water quality management throughout the organisation by:

- Defining Goldenfields Water's role and responsibility in regards to providing high quality 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 DWMS
- Reinforcing the ongoing and active involvement of all staff and supports senior management to ensure actions and policies support the management of drinking water quality

Action: Drinking water quality policy to be developed, endorsed by senior executives and communicated to employees.

8.1.2 Regulatory and formal requirements

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

The regulatory and formal requirements relating to drinking water quality in systems managed by Goldenfields Water have been identified and detailed in Table 8-1. Goldenfields Water has commenced a process to develop a formal water quality agreement with the Bulk Water Supply of Hilltops Council and Cootamundra-Gundagai Regional Council.

Table 8-1. Key formal requirements relating to water quality

Instrument	Jurisdiction	Type	Relevance
Competition and Consumer Act 2010	Commonwealth		Replaces the T*rade 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
AS/NZS 3500.0 to 4:2003 - Plumbing and Drainage Set	National	Standard	Largely for management of the distribution system including standards for plumbing and drainage issues
Plumbing Code of Australia (National Construction Code Series 2013)	National	Standard	Largely for management of the distribution system including standards for plumbing and drainage issues
Australian Drinking Water Guidelines 2011	National	Guideline	Sets frameworks and guidance for the provision of safe, quality drinking water
Local Government Act 1993	NSW	Statute	Urban water services and management/review of on-site sewage management systems; Have only persons licensed or certified under the Home Building Act 1989 (or supervised by such a person) carry out any water supply work, sewerage work or stormwater drainage work Preparation of Asset Management Plans
Public Health Act 2010	NSW	Statute	Protection of public health, follow any advice issued from the Chief of Health regarding drinking water safety to the public; sample drinking water in accordance with NSW Health recommendations. Prepare a drinking water management system
Public Health Regulation 2012	NSW	Regulation	Requirement to have a quality assurance program (QAP) in place that addresses the elements of the Framework as set out in the ADWG. A copy of the most recent QAP is to be provided to the Director-

Instrument	Jurisdiction	Type	Relevance
			General who may arrange a review of the QAP at any time.
Protection of the Environment Operations Act 1997	NSW	Statute	Environment protection including licensed discharges
NSW Water and Sewerage Strategic Business Planning Guidelines	NSW	Guidelines	Prepare Strategic Business plans including a review of the operating environment and IWCM which should identify key water quality issues in the catchment.
NSW Health Drinking Water Monitoring Program	NSW	Guidelines	Free-of-charge testing for water supply system monitoring for indicator bacteria and health-related inorganic chemicals. Includes NSW Health Response Protocols for chemical and quality, treatment failure and *Cryptosporidium* and *Giardia.*
Fluoridation of Public Water Supplies Act 1957 No 58	NSW	Statute	Auth orises and controls the addition of fluorine to public water supplies and for purposes connected to the supply.
Fluoridation of Public Water Supplies Regulation 2012	NSW	Statute	Made under the Fluoridation of Public Water Supplies Act 1957, relating to correct fluoride dosing equipment; collection, supply and analysis of water samples; provision of results monthly.
Environmental Planning and Assessment Act 1979 No 203	NSW	Statute	Proper management, development and conservation of resources including water for the welfare of the community and environment.

8.1.3 Engaging stakeholders

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

Stakeholders involved in the provision of a safe reliable drinking water supply have been identified and are listed in Table 8-2.

Table 8-2. GWCC Stakeholders

Stakeholder	
Constituent councils	Goldenfields and Hilltops Council bulk user agreement Goldenfields and Cootamundra-Gundagai Regional Council
General stakeholders	Stakeholders list
NSW Health	Provides water analysis through the NSW Health Drinking Water Monitoring Program.

Stakeholder	
	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
DPI Water (formerly NSW Office of Water)	Inspector visits and assesses WTPs compliance every three months. Technical support on investigations, design, construction, operation, maintenance and management Annual Reporting on Water Supply performance Participated in Site Visits and Risk Assessment Workshops as part of the Goldenfields Water DWMS
Riverina Local Land Services	It is recommended that Goldenfields Water liaises with Local Land Services regarding the management of water quality in the drinking water catchment

8.2 Element 2: Assessment of the Drinking Water Supply System

8.2.1 Water Supply system analysis

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

Goldenfields Water operates four drinking water supply systems. A summary of these drinking water systems is included in this section.

TABLE 9.3 OVERVIEW OF GOLDENFIELDS WATER: DRINKING WATER SUPPLY SYSTEMS

Process	Jugiong	Oura	Mt Arthur	Mt Daylight
Catchment	Murrumbidgee River catchment	Murrumbidgee inland alluvial aquifer	Lachlan Fold Belt aquifer system	Lower Lachlan alluvium aquifer
Source water	Murrumbidgee River	Oura Borefield - three bores: 3, 4 and 6	Mt Arthur Borefield - two bores: 1 and 2	Mt Daylight Borefield - two bores jointly operated with Carrathool Shire Council. Carrathool Shire Council is responsible for bore management
Water treatment	Jugiong WTP (40 ML/day): Coagulation Flocculation Clarification Filtration Disinfection	Treatment process: Aeration Disinfection Fluoridation	Treatment process: Disinfection	Treatment process: Disinfection

Process	Jugiong	Oura	Mt Arthur	Mt Daylight
	Fluoridation			
Reservoirs	14 reservoirs	33 reservoirs	9 reservoirs	7 reservoirs
Reticulation	Bulk supply: Cootamundra Shire: pop. 6,800 Harden Shire: pop. 2,200 Young Shire: pop. 8,000 Retail supply to approximately 600 people in the villages of Stockinbingal, Wallendbeen and Springdale	Retail supply to approximately 14,600 people in Bland, Coolamon, Junee, Narranderra and Temora Shire Councils. This system can also supply to the northern side of Wagga Wagga Shire Council, when required	Retail supply to approximately 2,400 people in Coolamon Shire	Retail supply to 125 people in the villages of Naradhan, Weethalle and Tallimba in Bland Shire Council

***Source**: HydroScience, 2015*

Water supply system information, including a flow diagram of the water supply system from catchment to consumer, information and key characteristics of the water supply system are shown in:

Jugiong Water Supply system – Appendix D
Oura water supply system – Appendix E
Mt Arthur water supply system – Appendix F
Mt Daylight water supply system – Appendix G

A list of drinking water supply system analyses is summarised in Table 8-3.

Table 8-3. Assessment of water supply system

Document	Water supply systems	Includes	Reference
Risk assessment briefing paper, 2014	Jugiong, Oura, Mt Arthur and Mt Daylight water supply systems	• Analysis of historical water quality data • Flow diagram of water supply system from system to tap	HydroScience, 2015, Technical Note 1: Risk Assessment Workshop Briefing Paper: Drinking Water Systems Analysis.
Risk assessment workshop, 28 July to 1 August 2014	Jugiong, Oura, Mt Arthur and Mt Daylight water supply systems	• Risk assessment workshop outputs	HydroScience, 2015, Technical Note 2: Risk Assessment and Critical Control Point Workshop.

8.2.2 Assessment of water quality data

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

Historical water quality data was assessed as part of the risk assessment process as summarised in Table 8-3.

8.2.3 Hazard identification and risk assessment

Define the approach and methodology to be used for hazard identification and risk assessment.
Identify and document hazards, sources and hazardous events for each component of the water supply system.
Estimate the level of risk for each identified hazard or hazardous event.
Evaluate the major sources of uncertainty associated with each hazard and hazardous event and consider actions to reduce uncertainty.
Determine significant risks and document priorities for risk management.
Periodically review and update the hazard identification and risk assessment to incorporate any changes.

A list of hazard identification and risk assessment are summarised in Table 8-4, with referenced documents included in appendix A.

Table 8-4. Assessment of water supply system

Document	Water supply systems	Includes	Reference
Risk assessment briefing paper, 2014	Jugiong, Oura, Mt Arthur and Mt Daylight water supply systems	• Hazard identification and risk assessment methodology	HydroScience, 2015, Technical Note 1: Risk Assessment Workshop Briefing Paper: Drinking Water Systems Analysis.
Risk assessment workshop, 28 July to 1 August 2014	Jugiong, Oura, Mt Arthur and Mt Daylight water supply systems	Documentation of • Hazards, sources and hazardous events • Level of risk for each identified hazard or hazardous event • Risk estimation • Significant risks and priorities	HydroScience, 2015, Technical Note 2: Risk Assessment and Critical Control Point Workshop.

8.3 Element 3: Preventive Measure for drinking Water Quality Management

8.3.1 Preventative measures and multiple barriers

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

A list of preventative measures and multiple barriers are summarised in Table 8-5, with referenced documents included in appendix A.

Table 8-5. Assessment of water supply system

Document	Water supply systems	Includes	Reference
Risk assessment workshop, 28 July to 1 August 2014	Jugiong, Oura, Mt Arthur and Mt Daylight water supply systems	Documentation of identifications of recommendations for additional preventative measures	HydroScience, 2015, Technical Note 2: Risk Assessment and Critical Control Point Workshop.

8.3.2 Critical Control Points

- Assess preventive measures from catchment to consumer to identify critical control points.
- Establish mechanisms for operational control.
- Document the critical control points, critical limits and target criteria.

As part of the development of the drinking water management system, key operating procedures and corrective actions were established for each Critical Control Point (CCP) within the Jugiong, Oura, Mt Arthur and Mt Daylight drinking water supply systems. These included operational procedures required to achieve the target levels and corrective actions in the event that the alert levels or critical limits are reached.

Critical control points are included in appendix B.

8.4 Element 4: Operations Procedures and Process Control

8.4.1 Operational Procedures

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

Operational procedures formalise the system specific activities that are essential to ensure the provision of consistently good quality water. The ADWG requires detailed procedures for the operation of all processes and activities (both ongoing and periodic) from catchment to consumer, including preventive measures, operational monitoring and verification procedures, and maintenance requirements. A standard operating procedure (SOP) is a set of written instructions that will document the routine activities undertaken by Goldenfields Water staff in the delivery of consistent, high quality water. The development and use of SOPs are an integral part of a successful

quality system as it provides Goldenfields Water staff with the information to perform a job consistently, effectively, and efficiently which facilitates consistency in the quality of water supplied to consumers.

DPI Water requires each local water utility to ensure that the SOPs for its drinking water supply system must meet the key barriers described in section 6.4. SOPs and incident response procedures have been developed for the CCPs, which are available in appendix B of the DWMS.

Action: It is recommended that Goldenfields Water develop SOPs for key operations including mains break repair and mains flushing procedure to ensure that the distribution integrity is upheld and that chlorine residual is maintained.

8.4.2 Operational Monitoring

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

Goldenfields Water employs a range of manual and online sampling techniques to monitor operational water quality. Online instruments and manual sampling and testing within the distribution and reticulation system are used to monitor and verify system performance. Manually collected data is recorded both electronically and in log books located at Jugiong WTP, Oura Borefield, and Cootamundra Depot. Electronic records are held at Jugiong WTP and the Goldenfields Water head office in Temora. Goldenfields Water has also developed a chlorine monitoring system; whereby real-time data is recorded by online instruments or entered manually by operators to model the chlorine levels and chlorine consumption within the distribution system. Goldenfields Water is currently working to increase its remote monitoring system to ensure that all of its drinking water supply systems are appropriately and efficiently monitored.

Operational monitoring programs for Jugiong, Oura, Mt Arthur and Mt Daylight are shown in Table 8-6, Table 8-7, Table 8-8 and Table 8-9.

TABLE 8-6. JUGIONG OPERATIONAL MONITORING PROGRAM

Parameter	Raw	Post dose	Clarified	Filtered	Final	Reticulation	Reservoirs	Secondary disinfection
River level	online (level sensor)							
Turbidity	Daily/ online		Daily	Daily/ online		Weekly	Monthly	
Fluoride	Daily				Daily	Weekly		
Colour (HU)	Daily		Daily		Daily			
pH	Daily	Daily	Daily/ online		Daily	Weekly	Monthly	
Alkalinity	Daily				Daily			
Hardness	Daily				Daily			

Parameter	Raw	Post dose	Clarified	Filtered	Final	Reticulation	Reservoirs	Secondary disinfection
Temperature	Daily				Daily			
Chlorine residual					Daily/ online	3 x weekly	1-2 x weekly	online
Total Chlorine					Daily		Monthly	
Structural integrity/ contamination							Monthly	

TABLE 8-7. OURA OPERATIONAL MONITORING PROGRAM

Parameter	Raw	Final	Supply	Reservoirs	Secondary disinfection	
					Wyalong PS	Reefton PS
Suspended solids	Daily					
Fluoride	Fluoride	Daily				
Turbidity		Daily				
pH	Twice weekly					
Chlorine residual		Continuous online	Monthly		Continuous online	Continuous online
Pesticides	Annual					
Structural integrity/contamination	Daily			Monthly		

TABLE 8-8. MT ARTHUR OPERATIONAL MONITORING PROGRAM

Parameter	Raw: Mt Arthur Borefield	Final	Reservoirs	Reticulation
Chlorine residual		3xweekly		3xweekly
Iron	Monthly			
Manganese	Monthly			
Pesticides	Annual			
Structural integrity/contamination	Weekly		Monthly	

TABLE 8-9. MT DAYLIGHT OPERATIONAL MONITORING PROGRAM

Parameter	Raw: Mt Daylight Borefield	Final (reservoir inlet)	Reservoirs	Reticulation
Chlorine residual	Daily	Continuous online/Monthly		Weekly
Pesticides	Monthly	Monthly		
Structural integrity/contamination			Monthly	

*Note: Also recorded on microbiology labels sent to labs as part of the NSW Health Drinking Water Monitoring Program

8.4.3 Corrective Action

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

As part of the development of the drinking water management system and risk assessment process, key operating procedures and corrective actions were established for each Critical Control Point (CCP) within the Jugiong, Oura, Mt Arthur and Mt Daylight drinking water supply systems. These included target levels and corrective actions in the event that the alert levels or critical limits are reached. Critical control points are included in appendix B.

8.4.4 Equipment capability and maintenance

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

Goldenfields Water's objective is to ensure all assets owned or operated by Goldenfields Water are managed responsibly, in compliance with regulatory requirements (GWCC, 2012a). To ensure all assets are able to meet the required levels of service on a long-term basis, Goldenfields Water has prepared an Asset Management Plan (AMP) (GWCC, 2012a). The AMP guides Goldenfields Water on capital and operating expenditure. The Goldenfields Water AMP aims to measure performance through the following (GWCC, 2012a):
Quality - water supply assets will be maintained in a condition that is fit for purpose and provides an acceptable level of redundancy
Function - maintain an appropriate water supply network in partnership with other levels of government and stakeholders, to meet the current and future water needs of the community. Goldenfields Water aims to ensure that assets are able to meet and comply with:

- ADWG
- Pressure and flow requirements
- Water demand requirements

Safety - regularly monitor and inspect various components of the water supply network and prioritise and repair defects in accordance with an overall inspection schedule

To achieve the objectives, routine maintenance, replacement / renewal and improved level of service plans have been developed to guide Goldenfields Water on their capital and operational expenditure.

Capital expenditure

Replacement of assets aims to restore existing assets to original levels of service. When an asset reaches the end of its effective working life it is scheduled to be replaced in the future works program. Modelling of the distribution and reticulation systems aids Goldenfields Water in determining the priority of projects in the future works program as well as identifying which assets require upgrade (GWCC, 2012a).

Asset creation, acquisition and upgrade projects are works that create a new asset or expand an asset's existing capabilities. Assets that require improvement in levels of service may be a result of growth, social or environmental needs and are identified through various sources such as network modelling, Councillor requests, community requests or strategic business plans (GWCC, 2012a)

Operational expenditure

Routine maintenance includes unplanned (reactive), planned (pro-active) and recurring (cyclic) maintenance procedures. Goldenfields Water aims to perform planned and recurring maintenance in order to prolong the life of assets and prevent the occurrence of unplanned maintenance, which can be costlier.

Goldenfields Water has a maintenance management system where excel spreadsheets are used to record works such as inspections, flushing, cleaning of reservoirs, etc. According to the AMP, maintenance expenditure levels are considered adequate to meet required levels of service. Routine maintenance is performed by Goldenfields Water staff (GWCC, 2012a).

8.4.5 Materials and Chemicals

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

Goldenfields Water conforms to the WSAA Codes and its Procurement Policy for purchasing of materials and chemicals.

The use, including transport and storage, of chemicals listed as "Dangerous Goods" under the Work Health and Safety Regulation 2012 (NSW), including chlorine and fluoride, is dictated by the provisions of the Work, Health and Safety Regulation and Work Cover. Storages and trucks are licensed according to the Work, Health and Safety Regulation.

The NSW Guidelines for Drinking Water Management Systems (NSW Health and NSW Office of Water, 2013) recommends that all chemical deliveries are attended by a trained water treatment plant operator, and that the following procedures are followed:

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 ADWG, prior to the commencement of unloading

The operator is to check and confirm the correct chemical is being delivered into the appropriate storage

If relevant, the operator is to check that the correct concentration has been supplied

Safety Data Sheets (SDS) and appropriate chemical signs are displayed in a SDS register within the vicinity of chemical storage areas. Chemicals used in the supply of drinking water in the drinking water supply systems managed by Goldenfields Water are listed Table 8-10.

TABLE 8-10. CHEMICALS USED IN GWCC DRINKING WATER SUPPLY SYSTEMS

Chemical	Purpose	Dosing Concentration	Storage
Jugiong Drinking Water Supply System			
Chlorine gas	Disinfection	1.8 mg/L	2 x 920 kg gas tanks in chlorine dosing rooms Supplied by Orica
	Secondary disinfection	0.8 mg/L	2 x 70 kg gas tanks in chlorine dosing rooms Supplied by Orica

Chemical	Purpose	Dosing Concentration	Storage
Soda Ash	pH adjustment	Varied	35 tonne storage container Supplied by Redox
Aluminium Sulphate	Flocculation	Varied	2 x 36 kL storage tanks in a bunded area Supplied by Nowra Chemicals
Polymer	Coagulation	Varied	50 L storage tank in bunded area 10 x 25 kg bags Supplied by Aquapac
Sodium silicofluoride	Fluoridation	1.0 mg/L	96 x 25 kg bags stored in fluoride dosing room Supplied by Consolidated Chemicals
Oura Drinking Water Supply System			
Chlorine gas	Disinfection	0.6 mg/L	2 x 70 kg gas tanks in chlorine dosing rooms Supplied by Orica
	Secondary disinfection	0.8 mg/L	
Sodium silicofluoride	Fluoridation	1.0 mg/L	48 x 25 kg bags stored in fluoride dosing room Supplied by Consolidated Chemicals
Mt Arthur Drinking Water Supply System			
Chlorine gas	Disinfection	0.8 mg/L	2 x 70 kg gas tanks in chlorine dosing rooms Supplied by Orica
Mt Daylight Drinking Water Supply System			
Chlorine gas	Disinfection	1.0 mg/L	2 x 70 kg gas tanks in chlorine dosing rooms Supplied by Orica

***Source**: HydroScience, 2015*

8.5 Element 5: Verification of drinking water quality

8.5.1 Drinking water quality monitoring

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

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.

Verification of the drinking water supply systems managed by Goldenfields Water is also undertaken through the NSW Drinking Water Monitoring Program. The Program monitors water quality at the point of supply to provide ongoing, independent verification of the treatment barriers. Frequency of sampling is based on population.

The Water Quality Officer is responsible for the collection of samples for the NSW Health Drinking Water Monitoring Program. The samples are submitted in accordance with the "Guide for Submitting Water Samples to FASS for Analysis" (Sydney West Area Health Service, 2010) and Goldenfields Water's formal sampling procedure for all routine sampling and analysis. In accordance with the "Guide for Submitting Water Samples to FASS for Analysis", the Water Quality Officer must ensure that all field parameters (pH, turbidity, fluoride, free and total chlorine) are tested and recorded on the sampling labels prior to submission to the labs for analysis.

The NSW Health Drinking Water Monitoring Program assesses 36 parameters for microbial, physical and chemical properties of the water. The results can be accessed at www.drinkingwaterdb.nsw.gov.au.

- Microbial
  - *E. coli*
  - Total coliform
- Physical
  - pH
  - True Colour
  - Turbidity
  - Total Dissolved Solids (TDS)
  - Total Hardness as CaCO3
- Chemicals
  - Aluminium
  - Antimony
  - Arsenic
  - Barium
  - Boron
  - Cadmium
  - Calcium
  - Chlorine
  - Chromium
  - Copper
  - Cyanide
  - Fluoride
  - Iodine
  - Iron
  - Lead
  - Magnesium
  - Manganese
  - Mercury
  - Molybdenum
  - Nickel
  - Nitrate
  - Nitrite
  - Selenium
  - Silver

- Sodium
- Sulphate
- Zink

TABLE 8-11. VERIFICATION MONITORING PROGRAM

	Jugiong	Oura	Mt Arthur	Mt Daylight
Microbial	Monthly	Monthly	Monthly	Monthly
Physical	6 Monthly	Monthly	6 Monthly	6 Monthly
Chemical	6 Monthly	Monthly	6 Monthly	6 Monthly

***Source**: HydroScience, 2015*

TABLE 8-12. JUGIONG DRINKING WATER SUPPLY SYSTEM SAMPLING LOCATIONS

Area	Number	Street Location
Cootamundra	106	Cowangs Reservoir inlet, Cootamundra
	108	Gundagai Road, Cootamundra
	109	12-16 Bradman Street, Cootamundra
	114	Dirnaserr Road, Cootamundra
	115	Dirnasser Reservoir outlet, Cootamundra
	334	Bauloora Reservoirs outlet, Cootamundra
	335	Bauloora Reservoirs inlet, Cootamundra
Springdale	116	Springdale Park, Springdale
	216	Town offtake, Springdale
Stockinbingal	111	Stockinbingal Bowling Club, Stockinbingal
	311	Stockinbingal Hotel, Stockinbingal
Wallendbeen	110	Wallendbeen Hotel, Wallendbeen
	210	Service Station, Wallendbeen
	310	Wallendbeen School, Wallendbeen

***Source**: HydroScience, 2015*

TABLE 8-13. OURA DRINKING WATER SUPPLY SYSTEM SAMPLING LOCATIONS

Area	Number	Street Location
Ardlethan	205	Ardlethan Reservoir outlet, Ardlethan
	206	Parks Street, Ardlethan
	336	Palace Hotel, Ardlethan
	346	Bygoo Street, Ardlethan
Ariah Park	201	Tara P.S. discharge, Ariah Park
	202	Ariah Park Reservoir outlet, Ariah Park
	203	Wellmans Street, Ariah Park
	333	Central School, Ariah Park
	343	Golf Club, Ariah Park
Barellan	207	Barellan Reservoir outlet, Barellan
Barmedman	401	Barmedman Reservoir outlet, Barmedman
	402	Loftus Street, Barmedman
	442	Barmedman Hotel, Barmedman
	452	Public School, Barmedman
Beckom	204	Beckom Hotel, Beckom
Bethungra	221	01 Amos Street, Bethungra
	318	Bethungra Police Station, Bethungra
	358	Bethungra Service Station, Bethungra
	368	Memorial Park, Bethungra

Area	Number	Street Location
Eurongilly	319	Eurongilly Reservoir outlet, Eurongilly
Illabo	317	Illabo Hotel, Illabo
Junee	310	Old Junee, Junee
	311	Junee B.T. inlet, Junee
	312	Junee B.T. outlet, Junee
	313	Junee Public School, Junee
	314	Junee High School, Junee
	315	Prince Street, Junee
	316	Marinna P.S. discharge, Junee
Marrar	308	Cnr Don and Wood Street, Marrar
	309	Marrar Pinnacle Reservoir outlet, Marrar
	338	Public School, Marrar
	348	Royal Hotel, Marrar
Temora	301	Temora Balance Tank inlet, Temora
	302	Temora H.L. Reservoir outlet, Temora
	303	Temora High School, Temora
	304	Beattie Street, Temora
	305	Temora West School, Temora
	306	Temora Caravan Park, Temora
	307	Cartwright's Hill Reservoir outlet, Temora
	999	Not Defined, Temora
Ungarie	409	Urgarie Town Reservoir inlet, Urgarie
	410	Bing Wallder Park Urgarie, Urgarie
	440	Urgarie Motel, Urgarie
	450	Central School, Urgarie
Wantabadgery	320	Wantabadgery Shop, Wantabadgery
West Wyalong	405	Perserverance Street, West Wyalong
	406	West Wyalong Public School, West Wyalong
	407	West Wyalong T.S. outlet, West Wyalong
Wyalong	403	Wyalong P.S. meter pit, Wyalong
	404	Wyalong School, Wyalong
	408	Calleen B.T. outlet Wyalong

***Source**: HydroScience, 2015*

TABLE 8-14. MT ARTHUR DRINKING WATER SUPPLY SYSTEM SAMPLING LOCATIONS

Area	Number	Street Location
Collamon	212	Coolamon Hospital, Coolamon
	213	Central School, Coolamon
	214	Coolamon H.L. Reservoir outlet, Coolamon
	215	Wagga Road, Coolamon
	999	Not Defined, Coolamon
Ganmain	210	Ganmain H.L. Reservoir outlet, Ganmain
	211	Hay Industry Display Centre, Ganmain
	331	Pre School, Ganmain
	332	Langham Street, Ganmain
Grong Grong	208	Public School, Grong Grong
	338	Grong Grong Park, Grong Grong
Matong	209	Public School, Matong
	309	NA Grong Grong Road, Grong Grong

***Source**: HydroScience, 2015*

TABLE 8-15. MT DAYLIGHT DRINKING WATER SUPPLY SYSTEM SAMPLING LOCATIONS

Area	Number	Street Location
Naradhan	411	Hanna P.S. discharge, Naradhan
	412	Naradhan Reservoir outlet, Naradhan
	413	North Weethalle Reservoirs outlet, Naradhan
Tallimba	416	Tallimba Park, Tallimba
	426	Tallimba School, Tallimba
	436	Tallimba Inn, Tallimba
	999	Not Defined, Tallimba
Weethalle	414	Railway Street, Weethalle
	415	Narriah Reservoirs outlet, Weethalle
	424	Weethalle School, Weethalle
	434	Pioneer Park, Weethalle

8.5.2 Consumer satisfaction

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

Phone numbers (general and emergency) are displayed on GWCC website. Reception passes on complaints received to the duty officer. The duty officer circulates daily report of all out of hours' calls. During office hours, customer service takes the call and logs details of the complaint within the system. For both standard and out of hours calls an end of week report is generated that details exceptions, complaints and notifications. Annual data is kept by the Corporate section and undertakes annual benchmark reporting. Levels of service is included in the asset management plan

Table 8-16 Shows Goldenfields Water's current target levels of service.

TABLE 8-16. GWCC TARGET LEVELS OF SERVICE

Key Performance Measure	Level of Service
Pressure and flow – reticulated connections	12 - 90 m head per standard 20 mm connection
Pressure and flow – non-reticulated connections	Equivalent to reticulated connections as a target but may not be achieved in all circumstances. It is a condition of supply that new connections have an onsite 10,000 Litres minimum size storage tank. Retrospective fitting to existing connections to be implemented over time
Water quantity	Annual demand: 294 kL/ET Peak day demand 4 kL/ET/d
Notice of planned interruption (written notice)	Domestic and rural – minimum 24 hours Commercial/industrial – 3 working days
Unplanned interruption – reticulated connections	Maximum 2 times/yr if lasting up to 12 hours Maximum 5 times/yr if lasting up to 5 hours
Unplanned interruptions – non reticulated connections	May experience interruptions without prior notice

Key Performance Measure	Level of Service
Service provision	All urban areas of towns and villages within the GWCC area of responsibility. It will also be available to non-urban areas where adequate supply lines already exist or can be laid at a practical and economically recoverable cost
Water quality	Potable water should meet ADWG. Non-potable water is not supplied for human consumption
Response time to complaints	Written: 10 working days Phone: 24 hours
Complaints	Less than 2 complaints per 1,000 properties
Response to supply failures	Priority 1 – 15 min (supply to a large number of customers at a critical time) Priority 2 – 30 min (supply to a small number of customers at a non-critical time Priority 3 – same day (supply to a single customer) Priority 4 – within 1 week (minor problem or complaint) Immediate – in case of emergency or catastrophe
Response to inquiries	Respond to 95% of written inquiries within 10 working days Respond to 95% of personal inquiries within 2 working days
Ongoing water conservation measures	Implement a regional demand management strategy

***Source**: GWCC, 2012a*

8.5.3 Short term evaluation of results

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

Goldenfields Water evaluates water quality data on receipt of monitoring results. Water quality results from the NSW Health Drinking Water Monitoring Program are reported to the Production & Services Manager, General Manager and the Manager Distribution and Construction when the Production & Services Manager or General Manager are not available.

8.5.4 Corrective action

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

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 Goldenfields Water. The NSW Health Drinking Water Monitoring Program provides the following response protocols:
NSW Health Response Protocol: for the management of microbiological quality of drinking water (November 2011)
NSW Health Response Protocol: for the management of physical and chemical quality (January 2004)
NSW Code of Practice for Fluoridation of Public Water Supplies (2011) and Fluoride Overdose Response

8.6 Element 6: Management of incidents and emergencies

8.6.1 Communication

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

In the event of an emergency, communication internally within Goldenfields Water and externally with stakeholders and emergency service providers is integral to the incident response and recovery process. An emergency contact list is displayed in the Goldenfields Water offices. The emergency contact list is reviewed and updated as required.

If the community is required to be alerted, Goldenfields Water follows the procedure outlined in the Goldenfields Water County Council Emergency Response Management Plan.

Stakeholder contact details are listed in the Critical Control Point documents.

Communication for water quality incidents are found in the NSW Health Drinking Water Monitoring Program. Council will follow the NSW Health protocols, available from <http://www.health.nsw.gov.au/environment/water/Pages/drinking-water.aspx>, should a water quality incident occur. These protocols relate to:

Physical and chemical quality;
Treatment failure, *Cryptosporidium* and *Giardia*; and
Microbiological quality.

Action: Develop templates for communicating water quality incidents to the public, e.g. media releases, letters, website content.

8.6.2 Incident and emergency response protocols

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

In the event of a water quality incident, Goldenfields Water responds according to the protocols and procedures in Table 8-17.

TABLE 8-17 LIST OF GWCC WATER QUALITY INCIDENT RESPONSE PROTOCOLS

Response Protocol	Notes
Goldenfields Water County Council Emergency Response Management Plan	In the event of any emergency, the operator is to report to their Supervisor, who informs the Manager Production & Services, who informs the General Manager. The General Manager authorises the response actions.
Goldenfields Water County Council Pollution Incident Response Management Plan (GWCC, 2012b)	Defines an incident as extreme, medium or low, where: • Extreme: imminent/Serious danger to onsite personal and surrounding township. Immediate action required. Implement emergency evacuation procedure and notification procedure per Pollution Incident Response Management Plan • Medium: Moderate danger. Action as soon as possible. Implement controls i.e spill containment. Notify supervisor • Low: Minor to negligible danger. Assess if further action is required. Monitor controls so the hazard is maintained as 'low' if hazard cannot be eliminated completely. Notify supervisor
NSW Health Response Protocol: for the management of microbiological quality of drinking water (25 Nov 2011)	*E. coli* detections require immediate resampling as stipulated in the NSW Health response protocol. Council should immediately discuss any *E. coli* detections with NSW Health to determine appropriate public health response, including the need to issue a boil water alert. This protocol also includes actions in response to failure of treatment, disinfection or poor or rapidly changing source water quality.
NSW Health Response Protocol: for the management of physical and chemical quality (01 Jan 2004)	For physical and chemical exceedances, Council follows the NSW Health Response Protocol, with resampling and risk assessments carried out with Council and NSW Health as required.
NSW Code of Practice for Fluoridation of Public Water Supplies (2011)	Details operator training and qualification requirements as well as normal and incident reporting procedures. Provides an incident management procedure for adoption.

8.7 Element 7: Employee awareness and training

8.7.1 Employee awareness and involvement

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

Goldenfields Water aims to provide an environment of equal opportunity in its workplace and is committed to the development of skilled, knowledgeable and dedicated staff. Staff training is an important and essential element of corporate development and Goldenfields Water supports this through on-going on and off-the-job training for all employees.

8.7.2 Employee training

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

Human resources maintain a spreadsheet register of training and employee qualifications. Human resources are responsible for learning and development of employees.

Specialist training and certification, including fluoridation and chemical dosing is regularly refreshed, as required. Training requirements are identified each year through the annual skills assessment and performance review of each employee by their direct supervisor. Training requirements for each employee are then factored into Council's budget for the proceeding financial year.

Goldenfields Water also has in place a Workforce Management Plan that sets out the path for development of Goldenfields Water human resources (GWCC, 2012c). In addition to the training described above, employees are also trained in:

- Backflow prevention
- Basic risk management
- Asset condition rating
- Customer relations and customer service
- GIS training (office and field staff)
- Procurement (financial officer and supervisors)
- Media presentation (key staff)

8.8 Element 8: Community involvement and awareness

8.8.1 Community consultation

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

GWCC encourages community involvement and consultation through the following initiatives Goldenfields Water County Council Ordinary Meetings. Ordinary meetings of Goldenfields Water County Council are open to the public and are normally held at 1 pm on the fourth Thursday of every second month. The meetings are held in the Goldenfields Water County Council offices in Temora, NSW. The meeting schedules, agendas and minutes can be found on the Goldenfields Water website and in the Temora office the Thursday prior to the ordinary meeting. Members of the public can address Council during ordinary council meetings, however, written notification to the General Manager is required by the Monday prior to the meeting.

8.8.2 Communication

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

The Goldenfields Water County Council website has detailed information regarding their drinking water supply systems under the "About Us" and "Our Infrastructure" section. The water supply services section provides details on the drinking water supply systems':

- Source water
- Treatment systems
- Distribution systems

8.9 Element 9: Research and development

8.9.1 Investigative studies and research monitoring

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

Continual improvement is necessary to ensure that Goldenfields Water can ensure the delivery of safe drinking water to the community into the future. The following items have been identified as investigative research projects for Goldenfields Water to improve the effectiveness and efficiency of the barriers protecting the community against waterborne pathogens.

Identified areas of investigation are included in the improvement and action plan, included in appendix C.

8.9.2 Validation of processes

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

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

8.9.3 Design of equipment

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

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 15 mg. min/L is required to be consistent with ADWG requirements of 30 mins contact time at 0.5 mg/L. Table 8-18 shows the calculated C.t. for each system.

The four drinking water supplies operated by Goldenfields Council have adequate chlorine contact time for microbial removal. Based on the information provided, the C.t for each drinking water supply is documented in Table 8-18.

TABLE 8-18. CHLORINE CONTACT TIME TO FIRST CUSTOMERS

Drinking Water Supply System	Primary Chlorinator	Comments	C.t. (mg. min/L)
Jugiong	Jugiong WTP chlorinator	Total C.t. is achieved at the clear water tank (2973 kL) at the Jugiong WTP.	20.4
Oura	Oura chlorinator	Total C.t. has been calculated using the Oura collection tank (2279 kL) at the Oura WTP as well as the 450 m pipe distance to the first connection.	21.8
Mt Arthur	Mt Arthur chlorinator	Total Ct is achieved at the three collection tanks (1454 kL each) at Mt Arthur WTP.	41.9
Mt Daylight	Mt Daylight chlorinator	Total Ct is achieved at the four collection tanks (239 kL each) at Mt Daylight WTP.	56.7

***Source**: HydroScience, 2015*

Action: Chlorine calculations to be rechecked for minimum operating levels.

8.10 Element 10: Documentation and record keeping

8.10.1 Management of documentation and records

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

The DWMS documents information pertinent to all aspects of drinking water quality management for the Jugiong, Oura, Mt Arthur and Mt Daylight drinking water supply systems. The DWMS is a living document and should be maintained in-line with actual operations and management. Any changes to the drinking water supply systems should be updated and documented within this DWMS.

Goldenfields Water has in place a policy for record management to effectively record, manage and enable access to information stored in both physical and electronic formats in accordance with statutory requirements.

8.10.2 Reporting

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

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

- Council Annual Report: it is recommended by NSW Health that references to drinking water quality and the DWMS should be made in Council's Annual Report. The Annual Report is available electronically on Council's website and in Goldenfields Water's head office in Temora
- NSW Health compliance reporting for drinking water quality monitoring: drinking water quality within Goldenfields Water is monitored and the results are recorded in the NSW Health Drinking Water Database. Water quality reports can be produced from the database, which is located at the following web page: http://www.drinkingwaterdb.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 DPI Water
- Goldenfields Water County Council Business Activity Strategic Business Plan
- Drinking water management system annual report to be provided to NSW Health

8.11 Element 11: Evaluation and audit

8.11.1 Long term evaluation of results

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

Water quality results for the Jugiong, Oura, Mt Arthur and Mt Daylight drinking water supply systems are measured at the sample points listed in section 6.4 and 6.5. The sample points are measured by a mix of manual testing and online instruments, with results recorded both in log books and electronically.

8.11.2 Audit of drinking water quality management

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

An external Gap Analysis of GWCC water supply system was undertaken on 23 November 2016 by Atom Consulting. The results of the Gap Analysis were used to facilitate review of the Drinking Water Management System.

External inspections of the system are regularly carried out by Department of Primary Industries Water (DPI Water) inspectors. Council engineers are not notified of these inspections in advance. Water quality results are reviewed by the WTP Operator and DPI Water inspector. Reports of findings are provided by the inspectors.

External auditing of data submitted for the New South Wales Office of Water annual performance reporting (including the NWI indicators) is undertaken every three years. The external auditor is approved by DPI Water.

Internal audits of the Critical Control Points, critical limit monitoring instruments and the Drinking Water Management System are undertaken in accordance with the internal audit schedule.

The drinking water management system will be internally audited by the Water Quality Officer. The review will assess Goldenfields Water's performance in relation to:

- CCPs and their exceedances
- Improvement Plan
- Record keeping
- NSW Health Database performance

Action: Develop internal audit schedule

8.12 Element 12: Review and continual improvement

8.12.1 Review by senior executive

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

The Drinking Water Management System and its implementation will be reviewed regularly (at least annually) to ensure that it maintains currency with the water supply operation and management. Where possible, the PHU and DPI regional officers will be included in the review process.

As part of the requirements of Goldenfields Water's reporting procedures, the Executive Manager Distribution and Construction will review the effectiveness of the management system and the underlying policies. This review will be undertaken annually and will focus on reviewing the effectiveness and implementation of the DWMS.

8.12.2 Drinking water quality management improvement plans

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

An action and improvement plan is included in appendix C. The Executive Manager Distribution and Construction is responsible for the Improvement Plan. Individual actions are assigned to the appropriate officers. Priorities have been determined based on the risks as identified through the workshop process. The Improvement Plan is used by Goldenfields Water to monitor the implementation of the drinking water management system. The Improvement Plan is subject to an annual review by the General Manager.

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10 APPENDIX A RISK ASSESSMENT

10.1 Technical Note 2 - Risk Assessment and Critical Control Point Workshop

Prepared for Goldenfields Water County Council by:

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Approved for Issue					
Issue	**Author**	**Reviewer**	**Name**	**Signature**	**Date**
3	MTR	JHU	Jessica Huxley		October 2015

10.2 Risk Assessment and Critical Control Point Workshop Introduction

Goldenfields Water County Council hosted a five day site visit and risk assessment workshop which included participants from HydroScience Consulting, NSW Health Water Unit, Local Public Health Unit, and DPI Water (formerly NSW Office of Water), as well as the bulk water Councils of Cootamundra, Harden and Young Shire Councils. The purpose of the site visit was to get a thorough understanding of the drinking water supply systems

operated by Goldenfields Water County Council, hereafter referred to as Goldenfields Water in this technical note. The risk assessment aimed to identify all hazards and develop appropriate controls for the drinking water systems.

Goldenfields Water operates four drinking water supplies: Jugiong, Oura, Mt Arthur and Mt Daylight. Goldenfields Water also operates a non-drinking water supply at Hylands Bridge, which was not assessed as part of this drinking water management system.

The Jugiong drinking water supply is a surface water system that draws raw water from the Murrumbidgee River. Water is treated at the Jugiong Water Treatment Plant (WTP) and the majority of water produced is distributed to bulk customers: Cootamundra, Harden, and Young Shire Councils. The Oura drinking water supply is a groundwater system, drawing water from three bores at the Oura borefield, situated in the Murrumbidgee inland alluvial aquifer. Water from the bores is aerated and disinfected prior to distribution. The Oura system is the largest distribution system managed by Goldenfields Water, spanning from Junee in the south to Ungarie in the north. The Mt Arthur and Mt Daylight drinking water supplies are groundwater systems that draw water from the Lachlan Fold Belt fractured rock aquifer system and the lower Lachlan alluvium, respectively. Raw water from the Mt Arthur and Mt Daylight drinking water supply systems is disinfected prior to distribution. The Mt Arthur system distributes to retail customers in the Coolamon and Grong Grong area, and the Mt Daylight system distributes to the villages and surrounds of Naradhan, Weethalle and Tallimba in Bland Shire Council area.

The site investigation and risk assessment workshop was undertaken on 28 Jul 2014 - 01 Aug 2014. The workshop was held at the Goldenfields Water Council Chambers in Temora. Participants at the workshop included:

Goldenfields Water County Council

1. Andrew Grant - General Manager (Wednesday and Thursday)
2. Shane Baldry - Acting Workshop Manager
3. Tony Corby - Water Quality Officer
4. Chris Perry - Manager Distribution and Construction
5. Sean Tiernan - Southern Distribution and Construction Manager (Friday)

Cootamundra Shire Council

1. Gary Arthur - Director Engineering Services (Wednesday)
2. Mark Ellis - Manager Works and Services (Thursday)
3. Chris Imrie - Manager Development Services (Wednesday)
4. Daryl Kelly - Workshop Foreman (Thursday)

Harden Shire Council

1. Mark Crisp - Director Technical Services (Thursday)
2. Jon Hill - Water Supply Supervisor (Thursday)

Young Shire Council

1. Sally Atkinson - Environmental Health Officer (Thursday)
2. Greg Prest - Supervisor Utility Services (Wednesday and Thursday)
3. Guy Rolfe - Utility Services (Wednesday)
4. Abe Sweaney - Utility Services (Thursday)
5. Nicole Vonarx - Director Utility Services (Wednesday and Thursday)

HydroScience Consulting

1. Jessica Huxley – Environmental Manager
2. Andrew Fraser - Planning Manager (Wednesday and Thursday)

3. Maria Tran – Water and Wastewater Engineer

NSW Health

1. Tony Burns - Senior Environmental Health Officer
2. Michelle Phoenix - Project Officer, NSW Health Water Unit

DPI Water

3. Bernie Barnes - Regional Inspector

10.3 Hazard Identification and Risk Assessment

Hazard Identification and Risk Assessment workshops were facilitated by HydroScience to identify key hazardous events and rate the risks associated with Goldenfields Water's drinking water supply systems from source to consumers.

Council used the *Australian Drinking Water Guidelines 2011* (ADWG) (NHMRC, 2011) risk assessment matrix where risks are classified as very high, high, moderate and low. Both maximum and residual risks were assessed within the system.

Maximum risk:	risks that are present without preventative measures and controls
Residual risks:	risks that are present after implementing the system's preventative measures and controls
Preventative measures and controls:	actions, activities and processes used to prevent the identified hazards or reduce them to acceptable levels

The risk assessment matrix adopted by Goldenfields Water and the prioritisation of actions is set out in Table 1. Table 2, Table 3, Table 4, and Table 5 detail the risk assessment results for Jugiong, Oura, Mt Arthur, and Mt Daylight, respectively.

10.3.1 Table 1 – Risk Assessment Matrix

CONSEQUENCE / LIKELIHOOD	1. Insignificant Insignificant impact, little disruption to normal operation, low increase in normal operation costs	2. Minor Minor impact for small population, some manageable operation disruption, some increase in operating costs	3. Moderate Minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring	4. Major Major impact for small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required	5. Catastrophic Major impact for large population, complete failure of systems
1. Rare May occur in exceptional circumstance	**Low**	**Low**	**Moderate**	**High**	**High**
2. Unlikely Could occur at some time	**Low**	**Low**	**Moderate**	**High**	**Very High**
3. Possible Might occur at some time	**Low**	**Moderate**	**High**	**Very High**	**Very High**
4. Likely Will probably occur in most circumstances	**Moderate**	**High**	**High**	**Very High**	**Very High**
5. Almost Certain Expected to occur in most circumstances	**Moderate**	**High**	**Very High**	**Very High**	**Very High**

Very High Risk: **Senior Management to be advised immediately** **High Risk:**

Senior Management attention needed immediately

Moderate Risk: **Issue to be resolved immediately or Senior Management notified** **Low Risk:**

Responsibility distributed to staff and supervisor immediately

The risk rating of an incident is based on the combination of Consequence and Likelihood.

Consider the Consequence and Likelihood to determine a Risk Rating

Consequence + Likelihood = Risk Rating

10.3.2 Table 2 – Jugiong Drinking Water Supply System Risk Assessment

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
	Likelihood	Consequence	Maximum risk	What control measures are currently in place?	Likelihood	Consequence	Residual Risk		
Catchment - Murrumbidgee River									
Pathogens									
Sewerage or septic overflow into catchment	3	5	Very High	Jugiong WTP processes – (coagulation, flocculation, sedimentation, filtration, disinfection); ability to shut down plant; well-trained operators	1	5	High	▪ 2xWeekly visual inspection of raw water intake ▪ Online raw water turbidity monitoring (on raw water pipeline) ▪ Monthly bacto sampling ▪ SCADA/telemetry	POSSIBLE CAUSES: STP overflows and leaks, On-site Sewerage Management System (OSSMS) in Jugiong township experiencing discharges and failures, tankers carrying sewerage on highway. RECOMMENDATION (REC): GWCC to consider installing an online turbidity meter in Murrumbidgee River to predict water quality decline.
Flooding events, storm water flows, and high river events increasing turbidity in source water	5	5	Very High	Jugiong operator advised by State Water to variation in discharges; Jugiong WTP processes; continuous monitoring of river level (level sensor); operators monitor weather conditions daily; experienced operators; quality tests/ jar testing before extraction of suspect water; auto shut down on rapid turbidity rise; system storage capacity (3- 4 days storage capacity in winter)	1	5	High	▪ 2xWeekly visual inspection of raw water intake ▪ Daily check of weather forecast ▪ Online raw water turbidity monitoring (on raw water pipeline) ▪ Monthly bacto sampling ▪ SCADA/telemetry	POSSIBLE CAUSES: high rainfall events, flooding events, releases from Burrinjuck Dam Murrumbidgee River flow can be accessed at: http://www.waterinfo.nsw.gov.au/drr/murrumbidgee.shtml. Burrinjuck Dam is monitored by State Water Corp (ph: 6227 8121). State Water informs GWCC of any discharges (telephone, email, sms). In 2001, dam was augmented to handle largest possible flood. REC: alternate water supply - Jugiong and Oura systems to be connected for emergency supply REC: GWCC to consider installing an online turbidity meter in Murrumbidgee River to predict water quality decline.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
Unrestricted livestock and/or wildlife access to water supply catchment	5	5	Very High	Murrumbidgee catchment management - riparian zones, stream fences, stocking rate controls; Jugiong WTP processes; quality tests and jar testing before extraction of suspect water	1	5	High	▪ 2xWeekly visual inspection of raw water intake ▪ Online raw water turbidity monitoring ▪ Monthly bacto sampling ▪ SCADA/telemetry	POSSIBLE CAUSES: dead animals at the intake, etc Murrumbidgee catchment management performed by Riverina Local Land Services REC: GWCC to consider installing an online turbidity meter in Murrumbidgee River to predict water quality decline.
Rapid change in raw water quality	4	5	Very High	Archival records showing past events and actions taken; Jugiong WTP processes; quality tests and jar testing before extraction of suspect water; Jugiong raw water pumps auto shut down on rapid turbidity rise; pH correction in WTP; able to access plant during floods	1	5	High	▪ 2xWeekly visual inspection of raw water intake ▪ Online raw water turbidity monitoring (on raw water pipeline) ▪ Monthly bacto sampling ▪ SCADA/telemetry	POSSIBLE CAUSES: water extracted from different levels of Burrinjuck Dam REC: GWCC to consider changing operator working hours or plant operation hours to ensure that water operator is present at Jugiong WTP for a few hours whilst plant is in operation. REC: GWCC to consider installing an online turbidity meter in Murrumbidgee River to predict water quality decline.
Murrumbidgee River and Burrinjuck Dam									
Turbidity									
Controlled and uncontrolled fires	2	3	Moderate	Jugiong WTP processes; communication with emergency personnel; SCADA; jar testing; GWCC liaises with LEMC or REMC depending on size/area of the fire	1	3	Moderate	▪ SCADA / telemetry	REC: Alternate water source e.g. Oura system to supplement Jugiong supply (in process)

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
Chemicals									
Slow seepage of chemicals into catchment by point source contaminant, including industrial discharges	2	2	Low	Dilution	2	2	Low		POSSIBLE CAUSES: active or closed waste disposal, contaminated waste sites, active or closed petrol stations Currently there are old fuel stations along the river and one operating fuel station (BP)
Chemical spill in catchment	3	2	Moderate	Warnings on Hume Highway with emergency contact numbers; dilution; GWCC contacted in the event of chemical spills; storage capacity in system; extraction management; fast flowing river	2	2	Low		POSSIBLE CAUSES: farm drums, fuel truck spillages on highway or bridges over Jugiong Creek
Farming, forestry practices leading to pesticides and fertilisers in source waters	3	3	High	Annual pesticide analysis; dilution; Young, Harden and Cootamundra Shires have drum musters (all are members of regional waste groups)	1	3	Moderate		Annual pesticide analysis - only detection occurred last year (under guideline values) REC: GWCC to consider partnering with NSW Health to investigate pesticides in raw water
Algal blooms	1	2	Low	Multiple extraction levels at Burrinjuck Dam; use of tank storage in periods of poor water quality; extraction management; Jugiong WTP processes; jar testing	1	2	Low		Burrinjuck Dam is monitored by State Water Corp (ph: 6227 8121)

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
Jugiong WTP									
Pathogens									
Failure of inlet screen / inlet well	3	5	**Very High**	Screens cleaned weekly	1	5	**High**	▪ 2xWeekly visual inspection of raw water intake ▪ Online raw water turbidity monitoring (on raw water pipeline) ▪ SCADA / telemetry	Possible causes: birds falling in screen, blockages, dead animals, blockages, fish
Failure of coagulation / flocculation	3	5	**Very High**	Jugiong WTP processes; alarms on rapid mixers and flocculators; well-trained operators; operators on-site for chemical delivery; reputable supplier; preventative maintenance; spares onsite	1	5	**High**	▪ Daily visual plant inspection ▪ Monthly bacto sampling ▪ SCADA/telemetry	POSSIBLE CAUSES: inadequate chemical dosing, incorrect chemical dosage, power failure, inadequate mixing, mechanical / electrical failure, pump / mixer failure, running out of chemical, fluctuation in water quality, birds in rapid mixer, human error (valves not shut etc), failure of raw water turbidity meter, low alkalinity in raw water. Past incident: failure of alarms. REC: GWCC to consider changing operator working hours or plant operation hours to ensure that operator is present to observe WTP operations (1hr at least) REC: GWCC to consider adjusting chemical delivery SOP to include specific gravity tests on alum upon delivery to verify chemical REC: GWCC to consider flushing soda ash mains yearly to ensure pre-dosing line is functional
Failure of soda ash dosing (post-dosing)	5	5	**Very High**	Jugiong WTP processes; weekly chemical drop tests; jar tests performed weekly and when there is a change in water quality; chemical verification procedure upon delivery	2	4	**High**	▪ Daily visual plant inspection ▪ SCADA / telemetry ▪ Daily manual pH testing in finished water ▪ Monthly bacto sampling	POSSIBLE CAUSES: electrical / mechanical failure, pipe failure, running out of chemical, incorrect dosing rate, failure of water softening process etc

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
Failure of clarifier	3	5	Very High	Jugiong WTP processes; auto plant shut down on turbidity after filters; de-sludging occurs on timer; alarms on sludge valves and rakes; ability to isolate tanks; cleaning of clarifiers as required	1	5	High	▪ Daily visual plant inspection ▪ SCADA / telemetry ▪ Daily manual testing of pH, turbidity, apparent colour at clarifier outlet ▪ Online turbidity monitoring at common filter outlet ▪ Monthly bacto sampling	POSSIBLE CAUSES: mechanical / electrical failure, sludge scraper failure; rake failure, failure of valves, build-up of sludge, blockages, increased flow rate through plant, boiling in sedimentation tanks, short circuiting of hot/cold water, etc No online turbidity or pH at clarifier outlet REC: GWCC to consider installing online turbidity and pH meters at clarifier outlet REC: GWCC to consider changing operator working hours or plant operation hours to ensure that operator is present to observe WTP operations (1hr at least)
Failure of filtration	4	5	Very High	Jugiong WTP processes; Auto plant shut down on high turbidity post-filter; filter headloss indicators; auto- backwash on headloss and time; established program for draining, cleaning, disinfection of filters; pre-dose chlorine prior to filters if required; operators monitor media and nozzle performance; individual filters can be taken offline	1	5	High	▪ Daily visual plant inspection ▪ SCADA / telemetry ▪ Online turbidity monitoring at common filter outlet ▪ Monthly bacto sampling	POSSIBLE CAUSES: mechanical / electrical failure - blowers, backwash pumps, short filter runs due to early high head loss, problems with backwash, filter breakthrough, loss of media Backwash triggers: headloss (3 m) and time (96 hours) REC: GWCC to consider installing online turbidity meters after individual filters REC: GWCC to consider initiating filter backwash based on turbidity at filter outlet and changing backwash on 72 hours based on advice from DPI Water REC: GWCC to develop SOP for draining, cleaning and disinfecting filters
Failure of disinfection	5	5	Very High	Jugiong WTP processes; Auto plant shut down based on low or high free chlorine; reputable supplier; scales on chlorine tanks; redundancy - duty/standby chlorinators;	1	5	High	▪ Daily visual insp. ▪ SCADA / telemetry ▪ Daily manual free chlorine testing in finished water ▪ 1 - 2 times weekly	POSSIBLE CAUSES: electrical / mechanical failure, pipe failure, running out of chemical, incorrect dosage, failure of injector, blockages, human error, etc Past incident: almost run out of chemicals (suspected that half-full cylinder was supplied) - able to use small 70kg cylinders as backup for 1 day. GWCC has

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
				auto changeover; established maintenance programs; 70kg cylinders available in emergencies; heater in chlorine room; secondary chlorination units; manual dosing of reservoirs with hypo in the event that low chlorine water enters supply; well-trained operators				manual free chlorine testing in reservoirs ▪ Online chlorine analyser in finished water at Jugiong WTP ▪ Monthly bacto sampling ▪ Online chlorine analysers in reticulation: Prunevale PS and Cootamundra Depot	now installed scales on chlorine tanks to monitor usage REC: GWCC to complete live chlorine monitoring system for reticulation system (in progress)
Sabotage or vandalism at Jugiong WTP	2	5	Very High	Locked gates; man-proof fences; operators living next door; signage with GWCC emergency contact numbers	1	5	High	▪ Daily visual plant inspection	
Chemicals									
Overdose of fluoride	3	3	High	Auto plant shut down when fluoride plant fails; chemical verification procedure upon delivery; fluoride plant designed as per *Code of Practice for the Fluoridation of Public Water Supplies*; well-trained operators; flow meter, flow switch, pressure switch on fluoride dosing system; heater in fluoride room; cross-reference different fluoride probes; fluoride probes calibrated daily; preventative	1	3	Moderate	▪ Daily visual plant inspection ▪ SCADA / telemetry ▪ Daily fluoride testing in raw and finished water ▪ 3x weekly manual testing in retic	POSSIBLE CAUSES: flow meter failure, electrical / mechanical failure, poor chemical quality, clumping, blockages, etc Prominent system theoretically unable to overdose. REC: GWCC to consider developing SOP for fluoride hopper cleaning

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
				maintenance; hopper cleaned; fluoride calculations performed daily					
Overdose of chemicals (polymer, alum)	4	2	High	Chemical verification procedure upon delivery; register of dialysis patients that are customers of GWCC and are contactable in event of emergency; well-trainer operators; daily visual inspections; operators present upon chemical delivery	2	2	Low	▪ Daily visual plant inspection ▪ SCADA / telemetry	POSSIBLE CAUSES: mechanical / electrical failure, inconsistent chemical quality / concentration, incorrect dosage, human error, etc
Infrastructure leach components of materials	4	2	High	Tray designed to catch oil spills from rapid mixer and pumps; preventative maintenance	2	2	Low	▪ Daily visual plant inspection ▪ SCADA / telemetry	Infrastructure includes: pipework, lining of valves, pumps, oils POSSIBLE CAUSES: chemical reactions, oil spill from rapid mixer or pump
Disinfection By-Products									
Failure of chlorine pre-dosing	3	3	High	Jugiong WTP processes; chemical verification procedure upon delivery; cross-check online chlorine analysers with hand-held analyser; heater in chlorine room; scales on chlorine cylinder; auto plant shut down on high and low chlorine in finished water	1	3	Moderate	▪ Daily visual plant inspection ▪ SCADA / telemetry ▪ Online chlorine analyser in finished water at Jugiong WTP	POSSIBLE CAUSES: electrical / mechanical failure, pipe failure, running out of chemical, blockages, human error, etc Chlorine pre-dosing is optional and is available to dose prior to coagulation and prior to filters. Pre- dosing initiated for the removal of colour. Pre-dose chlorine needs to be turned on manually REC: GWCC to liaise with NSW Health to conduct a study on disinfection by-products
Loss of supply									
Power failure	3	2	Moderate	Breakdown procedures in place (Jugiong manuals); plant can be run manually; can access generator if necessary	3	2	Moderate	▪ Daily visual plant inspection ▪ SCADA / telemetry	

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
All of System									
Pathogens									
Loss of trained water treatment operators	3	5	Very High	5 trained operators, one trainee; scheduled leave; refresher training every 3 years; all water operators have Certificate III qualifications in water operations	1	5	High		
Failure of PLC	2	5	Very High	Visual inspection by experienced water operators; established maintenance programs; critical spares	1	5	High		POSSIBLE CAUSES: electrical / mechanical failure, loss of communication between PLCs, etc
Reservoirs									
Pathogens									
Breach of reservoir integrity	5	5	Very High	Chlorine residual; regular cleaning program; all reservoirs and tanks roofed, secure; flashing; hatches built to AS/NZS; predictive maintenance; gauze and rubber ring around overflows	1	5	High	▪ Weekly visual insp. ▪ Inspection of high-risk reservoir roofs monthly /low-risk reservoir roofs every two months ▪ Online free chlorine analysers at Prunevale PS and Cootamundra depot	POSSIBLE CAUSES: inadequate repairs / maintenance, pests, vermin, etc.
Aged water at Young Terminal Storage (YTS)	3	5	Very High	Manual dose of liquid chlorine into YTS; GWCC has a chlorine booster station at Demondrille; online chlorine analyser at Prunevale PS	2	5	Very High	▪ Weekly chlorine residual testing in reticulation ▪ Monthly bacto sampling	POSSIBLE CAUSES: seasonal consumption, operational constraints, specifically affects Young Terminal Storage Young township has a peak demand of approx 7 - 8 ML/day. YTS has a 32 ML capacity. Currently the YTS is maintained at a level of 90%.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
									GWCC would like to maintain a lower operating level to maintain chlorine residual and YSC needs to keep operating level high to maintain pressure in the town. REC: GWCC to liaise with Young Shire Council (YSC) to develop operational or capital solutions to eliminate aged water in YTS and to maintain pressure for Young township.
Sabotage or vandalism of reservoir / accidental or negligent contamination	2	5	Very High	Prevention of unauthorised access; chlorine residual; locked hatches; security fences; locked ladders; signage with emergency numbers	1	5	High	▪ Weekly visual inspection ▪ Weekly chlorine residual testing in reticulation ▪ Online free chlorine analysers at Prunevale PS and Cootamundra depot	REC: GWCC to consider alarming hatch doors in case of sabotage or vandalism REC: GWCC to consider purging reservoir as part of emergency response if contamination is suspected
Short circuiting of water within reservoirs	4	4	Very High	Most reservoirs are top inlet and bottom outlet; some reservoirs have risers on the bottom;	2	4	High	▪ 3xWeekly chlorine residual testing in reticulation ▪ Online free chlorine analysers at Prunevale PS and Cootamundra depot ▪ SCADA / telemetry	Whilst most reservoirs are top inlet with bottom outlet, there are some reservoirs with bottom inlet and bottom outlet.
Breach of pipelines	5	4	Very High	Preventative maintenance program (air valve servicing); mains replacement program; chlorine residual; protocol and procedures for new & repairs; internal maintenance on all mains; training program for contractors; flushing until	1	4	High	▪ Online free chlorine analysers at Prunevale PS and Cootamundra depot ▪ 3xWeekly chlorine residual testing in reticulation	POSSIBLE CAUSES: breaks, inappropriate maintenance, new or service works, etc. Renewing of mains is performed by contractors. Any contractors employed to renew mains must undergo training and brief of GWCC work method statements. Procedure for disinfecting pipes during mains installation: all pipes disinfected prior to installation and main is superchlorinated once installed as per

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
				chlorine residual is detected (mains break); procedure for disinfection of pipes during mains installation				▪ SCADA / telemetry	GWCC procedure
Chemicals									
Rust forming in steel reservoirs	3	3	High	Cathodic protection on most steel reservoirs; reservoir cleaning and inspection; painting of reservoir; scheduled maintenance and coating replacement program	2	3	Moderate	▪ Weekly visual reservoir inspection	
Reticulation System									
Pathogens									
Contamination due to cross-connections and backflows	5	5	Very High	Chlorine residual; high risk areas identified; pressure control; regular cleaning program; high risk areas have RPZs; meter replacement; dual check valves on new meters; GWCC inspects council- required RPZs; GWCC backflow prevention policy; high volume consumers have their dual check valve meters changed every 12 months	2	5	Very High	▪ Online free chlorine analysers at Prunevale PS and Cootamundra depot ▪ 3xWeekly chlorine residual testing in reticulation ▪ SCADA/telemetry ▪ Monthly bacto sampling	POSSIBLE CAUSES: rainwater tanks, private bores, water carters, failure of transmission pumps, water hammer, hydrant usage, negative pressure, illegal private lines, rural connections (OSSMS, chemicals, pesticides as well as possible cross connection with private dam water), abattoirs, animal troughs, etc. High risk areas incl. schools, abattoirs, hospitals, etc Meter replacement program: old meters are progressively replaced with dual check valve meters. GWCC inspect RPZs that they require to be installed but sub-contracted plumbers inspect RPZs on the consumer side. Note: this risk includes the meter on GWCC main that is owned by HSC. Not all GWCC standpipes have BFPD - only a lay-flat hose. GWCC do not have a register of water carters operating within the area. REC: GWCC to consider training staff in backflow prevention. REC: GWCC to consider conducting a community education program on backflow prevention.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
									REC: GWCC to liaise with bulk water councils to ensure concurrence with all DA. REC: GWCC to develop a register for water carters and investigate options for electronic card systems on standpipes to record water carter access. REC: GWCC to develop and maintain a register of RPZs within distribution system. Once a register has been developed, it is recommended that GWCC implement a BFPD inspection schedule for all high risk connections etc. REC: GWCC in conjunction with HSC to investigate options at HSC water meter eg. constructing a reservoir.
Loss of chlorine residual due to long reticulation	4	4	Very High	Limited chlorine residual; mobile chlorine dosing unit available for back up; automatic chlorine cylinder changeover; secondary chlorination facilities; manual dosing of chlorine in reservoir	1	4	High	▪ Online free chlorine analysers at Prunevale PS and Cootamundra depot ▪ 3x weekly chlorine residual testing in reticulation ▪ Monthly bacto sampling ▪ SCADA/telemetry	POSSIBLE CAUSES: long retic lines REC: GWCC to complete live chlorine monitoring system for reticulation system (in progress)
Inadequate chlorine residual									
Failure of secondary disinfection units (chlorine boosters)	3	3	High	Limited chlorine residual; mobile chlorine dosing unit for back up; automatic chlorine cylinder changeover; redundancy - duty/standby; scales for chlorine cylinders; procurement processes - chlorine delivery every 3 weeks; visual inspection of booster stations	1	3	Moderate	▪ Online free chlorine analysers at Prunevale PS and Cootamundra depot ▪ Daily chlorine residual testing in reticulation ▪ SCADA / telemetry ▪ Monthly bacto	POSSIBLE CAUSES: electrical / mechanical failure, pipe failure, running out of chemical, failure of alarms / monitoring equipment, incorrect dosing, human error, leaking injector hose etc REC: GWCC to complete live chlorine monitoring system for reticulation system (in progress)

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes / Recommendations
								sampling	
Dead ends in reticulation system leading to stagnation	3	2	Moderate	Reactive dead end looping; mains flushing program; annual swabbing of mains; reactive flushing after dirty water complaints	2	2	Low		

10.3.3 Table 3 – Oura Drinking Water Supply System Risk Assessment

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
	Likelihood	Consequence	Maximum risk	What control measures are currently in place?	Likelihood	Consequence	Residual Risk		
Oura Borefield									
Pathogens									
Surface water ingress or short-circuiting of contaminants at poorly constructed or maintained bores	3	5	**Very High**	Very well-constructed bores; all bores in secure bore huts; disinfection; secure boreheads; disinfection	1	5	**High**	▪ Water quality tests and visual checks after storm events ▪ Daily visual inspection ▪ Daily chlorine residual testing at disinfection ▪ Monthly bacto sampling ▪ 3x weekly free chlorine testing in reticulation	REC: GWCC to conduct bacto sampling after storm event if visual check of bores show signs of being compromised.
Unrestricted livestock and/or wildlife access to areas surrounding borefields	5	5	**Very High**	Rotation of bore selection due to quality and output; maintenance program; all bore huts secure and vermin-proof; disinfection; secure boreheads; cattle fences around bores Disinfection	1	5	**High**	▪ Daily visual inspection ▪ Daily chlorine residual testing at disinfection ▪ Monthly bacto sampling ▪ 3x weekly free chlorine testing in reticulation	
Aquifer contamination due to seepage of pathogens from a point source eg. OSSM	3	5	**Very High**	Rotation of bore selection due to quality and output; established maintenance program; all bore huts secure and vermin-proof; Disinfection	1	5	**High**	▪ Daily visual inspection ▪ Daily chlorine residual testing at disinfection ▪ Monthly bacto sampling ▪ 3x weekly free chlorine testing in reticulation	POSSIBLE CAUSES: OSSM located in same area as aquifer. No service stations and no opportunities for chemical point source leaks.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Poor operation and management of non-GWCC managed bores (cross-contamination of aquifers)	3	5	Very High	Disinfection	1	5	High	▪ Daily chlorine residual testing at disinfection ▪ Monthly bacto sampling ▪ 3x weekly free chlorine testing in reticulation	The bore in close proximity to the Oura Borefield was constructed by GWCC and sold to private farmer. The bore has a raised bore hut, no fences. GWCC is unaware of how the private bore is managed. REC: educate private bore owner to ensure he knows that the bore accesses the drinking water aquifer
Surface water - groundwater interactions bringing contaminants into aquifer	1	5	High	Disinfection	1	5	High	▪ Water quality tests and visual checks after storm events ▪ Daily visual inspection ▪ Daily chlorine residual testing at disinfection ▪ Monthly bacto sampling ▪ 3x weekly free chlorine testing in reticulation	REC: GWCC to conduct bacto sampling after storm event if visual check of bores show signs of being compromised.
Chemicals									
Naturally occurring concentrations above ADWG values e.g. iron	5	3	Very High	Aeration; chlorine dosing to oxidise iron; 'settling' reservoirs	1	3	Moderate		Water passes through three settling reservoirs located at Junee where the iron is able to settle out before distribution.
Loss of supply									
Loss of supply due to low water table	2	4	High	Notify Manager Distribution and Construction of unusual events	1	4	High	▪ Daily visual inspection ▪ SCADA / telemetry	POSSIBLE CAUSES: drought, over-extraction, low water table Past incident: operators haven't noticed any changes in quality due to lowering of water table

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Water Treatment Process									
Pathogens									
Failure of disinfection	5	5	**Very High**	Established preventative maintenance programs; target criteria established for chlorine residual; redundancy - duty/standby chlorine dosing pumps; scales on chlorine cylinders; well-trained operators	2	5	**Very High**	▪ Daily visual inspection ▪ SCADA / telemetry ▪ Daily chlorine residual testing at disinfection ▪ Monthly bacto sampling ▪ 3x weekly free chlorine testing in reticulation	POSSIBLE CAUSES: mechanical / electrical failures; running out of chemical; incorrect dosage, human error Past issues: interference between chlorine testing reagent and manganese in the sample water, leading to a false high reading. REC: GWCC to consider conducting internal training on chlorine residual testing. REC: GWCC to consider developing SOPs for chlorine testing to include manganese interference with reagent. REC: GWCC to consider purchasing electronic chlorine analyser to eliminate manganese interference with chlorine residual testing as per DPI Water recommendation (eg chloro-sense kits) REC: GWCC to consider installing an online free chlorine analyser at Oura disinfection point (after 30 min contact time).
Vermin access to aeration tower	3	5	**Very High**	Regular cleaning program; established maintenance program; daily visual inspection of tank roofs for vermin; disinfection; partial shade cloth around aerator	1	5	**High**	▪ Daily visual inspection ▪ SCADA / telemetry ▪ Daily chlorine residual testing at disinfection ▪ Monthly bacto sampling ▪ 3x weekly free chlorine testing in reticulation	POSSIBLE CAUSES: birds, possums, frogs, etc.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Loss of supply									
Power failure	3	3	**High**	Water cannot be pumped during power failures; notify Manager of Distribution and Construction of unusual events; able to manually dose at Junee reservoirs; increased monitoring during power outages; alternate water source (Jugiong can supply to parts of Oura system);	1	3	**Moderate**	▪ Daily visual inspection ▪ SCADA / telemetry	If power is lost at the treatment process, chlorine residual can be depleted in Junee Reservoir REC: GWCC to consider increasing monitoring of chlorine residual throughout system during power outages. REC: GWCC to develop a business continuity plan (in progress).
Chemicals									
Failure of iron oxidation	3	3	**High**	Four outlets for the aerator system; scales on chlorine tanks	1	3	**Moderate**	▪ Daily visual inspection ▪ SCADA / telemetry	POSSIBLE CAUSES: pump failure, changes in raw water quality, chlorine dosing failure, etc. There are four aerator sections in the Oura aeration tower. GWCC operators have the ability to take selective sections to perform maintenance etc.
Overdose of fluoride	3	3	**High**	Well-trained operators; fluoridation system designed as per *Code of Practice for the Fluoridation of Public Water Supplies*; chemical drop tests; control of chemical stock; Form 3 filled out daily; Prominent system cannot theoretically overdose; fluoride calculations performed daily	2	3	**Moderate**	▪ Daily visual inspection ▪ SCADA / telemetry ▪ Daily natural fluoride monitoring ▪ Daily treated water fluoride monitoring	POSSIBLE CAUSES: mechanical / electrical failure, poor chemical quality, human error, etc Past incident: failure of solenoid valves in fluoride dosing system, leading to overdosing of fluoride. REC: GWCC to consider performing preventative maintenance on solenoid valves leading into fluoride batching tank. REC: GWCC to consider checking fluoride alarms weekly, as per DPI Water recommendation REC: GWCC to check data entry to ensure no errors and record all incidents and causes of high readings (eg data entry error, human error, etc)

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
All of System									
Pathogens									
Loss of trained water treatment operators	3	5	Very High	7 trained operators; scheduled leave; refresher training every 3 years; all water operators have Certificate III qualifications in water operations	1	5	High		
Reservoirs									
Pathogens									
Breach of reservoir integrity	5	5	Very High	Secondary chlorination at Reefton and Thanowring Rd PS; regular cleaning program; regular inspection of tank roofs for vermin; all tanks and reservoirs roofed; chlorine residual; bacto testing monthly; online turbidity meter from Oura plant to Junee reservoirs; ongoing maintenance program to ensure all reservoirs meet AS/NZS	2	5	Very High	▪ 3x weekly free chlorine testing in reticulation ▪ Weekly visual inspection of reservoir ▪ Inspection of high-risk reservoir roofs monthly ▪ Inspection of low-risk reservoir roofs every two months ▪ Online free chlorine analysers at Wyalong PS ▪ Monthly bacto test	POSSIBLE CAUSES: inadequate repairs / maintenance, pests, vermin, etc. REC: ensure all hatches on reservoirs comply with AS/NZS REC: GWCC to consider installing online chlorine analysers at Oura and Ariah Park PS

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Sabotage or vandalism of reservoir / accidental or negligent contamination	2	5	Very High	Prevention of unauthorised access; chlorine residual; roofed reservoirs; locked hatches; man-proof fences	1	5	High	▪ 3x weekly free chlorine testing in reticulation ▪ Weekly visual inspection of reservoir ▪ Inspection of high-risk reservoir roofs monthly ▪ Inspection of low-risk reservoir roofs every two months ▪ Online free chlorine analysers at Wyalong PS and Reefton PS ▪ Monthly bacto test	REC: GWCC to consider alarming reservoir hatch doors in case of sabotage or vandalism. REC: GWCC to consider purging reservoir as part of emergency response if contamination is suspected.
Reticulation									
Pathogens									
Breach of pipelines	5	4	Very High	Preventative maintenance program; mains replacement program; repairs carried out as per manufacturer's instructions; chlorine residual	1	4	High	▪ Online chlorine residual analyser at Wyalong PS ▪ 3x weekly free chlorine testing in reticulation ▪ Monthly bacto test	POSSIBLE CAUSES: breaks, inappropriate maintenance, new or service works, etc. Approximately 4-8 breaks per month in Oura system.
Contamination due to cross-connections and backflows	4	5	Very High	Chlorine residual; high risk areas identified; pressure control; regular cleaning program; high risk areas have RPZs; meter replacement; dual check valves on new meters; GWCC inspects council- required RPZs; GWCC backflow prevention policy; high volume consumers have their dual check valve meters changed every 12 months	2	5	Very High	▪ Online chlorine residual analyser at Wyalong PS and Reefton PS ▪ 3x weekly free chlorine testing in reticulation ▪ Monthly bacto test	POSSIBLE CAUSES: rainwater tanks, private bores, stock troughs, water carters, failure of transmission pumps, water hammer, hydrant usage, etc. High risk areas incl. schools, abattoirs, hospital Meter replacement program: old meters are progressively replaced with dual check valve meters. GWCC inspect RPZs that they require to be installed but sub-contracted plumbers inspect RPZs on the consumer side.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
									Not all GWCC standpipes have BFPD - only a lay-flat hose. GWCC do not have a register of water carters operating within the area. REC: GWCC to consider training staff in backflow prevention. REC: GWCC to consider conducting a community education program on backflow prevention. REC: GWCC to develop a register for water carters and investigate options for electronic card systems on standpipes to record water carter access. REC: GWCC to consider developing and maintaining a register of RPZs within distribution system. Once a register has been developed, it is recommended that GWCC implement a BFPD inspection schedule for all high risk connections including hospitals, schools, rural properties, etc.
Cross-connection with non-potable supply (Hylands Bridge)	3	5	Very High	Reflux valve; able to visually see if valves are open or close; chlorine residual	2	5	Very High	▪ Online chlorine residual analyser at Wyalong PS ▪ Weekly chlorine residual testing ▪ Monthly bacto testing	POSSIBLE CAUSES: Hylands Bridge's non-potable supply can be supplemented by the Oura system during drought. REC: GWCC to consider and investigate and install the most suitable BFPD on the connection between Oura and Hylands Bridge (eg RPZ, break tank with air gap, etc)

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Inadequate chlorine residual									
Loss of chlorine due to long reticulation	4	4	**Very High**	Two chlorine booster stations on both branches at Temora; chlorine residual	2	4	**High**	▪ Online chlorine residual analyser at Wyalong PS ▪ 3x weekly chlorine testing ▪ Monthly bacto testing	Oura has the longest reticulation mains managed by GWCC.
Failure of secondary disinfection units (chlorine boosters)	3	3	**High**	Established maintenance program	1	3	**Moderate**	▪ Online chlorine residual analyser at Wyalong PS ▪ SCADA / telemetry	POSSIBLE CAUSES: electrical / mechanical failure, pipe failure, running out of chemical, failure of alarms / monitoring equipment, incorrect dosing, etc
Aesthetic issues - taste, odour, colour									
Dead ends in reticulation system leading to stagnation	5	2	**High**	Swabbing and flushing undertaken up to 2x yearly; 'settling'	3	2	**Moderate**		Water passes through three settling reservoirs located at Junee where the iron is able to settle out before distribution. The Oura system has hundreds of dead ends.

10.3.4 Table 4 – Mt Arthur Drinking Water Supply System Risk Assessment

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
	Likelihood	Consequence	Maximum risk	What control measures are currently in place?	Likelihood	Consequence	Residual Risk		
Mt Arthur Bores									
Pathogens									
Surface water ingress or short-circuiting of contaminants at poorly constructed and maintained bores	3	4	Very High	Very well-constructed bores; al bores in secure bore huts; disinfection; secure boreheads	1	4	High	▪ Water quality tests and visual checks after storm events ▪ Weekly visual inspection ▪ 3x weekly chlorine residual testing at disinfection ▪ Monthly bacto sampling ▪ Daily free chlorine testing in reticulation	REC: GWCC to conduct bacto sampling after storm event if visual check of bores show signs of being compromised.
Aquifer contamination due to seepage of pathogens from a point source	4	4	Very High	Chlorine residual	1	4	High	▪ Weekly visual inspection ▪ 3x weekly chlorine residual testing at disinfection ▪ Daily free chlorine testing in reticulation ▪ Monthly bacto sampling	POSSIBLE CAUSES: OSSMS on rural properties

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Chemicals									
Naturally occurring concentrations above ADWG values e.g. iron	5	3	Very High	'Settling' reservoirs in Ganmain; oxidation with chlorine	1	3	Moderate		Ganmain has three 'settling' tanks with baffles to drop out iron
Loss of supply									
Loss of supply due to low water table	2	4	High	Notify operations coordinator of unusual events	1	4	High	▪ Weekly visual inspection ▪ SCADA / telemetry	POSSIBLE CAUSES: drought
Water Treatment Process									
Pathogens									
Failure of disinfection	4	4	Very High	Manual dosing of reservoir in case of failure; manual dosing at settling tank in case of failure; preventative maintenance schedule; target criteria established for chlorine residual; redundancy - duty/standby chlorine dosing pumps; well- trained operators	1	4	High	▪ Daily visual inspection of chlorine dosing	POSSIBLE CAUSES: mechanical / electrical failures; poor chemical quality; running out of chemical; incorrect dosing rates; power failure REC: GWCC to consider installing online chlorine residual analyser at outlet of settling tanks to ensure 30 minutes contact time.
Power failure	3	4	Very High	Manual dosing at settling tank; ability to manually switch off bore pumping in case of power failure at chlorination point	1	4	High	▪ SCADA / telemetry ▪ Daily chlorine residual testing	REC: GWCC to consider installing online chlorine residual analyser at outlet of settling tanks.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Chemicals									
Overdosing of chlorine	3	3	High	Target criteria for chlorine residual; well-trained operators	1	3	Moderate	▪ Weekly visual inspection ▪ Daily chlorine residual testing	POSSIBLE CAUSES: electrical / mechanical failure, pipe failure, running out of chemical, blockages, human error, etc. REC: GWCC to consider installing online chlorine residual analyser at reservoir outlet
All of System									
Pathogens									
Loss of trained water treatment operators	3	5	Very High	7 trained operators; scheduled leave; refresher training every 3 years; all water operators have Certificate III qualifications in water operations	1	5	High		
Failure of SCADA / telemetry	3	4	Very High	Established maintenance programs; disinfection; SCADA checked daily by multiple operators	1	4	High	▪ Weekly visual inspection	
Reservoirs									
Pathogens									
Breach of reservoir integrity	5	5	Very High	Regular cleaning program; regular inspection of tank roofs for vermin; all tanks and reservoirs roofed; chlorine residual; bacto testing monthly; ongoing maintenance program to ensure all reservoirs meet	2	5	Very High	▪ 3x weekly free chlorine testing in reticulation ▪ Weekly visual inspection of reservoir ▪ Inspection of high-risk reservoir roofs	POSSIBLE CAUSES: inadequate repairs / maintenance, pests, vermin, etc. REC: ensure all hatches on reservoirs comply with AS/NZS

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
				AS/NZS				monthly ▪ Inspection of low-risk reservoir roofs every two months ▪ Monthly bacto test	
Sabotage or vandalism of reservoir (unauthorised access) / accidental or negligent contamination	2	5	Very High	Prevention of unauthorised access; chlorine residual; locked hatches; security fences; locked ladders; signage with emergency numbers	1	5	High	▪ 3x weekly free chlorine testing in reticulation ▪ Weekly visual inspection of reservoir ▪ Inspection of high-risk reservoir roofs monthly ▪ Inspection of low-risk reservoir roofs every two months ▪ Monthly bacto test	REC: GWCC to consider alarming hatch doors in case of sabotage or vandalism REC: GWCC to consider purging reservoir as part of emergency response if contamination is suspected
Reticulation									
Pathogens									
Contamination due to cross-connections and backflows	4	5	Very High	Chlorine residual; high risk areas identified; pressure control; regular cleaning program; high risk areas have RPZs; meter replacement; dual check valves on new meters; GWCC inspects council-required RPZs; GWCC backflow prevention policy; high volume consumers have their dual check valve meters changed every 12 months	2	5	Very High	▪ 3x weekly free chlorine testing in reticulation	POSSIBLE CAUSES: rainwater tanks, private bores, stock troughs, water carters, failure of transmission pumps, water hammer, hydrant usage, etc. High risk areas include schools, hospitals, etc. Meter replacement program: old meters are progressively replaced with dual check valve meters. GWCC inspect RPZs that they require to be installed but sub-contracted plumbers inspect RPZs on the consumer side. Not all GWCC standpipes have BFPD - only a lay-flat hose. GWCC do not have a register of water carters operating within the area.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
									REC: GWCC to consider training staff in backflow prevention REC: GWCC to consider conducting a community education program on the importance of backflow prevention. REC: GWCC to develop a register for water carters and investigate options for electronic card systems on standpipes to record water carter access. REC: GWCC to consider developing and maintaining a register of RPZs within distribution system. Once a register has been developed, it is recommended that GWCC implement a BFPD inspection schedule for all high risk connections including hospitals, schools, rural properties, etc.
Aesthetic issues - taste, odour, colour									
Dead ends in reticulation system leading to stagnation	3	2	**Moderate**	Settling tanks - iron removal; scheduled maintenance - flushing	2	2	**Low**		Approximately 30 dead ends in Mt Arthur reticulation system

10.3.5 Table 5 – Mt Daylight Drinking Water Supply System Risk Assessment

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
	Likelihood	Consequence	Maximum risk	What control measures are currently in place?	Likelihood	Consequence	Residual Risk		
Mt Daylight Bores									
Pathogens									
Surface water ingress or short-circuiting of contaminants at poorly constructed and maintained bores	4	4	Very High	Borehead protection; disinfection	2	4	High	▪ Online chlorine analyser at Naradhan Reservoir inlet ▪ Weekly visual inspection ▪ Weekly chlorine residual testing in reticulation ▪ Monthly bacto tests at reservoir	POSSIBLE CAUSES: unrestricted livestock and wildlife access in areas surrounding bores, lack of maintenance by Carrathool Shire Mt Daylight bores are operated and maintained by Carrathool Shire Council. GWCC does not have control over the bores. REC: GWCC to consider developing a communication protocol with Carrathool Shire Council to ensure pertinent information regarding bore water protection and reservoir integrity is shared.
Unrestricted livestock and / or wildlife access to areas surrounding bores	4	4	Very High	Man-proof fence around bores; borehead protection; disinfection	1	4	High	▪ Online chlorine analyser at Naradhan Reservoir inlet ▪ Weekly visual inspection ▪ Weekly chlorine residual testing in reticulation ▪ Monthly bacto tests at reservoir	Mt Daylight bores are operated and maintained by Carrathool Shire Council. GWCC does not have control over the bores. REC: GWCC to consider developing a communication protocol with Carrathool Shire Council to ensure pertinent information regarding bore water protection and reservoir integrity is shared.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Aquifer contamination due to ingress of pathogens from flooding	2	4	High	Borehead protection; disinfection	2	4	High	▪ Online chlorine analyser at Naradhan Reservoir inlet ▪ Weekly visual inspection ▪ Weekly chlorine residual testing in reticulation ▪ Monthly bacto tests at reservoir	POSSIBLE CAUSES: OSSM from rural properties There is no STP in the surrounding area. Mt Daylight bores are operated and maintained by Carrathool Shire Council. GWCC does not have control over the bores. REC: GWCC to consider developing a communication protocol with Carrathool Shire Council to ensure pertinent information regarding bore water protection and reservoir integrity is shared
Loss of Supply									
Loss of supply due to low water table	3	4	Very High	Notify operations coordinator of unusual events; bore draw down indication	2	4	High	▪ SCADA / telemetry	POSSIBLE CAUSES: drought

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Bores and Carrathool Shire Council Non-Drinking Water Reservoir									
Pathogens									
Poor operation and management of Carrathool Shire Council managed bores and non- potable reservoir	3	4	Very High	Chlorine residual; disinfection	1	4	High	▪ Online chlorine analyser at Naradhan Reservoir inlet ▪ Weekly visual inspection ▪ Weekly chlorine residual testing in reticulation ▪ Monthly bacto tests at reservoir	Current set up - bores pump based on GWCC reservoir levels. The water is chlorinated at reservoir inlet. These reservoirs can be balanced with the Carrathool Shire Council which are not managed very well (open roof, etc) - potential issue of contamination of GWCC water REC: GWCC to consider developing a communication protocol with Carrathool Shire Council to ensure pertinent information regarding bore water protection and reservoir integrity is shared.
Water Treatment Process									
Pathogens									
Failure of disinfection	4	4	Very High	Established maintenance programs; target criteria established for chlorine residual; chlorine scales; procurement process; alarms on leaks; delivery of chlorine every 3 weeks	2	4	High	▪ SCADA/telemetry ▪ Online chlorine analyser at Naradhan Reservoir inlet ▪ Weekly visual inspection ▪ Weekly chlorine residual testing in reticulation ▪ Monthly bacto tests at reservoir	POSSIBLE CAUSES: mechanical / electrical failures, running out of chemical, incorrect dosage, power failure, etc. Possible oxidation and settling of iron in 4 reservoirs due to relocation of chlorine dosing point from reservoir outlet to reservoir inlet. Since relocation of chlorine dosing, there have been no failures of disinfection. REC: GWCC to consider changing location of online chlorine analyser to ensure free chlorine measurement after 30 min contact time. Both the chlorine dosing and the chlorine analyser are located at the reservoir inlet.
Chemicals									
Overdosing of chlorine	3	3	High	Target criteria for chlorine residual; well-trained operators	1	3	Moderate	▪ Online chlorine analyser at reservoir inlet	POSSIBLE CAUSES: mechanical/electrical failures, incorrect dosage, etc.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
								▪ Weekly visual ▪ Weekly chlorine residual testing in reticulation	
All of System									
Pathogens									
Loss of trained water treatment operators	3	5	Very High	7 trained operator; scheduled leave; refresher training every 3 years; all water operators have Certificate III qualifications in water operations	1	5	High		
Failure of SCADA / telemetry	3	4	Very High	Established maintenance programs; target criteria established for chlorine residual; disinfection; SCADA checked daily by multiple operators	1	4	High	▪ Weekly visual inspection by experienced water operators ▪ Daily chlorine residual testing ▪ SCADA / telemetry	
Reservoirs									
Pathogens									
Breach of reservoir integrity	5	4	Very High	All tanks roofed; hatches recently replaced in Mt Daylight	1	4	High	▪ Weekly chlorine residual testing ▪ Weekly inspection of tank roofs for vermin ▪ Inspection of high-risk reservoir roofs monthly / low-risk reservoir roofs every two months	POSSIBLE CAUSES: inadequate repairs / maintenance, pests, vermin, etc.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Sabotage or vandalism of reservoir (unauthorised access) / accidental or negligent contamination	2	4	High	Prevention of unauthorised access; chlorine residual; locked hatches; security fences; locked ladders; signage with emergency numbers	1	4	High	▪ Weekly chlorine residual testing ▪ Weekly inspection of tank roofs for vermin ▪ Inspection of high-risk reservoir roofs monthly /low-risk reservoir roofs every two months	REC: GWCC to consider developing a system of different key levels to increase security REC: GWCC to consider alarming hatch doors in case of sabotage or vandalism - particularly at the Mt Daylight reservoir as it is more remote REC: GWCC to consider purging reservoir as part of emergency response if contamination is suspected
Reticulation System									
Pathogens									
Breach of pipelines through breaks, inappropriate maintenance, new or service works etc	5	4	Very High	Preventative maintenance program (air valve servicing); mains replacement program; chlorine residual; protocol and procedures for new & repairs; internal maintenance on all mains; training program for contactors; flushing until chlorine residual is detected (mains break); procedure for disinfection of pipes during mains installation	1	4	High	▪ Weekly chlorine residual testing in reticulation ▪ SCADA / telemetry	POSSIBLE CAUSES: breaks, inappropriate maintenance, new or service works, etc. Approximately 4 breaks per month in Mt Daylight Renewing of mains is performed by contractors. Any contractors employed to renew mains must undergo training and brief of GWCC work method statements. Procedure for disinfecting pipes during mains installation: all pipes disinfected prior to installation and main is superchlorinated once installed as per AS/NZS 3500

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Contamination due to cross-connections and backflows	5	4	Very High	Chlorine residual; 2 operators trained in backflow prevention; high risk areas identified; pressure control; regular cleaning program; high risk areas have RPZs; meter replacement; dual check valves on new meters; GWCC inspects council- required RPZs; GWCC backflow prevention policy; high volume consumers have their dual check valve meters changed every 12 months	2	4	High	▪ Weekly chlorine residual testing in reticulation ▪ Monthly bacto test	POSSIBLE CAUSES: rainwater tanks, private bores, stock troughs, water carters, failure of transmission pumps, water hammer, hydrant usage, etc. High risk areas incl. schools, abattoirs, hospital Meter replacement program: old meters are progressively replaced with dual check valve meters. GWCC inspect RPZs that they require to be installed but sub-contracted plumbers inspect RPZs on the consumer side. Not all GWCC standpipes have BFPD - only a lay-flat hose. GWCC do not have a register of water carters operating within the area. REC: GWCC to consider installing backflow prevention devices (BFPD) on all rural property connections, as recommended by DPI Water. REC: GWCC to comply with AS/NZS 3500 as per DPI Water recommendation REC: GWCC to consider conducting a community education program on backflow prevention. REC: GWCC to liaise with Councils in Oura distribution to ensure concurrence with all DA. REC: GWCC to install appropriate BFPD on all standpipes e.g. RPZs REC: GWCC to develop a register for water carters and investigate options for electronic card systems on standpipes to record water carter access. REC: GWCC to consider developing and maintaining a register of RPZs within distribution system. Once a register has been developed, it is recommended that GWCC implement a BFPD inspection schedule for all high risk connections including hospitals, schools, rural properties, etc.

Hazardous event	Maximum Risk with no Preventive Measures			Preventive Measures	Residual Risk with Preventive Measures			Monitoring	Notes
Aesthetic Issues - taste, odour, colour									
Dead ends in reticulation system leading to stagnation (aesthetic impacts)	2	2	Low	Reactive maintenance - flushing	2	2	Low		Less than 20 dead ends in the Mt Daylight system

11 APPENDIX B CRITICAL CONTROL POINTS

11.1 Version Control

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	Issued as part of 2015 DWMS	HydoScience	1.0	November 2015
	Issued to Geoffrey Veneris (GWCC), Tony Burns (NSW Health PHU) and Bernie Barnes (DPI Water)	Atom Consulting	2.0	March 2017
Current version authors:	Natalie Crawford (Atom Consulting), Annalisa Contos (Atom Consulting)			
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11.2 Amendment Summary

A summary of the changes made to critical control points is shown in table 1.

Table 1. Critical and operational control point summary of changes

Version	System	CCPs
Version 2.0 March 2017	Jugiong	All CCPs – Added table at beginning of each CCP documenting, what is being measured; where/how it measured; what is the control point and what are the hazards.
		CCP1 Extraction Management - Protocols updated to reflect onsite practices.
		CCP2 Filtration - Protocols updated to reflect onsite practices.
		CCP3 Disinfection - Protocols updated to reflect onsite practices.
		CCP4 Fluoridation - Adjustment limit amended to < 0.95 mg/L or > 1.05 mg/L from <0.9 mg/Lor > 1.2 mg/L. Protocols updated to reflect onsite practices.
		CCP 5 pH adjustment - changed to an operational control point OCP1 pH adjustment. Protocols updated to reflect onsite practices.
		CCP 5 Reservoir integrity – Changed from CCP6 Reservoir integrity. Protocols updated to reflect onsite practices.
		CCP 6 Secondary disinfection – changed from CCP 7 Secondary disinfection. Protocols updated to reflect onsite practices.
	Oura	All CCPs – Added table at beginning of each CCP documenting, what is being measured; where/how it measured; what is the control point and what are the hazards.
		CCP 1 Disinfection – Target limit 0.4 mg/L changed to 0.5 mg/L. Protocols updated to reflect onsite practices.
		CCP2 Fluoridation - Protocols updated to reflect onsite practices.
		CCP3 Reservoir integrity - Protocols updated to reflect onsite practices.
		CCP4 Secondary disinfection – Combined CCP4 and CCP5 Secondary disinfection for Wyalong and Thanowring.

	Mt Arthur	All CCPs – Added table at beginning of each CCP documenting, what is being measured; where/how it measured; what is the control point and what are the hazards.
		CCP1 Disinfection - Protocols updated to reflect onsite practices.
		CCP2 Reservoir integrity - Protocols updated to reflect onsite practices.
	Mt Daylight	All CCPs – Added table at beginning of each CCP documenting, what is being measured; where/how it measured; what is the control point and what are the hazards.
		CCP1 Disinfection - Protocols updated to reflect onsite practices.
		CCP2 Reservoir integrity - Protocols updated to reflect onsite practices.

11.3 Jugiong Critical Control Points

The critical parameters for the safe management of the Jugiong water supply system are shown below and should be displayed at Jugiong WTP.

Target Criteria	This is where you should be operating. Aim to keep the system operating at this value.
Adjustment Limit	If you reach this limit, refer to CCP management sheet and try to get back to the operational target. Increase monitoring until returned to normal.
Critical Limit	If you reach this limit, you have lost control of your system. Refer to CCP management sheet and try to return to operational target as a matter of urgency.

11.3.1 CCP1 Extraction Management

What is being measured?	Turbidity (continuous online)
Where/how is it measured?	Raw water
What is the control point?	Raw water extraction point
What are the hazards?	Turbidity, pathogens

TARGET Operator Set Point (SP)	CRITICAL 20% above SP for > 20 min
▪ Check SCADA daily and respond accordingly to all alarms ▪ Record all observations and monitoring results in diary ▪ Daily (if running): o Visual plant inspection o Visual inspection of river level (river gauge) o Check weather forecast o Manual sampling of raw water and testing for turbidity o Cross-check online and manual turbidity meters o Jar testing on raw water and adjust chemical dosing as required o Change raw water turbidity set point (SP) based on jar testing results o Check email and phone for any notification sent by State Water of releases from Burrinjuck Dam	▪ Plant will automatically shut down when the critical limit is reached and call operator on duty ▪ Perform jar tests using samples of river water to determine appropriate chemical dose and adjust dosing as required ▪ Notify Water Quality Coordinator and Manager Production Services if raw water quality is not treatable to an acceptable standard and if treated water storages are low ▪ Increase monitoring until system conforms ▪ Prior to restarting raw water extraction, assess the raw water quality and treated water storage levels. Consider ceasing pumping until raw water quality improves

11.3.2 CCP2 Filtration

What is being measured?	Turbidity (Continuous Online)
Where/how is it measured?	Common filter outlet
What is the control point?	Filters
What are the hazards?	Pathogens, turbidity

TARGET ≤ 0.2 NTU	ALERT ≥ 0.5 NTU	CRITICAL ≥ 1.0 NTU
Check SCADA daily and respond accordingly to all alarms Record all observations and monitoring results in diary Daily (if running): o Visual plant inspection o Inspect all plant processes (coagulation, flocculation, clarification, filtration, disinfection) o Manual sampling at common filter outlet and testing of turbidity o Cross-check handheld turbidity meter with online analyser o Check all chemical dosing systems Clean raw water turbidity meter every three weeks Clean filtered water turbidity meter monthly Twice yearly cleaning of filters - drain, clean and disinfect Perform scheduled preventative maintenance	Record all observations, monitoring results and operational changes in plant diary Repeat operational checks Check the coagulation, flocculation, clarification performance Check chemical dosing systems: o Check for blockages, leaks o Check chemical storage levels o Check polymer concentration in poly maturation tank o Drop tests and adjust dosing as required o Refer to past records for chemical dosage guide Notify and seek assistance from supervisor Perform jar tests and adjust dosing as required (note: use polymer in maturation tank for jar tests) Perform visual and handheld turbidity tests on individual filter outlets to determine if it is a common problem. o If it is one filter that is underperforming, isolate the filter and initiate a backwash o If it is a common issue, investigate raw water quality and prior plant processes ▪ Increase monitoring	Notify supervisor and manager as per Goldenfields Water communication protocols Automatic plant shut down on alarm Consider dumping filter water Repeat corrective actions from alert level If issue is not resolved and water needs to be distributed to keep up with demand: o Notify NSW Health DPI Water as per Goldenfields Water communication protocol o Notify bulk water councils as per Goldenfields Water communication protocol Troubleshoot problem and implement corrective actions as appropriate Increase monitoring

11.3.3 CCP3 Disinfection

What is being measured?	Free chlorine residual (Continuous Online & alarmed)
Where/how is it measured?	Finished water
What is the control point?	Chlorine dosing system
What are the hazards?	Chlorine sensitive pathogens

TARGET	ALERT	CRITICAL
1.8 mg/L	≤ 1.2 mg/L or ≥ 2.0 mg/L	Summer: ≤ 0.8 mg/L for > 30 mins or ≥ 5.0 mg/L Winter: ≤ 0.5 mg/L for > 30 mins or ≥ 5.0 mg/L
▪ Check SCADA daily and respond accordingly to all alarms ▪ Record all observations and monitoring results in diary ▪ Daily (if running): o Visual plant inspection o Manual sampling and testing of finished water free chlorine o Check chlorine dosing system: ▫ Check for blockages, leaks (head unit, injector) ▫ Check chemical storage levels (scales and spare tanks) ▫ Check heater is operational ▪ 1 - 3 times weekly manual free chlorine test in reticulation undertaken by distributions team ▪ Chlorine delivery every 3 weeks ▪ Monthly bacto sampling in reservoirs ▪ Annual servicing of online chlorine analysers	▪ Record all observations and monitoring results in plant diary ▪ Record all operational changes in plant diary ▪ Repeat chlorine dosing system checks ▪ Retest for chlorine ▪ Adjusting chlorine dose ▪ Change dosing point (pre-or mid) ▪ Retest for chlorine ▪ Increase pH, turbidity, total and free chlorine monitoring at No. 2 and Cowangs Reservoirs ▪ Perform drop test and adjust dose as required ▪ Increase monitoring ▪ Notify and seek assistance from supervisor	▪ Automatic plant shut down at critical limit ▪ Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health if free chlorine is < 0.2 mg/L or > 5 mg/L and water has been supplied as per Goldenfields Water communication protocols ▪ Repeat corrective actions from alert level ▪ Increase sampling and testing until at plant, in reservoirs and reticulation. ▪ Record all sampling results ▪ If chlorine residual < 0.5 mg/L o Manually topping up chlorine at reservoirs o Increasing chlorine dose at secondary disinfection units ▪ Troubleshoot problem and implement corrective actions as appropriate ▪ Increase monitoring

11.3.4 CCP4 Fluoridation

What is being measured?	Fluoride daily
Where/how is it measured?	Finished water
What is the control point?	Fluoride dosing point
What are the hazards?	Fluoride overdosing and underdosing

TARGET 1.0 mg/L	ALERT < 0.95 mg/L or > 1.05 mg/L	CRITICAL < 0.9 mg/L for > 72 hr or > 1.5 mg/L
▪ Check SCADA daily and respond accordingly to all alarms ▪ Record all observations and monitoring results in diary ▪ Daily (if running): o Visual plant inspection o Manual sampling and testing of raw water fluoride o Manual sampling and testing of treated water fluoride o Complete Form 3 o Check fluoride dosing system: ▫ Check for blockages, leaks ▫ Check chemical storage levels ▫ Check heater operational in fluoride dosing room ▪ Test twice weekly fluoride samples from the reticulation ▪ Monthly: o Perform drop test and adjust dose as required o Clean fluoride hopper	▪ Record all observations and monitoring results in plant diary ▪ Record all operational changes in plant diary ▪ Re-test fluoride ▪ Re-calibrate fluoride probe ▪ Leave to next day, retest fluoride ▪ Confirm daily checks and operational inspections ▪ Allow for changing raw water conditions ▪ Seek assistance from supervisor ▪ Adjust fluoride dose as required ▪ Increase monitoring until	▪ Notify: o General Manager o Supervisor and manager o NSW Health o DPI Water as per Goldenfields Water communication protocols ▪ Shut down fluoride dosing system immediately ▪ Consider dumping fluoride tank and affected pipeline ▪ Follow NSW Health response protocol in the Code of Practice for the Fluoridation of Public Water Supplies ▪ Repeat corrective actions from alert level ▪ If ≥ 1.5 mg/L, notify bulk water councils as per Goldenfields Water communication protocols ▪ Troubleshoot problem and implement corrective actions as appropriate ▪ Increase monitoring

11.3.5 OCP1 PH Adjustment

What is being measured?	pH Daily
Where/how is it measured?	Finished water
What is the control point?	Soda ash dosing system

TARGET 7.4	ALERT ≤ 7.2 or ≥ 7.8	CRITICAL 1 ≤ 7.0 or ≥ 8.0
Check SCADA daily respond accordingly to all alarms Record all observations and monitoring results in plant diary Daily (if running): o Visual plant inspection o Manual sampling at finished water and testing for pH o Check soda ash dosing system, if running: ▪ Dosing point to ensure dosing is occurring ▪ Water hardness and ensure water softening system is working ▪ Leaks and blockages (soda ash and water softening units) Weekly: o Visual plant inspection o Calibrate pH meter o Perform drop tests and adjust dose as required o Alternate duty soda ash hoppers o Check level of soda ash and re-order if < 25%	Record all observations and monitoring results in plant diary ▪ Record all operational changes in plant diary Adjust soda ash Retest and wait for one day ▪ Seek assistance from supervisor ▪ Redo soda ash dosing system checks ▪ Undertake drop tests and adjust dose as required o Refer to past records for chemical dosage guide ▪ Perform jar testing and adjust dosing as required ▪ Re-calibrate pH meter ▪ Increase monitoring	▪ Notify: o General Manager o Supervisor and manager ▪ Repeat corrective actions from alert level ▪ Shut down plant ▪ Troubleshoot problem and implement corrective actions as appropriate

11.3.6 CCP5 Reservoir Integrity

What is being measured?	System integrity (monthly)
Where/how is it measured?	Visual inspection of the reservoirs
What is the control point?	Distribution reservoirs
What are the hazards?	Pathogens

TARGET	ALERT	CRITICAL
Secure, no evidence of break or vermin	**Visual identification of breach or vermin access to reservoir**	**Visual identification of vermin or contaminant in reservoir**
▪ Monthly: o Visual inspection of reservoirs ▫ Check hatches, corrugation, fences, locks o Free chlorine testing at all reservoirs. If there is an unusually high chlorine demand, investigate further o Reservoir roof inspections	▪ Notify supervisor and workshop manager as per Goldenfields Water communication protocols ▪ If possible and safe to do so, take immediate action to rectify breach ▪ If unable to immediately repair, action is to be taken within two working days ▪ Check chlorine residual in reservoir and reticulation ▪ Perform bacto test in reservoir ▪ If chlorine residual in reservoir or reticulation is inadequate, consider manually adding chlorine ▪ Increase monitoring of chlorine residual in reservoir and reticulation until system conform	▪ Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health as per Goldenfields Water communication protocols ▪ Repeat corrective actions from alert level ▪ If possible and safe to do so, take immediate action to remove contaminant ▪ Consider taking reservoir offline: o isolate and bypass tank (if possible) o empty tank o clean tank o fill and super chlorinate ▪ In consultation with NSW Health, consider the possibility of issuing a boil water alert ▪ Increase monitoring until system conforms

11.3.7 CCP6 Secondary Disinfection

What is being measured?	Free chlorine residual (online continuous, alarmed)
Where/how is it measured?	Prunevale Pump station and Cootamundra Depot
What is the control point?	Chlorine dosing system
What are the hazards?	Chlorine sensitive pathogens

TARGET 0.8 mg/L	ALERT ≤ 0.5 mg/L or ≥ 2.0 mg/L	CRITICAL ≤ 0.2 mg/L or ≥ 5.0 mg/L
Note: Secondary disinfection units located at Demondrille. The online analyser is located at Prunevale PS. These levels apply to the reading at the online analyser. ▪ Check SCADA daily and respond accordingly to all alarms ▪ Record all observations, monitoring results and free chlorine result in diary ▪ Weekly: o Manual free chlorine sampling and testing at secondary disinfection units and in reticulation o Calibrate online analysers at Prunevale PS and Cootamundra depot o Check chlorine dosing system: o Check for blockages, leaks (injector, head unit) o Check chemical storage levels (scales and spare tanks) o Check heater operational in chlorine dosing room ▪ Cross-check handheld and online chlorine analyser ▪ 1 - 3 times weekly manual free chlorine test in reticulation undertaken by distributions team	Record all observations and monitoring results in plant diary Record all operational changes in diary Seek assistance from supervisor Check pump run time. If pump has just started (running < 30 min): Wait for 30 min for free chlorine to increase. If pump has been running > 30 min: o Increase chlorine dosing and test free chlorine at sample points that have > 30 min chlorine contact time Repeat secondary chlorine dosing system checks	▪ Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health if problem persists more than 24 hr and pumping needs to resume as per Goldenfields Water communication protocols ▪ Repeat corrective actions from alert level ▪ Manually dose reservoirs with chlorine ▪ Stop pumping ▪ Troubleshoot problem and implement corrective actions as appropriate o Investigate cause of low chlorine - from source or particular reservoirs? ▪ Increase monitoring of upstream and downstream free chlorine until system conform

11.4 Oura Critical Control Points

The critical parameters for the safe management of the Oura water supply system are shown below and should be displayed onsite.

Target Criteria	This is where you should be operating. Aim to keep the system operating at this value.
Adjustment Limit	If you reach this limit, refer to CCP management sheet and try to get back to the operational target. Increase monitoring until returned to normal.
Critical Limit	If you reach this limit, you have lost control of your system. Refer to CCP management sheet and try to return to operational target as a matter of urgency.

11.4.1 CCP1 Disinfection

What is being measured?	Free chlorine residual (daily)
Where/how is it measured?	Treated water, daily manual test
What is the control point?	Chlorine dosing system
What are the hazards?	Chlorine sensitive pathogens

TARGET 0.5 mg/L	ALERT ≤ 0.3 mg/L or ≥ 1.0 mg/L	CRITICAL ≤ 0.2 mg/L or ≥ 5.0 mg/L
▪ Daily chlorine residual test ▪ Record all observations and monitoring results in diary ▪ Daily (if running): o Check chlorine dosing system: ▫ Check for blockages, leaks (injector, head unit) ▫ Check chemical storage levels (scales and spare tanks) o Suspended solids (pad) test ▪ pH test 3 times weekly (treated and raw water) ▪ Weekly turbidity testing in reticulation ▪ Chlorine delivery every 3 weeks ▪ Monthly bacto sampling in reservoirs	▪ Record all observations and monitoring results in diary ▪ Record all operational changes in plant diary ▪ Redo chlorine dosing system checks ▪ Retest chlorine residual ▪ Review previous water quality data Seek assistance from supervisor ▪ In consultation with supervisor, consider: ▪ Manually topping up chlorine at reservoirs ▪ Adjusting flow rate ▪ Adjusting chlorine dose or feed point ▪ Sample for pH, turbidity, total and free chlorine monitoring along Junee pipeline and at Junee BT	▪ Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health if ≤ 0.2 mg/L or > 5 mg/L as per Goldenfields Water communication protocols and water has been supplied ▪ Cease pumping ▪ Test free chlorine in: o Junee BT o Distribution pipelines to track flow of low residual water o Record all monitoring results ▪ Repeat corrective actions from alert level ▪ Increase chlorine dose at secondary disinfection units ▪ Troubleshoot problem and implement corrective actions as appropriate ▪ Increase monitoring ▪ Develop incident plan

11.4.2 CCP2 Fluoridation

What is being measured?	Fluoride (daily)
Where/how is it measured?	Treated water, daily manual test
What is the control point?	Fluoride dosing
What are the hazards?	Fluoride overdosing and underdosing

TARGET	ALERT	CRITICAL
1.0 mg/L	**< 0.9 mg/L or > 1.2 mg/L**	**< 0.9 mg/L for > 72 hr or ≥ 1.5 mg/L**
Daily fluoride test Record all observations and monitoring results in diary Daily (if running): o Visual plant inspection o Manual sampling and testing of raw water fluoride o Manual sampling and testing of treated water fluoride o Complete Form 3 o Check fluoride dosing system: ▫ Check for blockages, leaks ▫ Check chemical storage levels ▫ Check heater operational in fluoride dosing room Twice weekly fluoride testing in reticulation Monthly: o Perform drop test and adjust dose as required o Clean fluoride hopper	Record all observations and monitoring results in plant diary Record all operational changes in plant diary Seek assistance from supervisor Re-calibrate fluoride probe Re-test fluoride (raw and finished water) Check fluoride dosing system: o Check for blockages, leaks o Check for clumping in fluoride hopper o Check chemical storage levels o Check heater operational in fluoride dosing room Perform drop test and adjust dose as required Increase monitoring	Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health as per Goldenfields Water communication protocols Shut down fluoride dosing system immediately Consider dumping fluoride tank and affected pipeline Follow NSW Health response protocol in the Code of Practice for the Fluoridation of Public Water Supplies Repeat corrective actions from alert level If ≥ 1.5 mg/L, notify bulk water councils as per Goldenfields Water communication protocols Troubleshoot problem and implement corrective actions as appropriate Increase monitoring

11.4.3 CCP3 Reservoir Integrity

What is being measured?	System integrity (monthly)
Where/how is it measured?	Visual inspection of the reservoirs
What is the control point?	Distribution reservoirs
What are the hazards?	Pathogens

TARGET	ALERT	CRITICAL
Secure, no evidence of break or vermin	**Visual identification of breach or vermin access to reservoir**	**Visual identification of vermin or contaminant in reservoir**
▪ Monthly: o Visual inspection of reservoirs ▫ Check hatches, corrugation, fences, locks o Free chlorine testing at all reservoirs. If there is an unusually high chlorine demand, investigate further o Reservoir roof inspections	▪ Notify supervisor and workshop manager ▪ If possible and safe to do so, take immediate action to rectify breach ▪ If unable to immediately repair, action is to be taken within two working days ▪ Check chlorine residual in reservoir and reticulation ▪ Perform bacto test in reservoir ▪ If chlorine residual in reservoir or reticulation is inadequate, consider manually adding chlorine ▪ Increase monitoring of chlorine residual in reservoir and reticulation	▪ Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health as per Goldenfields Water communication protocols ▪ Repeat corrective actions from alert level ▪ If possible and safe to do so, take immediate action to remove contaminant ▪ Consider taking reservoir offline: o isolate and bypass tank (if possible) o empty tank o clean tank o fill and super chlorinate ▪ In consultation with NSW Health, consider the possibility of issuing a boil water alert ▪ Increase monitoring

11.4.4 CCP4 Secondary Disinfection

What is being measured?	Chlorine residual (weekly)
Where/how is it measured?	Wyalong and Thanowring, weekly manual test
What is the control point?	Secondary chlorine dosing system
What are the hazards?	Chlorine sensitive pathogens

TARGET 0.5 mg/L	ALERT ≤ 0.35 mg/L	CRITICAL ≤ 0.25 mg/L
▪ Test for chlorine residual ▪ Record all observations, monitoring results and free chlorine result in diary ▪ Weekly: o Manual free chlorine sampling and testing at secondary disinfection unit and in reticulation (flush line for 5 min prior to taking sample) o Check chlorine dosing system: ▫ Check for blockages, leaks (injector, head unit) ▫ Check chemical storage levels (spare tanks) ▫ Check heater operational in chlorine dosing room	Record all observations and monitoring results in diary Record all operational changes in diary Seek assistance from supervisor Redo chlorine dosing system checks Perform chlorine residual testing progressively along reticulation system to determine the extent of low residual water Perform pH, turbidity and total chlorine testing in reticulation	Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health if < 0.2 mg/L or > 5 mg/L as per Goldenfields Water communication protocols Repeat corrective actions from alert level Manually dose reservoirs with chlorine until residual of 0.5 mg/L is detected in the reservoir Stop pumping Perform bacto test in reservoir if < 0.1 mg/L free chlorine In consultation with supervisor and manager, consider emptying, cleaning and refilling reservoir Troubleshoot problem and implement corrective actions as appropriate Increase monitoring free chlorine until system conforms

11.5 Mt Arthur Critical Control Points

The critical parameters for the safe management of the Mt Arthur water supply system are shown below and should be displayed onsite.

Target Criteria	This is where you should be operating. Aim to keep the system operating at this value.
Adjustment Limit	If you reach this limit, refer to CCP management sheet and try to get back to the operational target. Increase monitoring until returned to normal.
Critical Limit	If you reach this limit, you have lost control of your system. Refer to CCP management sheet and try to return to operational target as a matter of urgency.

11.5.1 CCP1 Disinfection

What is being measured?	Free chlorine residual (3 x weekly)
Where/how is it measured?	Tank 4 outlet
What is the control point?	Chlorine dosing system
What are the hazards?	Chlorine sensitive pathogens

TARGET 0.8 mg/L	ALERT ≤ 0.5 mg/L or ≥ 2.0 mg/L	CRITICAL ≤ 0.3 mg/L or ≥ 5.0 mg/L
▪ Test chlorine residual 3 x weekly ▪ Record all observations and monitoring results in diary ▪ 3 x Weekly: o Check chlorine dosing system: ▫ Check for blockages, leaks (injector, head unit) ▫ Check chemical storage levels (spare tanks) ▫ Check heater operational in chlorine dosing room o Manual chlorine residual testing in reticulation ▪ Chlorine delivery	▪ Record all observations and monitoring results in monthly testing report ▪ Record all operational changes in plant diary ▪ Seek assistance from supervisor ▪ Cease pumping until system conforms ▪ Check chlorine dosing system: o Check for blockages, leaks (injector, head unit) o Check chemical storage levels (spare tanks) o Check heater operational in chlorine dosing room o Adjust flow rate, dose rate or feed point o Perform pH, turbidity, total and free chlorine testing in reticulation o Increase monitoring	▪ Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health if ≤ 0.2 mg/L or > 5 mg/L if water supplied as per Goldenfields Water communication protocols ▪ Cease pumping until system conforms ▪ Manually dose reservoirs with chlorine until residual of 0.5 mg/L is detected in the reservoir ▪ Perform bacto test in reservoir if < 0.1 mg/L free chlorine ▪ Repeat corrective actions from alert level ▪ Troubleshoot problem and implement corrective actions as appropriate ▪ Increase monitoring

11.5.2 CCP2 Reservoir Integrity

What is being measured?	System integrity (monthly)
Where/how is it measured?	Visual inspection of the reservoirs
What is the control point?	Distribution reservoirs
What are the hazards?	Pathogens

TARGET	ALERT	CRITICAL
Secure, no evidence of break or vermin	**Visual identification of breach or vermin access to reservoir**	**Visual identification of vermin or contaminant in reservoir**
▪ Monthly: o Visual inspection of reservoirs ▫ Check hatches, corrugation, fences, locks o Free chlorine testing at all reservoirs. If there is an unusually high chlorine demand, investigate further o Reservoir roof inspections	▪ Notify supervisor and workshop manager as per Goldenfields Water communication protocols ▪ If possible and safe to do so, take immediate action to rectify breach ▪ If unable to immediately repair, action is to be taken within two working days ▪ Check chlorine residual in reservoir and reticulation ▪ Perform bacto test in reservoir ▪ If chlorine residual in reservoir or reticulation is inadequate, consider manually adding chlorine ▪ Increase monitoring of chlorine residual in reservoir and reticulation	▪ Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health as per Goldenfields Water communication protocols ▪ Repeat corrective actions from alert level ▪ If possible and safe to do so, take immediate action to remove contaminant ▪ Consider taking reservoir offline: o isolate and bypass tank (if possible) o empty tank o clean tank o fill and super chlorinate ▪ In consultation with NSW Health, consider the possibility of issuing a boil water alert ▪ Increase monitoring

11.6 Mt Daylight Critical Control Points

The critical parameters for the safe management of the Mt Daylight water supply system are shown below and should be displayed onsite.

Target Criteria	This is where you should be operating. Aim to keep the system operating at this value.
Adjustment Limit	If you reach this limit, refer to CCP management sheet and try to get back to the operational target. Increase monitoring until returned to normal.
Critical Limit	If you reach this limit, you have lost control of your system. Refer to CCP management sheet and try to return to operational target as a matter of urgency.

11.6.1 CCP1 Disinfection

What is being measured?	Free chlorine residual (continuous online)
Where/how is it measured?	Naradhan Reservoir
What is the control point?	Chlorine dosing system
What are the hazards?	Chlorine sensitive pathogens

TARGET 0.8 mg/L	ALERT ≤ 0.5 mg/L or ≥ 2.0 mg/L	CRITICAL ≤ 0.3 mg/L or ≥ 5.0 mg/L
▪ Check SDADA daily and respond accordingly to all alarms ▪ Record all observations and monitoring results in diary ▪ Weekly: o Check chlorine dosing system: ▫ Check for blockages, leaks (injector, head unit) ▫ Check chemical storage levels (spare tanks) ▫ Check heater operational in chlorine dosing room ▫ Cross-check hand held and online chlorine analysers o Calibrate online chlorine analyser o Manual chlorine residual testing in reticulation ▪ Chlorine delivery ▪ Monthly bacto sampling in reservoirs	▪ Record all observations and monitoring results in diary ▪ Record all operational changes in plant diary ▪ Duty operator will be notified by telemetry if alert limit is reached o Duty officer to respond to alarm as soon as practicable ▪ Seek assistance from supervisor ▪ Cease pumping until system conforms ▪ Check chlorine dosing system: o Check for blockages, leaks (injector, head unit) o Check chemical storage levels (scales and spare tanks) o Check heater operational in chlorine dosing room o Cross-check handheld and online chlorine analysers o Adjust flow rate dose rate or feed point	▪ Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health if problem persists and pumping needs to resume as per Goldenfields Water communication protocols ▪ Cease pumping if water storage level is sufficient ▪ Manually dose reservoirs with chlorine until residual of 0.5 mg/L is detected in the reservoir ▪ Perform free chlorine and bacto test in reservoir ▪ Repeat corrective actions from alert level ▪ Troubleshoot problem and implement corrective actions as appropriate ▪ Increase monitoring

11.6.2 Reservoir Integrity

What is being measured?	System integrity (monthly)
Where/how is it measured?	Visual inspection of the reservoirs
What is the control point?	Distribution reservoirs
What are the hazards?	Pathogens

TARGET	ALERT	CRITICAL
Secure, no evidence of break or vermin	**Visual identification of breach or vermin access to reservoir**	**Visual identification of vermin or contaminant in reservoir**
▪ Monthly: o Visual inspection of reservoirs ▫ Check hatches, corrugation, fences, locks o Free chlorine testing at all reservoirs. If there is an unusually high chlorine demand, investigate further o Reservoir roof inspections	▪ Notify supervisor and workshop manager as per Goldenfields Water communication protocols ▪ If possible and safe to do so, take immediate action to rectify breach ▪ If unable to immediately repair, action is to be taken within two working days ▪ Check chlorine residual in reservoir and reticulation ▪ Perform bacto test in reservoir ▪ If chlorine residual in reservoir or reticulation is inadequate, consider manually adding chlorine ▪ Increase monitoring of chlorine residual in reservoir and reticulation	▪ Notify: o General Manager o Supervisor and manager o DPI Water o NSW Health as per Goldenfields Water communication protocols ▪ Repeat corrective actions from alert level ▪ If possible and safe to do so, take immediate action to remove contaminant ▪ Consider taking reservoir offline: o isolate and bypass tank (if possible) o empty tank o clean tank o fill and super chlorinate ▪ In consultation with NSW Health, consider the possibility of issuing a boil water alert ▪ Increase monitoring

12 APPENDIX C ACTION AND IMPROVEMENT PLAN

No.	Action	Type	Status	Date completed/ closed	Comments	Priority	Responsibility	Action reference
1	GWCC to consider installing an online free chlorine analyser at Oura disinfection point (after 30 min contact time).	Capital works	In progress		25/11/2016 - 9 analysers purchased. As Oura is not disinfecting for primary kill, the analyser should be located as close as practical to the disinfection point.	Very High	Manger Production and Services	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
2	GWCC to consider training staff in backflow prevention	Training	Complete	Sep-16				GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
3	GWCC to consider conducting internal training on chlorine residual testing	Training	Complete					GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
4	GWCC to conduct internal training (or refresher training) on correct sampling techniques	Training	In progress		25/11/2016 - Register needs to be updated to capture internal training completed			GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)

5	GWCC to consider conducting a community education program on backflow prevention	Community engagement	Closed	25-Nov	25/11/2016 - Action closed due to changed process. Refer to action 33 (implement backflow prevention program)		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
6	GWCC to conduct bacto sampling after storm event if visual check of bores show signs of being compromised	Monitoring	Closed	25-Nov	25/11/2016 - Action closed due to changed process. Refer to action 33 (implement backflow prevention program)	High	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
7	GWCC to install an online turbidity meter in Murrumbidgee River to predict water quality decline	Capital works	In progress		25/11/2016 - Turbidity meter purchased.		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
8	GWCC to roll out system of different levels of key access to increase security	Operations and maintenance	In progress		25/11/2016 - Keys purchased		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
9	GWCC to consider performing preventative maintenance on solenoid valves leading into fluoride batching tank	Operations and maintenance	Closed	25-Nov	25/11/2016 - Considered as part of maintenance	Medium	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
10	GWCC to check data entry to ensure no errors and record all incidents and causes of high readings (e.g. data entry error, human error, etc.)	Monitoring	In progress		25/11/2016 - In developing operational monitoring spreadsheet will review anomalies		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop

						(HydroScience, 2015)
11	GWCC to consider purchasing electronic chlorine analyser to eliminate manganese interference with chlorine residual testing as per DPI Water recommendation (e.g. chloro-sense kits)	Capital works	Complete	2014	25/11/2016 - One at Jugiong and one at Oura	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
12	GWCC to consider increasing monitoring of chlorine residual throughout system during power outages	Monitoring	Closed	25-Nov	25/11/2016 - Covered within incident management. 9 chlorine analysers to be installed	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
13	GWCC to consider installing online chlorine analysers at Oura PS	Capital works	In progress		25/11/2016 - analyser purchased	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
14	GWCC to develop a register for water carters	Procedures and documentation	In progress			GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
15	GWCC to develop and maintain a register of RPZs within distribution system	Procedures and documentation	Rolled into other action		To be completed as part of *Action33 Implement backflow prevention program*	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop

						(HydroScience, 2015)
16	GWCC to consider and investigate and install the most suitable BFPD on the connection between Oura and Hylands Bridge (e.g. RPZ, break tank with air gap, etc.)	Capital works	Not yet started		High	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
17	GWCC to ensure all hatches on reservoirs comply with AS/NZS	Operations and maintenance	Rolled into other action	To be completed as part of *Action 36 To complete and submit circular 18*		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
18	GWCC to implement a formal water quality monitoring regime at Mt Arthur to monitor pH, turbidity, free, and total chlorine	Monitoring	Rolled into other action	To be completed as part of *Action 37 Complete formal review of monitoring plan, against ADWG, NSW Health*		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
19	GWCC to implement a formal water quality monitoring regime at Mt Daylight to monitor pH, turbidity, free, and total chlorine	Monitoring	Rolled into other action	To be completed as part of *Action 37 Complete formal review of monitoring plan, against ADWG, NSW Health*		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
20	GWCC to install a backflow prevention device between the GWCC reservoir and the reservoir managed by Carathool Shire Council to protect water quality in the Mt Daylight drinking water supply	Capital works		25/11/2016 - Part of broader discussion on governance with Carathool Shire Council		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)

21	GWCC to consider purging reservoir as part of emergency response if contamination is suspected	Operations and maintenance	Closed	25/11/2016 - Considered as part of emergency procedures	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
22	GWCC to consider alarming all reservoir hatch doors in case of sabotage or vandalism. Mt Daylight reservoir is a priority, which is the most remote	Operations and maintenance	Closed	25/11/2016 - Been considered, but currently not practical. Managed with weekly and quarterly inspections.	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
23	GWCC to complete live chlorine monitoring system for reticulation system (in progress)	Capital works	In progress	25/11/2016 - analyser purchased	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
24	GWCC to consider developing SOP for fluoride hopper cleaning	Procedures and documentation	Not yet started		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
25	GWCC to consider developing SOPs for chlorine testing to include manganese interference with reagent	Procedures and documentation	Not yet started		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)

26	GWCC to develop SOPs for operational and supporting activities, such as plant operation, mains break repair, mains flushing, etc.	Procedures and documentation	Not yet started			GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
27	GWCC to include drinking water quality management in the annual report, as recommended in Element 10 of the ADWG	Procedures and documentation	Not yet started			GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
28	Educate community member that owns the private bore in close proximity to Oura Borefield to ensure they are aware that the bore accesses the drinking water aquifer	Community engagement	Closed	25/11/2016 - Refer to new action 38		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
29	GWCC to consider installing online chlorine residual analyser at outlet of settling tanks to ensure 30 minutes contact time (Mt Arthur system)	Capital works	In progress	25/11/2016 - Analyser purchased	Low	GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
30	GWCC to consider changing location of online chlorine analyser in the Mt Daylight system to ensure free chlorine measurement after 30 min contact time. Both the chlorine dosing and the chlorine analyser are located at the reservoir inlet	Capital works	In progress	Consider as part of analyser installation		GWCC DWMS Technical Note 2 Risk Assessment and Critical Control Point Workshop (HydroScience, 2015)
31	Determine the level of water quality training required for new staff and add to induction program	Training				Added as part of action and improvement plan review (25 November 2016)

32	Develop and implement competency checklist/schedule on sampling methodology	Training				Added as part of action and improvement plan review (25 November 2016)
33	Implement backflow prevention program, including developing register of RPZs	Capital works	In progress	25/11/2016 - Budget approved, project underway		Added as part of action and improvement plan review (25 November 2016)
34	Develop a microbiological sampling SOP when bore head integrity has been potentially compromised (maintenance, flooding, vandalism)	Procedures and documentation	In progress			Added as part of action and improvement plan review (25 November 2016)
35	Investigate options for electronic card systems on standpipes to record water carter access	Capital works	Not yet started			Added as part of action and improvement plan review (25 November 2016)
36	To complete and submit circular 18	Operations and maintenance	Not yet started			Added as part of action and improvement plan review (25 November 2016)
37	Complete formal review of monitoring plan, against ADWG, NSW Health	Monitoring	Not yet started			Added as part of action and improvement plan review (25 November 2016)
38	Investigate bore 5 private ownership and licensing, in liaison with DPI Water. Considering water quality contamination risks from bore	Investigative studies			High	Added as part of action and improvement plan review (25 November 2016)

39	Ensure bore 1 wellhead security e.g. secure gaps in casement	Capital works			Very High	Added as part of action and improvement plan review (25 November 2016)
40	Review operational monitoring data	Monitoring	In progress			Added as part of action and improvement plan review (25 November 2016)

13 APPENDIX D JUGIONG WATER SUPPLY SYSTEM

13.1 Version Control

Document Status:	Issued			
Document History:	**Status**	**Author**	**Version**	**Date**
	Included within 2015 DWMS	HydoScience	Version 1.0	November 2015
	Issued	Atom Consulting	Version 2.0	March 2017
Current version authors:	Natalie Crawford (Atom Consulting), Annalisa Contos (Atom Consulting)			
Contact:	Annalisa Contos Atom Consulting 65 Cambourne Avenue annalisa@atomconsulting.com.au			
File Name:	GWCC_Jugiong Water Supply System_v2.0.docx			

13.2 Amendment Summary

A summary of the changes made to the document is shown in **Table 13-1**.

Table 13-1. Summary of changes

Version	Date	CCPs
Version 2.0	March 2017	Process flow diagram updated following October 2016 site visit
		Water supply system information split into individual water supply system from November 2015 DWMS

13.3 Description

The Jugiong drinking water supply system is one of the largest water supply systems managed by Goldenfields Water. The majority of water produced in the Jugiong system supplies the bulk water Councils of Cootamundra, Harden and Young. Water is also delivered to a small number of retail customers in rural properties and the villages of Stockinbingal, Wallendbeen and Springdale. Approximately 18,000 people are supplied water from the Jugiong system.

13.4 Murrumbidgee River

Raw water for the Jugiong drinking water supply system is sourced from the Murrumbidgee River. Water is extracted adjacent to the town of Jugiong, which is located downstream of Burrinjuck Dam and upstream of the confluence with Tumut River. The majority of land within the Murrumbidgee catchment area is primarily used for grazing, with the exception of the Burrinjuck Dam catchment, which is composed of conservation and forestry practices. High risks from the catchments with the potential to introduce pathogenic micro-organisms into the water supply have been identified as:

- STP overflows, on site sewerage management systems in Jugiong township
- Flooding events, storm water flows, and high river events increasing turbidity in source, including water released from Burrinjuck Dam
- Unrestricted livestock and/or wildlife access to water supply catchment
- Rapid changes in raw water quality when water is extracted from different levels of Burrinjuck Dam

Multiple planning tools such as Local Environment Plans (LEPs) and communication with WaterNSW who control Burrinjuck Dam exist as a preventative measure. Goldenfields Water also has a raw water turbidity meter that can initiate a plant shut down based on a rapid rise in turbidity.

13.5 Source Water

Goldenfields Water is licenced to extract water from the Murrumbidgee River via two submersible pumps operated in a duty / stand-by configuration. The submersible pumps are fixed speed; pump 1 operates at 190 L/s and pump 2 operates at 290 L/s. The Murrumbidgee River extraction point is shown in Figure 4-1 and Figure 4.2

Figure 4.1 Murrumbidgee River Extraction Point

***Source**: Atom Consulting, taken October 2016*

Figure 4.2 Murrumbidgee River Extraction Point

***Source**: Atom Consulting, taken October 2016*

13.6 Water Treatment Process

The Jugiong Water Treatment Plant (WTP) is located on Waterworks Road in the township of Jugiong. The plant is a conventional WTP with a nominal capacity of 40 ML/day.

The treatment process at Jugiong WTP comprises of the following process steps:

- Water from the Murrumbidgee River is pumped via 120 m rising main to Jugiong WTP (capacity 40 ML/day) by two pumps in a duty/standby configuration
- Water passes through a flow meter, where a flow of greater than 101 L/s starts the chlorine and soda ash pre-dosing systems for oxidisation of metals and pH adjustment, respectively. The chlorine pre-dose is optional, and is switched on or off by the operator, depending on water quality conditions
- The pre-dosed water enters the rapid mix tank which consists of baffles and two mixers in series. Polymer and aluminium sulphate are dosed into the rapid mix tank to aid flocculation
- Water then flows into the two flocculation tanks which has three mixers in series operating at declining speeds to allow for floc formation
- Flocculated water then enters the two clarifiers and sludge is removed by a travelling sludge rake. Sludge is sent to the duty sludge lagoon
- Clarified water enters the filter block, where it is dosed with chlorine and subsequently distributed across six gravity sand filters
- Filtered water enters a common channel. When flow in the filtered water channel is above 101 L/s, post-dosing of soda ash and chlorine are activated for pH adjustment and increased disinfection capacity, respectively. Water is also dosed with fluoride in the filtered water channel
- Flow from the filtered water channel enters the 3 ML clear water tank through a mid-level inlet and bottom outlet configuration
- Water from the clear water tank proceeds to clear water pumping station 1 (CWPS1), which has two 680 kW pumps and a smaller 317 kW pump that operate in a duty/standby/standby mode. CWPS1 distributes water to Jugiong drinking water supply system

Figure 13-3 Jugiong Water Treatment Plant - Clarification

***Source**: Atom Consulting, taken October 2016*

Figure 13-4 Jugiong Water Treatment Plant - Filters

***Source**: Atom Consulting, taken October 2016*

Figure 13-5 Jugiong Water Treatment Plant – Chlorine drums

***Source**: Atom Consulting, taken October 2016*

Figure 13-6 Jugiong Water Treatment Plant – Clear water tank

***Source**: Atom Consulting, taken October 2016*

13.7 Water Distribution

The Jugiong drinking water supply system is the second largest distribution systems managed by Goldenfields Water. Treated water in the system is distributed to the towns and villages listed in table 14.2.

Treated water is distributed through 14 reservoirs and by 8 pumping stations. One of the challenges for Goldenfields Water is maintaining free chlorine in a long distribution system. There are 138 km of trunk mains and 182 km of reticulation mains in the Jugiong system. Mains breaks are recorded and Goldenfields Water uses this data to schedule maintenance and future mains replacement works. There are two chlorine booster pumping stations located near Cootamundra and Harden to ensure adequate free chlorine residual is maintained throughout the system.

Table 13-2 Towns and Villages Supplied by Jugiong Drinking Water Supply System

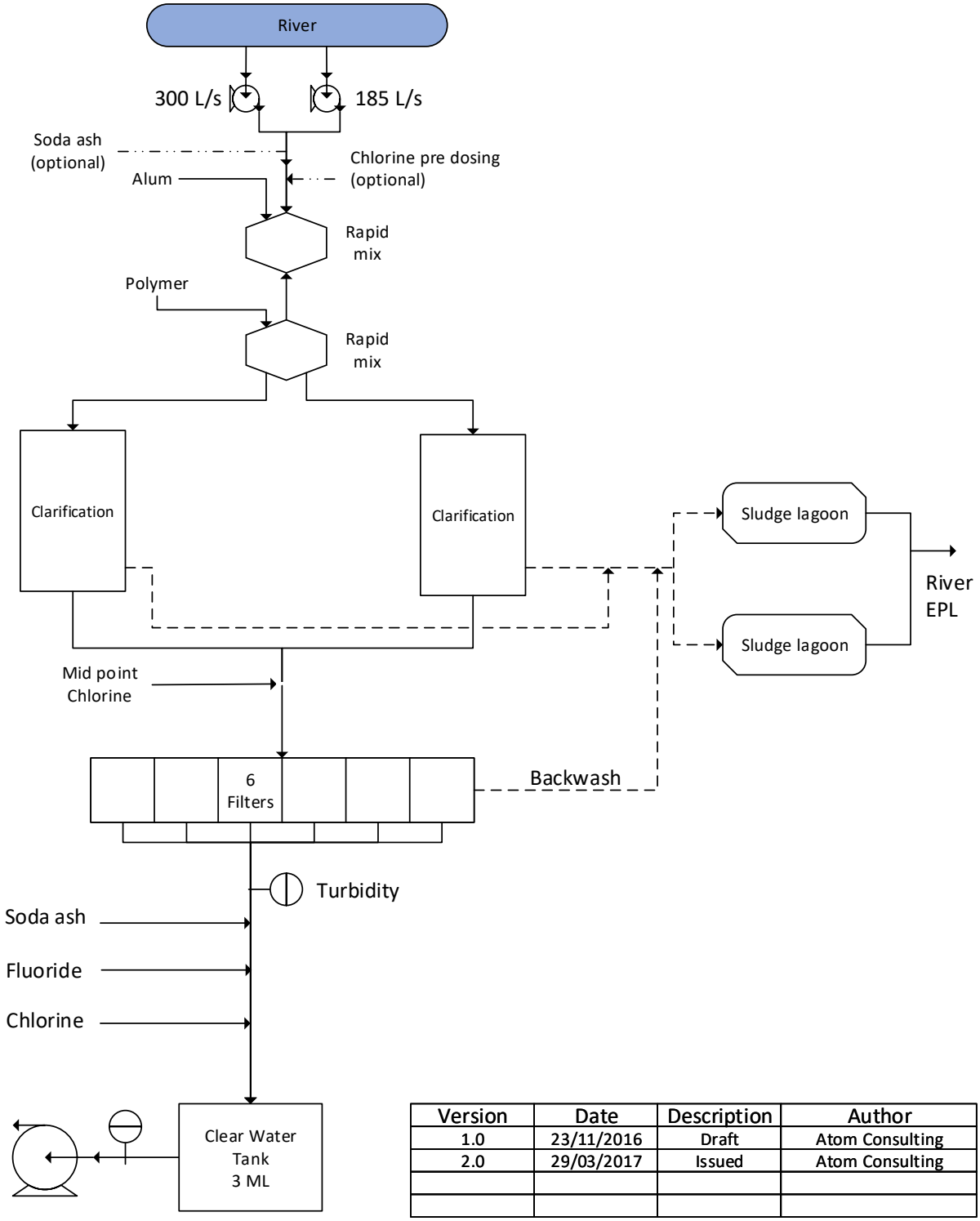
Town	Population Supplied
Cootamundra Shire Council	
Cootamundra	6,800
Stockinbingal	210
Wallendbeen	348
Harden Shire Council	
Jugiong	
Harden local government area	2,200
Temora Shire Council	
Springdale	
Young Shire Council	
Young local government area	8,000
Total population serviced	17,558

***Source**: HydroScience 2015*

13.8 Process Flow Diagrams

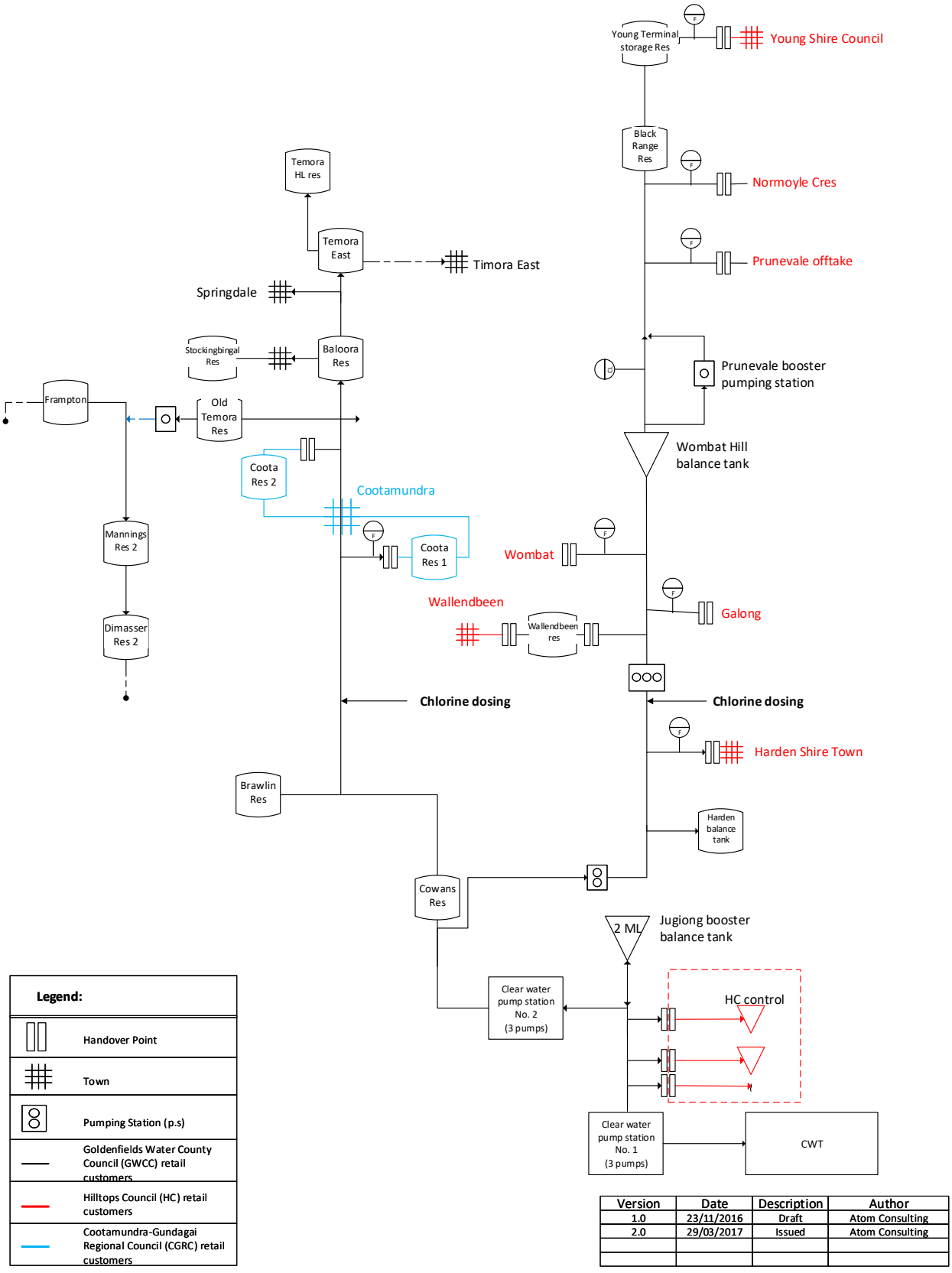
Figure 14.2 shows the process flow diagram of the Jugiong drinking water supply system from catchment to consumer.

Figure 13.2 Jugiong WTP process flow diagram



Version	Date	Description	Author
1.0	23/11/2016	Draft	Atom Consulting
2.0	29/03/2017	Issued	Atom Consulting

Figure 13.1 Jugiong Water Supply System



Version	Date	Description	Author
1.0	23/11/2016	Draft	Atom Consulting
2.0	29/03/2017	Issued	Atom Consulting

tem process flow diagram

13.9 References

HydroScience, 2015, *Goldenfields Water County Council Drinking Water Management System*, developed for Goldenfields Water County Council and NSW Health

NSW Office of Water (DPI Water), 2011, *Water Resources and Management Overview - Murrumbidgee Catchment*

14 APPENDIX E OURA WATER SUPPLY SYSTEM

14.1 Version Control

Document Status:	Issued			
Document History:	**Status**	**Author**	**Version**	**Date**
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Current version authors:	Natalie Crawford (Atom Consulting), Annalisa Contos (Atom Consulting)			
Contact:	Annalisa Contos Atom Consulting 65 Cambourne Avenue annalisa@atomconsulting.com.au			
File Name:	GWCC_Oura Water Supply System_v2.0.docx			

14.2 Amendment Summary

A summary of the changes made to the document is shown in **Table 14-1**.

Table 14-1. Critical and operational control point summary of changes

Version	Date	CCPs
Version 2.0	March 2017	Process flow diagram updated following October 2016 site visit
		Water supply system information split into individual water supply system from November 2015 DWMS

14.3 Description

The Oura drinking water supply system is one of the largest water supply systems managed by Goldenfields Water. The majority of water is delivered to retail customers; however, a small amount is supplied to Riverina Water in bulk to customers along the Goldenfields Water pipeline. Approximately 15,000 people are supplied water from the Oura system. The Oura drinking water supply system can be connected to Goldenfields Water's non-drinking water supply at Hylands Bridge.

14.4 Murrumbidgee Inland Alluvial Aquifer

Water in the Murrumbidgee Inland Alluvial Aquifer is recharged by the Murrumbidgee River and is managed by the mid Murrumbidgee alluvium groundwater management authority. There are two alluvial formations in this region: the Lachlan formation is a confined aquifer system that is overlain by the semi-confined to unconfined Cowra formation (NSW Dept. of Water and Energy, 2007). According to the DPI Water (NSW Office of Water, 2011), groundwater in the Oura system is fresh, with total dissolved solids (TDS) ranging from zero to 500 mg/L and is suitable for domestic stock, some irrigation purposes and municipal use.

14.5 Source water

Water is sourced from the Oura Borefield, which is located at Gumly Gumly Island to the north of Murrumbidgee River. Goldenfields Water is licensed to draw from four groundwater bores: Bore 2, Bore 3, Bore 4 and Bore 6. Bores are located in bore huts.

High catchment risks include pathogens entering the source water through surface water ingress, unrestricted livestock access and contamination due to seepage of pathogens from on-site sewerage management systems.

Figure 14-1 Oura bore

***Source**: Atom Consulting, photo taken October 2016*

14.6 Water Treatment Process

Water for the Oura drinking water supply system undergoes aeration, disinfection and fluoridation prior to distribution.

The treatment process for Oura drinking water supply system comprises of the following process steps:

- Groundwater is pumped from the Oura borefield by line shaft bore pumps in each bore. The bores are operated in sequential mode where increased water demand will increase the number of bores online. The order of bore start up is operator adjustable, with the current order of preference set as: Bore No. 4, 6 and 3
- The groundwater is dosed with chlorine prior to entering a tray aerator. The aerator serves to oxidate dissolved iron and manganese from the raw water
- After aeration, water is transferred to the Oura Contact Tank (2.2 ML), where chlorine contact time is achieved before being pumped by Oura pumping station to Marrar Pinnacle (Marrar Pinnacle 1.6 ML, 1 reservoir) or the Junee BT Reservoir (Junee 17 ML, 3 reservoirs)
- The Oura pumping station consists of two 605 kW pumps and a smaller 400 kW pump that operator on a duty/duty/standby configuration
- Fluoride is dosed on the outlet of the Oura pumping station

Figure 14-2 Oura aerators

***Source**; Atom Consulting, taken October 2015*

Figure 14-3 Oura chlorination

***Source**; Atom Consulting, taken October 2015*

14.7 Water Distribution

The Oura drinking water supply system is one of the largest distribution systems managed by Goldenfields Water. Treated water in the system is distributed to the towns and villages listed in table 12-2.

Treated water is distributed through 33 reservoirs and by 19 pumping stations. One of the challenges for Goldenfields Water is maintaining free chlorine in a long distribution system. There are 201 km of trunk mains and 1,055 km of reticulation mains in the Oura system. Mains breaks are recorded and Goldenfields Water uses this data to schedule maintenance and future mains replacement works. There are two chlorine booster pumping stations are located at Thanowring Road and Reefton pumping stations to ensure adequate free chlorine residual is maintained throughout the system.

Table 14-2 Towns and Villages Supplied by Jugiong Drinking Water Supply System

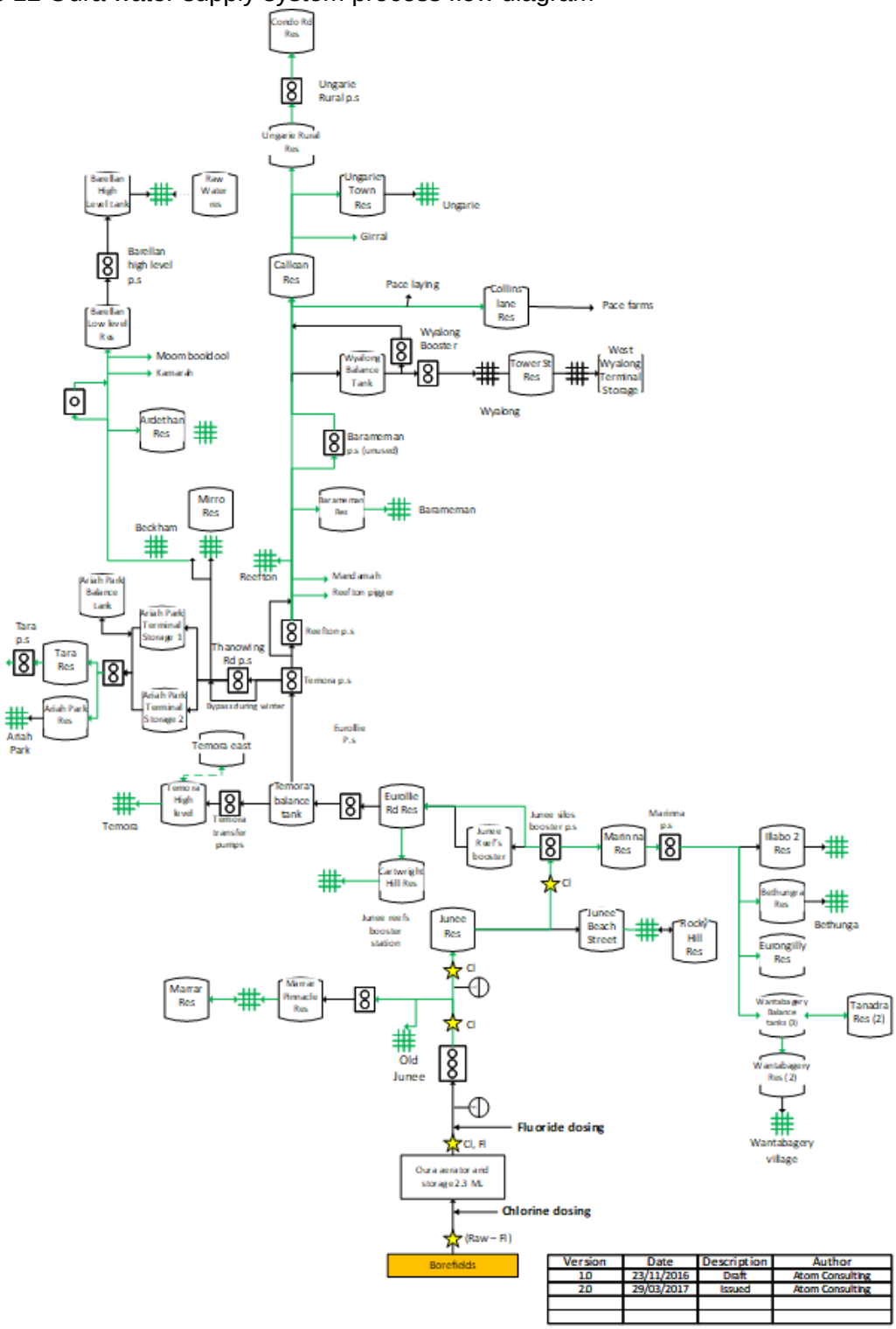
Town	Population Supplied	Bulk / Retail Water
Bland Shire Council		
Barmedman	214	Retail
Ungarie	378	Retail
West Wyalong	3,419	Retail
Wyalong	50	Retail
Coolamon Shire Council		
Ardlethan	438	Retail
Beckom		Retail
Marrar	162	Retail
Junee Shire Council		
Bethungra	80	Retail
Eurongilly		Retail
Illabo	60	Retail
Junee	4,000	Retail
Wantabadgery		Retail
Narranderra Shire Council		
Barellan	**392**	**Retail**
Temora Shire Council		
Ariah Park	400	Retail
Temora	5,000	Retail
Wagga Wagga City Council		
Rural customers located on Goldenfields water main		Bulk
Total population serviced	**14,596**	

Source: HydroScience 2015

14.8 Process Flow Diagram

Figure 12 shows the process flow diagram of the Oura drinking water supply system from catchment to consumer.

Figure 12 Oura water supply system process flow diagram



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1.0	23/11/2016	Draft	Atom Consulting
2.0	29/03/2017	Issued	Atom Consulting

14.9 References

HydroScience, 2015, *Goldenfields Water County Council Drinking Water Management System*, developed for Goldenfields Water County Council and NSW Health

NSW Office of Water (DPI Water), 2011, *Water Resources and Management Overview - Murrumbidgee Catchment*

15 APPENDIX F MOUNT ARTHUR WATER SUPPLY DESCRIPTION

15.1 Version Control

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Contact:	Annalisa Contos Atom Consulting 65 Cambourne Avenue annalisa@atomconsulting.com.au			
File Name:	GWCC_Mt Arthur Water Supply System_v2.0.docx			

15.2 Amendment Summary

A summary of the changes made to the document is shown in **Table 15-1**.

Table 15-1. Critical and operational control point summary of changes

Version	Date	CCPs
Version 2.0	March 2017	Process flow diagram updated following October 2016 site visit
		Water supply system information split into individual water supply system from November 2015 DWMS

15.3 Description

The Mt Arthur drinking water system supplies approximately 2,300 people. The Mt Arthur system can be supplemented by the Oura drinking water supply system through Coolamon and Ganmain, however this is not common practice.

15.4 Lachlan Ford Belt Fracture Aquifer System

Water for the Mt Arthur drinking water supply system is drawn from the Lachlan Fold Belt fractured rock aquifer system, near the Murrumbidgee River at Matong. According to the DPI Water (NSW Office of Water, 2011), groundwater in this region is of moderate quality with TDS between 500 to 1,500 mg/L and is suitable for domestic stock and some irrigation purposes.

15.5 Source Water

Water is sourced from the Mt Arthur Borefield, which is located at near the Murrumbidgee River at Matong. Goldenfields Water is licensed to draw 762 ML per annum from two groundwater bores. Bores are located in bore huts.

High risks from the catchments with the potential to introduce pathogenic micro-organisms into the water supply include surface water ingress and contamination due to seepage of pathogens from on-site sewerage management systems.

Figure 15-1 Mt Arthur Bores 1

Source: Atom Consulting, photo taken October 2016

Figure 15-2 Mt Arthur Bores 2

***Source**: Atom Consulting, photo taken October 2016*

15.6 Water Treatment Process

The treatment process at the Mt Arthur drinking water supply system comprises of the following steps:

- Groundwater is pumped to the surface by two 94 kW bore pumps in a duty/stand-by configuration
- Water is injected with chlorine prior to entering the four Ganmain Low Level Reservoirs where iron and manganese are settled out
- The water is then distributed to retail consumers in Coolamon, Ganmain, Matong, and Grong Grong

Figure 15-3 Mt Arthur – Ganmain high level reservoir

Source: Atom Consulting, photo taken October 2016

Figure 15-4 Mt Arthur – Chlorination and Ganmain low level reservoir

Source: Atom Consulting, photo taken October 2016

Figure 15-5 Mt Arthur – Chlorine cylinder

***Source**: Atom Consulting, photo taken October 2016*

Figure 15-6 Mt Arthur – Ganmain pump station

***Source**: Atom Consulting, photo taken October 2016*

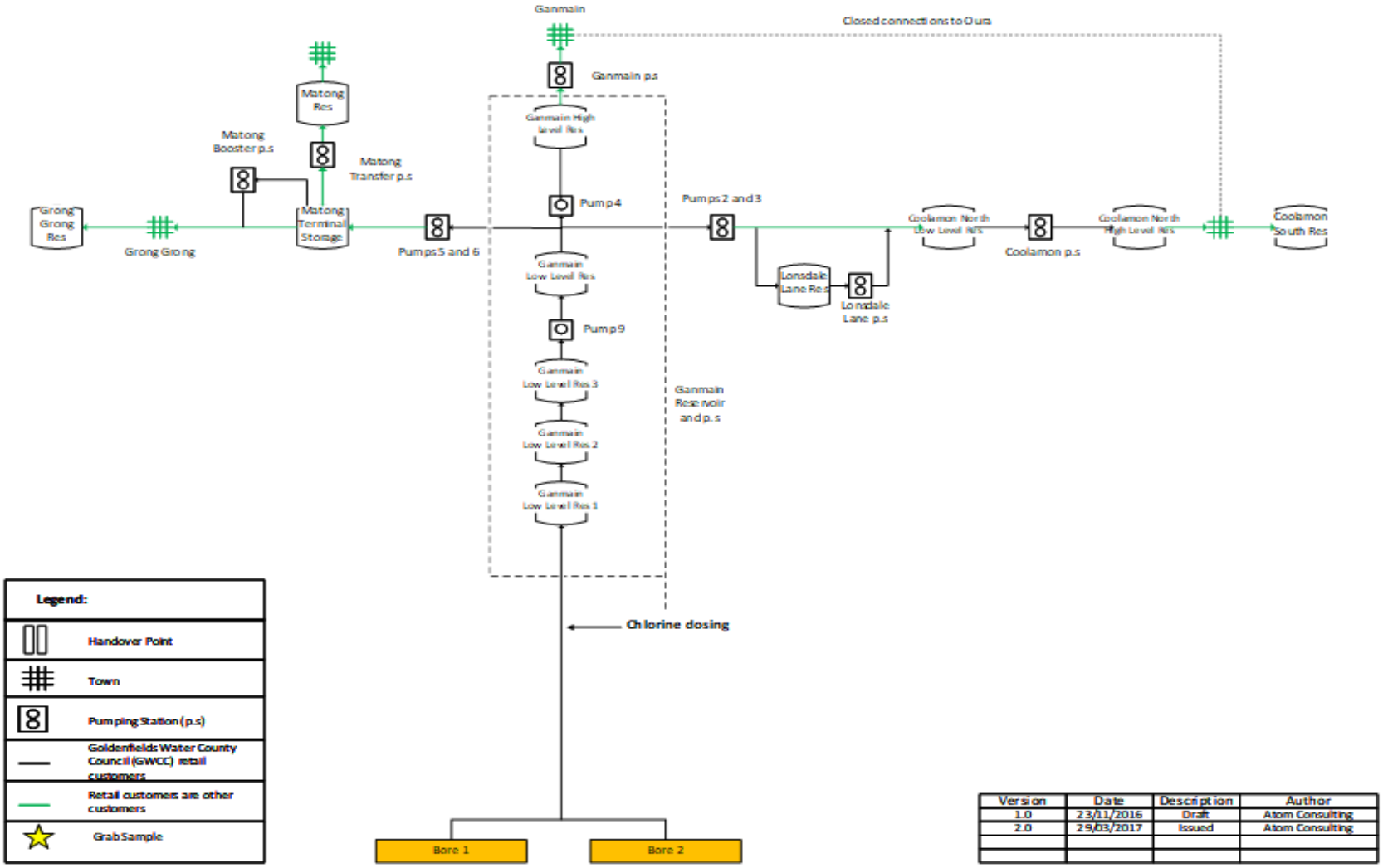
15.7 Water Distribution

The Mt Arthur drinking water supply system distributes water to the areas of Ganmain (population: 578), Coolamon (population: 1,261), Grong Grong (population: 250) and Matong (population: 250). Treated water is distributed through 9 reservoirs and by 6 pumping stations. One of the challenges for Goldenfields Water is maintaining free chlorine in a long distribution system. There are 76 km of trunk mains and 67 km of reticulation mains in the Mt Daylight system (HydroScience, 2015).

15.8 Process Flow Diagrams

Figure 13 shows the process flow diagram of the Mt Arthur drinking water supply system from catchment to consumer

Figure 13 Mt Arthur



Version	Date	Description	Author
1.0	23/11/2016	Draft	Atom Consulting
2.0	29/03/2017	Issued	Atom Consulting

15.9 References

HydroScience, 2015, *Goldenfields Water County Council Drinking Water Management System*, developed for Goldenfields Water County Council and NSW Health

NSW Office of Water (DPI Water), 2011, *Water Resources and Management Overview - Murrumbidgee Catchment*

16 APPENDIX G MOUNT DAYLIGHT WATER SUPPLY SYSTEM

16.1 Version Control

Document Status:	Issued			
Document History:	**Status**	**Author**	**Version**	**Date**
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Current version authors:	Natalie Crawford (Atom Consulting), Annalisa Contos (Atom Consulting)			
Contact:	Annalisa Contos Atom Consulting 65 Cambourne Avenue annalisa@atomconsulting.com.au			
File Name:	GWCC_Mt Daylight Water Supply System_v2.0.docx			

16.2 Amendment Summary

A summary of the changes made to the document is shown in **Table 16-1**.

Table 16-1. Critical and operational control point summary of changes

Version	Date	CCPs
Version 2.0	March 2017	Process flow diagram updated following October 2016 site visit
		Water supply system information split into individual water supply system from November 2015 DWMS

16.3 Description

The Mt Daylight drinking water is a water supply system supplies approximately 125 people in the villages and surrounds of Naradhan, Weethalle and Tallimba.

16.4 Lower Lachlan Alluvium Aquifer

The Mt Daylight drinking water supply system draws its groundwater from the lower Lachlan alluvium, located in the Lachlan River catchment (NSW Office of Water, 2011). The aquifers surrounding Lake Ballyrogan (Lake Brewster) from which the Mt Daylight bores draw water, is hydraulically connected to the surface water (National Resources Commission, 2006). This means that groundwater quality in the Mt Daylight system is linked to surface water quality, although it is expected that the groundwater will have lower turbidity due to filtration through subsurface flow. Both the DPI Water (NSW Office of Water, 2011) and National Resources Commission (2006) report that the groundwater in the Mt Daylight region is relatively fresh with low salinity, suitable for municipal use.

16.5 Source Water

Water is sourced from the Mt Daylight Borefield, which consists of two bores located in the Carathool Shire local government area, between Lake Brewster (Lake Ballyrogan) and the Lachlan River. The bores are jointly owned and operated between Goldenfields Water and Carrathool Shire Council for their respective drinking water supply systems. Goldenfields Water owns a 71% stake in the Mt Daylight bores and Carrathool Shire Council owns 29%. Carrathool Shire is responsible for the maintenance, repair and replacement of all bores (HydroScience, 2015).

High catchment risks include pathogens entering the source water through surface water ingress and contamination due to seepage of pathogens from on-site sewerage management systems.

16.6 Water Treatment Process

The treatment process at the Mt Daylight drinking water supply system comprises of the following steps:

- Groundwater is pumped to the surface by two 30 kW bore pumps in a duty/stand-by configuration to the Mt Daylight Reservoirs
- Water is injected with chlorine at the inlet to the Mt Daylight Reservoir
- Water is distributed to retail consumers in Naradhan, Weethalle and Tallimba

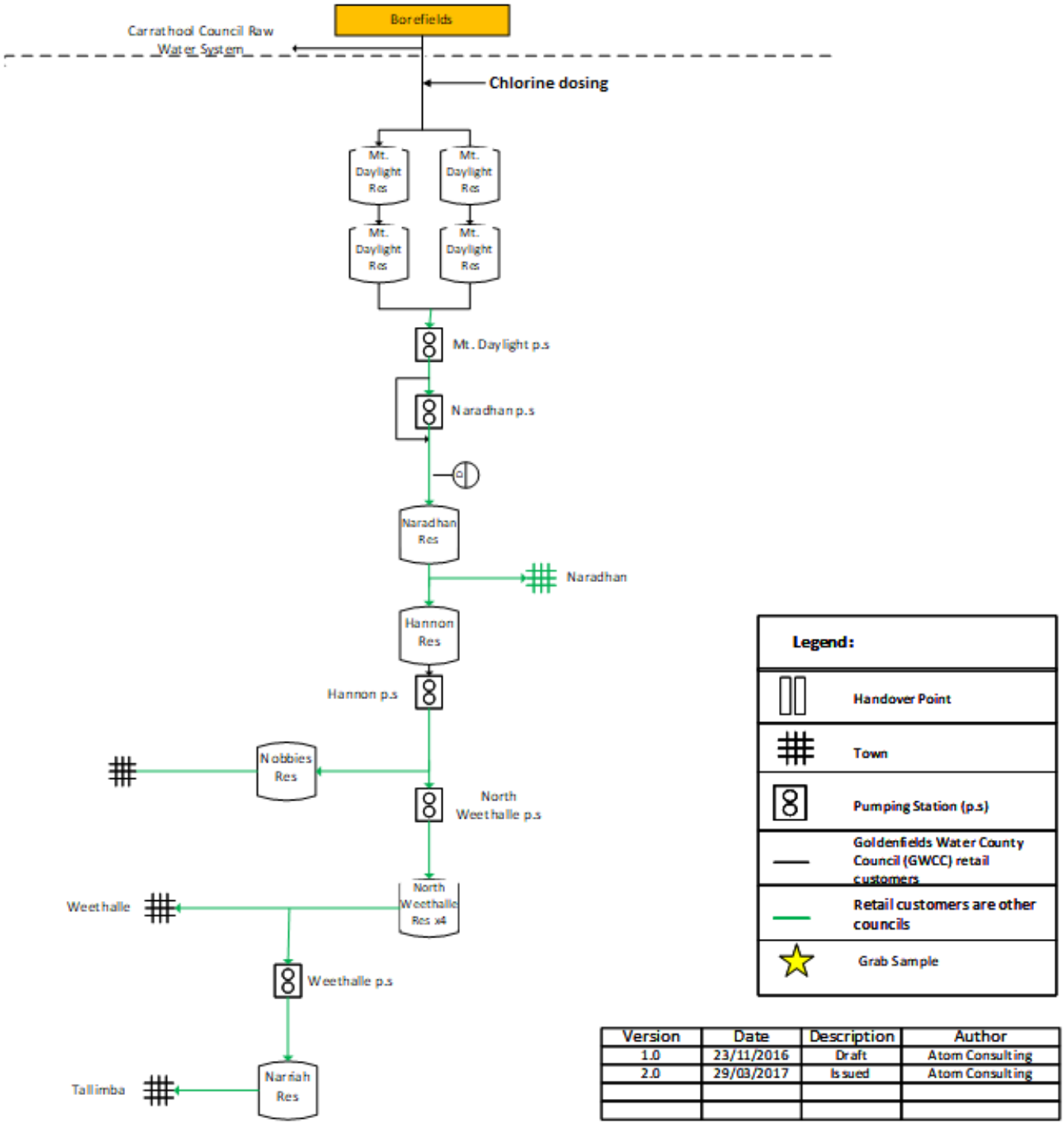
16.7 Water Distribution

The Mt Daylight drinking water supply system distributes water to approximately 125 people in the villages and surrounds of Naradhan, Weethalle and Tallimba. Treated water is distributed through 7 reservoirs and by 5 pumping stations. One of the challenges for Goldenfields Water is maintaining free chlorine in a long distribution system. There are 308 km of trunk mains and 8 km of reticulation mains in the Mt Daylight system. Mains breaks are recorded and Goldenfields Water uses this data to schedule maintenance and future mains replacement works (HydroScience, 2015).

16.8 Process Flow Diagram

Figure 17.1 shows the process flow diagram of the Mt Daylight drinking water supply system from catchment to consumer.

Figure 16.1 Mt Daylight water supply system process flow diagram



Version	Date	Description	Author
1.0	23/11/2016	Draft	Atom Consulting
2.0	29/03/2017	Issued	Atom Consulting

16.9 References

HydroScience, 2015, *Goldenfields Water County Council Drinking Water Management System*, developed for Goldenfields Water County Council and NSW Health

National Resources Commission, 2006, *Scientific Review Lower Lachlan Groundwater Sharing Plan - November 2006*

NSW Office of Water (DPI Water), 2011, *Water Resources and Management Overview - Lachlan Catchment*