

# Water Safety Plan

Piopio Drinking Water Supply



## Contact Details

*Name: Mike Charteris*

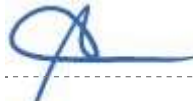
WSP Opus  
Paeroa Office  
Corner of William & Marshall St  
PO Box 91, Paeroa 3640  
New Zealand

Telephone: +64 7 889 8600  
Mobile: +64 27 552 6841

*Document Details:*

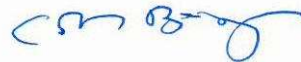
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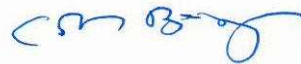
Mike Charteris | Senior Project Manager

*Reviewed by:*



Christopher Bergin | Senior Environmental Consultant

*Approved for Release by:*



Christopher Bergin | Senior Environmental Consultant

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## 1. Revision Details

VERSION NO	DESCRIPTION	APPROVED	REVISION DATE
V1	Prepared in 2009	2009	Aug 2014
V2	Prepared in October 2014	-	Jan 2019
V3	For approval by Drinking Water Assessor (DWA)		Dec 2022

This plan will be revised and submitted for approval before 31 December 2022.

### Assessment of the performance of the plan

Assessment of the performance of this Water Safety Plan (WSP) plan will be undertaken annually. The assessment will consider any events, non-compliances, near misses and unexpected situations that have occurred, progress against the improvement schedule and any changes to any of the supply elements. Any matters requiring attention will be included into the Annual Plan, the Asset Management Plan for Water Supplies and if requiring significant capital funding, the Council Long Term Plan.

### Reporting of the plan

A brief report on the performance of the plan, including information from the assessment of the plan will be provided by the Manager Water Services to the General Manager Infrastructure Services annually on the anniversary of finalisation of the plan. The report will cover the items listed above in the assessment of the performance of the plan. The Manager Water Services will be responsible for ensuring that any matters requiring attention will be appropriately included into the Annual Plan or the Asset Management Plan for Water Supplies. If significant capital funding is required, the Manager Water Services will include the matter into the Council approval process and the Council Long Term Plan.

### Links to other quality systems

This WSP will be linked to the Annual Plan, the Asset Management Plan for Water Supplies, the Council Long Term Plan and the Council Emergency Response Plan.

## **2. Introduction**

This WSP has been prepared for the Piopio drinking-water supply to identify potential events that present public health risks to the consumers of the drinking water. Waitomo District Council is committed to the WSP and to the future improvements to the supply that have been identified in this WSP.

The Piopio water supply provides water to the small community of Piopio in Waitomo District. The supply is classified as a small drinking-water supply under the Health (Drinking Water) Amendment Act 2007 and provides water to a population of approximately 500 normally resident people.

Water is sourced from the Kurataha River, is pumped through a clarifier and roughing filters to a membrane filtration plant, before being chlorinated and pH adjusted, then stored prior to being distributed to consumers in Piopio.

The scheme is administered at the main Council offices in Queen Street, Te Kuiti and managed by the Manager Water Services.

The maintenance and operation of the Piopio drinking-water supply is carried out by Council's Water Services Business Unit (WSBU), supported by external contractors for the provision of reticulation services, McIndoe Group and Neustroski Plumbing and Gas.

### 3. Supply Details

Table 1. Summary of Piopio water supply details

Supply Details		
Supply Name	Piopio	
WINZ Community Code	PIO001	
Supply Owner	Waitomo District Council	
Manager Water Services	Andreas Senger	
Water Supply Operator	Christo de Beer	
Population Served by Supply	500 (WINZ register 23 April 2018)	
Source Details		
Source Name	Kuratahi River	
Source WINZ Code	S00112	
Type of Source	River	
Consent Number	107477	
Consent Expires	2023	
Maximum Consented water take:	Maximum rate of 450m <sup>3</sup> /day	
Grid Reference of Source (NZTM)	<b>Easting:</b> 2686181	<b>Northing:</b> 6302819
Treatment		
Plant Name	Piopio	
Plant WINZ Code	TP00186	
Location	Kuratahi Street, Piopio	
Treatment Processes	Coagulation; horizontal clarification; membrane filtration; chlorination	
Average Daily Volume	350 m <sup>3</sup> /day	
Peak Daily Volume	450 m <sup>3</sup> /day	
Distribution		
Distribution Zone Name	Piopio	
Distribution Zone WINZ Code	PIO001PI	
Distribution Zone Population	500 (WINZ register 23 April 2018)	

## 4. Description of the Piopio Water Supply

The original supply for Piopio was established in 1954 and was located north of the town, drawing water from the Mokau River. In 1976, because of the poor water quality of the Mokau River the source was changed to a spring at the head of a tributary of the Mokau River, known locally as the Kurataha River and a treatment plant was constructed. The plant was constructed near to the river at the end of Kuratahi Road and consisted of pre-clarifier coagulant dosing, clarification and filtration with an automatic valveless gravity filter and chlorination. In 2012 the treatment plant was upgraded with the removal of the AVG filter and installation of membrane filtration. Chlorination has been retained.

The Piopio water treatment plant provides potable water for the domestic, commercial and industrial needs of the Piopio community. Although the source water is derived from an underground system, numerous tomos/sinkholes in the catchment mean that the water is still heavily influenced by surface conditions. Treatment is required and consists of coagulation and clarification followed by coarse filtration, membrane filtration and chlorination.

Water is abstracted from a spring exiting from the karst waterway system, listed on the WINZ database as being the Kurataha River. The intake consists of a single pump hanging from a steel walkway. After abstraction, the water is dosed with poly aluminium chloride and pumped to a three-chamber cross flow clarifier. Dose rate is flow proportional.

After the water passes through the clarifier it is then gravity fed to two Arkal 200 $\mu$  roughing filters in parallel. The main treatment process consists of a bank of membrane filters. The membranes are backwashed automatically as required using water from the treated water tanks. The backwash cycle is preceded by an air scour. Chemical washing of the membranes using sodium hypochlorite or caustic soda occurs periodically as and when determined by the monitored pressure differentiation across the membranes and is initiated remotely by the operators using the SCADA system. Washes can be automatically initiated on the differential pressure across the membranes but this facility is not currently used. Membrane integrity testing, a DWSNZ compliance requirement is undertaken automatically with the results reported to SCADA.

The water is then dosed with chlorine using sodium hypochlorite. The dose rate is flow proportional to a set point adjusted by the operators. Turbidity is continuously monitored post clarifier and in the final water. FAC and pH are continuously monitored in water leaving the plant. Data is transmitted to the Waitomo District Council offices, with alarms sent to operators' mobile phones. FAC is also tested daily in the reticulation. *E. coli* is tested weekly in the reticulation.

The reticulation network is some 6,750m in length, the majority of this Asbestos Cement (86%), with the balance being Polyethylene. The mains are in good condition which is based on an average burst rate of one every 18 months. There are around 150 connections, with no major industrial users on this supply. The supply feeds one primary school and one college.

Sodium Hydroxide (caustic soda) is dosed to maintain a pH of between 7.0 and 8.0 to ensure effective disinfection and provide water that is attractive to the consumers thus avoiding the substitution with potentially unsafe sources of water.

Treated water is stored in five 30m<sup>3</sup> storage tanks before it is pumped through the reticulation to a concrete storage reservoir of 450 m<sup>3</sup>. Pumps are in a duty/standby arrangement. Some spare parts for the plant are held in Te Kuiti.

Wastewater created by the treatment process (sedimentation sludge and filter backwash water) is retained in a settling pond and the supernatant is discharged into the Kurataha River downstream of the water intake.

Although the Piopio WTP abstracts raw water from a ‘spring’, the karst nature of the surrounding land means that the raw water is affected by surface conditions such as rainfall. As with most surface waters, water quality is variable and the primary concerns are microbiological (protozoa, and bacteria / viruses) and chemical (fertiliser derived nitrate). The catchment is estimated to be some 600 hectares consisting predominantly of dairy farms.

The land on which the plant components are located is owned by Waitomo District Council.

A catchment risk assessment was prepared in January 2015 and identified that the source water has a moderate risk of protozoal contamination and requires log-4 protozoa treatment.

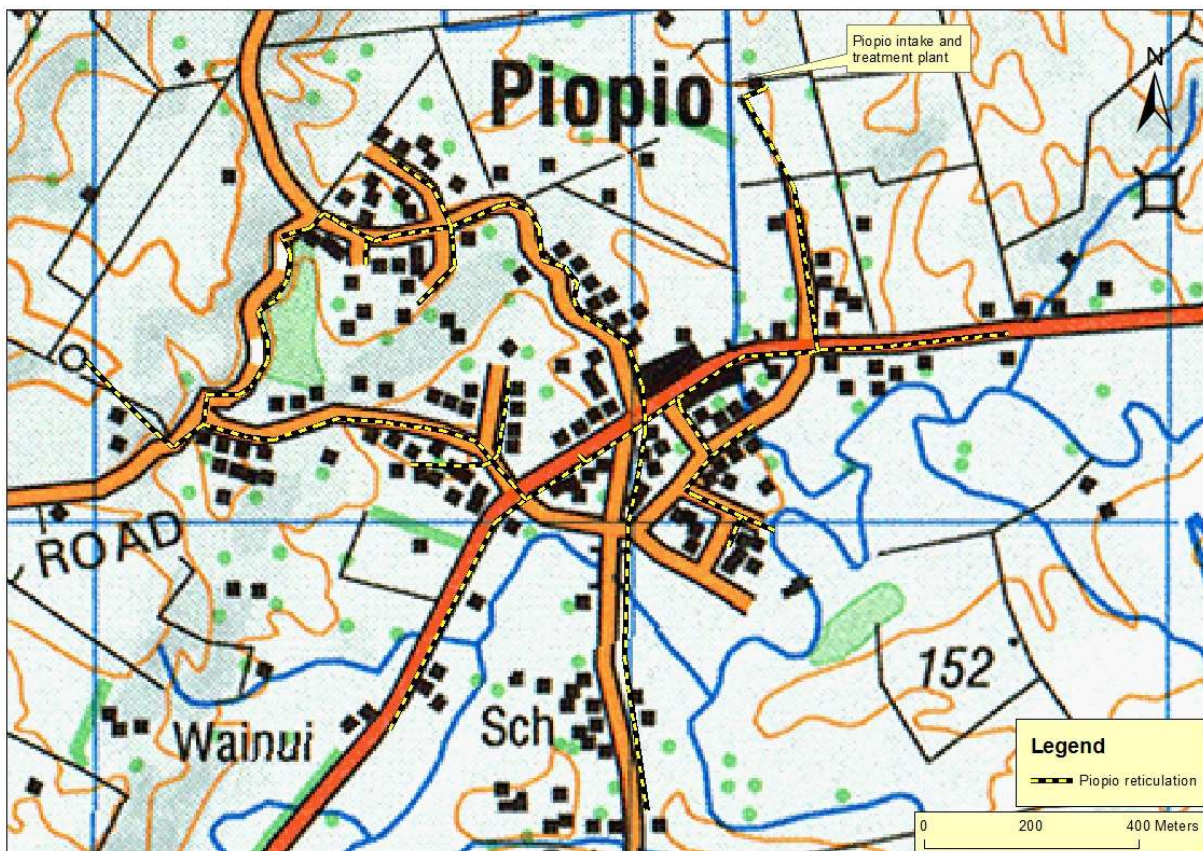


Figure 1. Location of Piopio drinking water supply and source catchment



## 5. Piopio Water Supply Photos

The following photos were taken on a site visit to the Piopio water supply on 21 June 2017.

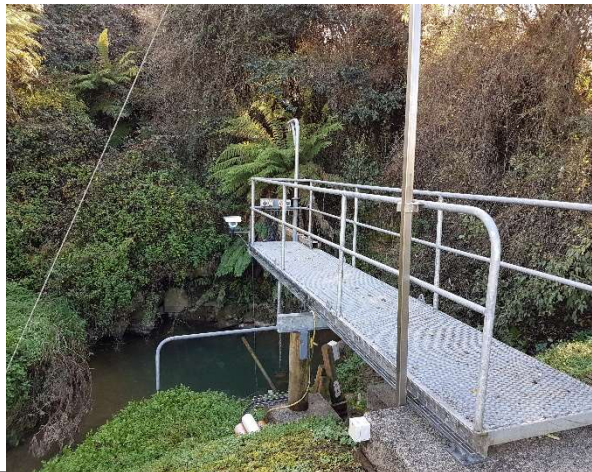


Figure 2. Intake walkway



Figure 3. Clarifier



Figure 4. Chemical store



Figure 5. Membrane train



Figure 6. Online monitoring



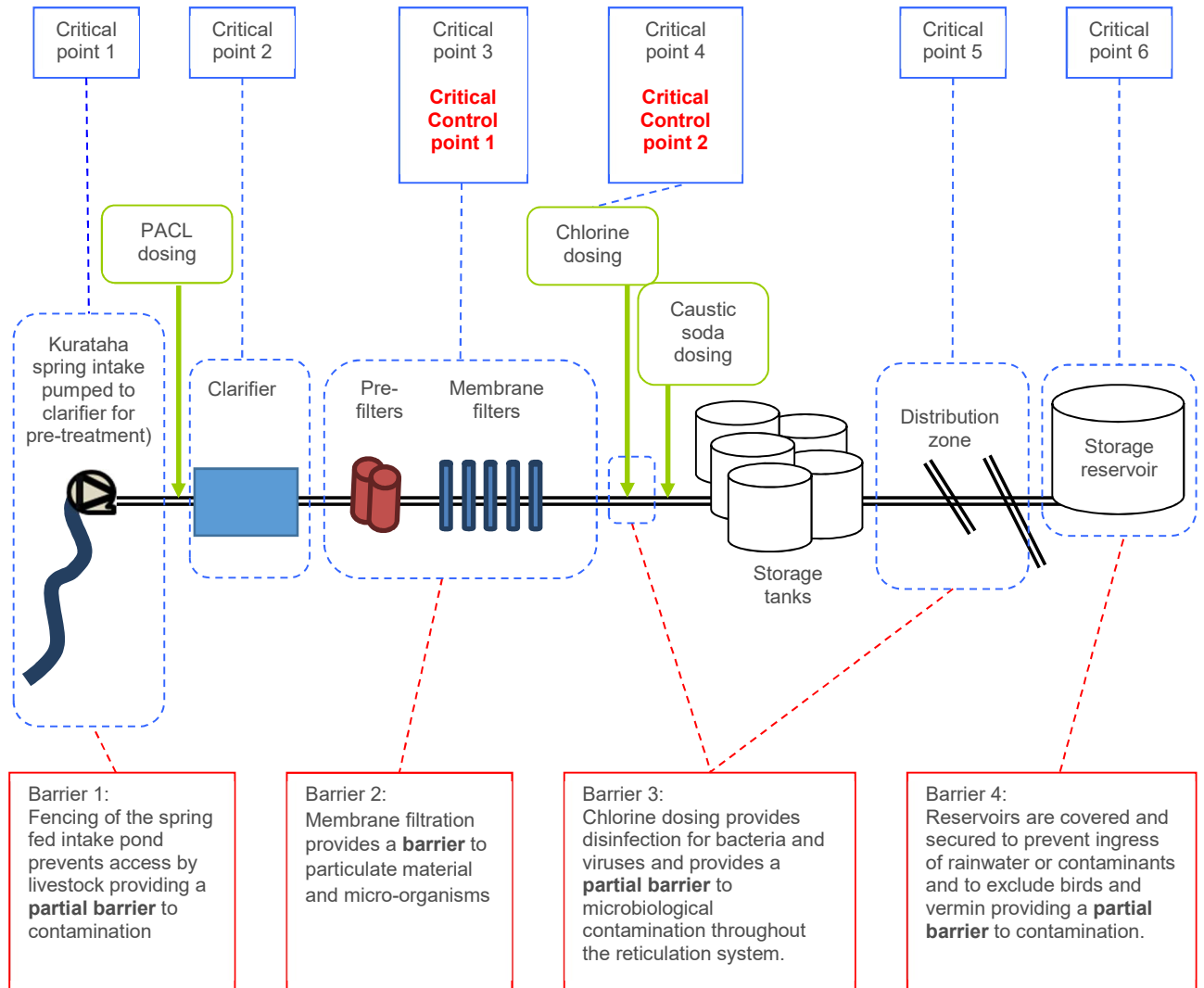
Figure 7. Treatment plant



*Figure 8: Reservoir*

## 6. Flow Chart/Schematic of the Supply

Figure 9. Supply schematic



## 7. Barriers to Contamination

Table 2. Critical points

**Critical points** where hazards can be eliminated, minimised or isolated include:

	Critical Point	Description
1.	Intake	<i>Failure of intake or pump means no water is available</i>
2.	Clarifier	<i>Failure will result in reduced particle removal</i>
3.	<b>Critical Control Point</b> Pre-filters and membrane filtration	<i>Failure will result in reduced removal of particulate material and micro-organisms including protozoa Membrane fouling may result in an inadequate quantity of water</i>
4.	<b>Critical Control Point</b> Chlorine dosing and pH adjustment	<i>Failure will result in a lack of bacterial and viral control Overdosing may exceed chemical MAV</i>
5.	Distribution system hydrants and connections	<i>Possible access point for contamination and backflow</i>
6.	Treated water storage	<i>Possible point for microbiological contamination</i>

**Existing barriers to contamination include:**

### Membrane filtration

Membrane filtration removes particulate material and micro-organisms. This process **provides a barrier to micro-biological contamination.**

### Chlorination

The treatment plant uses chlorination to disinfect the water of non-protozoan micro-organisms. There is at least 30 minutes contact time before the chlorinated water is distributed to customers which provides **a barrier to bacterial and viral contamination.**

### Prevention of contamination of treated water in storage

The tanks and reservoir are covered to prevent unauthorised access, ingress of rainwater or contaminants, and to exclude birds and vermin. The following measures contribute to provision of a **partial barrier against recontamination** of water following treatment.

### Prevention of contamination of treated water while it is in the network reticulation

Maintaining a chlorine residual at a level to protect against microbiological contamination and training of those who work on the reticulation system provides a **barrier against recontamination** of the water in the distribution zone.

**There are limited barriers to contamination at the intake consisting of fencing of the intake pond, as the source catchment is not protected.**

## 8. Critical Control Point Process Control

A Critical Control Point is a point, step or procedure at which controls can be applied and a drinking water safety hazard can be prevented, eliminated or reduced to acceptable (critical) levels. The most common CCPs are filtration and disinfection, where water suppliers designate critical limits.

The Piopio supply has two critical control points over which process control can be made. The critical control points are:

- Filtration processes which provide a barrier within the supply system to micro-organisms including bacteria, viruses and protozoa;
- Chlorination which provides a barrier to bacterial and viral organisms

## 8.2. Membrane Filtration

### Process objectives:

To provide a **primary filtration control point** against bacterial, viral and protozoan pathogens that may have entered the water supply system upstream of the treatment plant.

Table 3. Membrane CCP

<b>OPERATIONAL DAY-TO-DAY MONITORING OF CONTROL PROCESSES</b>		
<b>What</b>	Turbidity	
<b>When</b>	Turbidity is continuously monitored	
<b>Where</b>	At the outlet of the membrane filter	
<b>How</b>	Continuous on-line monitoring analysers with alarms to the operators if measurements approach designated parameters.	
<b>Who</b>	Results are stored on the plant SCADA machine, are transmitted and stored at the Te Kuiti Offices, and are available to operators on their laptop computers.	
<b>Records</b>	All data is recorded digitally to the SCADA historian.	
<b>Process performance criteria at the operational monitoring point.</b>		<b>Correction required if performance criteria are not met.</b>
<b>Target Range</b>	<ul style="list-style-type: none"> <li>Filtrate turbidity less than 0.1 NTU</li> <li>Filtrate turbidity less than infeed turbidity</li> </ul>	No action
<b>Action Limits</b>	<ul style="list-style-type: none"> <li>Turbidity greater than 0.1 NTU for more than 5 minutes</li> <li>Filtrate turbidity greater than infeed turbidity for more than 1 minute</li> </ul>	Shut plant down and initiate direct integrity testing (PDT) If PDT fails, leave rack isolated until operator identifies and fixes the fault. Duty operator notifies the Manager Water Services
<b>Critical Limits</b>	<ul style="list-style-type: none"> <li>Turbidity exceeds 0.1 NTU for more than 15 minutes, or:</li> <li>Filtrate turbidity exceeds infeed turbidity for more than 3 minutes</li> </ul>	Operator notifies Manager Water Services Duty operator undertakes direct integrity testing of the membranes Manager Water Services notifies DWA if inadequately treated water needs to be supplied or has been supplied to the community and considers with DWA the need to issue a boil water notice.

### 8.3. Chlorination

#### Process objectives:

To provide a **disinfection control point** against bacterial and viral pathogens and some protozoan pathogens that may have entered the water supply system upstream of the treatment plant.

Table 4. Chlorination CCP

<b>OPERATIONAL DAY-TO-DAY MONITORING OF CONTROL PROCESSES</b>		
<b>What</b>	Turbidity pH FAC	
<b>When</b>	Turbidity, pH and FAC are continuously monitored	
<b>Where</b>	Post dosing	
<b>How</b>	Continuous on-line monitoring analysers with alarms to the operators if measurements approach designated parameters.	
<b>Who</b>	Results are stored on the plant SCADA machine, are transmitted and stored at the Te Kuiti Offices, and are available to operators on their laptop computers.	
<b>Records</b>	All data is recorded digitally to the SCADA historian.	
<b>Process performance criteria at the operational monitoring point.</b>		<b>Correction required if performance criteria are not met.</b>
<b>Target Range</b>	• Turbidity less than 0.1 NTU	No action required
	• FAC between 0.6 – 1.2 mg/L	No action required
	• pH between 7.0 – 7.5	No action required
<b>Action Limits</b>	• Turbidity greater than 0.1 NTU for up to 15 minutes	Refer CCP for membrane filtration
	• FAC between 0.2 – 0.6 mg/L	Operator to respond by checking for faults in dosing system Operator adjusts chlorine dose rate. Operator notifies the Manager Water Services
	• pH greater than 7.5 or less than 7.0	Operator to respond by checking for faults in dosing system. Operator adjusts Sodium Hydroxide dose rate. Operator notifies the Manager Water Services
<b>Critical Limits</b>	• Turbidity greater than 1.0 NTU for more than 72 minutes in a day	Operator shuts down treatment plant and operates supply from storage until parameters return to within critical limits
	• Turbidity greater than 2.0 NTU for more than 3 minutes	Duty operator notifies Manager Water Services
	• FACE less than 0.2 mg/L for more than 28 minutes in a day	The Manager Water Services notifies DWA if inadequately treated water needs to be supplied or has been supplied to the community and considers with DWA the need to issue a boil water notice.

#### **8.4. Supporting programs**

Critical instrumentation is calibrated annually by the suppliers EMC, weekly verification and monthly calibration is performed by the Operators following the process set out in the manufacturers manuals.



## 9. Improvement Schedule

The improvement schedule outlines improvements that have been recommended for preventing, reducing or eliminating the identified public health risks in the Piopio water supply. Possible improvements to the water supply have been identified in the 'Additional Measures That Could Be Put in Place' column of the risk tables. The most suitable option to improve the management of each unmanaged risk has then been included in the improvement schedule. It should be noted that costs are estimates only. Each project is ranked according to the priority to which projects should be completed.

MWS – Manager Water Services

TPO – Treatment Plant Operator

RC – Reticulation Contractor

Table 5. Recommended Improvements

PRIORITY	RISK LEVEL	WATER SUPPLY AREA	REFERENCE TO RISK TABLE	PROPOSED WORKS	PERSON RESPONSIBLE	EXPECTED COST	INTENDED COMPLETION DATE
1	Very high	Membrane filtration	4.8, 4.9	Develop and implement controls to prevent changes to membrane vendor programming Develop and implement audit process to confirm log removal validation	MWS	Staff time	June 2018
2	Very high	Other	10.5	Develop model training and skills maintenance plan for existing and new operators.	MWS	Staff time	October 2018
3	High	Reticulation	9.8	Reduce system pressure and incidence of water hammer by installing a dedicated rising main from the treatment plant to the reservoir.	MWS	\$200,000	End 2019
4	High	Catchment	1.6	Undertake an assessment of the cyanobacteria/cyanotoxin source water risk level to determine the level of risk and whether a management protocol is required.	MWS	\$2,500	End 2018
5	High	Catchment	1.7	Participate in the establishment and maintenance of a Joint Working Group for Drinking Water with Regional Council and Drinking Water Assessors	MWS	Staff time	Mid 2018
6	High	Reticulation	9.5	Prepare and implement a formal backflow protection policy that identifies all risk sites, ensures suitable backflow protection devices are installed and all backflow protection devices are tested appropriately.	MWS	Staff time	End 2018
7	Moderate	Other	10.8	Prepare a drinking water supply contamination response plan.	MWS	Staff/JWG time	End 2018
8	Moderate	Other	10.1	Improve continuous monitoring systems to avoid loss of data, and ensure timely provision of data to DWA.	MWS	\$1,500	End 2018

## **10. Benefits of Proposed Improvements**

The proposed improvements will provide public health benefits by reducing the risk of adverse health outcomes associated with poor drinking water quality.

The Piopio treatment plant has recently been upgraded. Further significant improvements to the infrastructure are not required, although renewal of the membrane modules is planned for mid-2018.

Preparation and implementation of a backflow prevention policy will reduce the risks of contamination of the supply due to a backflow event. Investigating water hammer in the system allows consideration of options to protect the system pipework.

## 11. Methodology

This WSP has been prepared consistent with the approaches recommended by the Ministry of Health. Supporting documents include the WSP Guides and *A Framework on How to Prepare and Develop Water Safety Plans for Drinking-water Supplies*, Ministry of Health (2014).

A qualitative risk assessment approach has been taken following the guidance notes in Appendix 2 of the “Framework” allowing the prioritisation of improvement needs and development of the Improvement Schedule.

Indicative cost estimates and implementation timeframes have been prepared for the required improvement measures. These will be carried forward to the next Asset Management Plan (AMP) and Council Long Term Plan for approval and inclusion in annual budgets following the statutory public consultation process. Implementation of the Improvement Schedule is ultimately subject to Council funding approval.

The Manager Water Services is responsible for implementation of the Improvement Plan within the timeframes indicated, subject to community and council approvals, funding constraints and availability of resources. The Manager Water Services is also responsible for on-going review and updating of the WSP and associated Improvement Schedule.

Contingency Plans have been prepared to provide guidance in the event that control measures fail to prevent the occurrence of a risk event that may present an acute risk to public health. The Manager Water Services and the WTP Operators are responsible for implementation of the Contingency Plans when monitoring has identified the occurrence of a risk event.

Separate risk tables have been prepared for:

Catchment	Abstraction	Coagulation clarification
Membrane filtration	Chlorination	pH adjustment
Storage tanks (treatment plant)	Service pumps	Reticulation
Other		

## 12. Risk Ranking Procedure

Potential public health risks have been evaluated using the Likelihood and Consequence scales tabulated below to determine a risk level – low, moderate, high, very high or extreme. The assessed risk level allows prioritisation of the associated improvement measures.

**Table 6. Likelihood Scale**

Likelihood	Description
Almost certain	Is expected to occur in most circumstances.
Likely	Will probably occur (once in a year)
Possible	Might occur at some time (once in 5 years)
Unlikely	Could occur at some time (once in 15 years).
Rare	Only in exceptional circumstances (once in 25 years).

**Table 7. Consequence Scale**

Consequences	Description
Insignificant	Insignificant public health impact
Minor	Minor public health impact or inconvenience to supply users
Medium	Moderate public health impact and/or short-term loss of supply
Major	Major public health impact and/or loss of supply for a long period. Small number of water-borne illnesses
Catastrophic	Major public health impact. Significant water-borne illness

**Table 8. Risk Level Allocation Table**

Likelihood	Consequence				
	Insignificant	Minor	Medium	Major	Catastrophic
Almost certain	Moderate	Moderate	Very High	Extreme	Extreme
Likely	Low	Moderate	High	Very High	Extreme
Possible	Low	Moderate	Moderate	Very High	Very High
Unlikely	Low	Low	Moderate	High	Very High
Rare	Low	Low	Low	Moderate	High

## 13. Drinking Water Standards and Grading

The Piopia water supply did not fully comply with the DWSNZ during the 2015-2016 compliance year. Table 5 below provides a summary of how compliance is demonstrated. The original treatment plant at Piopia was graded E but the new plant has not yet been graded. The distribution zone has a grade of b.

Table 9. Summary of Compliance with DWSNZ

COMPLIANCE AREA	COMMENTS
Bacterial compliance criteria used for water leaving the treatment plant	Section 10 – Participating supply
Protozoa log removal requirement required for the supply	4-log
Protozoa treatment process	Membrane filtration provides 4-log
Compliance criteria 6A or 6B is used for water in the distribution zone.	Section 10 – Participating supply
Bacterial compliance for water leaving the treatment plant has been achieved for the last 4 quarters.	Yes
Protozoa compliance for water leaving the treatment plant has been achieved for the last 4 quarters.	No
Bacteria compliance for water in the distribution zone has been achieved for the last 4 quarters.	Yes
P2 determinands allocated to supply	None
Chemical compliance achieved for the last 4 quarters.	Yes
Cyanobacteria identified in the supply	No
Cyanobacterial compliance has been achieved for the last 4 quarters.	N/A

## **14. Consultation**

On 21 June 2017, a site visit to the Piopio water supply was carried out by Mike Charteris of Opus with the Manager Water Services, Waitomo District Council.

An inspection of the source water, treatment plant and other parts of the supply was undertaken. The supply was discussed with the Manager Water Services, including the operation and performance limits, the critical points, critical control points, the treatment barriers, the risks that have been identified, how these risks are managed currently and the improvements that could be put in place. The information provided during this site visit was used to compile the risk tables.

Subsequent to this site visit, telephone discussions and email contact has been used to provide further information necessary for the preparation of this WSP. The WSP was then reviewed by Andreas Senger, Manager Water Services, and Kobus du Toit, General Manager Infrastructure Service, who hosted a workshop with the operators to obtain corrections and details to complete the plan.

## 15. Contingency Plan

<b>Piopio Water Supply Contingency Plan</b>	
<b>Type of Event</b>	<b>Required Contingency Action</b>
<p>Inadequate chlorination</p> <p>Indicators: Low FAC (&lt;0.2mg/L) or no FAC reported from treatment plant monitoring.</p>	<p>Manager Water Services: Advise DWA of situation</p> <p>Operator: Inspect chlorination process to identify cause of problem and rectify as quickly as possible Consider advising customers if changes to the character of the water supplied is significant</p>
<p>Severe microbiological contamination of source water (such that treatment is ineffective)</p> <p>Indicators: A contamination event in the catchment may be observed by or reported to Waitomo District Council staff. May also be indicated by reported illness among consumers or positive <i>E. coli</i> monitoring results.</p>	<p>Manager Water Services: Issue boil water notice to consumers</p> <p>Advise DWA of situation</p> <p>Keep customers informed and advise once regular supply is restored</p> <p>Operator: Follow supply contamination response plan (to be prepared)</p> <p>Inspect catchment and intake to identify source of contamination and rectify problem as quickly as possible</p> <p>Super chlorinate the reservoirs and distribution system and flush mains if they contain contaminated water</p>
<p>Chemical contamination of source water</p> <p>Indicators: A contamination event in the catchment may be observed by or reported to Waitomo District Council staff. May also be indicated by reported water quality concerns from consumers (taste, odour, colour) or illness among consumers.</p>	<p>Manager Water Services: Advise consumers not to drink the water supply</p> <p>Advise Drinking Water Assessor (DWA)</p> <p>Arrange emergency water supply (tankers) if necessary</p> <p>Assess situation and advise customers regarding use/treatment/disposal of contaminated water</p> <p>Keep customers informed and advise once regular supply is restored</p> <p>Operator: Follow supply contamination response plan (to be prepared)</p> <p>Inspect the supply to identify source of contamination and rectify problem as quickly as possible</p> <p>Flush reservoirs and mains</p>



<b>Piopio Water Supply Contingency Plan</b>	
<b>Type of Event</b>	<b>Required Contingency Action</b>
<p>Insufficient water available for abstraction and treatment or loss of ability to take water from river.</p> <p>Indicators: Observed or reported low river levels</p>	<p>Manager Water Services: Advise customers to conserve water</p> <p>Implement drought management plan and demand management procedures as required</p> <p>Arrange emergency water supply (tankers) if necessary</p> <p>Keep customers informed and advise once regular supply is restored</p>
<p>Pipe break or other failure posing a risk of an outage of more than 8 hours</p> <p>Indicators: Observed high flow rates or customer complaints</p>	<p>Manager Water Services: Advise customers to conserve water</p> <p>Assess the likely duration of the outage and if necessary, arrange the purchase of bottled water from a major retailer(s) in Te Kuiti (The Warehouse, New World and/or Super Value) and delivery to affected customers.</p> <p>If the number of consumers affected is large, arrange emergency water supply from tankers.</p> <p>Keep customers informed and advise once regular supply is restored.</p>
<p>E. coli transgression in water leaving treatment plant or distribution zone</p> <p>Indicators: E. coli transgression reported following routine monitoring.</p>	<p>Manager Water Services: Advise Drinking Water Assessor (DWA)</p> <p>Operator: Follow supply contamination response plan (to be prepared)</p> <p>Follow transgression response procedure in DWSNZ</p> <p>Commence daily <i>E. coli</i> testing at WTP</p> <p>Use an enumeration test method</p> <p>Sample in distribution system</p> <p>Investigate cause, inspect plant and source</p> <p>Take remedial action</p> <p>Continue to sample for <i>E. coli</i> until 3 consecutive samples are free of <i>E. coli</i></p> <p>If <i>E. coli</i> is found in repeat samples consult with DWA, intensify remedial action, increase disinfection, consider 'Boil Water' notice</p>

<b>Piopio Water Supply Contingency Plan</b>	
<b>Type of Event</b>	<b>Required Contingency Action</b>
Loss of power supply to treatment plant	<p>Manager Water Services: If it is possible that power outage will exceed 24 hours implement demand management</p> <p>Operator: Determine likely length of power outage.</p> <p>Connect portable generator to supply power to the plant</p>
Earthquake, flood or other disaster	Refer to Council Emergency Response Management Plan

# 16. Risk Tables

MWS – Manager Water Services

TPO – Treatment Plant Operator

RC – Reticulation Contractor

Table 10. Risk Tables

1. Catchment											
Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Microbiological Contamination	1.1	Surface contamination from farmland in the catchment and adjacent area	Extreme  (almost certain x major)	Monitoring of source water turbidity at the treatment plant indicates elevated turbidity (greater than 5 NTU)  Illness in community	Effective treatment processes including coagulation, membrane filtration and chlorination  FAC and treated water turbidity is monitored continuously at the treatment plant  Membrane integrity tests are performed automatically	If there is evidence of microbiological contamination post treatment, issue a boil water notice to all consumers	Telemetry readings	Yes	Moderate  (almost certain x minor)	None required	TPO
Microbiological contamination	1.2	Discharges from community wastewater systems, buildings, septic tanks, or agricultural discharges such as dairy effluent ponds	High  (unlikely x major)	High raw water <i>E. coli</i> results.  Turbidity in raw water  Illness in community	Effective treatment processes including coagulation, membrane filtration and chlorination  FAC and treated water turbidity is monitored continuously at the treatment plant  Membrane integrity tests are performed automatically	If there is evidence of microbiological contamination post treatment, issue a boil water notice to all consumers	Land use changes within the catchment  Telemetry readings	Yes	Low  (unlikely x minor)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Chemical contamination	1.3	Surface runoff containing chemical contaminants from agricultural activities. (e.g. pesticides, fertilisers etc)	Moderate  (possible x medium)	Taste and/or odour.  Complaints or information provided by public about activities in catchment.	Chemical suite is analysed on a five-yearly basis  24 hours treated water storage is provided	If there are any indications of chemical contamination of the source water which exceeds the DWSNZ MAVs consumers must be advised and the supply disconnected at each connection until the issue has been resolved	Chemical suite results provide a five-yearly check, otherwise evidence of a chemical spill or taste and odour complaints indicate contaminants in water	Yes	Low  (rare x medium)	None required	MWS
Chemical Contamination	1.4	Naturally occurring chemical contaminants	High  (likely x medium)	Taste and/or odour.  Chemical analysis identifies chemical contaminants exceeding 50% of DWSNZ MAV	Chemical suite is analysed five-yearly  An analysis has not identified any naturally occurring chemicals in the source water at levels of concern	If there is evidence of unacceptable chemical contamination of the source water consumers must be advised and the supply disconnected until the issue is better understood	Chemical suite results provide a five-yearly check, otherwise taste and odour complaints indicate contaminants are in source water	Yes	Low  (rare x medium)	None required	MWS
Loss of Supply	1.5	Drought reduces quantity of water that can be abstracted	High  (unlikely x major)	Prolonged drought or low rainfall conditions  Reduced flows to treatment plant/low reservoir level	Drought Management Plan can be implemented during drought or low rainfall conditions	Implement water demand management measures	Cumulative rainfall  Stream levels	Yes	Moderate  (rare x major)	None required	MWS

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Cyanobacterial or Cyanotoxin contamination	1.6	Cyanobacterial contamination in catchment	High  (unlikely x major)	Visible presence of cyanobacteria  Taste and/or odour complaints from customers	Abstraction point is shaded with high flows.  Much of the catchment upstream of the abstraction point is underground	If there are any indications of cyanotoxins in the supply, consumers must be advised and the supply disconnected at each connection until the issue has been resolved	Growth of Algal mats in the intake area  Algal count  Cyanotoxin analysis	No	High  (unlikely x major)	Undertake an assessment of the cyanobacteria/cyanotoxin source water risk level to determine the level of risk and whether a management protocol is required	MWS
Contamination of source waters	1.7	Poor application of the NES for Sources of Human Drinking Water to upstream activities	High  (unlikely x major)	Lack of regular communication with Regional Authority  Consents are granted for catchment activities without robust controls	Regular contact is maintained with the Regional Council consents team  Council is a member of the Central North Island Water Managers Working Group who will actively seek establishment of Joint Working Groups with DWA and Regional Councils	Initiate regular meetings with Regional Council	Consent notifications in local media  Regional Council resource consent maps  Frequency of meetings	Partially	High  (possible x major)	Participate in the establishment and maintenance of a Joint Working Group for Drinking Water with Regional Council and Drinking Water Assessors	MWS

## 2. Abstraction

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of Supply	2.1	Intentional vandalism or accidental damage to the intake structures resulting in inability to draw water	Very high  (possible x major)	Obvious signs of damage to structure.  Reduced/no flow to treatment plant.	Intake is a simple structure that would be hard to damage  Intake is remote and not easily accessed	Arrange temporary pumps	Flow to treatment plant	Yes	Moderate  (unlikely x medium)	None required	TPO
Loss of Supply	2.2	Blockage of intake	Moderate  (possible x medium)	Reduced/no flow from intake	Spring source does not contain debris that could block intake  24 hours storage provided across the system  Intake is inspected regularly  Lack of flow to plant initiates alarm to operator	Arrange temporary pumps	Flow to treatment plant	Yes	Moderate  (unlikely x medium)	None required	TPO
Loss of supply	2.3	Mechanical or electrical failure of intake pump	Moderate  (possible x medium)	Reduced/no flow from intake	24 hours storage provided across the system  Pump maintenance programme in place  Spare pump held	Install spare pump	Flow to treatment plant	Yes	Moderate  (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of supply	2.4	Failure of pump due to power outage	Moderate  (possible x medium)	No flow to treatment plant	24 hours storage provided across the system  Distribution zone is supplied under gravity  Generator is available from Te Kuiti	Use generator if outage will exceed available storage	Telemetry readings/alarms	Yes	Moderate  (unlikely x medium)	None required	TPO
Loss of right to take Water	2.5	Consent to take water is not renewed or is declined by the Regional Council.	Very High  (possible x major)	Plan to renew consent is not being actioned within 1 year prior to consent expiry	Current consent expires in 2023	Renew consent before it expires	Nothing to check	Yes	High  (unlikely x major)	None required	MWS

### 3. Coagulation and Clarification

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Floc not formed	3.1	Failure of coagulant dosing	High  (likely x medium)	High sediment carry over to filtration	Membrane filtration tends to block rather than pass non-compliant water  FAC and turbidity is monitored continuously at the treatment plant	Repair dose system  Backwash membranes as required  Cease treatment if turbidity exceeds 1 NTU and supply from stored water  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Operation of dose pump, pipework and injector  Telemetry readings	Yes	Low  (unlikely x minor)	None required	TPO
Floc not formed	3.2	Inappropriate dose rate of coagulant	Moderate  (possible x medium)	High sediment carry over to filtration  Chemicals exceeding MAVs.	Dosing is flow proportional  Membrane filtration tends to block rather than pass non-compliant water  FAC and turbidity is monitored continuously at the treatment plant	Adjust dose rate  Backwash membranes as required  Cease treatment if turbidity exceeds 1 NTU and supply from stored water  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Quality of floc formation prior to clarifier  Telemetry readings	Yes	Low  (unlikely x minor)	None required	TPO



Event No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Floc not formed	3.3	Inadequate mixing of coagulant.	Moderate  (possible x medium)	High sediment carry over to filtration	Energy post dosing has been shown to provide sufficient mixing  Membrane filtration tends to block rather than pass non-compliant water  FAC and turbidity is monitored continuously at the treatment plant	Cease treatment if turbidity exceeds 1 NTU and supply from stored water  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Quality of floc formation prior to clarifier  Telemetry readings	Yes  Low  (unlikely x minor)	None required	TPO
	Poor floc formation	3.4	Raw water pH too low for optimal coagulation  (likely x medium)	Poor floc formation.	pH of raw water has been demonstrated to be suitable for coagulation process	Cease treatment if turbidity exceeds 1 NTU and supply from stored water	Quality of floc formation prior to clarifier  Telemetry readings	Yes  Low  (unlikely x minor)	None required	TPO
				Floc carryover to the membranes  High sediment carry over to filtration	Membrane filtration tends to block rather than pass non-compliant water  FAC and turbidity is monitored continuously at the treatment plant	If there is evidence of microbiological contamination, issue a boil water notice to all consumers				
Flocs not formed	3.5	Coagulant chemical supply exhausted.	Moderate  (possible x medium)	Poor floc formation.  High sediment carry over to filtration	FAC and turbidity is monitored continuously at the treatment plant  Membrane filtration tends to block rather than pass non-compliant water	Cease treatment if turbidity exceeds 1 NTU and supply from stored water  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	PACL tank	Yes  Moderate  (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Flocs not formed	3.6	Inappropriate or poor-quality chemicals used.	Moderate  (unlikely x medium)	No or poor floc formation.  High turbidity in water leaving the clarifiers or filters.	Product supplier provides treatment chemicals of agreed quality  Turbidity of water filters is monitored	Arrange delivery of replacement chemicals	Filter turbidity  Chemical packing slips on delivery	Yes	Low  (rare x medium)	None required	TPO
Flocs not formed	3.7	Loss of chemicals from bulk storage tanks.	Very high  (possible x major)	Chemicals identified in tank bunding  No or poor floc formation.	Chemicals held in self bunded tanks  Tanks are replaced when certification expires which is typically well before condition deteriorates	Arrange delivery of IBCs and use portable bunding while tanks are replaced	Expiration of certification	Yes	Low  (rare x medium)	None required	TPO
Coagulation failure	3.8	Chemicals are delivered to incorrect storage tank.	Very high  (possible x major)	Coagulation does not occur or only partially occurs.	Operator is on site when chemicals are delivered to ensure they are delivered to the correct tank.  Tanks are clearly marked	Empty tank into IBCs, clean and arrange replacement chemical  Arrange delivery of chemical in IBCs and use portable bunding while tanks are emptied, cleaned and refilled	Chemical delivered to correct tank	Yes	Moderate  (unlikely x medium)	None required	TPO

## 4. Membrane Filtration

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Particles not removed	4.1	Assessment of filter performance is difficult due to inadequate turbidity information	High  (likely x medium)	High turbidity in water leaving the membrane filters  Lack of information available on the performance of each bank of filters	Turbidity is continuously monitored on-line post membranes  Membranes are automatically shutdown, a backwash triggered and an alarm raised if turbidity is high	Cease treatment if turbidity exceeds 0.1 NTU for 15 minutes and a successful PDT is not completed, then supply from stored water  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Turbidity	Yes	Moderate  (unlikely x medium)	None required	TPO
Particles not removed	4.2	Arkal filter fails to remove particulate material prior to membranes	Moderate  (unlikely x medium)	Membranes fouling and in need of cleaning more regularly than expected	Membranes can function without Amiad screens but are less efficient  24 hours storage provided across the system	Clean or repair Arkal filter	Membrane performance	Yes	Low  (unlikely x minor)	None required	TPO
Insufficient treated water produced	4.3	Membrane capacity is insufficient to meet demand	Moderate  (possible x medium)	Plant needs to be operated at capacity for long periods of time	Additional membranes can easily be installed  Membranes have approximately 25% spare capacity	Upgrade plant to provide sufficient capacity	Demand changes over time	Yes	Low  (rare x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Particles not removed	4.4	Automated operation of membranes fails	High  (likely x medium)	Membranes don't wash, air scour, flux maintenance within the programmed timeframes	Membrane processes can be instigated and operated manually  24 hours storage provided across the system	Manually operate membranes while fault is corrected.	Telemetry readings	Yes	Moderate  (likely x minor)	None required	TPO
Membranes production is less than optimal	4.5	Chemicals for cleaning processes run out	Moderate  (unlikely x medium)	Membrane washing process is inadequate  Inspections of chemical tanks indicates low levels  Checks show low levels in chemical storage tanks	Inspections of levels in chemical tanks are undertaken by operators when they attend plant	Source sufficient chemical from other plants in District for immediate cleaning  Arrange delivery of chemical	Tank levels	Yes	Low  (rare x medium)	None required	TPO
Membranes production is less than optimal	4.6	Automated cleaning of membranes fails	Moderate  (possible x medium)	Membrane washing process is inadequate  Plant flow reduces	Membrane washing processes can be instigated and operated manually  24 hours storage provided across the system	Manually trigger membrane cleaning cycles while fault is corrected.	Plant flows	Yes	Moderate  (unlikely x medium)	None required	TPO
Membrane throughput is less than optimal	4.7	Air scour and flux maintenance fails	Moderate  (possible x medium)	Membranes air scour or flux maintenance as expected	24 hours storage provided across the system	Perform CIP	Plant flows over time  Perform CIP	Yes	Moderate  (possible x minor)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Micro-organisms pass through membranes	4.8	Membrane integrity testing process fails	Very high  (Possible x major)	Suspended solids and contaminants pass membrane  Increased turbidity in post filter water  Process indicates membrane testing failure	SCADA monitoring of integrity testing  24 hours storage provided across the system	Cease treatment if turbidity exceeds 0.1 NTU for more than 15 minutes and perform PDT to confirm membrane validity  If there is evidence of microbiological contamination, issue a boil water notice to all consumers  Identify faulty module and remove from bank for pinning	Plant flows  PDT test results  Telemetry alarm	Partially	Very high  (Possible x major)	Develop and implement controls to prevent changes to membrane vendor programming  Develop and implement audit process to confirm log removal validation	MWS
Particles not removed	4.9	Operator disables automated shutdown/PDT testing due to operational issues	Very high  (likely x major)	Treated turbidity exceeds 0.1NTU for more than 15 minutes without correct follow-up action  Treated turbidity exceeds raw water turbidity for more than 3 minutes with no follow-up action	SCADA monitoring of turbidity  Override requires programming.	Resolve issues with turbidity monitoring without delay  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	SCADA trends  PDT test results	Partially	Very high  (possible x major)	Develop and implement controls to prevent changes to membrane vendor programming  Develop and implement audit process to confirm log removal validation	MWS

5. Chlorination											
Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Inadequate Chlorination	5.1	Inadequate contact time	High  (likely x medium)	<i>E. coli</i> detected in water leaving the treatment plant	Contact time is provided in the storage reservoirs	Ensure chlorine dose remains above 0.5 mg/L and storage reservoir is in service	Nothing to check	Yes	Low  (rare x medium)	None required	TPO
Inadequate Chlorination	5.2	Sodium hypochlorite supply exhausted.	Very high  (possible x major)	Visual inspection of hypochlorite tanks indicates low level  Illness in community  FAC is less than 0.2mg/L or <i>E. coli</i> detected in water in the distribution system.  Low chlorine alarm activated	Operator visits the plant at least weekly to check hypochlorite levels.  Low chlorine alarm  Hypochlorite is delivered relatively soon after ordering	Replenish hypochlorite supply	Amount of hypochlorite available  FAC monitoring results from treatment plant	Yes	High  (unlikely x major)	None required	TPO
Inadequate Chlorination	5.3	Dosing system failure.	Very high  (possible x major)	FAC is less than 0.2mg/L or <i>E. coli</i> detected in water in the distribution system  <i>E. coli</i> detected in water leaving treatment plant  Chlorine alarm to operator	FAC is continuously monitored and alarmed for high or low chlorine levels	Repair chlorine dosing system	Operation of chlorine dosing system  FAC level at treatment plant and in distribution system	Yes	High  (unlikely x major)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Inadequate Chlorination	5.4	Chlorine dose rate incorrect	High  (likely x major)	FAC is less than 0.2mg/L or <i>E. coli</i> detected in water leaving the WTP  <i>E. coli</i> detected in water leaving treatment plant  Chlorine alarm to operator	FAC is continuously monitored and alarmed for high or low chlorine levels	Adjust dose rate as required	FAC level at treatment plant and in distribution system	Yes	Moderate  (unlikely x medium)	None required	TPO
Inadequate Chlorination	5.5	Chlorine demand exceeds chlorine dose due to high raw water turbidity	High  (likely x medium)	High turbidity in water leaving treatment plant  FAC is less than 0.2mg/L or <i>E. coli</i> detected in water leaving the WTP	Dose rate is flow proportional and adjusted by operators based on-line FAC results  Treatment process provides stable turbidity post filtration	Cease treatment if turbidity exceeds 1 NTU and supply from stored water  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Turbidity of water at treatment plant and in distribution system  FAC level at treatment plant and in distribution system	Yes	Moderate  (unlikely x medium)	None required	TPO
Inadequate Chlorination	5.6	Lack of chlorine due to dosing line failure or leak.	High  (likely x medium)	FAC is less than 0.2mg/L or <i>E. coli</i> detected in water leaving the WTP  Strong chlorine smell at treatment plant	FAC is continuously monitored and alarmed for high or low chlorine levels	Repair chlorine dosing line  Cease treatment if turbidity exceeds 1 NTU and supply from stored water  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	FAC level in distribution system and at treatment plant	Yes	Moderate  (unlikely x medium)	None required	MWS  TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Over Chlorination	5.7	Dosing system failure	Low  (unlikely x minor)	FAC level high  Taste and odour complaints	Dosing system is simple  FAC is continuously monitored and alarmed for high or low chlorine levels	Advise consumers of high chlorine and FAC in system  Flush network until FAC is lower than 0.5mg/L	FAC in water leaving treatment plant	Yes	Low  (rare x minor)	None required	TPO
Over Chlorination	5.8	Chlorine dose rate incorrect	Low  (unlikely x minor)	FAC level exceeds 1.5mg/L  Taste and odour complaints	FAC is continuously monitored and alarmed for high or low chlorine levels  Operators are trained in disinfection dosing  Operations manual outlines disinfection dosing procedures	Advise consumers of high FAC level in the distribution system	Operation of chlorine dosing system  FAC level in distribution system	Yes	Low  (rare x minor)	None required	TPO
Production of disinfection by-products	5.9	Organic material in raw water results in the production of disinfection by-products	Moderate  (likely x minor)	Testing identifies THMs which exceed 50% of DWSNZ MAV	Clarification and membrane filtration removes organic material	Maintain efficient level of filtration process	Level of THMs in treated water remains below 50%	Yes	Low  (unlikely x minor)	None required	MWS



## 6. pH Adjustment

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
pH Adjustment too High or Low	6.1	Dosing system failure	Moderate  (Possible x Medium)	pH of the water post treatment is outside required parameters	pH continuously monitored, post membranes data reported in SCADA	Repair fault without delay	pH levels in water leaving treatment plant  FACE levels in water leaving treatment plant	Yes	Low  (unlikely x minor)	None required	TPO
pH Adjustment too High or Low	6.2	Automated pH dosing control failure	High  (Likely x medium)	pH of the water post membranes is outside required parameters	pH continuously monitored, post membranes data reported in SCADA  pH dosing system can be manually operated to a set point	Repair fault without delay  Dose at fixed setpoint if possible	pH levels in water leaving treatment plant	Yes	Low  (unlikely x minor)	None required	TPO
pH Adjustment too High or Low	6.3	Caustic soda supplies exhausted	Moderate  (Possible x medium)	Low pH in water leaving the membranes or reservoirs	Inspection of levels in caustic soda tank is undertaken by operators when they attend plant	Replenish caustic soda supply	pH levels in water leaving treatment plant  FACE levels in water leaving treatment plant	Yes	Moderate  (unlikely x medium)	None required	TPO
pH Adjustment does not occur	6.4	Loss of caustic soda from bulk storage tank.	Very high  (possible x major)	Caustic soda identified in tank bunding  Low pH in water leaving membranes or reservoirs	Chemicals held in self banded tanks	Replenish caustic soda supply	pH levels in water leaving treatment plant	Yes	Low  (unlikely x minor)	None required	TPO

## 7. Storage

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Microbiological contamination	7.1	Leakage through reticulation reservoir roof or other parts of structure or access by birds or vermin.	Very high  (possible x major)	Visual evidence of leakage  <i>E. coli</i> in water leaving reservoir  Decreased FAC in water leaving reservoir.	Residual chlorine in water.  Reservoir is covered and all entry hatches are secured and locked against ingress  Regular inspection of reservoirs is carried out	Repair any reservoir leaks or bird and vermin access points without delay	Leakage from reservoirs  Access points for birds and vermin  Evidence of birds or vermin inside reservoirs	Yes	Moderate  (unlikely x medium)	None required	TPO
Microbiological or chemical contamination	7.2	Vandalism to reservoirs.	Moderate  (possible x medium)	<i>E. coli</i> in water leaving reservoir  Decreased FAC in water leaving reservoir  Reports from the public	Residual chlorine in water  Reservoirs are located on private farmland away from public road	Inspect reservoir in response to reports of suspicious activity	Access hatches	Yes	Moderate  (unlikely x medium)	None required	TPO
Microbiological contamination	7.3	Sediment/slime accumulation within reservoirs	Moderate  (possible x medium)	Visible suspended matter in water exiting reservoir  Decreased FAC in water leaving reservoir.  Complaints from consumers	Residual chlorine in water  Regular inspection of reservoir is carried out and cleaning undertaken if required	Isolate and clean reservoirs as required	Check accumulation of sediment in reservoirs every 5 years	Yes	Moderate  (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of supply	7.4	Failure of reservoir	Very high  (likely x major)	Complaints from consumers about loss of supply or pressure  Obvious signs of leakage or failure at reservoir site	There is a total of seven reservoirs at the treatment plant each of which can be isolated  The treatment plant reservoirs can supply the network directly in the event of the reticulation reservoir failing	Isolate faulty reservoir and use others	Structural integrity of reservoirs	Yes	Moderate  (rare x major)	None required	TPO
Loss of supply	7.5	Insufficient storage for peak demand	Very high  (likely x major)	Loss of water or pressure in reticulation  Frequent low reservoir levels	Low reservoir alarm  Drought management plan  More than 24 hours of stored treated water	Implement water restrictions in accordance with drought management plan	Reservoir levels and alarms	Yes	Moderate  (unlikely x medium)	None required	TPO

## 8. Service Pumps

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of Supply	8.1	Pump failure due to power outage	High  (likely x medium)	No pump activity  Reduction in storage reservoir water level	Portable generator available as a backup power supply  24 hours storage is provided across the system  Supply agreement with power company for reinstatement	Use generator if required	Reservoir levels	Yes	Moderate  (unlikely x medium)	None required	TPO
		Pump mechanical failure	Moderate  (possible x medium)	No pump activity  Low reservoir levels or loss of pressure in reticulation	Two pumps used in duty/standby arrangement  Planned and routine maintenance undertaken including basic lubrication and greasing of pumps  24 hours storage is provided across the system	Repair pump faults without delay	Reservoir levels	Yes	Moderate  (unlikely x medium)	None required	TPO

## 9. Reticulation

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of Supply	9.1	Pipe failure.	Moderate  (possible x medium)	Complaints from consumers about loss of supply.  Change in flow or pressure in reticulation.	Pipe failures are repaired as a priority by panel contractor	Repair all pipe failures without delay	Reports of pipe failures	Yes	Moderate  (unlikely x medium)	None required	MWS  RC
Microbiological Contamination	9.2	Inadequate controls on maintenance and construction work.	Moderate  (possible x medium)	Complaints from consumers about taste or odour  <i>E. coli</i> present in reticulation system  Less than expected FAC in reticulation	Maintenance and replacement work is supervised by a degree qualified Engineer, with work carried out by registered drain layers/plumbers  Specialist contractors used when required	Ensure satisfactory FAC level in distribution system whenever repairs or maintenance are undertaken	Sanitation procedures and sanitation practices of contractors	Yes	Moderate  (unlikely x medium)	None required	RC
Microbiological Contamination	9.3	Poor circulation leading to biofilm growth.	Moderate  (possible x medium)	High HPC count  Taste or odour complaints from consumers.  Reduced FAC in water	Routine flushing programme in place, carried out by contractor  Residual chlorine in water	Flush or air scour affected mains  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	FAC levels	Yes	Moderate  (unlikely x medium)	None required	MWS  RC
Microbiological Contamination	9.4	Contamination through insanitary sampling procedures.	Moderate  (possible x medium)	<i>E. coli</i> present in samples from the reticulation system.	Residual chlorine in water  Sampler is qualified (Bachelor of Applied Science)	If there is evidence of microbiological contamination, issue a boil water notice to all consumers	FAC levels	Yes	Moderate  (unlikely x medium)	None required	MWS  RC

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Chemical/Microbiological Contamination	9.5	Backflow from consumer connections.	Very High  (likely x major)	Contaminants identified in the reticulation system.  Taste or odour complaints from consumers.	Work is underway to ensure all residential connections have double check valves and 50mm or larger connections have RPZ backflow preventers  Chlorine residual in water	Maintain FAC in distribution system	Land-use and building use changes  Test backflow devices	Partially	High  (likely x medium)	Prepare and implement a formal backflow protection policy that identifies all risk sites, ensures suitable backflow protection devices are installed and all backflow protection devices are tested appropriately	MWS
Supply of Turbid Water	9.6	Silt build up within reticulation pipes.	Moderate  (possible x minor)	Reduced flows in reticulation.  Complaints from consumer about quality of water	Routine flushing programme in place	Flush affected mains  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Dirty water complaints	Yes	Low  (unlikely x minor)	None required	RC
Inadequate Supply of Water	9.7	Poor quality workmanship or inappropriate materials used for reticulation pipes and fittings	Moderate  (possible x medium)	Contaminants identified in the reticulation system.  Taste and odour complaints from consumers  Reduced FAC in water	Waitomo District Council requires all work and materials used in reticulation to meet standard specifications  Best practice approach taken to reticulation work	Redo work that has been poorly undertaken  Replace any materials that do not meet minimum specifications	Quality of work undertaken  Types of material used	Yes	Moderate  (unlikely x medium)	None required	RC
Pipe Damage	9.8	Water hammer causes damage to reticulation system	High  (likely x medium)	Clear evidence of water hammer  Customer complaints	Water hammer is managed as best it can be	Repair all pipe failures without delay	Reports of pipe failures	Partially	High  (likely x medium)	Install a dedicated rising main from the treatment plant to the reservoir	MWS

## 10. Other

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Sampling Failure	10.1	Inadequate sampling programme, sample or data collection error.	High  (likely x medium)	DWSNZ compliance failure due to days of week, days between samples, insufficient samples, information gaps, positive results or sampling error	Sampling programme prepared and checked against standards.  Chlorine, turbidity and pH continuously monitored at treatment plant.	Review sampling programme  Investigate and remedy cause of data loss	Sampling programme against DWSNZ  Data set is complete	Partially	Moderate  (possible x medium)	Improve continuous monitoring systems to avoid loss of data, and ensure timely provision of data to DWA.	MWS
Unidentified Operational Failure	10.2	Insufficient monitoring and alarming of key operational data	Very High  (likely x major)	Contamination identified in supply.  Operational near miss identified  Inadequate information collected to provide confidence in supply operation	Supply is continuously monitored and alarmed by telemetry for FAC, turbidity, and pH.  Critical instrumentation is calibrated annually by the suppliers  Weekly verification and monthly calibration is performed by the Operators	If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Telemetry alarms	Yes	High  (unlikely x major)	None required	MWS  TPO
Failure due to Inadequate Maintenance	10.3	Supply equipment fails due to inadequate asset information and inadequate maintenance planning	Moderate  (possible x medium)	Unexpected plant equipment failure.  Not having an asset register and maintenance programme	Planned and routine maintenance undertaken including basic lubrication and greasing of pumps	Attend to failure as a priority  Plan to renew or improve assets as required	Condition and forward planning for asset renewal	Yes	Moderate  (unlikely x medium)	None required	MWS

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Failure due to unavailability of spare parts	10.4	Inadequate spare parts held or spare parts unavailable	Moderate  (possible x medium)	Plant is out of operation due to missing parts	Spare parts are held for critical components  Replacement spares are usually available overnight  More than 24 hours storage	Replace spare parts as used	Spares in stock and within use by date	Yes	Moderate  (unlikely x medium)	None required	TPO
Operator Error or Mismanagement	10.5	Inadequate training, professional development and upskilling of operators	Very high  (possible x major)	Poor operation of plant  Plant compliance failure  Loss of supply  Poor score on question about level of supervision in supply grading	One operator is qualified to certificate level, the other operator is currently working towards this.  Manager Water Services is an experienced and qualified engineer	Provide in-house training where abilities are in deficit	Operator abilities, knowledge and training qualifications	Partially	Very high  (possible x major)	Develop model training and skills maintenance plan for existing and new operators.	MWS
Failure due to inadequate operating procedures	10.6	Inadequate, out of date or incorrect manual or operational procedures.	Moderate  (possible x medium)	Standard Operating Procedures (SOP) not used.  SOPs not up to date.  SOP copies are not the same.	SOPs have been prepared for Piopio water supply.	Revise SOP/manual and provide refresher training	SOPs current and up to date	Yes	Moderate  (unlikely x medium)	None required	MWS  TPO



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Failing to meet the requirements of the DWSNZ	10.7	Treatment processes are not sufficient to comply with the requirements of the DWSNZ	Extreme  (almost certain x major)	Treatment processes at the treatment plant do not comply with the DWSNZ	Coagulation, clarification, membrane filtration and Chlorination are in place for 4 Log removal	Upgrade plant  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	DWSNZ compliance data	Yes	High  (unlikely x major)	None required	MWS  TPO
Microbiological or chemical contamination	10.8	Events for any reason result in contamination of the supply	Very High  (possible x major)	Sampling results indicate contamination  Illness in the community	Water is filtered with membranes and disinfected with chlorine	If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Sampling results indicate contamination  Evidence of illness in the community	Partially	Moderate  (rare x major)	Prepare a drinking water supply contamination response plan	MWS
Water not treated or supplied	10.9	Power outage prevents water treatment plant operating	Moderate  (possible x medium)	Treated water not leaving treatment plant  Telemetry alarm  Telemetry does not provide any information	Flow through treatment plant is continuously monitored and telemetered to WDC  More than 24 hours treated water supply and reticulation is gravity fed  Portable generator located in Te Kuiti which can operate plant	Use portable generator to maintain supply until fault is rectified  If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Power at plant  Reservoir levels	Yes	Moderate  (unlikely x medium)	None required	MWS

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Total Plant Failure	10.10	Catastrophic natural disaster or failure including earthquake and flooding	High  (rare x catastrophic)	Major natural disaster occurs	Prior warning from Govt agencies incl Met Office, Niwa, Civil Defence, Regional Council or Police  Robust secure plant structures and buildings  Business continuity plan in place and exercised  Emergency response plan	Implement all measures necessary to ensure plant continues to operate in a natural disaster	Prior warnings issued by Govt agencies incl Met Office, Niwa, Civil Defence, Regional Council or Police	Yes	Moderate  (rare x major)	None required	MWS
				Intense sustained weather							TPO
				Land slide, flooding, volcanic eruption							RC
				Total plant failure is evident							
				Warnings from Govt agencies incl Met Office, Niwa, Civil Defence, Regional Council or Police							

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