Ngaruawahia Water

Supply Water Safety Plan

Organisation and Supply Details:

Community Name	Ngaruawahia (NGA002)
Supply owner/organisation name:	Waikato District Council
Prepared by:	CH2M Beca Ltd and Waikato District Council staff
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1 Revision Details

This plan will be revised and submitted for approval before 1 March 2023.

Assessment of the Performance of the Plan
Assessment of the performance of the Water Safety Plan (WSP) 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 Water Supply Activity Management Plan and if requiring significant capital funding, the Council Long Term Plan.

Reporting of the Plan
A brief report on the performance of the WSP, including information from the assessment of the plan will be provided by the Compliance and Income Team Leader to the Treatment and Services Team Leader in February of each year. The report will cover the items listed in the assessment of the performance of the plan, listed above. The Treatment and Services Team Leader will be responsible for ensuring that any matters requiring attention will be appropriately included into the Annual Plan or the Water Supply Activity Management Plan. If significant capital funding is required the Treatment and Services Team Leader 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 Water Supply Activity Management Plan and the Long Term Plan.

2 Introduction

This Water Safety Plan (WSP) has been prepared for the Ngaruawahia water supply to identify potential events that present public health risks to the consumers of the drinking water supply. Waikato District Council (WDC) is committed to the WSP and to the future improvements to the supply identified in this WSP.

A Public Health Risk Management Plan (PHRMP) was first prepared by Opus International Consultants Ltd for the Ngaruawahia supply in 2009. This WSP has been prepared using the original PHRMP as a starting point but including more up to date information following inclusion of the Zones Hopuhopu TAU002HO and Taupiri TAU002TA in March 2016, and further consultation.

The Ngaruawahia drinking water supply is a small urban supply providing water to a population of approximately 6,879 people in the towns of Ngaruawahia, Horotiu, Hopuhopu and Taupiri.

The water is sourced from the Waikato River before it undergoes conventional treatment at the Ngaruawahia Water Treatment Plant (WTP). The water is then pumped from the treatment plant clear water tank to reservoirs from where the water gravity feeds to the reticulation and storage reservoir. water main is currently in works from Ngaruawahia WTP to Huntly WTP, to help with the productivity of Ngaruawahia WTP as a boost/ water line to be completed by December 2018.

The scheme is administered at the main WDC offices in Galileo Street, Ngaruawahia and managed by the Waters Manager.

The management, maintenance and operation of the Ngaruawahia water supply is the responsibility of:

- Waters Manager – Karl Pavlovich
- Treatment & Services Team Leader – Vacant
- Treatment Supervisor – David Kennington
- Compliance and Income Team Leader – Jaime Wara
- Water Planning Team Leader – Richard Pullar
- Six Treatment plant operators with expected qualifications of Level 4 Waters
- Five Reticulation serviceman and Two cadets with expected qualifications of Level 4 Waters

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3 Supply Details

Table 1. Summary of Ngaruawahia Water Supply Details

Supply Details	
Supply Name	Ngaruawahia
WINZ Community Code	NGA002
Supply Owner	Waikato District Council
Population Served by Supply	6,879 (WINZ register March 2016)
Source Details	
Source Name	Waikato River for Ngaruawahia
Source WINZ Code	S00070
Type of Source	River
Depth of Bore	NA
Consent Expires	30 June 2050
Maximum Consented water take:	1 July 2015 to 30 June 2021 - 4,400 m^3/day 1 July 2021 to 30 June 2027 - 4,500 m^3/day 1 July 2027 to 30 June 2033 - 4,600 m^3/day 1 July 2033 to 30 June 2039 - 4,800 m^3/day 1 July 2039 to 30 June 2050 - 5,000 m^3/day
Grid Reference of Source (NZMG)	
Easting : 1788532	**Northing** : 5828756
Treatment	
Location	Ngaruawahia
Treatment Processes	Clarification; Filtration; UV; Chlorination; Fluoridation
Average Daily Volume	2,800 m^3/day
Peak Daily Volume	3,900 m^3/day
Distribution – Zone 1	
Distribution Zone Name	Ngaruawahia
Distribution Zone WINZ Code	NGA002NG
Distribution Zone Population	5,691 (WINZ register March 2016)

Distribution – Zone 2	
Distribution Zone Name	Horotiu
Distribution Zone WINZ Code	NGA002HO
Distribution Zone Population	459 (WINZ register March 2016)
Distribution – Zone 3	
Distribution Zone Name	Hopuhopu
Distribution Zone WINZ Code	TAU002HO
Distribution Zone Population	200 (WINZ register March 2016)
Distribution – Zone 4	
Distribution Zone Name	Taupiri
Distribution Zone WINZ Code	TAU002TA
Distribution Zone Population	529 (WINZ register March 2016)

4 History of the Ngaruawahia Water Supply

The Ngaruawahia water supply was first established in 1923 by taking water from three dams constructed on “Firewood Creek” in the Hakarimata Hills and delivered untreated through a reticulation system. In the 1950’s, as a result of demand exceeding supply and fears of microbiological contamination, the source was changed and water was taken from bores drilled at the area known as The Point (at the confluence of the Waipa and Waikato Rivers).

In 1965 a treatment plant was built to deal with human contaminations and the presence of iron. The processes included aeration, filtration and chlorination. Fluoridation of the supply commenced at about the same time. Treated water was stored in a 1,150m^3 reservoir and gravity fed to the town. Because the filtration process at the treatment plant was inadequate for removing the iron, the Ngraruawahia Town Borough moved to the Waikato River as the source.

In 1973 a new intake structure was constructed and a clarification plant was introduced to the treatment plant and an additional 1,150m^3 reservoir was constructed in 1981.

The Horotiu area was originally supplied with water sourced and treated by the AFFCO Beef Works. The scheme drew water from the Waikato River, treated and stored it before using it for beef processing and supplying consumers. In 2000, AFFCO discontinued supplying the local community and the Horotiu water supply was amalgamated with the Ngaruawahia supply.

Significant investment has been made in recent years into dosing equipment, monitoring instrumentation, and process controls in order to improve and ensure the final water quality.

In early 2016 a new watermain connecting Ngaruawahia and Taupiri - Hopuhopu was commissioned and the Hopuhopu water treatment plant decommissioned. Water supplied from the Ngaruawahia water treatment plant now also supplies the Hopuhopu and Taupiri zones.

The Waikato River is known to sometimes contain cyanobacteria algal blooms during the warmer summer months. A powdered activated carbon dosing system has subsequently been installed at the treatment plant to be used in the event of cyanotoxin contamination.

5 Description of the Ngaruawahia Water Supply

The Ngaruawahia water treatment plant is located on Brownlee Avenue, Ngaruawahia. The treatment process is a conventional coagulation, clarification, filtration design with chlorine disinfection and provides potable water for domestic, commercial and industrial needs. The supply has four distribution zones; Ngaruawahia, Horotiu, Hopuhopu and Taupiri. Urban areas are provided an on-demand supply, and rural areas are provided a restricted supply.

Because the Ngaruawahia WTP abstracts raw water from the Waikato River, the primary water quality concerns are microbiological - protozoa, bacteria / viruses and cyanobacteria. The Waikato River water is low in turbidity but reasonably high in colour. Quality is also relatively constant compared to most surface waters, being heavily influenced by Lake Taupo and hydro-electric impoundments along the river.

Figure 1. Location of Ngaruawahia Water Supply Network

5.1 Intake

Raw water is abstracted from the Waikato River at an intake near to the treatment plant. Screening on the intake prevents debris and aquatic life from being included in the abstracted water. An automated air backwash system, using one compressor, is fitted to ensure the screen does not block. Two submersible pumps are used in duty / standby arrangement to abstract raw water. A flow meter

monitors the rate of abstraction. Abstracted water is dosed with Powdered Activated Carbon (PAC) seasonally at the intake.

An electrical connection is provided for backup power generation using a portable generator.

5.2 Water Treatment Plant – Lower Section

Raw water turbidity and pH is continuously monitored. Alum and polyelectrolyte is dosed prior to entering the flash mixer tank (effective mixing is achieved through the use of an in-line static mixer prior to the flash mixer tank). Alum pumps act in duty / assist arrangement, poly pumps act in duty / standby arrangement. The infrastructure exists for pH correction to optimise coagulation, but its use is not required. Coagulated water pH is continuously monitored. The coagulant dose rate is set proportional to flow and trimmed using the output from the streaming current meter. Jar testing is undertaken to set the correct coagulant dose rate. Flow is then divided between two clarifiers. A single turbidimeter monitors the combined water leaving the clarifiers. Sludge from the clarifiers is discharged to the sewer system.

Following clarification the water is dosed with caustic soda, using pumps in duty / standby arrangement, for final pH correction and pumped from a lift pump station, containing two pumps operating in duty / standby configuration, to three rapid gravity sand filters to be filtered. Fluoride is dosed pre filters using one pump.

An electrical connection is provided for backup power generation using a portable generator.

5.3 Water Treatment Plant – Upper Section

Each filter has two beds. The filter media is a mixture of sand and pumice. Backwashing of the filters is carried out at regular time intervals but can also be triggered by high turbidity, headloss or manual intervention. Backwash air scour is provided by one blower. Backwash water is drawn from the clear water tank and supplied by one pump. Backwash waste water from the filters is discharged to a neighbouring stream. The turbidity of filtered water leaving each sand filter is monitored by individual turbidimeters and a filter to waste facility is in place following filter backwash and if raised turbidity levels are detected.

A UVT meter measures the filtered water transmissivity prior to the UV reactors.

Two UV reactors, acting in duty / manual standby configuration, disinfect the filtered water.

The water is chlorinated post UV with chlorine gas using one chlorinator. Chlorine dosing is feedback controlled to a set point and automatically adjusted. The chlorine dosing system uses pressurised feed water and a venturi vacuum delivery. One 920kg drum and one 70kg cylinder, acting as duty / standby, are kept at the treatment plant. After chlorination the water enters a clear water tank that provides 30 minutes contact time.

Clear water tank chlorine, pH and fluoride are continuously monitored. The clear water tank is fitted with two pumps, acting in duty / standby configuration, which pump final water to the upper reservoirs on-site. Water controlled via an altitude valve gravitates to the lower reservoir. Each reservoir has

1,150m^3 capacity. The reservoirs are alarmed for high and low water level, sending a message to the duty operator.

The final water is continuously monitored for turbidity, chlorine, pH and fluoride using duplicate instrumentation. The results are telemetered to the WDC office. The monitoring equipment is calibrated weekly and validated quarterly.

An electrical connection is provided for backup power generation using a portable generator.

5.4 Reticulation

The treated water gravitates to the reticulation and Hopuhopu reservoir (1,134 m^3 capacity). The reservoir is alarmed for high and low water level, sending a message to the duty operator. Much of the distribution network has been replaced over the years and it is now made up of PE, HDPE and PVC pipes.

5.5 Management

The treatment plant and the reticulation system are managed and operated by two different teams within WDC.

All of the Ngaruawahia water supply assets are managed using the WDC's asset management system.

The land on which the plant components are located is owned by WDC.

6 Photographs of Ngaruawahia Water Supply

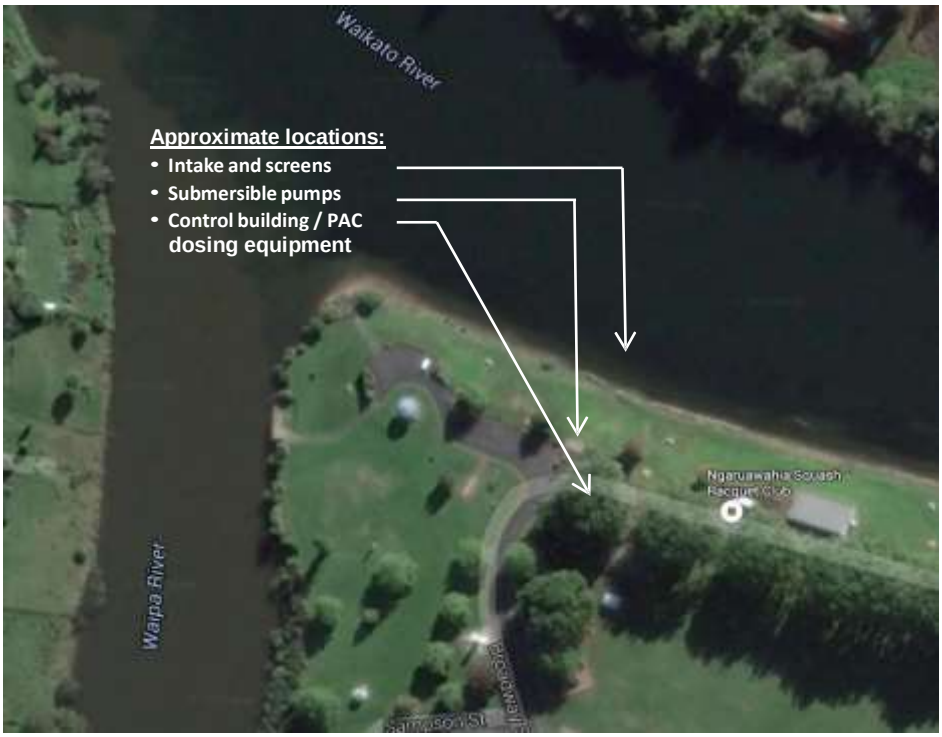


Figure 2 Intake Structures

Figure 3 Water Treatment Plant – Lower Section

Figure 4. Flash Mixer Tank

Figure 5. Coagulant Dosing Control Equipment

Figure 6. Coagulation Dose Pumps

Figure 7. Clarifiers

Figure 8. Water Treatment Plant – Upper Section

Figure 9. Sand Filter

Figure 10. Individual Filter Turbidity and Flow Monitoring Equipment

Figure 11. CWT and Final Water Quality Monitoring Equipment

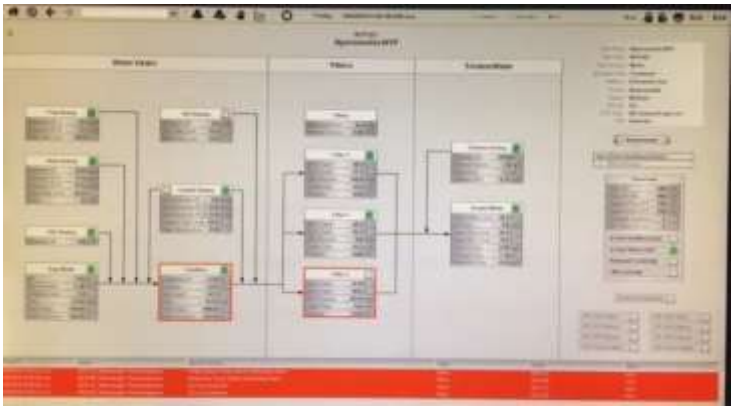
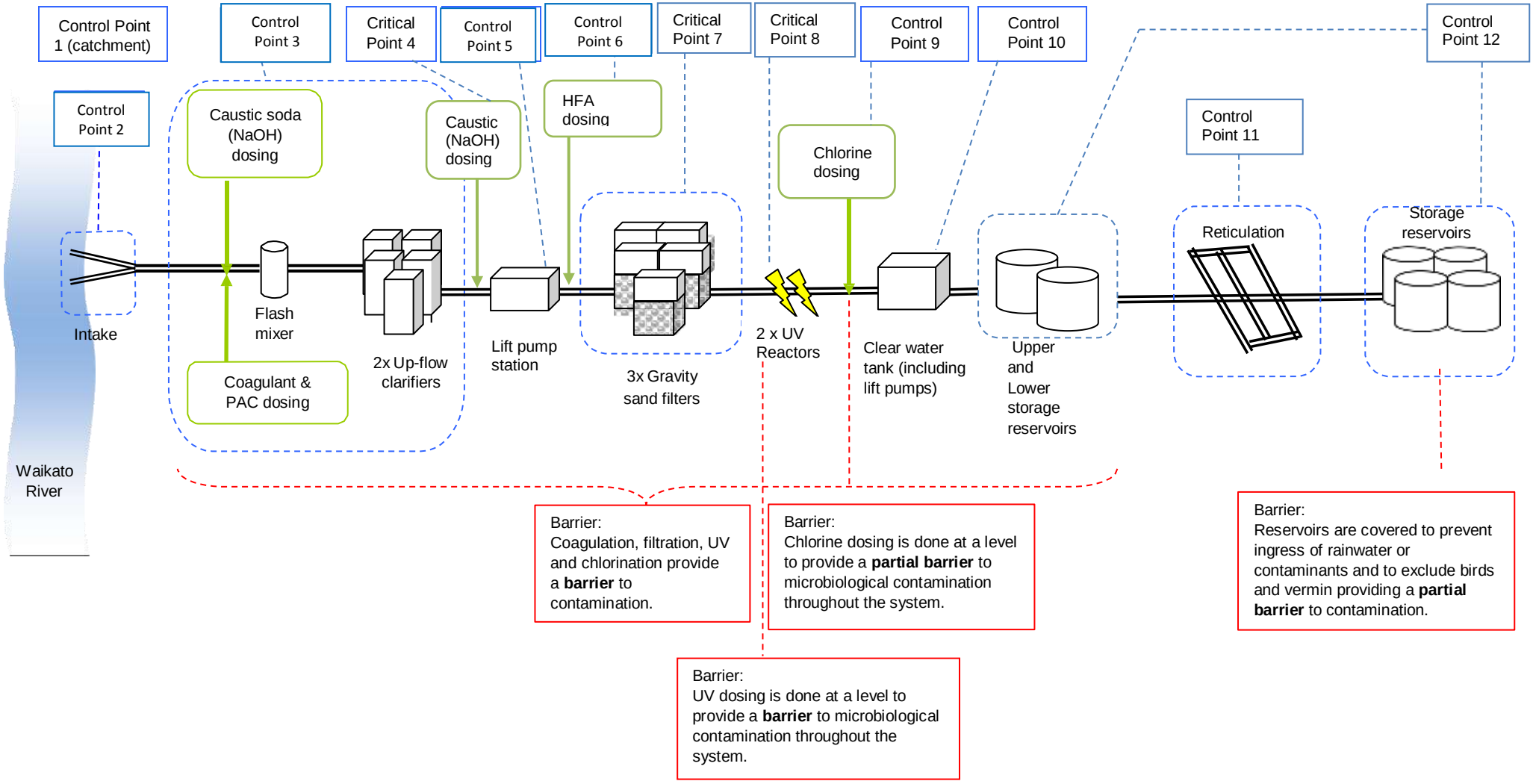


Figure 12. MMI Plant Overview Screen

Figure 13. UV Reactors

7 Flow Chart / Schematic of the Supply



8 Barriers to Contamination

Table 2. Control and Critical points

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

	Critical Point	Description
1.	Catchment	*Possible access point for contamination.*
2.	Intake	*Pump failure means eventual loss of supply.*
3.	Coagulant / flocculation / sedimentation / PAC dosing	*Failure will result in reduced particle and pathogen removal in the clarification and filtration processes.* *Failure of PAC dosing will inhibit cyanotoxin removal.*
4.	pH adjustment	*Failure could result in a lack of coagulation control and failure to meet pH guideline values.*
5.	Lift pumps	*Pump failure means eventual loss of supply.*
6.	HFA dosing	*Failure will result in residual HFA exceeding MAV*
7.	Filtration	*Failure will result in reduced organic matter, particle and pathogen removal.*
8.	UV disinfection	*Failure will result in reduced protozoa inactivation.*
9.	Chlorine dosing	*Failure will result in compromised bacterial inactivation.* *Overdosing may exceed chemical MAV.*
10.	Clear water tank	*Possible point for contamination.* *Pump failure means eventual loss of supply.*
11.	Reticulation	*Possible access point for contamination.* *Possible access point for contamination due to backflow.*
12.	Reservoirs	*Possible point for microbiological contamination.*

Existing barriers to contamination include:

1. Coagulation, Clarification and Filtration

The treatment plant uses the addition of coagulants to stabilise and flocculate contaminants to enable settling and filtration of the water removing microbiological organisms, organic material and suspended solids. PAC dosing provides removal of cyanotoxins when they are present in the source water. This process step **provides a barrier to pathogen and particulate and cyanotoxin contamination**.

2. Chlorination

The treatment plant uses chlorination to disinfect the water of non-protozoan microbiological organisms. As there is at least 30 minutes contact period before the chlorinated water is distributed to consumers, this provides **a barrier to bacterial and viral contamination**.

3. UV Disinfection

The treatment plant uses UV disinfection to inactivate microbiological organisms that have not been removed by the filtration process. This provides a **barrier to microbiological contamination.**

4. Prevention of Contamination of Treated Water while it is in the Network Reticulation

The following measures contribute to provision of a **barrier against recontamination** of water following treatment:

- Chlorine dosing is done at a level to ensure it is available to protect the water against microbiological contamination throughout the storage and reticulation.
- Hygiene procedures are documented and followed for all distribution system maintenance.
- Operators are trained and experienced.

5. Prevention of Contamination of Treated Water in Storage

The reservoirs 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.

The process control summaries for identified Critical Control Points (Critical Points) are stored in Council's Promapp process management online repository.

9 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 treatment plant provides good quality water and can meet the Drinking Water Standards New Zealand (DWSNZ) requirements for 4-log protozoa removal.

Improvements to the operation and management of the supply will further reduce the risk of poor

quality water being provided to consumers.

10 Methodology

This WSP has been prepared in accordance 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 have been prepared for the required improvement measures. Implementation timeframes will be discussed and agreed between the Treatment Services Team

Leader and the Treatment Supervisor at the start of the financial year. Implementation of the Improvement Schedule is ultimately subject to Council funding approval.

The Treatment and Services Team Leader is responsible for implementation of improvements, subject to community and WDC approvals, funding constraints and availability of resources. The Compliance and Income Team Leader is responsible for ongoing review and updating of the WSP and associated Improvement Schedule.

Contingency Plans have been prepared to provide guidance in event that control measures fail to prevent the occurrence of a risk event that may present acute risk to public health. The Treatment Supervisor is 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
- Intake
- Coagulation, Flocculation and Sedimentation / PAC Dosing
- pH Adjustment
- Lift Pumps
- Fluoridation
- Filtration
- UV Disinfection
- Chlorination
- Clear Water Tank and Lift Pumps
- Reticulation
- Reservoirs
- Other

11 Risk Ranking Procedure

The tables in this section identify the possible public health risks in each part of the supply. Each risk or possible 'event' which might occur has been evaluated based on the likelihood of the event occurring and the consequence (or outcome) if it occurs.

For the purposes of this WSP, categories for likelihood and consequence have been adapted from those in the 2014 MoH Guide, in order to make them more appropriate to this supply. These adapted ratings are given below in Table 3 and Table 4. The overall risk estimate derived from the product of likelihood and consequence is provided in Table 5.

Table 3. Likelihood Scale

Likelihood	Description
Almost certain	Is expected to occur in most circumstances.
Likely	Will probably occur (once in 1 or 2 years)
Possible	Might occur at some time (once in 10 years)
Unlikely	Could occur at some time (once in 50 years).
Rare	Only in exceptional circumstances (once in 100 years).

Table 4. 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 5. Risk Level Allocation Table

	Consequence				
Likelihood	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

12 Improvement Schedule

The improvement schedule is derived from the risk tables that follow in Section 16. The improvement schedule outlines improvements that have been recommended for preventing, reducing or eliminating the identified public health risks in the Ngaruawahia drinking 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. Detail, further to that contained in Tables 3 and 4 can be found be following the number in the Reference to Risk Table column. It should be noted that costs are estimates only. Each project is ranked according to the priority to which projects should be completed. Improvement timelines will be enacted as per the improvement schedule adopted by The Waikato District Council Asset Management Plan 2017.

- TSTL – Treatment and Services Team Leader
- TS – Treatment Supervisor
- CITL – Compliance and Income Team Leader
- WPTL - Water Planning Team Leader

Table 6. Capital and Significant Projects

Priority	Risk Level	Water Supply Area	Reference to Risk Table	Proposed Works	Person Responsible	Expected Cost	Timeframe
1	High	Other	11.11	Seismic structural review and implementation of seismic strengthening of existing water infrastructure where required. Preparation of an earthquake response plan.	TSTL	Not quantified	2021-22

Priority	Risk Level	Water Supply Area	Reference to Risk Table	Proposed Works	Person Responsible	Expected Cost	Timeframe
2	Moderate	Other	11.10	Install computer hard drive process data storage capacity at the treatment plant as the primary data storage for the treatment plant.	TSTL / TS	$10,000	2021-22
3	Moderate	Other	11.1	Ensure sampling programme is reviewed by independent person. Ensure sample collection follows sampling programme.	CITL	Staff time	2018-19
4	Moderate	Other	11.5	Evaluation of required spares to be undertaken following asset criticality assessment.	WPTL	Staff time	2019-20
5	Moderate	Intake	2.1, 2.2, 2.3, 2.4, 2.6	Implement a contingency plan in case temporary floating pumping is required.	TS	Staff time	2019-20
6	Moderate	Intake, Coagulation, Flocculation and Sedimentation / PAC Dosing, Lift Pumps, Filtration, Clear Water Tank and Lift Pumps	2.5, 3.7, 5.1, 6.4, 8.2	Ensure WDC owned generators are serviced. Ensure generator supplier agreements are set up.	TS	Staff time	2018-19

Priority	Risk Level	Water Supply Area	Reference to Risk Table	Proposed Works	Person Responsible	Expected Cost	Timeframe
7	Moderate	Reservoirs	10.2	Restrict access to reservoir sites through construction of appropriate fencing and install alarms on reservoir access hatches.	TSTL	$50,000	2021-22
8	Moderate	Reservoirs	10.1	Ensure all hatches and possible entry points for rainwater, plant matter, insects, birds, vermin etc. are secure against ingress or access. Implement routine inspection of the reservoirs.	TS	Staff time + $3000	2022-23
9	Moderate	Clear Water Tank Lift Pumps	8.1	Install bypass pipe from filter wet well to clear water tank outlet pipe. (Bypassing treatment plant clear water tank).	TSTL	$50,000	2022-23

Table 7. Operational Improvements and Minor Projects

Priority	Risk Level	Water Supply Area	Reference to Risk Table	Proposed Works	Person Responsible	Expected Cost	Timeframe
1	High	Other	11.7	Provide ongoing annual training to maintain operator competence. Provide water treatment operator training.	TSTL / TS	Staff time + $15000	2018-19
2	Moderate	Other	11.4	Review the process for planning and recording of preventative maintenance. Prepare a preventative maintenance plan for the treatment plant.	TS	Staff time	2019-20
3	Moderate	Catchment	1.1, 1.2	Investigate optimising iron and manganese removal.	TSTL	Staff time	2019-20
4	Moderate	Reticulation	9.1	Review and upgrade documentation procedures for pipe renewal and maintenance. Review the process for planning and recording of preventative maintenance.	WPTL	Staff time	2020-21
5	Moderate	Reservoirs	10.3	Implement routine inspection and cleaning of storage reservoirs.	TSTL / WPTL	Staff time	2018-19
6	Moderate	Other	11.6	Undertake a review of the operational manual and standard operating procedures for the treatment plant. Update, complete and finalise where necessary.	TS	Staff time	2019-20

Priority	Risk Level	Water Supply Area	Reference to Risk Table	Proposed Works	Person Responsible	Expected Cost	Timeframe
7	Moderate	Other	11.9	Undertake testing for aesthetic determinands and compare against DWSNZ Guideline Values.	CITL	Staff time +$4000	2021-22
8	Moderate	Filtration	6.3	Implement a contingency plan in case temporary air blower is required.	TS	Staff time	2021-22
9	Moderate	Coagulation, flocculation and Sedimentation / PAC Dosing	3.8	Check that supplier agreement states the quality to which the chemical has to meet.	TS	Staff time	2019-20
10	Low	Filtration	6.2	Plan regular checking of the condition and depth of the filter media.	TS	Staff time	2019-20
11	Low	Reticulation	9.7	Implement routine flushing programme for reticulation.	TSTL	Staff time	2018-19

13 Drinking Water Standards and Grading

At the time of writing of this report the Ngaruawahia water supply demonstrates an ability to fully comply with DWSNZ. Table 5 below shows a summary of the compliance with the drinking water standards to date.

The treatment plant at Ngaruawahia is currently graded U, the distribution zones are graded as follows:

- Ngaruawahia e
- Horotiu e
- Hopuhopu e
- Taupiri e

These gradings are out of date and do not reflect the supply's current capability.

Table 8. Summary of Compliance with DWSNZ

Standards compliance assessed against.	DWSNZ 2005 (revised 2008).
Secure bore water.	NA
Bacterial compliance criteria used for water leaving the treatment plant.	Criterion 2A (continuously monitored chlorination).
Protozoa log removal requirement required for the supply.	Waikato River has been accepted as requiring 4-log removal.
Protozoa treatment process.	Coagulation, clarification, sand filtration and UV (one installed) would provide 7 log removal.
Compliance criteria 6A or 6B is used for water in the distribution zone.	Criterion 6A.
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.	Yes.
Bacteria compliance for water in the distribution zone has been achieved for the last 4 quarters.	Yes.
P2 determinands allocated to supply.	Fluoride.
Chemical compliance achieved for the last 4 quarters.	Yes.
Cyanobacteria identified in the supply.	Yes
Cyanobacterial compliance has been achieved for the last 4 quarters.	Yes

14 Consultation

A site visit was undertaken at the Ngaruawahia water supply by those involved in the preparation of the WSP and WDC staff. The WDC staff provided input into identifying the systems, procedures and practices that are currently in place to prevent, reduce and mitigate risks.

The plan was then modified to take account of required updates.

Subsequent to this consultation telephone discussions and email contact has been used to provide information necessary for the preparation of this WSP. The WSP was then reviewed by all divisions of the water team and signed off by the Waters Manager.

The information provided during this consultation has been used to compile the risk tables.

15 Contingency Plan

Ngaruawahia Water Supply Contingency Plan	
Type of Event	***Required Contingency Action***
An earthquake may cause damage to the source, treatment plant or distribution system. The water supply may be shut down as a result.	Contact the Ministry of Civil Defence in the event of an earthquake emergency. (Keep a list of the contact details for the nearest Ministry office and of the Earthquake Commission). Check all structures associated with water storage, abstraction, treatment and distribution. If water supply structure is damaged so that water cannot be distributed, or cannot be distributed with a satisfactory quality, use alternative supply. Provide another source of potable water until water of acceptable quality can again be supplied. Advise Drinking Water Assessor (DWA). Keep customers informed and advise once regular service is restored.
Inadequate chlorination. Indicators: Low FAC (<1mg/L) or no FAC reported from treatment plant monitoring.	Inspect treatment plant to identify cause of problem and rectify as quickly as possible. Hand dose sodium hypochlorite to clear water tank. Advise Drinking Water Assessor (DWA) and prepare to issue boil water notice if appropriate, i.e. if cannot reinstate adequate chlorination. Make arrangements for provision of emergency treatment or alternative water supply. Keep customers informed and advise once regular service is restored.

Ngaruawahia Water Supply Contingency Plan	
Type of Event	***Required Contingency Action***
Severe turbidity of source water and high turbidity in treated water for more than 1 minute. Indicators: Highly turbid water in the Waikato River or monitoring indicates treated water leaving the treatment plant exceeds 1NTU for more than 1 minute.	Cease abstraction whilst source is turbid and supply from storage, or continue to operate treatment plant but filter water to waste until treated water turbidity is less than 0.3 NTU. Assess turbidity performance of individual filters to determine if problem is common to filters or specific to one or more filter. Take filters with turbidity continuing to exceed 1NTU out of service. Monitor reservoir level. Monitor source water turbidity. If reservoir storage is low and effective treatment cannot be resumed then advise DWA and issue Boil Water notice while problem is resolved. Keep customers informed and advise once regular service is restored.
E. coli transgression in water leaving treatment plant or distribution zone. Indicators: E. coli transgression reported following routine monitoring.	Follow transgression response procedure in DWSNZ. Advise Drinking Water Assessor (DWA). Commence daily E. coli testing at WTP. Use an enumeration test method. Sample in distribution system. Investigate cause, inspect plant and source. Take remedial action. Continue to sample for E. coli until 3 consecutive samples are free of E. coli. If E. coli is found in repeat samples consult with DWA, intensify remedial action, increase disinfection, consider 'Boil Water' notice, and consider alternative supply.

Ngaruawahia Water Supply Contingency Plan	
Type of Event	***Required Contingency Action***
Severe microbiological contamination of source water (such that treatment is ineffective). Indicators: A contamination event in the catchment may be observed by or reported to WDC staff. May also be indicated by reported illness among consumers or positive E coli monitoring results.	Issue "Boil Water' notice. Advise Drinking Water Assessor (DWA). Inspect the river upstream of the intake to identify source of contamination and rectify problem as quickly as possible. Consider provision of emergency treatment or alternative water supply (e.g. tankers). Disinfect contaminated reservoirs and flush mains. Keep customers informed and advise once regular service is restored.
Chemical contamination of source water. Indicators: A contamination event in the catchment may be observed by or reported to WDC staff. May also be indicated by reported water quality concerns from consumers (taste, odour, and colour) or illness among consumers.	Advise Drinking Water Assessor (DWA). Assess situation and advise customers regarding use / treatment / disposal of contaminated water. Arrange emergency water supply (tankers) if necessary. Inspect the river upstream of the intake to identify source of contamination and rectify problem as quickly as possible. Flush contaminated reservoirs and mains. Keep customers informed and advise once regular service is restored.

Ngaruawahia Water Supply Contingency Plan	
Type of Event	***Required Contingency Action***
Cyanobacteria / Cyanotoxin contamination of source water.	Implement cyanobacteria management plan. Advise Drinking Water Assessor (DWA). Dose powdered activated carbon. Monitor source water for cyanobacteria (Alert Level 1 weekly). Monitor water leaving the treatment plant for cyanotoxins. If cyanotoxins in water leaving the treatment plant exceed 50% of the MAV prepare to supply drinking water from tankers to the community. If cyanotoxins in water leaving the treatment plant exceed the MAV supply drinking water from tankers to the community. Keep customers informed and advise once regular service is restored.
Insufficient water available for abstraction and treatment or loss of ability to take water from river. Indicators: Observed or reported low river levels.	Advise customers to conserve water. Implement demand management strategies as required. Arrange emergency water supply (tankers) if necessary. Keep customers informed and advise once regular service is restored.
Instrument fault resulting in non-compliance with Criterion 2A of the DWSNZ for continuously monitored chlorine disinfected water leaving the treatment plant.	Instigate a sampling schedule for FAC, pH, Turbidity and E coli as per Criterion 2B for non-continuously monitored chlorine disinfected water leaving the treatment plant supplying populations up to 5,000. If the bacterial compliance criteria cannot be met using 2B, perform the remedial actions in Section 4.3.9 of the DWSNZ.
Instrument fault resulting in non-compliance with Part 5.4 DWSNZ coagulation, sedimentation and filtration processes: treatment compliance criteria.	Remove filter from service until instrument is repaired. If the Coagulation, sedimentation and filtration processes: treatment compliance criteria cannot be met by the above action, perform the remedial actions in Section 5.4.3 of the DWSNZ.

Ngaruawahia Water Supply Contingency Plan	
Type of Event	***Required Contingency Action***
Instrument fault resulting in non-compliance with Part 5.16 DWSNZ ultraviolet light disinfection: treatment compliance criteria.	Instigate a sampling schedule as per Table 5.7 Enhanced combined filter performance: treatment compliance criteria of the DWSNZ. If the protozoal compliance criteria requirements cannot be met by the above action, perform the remedial actions in Section 5.16.4 of the DWSNZ.

16 Risk Tables

- TSTL – Treatment and Services Team Leader
- TS – Treatment Supervisor
- CITL – Compliance and Income Team Leader
- WPTL – Water Planning Team Leader

Table 9. Risk Table: Catchment

1. Catchment									
Event	**No.**	**Cause**	**Risk Without Preventative Measures**	**Indicators**	**Preventative Measures in Place**	**Controlled**	**Residual Risk**	**Additional Measures That Could be put in Place**	**Resp.**
Microbiological Contamination	1.1	Surface runoff from farmland in the Waikato River catchment.	Extreme (Almost Certain x Major)	High raw water E. coli results. Turbidity in raw water. Illness in community. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	Coagulation, filtration, UV and chlorination treatment.	Partially.	Moderate (Possible x Medium)	Investigate optimising iron and manganese removal.	TSTL

Microbiological contamination	1.2	Discharges from community wastewater systems, dairy effluent ponds or septic tank systems.	Extreme (Almost Certain x Major)	High raw water E. coli results. Turbidity in raw water. Illness in community. *(Set points outlined in Managing Drinking Water Supply Critical Control* *points WDC promapp)*	Coagulation, filtration, UV and chlorination treatment.	Partially.	Moderate (Possible x Medium)	Investigate optimising iron and manganese removal.	TSTL

1. Catchment

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	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.	Coagulation and filtration treatment. 24 hours' storage provided in reservoirs. PAC dosing. Annual raw water chemical testing regime to test for contaminants in raw water.	Yes.	Moderate (Unlikely x Medium)	None.	
Chemical Contamination	1.4	Chemical contamination from coal mining activities in the region. (E.g. leachate, acid mine drainage).	Moderate (Possible x Medium)	Reduction in visual quality of raw water. Taste and / or odour.	Coagulation and filtration treatment. 24 hours' storage provided in reservoirs. PAC dosing. Annual raw water chemical testing regime to test for contaminants in raw water.	Yes.	Moderate (Unlikely x Medium)	None.	

1. Catchment

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Chemical Contamination	1.5	Naturally occurring chemical contaminants.	High (Likely x Medium)	Arsenic is a known contaminant of the Waikato River due to geothermal activity around Lake Taupo.	Tributaries of the Waikato between Taupo and Ngaruawahia provide significant dilution to the contaminated water. Coagulation / sedimentation / filtration reduces arsenic. Annual raw water chemical testing regime to test for contaminants in raw water.	Yes.	Moderate (Unlikely x Medium)	None.	
Chemical Contamination	1.6	Industrial chemical spill.	Very High (Possible x Major)	Reduction in visual quality of raw water. Taste and / or odour. Complaints or information provided by public. Chemical tests if a problem is suspected.	24 hours' storage provided in reservoirs. PAC dosing. Relationship with Waikato Regional Council so that river pollution incidents are reported to WDC.	Yes.	Moderate (Unlikely x Medium)	None.	

1. Catchment

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Chemical Contamination	1.7	Cyanobacteria growth in source water.	Very High (Likely x Major)	Algal bloom in river – discolouration of water. Taste and / or odour complaints from consumers. Weekly visual inspection of river for evidence of algal growth and history of algal growth in the river triggers weekly sampling for cyanobacterial cells (cells / ml) in river in source water.	PAC dosing. Cyanobacteria / cyanotoxin management plan requires weekly visual inspection of river for evidence of cyanobacterial growth and provides for weekly cyanobacteria monitoring at Alert Level 1 and subsequent graduated alert and monitoring levels.	Yes.	Moderate (Unlikely x Medium)	None.	

Table 10. Risk Table: Intake

2. Intake									
Event	**No.**	**Cause**	**Risk Without Preventative Measures**	**Indicators**	**Preventative Measures in Place**	**Controlled**	**Residual Risk**	**Additional Measures That Could be put in Place**	**Resp.**
Loss of Supply	2.1	Intentional vandalism or accidental damage to intake structure by floating objects in river.	Very High (Possible x Major)	Obvious signs of damage to structure. Reduced / no flow to treatment plant.	Intake structure is submerged and not likely to be accessible to vandals. Intake structure does not extend out into the river far. Temporary floating intake pumps can be installed if required.	Partially.	Moderate (Unlikely x Medium)	Implement a contingency plan in case temporary floating pumping is required.	TS
Loss of Supply	2.2	Damage to intake support structure due to lack of maintenance.	Very high (Likely x Major)	Obvious signs of damage to the structure. Reduced / no flow to treatment plant.	Intake structure is in good condition. Maintenance regime in place. Temporary floating intake pumps can be installed if required.	Partially.	Moderate (Unlikely x Medium)	Implement a contingency plan in case temporary floating pumping is required.	TS

2. Intake

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Loss of Supply	2.3	Drought or extreme low flows in Waikato River making pumps ineffective.	High (Possible x Major)	Low flows in river or prolonged drought conditions.	No current issues with low river level affecting abstraction. Temporary floating intake pumps can be installed if required.	Partially.	Moderate (Possible x Medium)	Implement a contingency plan in case temporary floating pumping is required.	TS
Loss of Supply	2.4	Mechanical failure of intake pump / s.	Moderate (Possible x Medium)	Reduced / no flow to treatment plant.	Greater than 24 hours' storage throughout supply. Two intake pumps in duty / standby. Replacement pumps can be readily sourced.	Partially.	Moderate (Possible x Minor)	Implement a contingency plan in case temporary floating pumping is required.	TS
Loss of Supply	2.5	Failure of pumps due to power outage.	Moderate (Possible x Medium)	No flow to treatment plant.	Alarm sent during power failure. Greater than 24 hours' storage throughout supply. Generator connection point fitted to pump station control building.	Yes.	Moderate (Possible x Medium)	Ensure WDC owned generators are serviced. Ensure generator supplier agreements are set up.	TS

2. Intake

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Loss of Supply	2.6	Failure of intake pipe.	High (Likely x Medium)	Reduced / no flow to treatment plant.	Greater than 24 hours' storage throughout the supply.	Partially.	Moderate (Unlikely x Medium)	Implement a contingency plan in case temporary floating pumping is required.	TS
Loss of right to take Water	2.7	Consent to take water is not renewed or is declined by Regional Council.	Very High (Possible x Major)	No valid water take consent currently held by WDC.	Valid water take consent currently held by WDC until June 2050. Incremental volume increases from 4,400 m^3/day to 5,000 m^3/day of water.	Yes.	Moderate (Rare x Major)	None.	
Loss of Supply	2.8	Intake blockage occurs because there is no screen to exclude debris.	Moderate (Possible x Medium)	Reduced or restricted flow to treatment plant.	Greater than 24 hours' storage throughout the supply. Intake screen fitted, including air backwash system for cleaning.	Yes.	Low (Unlikely x Minor)	None.	

Table 11. Risk Table: Coagulation, Flocculation & Sedimentation / PAC Dosing

3. Coagulation, Flocculation & Sedimentation / PAC Dosing									
Event	**No.**	**Cause**	**Risk Without Preventative Measures**	**Indicators**	**Preventative Measures in Place**	**Controlled**	**Residual Risk**	**Additional Measures That Could be put in Place**	**Resp.**
Flocs not formed	3.1	Coagulant dose pump failure.	Moderate (Possible x Medium)	No or poor floc formation. High turbidity in water leaving the clarifiers or filters.	Operator regularly visits plant. Telemetry displays dosing pump activity and turbidity. Turbidity or water from clarifiers is monitored. Turbidity alarmed at 0.10NTU leaving the filters. Process will shut down prior to forfeiting compliance. Coagulant dose pumps operate in duty / assist arrangement.	Yes.	Low (Unlikely x Minor)	None.	

3. Coagulation, Flocculation & Sedimentation / PAC Dosing

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Flocs not formed	3.2	Inappropriate dose rate of coagulant chemicals.	Moderate (Possible x Medium)	No or poor floc formation. High turbidity in water leaving the clarifiers or filters. Chemicals exceeding MAVs. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	Jar testing regime. Operator regularly visits plant. Dosing is flow proportional. Turbidity or water from clarifiers is monitored. Turbidity alarmed at 0.10NTU leaving the filters. Process will shut down prior to forfeiting compliance. Raw water turbidity and pH is continuously monitored. Coagulated water pH is continuously monitored.	Yes.	Moderate (Unlikely x Medium)	None.	

3. Coagulation, Flocculation & Sedimentation / PAC Dosing

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Flocs not formed	3.3	Inadequate mixing of coagulant.	Moderate (Possible x Medium)	Poor floc formation. High turbidity in water leaving the clarifiers or filters. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	Mixing energy calculated and adequate. A static mixer is installed prior to the flash mixer tank for effective mixing. Process will shut down prior to forfeiting compliance. Turbidity or water from clarifiers is monitored.	Yes.	Moderate (Unlikely x Medium)	None.	

3. Coagulation, Flocculation & Sedimentation / PAC Dosing

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Flocs not formed	3.4	Coagulant chemical supply exhausted.	Moderate (Possible x Medium)	Poor floc formation. High turbidity in water leaving the clarifiers or filters. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	Operators at plant daily and aware when chemical supplies are getting low. Chemicals are held in bulk at treatment plant. Delivery of chemicals is usually 3 working days after ordering. Process will shut down prior to forfeiting compliance.	Yes.	Low (Rare x Medium)	None.	

3. Coagulation, Flocculation & Sedimentation / PAC Dosing

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Poor floc formation	3.5	Raw water pH too low for optimal coagulation	High (Likely x Medium)	Poor floc formation. Floc carryover to the filters. High turbidity in water leaving the clarifiers.	Raw water pH is suitable about 80% of the time. pH correction to provide optimum coagulation is fitted. Raw water turbidity and pH is continuously monitored. Coagulated water pH is continuously monitored. Turbidity or water from clarifiers is monitored.	Yes.	Low (Rare x Medium)	None.	
Poor sedimentation	3.6	Poor flow distribution between clarifiers.	High (Likely x Medium)	Poor floc formation. High turbidity in water leaving the clarifiers or filters. Increased frequency in backwashing of filters required.	Clarifier inlet channels designed to balance incoming flow. Turbidity or water from clarifiers is monitored. Process will shut down prior to forfeiting compliance.	Yes	Moderate (Unlikely x Medium)	None.	

3. Coagulation, Flocculation & Sedimentation / PAC Dosing

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
High turbidity passes clarifier	3.7	Power failure causes loss of water flow from intake and loss of sludge blanket.	Very high (Possible x Major)	Turbidity in water leaving clarifiers or filters.	Alarm sent during power failure. Plant can run to waste if high turbidity is detected. 24 hours' supply storage. Turbidity or water from clarifiers is monitored. Turbidity alarmed at 0.10NTU leaving the filters. Process will shut down prior to forfeiting compliance. Generator connection point fitted to pump station control building, lower and upper treatment facilities.	Yes.	Low (Unlikely x Minor)	Ensure WDC owned generators are serviced. Ensure generator supplier agreements are set up.	TS

3. Coagulation, Flocculation & Sedimentation / PAC Dosing

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Flocs not formed	3.8	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 a suitable grade of chemicals. Turbidity or water from clarifiers is monitored. Process will shut down prior to forfeiting compliance.	Partially.	Moderate (Unlikely x Medium)	Check that supplier agreement states the quality to which the chemical has to meet.	TS

Table 12. Risk Table: pH Adjustment

4. pH Adjustment									
Event	**No.**	**Cause**	**Risk Without Preventative Measures**	**Indicators**	**Preventative Measures in Place**	**Controlled**	**Residual Risk**	**Additional Measures That Could be put in Place**	**Resp.**
pH Adjustment too High or Low	4.1	Dosing system failure.	Moderate (Possible x Medium)	pH of the water leaving the treatment plant is high or low. (<7 or >8.5)	pH continuously monitored in water leaving treatment plant. High and low pH alarms. Dose pumps operate in duty / standby arrangement. Process will shut down prior to forfeiting compliance.	Yes.	Moderate (Unlikely x Medium)	None.	
pH Adjustment too High or Low	4.2	Incorrect dosing rate.	Moderate (Possible x Medium)	pH of the water leaving the treatment plant is high or low. (<7 or >8.5)	pH continuously monitored in water leaving treatment plant. High and low pH alarms. Process will shut down prior to forfeiting compliance.	Yes.	Moderate (Unlikely x Medium)	None.	

Table 13. Risk Table: Lift Pumps

5. Lift Pumps									
Event	**No.**	**Cause**	**Risk Without Preventative Measures**	**Indicators**	**Preventative Measures in Place**	**Controlled**	**Residual Risk**	**Additional Measures That Could be put in Place**	**Resp.**
Loss of Supply	5.1	Pump failure due to power outage.	High (Likely x Medium)	No pump activity. Low filter levels.	24 hours' storage provided in reservoirs throughout the reticulation. Telemetry alarms indicate no pump activity. Generator connection point fitted to lower treatment facility.	Yes.	Moderate (Likely x Minor)	Ensure WDC owned generators are serviced. Ensure generator supplier agreements are set up.	TS

5. Lift Pumps

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Loss of Supply	5.2	Pump failure due to mechanical failure.	High (Likely x Medium)	No pump activity. Low filter levels.	Two pumps operate in duty / standby arrangement. Pump maintenance planned and undertaken by contractors. 24 hours' storage provided in reservoirs throughout the reticulation. Pumps are standard off the shelf models and easily replaceable.	Yes.	Moderate (Unlikely x Medium)	None.	
Loss of Supply	5.3	Failure of pump controls.	Moderate (Possible x Medium)	Excessive or reduced pump activity.	Manual over-ride.	Yes.	Moderate (Possible x Minor)	None.	

5b. Fluoridation

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Too much fluoride	5b. 1	Incorrect dosing set point.	Moderate (Possible x Medium)	Fluoride levels found to be high (>1mg/L).	Fluoride is continuously monitored in the clear water tank. Fluoride is continuously monitored in the final water, using duplicate instrumentation. Fluoride testing done weekly at treatment plant and in reticulation as required by DWSNZ.	Yes.	Low (Unlikely x Minor)	None.	
Too much fluoride	5b. 2	Failure of dosing system.	Moderate (Possible x Medium)	Fluoride levels found to be high. (>1mg/L).	Fluoride is continuously monitored in the clear water tank. Fluoride is continuously monitored in the final water, using duplicate instrumentation. Fluoride testing done weekly at treatment plant and in reticulation as required by DWSNZ.	Yes.	Low (Unlikely x Minor)	None.	

Table 14. Risk Table: Filtration

6. Filtration									
Event	**No.**	**Cause**	**Risk Without Preventative Measures**	**Indicators**	**Preventative Measures in Place**	**Controlled**	**Residual Risk**	**Additional Measures That Could be put in Place**	**Resp.**
Particles not removed	6.1	Assessment of filter performance is difficult due to inadequate turbidity information.	Moderate (Almost Certain x Minor)	High turbidity in water leaving the filter. Lack of information available on the performance of each filter.	Each filter has individual turbidity meter. High turbidity alarm at 0.10NTU. Process will shut down prior to forfeiting compliance.	Yes.	Low (Unlikely x Minor)	None.	
Particles not removed	6.2	Media loss from excessive backwashing rate or deterioration of filtration media.	Moderate (Possible x Medium)	High turbidity in water leaving the filter. Increased frequency of backwashing required.	Filter media replaced 5 to 6 years ago. High turbidity alarm at 0.10NTU. The backwash rate is set, so as not to exceed optimum backwash flow rate. Filter performance is monitored through turbidity trending. Process will shut down prior to forfeiting compliance.	Yes.	Low (Unlikely x Minor)	Plan regular physical checking of the condition and depth of the filter media.	TS

6. Filtration

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Particles not removed	6.3	Failure of backwash air blowers.	Moderate (Possible x Minor)	High turbidity in water leaving the filter.	Temporary blower can be installed if required. Filter to waste facility in place if high turbidity is detected. High turbidity alarm at 0.10NTU. Process will shut down prior to forfeiting compliance.	Partially.	Moderate (Unlikely x Medium)	Implement a contingency plan in case temporary air blower is required.	TS
Particles not removed	6.4	Inability to backwash effectively due to power outage.	High (Likely x Medium)	High turbidity in water leaving the filter.	Power failure stops water flow through the plant. Greater than 24 hours' water storage in system. Generator connection point fitted to upper treatment facility. Process will shut down prior to forfeiting compliance.	Yes.	Moderate (Likely x Minor)	Ensure WDC owned generators are serviced. Ensure generator supplier agreements are set up.	TS

6. Filtration

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Particles not removed	6.5	Failure of filter modulating valves.	Moderate (Possible x Minor)	High turbidity in water leaving the filter.	Three filters available. High turbidity alarm at 0.10NTU. Greater than 24 hours' water storage in system. Process will shut down prior to forfeiting compliance.	Yes.	Moderate (Unlikely x Medium)	None.	
Failure to Remove Protozoa	6.6	Existing filtration inadequate for removal of particles to log level required by DWSNZ.	High (Likely x Medium)	Coagulation, flocculation and filtration processes do not meet protozoa log removal requirements of DWSNZ.	Existing coagulation, clarification and filtration provides a barrier against protozoa (Log 4). Filter to waste facility in place if high turbidity is detected. Process will shut down prior to forfeiting compliance.	Yes.	Moderate (Unlikely x Medium)	None.	

Table 15. Risk Table: UV Disinfection

7. UV Disinfection

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Dose too Low	5.1	Dosing system failure.	High (Possible x Moderate)	E. coli or aerobic bacterial spores is detected in 100 ml sample of water leaving the UV unit. UV intensity readings low Calculated UV Flow<90% UV Does <40mJ/cm2 Absence of maintenance records.	Identify cause of fault and rectify. 100% duty / standby UV unit available. Dose continuously monitored. Low UV intensity alarm . Process will shut down prior to forfeiting compliance. Recalculate dose rates and change flow settings. Undertake flow controller calibration. Reduce water flow until UV irradiation dose exceeds 40 mW.s/cm2 is acceptable.	Yes.	Moderate (Unlikely x Moderate)	None.	

Dose too low	5.2	Failure of pre-treatment processes.	High (Possible x Moderate)	E. coli or aerobic bacterial spores is detected in 100 ml sample of water leaving the UV unit. UV intensity readings low Calculated UV Flow<90% UV Does <40mJ/cm2 Absence of maintenance records.	Identify cause of fault and rectify. 100% duty / standby UV unit available. Dose continuously monitored. Low UV intensity alarm. Process will shut down prior to forfeiting compliance. Recalculate dose rates and change flow settings. Undertake flow controller calibration. Reduce water flow until UV irradiation dose exceeds 40 mW.s/cm2 is acceptable.	Yes.	Moderate (Unlikely x Moderate)	None.	

Dose too low	5.3	Excessive colour or turbidity	High (Likely x Medium)	UVT readings high. High turbidity in water leaving the filter. *E. coli* or aerobic bacterial spores is detected in 100 ml sample of water leaving the UV unit. Excessive turbidity or colour (sufficient to reduce the UV intensity to a level that is too low). Absence of maintenance records. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	UVT continuously monitored in water leaving filters. Five filters available. Install adequate filtration system. Regular replacement and maintenance of filters. Automatic wipe system for sleeves with routine inspections Filter to waste facility in place if high turbidity is detected. Process will shut down prior to forfeiting compliance.	Yes.	Moderate (Possible x Meduim)	None.	

Dose too low	5.4	Power supply failure	Moderate (Possible x Medium)	Activation of Alarm. No Power Water flow shut off.	An alarm to indicate power failure 24hour supply of water Upgrading plant to take portable generator Annual electrical maintenance program for plant and reticulation supply.	Yes.	Moderate (Possible x Medium)	Investigate larger stand-by generator	

Table 16. Risk Table: Chlorination

7. Chlorination									
Event	**No.**	**Cause**	**Risk Without Preventative Measures**	**Indicators**	**Preventative Measures in Place**	**Controlled**	**Residual Risk**	**Additional Measures That Could be put in Place**	**Resp.**
Inadequate Chlorination	7.1	Inadequate contact time during peak demand.	High (Likely x Medium)	E. coli detected in water leaving the treatment plant. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	Contact tank and site reservoirs have greater than 30 minutes.	Yes.	Low (Rare x Medium)	None.	
Inadequate Chlorination	7.2	Chlorine gas supply exhausted.	Very High (Likely x Major)	Illness in community. FAC is less than 0.2 mg/L or E. coli detected in water leaving treatment plant.	Bulk (900kg) duty and standby chlorine gas tanks used. FAC continuously monitored. Process will shut down prior to forfeiting compliance.	Yes.	Moderate (Rare x Major)	None.	

7. Chlorination

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Inadequate Chlorination	7.3	Dosing system failure.	Very High (Likely x Major)	Illness in the community. FAC is less than 0.2 mg/L or E. coli detected in water leaving treatment plant.	FAC continuously monitored. Low chlorine alarm. Venturi vacuum system has low failure rate. Process will shut down prior to forfeiting compliance.	Yes.	Low (Rare x Medium)	None.	
Inadequate Chlorination	7.4	Chlorine dose rate incorrect.	Very high (Likely x Major)	Illness in the community. FAC is less than 0.2 mg/L or E. coli detected in water leaving the treatment plant.	FAC continuously monitored. Low chlorine alarm. Set point determined and adjusted automatically from FAC on-line monitoring. Process will shut down prior to forfeiting compliance.	Yes.	Low (Rare x Medium)	None.	

7. Chlorination

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Inadequate Chlorination	7.5	Chlorine demand exceeds chlorine dose due to high raw water turbidity.	Very High (Likely x Major)	High turbidity in water leaving clarifiers or filters. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)* FAC is less than 0.2 mg/L or E. coli detected in water leaving the treatment plant.	FAC continuously monitored. Low chlorine alarm. High turbidity alarms and filter to waste available. Process will shut down prior to forfeiting compliance.	Yes.	Low (Rare x Medium)	None.	
Inadequate Chlorination	7.6	Lack of chlorine due to pipe failure or leak.	Very high (Possible x Major)	FAC is less than 0.2 mg/L or E. coli detected in water leaving the treatment plant. Chlorine gas leak alarm.	FAC continuously monitored. Low chlorine alarm. Chlorine gas leak alarm installed. Process will shut down prior to forfeiting compliance.	Yes.	Low (Rare x Medium)	None.	

7. Chlorination

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Over Chlorination	7.7	Dosing system failure.	High (Likely x Medium)	FAC level high. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)* Odour and taste complaints from consumers.	FAC continuously monitored. High chlorine alarm. Venturi vacuum system has low failure rate. Process will shut down prior to forfeiting compliance.	Yes.	Low (Rare x Medium)	None.	
Over Chlorination	7.8	Chlorine dose rate incorrect.	Moderate (Likely x Minor)	FAC is greater than 1 mg/L.	FAC continuously monitored. Set point determined and adjusted automatically from FAC on-line monitoring. Process will shut down prior to forfeiting compliance.	Yes.	Low (Rare x Medium)	None.	

Table 17. Risk Table: Clear Water Tank and Lift Pumps

8. Clear Water Tank and Lift Pumps

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Loss of Supply	8.1	Problem or failure with clear water tank.	Moderate (Possible x Medium)	Loss of flow from treatment plant.	24 hours' storage provided in reservoirs throughout the reticulation.	Partially.	Moderate (Possible x Medium)	Install bypass pipe from filter wet well to clear water tank outlet pipe. (Bypassing treatment plant clear water tank). Sufficient chlorine contact time would be provided in the storage reservoirs.	TSTL
Loss of Supply	8.2	Pump failure due to power outage.	High (Likely x Medium)	No pump activity. Reduction in reservoir water level.	24 hours' storage provided in reservoirs throughout the reticulation. Telemetry alarms indicate no pump activity.	Yes.	Moderate (Likely x Minor)	Ensure WDC owned generators are serviced. Ensure generator supplier agreements are set up.	TS

8. Clear Water Tank and Lift Pumps

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Loss of Supply	8.3	Pump failure due to mechanical failure.	High (Likely x Medium)	No pump activity. Reduction in reservoir water level.	Two pumps operate in duty / standby arrangement. Pump maintenance planned and undertaken by contractors. 24 hours storage available within system. Pumps are standard off the shelf models and easily replaceable.	Yes.	Moderate (Unlikely x Medium)	None.	
Loss of Supply	8.4	Failure of pump controls.	Moderate (Possible x Medium)	Excessive or reduced pump activity.	Manual over-ride.	Yes.	Moderate (Possible x Minor)	None.	

Table 18. Risk Table: Reticulation

9. Reticulation									
Event	**No.**	**Cause**	**Risk Without Preventative Measures**	**Indicators**	**Preventative Measures in Place**	**Controlled**	**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.	WDC requires all work and materials used in reticulation to meet the specifications determined by the Hamilton City Standard Technical Specifications (Vol. 3). Failures, maintenance and renewals are recorded in WDC's asset management system.	Partially.	Moderate (Possible x Minor)	Review and upgrade documentation procedures for pipe renewal and maintenance. Review the process for planning and recording of preventative maintenance.	WPTL
Loss of Supply	9.2	Excessive demand in network or inadequate system capacity.	Moderate (Possible x Medium)	Complaints from consumers about low pressure or loss of supply. Change in flow or pressure in reticulation.	Network model can demonstrate the effect of high demand or future growth within the reticulation. History dictates that this is not an issue for this supply.	Yes.	Low (Unlikely x Minor)	None.	

9. Reticulation

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Microbiological Contamination	9.3	Inadequate controls on maintenance and construction work.	Moderate (Possible x Medium)	Complaints from consumers about taste or odour. E. coli present in reticulation system. Inadequate FAC in reticulation.	Maintenance and replacement work is undertaken by trained staff. WDC requires all work and materials used in the reticulation to meet the specifications determined by the Hamilton City Standard Technical Specifications (Vol. 3).	Yes.	Low (Unlikely x Minor)	None.	

9. Reticulation

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Chemical or Microbiological Contamination	9.4	Backflow from consumer connections.	Moderate (Possible x Medium)	Illness in community. Contaminants present in the reticulation system. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)* Taste or odour complaints from consumers.	Testable backflow devices are currently required in restricted supply areas, and non-testable devices are required at new domestic supplies and toby replacements. Testable devices required for industries. Backflow is covered in the Water Supply Policy and Bylaw. FAC maintained at suitable levels throughout the reticulation	Yes.	Moderate (Unlikely x Medium)	None.	

9. Reticulation

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Loss of Supply	9.5	Breaks or leaks in pipes.	High (Likely x Medium)	Contaminants present in the reticulation system. Taste, odour or sickness complaints from consumers. Reduced FAC in water. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	Breaks and leaks repaired as a priority. WDC provides a water main location service and supervision of contractors GIS database reticulation asset management system, repairs are recorded in system.	Yes.	Low (Rare x Medium)	None.	
Chemical Contamination	9.6	Inappropriate materials used for reticulation pipes and fittings.	Moderate (Possible x Medium)	Contaminants present in the reticulation system. Taste, odour or sickness complaints from consumers.	WDC requires all work and materials used in reticulation to meet the specifications determined by the Hamilton City Standard Technical Specifications (Vol. 3).	Yes.	Low (Rare x Medium)	None.	
Inadequate Supply	9.7	Silting build up within reticulation pipes.	Low (Unlikely x Minor)	Reduced flows in reticulation. Complaints from consumer about quality of water.	WDC undertakes flushing in response to consumer complaints.	Partially.	Low (Rare x Minor)	Implement routine flushing programme for the reticulation.	TSTL

9. Reticulation

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Inadequate Supply	9.8	Poor planning of maintenance and construction work leaves consumers without water supply.	Moderate (Possible x Medium)	No supply or reduced pressure in areas where upgrading is undertaken. Scheduled maintenance or renewals.	24 hours' notice is given for planned shutdowns of network. Customer service is kept informed. Temporary alternative supply provided if shut down exceeds 8 hours.	Yes.	Low (Unlikely x Minor)	None.	

Table 19. Risk Table: Reservoirs

10. Reservoirs									
Event	**No.**	**Cause**	**Risk Without Preventative Measures**	**Indicators**	**Preventative Measures in Place**	**Controlled**	**Residual Risk**	**Additional Measures That Could be put in Place**	**Resp.**
Microbiological contamination	10.1	Leakage through reservoir roof or other parts of structure or access by birds or vermin.	Very High (Possible x Major)	E. coli in water leaving reservoir. Decreased FAC in water leaving reservoir. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	Residual chlorine in water.	Partially.	Moderate (Possible x Medium)	Ensure all hatches and possible entry points for rainwater, plant matter, insects, birds, vermin etc. are secure against ingress or access. Implement routine inspection of the storage reservoirs.	TS
Microbiological contamination	10.2	Vandalism to reservoir.	Moderate (Possible x Medium)	E. coli in water leaving reservoir. Decreased FAC in water leaving reservoir. Reports from the public. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	Residual chlorine in water.	Partially.	Moderate (Possible x Minor)	Restrict access to the reservoir sites through the construction of appropriate fencing. Install alarms on reservoir access hatches.	TSTL

Table 19. Risk Table: Reservoirs									
Microbiological contamination	10.3	Sediment 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.	Partially.	Moderate (Unlikely x Medium)	Plan routine inspection and cleaning of the storage reservoirs.	TSTL / WPTL

10. Reservoirs

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Microbiological Contamination	10.4	Contamination through unsanitary maintenance or sampling procedures.	Moderate (Possible x Medium)	E. coli in water leaving reservoir. Decreased FAC in water leaving reservoir. *(Set points outlined in Managing Drinking Water Supply Critical Control Points WDC promapp)*	Residual chlorine in water. Access to reservoirs is restricted to trained staff.	Yes.	Low (Unlikely x Minor)	None.	

Table 20. Risk Table: Other

11. Other

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Sampling Failure	11.1	Inadequate sampling programme or sample 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. Relevant staff well trained and qualified.	Partially.	Moderate (Possible x Minor)	Ensure sampling programme is reviewed by independent person. Ensure sample collection follows sampling programme.	CITL
Unrecognised Contamination	11.2	Inadequate sampling programme, sample collection error or response to transgression.	High (Likely x Medium)	Gaps in records from weekly testing regime.	Sampling programme prepared checked against Standards. Relevant staff well trained and qualified. Hills Laboratory does E. coli testing and inform WDC promptly if positive result is detected. Results recorded in WaterOutlook (WDC's operational and data reporting system for monitoring the quality of water).	Yes.	Moderate (Unlikely x Medium)	None.	

11. Other

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Unidentified Operational Failure of Treatment Plant	11.3	Treatment plant processes are not sufficiently monitored or alarmed.	Very High (Likely x Major)	Process failure not identified before supply is contaminated. Contamination identified in supply. Operational near miss identified.	Telemetry recently upgraded to include continuous FAC, pH and turbidity monitoring. Process will shut down prior to forfeiting compliance.	Yes.	High (unlikely x major)	None.	
Failure of Supply Equipment due to Inadequate Maintenance.	11.4	Supply equipment fails due to inadequate asset information and inadequate maintenance planning.	Moderate (Almost Certain x Medium)	Unexpected plant equipment failure. Not having an asset register and maintenance programme.	Some maintenance planned and undertaken including basic lubrication and greasing of pumps undertaken by operator. Specialist maintenance is contracted out as required.	Partially.	Moderate (Unlikely x Medium)	Review the process for planning and recording of preventative maintenance. Prepare a preventative maintenance plan for the treatment plant.	TS
Failure of Supply due to Unavailability of Spare Parts	11.5	Inadequate spare parts held or spare parts unavailable.	Very High (Almost Certain x Medium)	Plant is out of operation due to not having spare parts available.	Spare parts are held for some things. Replacement spares parts are usually available overnight. Greater than 24 hours' storage in system.	Yes.	Moderate (Unlikely x medium)	Evaluation of required spare to be undertaken following asset criticality assessment.	WPTL

11. Other

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Failure of Supply due to Inadequate Operating Procedures Loss of supply	11.6	Insufficient, inadequate, out of date or incorrect manual of operational procedures.	Very High (Almost Certain x Medium)	Operational manuals not used. Operational Manuals not up to date. Operational manual copies are not the same.	Operational manuals are available but require review and completion. Standard operating procedures are incomplete.	Partially.	Moderate (Possible x Medium)	Undertake a review of the operational manual and standard operating procedures for the treatment plant. Update, complete and finalise where necessary.	TS
Operator Error or Mismanagement	11.7	Inadequate training, professional development and up-skilling of operators.	Very High (Likely x Major)	Poor operation of plant. Plant compliance failure. Loss of supply. Poor score on question about level of supervision in supply grading.	The plant operator has a National Certificate in Water Treatment. Ongoing training and upskilling provided for operators	Partially.	High (Unlikely x major)	Provide ongoing annual training to maintain operator competence. Provide water treatment operator training.	TSTL / TS
Security Breach	11.8	Inadequate security at treatment plant allowing theft or vandalism.	Very High (Possible x Major)	Obvious signs of break in, theft or vandalism.	Door security alarms telemetered. Treatment plant is fenced.	Partially.	Moderate (possible x medium)	None.	

11. Other

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Complaints of Poor Taste or Odour in Water	11.9	Poor aesthetic quality of water not identified.	Moderate (Possible x Medium)	Taste and odour complaints. Aesthetic sampling identifies determinands which exceed the NZDWS Guideline Values for aesthetic determinands.	Complaints investigated.	Partially.	Moderate (Possible x Medium)	Undertake testing for aesthetic determinands and compare against DWSNZ Guideline Values.	CITL
Loss of Treatment Plant Connectivity or Loss of Process Data	11.10	Lightning strike or power surge affecting telecoms.	High (Likely x Medium)	Loss of telecoms connection between treatment plant and office. Incomplete recorded data set of treatment plant process information. DWSNZ compliance failure due to not being able to provide complete treatment plant data sets.	Data recorded on WaterOutlook system.	Partially.	Moderate (Possible x Medium)	Install computer hard drive process data storage capacity at the treatment plant as the primary data storage for the treatment plant.	TSTL / TS

11. Other

Event	No.	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Controlled	Residual Risk	Additional Measures That Could be put in Place	Resp.
Failure of Supply Infrastructure due to Liquefaction	11.11	Earthquake reduces the strength and stiffness of soil supporting water supply structures, and subjects the structures and equipment to high accelerations.	High (Rare x Catastrophic)	Unexpected plant structures and equipment failure. Loss of supply. Complaints from consumers about low pressure or loss of supply. Change in flow or pressure in reticulation.	Structural review of Priority 1 and 2 buildings currently being undertaken by WDC.	Partially	Moderate (Rare x Major)	Structure review and seismic strengthening of existing water infrastructure where required. Preparation of an earthquake response plan.	TSTL