

# **DRINKING WATER SAFETY PLANNING: A COLLABORATIVE APPROACH**

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## **ABSTRACT**

By November 2022 all registered water suppliers should have an active and implemented drinking water safety plan in place. This will demonstrate the water supplier's due diligence in meeting the legislative requirement, as well as assisting in identifying risks and minimising residual risk in the water supply systems. Improvements required, identified as part of the risk assessment process, need to be actioned within the supplier's committed timeframe and the supplier will be held responsible for the implementation thereof.

Even though it might seem like a massive and onerous task, having a thorough and accurate water safety plan in place can be a "one stop shop" for everything related to the water supply. It can be a user friendly, central location for all information related to the water supply, all the way from the source, through treatment, to the distribution system. It is a very useful tool for training new personnel.

A simple approach can be used to transform the water safety plan into a useful and valuable document for any water supply. Involving all relevant water supply personnel in the water safety planning process, ownership of the water safety plan accuracy and implementation is shared. Collaboration between the supply owner, the people managing the supply and the authors of the water safety plan have proven to be invaluable in the water safety planning process.

This approach was applied to the active Tauranga City Council (TCC) and Kaipara District Council (KDC) water safety plans. TCC's water safety plan was approved in 2021. Approval of the plan is not the goal anymore; effective management of risks in a way that works for the supplier is the goal. Numerous unacceptable risks have been identified by the water suppliers through this process and planned improvements were actioned to minimise these risks. When improvement plans are well thought through, they can feed into the Long-term Plan (LTP) and justify budget expenditure. This collaborative approach to water safety planning led to effective planning, improved risk management and implementation of improvements in these water supplies.

## **KEYWORDS**

**Drinking water safety planning, risk management, improvement plan**

## **PRESENTER PROFILE**

Sadie is a Process Engineer with 10 years' experience in water treatment projects, both in New Zealand and abroad. She has experience in operations, design, supply, construction, and consulting aspects of water treatment.

# 1. INTRODUCTION

By 15 November 2022 all registered water suppliers need to have an active and implemented water safety plan in place and lodged with Taumata Arowai, as set out in the Water Services Act 2021. This will demonstrate the water supplier’s due diligence in meeting the legislative requirement, but more importantly assists in identifying risks and minimising residual risk in the water supply systems.

Improvements required, identified as part of the risk assessment process, need to be actioned within the supplier’s committed timeframe and the supplier will be held responsible for the implementation of these improvements.

Even though it might seem like a massive and onerous task, having a thorough and accurate water safety plan in place can be a “one stop shop” for everything related to the water supply. It can be a user friendly, central location for all information related to the water supply, all the way from the source, through treatment, to the distribution system. It is also a valuable tool for training new personnel and for consultants working on the water supply.

# 2. DRINKING WATER SAFETY PLANNING PROCESS

The water safety planning process is discussed in the sections that follow and is summarised in Figure 1. It is a continuous process of planning, doing and reviewing.

Figure 1: Water Safety Planning Process



## 2.1 PROVIDING SAFE DRINKING WATER

Providing safe drinking water to protect the health of our communities is the goal. To achieve this requires a thorough understanding of the supply catchment, treatment and reticulation systems, which needs to be captured in an accurate supply description. It also includes complying with the Water Services Act 2021, Drinking Water Standards, Drinking Water Quality Assurance Rules and Aesthetic Values (Taumata Arowai, 2022).

Maintaining multiple barriers to contamination is one of the principles of drinking water safety identified and endorsed by the 2017 Havelock North Drinking Water Inquiry. Examples of barriers include preventing contaminants from entering the supply with a physical barrier like a screen, removal of contaminants with a filter and a disinfection barrier such as UV inactivating pathogens. Each barrier may represent a Control Point (CP) within the supply system. Critical Control Points (CCPs) are specific preventative measures which can be controlled to reduce hazards in the drinking water supply (Ministry of Health, 2019). CCPs need to be identified and managed to protect public health.

Te Mana o te Wai is "*a holistic concept that recognises the importance of water (wai) and how by protecting the health of water, you also protect the health and wellbeing of people and the wider environment*" as described by Taumata Aorowai's Guidance on Drinking Water Safety Planning (Taumata Arowai, 2022) with its principles defined in the National Policy Statement for Freshwater Management (NPS-FM). This is a very important concept often already partially addressed by the water safety planning and risk assessment process in the form of governance (decisions made about the water sources prioritising health and well-being of the water), stewardship (managing water sources in a sustainable way) and with care and respect (demonstrated care for freshwater while providing for the health of the community). In most cases further work and collaboration with tangata whenua is required to implement the principles of *Mana whakahaere, kaitiakitanga and manaakitanga*. This may be addressed by the water safety planning process by scheduling a planned improvement to integrate Te Mana o te Wai into drinking water supply management.

## 2.2 RISK ASSESSMENT

All potential hazards that may compromise the supply of safe drinking water need to be identified through an organised approach to ensure issues are not overlooked (Ministry of Health, 2019). This is where a collaborative approach, including all internal stakeholders managing the supply, become valuable. The Water Services Act, Section 31(1) states "*(b) identify any hazards that relate to the drinking water supply, including emerging or potential hazards; and (c) assess any risks that are associated with those hazards*". Including different perspectives through collaboration will make the risk assessment more thorough and comprehensive.

The risk assessment process can be time consuming and repetitive, but it forms the backbone of water safety planning, so it needs to be well thought through. Input from a range of stakeholders is required to get it to a place where nearly all foreseeable risks are identified, evaluated, preventative measures in place assessed to determine if the residual risk (with preventative measures in place) is acceptable or not.

Stakeholders involved in the risk assessment process should include operations, maintenance, asset management, asset planning and senior management responsible for the water supply. If operations and/or maintenance are contracted out, it is important that the contractor is involved in the process. Other external stakeholders such as mana whenua and the regional council can be included in the risk assessment, particularly when considering source water risks.

If any residual risks are unacceptable, improvements need to be identified and included in the Improvement Plan. It is important that the risk assessment methodology and rating whether risks are acceptable or not allows the water supplier to focus their efforts on reducing the worst risks. If the number of unacceptable risks and improvement actions are too large, the water supplier can fail to focus on the most important risks and/or fail to deliver all the required improvement actions.

### **2.3 IMPROVEMENT PLAN**

The Improvement Plan is an important output of the water safety planning process, which can feed directly into a council's Long-Term Plan (LTP). Including an Improvement Plan relates to the Water Services Act 2021, Section 31(1)(d) stating that a drinking water safety plan must "*identify how those risks will be managed, controlled, or eliminated to ensure that drinking water is safe and complies with legislative requirements*". The Improvement Plan should highlight key improvements needed to minimise unacceptable risks associated with hazards identified in the water supply system. These improvements can include upgrades to the water supply, improved documentation, training and additional resources. These improvements are then prioritised according to the severity of the residual risk, assigned to a responsible person/role, and given a time constraint with an indicative cost to complete.

This means all unacceptable risks identified in the risk assessment process need to be addressed in the Improvement Plan. Planned improvements need to be endorsed by management, and where appropriate, fed into the LTP to ensure appropriate action is taken to implement them.

## **3. A COLLABORATIVE APPROACH**

The drinking water safety plan does not belong to one person or one entity, it belongs to all stakeholders involved in a drinking water supply, including every operator, every plant manager, asset planning and asset management staff, and the supply owner. It is a place where risks can be highlighted and assessed. A place where solutions can be documented and planned for. Once an improvement is captured in the water safety plan, there is an obligation on management to get it actioned. In effect, the water safety plan can be a useful tool for internal stakeholders to voice and document changes and improvements that may be required for their drinking water supply.

The focus of water safety planning is on continuous risk assessment and improvement and keeping the document live. It is not only a document for compliance purposes, but also an opportunity to capture live strategic and operational information through collaboration.

This simple approach can be used to transform the water safety plan into a useful and valuable document for all stakeholders involved in a water supply. Involving all relevant water supply personnel, ownership of the water safety plan accuracy and implementation is shared. Collaboration between the supply owner, the people managing the supply and the authors of the water safety plan have proven to be invaluable in the water safety planning process.

The collaborative water safety planning approach involves:

1. **Define Structure** by creating a new water safety plan structure or restructure the existing plan to include all components of the legislative requirements in a way that suits the supplier.
2. **Divide work** into manageable sections (e.g., catchment, treatment and distribution) and get the relevant people involved; multiple people working on the plan simultaneously.
3. **Schedule workshops** to facilitate collaboration on incorporating information like supply description, risk assessments, operational procedures and improvements required into the water safety plan.
4. **Include aspects of the wider business** (e.g., Long Term Plan (LTP), Quality Management Systems, emergency management, complaints) and link it to the water safety plan.
5. Aim to have an accurate and **achievable Improvement Plan**, to be reviewed by the supplier regularly, which is used to inform the supplier's LTP.
6. Work towards water safety plan **endorsement by management** and ownership by water supplier personnel to make the water safety plan their own.
7. **Continuously review** and update the plan when changes are made to the water supply, risks change, new risks are identified, or improvements are completed.

The collaborative water safety planning approach is scalable as per the Water Services Act, Section 31 (1)(a), stating it must "*be proportionate to the scale and complexity of, and the risks that relate to, the drinking water supply*". Smaller supplies might not have many people involved to collaborate with, and it is often up to one person to write, implement and maintain the water safety plan. In such cases opportunities to collaborate with other drinking water suppliers with similar systems in place or collaboration with subject matter experts in the wider industry may be valuable. There are some limitations to collaboration with other suppliers though. Information privacy policies or underlying pride preventing suppliers from sharing information about shortcomings may limit the amount of collaboration between different suppliers.

## **STEP 1: DEFINE STRUCTURE**

Investing enough time at the front end of water safety plan development to ensure it has a suitable structure, and that accurate descriptions and thorough risk assessments are included, will streamline the review process, and assist in keeping the document live for years to come.

It can be tricky to find the balance between it being a purely strategic or operational document, but it can be both if there is collaboration between management and operations personnel. To avoid the document becoming too

lengthy with operational details it may refer to other operational systems where operational data is captured and key documents relating to the water supply.

If there is no usable water safety plan in place, a completely new document may be created, or the existing plan may be restructured and expanded to include all components of the legislative requirements in a way that suits the drinking water supplier.

## **STEP 2: DIVIDE WORK**

Dividing work into smaller sections (e.g., catchment, treatment and distribution) and getting all relevant people involved, will make the plan more manageable. The collaborative approach means having multiple people working on the plan simultaneously, for example subject matter experts working on the source water risk management plan while operating personnel are confirming the accuracy of critical control point action limits and critical limits. Additional expertise like asset planners and quality control officers may be used to further enhance the water safety planning process and assure different perspectives are incorporated.

## **STEP 3: SCHEDULE WORKSHOPS**

Scheduling weekly or monthly workshops to facilitate collaboration on incorporating drinking water supply information into the plan ensures accountability and progress. The initial risk workshop is very important as assessing risks collaboratively, incorporating a range of perspectives and expertise, will result in a richer understanding of the water supply and better solutions to unacceptable risks. The focus may shift between different sections that need more attention from one workshop to the next. Keeping workshops interesting, interactive, and alternating between topics may assist in keeping collaborators engaged during workshops. It is important to have an objective facilitator for these workshops so that risk assessments are not skewed by individual opinions or aspirations.

## **STEP 4: INCLUDE WIDER BUSINESS**

Linking your drinking water safety plan with aspects of the wider business may assist avoiding information duplication and remove the need for updating information in multiple places. For example, referring to the council's LTP and including a hyperlink taking the user to the most recent LTP removes the need to repeat information that can be found in the LTP. Other systems and documents like Quality Management Systems, Incident Management Systems and Operational Procedures may also be hyperlinked into the water safety plan.

## **STEP 5: ACHIEVABLE IMPROVEMENT PLAN**

Aim to have an accurate and **achievable Improvement Plan**, to be reviewed regularly, which is used to inform the LTP. Any improvements that have not been addressed in the current version of the water safety plan may be included in the Improvement Plan to be actioned and included in the following revision of the plan.

The Improvement Plan may be divided into the following subsections:

- **Required Improvements** – Actions required to address unacceptable risks. These improvements need to be prioritised, resources allocated to action them and incorporated into the LTP if needed.

- **Additional Improvements** – Any further improvements that would be good to have, or would facilitate better operations, may be included here.
- **Completed Improvements** – Track record of improvements completed.

## **STEP 6: ENDORSEMENT BY MANAGEMENT**

Collaborating with management, especially to get approval and funds for the planned improvements, is essential for progress and implementing the plan. Once the document is in its final stages, a workshop including management may be scheduled to work through the unacceptable risks identified and the improvements that were proposed to solve these unacceptable risks. Endorsement of the plan by management is essential to its implementation.

It is also important to inform governors of the organisation about the unacceptable risks and improvements needed to address these, as they are ultimately responsible for making sure that safe water is provided to the community.

## **STEP 7: CONTINUOUS REVIEW**

As per the Water Services Act, Section 31 (1)(e), "*identify how the drinking water safety plan will be reviewed on an ongoing basis, and how its implementation will be amended, if necessary, to ensure that drinking water is safe and complies with legislative requirements*". Continuous review of the water safety plan may occur naturally if the plan is actively used for quality management, compliance monitoring or control of operational procedures. If there are changes made to treatment systems, new risks are identified or improvements completed, these can be captured in the live version of the water safety plan.

Monthly workshops to review different aspects of the water safety plan, keeping the live version up to date, will prove to be valuable when the time comes to resubmit the plan to Taumata Arowai. One person may be responsible for updating the live version, but all internal stakeholders should feel able to contribute to it.

## **4. CASE STUDIES**

This collaborative approach was applied to the active Tauranga City Council (TCC) and Kaipara District Council (KDC) water safety plans.

### **4.1 TAURANGA CITY COUNCIL**

In 2020 TCC updated the Water Safety Plan of its two large drinking-water supplies (Oropi and Joyce supplying two distribution zones, with serviced population of 67,000 and 80,000 respectively) to be consistent with the approach required by the Ministry of Health (MoH) at the time. Documents used to do this included the New Zealand Drinking-water Safety Plan Framework (Ministry of Health, 2018), Handbook for Preparing a Water Safety Plan (Ministry of Health, 2019) and the Water Safety Plan Guides (Ministry of Health, 2014).

As one of the Water Treatment Engineering Technicians, I was responsible for restructuring the previous Water Safety Plan to include all the components of the New Zealand Drinking-water Safety Plan Framework (Ministry of Health, 2018). A lot of time and resources were invested at the front end to make the water safety

plan user friendly and integrated with the TCC catchment management plan and TCC's quality control systems. Throughout the Water Safety Plan I included hyperlinks to reference documents, including operational procedures, Infrastructure Data (ID) forms and other plant information, making it useful when someone is looking for specific information about the water supply, and a valuable tool for training new personnel.

Once the water safety plan structure was updated according to the Framework (Ministry of Health, 2018) components, the water safety plan was divided into manageable sections and worked through one component at a time. The relevant people were involved at each stage with multiple people working on the plan simultaneously. For example, while working on Component 2 (Assessment of the drinking-water supply system), the Catchment Specialist was updating the catchment description, the Engineering Technician was updating the treatment description and the Water Network Engineer was reviewing the reticulation description. The Water Treatment Manager was involved every step of the way to ensure information was captured accurately, to answer questions and make decisions when it was needed.

Weekly workshops were scheduled (via videoconference since this occurred during lockdown in 2020) to discuss progress and the next steps as well as work through the risk assessments collaboratively. During this stage unacceptable risks were identified, and improvements were planned to reduce each risk to an acceptable level. The Water Services Manager took part in each of these risk workshops and planned improvements had to be endorsed by the Water Services Manager before they could be included in the Improvement Schedule.

The risk assessment included identifying, as far as practically possible, all possible events that may introduce hazards into the water supply. Each possible hazardous event was individually analysed, raw risk determined, the preventative measures in place identified and evaluated and the residual risk determined. Any unacceptable residual risks identified were linked to a planned improvement that would reduce the residual risk to an acceptable level. An extract from the TCC Water Safety Plan demonstrating how it was done is provided in Appendix A, *Table A*.

The Improvement Plan was the final product of the Water Safety Plan, and it fed into the TCC Annual Plan and Long-Term Plan (LTP). This is subject to an annual reprioritisation review process. The priority and timing for completing the recommended improvements were discussed during the workshops, with severity of the residual factor, ease of implementation, and capital costs as the key criteria.

TCC maintains a fully implemented Quality Management System (QMS) in line with ISO 9001:2015 (Quality management systems — Requirements) which covers all their raw water intake systems and water processing plants. This QMS system includes planning, operation, maintenance, safety aspects, regular audits and a process for corrective action and continual improvement. The TCC QMS system therefore covers many aspects of the Framework (Ministry of Health, 2018) which simplified the water safety planning process since TCC already had most of the required components in place. QMS audits have since been aligned with the Water Safety Plan with regular risk assessment playing a big part in effective quality management of the water supplies.



There is commitment from TCC management and staff to check that the Water Safety Plan meets the needs of the business and consumer to ensure the water supplies can always provide safe water to the community. Senior management endorses the Water Safety Plan which feeds into the TCC Annual Plan and Long-Term Plan (LTP), ensuring the availability of resources essential to establish, implement, maintain, and improve the water supply system.

The TCC Water Safety Plan was approved by a Drinking Water Assessor in 2021. Although approval of the plan is not the goal anymore, this provided assurance that TCC is on the right track in effectively managing risks to its water supplies. Recent feedback from TCC confirmed that they are actively managing risks and updating the Water Safety Plan as required. TCC water safety planning can be seen as a proactive and useful tool in the process of supplying safe drinking water to TCC consumers.

## **4.2 KAIPARA DISTRICT COUNCIL**

KDC owns and manages five drinking water supplies: Dargaville, Maungatūroto, Mangawhai, Glinks Gully and Ruawai, with serviced populations ranging in size from 50 to 4,700 people. All water supplies had water safety plans in place. KDC water safety planning has come a long way since the first revisions of the water safety plans. In 2021, the KDC water safety plans were consolidated into one document and structured according to the New Zealand Drinking-water Safety Plan Framework (Ministry of Health, 2018). Weekly workshops were held to facilitate collaboration on incorporating and updating the supply descriptions, risk assessments, operational procedures and the KDC Improvement Plan. Unacceptable risks identified as part of the risk assessment process of each water supply were linked to a numbered improvement in the Improvement Plan. Aspects of the wider business, e.g., Annual Plan, Asset Management Plan, LTP and Incident Management Plan are referenced and hyperlinked in the water safety plan.

Key KDC staff were involved throughout the water safety planning process. The Four Waters Infrastructure Officer, the Three Waters Senior Infrastructure Officer and the Drinking Water Treatment Supervisor (contractor) provided information, took part in the risk assessment workshops, and reviewed the final document. The final document was endorsed by management and the Improvement Plan accepted by the Operations Manager.

Each risk management workshop was a team effort, with the Treatment Supervisor identifying key issues, the Infrastructure Officers evaluating the risks and determining what improvements would be suitable where there were residual unacceptable risks. During the risk workshop, the Treatment Supervisor was asked to name a few hazardous events that he knows have a high risk associated with them in the relevant supplies. He identified some risks of concern and the preventative measures in place were discussed and assessed collaboratively to determine the residual risk and improvements required. Hazardous events were marked off as they were discussed and the workshop maintained its interactive approach, ensuring engagement of all participants until all risks were evaluated. An Extract from the KDC risk tables is provided in Appendix B, *Table B*.

The KDC Improvement Plan is consistent with the KDC LTP. Where additional improvements were identified, they were endorsed by management and planned to be completed within a specified timeframe. An extract from the KDC

Improvement Plan is provided in *Table 1* to demonstrate how the unacceptable risk identified in Appendix B, *Table B* is planned to be addressed.

*Table 1: KDC Improvement Plan extract*

Ref	Improvement Needed	Mitigate risk no.	Priority	Responsible	Timeframe	Project Costs	Comments
IMP03	<b>Backflow prevention programme</b> - Backflow prevention survey - Backflow Policy	4.10	High	TWSIO FWIO	2022-2023	\$100,000 Staff time	Survey of all connections requiring backflow prevention; check with RC team re: annual backflow prevention testing.  Improve backflow protection programme. Develop a process for dealing with infringements of the water supply bylaw.

Some improvements identified in the previous water safety plan have been completed, for example it was planned to annually test the disinfection by-products of all supplies, which is now actively taking place.

Ownership of the water safety plan sits with KDC Infrastructure Officers and ultimately the Operations Manager and Chief Executive. An active revision of the KDC water safety plan will be released each year, and as required if there are significant changes. The 2022 water safety plan will be submitted to Taumata Arowai in November 2022. This revision will remain in place as the active KDC Water Safety Plan until a new revision is submitted. A new revision will be created for continual updating as things change in 2023. This allows for continuous water safety planning as changes are made to the treatment systems, new risks are identified, and improvements are completed.

## **5. CONCLUSION**

Investing sufficient time and effort at the front end of drinking water safety planning through a collaborative approach will lead to a valuable, user-friendly document that is not just a strategic document or a compliance document, but rather a useful quality control and risk management tool used to improve services.

The collaborative water safety planning approach applied to the two water suppliers' case studies resulted in accurate supply descriptions, clearly set out compliance requirements, thorough risk assessments and actionable planned improvements.

As part of the risk assessment process hazards were thoroughly assessed and preventative measures scrutinised. Unacceptable risks have been identified by the water suppliers through this process and improvement plans are being actioned to minimise these risks. When improvement plans are accurate and endorsed by management, it can feed into the LTP and justify budget expenditure.

This collaborative approach to water safety planning led to effective planning, active risk management and implementation of improvements in these water supplies. The water safety plan is a live document, updated as things change in the water supply and used as a tool to find information, train new personnel, and identify improvement opportunities.

## **ACKNOWLEDGEMENTS**

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I would also like to acknowledge Bridget O'Brien (WSP) for her guidance, support and review of this paper.

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# APPENDIX A: TCC RISK TABLE

Table A: Risk assessment extract from TCC's Treatment Risk Tables.

Ref	Hazardous event (including hazards reasonably expected to be associated with hazardous event)	Cause of event	Raw Risk Analysis			Preventive Measures in place / Barriers to Contamination	Checks to ensure Barriers have not been Breached Ref APPENDIX D	Signs that action is needed / Indicators	Residual Risk Analysis			Uncertainty around the hazard identification and associated risk assessment (Certain, Confident, Estimate)	Additional Preventative measures/checks required (yes/no) Ref Section 6.0
			Likelihood Table A1	Consequence Table A2	Risk Table A3				L	C	R		
P6.5 – TREATMENT PROCESSES – MEMBRANE FILTRATION													
P6.5.1.1	MEMBRANE NOT PERFORMING TO SPECIFICATIONS (Output from treatment plant not to DWSNZ)  Possible hazards: Disinfection by-products, protozoa contamination, chemical contamination, not enough water.	Quality of raw water outside plant design specifications (Note that unless the raw water contains oxidants, and or extremely large sharp particulates, it is unlikely that the integrity of the membrane will be breached, but water quantity may be reduced due to fouling. Also, membranes are not designed to remove dissolved substances).	4	5	E	<ul style="list-style-type: none"> <li>The automatic (online) plant control systems and daily water quality checks ensure that the raw water quality is within prescribed limits for membrane feed water. If not, the treatment plant is either automatically shut down, or turned down to a lower treatment rate.</li> <li>Automated SCADA monitoring system, with phone out alarms.</li> <li>Membrane Maintenance Support Agreement and extensive warranty entered into with membrane supplier who are contracted to monitor the ongoing operational performance of the membrane treatment system bi-monthly.</li> <li>Modular construction – (if one unit is damaged it can be isolated).</li> <li>Planned maintenance, calibration of sensors.</li> <li>Pre-treatment (Oropi only) of raw water prior to membrane</li> </ul>	<ul style="list-style-type: none"> <li>CHK4.1: Raw water contaminants analysed.</li> <li>Flow rates from individual sub-modules known.</li> <li>CHK4.1.2: Raw water turbidity, pH, colour and conductivity monitored continuously online.</li> <li>CHK4.2: Settled water turbidity prior to microfiltration continuously monitored.</li> <li>CHK5.2: Online filtrate FAC, turbidity and pH monitoring (post reservoir).</li> <li>CHK5.1: Individual membrane skid integrity measured automatically every 24 hours.</li> <li>CHK4.2.2: Treatment plant automatic monitoring of instantaneous rate of increase.</li> <li>Monthly membrane health report in Infrastructure Data</li> <li>Weighting of individual membranes when removed for pinning.</li> </ul>	<ul style="list-style-type: none"> <li>Non-compliance with DWSNZ.</li> <li>Membranes foul and are difficult to clean.</li> <li>Frequency of cleaning increases.</li> <li>Unexplained decrease in flows.</li> <li>Unexplained integrity failure of membranes.</li> <li>Increased filtrate turbidity.</li> <li>Submodules exceed 12kg</li> </ul>	1	3	L	Certain	No  <a href="#">IMP02</a> : CMF unit rebuilds
P6.5.1.2	MEMBRANE NOT PERFORMING TO SPECIFICATIONS	Inadequate or inappropriate pre-treatment.	5	5	E	<ul style="list-style-type: none"> <li>The pre-treatment processes have been designed to produce water that complies with membrane feed water specifications and removes the level of colour expected within the raw water source.</li> <li>NB: Clarifier is in operation (Oropi only since early 2012).</li> </ul>	<ul style="list-style-type: none"> <li>Ref P5 (Clarification).</li> <li>CHK4.1.2: S-CAN monitoring raw water on SCADA.</li> <li>CHK5.2: Online filtrate FAC monitoring.</li> </ul>	<ul style="list-style-type: none"> <li>Membranes block and are difficult to clean.</li> <li>Frequency of cleaning increases.</li> <li>Unexplained decrease in flows.</li> <li>Chlorine levels drop below alarm levels</li> </ul>	3	3	M	Certain	Yes  Interim measure: Chlorine monitoring, especially during rain events  <a href="#">IMP06</a> : Joyce Rd upgrade & pre-treatment

# APPENDIX B: KDC RISK TABLE

Table B: Risk assessment extract from KDC's Distribution Risk Tables.

Supply System Element	Hazardous Event		Hazards (associated with the hazardous event)				MAXIMUM Risk (with no preventive measures in place and all barriers failing)				LEVEL OF UNCERTAINTY AND RISK ACCEPTABILITY								
	Event Description	Cause No.	Possible Causes	Bacteria / Viruses	Protozoa	Chemicals / Pharmaceuticals	Disruption to supply	Likelihood of HAZARDOUS EVENT occurring	Consequence of the HAZARD	Maximum (unmitigated) Risk	Existing Measures to Identify the Hazard	Existing Preventive measures	Likelihood of HAZARDOUS EVENT occurring	Modified Consequence of the HAZARD	Residual Risk	Level of certainty	Risk Acceptability	Additional Preventive Measure required?	Improvement Plan Reference
Distribution System	Loss of supply	4.08	<ul style="list-style-type: none"> <li>Excessive demand in network</li> <li>Inadequate system capacity</li> <li>Unidentified leakage or illegal connections</li> </ul>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Possible	Major	High	<ul style="list-style-type: none"> <li>Customer complaints</li> <li>Contractor reports</li> <li>Visual observations</li> <li>Reservoir level indicator</li> <li>SCADA controls and alarms</li> <li>Leak detection programme</li> </ul>	<ul style="list-style-type: none"> <li>Water supply infrastructure renewals programme</li> <li>Leakage reduction programme</li> <li>Water restrictions</li> </ul>	Unlikely	Moderate	Medium	Reliable	Acceptable	No	
Distribution System	Development of sediment or biofilm	4.09	Biofilm or sediment build up within reticulation pipes	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Possible	Minor	Medium	<ul style="list-style-type: none"> <li>Customer complaints</li> <li>FAC monitoring in network</li> <li>Reduced flow</li> <li>Samplers report high turbidity in reticulation network</li> </ul>	<ul style="list-style-type: none"> <li>Customers asked to do their own flush</li> <li>Flushing programme for dead end mains</li> <li>Flushing in response to complaints</li> </ul>	Possible	Minor	Medium	Reliable	Acceptable	No	
Distribution System	Introduction of contamination due to no / inadequate / faulty / incorrectly installed backflow prevention device	4.10	Unintentional backflow event due to backflow prevention device not installed, not actually connected, connected improperly, or faulty device	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Possible	Major	High	<ul style="list-style-type: none"> <li>Annual IQP inspections and testing of backflow prevention devices</li> <li>Customer complaints</li> <li>Water quality monitoring / contaminants identified in reticulation network</li> </ul>	<ul style="list-style-type: none"> <li>Water Services Act 2021 allows a water supplier to install backflow prevention devices or require property owners to do so</li> <li>Backflow hazard and backflow prevention device requirements assessed as part of building consent process</li> <li>Bylaw requires all new connections to have appropriate backflow prevention devices to be installed and tested annually</li> <li>Chlorine residual</li> </ul>	Possible	Major	High	Unsure	Unacceptable	Yes	<p><b>IMP03:</b> backflow prevention assessment</p>