Bunnythorpe Water Supply
Water Safety Plan

January 2017

PALMERSTON NORTH
CITY COUNCIL

This document was prepared by Palmerston North City Council, City Enterprises, Technical Services Division.

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1 Introduction

The Health Act, Part 2A Drinking Water, requires drinking-water suppliers to prepare and implement a Water Safety Plan (previously known as a Public Health Risk Management Plan) for their supplies.

This Water Safety Plan (WSP) for the Bunnythorpe Water Supply was prepared by Palmerston North City Council (PNCC). Representatives from PNCC's City Enterprises Water Treatment and City Networks Water Asset Management teams have been consulted and involved in the preparation of this WSP, including identification of the risks through participation in WSP workshops.

This WSP is based on the water supply systems and processes current at January 2017. This WSP will be briefly reviewed and updated annually in accordance with the Annual Compliance Reports and comprehensively reviewed and updated every five years and/or whenever there is a significant change made to the Bunnythorpe Water Supply. All reviews and updates will be completed by PNCC and the new WSP will be forwarded to the Drinking-Water Assessor. On approval of the WSP by the Drinking-Water Assessor, the approval report will be presented to the Council's Management Team prior to implementation of the WSP.

The key steps undertaken in preparing this Water Safety Plan for Bunnythorpe Water Supply comprise:

- Risk Assessment: The first part of the document identifies potential sources of contamination and the barriers preventing contamination resulting in health effects. Securing the safety of drinking water supplies is based on the use of multiple barriers, from source to consumer, to prevent the contamination of drinking water or to reduce contamination to levels which are not injurious to health. Possible events that might lead to contamination hazards are identified, preventive measures are considered and the level of risk to public health from these events is assessed.

- Risk Management: Based on the results of the risk assessment the second part of the document lists improvements to the supply with a programme for their introduction and the resources needed to do this.

Note this WSP considers risks to public health. It is acknowledged that staff or contractors' health may be at risk from a number of site specific issues related to the operation and maintenance of the Bunnythorpe Water Supply, but these are not covered by this WSP as such risks are the subject of health and safety in employment legislation, and site specific health and safety practices documented in operational protocols and health and safety manuals.

The document "A Framework on How to Prepare and Develop Public Health Risk Management Plans for Drinking-water Supplies" (Ministry of Health 2005) has been used in preparing this plan.

The Ministry of Health guides listed below have been used to assist in identifying risks to the water supply. Additional risks have been identified through workshops and consultation with PNCC staff.

- Source and Abstraction
  - S1.1 Raw water: Surface and groundwaters
  - P1.3 Source abstraction: Groundwaters – Bores and Wells
- Treatment
  - P7.1 Disinfection: Chlorine Disinfection

  - P10 Pump operation (also applicable to distribution system)
  - P11 Drinking-water treatment plant construction and operation

- Storage and Distribution System
  - D1 Post-treatment storage
  - D2.1 Reticulation network: Construction Materials
  - D2.2 Reticulation network: System pressure
  - D2.3 Reticulation network: Operation
  - D2.4 Reticulation network: Backflow prevention

- General Elements
  - G1 Staff training (draft)
  - G2 Monitoring (draft)

2 The Bunnythorpe Water Supply

2.1 Description

The Bunnythorpe township is located approximately 10 km north of Palmerston North City and has a population of approximately 480 and was part of Manawatu District until a boundary change in July 2012 when Bunnythorpe and Longburn became part of Palmerston North.

The water source comprises groundwater abstracted from a confined aquifer. Chlorine is dosed to provide a disinfectant residual level target of 0.2ppm to prevent the growth of the bacteria in the network. The water is not fluoridated.

The treated bore water is gravity fed to a single 154m^3 reservoir, which has capacity to supply Bunnythorpe for 20 hours at average flow. The water from the reservoir feeds directly into the reticulation network with no further treatment. The water supply reticulation comprises 5.4 km of pipelines, supplying approximately 183 service connections and is operated as a single pressure zone.

Figure 1 shows an overview of the Bunnythorpe water supply and a schematic is contained in Appendix A.

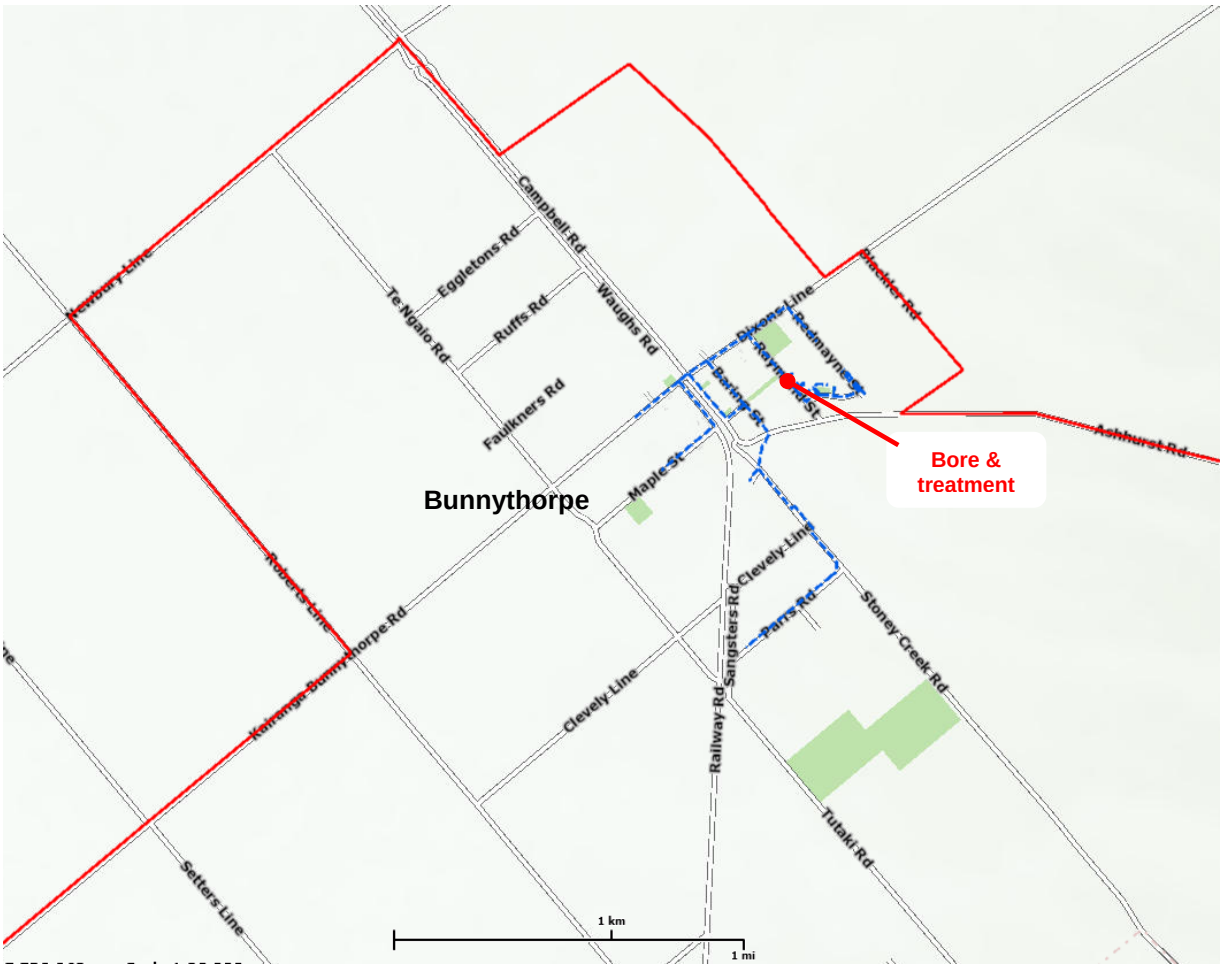


Figure 1: Overview of the Bunnythorpe Water Supply

2.2 Ownership

The land occupied by the bore is located between 6 and 8 Raymond St, Bunnythorpe, and is owned by the Palmerston North City Council.

City Networks oversees the water supply operations and make key decisions about asset management. Daily operations and management is performed by the City Enterprises operations team in accordance with relevant Service Level Agreements. Contractors are engaged by City Enterprises from time to time for electrical and mechanical maintenance work.

2.3 Groundwater Source & Bore

The Bunnythorpe water supply is drawn from an artesian aquifer in Bunnythorpe on Raymond St. The bore, constructed in 1996, is consented to withdraw up to 600m^3/day and is 202m deep with 150mm casing

The bore has sufficient depth to prevent surface water contamination and meet requirements for secure groundwater under the DWSNZ.

Chlorine is dosed from two 70kg gas cylinders and is controlled to a set point chlorine concentration. Once chlorine has been added the water passes through a 45m^3 contact tank, fitted with a baffle to prevent short circuiting.

2.4 Reservoirs

Following the contact tank the water overflows, controlled by a ball cock to the single 154m^3 reservoir, located at the Raymond St site. The concrete reservoir was constructed in 1952 and is approximately half buried and half above ground.

Water is withdrawn from the reservoirs by three pumps: two Sihi-Halberg ZLK32-200 5.5kW pumps controlled by VSDs in duty/assist configuration to provide 600-700kPa, and one Guinard GMVR 65-3R1 18.5kW pump providing fire flows in response to low network pressure.

2.5 Reticulation

The Bunnythorpe water reticulation network is composed of approximately 5.4km of 80-100mm asbestos cement pipe, possibly with some sections of low density polyethylene. Properties are supplied through 32mm PVC connections. The population is supplied through approximately 183 connections.

2.6 Operations, Monitoring and Control

City Networks oversee the water supply operations and make key decisions about asset management. Daily operations and management is performed by City Enterprises operations team, assisted by outside contractors for electrical maintenance work, in accordance with relevant Service Level Agreements.

In order to comply with the DWSNZ PNCC contracts Central Environmental Laboratories (CEL) to sample, analyse and report on both raw and treated water quality monitoring undertaken in the water supply system.

PNCC has a telemetry system linked to the Bunnythorpe bore and reservoir which transmits operational data in real time as well as provide advice of any alarms.

3 WSP Preparation & Methodology

The purpose of a WSP is to assist the Water Authority to identify and manage risks to the water supply that may have an impact on public health. WSPs encourage the use of a risk-management approach to identify situations that may lead to the contamination of the water supply as well as the actions necessary to protect the public.

Information provided by the Ministry of Health was used as a guide in preparing the WSP. The Ministry of Health recommends the following steps are undertaken when preparing a WSP:

- Develop a flow diagram of the supply that includes all elements that must be considered as part of the WSP;
- Identify barriers to contamination present in the supply;
- Identify events that may introduce contamination or health hazards into the water supply, and then consider causes, preventative measures and corrective actions for each event.

The WSP has been prepared in collaboration with PNCC staff and using available information from the 2010 WSP and other Council documents. Key documents relevant to this WSP are:

- Water Supply Asset Management Plan 2014;
- Water Supply Bylaw and Bylaw Administration Manual/Backflow Prevention Policy 2015;
- Water Supply Development Plan 2015.

Further input was provided by PNCC staff into the monitoring and maintenance plans and improvement schedule.

4 Barriers to Contamination

Table 3 describes the barriers to contamination present for the Bunnythorpe Water Supply.

Table 1: Barriers to Contamination

Source	Barrier	Barrier Description
Raymond St Bore	Stop contamination of raw water	• Existing planning rules regarding land use. • Meet DWSNZ secure groundwater classification. • Well is fenced off. • Wellhead is constructed to avoid contamination.
	Remove particles from the water	• Bore has sufficient depth and meets the requirements for secure ground water • The groundwater turbidity is typically 0.5-0.8 NTU. E. coli monitoring of raw has shown concentrations consistently less than 1 MPN/100mL.
	Kill germs in the water	• Disinfection (chlorine).
	Prevent recontamination after treatment	• Water is delivered through pressurised pipes • PNCC has a backflow prevention policy. • Backflow prevention device installation and maintenance programme. • Chlorine/chloramine residual maintained in reticulation. • Trained staff and contractors. • Alarm system.

5 Risk Information Tables

The risk information tables set out possible events for the Bunnythorpe water supply that may create public health risks.

The risk information tables include:

- The level of risk based on the likelihood and consequence of the event;
- The causes of each risk event;
- Preventive measures currently in place to avoid consequences of the risk event;
- Checks to determine whether the preventive measures are working;
- Corrective actions required where current preventive measures are insufficient to avoid consequences of the risk event.

Appendix 2 of *"A Framework on How to Prepare and Develop Water Safety Plans for Drinking-water Supplies"* provides scale descriptions for five categories of likelihood and five categories of consequences which are then used in a matrix for estimating risk. These scale descriptions and the resulting risk matrix has been used for the purposes of this WSP and is repeated below. The level of risk was assessed by PNCC's engineering and operations teams.

5.1 Likelihood Scale

Table 2: Likelihood Scale

Likelihood Ranking	Description
Rare	May occur only in exceptional circumstances (once in 1000 years)
Unlikely	Could occur (once in 100 years)
Possible	Might occur at some time (once in 10 years)
Likely	Will probably occur (once in 1 or 2 years)
Almost certain	Is expected to occur in most circumstances

Table from: A Framework on How to Prepare and Develop Public Health Risk Management Plans for Drinking-water Supplies, MoH, 2005

5.2 Consequence Scale

The consequence scale contained in Table 3 has been developed for this WSP to provide more specific and measurable consequences.

Table 3: Consequence Scale

Consequence ranking	Description
Insignificant	• Insignificant impact • Little disruption to normal operation • Small increase in operation costs

Consequence ranking	Description
Minor	• Short disruption of service (<1 hour) to part of a zone • Limited restrictions on outdoor water use to reduce demand • Aesthetic water quality event for some consumers • No reported illness • Some manageable operation disruption • Some increase in operating costs.
Moderate	• Disruption of service (<4 hours) to one or more zone • Restrictions on outdoor water use to reduce demand • Water quality event that requires flushing to clear • Boil water notice for up to 3 days • No reported illness • Significant modification to normal operation but manageable • Operation costs increased • Increased monitoring
Major	• Disruption of service (>4 hours) to two or more zones • Prolonged boil water notice • Probable illnesses • Adverse publicity and loss of trust of consumers • Systems significantly compromised and abnormal operation if at all • High level of monitoring required
Catastrophic	• Disruption of complete supply for one or more day • Several instances of illness in the community or instance of death • Prolonged boil water notice • Significant negative national press and long term loss of trust of consumers • Complete failure of systems

5.3 Level of Risk

Table 4: Risk Framework

		Consequences				
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Likelihood	**Almost certain**	High	High	Extreme	Extreme	Extreme
	Likely	Moderate	High	High	Extreme	Extreme
	Possible	Low	Moderate	High	Extreme	Extreme
	Unlikely	Low	Low	Moderate	High	Extreme
	Rare	Low	Low	Moderate	High	High

Table from: A Framework on How to Prepare and Develop Public Health Risk Management Plans for Drinking-water Supplies, MoH, 2005

6 Summary of Level of Risk

The risk assessment for the Extreme, High, Moderate and Low risk events from the risk information tables contained in Section 5 are summarised in the Table 5 to Table 8 below.

6.1 Source & Abstraction

Table 5: Groundwater Source and Abstraction Risks

			Risk Assessment of Existing		
Ref	**Event**	**Cause**	**Likelihood**	**Consequence**	**Residual Risk**
SA1	Source water receives leakage of contaminants down abandoned or decommissioned wells.	• Abandoned or improperly decommissioned wells within the source protection zone.	Unlikely	Major	High
SA2	Source water contaminated by sand.	• Excessive abstraction • Sand passing the bore structure and screen.	Possible	Insignificant	Low
SA3	Not enough source water to meet demand	• Aquifer exhausted • Aquifer compromised • Increased demand • Damage to the bore head • Catastrophic failure (eg. Earthquake related damage) • Vandalism/sabotage • Screens clogged • Deterioration in bore condition/structure	Possible	Moderate	High
SA4	Contaminated water getting into the bore from shallower depths.	• Poor joints, cracks, or corrosion in the bore casing	Unlikely	Major	High
SA5	Contaminated water getting into the bore from the surface.	• Water inundates the bore head. • Inappropriate bore head design, or poor construction. • Bore head not properly sealed. • Bore head or casing damaged. • Contamination sources (e.g. stock) too close to the bore head. • Back siphoning.	Unlikely	Major	High
SA6	Too little water can be drawn from the bore to meet demand.	• Damage to the pump or bore head. • Catastrophic failure (e.g. flood, slips or earthquake related damage). • Pump failure. • Vandalism/sabotage. • Screens clogged. • Deterioration in bore condition/structure.	Possible	Moderate	High

6.2 Treatment

Table 6: Treatment Risks

Ref	Event	Cause	Risk Assessment of Existing		
			Likelihood	Consequence	Residual Risk
Disinfection – Chlorination					
T1	Not enough free available chlorine.	• Dosing malfunction. • Dose controller's sensor incorrectly calibrated. • Dose controller's set-point incorrect or incorrect dose calculation. • High chlorine demand coupled with poor dose control. • Power failure. • Chlorine supply exhausted. • Chlorine supply adequate, but insufficient chlorine reaching dosing point. • FAC monitoring samples taken incorrectly or incorrectly recorded. • Method of FAC measurement incorrect, incorrectly calibrated, or analysis reagents have deteriorated.	Unlikely	Minor	Lwo
T2	Too much free available chlorine.	• Dosing malfunction. • Dose controller's sensor incorrectly calibrated. • Dose controller's set-point incorrect, or incorrect dose calculation. • Low chlorine demand coupled with poor dose control.	Unlikely	Insignificant	Low
T3	Excessive formation of chlorination by-products.	• Natural organic matter present in the water being chlorinated.	Unlikely	Moderate	Moderate
Pump Operation (Bores & Boosters Only)					
T4	Changes in pressure, or water hammer (pressure surges), suck contaminants into the water.	• Bore/booster pump failure due to mechanical failure or overload. • No water because of pump failure due to power failure. • No water because of pump failure due to other causes	Possible	Moderate	High

6.3 Storage & Distribution

Table 7: Storage & Distribution Risks

Ref	Event	Cause	Risk Assessment of Existing		
			Likelihood	Consequence	Residual Risk
Post-treatment Storage					
SD1	Not enough water in post-treatment storage to meet demand.	• Insufficient water treatment capacity, or output limited by one or more treatment stages not operating • Inability to transmit water from source to post-treatment storage. Earthquate damage to pipes. Ball cock fails • Leakage from the storage facility.	Possible	Moderate	High
SD2	Introduction of contaminating material into service reservoir.	• Access by animals/birds. • Unauthorised access/vandalism/sabotage. • Entry of roof drainage.	Possible	Moderate	High
SD3	Development or re-suspension of sediment within tank or reservoir.	• Sediment/slime accumulation and release.	Likely	Insignificant	Moderate
Reticulation Network - Construction Materials (also Applicable to Treatment Processes)					
SD4	Entry of or dissolution of chemicals from construction materials.	• Unsuitable materials in use. • Inadequate design standards. • Inadequate monitoring of new developments and construction. • Poor quality materials. • Inadequate flushing of new materials. • Inadequate maintenance or replacement of worn materials. • Materials insufficiently resistant to dissolution by the water and the surrounding environment. • Inadequate or inaccurate activity asset data. • Inadequate maintenance and repair programme.	Possible	Moderate	High
SD5	Failure of the distribution system through failed construction materials.	• Deterioration of distribution system, leading to ingress of micro-organisms. • Biofilm development sustaining pathogens. • Inadequate or inaccurate activity asset data. • Inadequate maintenance and repair programme.	Likely	Minor	High
SD6	No water available.	• Material failure.	Possible	Moderate	High
Reticulation Network - System Pressure					
SD7	Introduction of contamination by pressure fluctuations.	• Mains pressure failure elsewhere, or high instantaneous demand.	Possible	Moderate	High

Ref	Event	Cause	Risk Assessment of Existing		
			Likelihood	Consequence	Residual Risk
		• Pipe failure or accidental penetration. • Unpredicted event such as a major fire.			
SD8	Re-suspension of sediment or biofilm within the mains by pressure.	• Sediment or biofilm allowed to develop. • Significant fluctuations in reticulation pressure. • Flow reversal.	Likely	Insignificant	Moderate
Reticulation Network – Operation					
SD9	Introduction of contaminating material into the distribution system.	• Affected area not correctly isolated. • Standard hygiene practices not adopted. • Inadequate staff training. • Inadequate flushing and disinfection practices during repairs or commissioning of new mains. • Unsatisfactory location of water reticulation pipes. • Inappropriate materials used. • Breaks, leaks, incidental damage to water mains. • Unsuitable temporary bypass and/or supply bypass. Cross connections. • System pressure drop.	Possible	Moderate	High
SD10	Re-suspension of contaminants in sediments in the distribution system.	• Water velocity too high.	Possible	Minor	Moderate
SD11	Development of sediment or biofilm.	• Poor microbiological water quality leaving the treatment plant and in the distribution system. • Water flows too low resulting in: decay of chlorine, microbiological colonisation of surfaces. • Poor repair practices allowing colonisation.	Possible	Minor	Moderate
SD12	Failure to maintain sufficient water pressure.	• Insufficient water available from the source, treatment plant or post treatment reservoir. • Transmission pump failure • Leaks in the reticulation network.	Likely	Minor	High
Reticulation Network - Backflow Prevention					
SD13	Water pressure in the distribution system lower than pressure in supplied premises.	• A pressure drop in the reticulated system as a result of pump failure, pipe burst. • An elevated pressure in the premise(s) supplied as compared to the reticulated system.	Possible	Minor	Moderate
SD14	No, inadequate, faulty, or incorrectly installed backflow prevention device.	• The backflow prevention device is not actually connected or is connected improperly. No backflow prevention device installed because of insufficient knowledge of activities on the premises. An illegal cross connection to the	Possible	Minor	Moderate

Ref	Event	Cause	Risk Assessment of Existing		
			Likelihood	Consequence	Residual Risk
		reticulated system. • The backflow prevention device may have failed safe, but may then have been removed to maintain the water flow and not been replaced. • Failure of backflow prevention device. • Unauthorised drawing of water from fire hydrants. • Vandalism or accidental damage.			

6.4 General

Table 8: General Risks

Ref	Event	Cause	Risk Assessment of Existing		
			Likelihood	Consequence	Residual Risk
Staff Training					
GN1	Introduction of microbiological contaminants into the water supply, or the inadequate inactivation, or removal, of microbiological contaminants.	• Inadequate training in terms of breadth or depth or both.	Unlikely	Moderate	Moderate
GN2	Introduction of chemical contaminants (incorrect application of treatment chemicals), or the inadequate removal of chemical contaminants.	• Inadequate training in terms of breadth or depth or both.	Unlikely	Moderate	Moderate

Ref	Event	Cause	Risk Assessment of Existing		
			Likelihood	Consequence	Residual Risk
Monitoring					
GN3	Incorrect water quality data used for supply management.	• Inappropriate or incorrect sampling. • Inadequate or incorrect test equipment or incorrectly calibrated test equipment. • Inadequate reagents. • Inappropriate method or incorrect calibration. • Inadequate or incorrect monitoring records. • Failure of staff to follow the analytical method and other related quality assurance procedures. • Use of a non-Ministry of Health approved laboratory.	Unlikely	Moderate	Moderate

7 Improvement Schedule

The following list of improvements for the Bunnythorpe Water Supply has been developed from the preceding risk information tables with reference to Council's Water Asset Management Plan 2014 adopted by the Long Term Plan. Improvements are subject to Council funding availability. Regular monitoring and maintenance actions have not been included in this table but are outlined in Section 8. Improvements are prioritised from high to low according to the existing risk level, and from low to high on cost.

Table 9: Improvement Schedule

Ref	Improvement Needed	Reason for Improvement	Event Ref	Ex. Level of Risk	Priority	Cost Estimate	Target Date to Complete	Person Responsible	Benefit
1	Connection of Bunnythorpe reticulation to Palmerston North supply	Provide redundancy to supply	SA2 SA3 T1 SD1	High		$800k	2019/20	Water Asset Engineer (Dora Luo)	Provides a second source of water in event of contamination or demand exceeds supply
2	Develop reservoir inspection sheet	Monitor & maintain reservoir integrity	SD2	Moderate		$200	2017/18	Treatment Plants Manager (Mike Monaghan)	Reduced risk of contamination of treated water
3	Initiate TOC/colour testing programme	Prevention of chlorination by products	T3	Low		$40/year	2016/17	Water Asset Engineer (Dora Luo)	Improved aesthetic quality/reduced risk of disinfection by products
4	Water toby renewal.	To replace water tobies with manifolds with backflow functionality.	SD13	High		$2000	On going	Water Asset Engineer (Dora Luo)	Reduce the risk of backflow.
5	Carry out backflow prevention device survey	Prevention of backflow into reticulation	SD14			$500	On going	Water Asset Engineer (Dora Luo)	Reduce the risk of contamination of treated water.

8 Related Plans, Monitoring & Maintenance

8.1 Council Policy and Plans

This WSP will be considered in the updating of the Water Asset Management Plan, the Risk Management Plan and the preparation of Council's Annual Plans and Long Term Plan.

8.2 Regular Monitoring

Table 10 below contains a summary checks that are carried out on the Palmerston North water supply, how often they need to be made and who is responsible for them.

Table 10: Monitoring Summary

Ref	Check	Details	How often	Responsibility
1	Bacterial compliance	Take samples from the bore and reticulation as per DWSNZ requirements.	1 sample per quarter with not more than 135 days between samples and the sampling covers 3 different days of the week	PNCC Treatment Plant Technicians
2	Bore Radiological compliance.	Radiological tests.	10 yearly (next due 2026)	Water Asset Engineer (Dora Luo)
3	Bore water age (residence time).	Tests required for bore water security assessment.	Every 5 years (next due August 2018)	Water Asset Engineer (Dora Luo)
4	FAC and turbidity	Regularly monitor critical water supply alarms and respond accordingly.	Continuous	Treatment Plant Manager (Mike Monaghan)Senior water treatment technician
5	On-line monitoring instrument calibration.	Re-calibrate turbidity, pH probes using calibration buffers.	Weekly	PNCC Treatment Plant Technicians
6	Chemical storage levels.	Check chlorine, FAC levels and re-order if necessary.	Daily	PNCC Treatment Plant Technicians
7	Water bulk flow out of reservoirs and reservoir level	Pressure and flow in reticulation (alarm if abnormal).	Continuous	Water Asset Engineer (Dora Luo) /PNCC Treatment Plant Technicians
8	Backflow devices.	IQP test and record on asset management system.	Annual	Water Asset Engineer (Dora Luo)
9	Depth of sand layer in reservoir	Check during reservoir cleaning	2-yearly	Treatment Plant Manager (Mike Monaghan)

8.3 Maintenance Schedules

Table 11 below summarises key maintenance activities for the Palmerston North water supply and who is responsible for them. Refer also to Operation and Maintenance manuals.

Table 11: Maintenance Activities

Ref	Schedule	Frequency	Responsibility
1	Inspect well head condition and security.	5 yearly next due 2019	Water Asset Engineer (Dora Luo)
2	Inspect bore pumps and dosing equipment.	Monthly	Treatment Plant Manager (Mike Monaghan)
3	Service dosing equipment	Annually	Treatment Plant Manager (Mike Monaghan)
4	Annual inspection of power source, connections and electrical equipment.	Annually	Treatment Plant Manager (Mike Monaghan)
5	Service pressure booster stations and pressure reducing/sustaining valves.	6 monthly	Treatment Plant Manager (Mike Monaghan)
6	Exercising of valves and hydrants.	Every 4 years	Civil Works Supervisor
7	Calibrate flow meters.	5 yearly	Treatment Plant Manager (Mike Monaghan)
8	External condition of reservoirs/WTP.	Annually	Treatment Plant Manager (Mike Monaghan)
9	Reservoir cleaning.	Every 2 years	Treatment Plant Manager (Mike Monaghan)
10	Bunnythorpe reticulation sequential flushing	Annually	Water Asset Engineer (Dora Luo) Civil Works Supervisor
11	Backflow preventer inspection and re-certification.	6/12 monthly	Water Asset Engineer (Dora Luo)

9 Contingency Plans

Table 12 to Table 16 below contain Contingency Plans for all risk events. These contingency plans are based on those given in the Ministry of Health guidelines.

Table 12: Events that Affect the Groundwater Source

Event – Large amounts of contamination enter the groundwater or well	
Indicators:	• Report of chemical spill in an area where chemicals may get into the groundwater you use. • Your consumers complain of discoloured, or bad tasting or smelling water coming from their taps. • High levels of germs or chemicals are found in samples from routine sampling test • Many people in the community complain of illness which may be linked to water quality.
Required actions:	• Stop drawing water from the well, and alert emergency services if it is a chemical spill. • Tell the MOH about what has happened and discuss. Warn consumers not to draw water until further notice. • Organise water tanks and distribute bottled water for essential use. • Identify what is causing the contamination, and decide whether the problem is likely be short term or last for a long time. • If problem is short-term: – Drain and flush the affected part of the reticulation network and Disinfect the reticulation network with high levels of chlorine if high levels of germs were in the water. – Sample for the chemical of concern or germs to find out when the water can be used again. Inform the customers when the supply is safe to use, but need to flush their taps until good quality water is again flowing. • If problem is likely to be long-lasting: – Look for a new source of water or consider more treatment – Record cause of the system failure and the correction actions have been taken – Modify water safety plan if necessary.
Responsibility:	• Water Asset Engineer.
Event – Earthquake and landslides	
Indicators:	• An earthquake may cause damage to the source, treatment plant or reticulation network. The water supply may be shut down as a result. • Destroyed well-head, chlorination shed or reservoir. • Geysers of water from breaks in the reticulation network pipes.
Required actions:	• Contact the Ministry of Civil Defence in the event of an earthquake emergency. • Monitoring telemetry system if it is still working to and define and major leaks through mess balance • Inspect well-head, chlorination system, reservoirs, and the reticulation network. • Sample bore water in ensure it is safe to drink • If any part of the supply is damaged so that water cannot be distributed or the quality is unacceptable, organise water tanks and distribute bottled water for essential use. • Notify MOH about the situation. • Record cause of the system failure and the correction actions that have been taken. • Modify water safety plan if necessary.
Responsibility:	• Water Asset Engineer.

Event – Flooding	
Indicators:	• Excessive rain fall and high water level in Mangaone Stream, Pohangina River and Manawatu River • Breach on stopbank • The Bore site and pump station area is inundated
Required actions:	• Contact the Ministry of Civil Defence • Notify MOH about the situation • Monitoring telemetry system if it is still working • Sample water in reservoir if is safe to drink • Bore water sampling to check if it is safe to drink • Sand bag the bore site and pumping to keep the area dry if possible • Boiling water notice or water restriction notice when necessary • Post flood bore head, pump, facility inspection • Post flood bore water sampling and bore flush when required • Record cause of the system failure and the correction actions that have been taken • Modify water safety plan if necessary.
Responsibility:	• Water Asset Engineer.
Event – Water shortage	
Indicators:	• Low groundwater table. • Water usage much higher than usual. • Drop in water pressure.
Required actions:	• Consider restricting water use. • If water shortages occur frequently, consider increasing bore pumping capacity. • Plan for additional or alternative source. • Record incident and action taken. • Modify Water Safety Plan if necessary.
Responsibility:	• Water Asset Engineer.

Table 13: Events that Affect Treatment

Event – FAC concentration is lower than minimum acceptable level	
Indicators:	• A detectable chlorine residual cannot be obtained in the water leaving the treatment plant (high chlorine demand due to poor destratification). • In 100 mL samples of water leaving the treatment plant, E. coli or coliforms are continually detectable, or E. coli is present at elevated levels (more than 10 per 100 mL). • Widespread levels of illness in the community.
Required actions:	• Follow the actions given in Figure 4.1 of the DWSNZ2005. • Identify the reason for the failure and rectify. • Record cause of system failure and steps taken to correct. • Modify Water Safety Plan if necessary.
Responsibility:	• Civil Works Supervisor and Senior Water Treatment Technician.

Event – FAC concentration is very much higher than maximum acceptable value	
Indicators:	• A major spillage or overdose of chlorine into the water. • Inability to obtain pink colour from DPD chlorine indicator despite high chlorine dose rates. (NB: This indicates chlorine levels well in excess of the MAV – very high chlorine levels bleach the pink colour that normally develops in the presence of chlorine.) • Water develops a strongly chlorinous odour. • Widespread levels of taste and odour complaints, or illness, in the community.
Required actions:	• Close down the plant. Provide another source of potable water until water of acceptable quality can again be supplied. • Inform the MOH of the situation. • Identify the reason for the chlorine overdose and rectify. • Dump the reservoir water, or add chemicals to neutralise the chlorine if more appropriate (neutralisation may be required before any water is dumped, anyway). • Flush the distribution system, if excessive levels of chlorine are also present in the distribution system, and monitor water quality until chlorine concentrations are again back to normal operating levels. • Warn consumers to thoroughly flush their taps before drawing water for use (if they are likely to have been affected). • Record cause of system failure and steps taken to correct. • Modify Water Safety Plan if necessary.
Responsibility:	• Civil Works Supervisor and Senior Water Treatment Technician.

Table 14: Events that Affect Stored Water

Event – Breach of the post-treatment storage tank/reservoir	
Indicators:	• Visual inspection shows evidence of structural deterioration or a leak. • Water levels cannot be maintained despite water being pumped into storage at an adequate rate.
Required actions:	• Identify the location of the leak, and repair. • Bypass the tank/reservoir and take water directly from the treatment plant. • If the normal water source does not meet the needs of the community or treatment plant capacity (i.e. the quantity is too low at that time of year), implement water use restrictions investigate and obtain alternative source(s) of water; • Repair the storage tank/reservoir if a leak is the cause of the shortage. • Record cause of system failure and steps taken to correct. • Modify Water Safety Plan if necessary.
Responsibility:	• Civil Works Supervisor and Senior Water Treatment Technician.
Event – High levels of chemical contaminants in the stored water	
Indicators:	• Knowledge of a major chemical spill, or chemical overdose (e.g, chlorine), into the reservoir; vandalism. • Change in the appearance, smell or taste of the water. • Widespread levels of illness in the community. • Chlorine residual not restored.
Required actions:	• Close down the reservoir, and if necessary the supply. Provide another source of potable water until water of acceptable quality can again be supplied. • Inform the MOH of the situation. • Identify the source of contamination and take steps to avoid recontamination. • Dump the reservoir water. Consultation with the Regional Council will probably be required with regard to disposal of the flushed water. • Flush the reticulation system and monitor water quality until determinand concentrations are again less

	than 50% of the MAV. • Warn consumers to thoroughly flush their taps before drawing water for use. • Record cause of system failure and steps taken to correct. • Modify Water Safety Plan if necessary.
Responsibility:	• Civil Works Supervisor and Senior Water Treatment Technician.

Table 15: Events that Affect the Distribution Network

Event – Contamination enters the distribution system	
Indicators:	• Inability to maintain a chlorine residual when one can normally be maintained. • In 100 ml samples of water from the reservoir, E. coli is continually detectable or is present at elevated levels (more than 10 per 100 mL). • Widespread complaints of taste and odour from consumers. • Widespread levels of illness in the community. • Turbidity fluctuations and levels greater than that in water leaving the treatment plant.
Required actions:	• Follow the actions given in Figure 4.2 of the DWSNZ:2005. • Identify the reason for the failure and rectify. • Record cause of system failure and steps taken to correct. • Modify Water Safety Plan if necessary.
Responsibility:	• Water Asset Engineer.
Event – No water because of failure of materials	
Indicators	• Consumer complaints. • Burst or leaking pipes. • High unaccounted for water use.
Required Actions:	• Identify the location of the leak and repair. • Confirm that hygienic procedures for repairs have been followed. • Monitor chlorine residuals and increase residual to make sure that more than 0.2 mg/L FAC reaches all parts of the distribution system. • Identify the reason for the failure and rectify. • Record the reason for the failure and the steps taken to rectify. • Review of water main renewal priorities • Modify Water Safety Plan if necessary.
Responsibility	• Civil Works Supervisor and Senior Water Treatment Technician.
Event – Backflow into the distribution system occurs	
Indicators:	• Complaints of discoloured, tasting or smelling water coming from taps. • Backflow incident reported by industry. • Reports of illness in parts of the community. • Inability to maintain disinfectant residual in parts of the distribution system. • E. coli or coliforms found in the distribution system
Required actions:	• Notify the MOH, and in consultation warn consumers in the affected area not to draw water until further notice. If necessary, provide another source of potable water until water of acceptable quality can again be supplied. • Identify the source of the backflow incident, and isolate until a backflow prevention device can be fitted, or the one already installed can be made operational. • Drain and flush the affected part of the distribution system, considering the need to flush with elevated

	chlorine concentrations if the incident may have involved microbiological contaminants. (Consultation with the Regional Council will probably be required with regard to disposal of the flushed water.) • Monitor an appropriate determinand in the affected area to determine the successive of the contingency measures, and notify consumers, when the supply is safe to use, that they will need to flush their taps until good quality water an again be drawn. • Record cause of system failure and steps taken to correct. • Modify Water Safety Plan and Backflow Prevention Policy if necessary.
Responsibility:	• Water Asset Engineer.

Table 16: Events Related to Operators and Monitoring

Event – Operator Error	
Indicators:	• Incidents as a result of operation error.
Required actions:	• Refreshment training.
Responsibility:	• Civil Works Supervisor and Senior Water Treatment Technician.
Event – Poor quality assurance and/or quality control for monitoring	
Indicators:	• Too many errors detected during audits or surveillance. • Too many process control failures. • Too many outliers shown by inter-lab quality control studies. • Repeated unexplained compliance test failures (FAC/E. coli).
Required actions:	• Full audit of quality procedures. • Identify and resolve deficiencies in equipment/methods/staff training. • Identify all analysis records that may have been adversely affected. • Inform the Medical Officer of Health (MOH) if compliance tests may have been affected. • Once the cause of the poor performance has been identified, correct it. • Record the reason for the failure and the steps taken to rectify. • Modify the water safety plan if necessary.
Responsibility:	• Water Asset Engineer.

9.1 Post Event Debrief

A post event debrief should be carried out following any of the risk events identified in this Section.

The debrief should include a review of the following:

- Whether the indicators are clear enough to reflect the event;
- Whether the judgements and decisions around actions were timely and correct;
- Whether the corrective actions were effective;
- Gap identification and any improvements required.

The findings from the debrief should be used to update the WSP.

10 Water Safety Plan Performance Assessment

The Water Safety Plan should be reviewed and updated annually or any significant changes/event occurred and comprehensively reviewed and updated every five years to ensure the plan is current. The Water Asset Engineer is responsible for the review process. The review process will involve:

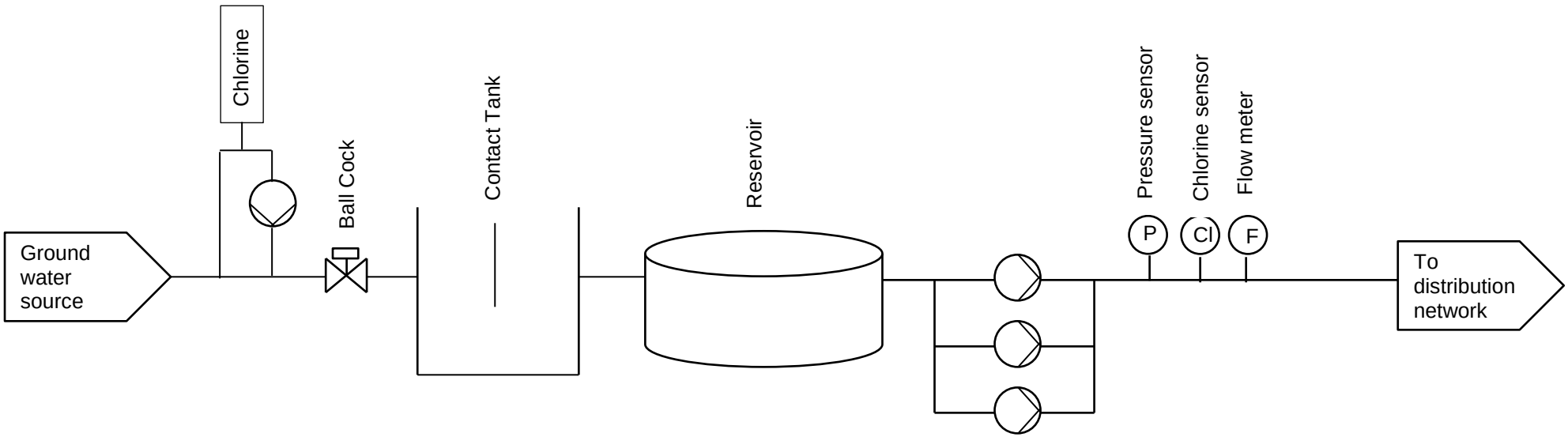
- Checking that roles and responsibilities are still valid.
- Reviewing the operation of the water supply by:
  - Checking compliance with the Drinking Water Standards for New Zealand;
  - Reviewing incident records and lessons learned from any incidents;
  - Checking whether any problems have been found during routine checks and maintenance.
- Reviewing progress with implementing improvements and updating the schedule with new improvements identified as a result of incidents occurring.
- Addressing new or altered risks arising from modification, additions or changes made to the supply.
- Reviewing monitoring and maintenance responsibilities.
- Checking personnel changes and that new staff are aware of the Water Safety Plan.

The first comprehensive review will be on 2021.

11 Water Safety Plan Progress Reporting

The implementation of this Water Safety Plan should be monitored and reported against measures in it on annual basis. The report will be submitted to the Drinking Water Assessor.

Appendix A. Bunnythorpe Water Supply Schematic


Chlorine
Ball Cock
Contact Tank
Reservoir
Pressure sensor
Chlorine sensor
Flow meter
P
Cl
F
Ground water source
To distribution network