Appendix C

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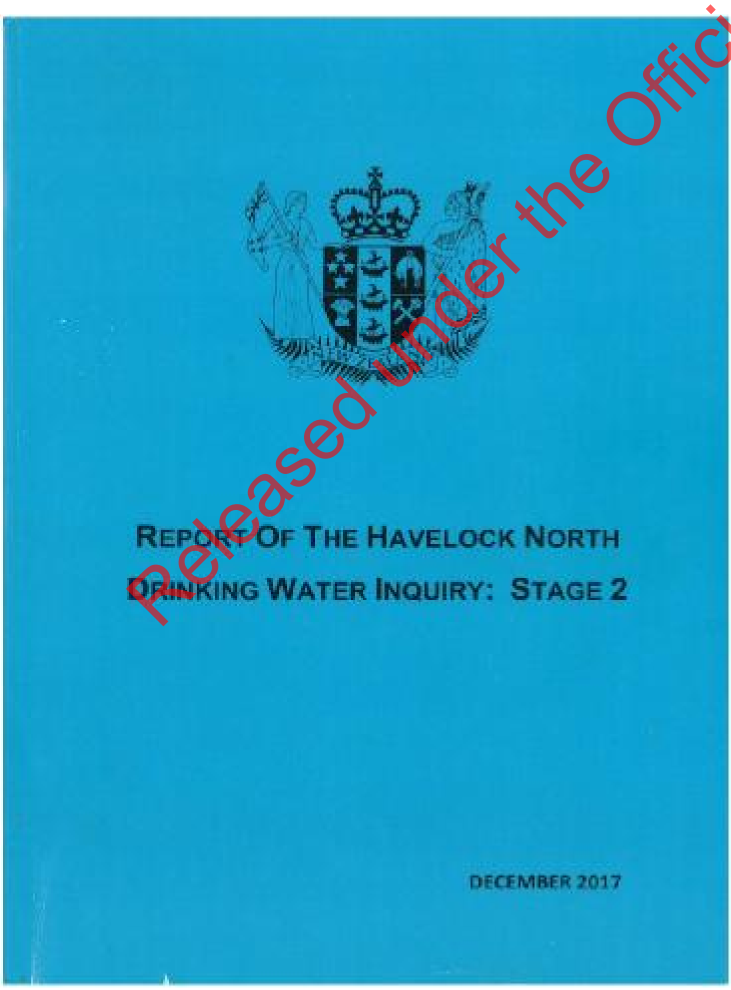
Report

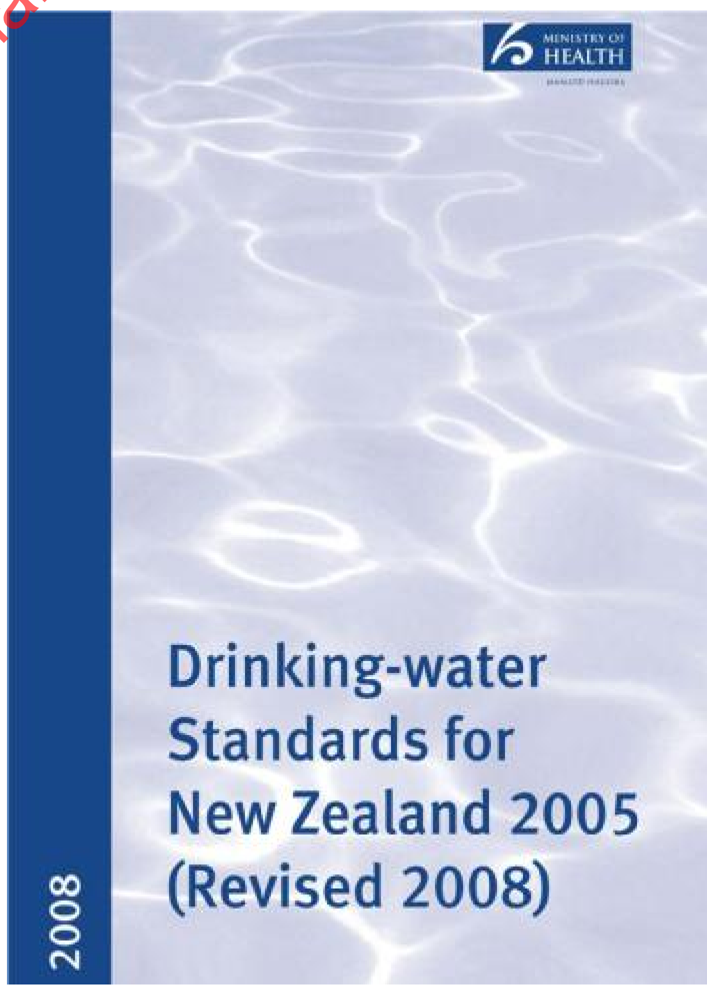
Cost Estimates for Upgrading Water Treatment Plants to Meet Potential Changes to the New Zealand Drinking Water Standards

Prepared for Department of Internal Affairs

Prepared by Beca Limited

15 March 2018





Revision History

Revision Nº	Prepared By	Description	Date
A	Kathryn Jessamine	Draft for Client Review	20 February 2018
B	Kathryn Jessamine	Final Draft	7 March 2018
C	Sarah Burgess	Final	15 March 2018

Document Acceptance

Action	Name	Signed	Date
Prepared by	Kathryn Jessamine		
Reviewed by	Sarah Burgess		
Approved by	Andrew Watson		
on behalf of	Beca Limited		

Executive Summary

The Department of Internal Affairs has commissioned Beca to prepare high-level cost estimates for implementing two of the recommendations of the Havelock North Drinking Water Inquiry (the Inquiry) Stage 2 report. These high-level estimates are intended to give an indication of the likely capital and increased operational costs to water suppliers for the purpose of informing discussion by Ministers around potential changes to Drinking Water Standards for New Zealand 2005 (revised 2008) (the drinking water standards). The two recommendations are:

- Removal of the “all practicable steps” clauses in the Health Act, making compliance with the drinking water standards mandatory (Scenario 1).
- Abolition of the secure groundwater classification system (Scenario 2).

All networked supplies are included in the analysis - both council-owned and non-council owned. Non-council-owned supplies are typically owned by community organisations (e.g. Incorporated Societies), while most others are owned by private companies. The definition of a networked supply (as opposed to a self-supply) is that it supplies water to a number of properties (i.e. it supplies a community). Self-supplies and emergency supplies are excluded from the analysis.

It is important to note that only costs directly associated with achieving compliance with the drinking water standards are included. The estimates assume that existing treatment plant capacities are adequate and therefore make no provision for capacity increases. The cost estimates exclude upgrading or replacement of existing assets, or any other infrastructure which may be needed or desired as part of a treatment plant upgrading. Depending on the condition of the existing assets, and the appropriateness of the existing treatment process for the quality of the source water, these costs can be significant (in the order of $1 to $2 million per plant for smaller plants).

The table below summarises the costs associated with implementing both of the Inquiry recommendations by region. The estimates of probable cost are presented as a range (± 30%) which reflects the uncertainties associated with the cost estimation process.

There are an estimated 181 non-council supplies that fall under Scenario 1 and/or 2 and are included in the table below (i.e. about 30% of the total). The estimated capital cost of upgrading the non-council supplies for both scenarios is $57 million, and the increased operational cost is $3 million per annum. The estimated capital cost to upgrade the remaining 430 council owned water treatment plants is $384 million with an increase in operational costs of $13 million per annum. The non-council owned supplies serve only 1% of the total population, making the costs much higher for these water treatment plants when considered on a per population basis.

Across both Scenarios, capital costs are generally highest in Canterbury, Otago, Waikato and Manawatu-Wanganui. Capital costs are lowest in Auckland, Nelson and Gisborne. Combined annualised capital and operating costs on a per population basis are generally highest in Otago, West Coast, Tasman and Hawkes Bay and lowest in Auckland and Wellington.

Summary of Estimate of Probable Costs

Region	No. water treatment plants Affected	Pop. Affected	Estimate of Probable Capital Cost ($ million)	Estimate of Probable Operating Cost (per annum)
Auckland	13	19,737	$1.7 - $3.1	$80,000 - $160,000
Bay of Plenty	42	75,818	$15.3 - $28.5	$620,000 – $1,160,000
Canterbury	170	506,825	$102.1 - $189.6	$4,470,000 - $8,300,000
Gisborne	4	710	$0.9 - $1.7	$40,000 – $70,000
Hawke's Bay	38	192,062	$18.1 - $33.7	$530,000 – $990,000
Manawatu-Wanganui	64	199,424	$23.2 - $43.1	$640,000– $1,190,000
Marlborough	19	11,422	$5.5 - $10.3	$210,000 - $390,000
Nelson	2	49,765	$1.0 - $1.9	$150,000 - $270,000
Northland	28	12,293	$6.3 - $11.7	$280,000 - $520,000
Otago	69	71,606	$66.0 - $122.6	$2,160,000 - $4,010,000
Southland	15	68,359	$8.3 - $15.5	$160,000 - $300,000
Taranaki	9	11,540	$2.7 – $5.0	$90,000 - $160,000
Tasman	25	24,655	$7.4 - $13.7	$290,000 - $550,000
Waikato	72	113,357	$30.3 - $56.3	$1,020,000 – $1,890,000
Wellington	18	88,279	$13.1 – $24.3	$180,000 - $330,000
West Coast	23	19,117	$6.8 – $12.7	$350,000 - $660,000
TOTAL	**611**	**1,400,206**	**$308.7 - $573.7M**	**$11.3 – $20.9M per annum**

These cost estimates build on previous work carried out by Beca in 2010 that focused only on the direct costs associated with compliance with the drinking water standards. In the interests of efficiency, a similar methodology has been applied to produce these updated costs. However, it is acknowledged that the actual costs faced by many water suppliers will be significantly higher – a very rough order estimate of $250 million in additional capital costs for Minor, Small and Neighbourhood water treatment plants is suggested. These additional costs are particularly relevant for smaller water treatment plants where there is limited existing infrastructure and the assets are often in poor condition.

The costs to water suppliers associated with the potential changes to the drinking water standards from the two recommendations from the Inquiry are significant. These costs may be unaffordable for many communities, particularly smaller communities.

For non-council owned supplies, because they generally serve smaller communities, costs are significantly more than those on council-owned supplies on a per person basis. In addition, these non-council owned supplies have no ability to spread the upgrading costs across a larger customer base because they are individually owned. This will further add to the unaffordability of upgrading work for small non-council supplies.

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Appendices

1 Introduction

1.1 Background, Scope and Purpose

As part of the government's review of the management of drinking water, storm water and wastewater (Three Waters Review) in New Zealand, and in response to the findings of the Stage 2 Report of the Havelock North Drinking Water Inquiry (the Inquiry), the Department of Internal Affairs has engaged Beca to provide high level estimates of costs for potential changes to the drinking water standards. The Three Waters Review was initiated in response to concerns about the condition and management of water infrastructure in New Zealand. The Inquiry was set up in response to the waterborne disease outbreak in Havelock North in August 2016. Both the Three Waters Review and the Inquiry are concerned with risks to public health.

The two recommendations from the Inquiry Stage 2 Report that Beca has been asked to provide cost estimates for are:

- Removal of the "all practicable steps" clauses in the Health Act, making compliance with the drinking water standards mandatory (Scenario 1).
- Abolition of the secure groundwater classification system (Scenario 2).

These changes, if adopted by the government, would require water suppliers to upgrade their water treatment plant infrastructure to comply with the drinking water standards or face prosecution under the Health Act. The majority of water suppliers in New Zealand are local councils who every year face pressure to fund a wide range of infrastructure and other capital works, but are also constrained by a number of drivers to keep rates rises low. Councils, as well as the other non-council suppliers, may or may not be willing or able to provide funding for the required water treatment plant upgrades. The purpose of this report is to estimate the likely costs associated with the required water treatment plant infrastructure upgrades for the two scenarios above. These high-level estimates are intended to give an indication of the likely costs to upgrade water supplies for the purpose of informing discussion by Ministers around potential changes to the drinking water standards.

Cost estimates for mandatory compliance with the drinking water standards were previously prepared by Beca as part of a cost-benefit analysis carried out for the Ministry of Health in 2010[1], and will provide the basis for the updated high-level cost estimates requested by the Department of Internal Affairs.

1.2 Water Treatment in New Zealand

There are nearly 800 registered networked water treatment plants in New Zealand. All networked water supplies serving 25 people or more must be registered in accordance with the Health Act. Of these 800 networked water treatment plants, 569 or 72% are council-owned. The remainder are mainly owned by community organisations or private companies. Water treatment plants are also classified based on the size of the population they serve. Table 1.1 summarises the distribution of water treatment plants by region and size. For each region and population category, three values are given, the first is the number of council-owned water treatment plants, the second is the number

[1] LECG 2010. Cost Benefit Analysis of Raising the Quality of New Zealand Networked Drinking Water.

of non-council owned water treatment plants, and the third is the total number of water treatment plants.

Table 1.1 - Summary of Registered Water Treatment Plants in New Zealand

Region	Number of Water Treatment Plants in Each Population Category (Council/Non-Council/Total)					
	Large (>10,000)	Medium (5,001-10,000)	Minor (501 – 5,000)	Small (101-500)	N'hood (25-100)	Total
Auckland	5 / 0 / 5	3 / 0 / 3	7 / 0 / 7	0 / 6 / 6	2 / 2 / 4	17 / 8 / 25
Bay of Plenty	6 / 0 / 6	9 / 0 / 9	15 / 0 / 15	5 / 8 / 13	1 / 15 / 16	36 / 23 / 59
Canterbury	24 / 0 / 24	6 / 1 / 7	59 / 2 / 61	52 / 11 / 63	20 / 18 / 38	161 / 32 / 193
Gisborne	2 / 0 / 2	0 / 0 / 0	0 / 0 / 0	2 / 2 / 4	0 / 1 / 0	4 / 3 / 7
Hawke's Bay	16 / 0 / 16	0 / 0 / 0	7 / 0 / 7	8 / 2 /10	3 / 8 /11	34 / 10 / 44
Manawatu-Wanganui	10 / 0 / 10	1 / 1 / 2	15 / 3 / 18	19 / 7 / 26	1 / 12 / 13	46 / 23 / 69
Marlborough	2 / 0 / 2	0 / 0 / 0	6 / 1 / 7	1 / 2 / 3	0 / 13 / 13	9 / 16 /25
Nelson	1 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 1 / 1	0 / 1 / 1	1 / 2 / 3
Northland	3 / 0 / 0	4 / 0 / 4	9 / 2 / 11	4 / 8 / 12	6 / 16 / 22	26 / 26 / 52
Otago	13 / 0 / 13	1 / 0 / 1	30 / 1 / 31	13 / 7 / 20	1 / 30 / 31	58 / 3 8 / 96
Southland	1 / 0 / 1	2 / 0 / 2	10 / 0 / 10	3 / 1 / 4	0 / 1 / 1	16 / 2 / 18
Taranaki	1 / 0 / 1	2 / 0 / 2	8 / 0 / 8	3 / 1 / 4	3 / 1 / 4	17 / 2 / 19
Tasman	1 / 0 / 1	0 / 0 / 0	5 / 0 / 5	10 / 4 / 14	1 / 8 / 9	17 / 12 / 29
Waikato	8 / 0 / 8	8 / 0 / 8	32 / 2/ 34	27 / 5 / 32	12 / 5 / 17	87 / 12 / 99
Wellington	7 / 0 / 7	2 / 0 / 2	10 / 1 / 11	1 / 2 / 3	0 / 5 / 5	20 / 8 / 28
West Coast	0 / 0 / 0	1 / 0 / 1	5 / 0 / 5	10 / 0 / 10	4 / 8 / 12	80 / 8 / 28
TOTAL	100/ 0/ 100	39/ 2/ 41	218/ 12/ 230	158/ 67/ 225	54/ 144 /198	569/ 225 /794

Table 1.1 shows that 653 of the 794 water treatment plants serve less than 5,000 people. It also shows that for the larger (Large and Medium) water treatment plants 139 out of 141 are owned and operated by councils, and the proportion of non-council owned water treatment plants increases for smaller population categories. In the Large population category, there are no non-council owned water treatment plants whereas in the Neighbourhood population category, 75% of water treatment plants are non-council owned.

Canterbury, Otago and Waikato have the three largest numbers of water treatment plants. In Marlborough, Nelson and Northland 50% or more of the water treatment plants are non-council owned.

Table 1.2 shows the population served by registered networked water treatment plants in each region, of which the Auckland region accounts for 35% of the total population served. The total population does not include people who are served by self-supplies (and possibly by a few networked water supplies serving less than 25 people) as these are not covered by the drinking water standards.

Table 1.2 – Populations Served by Registered Water Treatment Plants

Region	Total No. Water Treatment Plants	Total Population Served
Auckland	25	1,358,164
Bay of Plenty	59	241,763
Canterbury	193	535,507
Gisborne	7	31,821
Hawke's Bay	44	132,343
Manawatu-Wanganui	69	199,569
Marlborough	25	35,594
Nelson	3	49,921
Northland	52	100,222
Otago	96	207,239
Southland	18	71,664
Taranaki	19	91,428
Tasman	29	24,957
Waikato	99	310,175
Wellington	28	416,833
West Coast	28	25,201
TOTAL	**794**	**3,832,401**

1.3 Glossary of Terms and Abbreviations

A number of terms specific to water treatment and the New Zealand drinking water standards, which may be unfamiliar to those outside the industry, are used throughout this report. This glossary provides brief explanations for some of these terms as well as for acronyms which may also be used in this report. A more comprehensive glossary is included in Appendix A.

Affected population The number of people impacted by non-compliance (both technical and true non-compliance) and the proposed improvements/ upgrading work. In the context of this report this may refer to the population served by non-compliant water treatment plants (Scenario 1), the population served by water treatment plants with secure groundwater status (Scenario 2), or both.

Annualised cost The annual cost of owning, operating and maintaining an asset over its entire life. For the purposes of this report, this is defined as the annual payments on a loan taken out to cover the capital costs of upgrades at an interest rate of 6%pa[2] and a term of 25 years plus the increase in annual operating cost associated with those upgrades.

[2] 6% has been selected based on discussions with one council, which uses 5% for its financial planning, plus a small margin to provide some conservatism given the uncertainty around lending rates over a 25 year period.

Compliance	In the context of this report, the term compliance refers to compliance with the drinking water standards, and in particular compliance with Priority 1 (microbial) and Priority 2 (chemical) determinands.
DWSNZ or the drinking water standards	Refers to the Drinking-Water Standards for New Zealand 2005 (Revised 2008). A yardstick to assess the quality of drinking-water. The standards define the maximum acceptable values (MAVs) of health significant determinands and specify the methods for determining whether a drinking-water supply complies with the DWSNZ.
Household	An individual household consisting of one or more people who live in the same dwelling. For this report the number of households has been determined assuming there are 2.7 people per household.
Networked supplies	Supply that serves two or more properties, by means of a pipe connecting these properties.
Non-council owned	Drinking water supplies that are not under local government ownership. Examples include supplies owned by community organisations or private companies.
Population category	DWSNZ distinguishes between supplies based on the size of the population served: Large – greater than 10,000 people Medium – 5,001-10,000 people Minor – 501 – 5,000 people Small – 101 – 500 people Neighbourhood – 25 – 100 people
Registered supply	All networked supplies serving more than 25 people are required to be registered under the Health Act.
Self-supply or self-supplier	A supply that is exclusively used to supply water to a single property or one or more buildings owned by the same person. Self-suppliers do not come under the requirements of the drinking water standards, they are covered by the Building Act.
Technical non-compliance	When non-compliance is due to inadequate monitoring or problems demonstrating compliance that are not related to the treatment processes in place (as opposed to a true non-compliance).
Total population	The total population of a given region is the number of people served by the networked supplies (and the associated water treatment plants) in that region (both council and non-council supplies). This differs from the *affected population*. In the context of this report, the total population is not the same as the census

	population (for example) as there are people who obtain their water by means other than from a networked supply.
True non-compliance	Used to refer to the situation where upgrading of the treatment process is required in order to meet the DWSNZ requirements (as opposed to a technical non-compliance).
Water Supply	Refers to a system of supplying drinking water to a person or group of persons. Is sometimes used interchangeably with the term *water treatment plant.*
Water supplier	Any person or entity that owns, and is responsible for operating, a drinking-water supply.
Water treatment plant (WTP)	The place where raw water undergoes chemical, biological or physical treatment to remove particles or unwanted determinands, inactivate organisms or enhance the aesthetic quality of the water.

2 Methodology

2.1 Previous Approach (2010)

Due to the number of water treatment plants in New Zealand, in 2010 it was not practical to prepare individual cost estimates for each water treatment plant. Instead water treatment plants were categorised based on their size, compliance status and source water quality. For each category a set of existing treatment processes, and corresponding required upgrades to meet the drinking water standards, was assumed.

A cost model (for both capital and operating costs) was developed for each potential treatment upgrade component, drawing on cost data from water treatment plant upgrade projects in New Zealand undertaken by Beca that were available at that time. The model allowed a cost estimate for a particular treatment process to be generated based on the population served by a water treatment plant. The outputs from the cost model for each treatment component for a particular size of water treatment plant (medium, small etc.) were amalgamated to generate capital and operating cost estimates for each water treatment plant category.

Because of their size and complexity, large water treatment plants (serving populations greater than 10,000 people) were considered on an individual basis. Similarly, water treatment plants with chemical non-compliances were also considered individually. For these water treatment plants, information was collected from publicly available sources, or from discussions directly with the relevant water supplier (generally local councils) with responsibility for non-compliant water treatment plants. Where cost information was unavailable, Beca developed high-level cost estimates based on the experience at that time.

Only costs directly associated with achieving compliance with the drinking water standards were included. Costs associated with asset maintenance or replacement were specifically excluded. The cost model assumed that existing treatment plant capacities were adequate and therefore made no provision for capacity increases. Other infrastructure which could have provided a greater security of supply (e.g. seismic resilience), or improved raw water quality (such as an improved intake or raw water storage), or additional treated water storage, were also excluded as they were not strictly required for compliance with the drinking water standards.

A detailed description of the methodology used previously is presented in the 2010 Beca report "Drinking Water Standards New Zealand Cost Benefit Analysis – Engineering Input".

2.2 Current Approach

2.2.1 Methodology

For this project, a similar methodology to that taken in 2010 has been used. Many aspects from the 2010 report remain the same, including:

- The approach to determining the assumed upgrades required based on compliance status, source water quality and size. The assumptions around existing and future treatment remain unchanged. Refer to the source-treatment matrices in Appendix C for details of the assumed treatment.
- The same reference costing data has been used, but escalated to 2018 dollars.
- The same cost margins (preliminary and general, design and contingency) have been applied
- The approach to considering large water treatment plants on an individual basis.

- Emergency supplies are not included. It is assumed that if these are being used, emergency conditions apply.
- All networked supplies are included - both council-owned and non-council owned. Non-council owned supplies are typically owned by community organisations (e.g. Incorporated Societies), while most others are owned by private companies. The definition of a networked supply (as opposed to a self-supply) is that it supplies water to a number of properties (i.e. it supplies a community).
- As in 2010, self-suppliers are excluded as they do not come under the requirements of the drinking water standards, rather they are covered by the Building Act. Examples of typical self-supplies are those individual private dwellings, schools, universities, prisons, marae and hospitals which have their own water supplies because they are located beyond the boundaries of a council or non-council water supply, or that have their own supply because of historical reasons (e.g. Christchurch Hospital). We note that the Inquiry Stage 2 Report recommended that the findings for networked supplies are also considered for self-supplies, and that some self-supplies should be included in the recommended reforms.

However, a number of items that were covered in the 2010 report have not been considered in detail here:

- The 2010 report considered two levels of compliance with the drinking water standards – bacterial only or bacterial and protozoal. For the purposes of this report, mandatory compliance with drinking water standards is assumed to mean both bacterial and protozoal (and chemical) compliance.
- The 2010 report considered a number of real world case studies to calibrate the outputs from the cost model. Due to time constraints, this same calibration has not been undertaken. Instead a brief comparison to costs for smaller water supplies is made using information from Andrew Watson's submission to the Inquiry.
- No sensitivity analysis has been carried out, however some brief discussion of factors affecting the cost estimates is provided.
- No update to the discussion of household-level water treatment options in the 2010 report has been provided.

The Department of Internal Affairs has also requested that the results be reported on a regional basis, and also to differentiate between council and non-council owned water treatment plants, neither of which was done in 2010.

2.2.2 Abolition of Secure Groundwater Classification (Scenario 2)

Costs associated with abolishing the secure groundwater classification system in the drinking water standards were not considered in the 2010 report. A similar methodology is used for both Scenario 1 and Scenario 2, however a number of new assumptions regarding existing treatment and upgrades required had to be made for water treatment plants with secure groundwater status.

In practice, if a source is no longer considered as 'secure bore water' the current the drinking water standards require that a catchment risk assessment be carried out. Groundwater being recharged from a catchment with heavy agricultural use could result in a higher log reduction requirement (e.g., 4 log reduction) being assigned to reflect the risk to the water source.

However, secure groundwater sources can also be considered to have relatively good quality water that usually does not require filtration. On that basis, the proposed minimum treatment for these water treatment plants across all population bands is UV disinfection and chlorination. It is noted that this may not be sufficient in all cases to comply with the requirements of the drinking water standards (if, for example, a 4 log reduction is required), but for the purposes of this study is a reasonable assumption. Residual chlorination is proposed as best practice although it is not strictly required by the drinking water standards (but was a recommendation of the Inquiry). For water treatment plants without existing UV disinfection or chlorination, it is assumed that bacterial compliance will be achieved using UV.

By way of example, the Waterloo Water Treatment Plant is a large facility in the Hutt Valley in Wellington that draws from eight wells in a confined aquifer. During late 2016 and early 2017 monitoring showed the security of the aquifer had been compromised due to changes in the aquifer that followed the Kaikoura earthquake. Under urgency, Wellington Water has implemented UV disinfection and chlorination to maintain compliance with the drinking water standards.

For details of the assumed existing treatment and required upgrades for secure groundwater water treatment plants refer to the source-treatment matrix in Appendix E.

2.2.3 Treatment Assumptions

The assumed treatment upgrades required are based on the least cost to achieve compliance. This does not take into account other questions a community may face when choosing how to upgrade their treatment system, such as:

- Which treatment process will give the greatest reliability of achieving compliance?
- Which treatment process gives greatest flexibility of operation or can cope best with fluctuations in raw water quality?
- Which is the easiest or most robust to operate?
- Which process provides the best match to the water supplier's level of operator training and/or supervision?

In 2010, membrane treatment was not considered the 'least cost' treatment option. However, in the intervening time the costs for membrane treatment have dropped enough that they are comparable with conventional filtration treatment in certain circumstances. Because of this, membrane treatment was assumed for some of the large, non-compliant water treatment plants.

2.3 Data on Water Treatment Plants

To carry out the required analysis, information on the compliance status, supply size, population served, source water quality, and location of water treatment plants in New Zealand was required. This data was provided by ESR[3] (with permission from the Ministry of Health) from the WINZ 6[4] database. The data matches that used to produce the draft Annual Report on Drinking Water Quality that was released in December 2017.

The form and availability of data differed slightly from that provided in 2010, resulting in some alterations to the assumptions made in the analysis, which are detailed in the following sections.

2.3.1 Compliance Status

This was provided as a yes/no against bacterial, protozoal and chemical standards. In 2010 further detail was provided allowing bacterial non-compliance to be categorised as a technical non-

[3] The Institute of Environmental Science and Research

[4] Water Information New Zealand database

compliance, where non-compliance is due to administrative failures or inadequate monitoring, rather than due to E. coli transgressions or a lack of treatment which were considered non-compliances.

The 2017 data set did not contain this same level of information, so different assumptions were required to determine what differentiated a technical non-compliance from a true non-compliance. These assumptions are:

- Water treatment plants with more than two *E. coli* transgressions (in the monitoring year) are considered truly non-compliant.
- Where a water treatment plant is non-compliant for bacteria and there is some form of disinfection in place, it is assumed that non-compliance is due to an issue with monitoring and hence the water treatment plant is considered technically non-compliant.
- Where a water treatment plant is non-compliant for bacteria but there is no disinfection in place, then the non-compliance is assumed to be due to a lack of treatment and that water treatment plant is considered to be truly non-compliant.
- Non-compliant water treatment plants with secure groundwater status were considered on an individual basis.

It is recognised that there are a number of reasons that a water treatment plant may not meet the bacterial compliance criteria in the drinking water standards and these assumptions to do not intend to cover all of them. Rather they have been used to approximate a certain proportion of water treatment plants that do not meet the compliance criteria but for which extensive capital upgrades are not required.

For more details around the assumptions previously made regarding technical non-compliance, refer to the 2010 report.

2.3.2 Source Water

The 2010 data provided slightly different information about source water status to the 2017 data. However, the 2017 data did include information about the number of protozoal log credits required for each water source. Values ranged from 0 representing a secure groundwater, to 5 representing the poorest water quality. These log credit requirements were used to assign a source to the source water categories used in 2010, based on the assumptions made in Table 2.1.

Table 2.1 – Source Water Classification

2010 Source Water Categories	2017 Log Credits Required
Secure Groundwater (no log reduction)	0 (except for scenario of abolition of secure groundwater)
High Quality Water (3 log reduction)	2 or 3
Low Quality Water (4 log reduction)	4
Very Low Quality Water (5 log reduction)	5

2.3.3 Neighbourhood-Sized water treatment plants

The 2017 data did not include compliance information for neighbourhood-sized water treatment plants (those serving populations of 25 to 100 people) as these are not included in the Annual Report on Drinking Water Quality. However, other information about neighbourhood water treatment plants was available such as source water quality, population served and location.

Although neighbourhood water treatment plants are numerous, they serve a small overall population. Partly because of the large number of water treatment plants, and partly due to inefficiencies of scale, the costs to upgrade smaller water treatment plants are disproportionately higher. For example in 2010, 28% of the non-compliant water treatment plants were neighbourhood-sized (188 of 667 water treatment plants), representing just 1% of the non-compliant population (10,153 of 774,937 people). However, the costs associated with upgrading those neighbourhood water treatment plants made up nearly 10% of the total costs. The split between council and non-council owned water treatments plants was not considered in 2010. The 2017 results, including a split between council and non-council owned assets, are discussed in Section 3.

Because the costs to upgrade these neighbourhood water treatment plants make up a significant proportion of the overall costs, and the costs associated with these upgrades are born by small communities which are generally the least able to afford them, it was considered important to continue to include neighbourhood water treatment plants in this analysis. In order to do this a number of assumptions were required:

- The compliance rate for neighbourhood water treatment plants between 2010 and 2017 improved in line with that seen for the small category of water treatment plants (serving 101 to 500 people).
- The percentage of the population served by non-compliant neighbourhood water treatment plants has decreased in line with that seen for small water treatment plants between 2010 and 2017.
- For neighbourhood water treatment plants, the proportion of the types of non-compliance (bacterial only compliance, technical non-compliance for bacteria etc.) remains the same as in 2010.

These assumptions allowed a total cost for neighbourhood water treatment plants to be generated by the cost model. This total cost was distributed amongst the regions based on the number of neighbourhood-sized water treatment plants in each region.

2.3.4 Population

Multiple water sources may serve a single water treatment plant, and one or more water treatment plants may serve a single distribution zone or multiple distribution zones. This creates complexities in assigning populations to water treatment plants. For example, two or more water treatment plants may be sized to serve the population in a distribution zone with a 100% redundancy. This complexity can lead to inaccuracies in determining the population affected by non-compliance. The data has been reviewed to identify where population overlap between water treatment plants occurs and adjustments made where required. However, it is acknowledged that the total population affected by non-compliance in this report is different to that reported in the draft Annual Report on Drinking Water Quality of December 2017.

One reason for the difference is that this report includes neighbourhood-sized water treatment plants, which the Annual Report on Drinking Water Quality does not. If the neighbourhood population is discounted, a small discrepancy between total populations may still be observed because the draft Annual Report on Drinking Water Quality is based on zone populations, whereas this report uses water treatment plant populations. These should theoretically be the same on aggregate, however there are small discrepancies between zone and water treatment plant populations even in the simplest water supply arrangements. These are time consuming to identify and resolve. Considering that the overall error between the two values is less than 1%, the time constraints and the purpose of this report to provide high level information to Ministers, the level of error is considered acceptable.

2.3.5 Regions

Data has also been sorted by region. It is noted that the Chatham Islands are administered by the Chatham Islands Council and are not part of any other region, although the council receives administrative support from both Wellington City Council and Environment Canterbury. For the purposes of reporting they have been included in the Canterbury region.

2.4 Updating Cost Estimates

The cost estimates provided in this report are estimates of probable costs. They are high level and are only intended to inform discussion by Ministers around the consequences of potential changes to the drinking water standards. They are not intended to be suitable for establishing project budgets.

It is important to note that as in 2010, only costs directly associated with achieving compliance with the drinking water standards are included. Costs associated with existing asset maintenance or replacement are specifically excluded. The estimates assume that existing treatment plant capacities are adequate and therefore makes no provision for capacity increases. Other infrastructure which may be needed (e.g. new road access), or which provides a greater security of supply (e.g. seismic resilience, treated water storage or power supply upgrades), or improves raw water quality (e.g. improved intake or raw water storage), are also excluded as they are not directly required for compliance with the Standards.

2.4.1 Cost Indices

Due to the short timeframe and limited budget available to carry out this project, it was agreed with the Department of Internal Affairs that the basis and contents of the cost model used in 2010 would not be re-visited. Instead, cost indices would be used to escalate the outputs from the 2010 cost model to 2018 dollars. It is noted that the cost indices collected by Statistics New Zealand cover a wide range of sectors and are not specific to the water industry. This also introduces an extra source of uncertainty to the estimates of probable cost.

Statistics New Zealand does not collect information specific to the construction of water treatment plant infrastructure so the Producer Price Index (PPI) is considered the most appropriate for escalating capital costs under the circumstances. As a comparison, the trends in the PPI align relatively well with the civil construction subgroups within the Capital Goods Price Index (CGPI). Based on the Statistics New Zealand data for PPI, a cost index of +22% has been used to escalate the capital costs. For operating costs, a cost index of 15% has been selected based on trends in the labour cost indices and general materials inflation rates.

This cost escalation method is only used where costs are generated from the 2010 cost model, and does not necessarily apply to the estimates for the large water treatment plants.

2.4.2 Other Factors Influencing Cost

Summary costs have been presented as a range of ± 30% indicating the likely accuracy of the costs. There are a number of factors which may affect the accuracy of costs:

- The cost model is based on the mean population for each population category. This means for an individual water treatment plant, the model may not produce an accurate cost, particularly if it is significantly above or below the mean population. However, when all the water treatment plants in a region, or of a certain size are aggregated, these inaccuracies should balance out to a certain degree.
- Currency exchange rates can have a significant impact on costs for imported plant and materials. For water treatment plants it would be reasonable to assume that 30 - 40% of the total cost is on imported materials and equipment.
- Contractors' appetite for work. Fluctuations in the market can affect the number of tenders submitted for construction projects and also the affect the tendered prices. Recently it has been observed that calls for tender are receiving very few submissions from contractors, and prices

are higher than otherwise expected. This reflects the large amount of work currently available for contractors, who are under no pressure to compete for jobs.

- The location of the water treatment plant can also affect costs. Water treatment plants in more remote areas tend to attract fewer tenders and higher prices. This is largely to cover the more expensive mobilisation costs, and the costs of bringing materials and skilled labour into the remote area.

2.4.3 Other Notes Related to Cost Estimates

The capital cost estimates include margins for preliminary and general (P&G), design and contingency. Based on recent construction contracts, we have assumed a rate of 18% for P&G, 12% for design and construction management, and due to the variability and accuracy of the cost data we have assumed a further 18% contingency.

P&G is not a profit margin, rather it covers the Contractor's onsite and offsite overheads such as:

- Site establishment including site offices, provision of temporary services and site access
- Care and security of the works
- Provision of plant, tools, scaffolding, carnage, environmental protection measure and testing
- Management, supervision and administration of the works.

3 Results

The following sections present the results from the 2017 data, provide a brief comparison with the 2010 results, and discuss particular points of interest. Results are broken down by both water treatment plant size and region. Section 3.1 considers the results for Scenario 1 – Mandatory Compliance with Drinking Water Standards and Section 3.2 for Scenario 2 – Abolition of Secure Groundwater Classification System. Section 3.3 presents the combined costs for both Scenarios. Section 3.4 discusses the split of costs between council and non-council-owned water supplies.

In the tables in this section capital and annual operating costs are also reported on a per population or per household basis to show how costs may be theoretically distributed within a region. In the summary tables, the 'affected' population refers to the number of people served by non-compliant and/or secure groundwater water treatment plants. Similarly, 'affected' households refers to the number of households served by non-compliant and/or secure groundwater water treatment plants. This is different to the 'total' population (or number of households) which refers to all people or households in that region who are being served by a networked water supply. For clarity, in the tables costs per total population are given in brackets.

Dividing the costs by the total population assumes that the costs would be spread over the whole population in a region that is supplied by a networked supply, as opposed to only those directly affected by the upgrades required. An estimate of the combined annualised capital cost and annual operating expenditure is also provided, based on an assumed 6%[2] municipal interest rate, 25 year loan period and using population as a proxy for ratepayers (with 2.7 people per household). There is no allowance for any council or non-council overhead or administrative costs in this calculation.

3.1 Scenario 1 – Mandatory Compliance with the Drinking Water Standards

3.1.1 Large Water Treatment Plants

There are 17 large water treatment plants identified as being non-compliant with the drinking water standards in 2017, compared to 22 in the 2010 report. Eight of the 17 water treatment plants were also non-compliant in 2010. Table 3.1 provides a summary of large non-compliant water treatment plants in 2017 and compares the values to 2010. Note that these figures do not include chemical non-compliance which is addressed separately in Section 3.1.4.

Of these 17 large water treatment plants, two (Waterloo in the Wellington region and Levin in Manawatu-Wanganui) have recently completed upgrades which should allow them to gain compliance in the next monitoring year, and a further two (Hicks Road in Waikato and Branxholme in Southland) are in the process of carrying out upgrades. Because upgrading work is already completed, or well underway, no additional capital or operating costs have been included for these water treatment plants.

Four of these large, non-compliant water treatment plants are owned by Queenstown Lakes District Council (QLDC). QLDC has indicated that it is planning to upgrade two of these water treatment plants, decommission one and replace one with a new shallow borefield. For the purposes of cost estimation we have allowed for upgrades to three of the QLDC water treatment plants. This represents a significant capital investment, equivalent to approximately 20% of the total cost for Scenario 1.

The 2017 data shows Northwest Christchurch as non-compliant with the drinking water standards, but the rest of Christchurch City as compliant based on its secure groundwater status. However, this secure status was revoked in December 2017. Christchurch City Council has advised that they are planning to deepen the Northwest Christchurch borefield and apply for secure groundwater status for that area, and are planning to temporarily chlorinate other areas where secure groundwater status has been revoked until the necessary modifications to those bores have been made to regain secure status. For the purposes of this report, NW Christchurch is assumed to be non-compliant and an allowance has been made for treatment to meet the drinking water standards (as opposed to allowing to deepen the bores). The rest of Christchurch is assumed to be compliant under Scenario 1. Northwest Christchurch has also been included in the list of water treatment plants under Scenario 2 (even though it doesn't currently have secure groundwater status).

Table 3.1 – Summary of Results for Large Non-Compliant Water Treatment Plants

Large water treatment plants (>10,000)	2010	2017
Number of Non-Compliant Water Treatment Plants	22	17*
Population Affected by Non-Compliance	291,531	464,841
Estimate of Probable Capital Cost	$50.4 million	$54.1 – $100.4 million
Estimate of Probable Annual Operating Cost	$0.29 m per annum	$2.1 – $3.9 m per annum

* Note that 6 of the 17 non-compliant plants were technically non-compliant

The number of Large, non-compliant water treatment plants has decreased since 2010, but the population affected by non-compliance has increased. In 2010 the majority of the large, non-compliant water treatment plants served populations between 10,000 and 20,000 people, and there were only four that served more than 20,000 people and only one serving more than 60,000 people. In the 2017 data set, there are ten Large non-compliant water treatment plants serving more than 20,000 people and five serving more than 60,000 people. Population growth is also a factor, growth in the Queenstown and Wanaka areas has meant there are now four large water treatment plants in this area where there were none before.

Note that the increase in operating costs in 2017 compared with 2010 can largely be attributed to membrane treatment which has been assumed for three of the water treatment plants. For further detail of the Large, non-compliant water treatment plants refer to Appendix B.

3.1.2 Medium, Minor and Small Water Treatment Plants

Table 3.2 provides a summary of results for Medium (5001 – 10,000 people), Minor (501 – 5000 people) and Small (101 – 500) water treatment plants and compares the results to those obtained in 2010. In the Small to Medium-sized water treatment plant categories compliance has improved since 2010. The greatest improvement is in the Medium category where the number of non-compliant water treatment plants has decreased by half. The smaller size categories continue to have a greater number of non-compliant water treatment plants, but these affect a smaller population.

Note that these figures do not include chemical non-compliance which is addressed separately in Section 3.1.4. For more detail refer to the source-treatment matrices in Appendix C.

Table 3.2 – Summary of Results by Population Band (Medium to Small Water Treatment Plants)

Water Treatment Plant Size (Population)	Parameter	2010	2017	% decrease
Medium (5,001 – 10,000)	Number of Non-Compliant Water Treatment Plants	29	13	55%
	Population Affected by Non-Compliance	124,107	71,207	43%
	Upgrading Capital Cost Estimate	$42.3M	$21.8M	48%
	Increased Annual Operating Cost Estimate	$1.1M	$0.4M	64%
Minor (501 – 5,000)	Number of Non-Compliant Water Treatment Plants	192	140	27%
	Population Affected by Non-Compliance	289,480	216,221	25%
	Upgrading Capital Cost Estimate	$144.5M	$114.6M	21%
	Increased Annual Operating Cost Estimate	$4.0M	$2.0M	50%
Small (101-500)	Number of Non-Compliant Water Treatment Plants	236	169*	28%
	Population Affected by Non-Compliance	59,666	40,577	32%
	Upgrading Capital Cost Estimate	$67.6M	$57.3M	15%
	Increased Annual Operating Cost Estimate	$4.8M	$2.8M	43%

* Note that 5 of the 169 Small non-compliant plants were technically non-compliant

3.1.3 Neighbourhood Water Treatment Plants

As discussed in Section 2.3.3, compliance data for neighbourhood water treatment plants was not available. However a number of assumptions were made using the available information to create an estimate of probable costs for neighbourhood water treatment plants, these are discussed in Section 2.3.3. Refer to Table 3.3 for a summary of the 2017 results and a comparison to 2010. Note that these figures do not include chemical non-compliance which is addressed separately in Section 3.1.4.

Although the number of non-compliant water treatment plants has decreased since 2010, the costs associated with upgrades have increased. A higher number of water treatment plants with poorer quality source water is noted in 2017, which is likely to be one factor contributing to the overall increase in the cost estimate. However, because there have been so many assumptions made to arrive at these figures, there is little benefit to be gained from further analysing these results.

For more detail refer to the source-treatment matrices in Appendix C.

Table 3.3 – Summary of Results for Neighbourhood Water Treatment Plants

Neighbourhood Water Treatment Plants (25-100)	2010	2017
Number of Non-Compliant Water Treatment Plants	188	153
Population Affected by Non-Compliance	10,153	9,274
Estimate of Probable Capital Cost	$31.9M	$27.1 - $50.4M
Estimate of Probable Annual Operating Cost	$2.37M	$1.6 - $3.0M

3.1.4 Chemical Non-Compliance

Whereas Priority 1 (microbiological) determinands are required to be monitored in all supplies, monitoring for Priority 2 (chemical) determinands are only specified for those supplies which the Ministry of Health believes exceed half the maximum allowable value (MAV) for a particular health-significant determinand. A water treatment plant is considered non-compliant if an MAV for the water treatment plant or a zone it serves is exceeded (although a small number of exceedances is allowed over a monitoring year). With a few exceptions, MAVs for chemicals are calculated for long-term exposure; i.e., their health effects are manifested over a lifetime of consumption.

In 2010 there were 30 water treatment plants that were identified as being chemically non-compliant. In 2017, 30 water treatment plants have again been identified as being chemically non-compliant, and although these do not match exactly the water treatment plants from 2010, there are a number of water treatment plants that show up both times[5]. Of these 30, 19 have been identified as requiring no capital works upgrades as the non-compliance is associated with inadequate monitoring or has already been addressed by a change in supply. For water treatment plants with inadequate monitoring, an allowance has been made for increased monitoring in the operational costs. Of the remaining 11 water treatment plants, six had arsenic transgressions, and the remainder had transgressions associated with disinfection by-products. Refer to Table 3.4 for a summary of the 2017 results and a comparison with the results from 2010. Note that operating costs for chemical non-compliance were not reported in 2010. Chemical non-compliance for neighbourhood water treatment plants has not been considered at this time due to a lack of information (there were no chemically non-compliant neighbourhood water treatment plants in 2010).

Table 3.4 – Summary of Results for Chemically Non-Compliant Water Treatment Plants

Chemical Non-Compliance	2010	2017
Number of Chemically Non-Compliant Water Treatment Plants	30	30
Population Affected by Non-Compliance	59,992	112,114
Estimate of Probable Capital Cost	$1.17M	$5.8 – 10.8M
Estimate of Probable Annual Operating Cost	-	$0.4 - 0.7M per annum

The population affected by chemical non-compliance in 2017 is much greater than in 2010 due to three large water treatment plants serving two separate non-compliant zones. Nelson zone was non-compliant for MAV sum ratio of HAA and is served by the Tantragee Water Treatment Plant. An allowance for enhanced coagulation at this water treatment plant also makes up a large proportion of the capital costs.

Feilding zone is non-compliant for fluoride and is served by the Almadale and Awa St Water Treatment Plants. This non-compliance is due to inadequate monitoring and no capital costs have been assumed.

Raetihi, Omori and Coal Creek (Greymouth) water treatment plants also had large capital costs associated with upgraded treatment to address chemical non-compliance. More detail about chemically non-compliant water treatment plants can be found in Appendix D.

3.1.5 Summary of Results by Region

Refer to Table 3.5 for a summary of compliance and estimates of probable cost broken down by region. The high capital and operating costs for Otago are due to three Large water treatment plants in the Queenstown Lakes District that are currently non-compliant with the drinking water standards.

[5] These are Helensville in Auckland, Acacia Bay, Motuoapa and Omori in Waikato and Te Teko in the Bay of Plenty

A significant proportion of the Canterbury costs are associated with upgrades to NW Christchurch Water Treatment Plant.

A few points of interpretation of the regional results in Table 3.5 are:

- The proportion of non-compliant water treatment plants ranges from 24% in Auckland, to 82% in the West Coast and 83% in Southland. In all but two regions (Auckland and Taranaki), 50% or more of the water treatment plants are non-compliant.
- However this does not necessarily correspond to the highest populations affected by non-compliance - in six regions the population affected by non-compliance is greater than 50%.
- The regions with the highest capital costs associated with non-compliance are Otago, Canterbury and Waikato. The regions with the lowest capital costs are Auckland, Nelson and Gisborne.
- When the annualised costs (capital and operating) are distributed over the total regional population, costs are highest in Otago, West Coast and Tasman and lowest in Auckland, Gisborne and Wellington.

Table 3.5 – Summary of Estimate of Probable Costs for Scenario 1 by Region

Region	No. Non-Compliant WTPs	Non-Compliant Pop. Served	Estimate of Probable Capital Cost ($ million)	Estimate of Probable Annual Operating Cost	Capital Cost per Population		Operating Cost per Population		Annual Cost Impact per Household	
					Affected	Total	Affected	Total	Affected	Total
Auckland	6[6]	5,426	$0.8 - $1.5	$60,000 - $100,000	$212	$0.8	$15	$0.1	$85	$0.3
Bay of Plenty	32	41,043	$11.8 - $21.9	$460,000 - $860,000	$411	$70	$16	$3	$130	$22
Canterbury	114	138,208	$41.5 - $77.0	$1,720,000 – $3,200,000	$429	$111	$18	$5	$139	$36
Gisborne	4	710	$0.9 - $1.7	$40,000 - $70,000	$1,895	$42	$72	$2	$594	$13
Hawke's Bay	22	75,027	$8.5 - $15.8	$230,000 - $430,000	$162	$92	$4	$2	$46	$26
Manawatu-Wanganui	50	152,034	$14.8 - $27.4	$450,000 - $840,000	$139	$106	$4	$3	$41	$31
Marlborough	19	11,422	$5.5 – $10.3	$210,000 - $390,000	$693	$222	$26	$8	$217	$70
Nelson	2	49,765	$1.0 - $1.9	$150,000 - $270,000	$29	$29	$4	$4	$17	$17
Northland	28	12,293	$6.3 – $11.7	$280,000 - $520,000	$734	$90	$33	$4	$243	$30
Otago	68	71,486	$65.8 - $122.2	$2,150,000 – 4,000,000	$1,315	$454	$43	$15	$394	$136
Southland	15	68,359	$8.3 - $15.5	$160,000 - $300,000	$174	$166	$3	$3	$46	$44
Taranaki	6	7,815	$1.5 - $2.8	$60,000 - $110,000	$275	$23	$11	$0.9	$87	$7
Tasman	23	24,213	$6.9 - $12.9	$290,000 - $530,000	$409	$397	$17	$16	$132	$128
Waikato	67	100,361	$29.0 - $53.8	$960,000 - $1,780,000	$412	$133	$14	$4	$124	$40
Wellington	18	88,279	$13.1 - $24.3	$180,000 - $330,000	$212	$45	$3	$0.6	$53	$11
West Coast	23	19,117	$6.8 - $12.7	$350,000 - $660,000	$512	$388	$26	$20	$180	$136
TOTAL	**497**	**865,559**	**$222.5 - $413.4M**	**$7.8 – $14.4M per annum**	**$367**	**$83**	**$13**	**$3**	**$112**	**$25**

[6] Five of the six non-compliant water treatment plants in Auckland are not owned by Watercare Services. The one non-compliant Watercare water treatment plant is the Helensville water treatment plant and relates to a chemical non-compliance (THMs).

3.2 Scenario 2 – Abolition of Secure Groundwater Classification System

The results presented in this section relate only to water treatment plants that currently have secure groundwater status (or interim or provisional status) under the drinking water standards (however refer to Section 3.1.1 for approach taken to Christchurch). Any costs presented can be considered to be additional to those from Scenario 1. For more information about the assumptions made refer to Section 2.2.2.

There are currently 38 Large water treatment plants with secure groundwater status. Current treatment at these water treatment plants range varies; 12 have no treatment, 22 have chlorination only, three have UV disinfection only and one has both disinfection and residual chlorination. An additional six water treatment plants were removed from the list due to recent changes. Mosgiel has recently (December 2017) been switched over to the Dunedin's water supply which means that its five water treatment plants (supplied from 9 wells) are no longer used, and therefore no costs have been allowed for adding treatment. Secure groundwater status for Waterloo Water Treatment Plant in Wellington was compromised in late 2016/early 2017 and since then upgrades have been completed to ensure compliance with the drinking water standards. Waterloo Water Treatment Plant has therefore also been removed from the list of water treatment plants under Scenario 2.

Of the Large water treatment plants, 13 are in Canterbury and 12 in Hawkes Bay. The remainder are in Manawatu-Wanganui, Otago and Waikato. Further details of these large water treatment plants can be found in Appendix E.

Seven of the 13 water treatment plants in Canterbury represent the Christchurch water supply which is actually made up of more than 50 individual bore sites. There is considerable complexity in providing treatment to Christchurch's water supply. For the purposes of this report, it has been assumed that treatment will be provided at each of the bore sites, however, in reality it may be determined that there is benefit in consolidating treatment to fewer sites. The locations of the bores on small sites within residential areas also creates issues with disposal of high turbidity run-to-waste water, hazardous substances regulations, land purchase, restricted space for infrastructure and construction and access. These issues are beyond the scope of this project, and while these have not been specifically allowed for within our cost estimates, a general nominal allowance has been made. Addition of compulsory fluoridation, which could happen in the next couple of years, may compound the consequences of these issues (i.e. on a constrained site the costs of adding disinfection and also fluoridation may be greater than the estimated costs for adding them separately).

There are 81 water treatment plants in the Medium to Neighbourhood size categories that are identified as currently having secure bore water status.

3.2.1 Summary of Scenario 2 Results by Population Size and Region

Table 3.6 provides a summary of information related to Scenario 2 by water treatment plant size and Table 3.7 provides a summary by region. The cost to treat water in Christchurch makes up a large proportion of the Scenario 2 costs (47% of the national total).

The costs for the secure groundwater water treatment plants under Scenario 2 include residual disinfection with chlorine as this was recommended by the Inquiry. The capital cost associated with only chlorination are $18.9 to $35.0 million or 22% of the total capital costs for Scenario 2. The annual operating costs are $0.4 to $0.6 million or 10% of the total operating costs for Scenario 2. The remaining costs are associated with the upgrades required for installation of UV disinfection.

Table 3.6 – Summary of Estimate of Probable Cost for Scenario 2 by Population Size

Water Treatment Plant Size (Population)	No. WTPs with Secure Groundwater Status	Pop. Affected	Estimate of Probable Capital Cost ($ million)	Estimate of Probable Operating Cost (per annum)
Large (>10,000)	38	649,156	$62.0 - $115.1	$2,770,000 - $5,150,000
Medium (5,001 – 10,000)	17	61,977	$7.0 – $13.0	$330,000 - $600,000
Minor (501 – 5,000)	34	58,927	$12.8 – $23.7	$300,000 - $560,000
Small (101 – 500)	30	7,852	$4.6 – $8.5	$120,000 - $230,000
Neighbourhood (25 - 100)	0	0	-	-
TOTAL	**119**	**777,912**	**$86.8 - $161.2M**	**$3.5 - $6.6M per annum**

The majority of Scenario 2 costs are associated with large water treatment plants (including Christchurch) and the highest costs are in Canterbury, Hawkes Bay and Manawatu-Wanganui.

Table 3.7 – Summary of Estimates of Probable Cost for Scenario 2 by Region

Region	No. WTPs Affected	Pop. Affected	Estimate of Probable Capital Cost ($M)	Estimate of Probable Operating Cost (per annum)	Capital Cost per Population ($/person)		Operating Cost per Population ($/person)		Annual Cost Impact per Household	
					Affected	Total	Affected	Total	Affected	Total
Auckland	8	14,761	$0.9 - $1.6	$30,000 - $50,000	$85	$0.9	$3	$0.03	$25	$0.3
Bay of Plenty	10	34,775	$3.5 - $6.5	$160,000 – $300,000	$144	$21	$7	$1	$48	$7
Canterbury	58	449,047	$60.6 - $112.6	$2,750,000 - $5,100,000	$193	$162	$9	$7	$64	$54
Gisborne	0	0	No cost	No cost	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Hawke's Bay	16	117,035	$9.6 - $17.9	$300,000 - $560,000	$117	$104	$4	$3	$35	$31
Manawatu-Wanganui	16	138,068	$8.4 – $15.7	$190,000 - $350,000	$87	$60	$2	$1	$24	$16
Marlborough	0	0	No cost	No cost	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Nelson	0	0	No cost	No cost	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Northland	0	0	No cost	No cost	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Otago	1	120	$0.2 – $0.4	$4,000 - $10,000	$2500	$1	$52	$0.03	$688	$0.4
Southland	0	0	No cost	No cost	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Taranaki	3	3,725	$1.2 – $2.3	$30,000 - $50,000	$470	$19	$11	$0.44	$127	$5
Tasman	2	442	$0.4- $0.8	$10,000 - $20,000	$1357	$24	$29	$0.51	$374	$7
Waikato	5	19,939	$1.4 - $2.5	$60,000 - $110,000	$98	$6	$4	$0.28	$33	$2
Wellington	0	0	No cost	No cost	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
West Coast	0	0	No cost	No cost	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
TOTAL	**119**	**777,912**	**$86.2 – $160.3M**	**$3.5 – $6.6M per annum**	**$158**	**$32**	**$6**	**$1**	**$51**	**$10**

3.3 Scenarios 1 and 2 Combined

Table 3.8 provides a summary of the combined costs associated with both scenarios. As discussed in the introduction to Section 3, costs are presented in a number of ways. Capital and annual operating costs are reported on a per population basis to show how costs may be theoretically distributed within a region:

- The 'affected' population refers to the number of people served by non-compliant and/or secure groundwater water treatment plants.
- This is different to the 'total' population which refers to all people in that region who are being served by a networked water supply. For clarity, in the tables the "costs per total population" are given in brackets.

Dividing the costs by the total population assumes that the costs would be spread over the whole population in a region that is supplied by a networked supply, as opposed to only those directly affected by the upgrades required. An estimate of the combined annualised capital cost and annual operating expenditure is also provided.

When Scenarios 1 and 2 are considered together, the three highest capital costs are in the Canterbury, Otago and Waikato regions. As previously mentioned, a large proportion of the capital cost can be associated with the three large Queenstown Lakes water treatment plants (14% of combined cost) under Scenario 1 and to treat Christchurch's water (13% of combined cost) under Scenario 2. Auckland, Gisborne and Taranaki are the regions with the three lowest capital costs.

Annualised costs (capital and operating) distributed over the total population in each region are highest in Otago, Tasman and West Coast. This is expected as Otago had high capital costs and Tasman and West Coast are two of the regions with the smallest populations. The regions with lowest distributed costs were Auckland and Wellington, which is expected as they have large population bases, but also Gisborne and Taranaki. Although Canterbury also had high capital costs, it also has a large population base over which these costs can theoretically be distributed.

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Table 3.8- Summary of Estimate of Probable Cost for Scenarios 1 and 2 Combined

Region	No. WTPs Affected	Pop. Affected	Estimate of Probable Capital Cost ($M)	Estimate of Probable Operating Cost (per annum)	Capital Cost per Population ($/person)		Operating Cost per Population ($/person)		Annual Cost Impact per Household	
					Affected	Total	Affected	Total	Affected	Total
Auckland	13	19,737	$1.7 - $3.1	$80,000 - $160,000	$121	$2	$6	$0.1	$42	$0.6
Bay of Plenty	42	75,818	$15.3 - $28.5	$620,000 – $1,160,000	$289	$91	$12	$4	$93	$29
Canterbury	170	506,825	$102.1 - $189.6	$4,470,000 - $8,300,000	$288	$272	$13	$12	$95	$90
Gisborne	4	710	$0.9 - $1.7	$40,000 – $70,000	$1,895	$42	$72	$2	$594	$13
Hawke's Bay	38	192,062	$18.1 - $33.7	$530,000 – $990,000	$204	$196	$6	$6	$59	$57
Manawatu-Wanganui	64	199,424	$23.2 - $43.1	$640,000– $1,190,000	$166	$166	$5	$5	$47	$47
Marlborough	19	11,422	$5.5 - $10.3	$210,000 - $390,000	$693	$222	$26	$8	$217	$70
Nelson	2	49,765	$1.0 - $1.9	$150,000 - $270,000	$29	$29	$4	$4	$17	$17
Northland	28	12,293	$6.3 - $11.7	$280,000 - $520,000	$734	$90	$33	$4	$243	$30
Otago	69	71,606	$66.0 - $122.6	$2,160,000 - $4,010,000	$1,317	$455	$43	$15	$394	$136
Southland	15	68,359	$8.3 - $15.5	$160,000 - $300,000	$174	$166	$3	$3	$46	$44
Taranaki	9	11,540	$2.7 – $5.0	$90,000 - $160,000	$337	$42	$11	$1	$100	$13
Tasman	25	24,655	$7.4 - $13.7	$290,000 - $550,000	$427	$422	$17	$17	$136	$135
Waikato	72	113,357	$30.3 - $56.3	$1,020,000 – $1,890,000	$382	$140	$13	$5	$115	$42
Wellington	18	88,279	$13.1 – $24.3	$180,000 - $330,000	$212	$45	$3	$0.6	$53	$11
West Coast	23	19,117	$6.8 – $12.7	$350,000 - $660,000	$512	$388	$26	$20	$180	$136
TOTAL	**611**[7]	**1,400,206**	**$308.7 - $573.7 million**	**$11.3 – $20.9 million per annum**	**$315**	**$115**	**$12**	**$4**	**$98**	**$36**

[7] Note that there are eight communities that fall under both scenarios (one each in Auckland, Hawkes Bay and Waikato, two in Canterbury and three in Manawatu-Wanganui). The number of water treatment plants and population served have been adjusted to account for this.

3.4 Council and Non-Council Owned Water Supplies

As discussed in Section 2.2.1, both council and non-council owned water treatment plants have been included in the results presented in the preceding tables. Table 3-9 gives an indication of the extent of the costs associated with both Scenarios for council owned water treatment plants only and Table 3-10 for non-council owned water treatment plants only.

It is noted that non-council owned water treatment plants make up about 28% of all water treatment plants and 34% of non-compliant water treatment plants but only 3% of the non-compliant population. This is because the majority of non-council owned water treatments plants fall into the smaller population categories. Capital costs for non-council owned water treatment plants are 13% of the total for all water treatment plants for Scenarios 1 and 2 combined.

In terms of the notion of spreading upgrade costs over all networked supplies in a region, in practice this would be difficult to achieve as under current arrangements costs can only be shared between supplies that are owned and financed by a common district council or unitary authority. For this reason, for non-council supplies, costs have only been presented distributed over the affected population. Because there is a smaller population base over which to distribute costs, on a per person basis costs are much higher for non-council owned supplies.

In terms of the regions with the highest and lowest costs, the results for council owned supplies are similar to those for all water treatment plants in Section 3.3. The three highest capital costs are in the Canterbury, Otago and Waikato and the three lowest are in the Auckland, Gisborne and Nelson regions. When distributed amongst the total regional populations, the highest annualised costs are in Otago, Tasman and West Coast; and the lowest in Auckland, Gisborne and Wellington.

For non-council owned supplies, the three highest capital costs are in the Canterbury, Manawatu and Otago regions. The three lowest costs are in Nelson, Southland and Taranaki. On a per affected population basis, annualised costs are highest for Nelson, Otago and Wellington; and lowest for Auckland, Canterbury, and Manawatu-Wanganui. Note that because non-council supplies are individually owned, there is currently no mechanism for costs to be shared amongst non-council supplies that are non-compliant.

Table 3-9- Estimate of Probable Costs for Council Owned Water Treatment Plants (Scenarios 1 and 2)

Region	No. WTPs Affected	Pop. Affected	Estimate of Probable Capital Cost ($M)	Estimate of Probable Operating Cost (per annum)	Capital Cost per Population ($/person)		Operating Cost per Population ($/person)		Annual Cost Impact per Household	
					Affected	Total	Affected	Total	Affected	Total
Auckland	5	18,083	$0.8-$1.5	$50,000 - $100,000	$65	$0.9	$4	$0.05	$24	$0.3
Bay of Plenty	22	73,128	$11.0 - $20.5	$380,000 - $720,000	$215	$66	$8	$2	$66	$20
Canterbury	143	496,852	$95.3 -$176.9	$4,120,000 – $7,650,000	$274	$259	$12	$11	$90	$85
Gisborne	1	200	$0.2 – $0.4	$2,000 - $4,000	$1,626	$10	$24	$0.2	$407	$3
Hawke's Bay	30	126,646	$16.4 – $30.6	$440,000 - $820,000	$186	$179	$5	$5	$53	$51
Manawatu-Wanganui	44	180,375	$18.2 - $33.8	$390,000 - $720,000	$144	$144	$3	$3	$39	$39
Marlborough	6	8,920	$2.7 - $5.2	$70,000 - $130,000	$444	$120	$11	$3	$124	$34
Nelson	1	49,740	$0.9 - $1.6	$140,000 - $250,000	$25	$25	$4	$4	$16	$16
Northland	10	8,606	$2.5 - $4.6	$100,000 - $190,000	$414	$37	$18	$2	$135	$12
Otago	41	69,771	$60.3 - $112.0	$1,820,000 - $3,390,000	$1,234	$422	$37	$13	$361	$124
Southland	13	67,969	$8.0 – $14.9	$130,000 - $250,000	$168	$161	$3	$3	$43	$41
Taranaki	7	11,141	$2.3 – $4.3	$80,000 - $140,000	$302	$37	$10	$1	$90	$11
Tasman	16	23,458	$5.4 - $10.0	$180,000 - $340,000	$326	$326	$11	$11	$99	$99
Waikato	61	110,787	$27.5 - $51.1	$910,000 - $1,690,000	$355	$128	$12	$4	$107	$38
Wellington	12	87,823	$11.7 - $21.6	$110,000 - $200,000	$189	$40	$2	$0.4	$45	$9
West Coast	17	18,684	$5.7 - $10.7	$280,000 - $540,000	$440	$332	$22	$17	$152	$115
429	**430**	**1,352,139**	**$268.9 - $499.7 million**	**$9.2 - $17.1 million per annum**	**$284**	**$102**	**$10**	**$3**	**$86**	**$31**

Table 3-10 - Estimate of Probable Costs for Non-Council Owned Water Treatment Plants (Scenarios 1 and 2)

Region	No. WTPs Affected	Pop. Affected	Estimate of Probable Capital Cost ($M)	Estimate of Probable Operating Cost (per annum)	Capital cost per Affected Population	Operating cost per Affected Population	Annual Cost Impact per Affected Household
Auckland	8	1,698	$0.9 - $1.6	$30,000 - $60,000	$715	$29	$230
Bay of Plenty	20	2,691	$4.3 – $8.0	$240,000 - $440,000	$2,284	$127	$824
Canterbury	27	9,972	$6.8 - $12.7	$350,000 - $650,000	$978	$50	$341
Gisborne	3	510	$0.7 - $1.3	$30,000 - $60,000	$2,000	$91	$667
Hawke's Bay	8	652	$1.7 - $3.1	$90,000 - $170,000	$3,666	$198	$1,310
Manawatu-Wanganui	20	19,049	$5.0 - $9.3	$250,000 - $470,000	$377	$19	$130
Marlborough	13	2,502	$2.8 - $5.1	$140,000 - $260,000	$1,582	$80	$549
Nelson	1	25	$0.1 - $0.3	$10,000 - $20,000	$7,859	$475	$2,943
Northland	18	3686	$3.8 - $7.1	$180,000 - $330,000	$1,480	$68	$496
Otago	28	1,836	$5.7 - $10.6	$340,000 - $620,000	$4,459	$262	$1,649
Southland	2	390	$0.3 - $0.6	$30,000 - $50,000	$1,136	$100	$510
Taranaki	2	399	$0.4 - $0.7	$10,000 - $20,000	$1,305	$42	$388
Tasman	9	1,197	$2.0 - $3.7	$110,000 - $210,000	$2,404	$134	$870
Waikato	11	2,570	$2.8 - $5.2	$110,000 - $200,000	$1,544	$61	$491
Wellington	6	456	$1.4 - $2.7	$70,000 - $130,000	$4,530	$222	$1,556
West Coast	6	434	$1.1 - $2.0	$70,000 - $120,000	$3,614	$219	$1,353
TOTAL	**181**	**48,067**	**$39.8 - $74.0 M**	**$2.06 - $3.81 M per annum**	**$1,184**	**$61**	**$415**

4 Discussion

4.1 Real World Cost Comparison

As discussed briefly in Section 2.3.3, the costs to upgrade water treatment plants serving smaller populations is disproportionately high. It is likely the required upgrades and ongoing running costs associated with mandatory compliance with the drinking water standards will not be affordable for smaller water suppliers in New Zealand.

Table 4.1 is adapted from a submission[8] to the Inquiry Stage 2 and provides examples of actual costs borne by smaller water suppliers in New Zealand. The original table has been amended to show the corresponding output from the cost model for that particular water treatment plant. Table 4.1 shows that in some cases the cost model can significantly underestimate the total costs faced by smaller communities. This is largely because the cost model assumes that a basic level of reasonable quality infrastructure already exists. Where that is not the case and a new greenfield plant (or virtually a greenfield plant) is required, and the source water needs turbidity removal, the costs are far higher than the cost model – in the order of $2 to $3 million for even the Small category of supplies. As already stated, the cost model also does not allow for infrastructure that is not strictly related to compliance (like reservoirs), and other factors that are considered as part of a water supplier's decision-making process around reliability and operational preferences (also discussed in Section 2.2.3).

There are 140 non-compliant Minor water treatment plants and 169 Small water treatment plants, of which 140 and 164 respectively are truly non-compliant[9]. If we assume that a third of these truly non-compliant Minor and Small plants need greenfield-type upgrading, then this would add $2 million per plant to the cost estimates derived from the cost model presented in section 3.1.2. For the truly non-compliant Minor and Small plants, this adds $202 million to the costs, bringing the mid-point cost estimate for the Minor and Small plants to roughly $370 million – a figure that is likely to be more representative of the actual upgrading costs that these communities will have to fund in total.

There are 153 non-compliant Neighbourhood water treatment plants, of which we have assumed that 153 are truly non-compliant. If we further assume that for this size of supply that a third of the truly non-compliant plants need greenfield-type upgrading, and that this adds $1 million to the results from the cost model for these plants, then that adds $51 million to the costs.

The fact that many of these smaller supplies are in communities with high deprivation indices, and are already paying high water charges (as smaller and more remote supplies also cost more to operate on a per capita basis), means that unless the costs are spread across a higher population base in some way, they will not be affordable.

[8] Andrew Watson submission to Stage 2 of Havelock North Drinking Water Enquiry.

[9] For interest, twelve of the Minor water treatment plants and 67 of the Small water treatment plants are non-council owned.

Table 4.1- Comparison of Cost Model to Case Studies

Supply Name (Water Authority)	Population	Upgrading Capital Cost	Comments	Cost Model Scenario	Cost Model Output (+/- 30%)	Notes
Kaeo (Wai Care Environmental Consultants)	70	$0.2 million $0.75 million	Costs presented are estimates used for an unsuccessful CAP funding application. Lower cost is for upgrading existing plant, higher cost is for new source & treatment plant.	N-4-X Ranges from addition of two stage cartridge filtration and UV to install coagulation, sedimentation, filtration and UV	$0.17 - $0.34 million	Cost model does not include for new source
Shannon (Horowhenua District Council)	1,400	$3.3 million	Greenfield site, membrane filtration, includes reservoir.	MI-4-3 Add UV, improve coagulation and sedimentation, install additional turbidity monitoring	$0.41 - $0.77 million	Cost model assumes existing filtration plant. Does not allow for a greenfield plant and did not include for reservoir.
Tokomaru (Horowhenua District Council)	550	$0.35 million	Existing infiltration gallery. Containerised plant, media + cartridge filtration, and UV. Plant turned off when raw water above 2 NTU.	MI-4-3 Add UV, improve coagulation and sedimentation, install additional turbidity monitoring	$0.41 - $0.77 million	Cost model assumes existing filtration plant.
Eketahuna (Tararua District Council)	440	$0.49 million	Existing infiltration gallery in bush catchment. Media filtration and UV. Plant turned off when raw water above 2 NTU.	S-4-4 Add sedimentation, improve coagulation and instrumentation, add UV	$0.23 - $0.43 million	
Seddon (Marlborough District Council)	840 (seasonal peak)	$2.6 million	Greenfield site, membrane filtration, includes reservoir. Upgrading cost is contract award price, and excludes professional fees and costs for modifying reticulation to separate off the Seddon township from the Awatere rural water supply.	MI-3-3 Add coagulation and direct filtration	$0.66 - $1.22 million	Cost model does not allow for a greenfield plant and did not include for reservoir.
Little River (Christchurch City Council)	240	$2 million	Process consists of ion exchange for groundwater source, and slow sand filtration + UV for surface water. Cost includes a reservoir.	S-3-3 Add coagulation and filtration OR cartridge filtration and UV.	$0.13 - $0.23 million	Cost model does not allow for complexities of treating two sources and did not include for reservoir.

4.2 Other Considerations

4.2.1 Per Capita Water Use

New Zealand has high per capita water use compared to most other OECD countries. In the 2010 report it was noted that significant capital cost savings could be made if water usage was reduced. Cost estimates for infrastructure upgrades in the 2010 report were based on a typical (at that time) New Zealand unmetered peak demand of 1,200 L/person/day. This figure was not changed for this report even though many communities have made significant progress in reducing their demand over the last eight years.

4.2.2 Protozoa Risks and Public Health Benefits

The publication of the 1995 edition of DWSNZ shifted the focus of water treatment onto the risks of protozoa. A large portion of the costs of the upgrading work on New Zealand's treatment plants since then has been in response to the addition of the protozoal requirements. However, results of national baseline monitoring from 2009 onwards, show that the risks of protozoa in our natural waters may be overstated, in particular groundwater sources[10]. The outbreak at Havelock North was bacterial in origin, not protozoal. The argument that small water suppliers should focus more on bacterial compliance rather than protozoal is an issue that needs to be considered further, because the bulk of the upgrading cost is associated with UV treatment aimed at protozoal inactivation. If limited funds are available for upgrading our smaller water supplies it is best they are spent in a way which will produce the best public health benefits.

4.2.3 Decentralised Treatment

The 2010 report also considered whether decentralised treatment options would be cost effective for smaller communities. Decentralised treatment systems can consist of household-sized treatment systems (generally cartridge filtration and/or UV disinfection) located at point where the water supply enters the household or at individual points of use (i.e. taps). The supply of water to households would still be owned and operated by the water supplier and may include some form of pre-treatment such as filtration prior to distribution. The 2010 report found that for Small and Neighbourhood sized communities, the capital costs for decentralised and centralised treatment may be comparable, but that operating costs for decentralised treatment are significantly higher. Decentralised treatment also has a number of disadvantages over centralised treatment:

- Household treatment systems are not strictly compliant with the drinking water standards, but can still provide considerable health benefits if properly designed, operate under the design water quality conditions and are properly maintained
- It is difficult (expensive) to monitor the overall water quality supplied to consumers
- In the event of a power outage, any components of the household treatment system that require power would cease to work and thereby compromise the access to safe drinking water
- There is a risk of inadvertent consumption of untreated water if not all taps in the household have treatment installed.
- The cost of the maintenance required to ensure the effectiveness of the treatment is high. Homeowners may not fully understand the importance of regular maintenance of the treatment system, and may be unwilling to invest the time and money required to provide reliably safe drinking water. Maintenance could be provide by a service contractor but access would be required to each house.

[10] Section 8.2.1 of *Guidelines for Drinking-water Quality Management in New Zealand*, Ministry of Health, September 2017.

For further discussion around decentralised treatment options refer to the 2010 report.

5 Conclusions

The costs to water suppliers associated with the potential changes to the drinking water standards from the two recommendations from the Inquiry considered by this report are significant. The cost estimates in this report only look at the minimum upgrades required to meet the drinking water standards and exclude many other costs that water suppliers face and must budget for, such as asset maintenance and replacement, capacity increases, resilience, aesthetic problems (taste and odour), community preferences and operational capability.

Certain regions face higher costs than others. Reasons for this include:

- Higher number of water treatment plants and/or secure groundwater sources. Canterbury is a good example. It has the highest number of water treatment plants in the country (193), an average non-compliance rate (59% resulting in 114 non-compliant water treatment plants) and a large number of secure groundwater supplies (58). Otago is another example with 96 water treatment plants (71% non-compliant for a total of 68) but only one secure groundwater supply.
- Large non-compliant water treatment plants or large water treatment plants with secure groundwater status. Canterbury and Otago are again good examples as the costs to provide treatment to Christchurch's secure groundwater supply makes up 13% of the total costs and upgrades to three large non-compliant water treatment plants in Otago make up 14% of total costs.
- Small population bases. Good examples are Tasman and the West Coast which show the highest annualised cost impact and cost per population (besides Otago), but are around the mid-point in total capital cost per region.

These costs may be unaffordable for many communities, particularly smaller communities.

Because they generally serve smaller communities, costs faced by those served by non-council owned supplies are significantly more than those on council-owned supplies on a per person basis. In addition, these non-council owned supplies have no ability to spread the upgrading costs across a larger customer base because they are individually owned. This will further add to the unaffordability of upgrading work for small non-council supplies.

Appendix A

Glossary of Terms

Glossary of Terms

Accuracy	The combination of bias and precision of an analytical procedure that reflects the closeness of a measure value to a true value.
Aesthetic determinand	A constituent or property of the water that can adversely affect the water's taste, odour, colour, clarity or general appearance, including substances such as manganese and iron compounds that can stain washing and utensils.
Affected population	The number of people impacted by non-compliance (both technical and true non-compliance) and the proposed improvements/ upgrading work. In the context of this report this may refer to the population served by non-compliant water treatment plants (Scenario 1), the population served by water treatment plants with secure groundwater status (Scenario 2), or both.
Annualised cost	The annual cost of owning, operating and maintaining an asset over its entire life. For the purposes of this report, this is defined as the annual payments on a loan taken out to cover the capital costs of upgrades at an interest rate of 6%pa[1] and a term of 25 years plus the increase in annual operating cost associated with those upgrades.
Bacteria	The simplest form of life that can be unicellular or multicellular. Bacteria possess a simple nucleus, can reproduce rapidly and lack chlorophyll. Some members of the group are disease-causing.
Bore	A hole constructed to access groundwater for water supply purposes (also referred to as a well).
Borefield	More than one bore from the same aquifer connected to a single water supply.
Bore head	The physical structure, facility or device at the land surface from which groundwater is abstracted from subsurface water-bearing formations.
Bore water	Groundwater that has been extracted from the aquifer through a bore. See also secure bore water.
Cartridge filtration	A pressure-driven separation process that removes particulate matter larger than 1 µm, using an engineered porous filtration media through surface or depth filtration. A cartridge filter is typically constructed as rigid or semi-rigid, self-supporting filter elements placed in a housing. The flow is from the outside of the cartridge to the inside.

[1] 6% has been selected based on discussions with one council, which uses 5% for its financial planning, plus a small margin to provide some conservatism given the uncertainty around lending rates over a 25 year period.

Catchment assessment	A survey of the area from which raw water for a drinking-water supply is obtained to allow potential contaminant sources to be identified, and the risk they present to the raw water quality to be evaluated.
Chemical coagulation	The use of metallic salts (e.g., aluminium or iron) or organic polyelectrolytes (e.g., polyamines or polydadmacs) to aggregate fine suspended or colloidal particles, causing them to clump together into larger particles.
Compliance	In the context of this report, the term compliance refers to compliance with the New Zealand Drinking Water Standards, and in particular compliance with Priority 1 (microbial) and Priority 2 (chemical) determinands.
Contact time	The hydraulic residence time, determined by a tracer test or by a recognised calculation procedure, from the dosage point or point of entry to the disinfectant contact device to the point of exit. The contact time should ideally be within the treatment plant site, although 'contact mains' disinfection may be practised if the required contact time is met before the first consumer.
Conventional treatment	Is a series of processes including coagulation, flocculation, sedimentation and filtration, with sedimentation defined as a process for removing solids before filtration by gravity or separation.
Determinand	A constituent or property of the water that is determined, or estimated, in a sample, for example: microbial determinand – total coliforms; chemical determinand – chloride; physical determinand – turbidity; and radiological determinand – radon.
Direct filtration	A water treatment process using chemical coagulation without a clarification step upstream of the filter(s).
Disinfection	The process used to inactivate micro-organisms in a drinking-water supply. Common methods of disinfection include chlorination, ozonation, ultraviolet light (UV) irradiation and boiling.
Disinfection by-product	A contaminant produced in the drinking-water supply as a by-product of the disinfection process.
Distribution zone	The part of the drinking-water supply network within which all consumers receive drinking-water of identical quality, from the same or similar sources, with the same treatment and usually at the same pressure. It is part of the supply network that is clearly separated from other parts of the network, generally by location but in some cases by the layout of the pipe network. For example, in a large city, the central city area may form one zone, with outlying suburbs forming separate zones; in a small town, the system may be divided into two distinct areas. The main purpose of assigning zones is to separate parts of the system with distinctly different characteristics.

Drinking-water	Water intended to be used for human consumption, food preparation, utensil washing, oral hygiene or personal hygiene.

DWSNZ or the drinking water standards

	Refers to the Drinking-Water Standards for New Zealand 2005 (revised 2008). A yardstick to assess the quality of drinking-water. The standards define the maximum acceptable values (MAVs) of health significant determinands and specify the methods for determining whether a drinking-water supply complies with the DWSNZ.
Escherichia coli (E. coli)	A bacterium used as an indicator that faecal contamination of the water has almost certainly occurred, so pathogens may be present in the water.
Exceedance	The occurrence of a determinand in a sample at a concentration greater than the maximum acceptable value (MAV).
Filtration	A treatment process that removes suspended particles from water by passing the water through a medium such as sand or other granular material.
Flocculation	The gathering together of coagulated clumps of fine material to form floc.
Groundwater	Water contained beneath the land surface. More particularly, water contained in the saturated zone of the soil, which can be extracted in usable quantities. Also see bore water.
Household	An individual household consisting of one or more people who live in the same dwelling. For this report the number of households has been determined assuming there are 2.7 people per household.

Maximum acceptable value (MAV)

	The concentration of a determinand, below which the presence of the determinand does not result in any significant risk to a consumer over a lifetime of consumption. For carcinogenic chemicals, the MAVs set in the Drinking-water Standards for New Zealand (DWSNZ) generally represent a risk of one additional incidence of cancer per 100,000 people ingesting the water at the concentration of the MAV for a lifetime of 70 years.
Membrane filtration	A pressure- or vacuum-driven separation process in which sub-micron particulate matter is rejected by a non-fibrous, engineered barrier, primarily through a size-exclusion mechanism, and which has a measurable removal efficiency of a target organism that can be verified through the application of a direct integrity test. This definition is intended to include the common membrane technology classifications: microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RO).

Monitoring	The sampling and analysis of a drinking-water supply to test for compliance with the Drinking-water Standards for New Zealand (DWSNZ), or for process control, by detecting changes in the concentrations of its constituent determinands or deviations of these from target values. In New Zealand, monitoring is the water supplier's responsibility.
Networked supplies	Supply that serves two or more properties, by means of a pipe connecting these properties.
Non-council owned	Drinking water supplies that are not under government ownership. Examples include community organisations or private companies.
Population Category	DWSNZ distinguishes between supplies based on the size of the population served: Large – greater than 10,000 people Medium – 5,001-10,000 people Minor – 501 – 5,000 people Small – 101 – 500 people Neighbourhood – 25 – 100 people
Protozoa	Free-living, aquatic, unicellular animals, larger and more complex than bacteria, and can be differentiated into 4 general types: ciliates, flagellates, sporozoans and amoebae. The Priority 1 protozoa are *Giardia* and *Cryptosporidium*.
Raw water	Water taken from the environment that has not yet received treatment to make it suitable for drinking.
Registered Supply	All networked supplies serving more than 25 people are required to be registered under the Health Act.
Reticulation	The network of pipes, pumps and service reservoirs that delivers the drinking-water from the water treatment plant to the consumers' boundary.
Secure bore water	Water that is free from surface influences and free from contamination by harmful micro-organisms. It must be abstracted via a bore head demonstrated to provide protection from contamination. Water from springs and unconfined aquifers with bore intakes less than 10 m deep are excluded.
Sedimentation	The process in which solid particles settle out of the water being treated in a clarifier or settling tank.
Self-supply or self-supplier	A supply that is exclusively used to supply water to a single property or one or more buildings owned by the same person. Self-suppliers do not come under the requirements of the drinking water standards, they are covered by the Building Act.
Surface water	The water on the land surface. It can be running (as in streams and rivers) or quiescent (as in lakes, reservoirs, impoundments and ponds). Surface water is produced by run-off of precipitation and by groundwater seeping through the top layers of soil. Surface water

can also be defined as all water open to the atmosphere and subject to surface run-off.

Technical non-compliance	When non-compliance is due to inadequate monitoring or problems demonstrating compliance that are not related to the treatment processes in place (as opposed to a true non-compliance).
Total population	The total population of a given region is the number of people served by the networked supplies (and the associated water treatment plants) in that region (both council and non-council supplies). This differs from the *affected population*. In the context of this report, the total population is not the same as the census population (for example) as there are people who obtain their water by means other than from a networked supply.
Transgression	Of the Drinking-water Standards for New Zealand (DWSNZ), occurs when a determinand of any priority class that is present in the sample exceeds the maximum acceptable value (MAV) or its allowable concentration specified in the compliance criteria or when the limit of an operational requirement is exceeded.
True non-compliance	Used to refer to the situation where changes to the treatment process are required in order to meet the DWSNZ requirements (as opposed to a technical non-compliance).
Turbidity	A measure of the suspended particles in a sample that cause loss of clarity by scattering light.
Ultraviolet light (UV)	Light emitted with wavelengths from 200 – 400 nm, therefore outside the range visible to the human eye.
UV disinfection	Disinfection using electromagnetic radiation (light) in the range of 200 – 400 nm.
Water supply	Refers to the total system for supplying drinking water to a person or group of persons. In this report it iss sometimes used interchangeably with the term *water treatment plant.*
Water supplier	Any person or entity that owns, or is responsible for operating, a drinking-water supply.
Water treatment plant (WTP)	The place where raw water undergoes chemical, biological or physical treatment to remove particles or unwanted determinands, inactivate organisms or enhance the aesthetic quality of the water.
Water treatment process	A chemical, biological or physical process used to enhance the quality of a drinking-water supply before its distribution.

Appendix B

Large Non-Compliant Water Treatment Plants

Annual Survey 2016/17: Non-Compliant Treatment Plants Serving more than 10,000 People

Data received from B. Mattingley at ESR, 16/01/2018
Shaded squares indicate that that the WTP has already undergone upgrading for compliance, in the process of upgrading or is about to be decomissioned. As funding is already comitted for these plants, no cost has been assigned to them.

WTP No.	Plant Name	Plant Code	Plant Pop*	Ecoli Comply	Protozoa Comply	Terratorial Local Authority	Reason for non compliance	Upgrade description	Current Status of Implementation	Council reported Costs to implement	Beca Costs to implement	Capital Cost ($mill)	Operating Cost ($K)
1	Aramoho, Wanganui	TP02511	34475	N	Y	Wanganui District Council	E. coli transgression.	No upgrades required. False positive E.coli result assumed.	-	-	-	$ -	$ -
2	Billah Street, Tokoroa	TP00038	13300	N	N	South Waikato District Council	Non secure groundwater source. Insufficient monitoring to demonstrate compliance.	Minor upgrading work required to improve data integrity.	-	Cost estimate of $216,000 in the 10 year plan (2015-25) has been allowed for for upgrades to the Tokoroa Water Treatment Plant.	$50,000	$ 0.05	$ -
3	Branxholme, Invercargill	TP00079	50456	Y	N	Invercargill City Council	Water Safety Plan not valid.	The revised WSP is being redrafted after completion of the upgrades. Plant upgrades include GAC filters and UV disinfection.	Upgrades completed September 2017.	Cost of upgrade was estimated at $12M (Southland Times).	-	$ -	$ -
4	Feilding, Almadale	TP00162	13000	N	N	Manawatu District Council	Corrective action inadequate following transgression.	Minor upgrading work required to improve data integrity.	Investigating renewal and/or replacement of reservoir and truck main into town. UV disinfection installed in 2016/2017 - no further plant upgrades planned.	Planning $2.2 million in year two of the 2015-25 Long Term Plan.	$50,000	$ 0.05	$ -
5	Frimley Park, Hastings	TP00116	64764	Y	N	Hastings District Council	Non secure groundwater source. Insufficient treatment for protozoal compliance.	Addition of UV disinfection.	Design for UV installation underway (December 2017).	Council earmarked $1.75M for UV treatment at the Frimley AND Wilson Road bores.	-	$ 1.75	$ 44
6	Hicks Road, Cambridge	TP02526	13500	N	N	Waipa District Council	Non secure groundwater source.	Abandon bore. Connect Hicks Road consumers with the Karapiro plant supply.	Karapiro Cambridge plant upgrade is due for completion Easter 2018. Pipeline will be extended to supply the existing Hicks Road consumers by end of 2018	Council has estimated $2,447,540 for 10 year CAPEX costs for implementing WTP upgrades.	-	$ -	$ -
7	Kelvin Heights, Queenstown	TP00095	20000	Y	N	Queenstown Lakes District Council	High turbidity.	Beca has allowed for the addition of a membrane plant at this location.	Upgrades planned after release of LTP in mid-2018	Council has estimated $16M for a new borefield adjacent to the Shotover River (complete with treatment).	$18,750,000	$ 18.75	$ 660
8	Levin	TP00142	20000	N	N	Horowhenua District Council	Could be due to the plant upgrades occuring part way through the year.	Plant upgrades include a new reservoir, water clarifier, chemical dosing system and UV disinfetion.	Upgrades completed in 2017.	Cost of upgrades were $6.4M.	-	$ -	$ -
9	NW Christchurch	TP00181	80000	Y	N	Christchurch City Council	Gap in E.coli monitoring. Non secure groundwater source.	The 22 shallow wells in the area are planned to be fully decommissioned, sealed and replaced with deeper, secure bores. Currently no treatment. Beca has allowed for UV disinfection and chlorination of existing wells.	In progress - to be completed June 2019.	Speeding up the well replacement programme is estimated to cost $480,000 (September 2016). Does not include any costs for treatment.	$12,895,522	$ 12.90	$ 790
10	Richmond	TP03191	12300	Y	N	Tasman District Council	Non secure groundwater source. Problems demonstrating compliance.	Additional operator time	-	-	-	$ -	$ 60
11	Turitea, Palmerston North	TP00147	67653	N	Y	Palmerston North City Council	Power failure causing loss of SCADA data. Communication issues also apparent due to remote plant.	Improvements to data collection and communications with plant.	-	-	$100,000	$ 0.10	$ -
12	Two Mile, Queenstown	TP00094	20000	Y	N	Queenstown Lakes District Council	Insufficient treatment for protozoal compliance.	Council plans to upgrade plant to include filtration and UV. Beca has allowed for the addition of a membrane plant at this location.	-	$14 milllion	$20,820,000	$ 20.82	$ 690
13	Beacon Pt, Wanaka	TP02906	10114	Y	N	Queenstown Lakes District Council	Insufficient treatment for protozoal compliance.	Council plans to upgrade plant to include filtration and UV. Beca has allowed for the addition of a membrane plant at this location.	-	$22 million	$22,810,000	$ 22.81	$ 750
14	Western, Wanaka	TP02905	10114	Y	N	Queenstown Lakes District Council	High turbidity.	Council plans to decommission this intake.	-	-	-	$ -	$ -
15	Waterloo, Wellington	TP00203	85899	N	Y	Hutt City Council	-	-	UV disinfection plant completed December 2017	Estimated plant upgrade costs of $2M.	-	$ -	$ -
16	Whakatane Plant	TP00323	21020	Y	N	Whakatane District Council	Insufficient monitoring to demonstrate compliance.	Increased monitoring required.	-	-	-	$ -	$ 3.7
17	Wilsons Road, Hastings	TP00117	64764	Y	N	Hastings District Council	Insufficient treatment for protozoal compliance.	Online monitoring (turbidity and conductivity) added in 2017. Addition of UV disinfection.	Works underway.	Council earmarked $1.75M for UV treatment at the Frimley AND Wilson Road bores.	$0	Price accounted for above.	$ 22
											Total	**$ 77.2**	**$ 3,019.7**

Appendix C

Source-Treatment Matrices

CAPEX	Population Category	Source	Compliance Achieved E.Coli	Compliance Achieved Proto	Scenario	Assumed Existing Treatment	Upgrading Required
	Medium (5,001 - 10,000) Design flow mid-point 8,280 m³/day	Very low quality water (5 log)	Tech non-comp	Comply	ME-5-1	**Refer Note 1**	
			Non-comply	Comply	ME-5-2		
			Comply	Non-comply	ME-5-3	Coagulation/sedimentation /filtration and chlorina ion	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste
			Tech non-comp	Non-comply	ME-5-4	Coagulation/sedimentation /filtration and chlorina ion	Add UV system, improve coagulation and sedimentation and install additional urbidity monitoring and filter to waste. **Increase monitoring**
			Non-comply	Non-comply	ME-5-5	Coagulation/sedimentation /filtration and chlorina ion	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste
		Low quality water (4 log)	Tech non-comp	Comply	ME-4-1	**Refer Note 1**	
			Non-comply	Comply	ME-4-2		
			Comply	Non-comply	ME-4-3	Coagulation/sedimentation /filtration and chlorina ion	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring
			Tech non-comp	Non-comply	ME-4-4	Coagulation/sedimen ation /filtration and chlorina ion	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring. **Increase monitoring (twice weekly).**
			Non-comply	Non-comply	ME-4-5	Coagulation/direct filtration and chlorination	Add clarifier and UV system, improve coagulation and filtration and install additional turbidity monitoring
		High quality water (3 log)	Tech non-comp	Comply	ME-3-1	**Refer Note 1**	
			Non-comply	Comply	ME-3-2		
			Comply	Non-comply	ME-3-3	Chlorination system	Add coagula ion/direct filtration
			Tech non-comp	Non-comply	ME-3-4	Chlorination system	Add coagula ion/direct filtration. **Increase monitoring (twice weekly)**
			Non-comply	Non-comply	ME-3-5	No treatment	Add coagula ion/direct filtration and chlorination
		Secure Groundwater	Tech non-comp	Comply	ME-SG-1	**Refer Note 1**	
			Non-comply	Comply	ME-SG-2		
			Comply	Non-comply	ME-SG-3		
			Tech non-comp	Non-comply	ME-SG-4		
			Non-comply	Non-comply	ME-SG-5		

1 No WTPs identified with these conditions

OPEX	Population Category	Source	Compliance Achieved E.Coli	Compliance Achieved Proto	Scenario	Assumed Existing Treatment	Upgrading Required
	Medium (5,001 - 10,000) Design flow mid-point 8,280 m³/day	Very low quality water (5 log)	Tech non-comp	Comply	ME-5-1	**Refer Note 1**	
			Non-comply	Comply	ME-5-2		
			Comply	Non-comply	ME-5-3	Coagulation/sedimentation /filtration and chlorina ion	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste
			Tech non-comp	Non-comply	ME-5-4	Coagulation/sedimentation /filtration and chlorina ion	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste. Increase monitoring
			Non-comply	Non-comply	ME-5-5	Coagulation/sedimentation /filtration and chlorina ion	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and fil er to waste
		Low quality water (4 log)	Tech non-comp	Comply	ME-4-1	**Refer Note 1**	
			Non-comply	Comply	ME-4-2		
			Comply	Non-comply	ME-4-3	Coagulation/sedimentation /filtration and ch orina ion	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring
			Tech non-comp	Non-comply	ME-4-4	Coagulation/sedimentation /filtration and chlorina ion	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring. Increase monitoring (twice weekly).
			Non-comply	Non-comply	ME-4-5	Coagulation/direct filtration and chlorination	Add clarifier and UV system, improve coagulation and filtration and install additional turbidity monitoring
		High quality water (3 log)	Tech non-comp	Comply	ME-3-1	**Refer Note 1**	
			Non-comply	Comply	ME-3-2		
			Comply	Non-comply	ME-3-3	Chlorination system	Add coagula ion/direct filtration
			Tech non-comp	Non-comply	ME-3-4	Chlorination system	Add coagula ion/direct filtration. Increase monitoring (twice weekly)
			Non-comply	Non-comply	ME-3-5	No treatment	Add coagula ion/direct filtration and chlorination
		Secure Groundwater	Tech non-comp	Comply	ME-SG-1	**Refer Note 1**	
			Non-comply	Comply	ME-SG-2		
			Comply	Non-comply	ME-SG-3		
			Tech non-comp	Non-comply	ME-SG-4		
			Non-comply	Non-comply	ME-SG-5		

1 No WTPs identified with these conditions

	Population Category	Source	Scenario	Compliance Achieved		Assumed Existing Treatment	Upgrading Required
				E.Coli	Proto		
CAPEX	Minor (501 - 5,000) Design flow mid-point 2,460 m³/day	Very low quality water (5 log)	MI-5-1	Tech non-comp	Comply	Refer Note 1	
			MI-5-2	Non-comply	Comply		
			MI-5-3	Comply	Non-comply	Coagulation/sedimentation/filtration and chlorination	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste
			MI-5-4	Tech non-comp	Non-comply	Coagulation/sedimentation/filtration and chlorination	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste. Increase
			MI-5-5	Non-comply	Non-comply	Coagulation/sedimentation/filtration and chlorination	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste
		Low quality water (4 log)	MI-4-1	Tech non-comp	Comply	Refer Note 1	
			MI-4-2	Non-comply	Comply		
			MI-4-3	Comply	Non-comply	Coagulation/sedimentation/filtration and chlorination	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring
			MI-4-4	Tech non-comp	Non-comply	Coagulation/sedimentation/filtration and chlorina on	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring. Increase monitoring (weekly)
			MI-4-5	Non-comply	Non-comply	Coagulation/direct filtra ion and chlorination	Add clarifier and UV system, improve coagulation and filtration and install addi ional turbidity monitoring
		High quality water (3 log)	MI-3-1	Tech non-comp	Comply	Refer Note 1	
			MI-3-2	Non-comply	Comply		
			MI-3-3	Comply	Non-comply	Chlorina ion system	Add coagulation/direct filtration
			MI-3-4	Tech non-comp	Non-comply	Chlorina ion system	Add coagulation/direct filtration . Increase monitoring (weekly)
			MI-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination
		Secure Groundwater	MI-SG-1	Tech non-comp	Comply	Refer Note 1	
			MI-SG-2	Non-comply	Comply		
			MI-SG-3	Comply	Non-comply		
			MI-SG-4	Tech non-comp	Non-comply		
			MI-SG-5	Non-comply	Non-comply		

1 No WTPs identified with these conditions

OPEX	Population Category	Source	Scenario	Compliance Achieved		Assumed Existing Treatment	Upgrading Required
				E.Coli	Proto		
	Minor (501 - 5,000) Design flow mid-point 2,460 m³/day	Very low quality water (5 log)	MI-5-1	Tech non-comp	Comply	**Refer Note 1**	
			MI-5-2	Non-comply	Comply		
			MI-5-3	Comply	Non-comply	Coagulation/sedimentation/filtration and chlorination	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste
			MI-5-4	Tech non-comp	Non-comply	Coagulation/sedimentation/filtration and chlorination	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste. Increase monitoring (weekly)
			MI-5-5	Non-comply	Non-comply	Coagulation/sedimentation/filtration and chlorination	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring and filter to waste
		Low quality water (4 log)	MI-4-1	Tech non-comp	Comply	**Refer Note 1**	
			MI-4-2	Non-comply	Comply		
			MI-4-3	Comply	Non-comply	Coagulation/sedimentation/filtration and chlorination	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring
			MI-4-4	Tech non-comp	Non-comply	Coagulation/sedimentation/filtration and chlorination	Add UV system, improve coagulation and sedimentation and install additional turbidity monitoring. Increase monitoring (weekly)
			MI-4-5	Non-comply	Non-comply	Coagulation/direct filtration and chlorination	Add clarifier and UV system, improve coagulation and filtration and install additional turbidity monitoring
		High quality water (3 log)	MI-3-1	Tech non-comp	Comply	**Refer Note 1**	
			MI-3-2	Non-comply	Comply		
			MI-3-3	Comply	Non-comply	Chlorination system	Add coagulation/direct filtration
			MI-3-4	Tech non-comp	Non-comply	Chlorination system	Add coagulation/direct filtration . Increase monitoring (weekly)
			MI-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination
		Secure Groundwater	MI-SG-1	Tech non-comp	Comply	**Refer Note 1**	
			MI-SG-2	Non-comply	Comply		
			MI-SG-3	Comply	Non-comply		
			MI-SG-4	Tech non-comp	Non-comply		
			MI-SG-5	Non-comply	Non-comply		

1 No WTPs identified with these conditions

	Population Category	Source	Scenario	Compliance Achieved		Assumed Existing Treatment	Upgrading Required
				E.Coli	Proto		
CAPEX	Small (101 - 500) Design flow mid-point 360 m³/day	Very low quality water (5 log)	S-5-1	Tech non-comp	Comply	Infiltration gallery, coagulation/direct filtration and chlorination	Increase monitoring
			S-5-2	Non-comply	Comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process (incl. filter to waste)
			S-5-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add filter to waste and UV system
			S-5-4	Tech non-comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add filter to waste and UV system. Increase monitoring (quarterly)
			S-5-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process (incl. filter to waste), and UV
		Low quality water (4 log)	S-4-1	Tech non-comp	Comply	Infiltration gallery, coagulation/direct filtration and chlorination	Increase monitoring
			S-4-2	Non-comply	Comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process
			S-4-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system
			S-4-4	Tech non-comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Increase monitoring (quarterly)
			S-4-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process and UV
		High water quality (3 log)	S-3-1	Tech non-comp	Comply	**Refer Note 2**	
			S-3-2	Non-comply	Comply		
			S-3-3	Comply	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination (assume doesn't require SCAN)
			S-3-4	Tech non-comp	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination (assume doesn't require SCAN). Increase monitoring (quarterly)
			S-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment (assume doesn't require SCAN).
		Secure Groundwater	S-SG-1	Tech non-comp	Comply	No treatment	Remedial work on well and/or wellhead. Increase monitoring (quarterly)
			S-SG-2	Non-comply	Comply	No treatment	Remedial work on well and/or wellhead.
			S-SG-3	Comply	Non-comply	**Refer Note 2**	
			S-SG-4	Tech non-comp	Non-comply		
			S-SG-5	Non-comply	Non-comply		

NOTES

1 The costs for these scenarios are detailed in the table to the left. Costs for the two variants are averaged to provide a single scenario cost

2 No WTPs identified with these conditions

High water quality (3 log)	S-3-3	Comply	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination (assume doesn't require SCAN)
	S-3-4	Tech non-comp	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination (assume doesn't require SCAN). Increase monitoring (quarterly)
	S-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment (assume doesn't require SCAN).

OPEX

Population Category	Source (Very low quality water (5 log))	Scenario	Compliance Achieved: E.Coli	Compliance Achieved: Proto	Assumed Existing Treatment	Upgrading Required
Small (101 - 500) Design flow mid-point 312 m³/day	Very low quality water (5 log)	S-5-1	Tech non-comp	Comply	Infiltration gallery, coagulation/direct filtration and chlorination	Increase monitoring
		S-5-2	Non-comply	Comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process (incl. filter to waste)
		S-5-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add filter to waste and UV system
		S-5-4	Tech non-comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add filter to waste and UV system. Increase monitoring (quarterly)
		S-5-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process (incl. filter to waste) and UV
	Low quality water (4 log)	S-4-1	Tech non-comp	Comply	Infiltration gallery, coagulation/direct filtration and chlorination	Increase monitoring
		S-4-2	Non-comply	Comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process
		S-4-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system
		S-4-4	Tech non-comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Increase monitoring (quarterly)
		S-4-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process and UV
	High water quality (3 log)	S-3-1	Tech non-comp	Comply	**Refer Note 2**	
		S-3-2	Non-comply	Comply		
		S-3-3	Comply	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5μm cartridge filtration and UV treatment. Retain existing chlorination (assume doesn't require SCAN)
		S-3-4	Tech non-comp	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5μm cartridge filtration and UV treatment. Retain existing chlorination (assume doesn't require SCAN). Increase monitoring (quarterly)
		S-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5μm cartridge filtration and UV treatment (assume doesn't require SCAN).
	Secure Groundwater	S-SG-1	Tech non-comp	Comply	No treatment	Remedial work on well and/or wellhead. Increase monitoring (quarterly)
		S-SG-2	Non-comply	Comply	No treatment	Remedial work on well and/or wellhead.
		S-SG-3	Comply	Non-comply	**Refer Note 2**	
		S-SG-4	Tech non-comp	Non-comply		
		S-SG-5	Non-comply	Non-comply		

NOTES

1 The costs for these scenarios are detailed in the table to the left. Costs for the two variants are averaged to provide a single scenario cost

2 No WTPs identified with these conditions

Source	Scenario	E.Coli	Proto	Assumed Existing Treatment	Upgrading Required
High water quality (3 log)	S-3-3	Comply	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5μm cartridge filtration and UV treatment. Retain existing chlorination (assume doesn't require SCAN)
	S-3-4	Tech non comp	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5μm cartridge filtration and UV treatment. Retain existing chlorination (assume doesn't require SCAN). Increase monitoring (quarterly)
	S-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5μm cartridge filtration and UV treatment (assume doesn't require SCAN).

	Population Category	Source	Scenario	Compliance Achieved		Assumed Existing Treatment	Upgrading Required
				E.Coli	Proto		
CAPEX	Neighbourhood (25 - 100) Design flow mid-point 66 m³/day	Very low quality water (5 log)	N-5-1	Tech non comp	Comply	**Refer Note 2**	
			N-5-2	Non-comply	Comply		
			N-5-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add filter to waste and UV system
			N-5-4	Tech non comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Replace with two stage cartridge filtration and UV. Increase monitoring
			N-5-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process (incl. filter to waste), and UV
		Low quality water (4 log)	N-4-1	Tech non comp	Comply	**Refer Note 2**	
			N-4-2	Non-comply	Comply		
			N-4-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
			N-4-4	Tech non comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Increase monitoring (quarterly). Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
			N-4-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process and UV. Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
		High water quality (3 log)	N-3-1	Tech non comp	Comply	**Refer Note 2**	
			N-3-2	Non-comply	Comply		
			N-3-3	Comply	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination.
			N-3-4	Tech non comp	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination. Increase monitoring (quarterly)
			N-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment.
		Secure Groundwater	N-SG-1	Tech non comp	Comply	**Refer Note 2**	
			N-SG-2	Non-comply	Comply		
			N-SG-3	Comply	Non-comply		
			N-SG-4	Tech non comp	Non-comply		
			N-SG-5	Non-comply	Non-comply		

NOTES

1 The costs for these scenarios are detailed in the table to the left. Costs for the two variants are averaged to provide a single scenario cost

2 No WTPs identified with these conditions

Low quality water (4 log)	N-4-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
	N-4-4	Tech non comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Increase monitoring (quarterly). Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
	N-4-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process and UV. Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
High water quality (3 log)	N-3-3	Comply	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination.
	N-3-4	Tech non comp	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination. Increase monitoring (quarterly)
	N-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment.

OPEX

Population Category	Source: Very low quality water (5 log)	Scenario	Compliance Achieved: E.Coli	Compliance Achieved: Proto	Assumed Existing Treatment	Upgrading Required
Neighbourhood (25 - 100) Design flow mid-point 66 m³/day	Very low quality water (5 log)	N-5-1	Tech non comp	Comply		**Refer Note 2**
		N-5-2	Non-comply	Comply		
		N-5-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add filter to waste and UV system
		N-5-4	Tech non comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Replace with two stage cartridge filtration and UV. Increase monitoring
		N-5-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process (incl. filter to waste), and UV
	Low quality water (4 log)	N-4-1	Tech non comp	Comply		**Refer Note 2**
		N-4-2	Non-comply	Comply		
		N-4-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
		N-4-4	Tech non comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Increase monitoring (quarterly). Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
		N-4-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation sedimentation/filtration process and UV. Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
	High water quality (3 log)	N-3-1	Tech non comp	Comply		**Refer Note 2**
		N-3-2	Non-comply	Comply		
		N-3-3	Comply	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination.
		N-3-4	Tech non comp	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination. Increase monitoring (quarterly)
		N-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment.
	Secure Groundwater	N-SG-1	Tech non comp	Comply		**Refer Note 2**
		N-SG-2	Non-comply	Comply		
		N-SG-3	Comply	Non-comply		
		N-SG-4	Tech non comp	Non-comply		
		N-SG-5	Non-comply	Non-comply		

Source	Scenario	E.Coli	Proto	Assumed Existing Treatment	Upgrading Required
Low quality water (4 log)	N-4-3	Comply	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
	N-4-4	Tech non comp	Non-comply	Infiltration gallery, coagulation/direct filtration and chlorination	Add sedimentation step, improve coagulation and instrumentation, add new UV system. Increase monitoring (quarterly). Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
	N-4-5	Non-comply	Non-comply	Infiltration gallery and chlorination	Install coagulation/sedimentation/filtration process and UV. Assume that for 50% of plants that source water turbidity and UVT are low enough to only require two stage cartridge filtration and UV
High water quality (3 log)	N-3-3	Comply	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination.
	N-3-4	Tech non comp	Non-comply	Chlorination system	Add coagulation/direct filtration. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment. Retain existing chlorination. Increase monitoring (quarterly)
	N-3-5	Non-comply	Non-comply	No treatment	Add coagulation/direct filtration and chlorination. Assume that for 50% of the plants that source water turbidity and UVT are low enough to only require 5µm cartridge filtration and UV treatment.

NOTES

1 The costs for these scenarios are detailed in the table to the left. Costs for the two variants are averaged to provide a single scenario cost

2 No WTPs identified with these conditions

	Source Water	Population Category	Scenario	Assumed Existing Treatment	Upgrading Required
CAPEX	Previously Considered Secure Groundwater	Medium	SG-ME-1	No treatment	UV + chlorination. FAC monitoring
			SG-ME-2	Chlorination only	UV. FAC monitoring
			SG-ME-3	Disinfection and chlorination	Nothing. FAC monitoring
			SG-ME-4	Disinfection (not chlorination) only	Chlorination. FAC monitoring
		Minor	SG-MI-1	No treatment	UV + chlorination. FAC monitoring
			SG-MI-2	Chlorination only	UV. FAC monitoring
			SG-MI-3	Disinfection and chlorination	Nothing. FAC monitoring
			SG-MI-4	Disinfection (not chlorination) only	Chlorination. FAC monitoring
		Small	SG-S-1	No treatment	UV + chlorination. FAC monitoring
			SG-S-2	Chlorination only	UV. FAC monitoring
			SG-S-3	Disinfection and chlorination	Nothing. FAC monitoring
			SG-S-4	Disinfection (not chlorination) only	Chlorination. FAC monitoring
		Neighbourhood	SG-N-1	No treatment	UV + chlorination. FAC monitoring
			SG-N-2	Chlorination only	UV. FAC monitoring
			SG-N-3	Disinfection and chlorination	Nothing. FAC monitoring
			SG-N-4	Disinfection (not chlorination) only	Chlorination. FAC monitoring

OPEX	Population Category	Source	Scenario	Assumed Existing Treatment	Upgrading Required
	Previously Considered Secure Groundwater	Medium	SG-ME-1	No treatment	UV + chlorination. FAC monitoring
			SG-ME-2	Chlorination only	UV. FAC monitoring
			SG-ME-3	Disinfection and chlorination	Nothing. FAC monitoring
			SG-ME-4	Disinfection (not chlorination) only	Chlorination. FAC monitoring
		Minor	SG-MI-1	No treatment	UV + chlorination. FAC monitoring
			SG-MI-2	Chlorination only	UV. FAC monitoring
			SG-MI-3	Disinfection and chlorination	Nothing. FAC monitoring
			SG-MI-4	Disinfection (not chlorination) only	Chlorination. FAC monitoring
		Small	SG-S-1	No treatment	UV + chlorination. FAC monitoring
			SG-S-2	Chlorination only	UV. FAC monitoring
			SG-S-3	Disinfection and chlorination	Nothing. FAC monitoring
			SG-S-4	Disinfection (not chlorination) only	Chlorination. FAC monitoring
		Neighbourhood	SG-N-1	No treatment	UV + chlorination. FAC monitoring
			SG-N-2	Chlorination only	UV. FAC monitoring
			SG-N-3	Disinfection and chlorination	Nothing. FAC monitoring
			SG-N-4	Disinfection (not chlorination) only	Chlorination. FAC monitoring

Appendix D

Chemically Non-Compliant Water Treatment Plants

Community	Zone Name	P2 Determinand	Plant Name	Plant Code	Region	Source water code	Population Category	P1 compliance (E. coli, Proto)	Existing Treatment (noted if assumed)	Upgrading Required	Total CAPEX (incl. margins and fees)	Total OPEX
Helensville/Parakai	Helensville and Parakai	MAV ratio sum of THM	Helensville	TP00167	Auckland	3,3	Minor	Yes	Assumed at least coagulation, filtration and chlorination	Enhanced coagulation	$ 356,733	$ 32,32[illegible]
Raetihi	Raetihi Township	Dichloroacetic acid and MAV sum ratio of HAA	Raetihi	TP00055	Manawatu-Wanganui	4,4	Minor	No - NN	Chlorination	Addition of coagulation/clarification/filtration	$ 1,454,024	$ 32,1[illegible]1
Nelson	Nelson	MAV ratio sum of HAA	Tantragee	TP02544	Nelson	4,4,4	Large	Yes	Flocculation, ultrafiltration, chlorination	Enhanced coagulation	$ 1,234,335	$ 196,075
Omapere	Omapere	MAV ratio sum of THM	Omapere	TP00283	Northland	4,4	Minor	Yes	Assumed membrane filtration and chlorination	Allow for coagulation	$ 267 046	$ 8 179
Acacia Bay	Acacia Bay	Arsenic	Acacia Bay Plant	TP00002	Waikato	3	Minor	No - NN	Chlorination	Addition of coagulation and direct filtration allowed for under P1 compliance. Add enhanced coagulation	$ 356,733	$ 32,324
Motuoapa	Motuoapa	Arsenic	Motuoapa Pump Station	TP00602	Waikato	3	Minor	No - YN	Chlorination	Addition of coagulation and direct filtration allowed for under P1 compliance. Add enhanced coagulation	356,733	$ 32,324
Omori/Kuratau and Pukawa	Omori/Kuratau and Pukawa	Arsenic	Omori Pump Station	TP00440	Waikato	4	Minor	No - YN	Coarse screen and chlorination	Addition of coagulation, enhanced coagulation and direct filtration (this is not included under P1 compliance as it is assumed existing)	$ 1,034,945	$ 64,485
Hatepe Village	Hatepe Village	Arsenic	Hatepe Pump Station	TP00442	Waikato	4	Small	No - YN	Chlorination	Addition of coagulation, enhanced coagulation and direct filtration (this is not included under P1 compliance as it is assumed existing)	$ 483,268	$ 29,119
Kinloch	Kinloch Town	Arsenic	Kinloch	TP00003	Waikato	3	Minor	No - YN	Chlorination	Addition of coagulation and direct filtration allowed for under P1 compliance. Add enhanced coagulation	$ 356,733	$ 32,324
Centennial Drive	Rakanui Road	Arsenic	Centennial Nursery	TP02987	Waikato	3	Small	No - YN	Chlorination	Addition of coagulation and direct filtration allowed for under P1 compliance. Add enhanced coagulation	$ 356 733	$ 4 100
Greymouth	Greymouth	MAV ratio sum of HAA	Coal Creek	TP02257	West Coast	4,4	Medium	Yes	Assumed UV and chlorination	Addition of coagulation and direct filtration.	$ 2,013,412	$ 51,511
Waitoa	Waitoa Village and Factory	MAV ratio sum of HAA	Waitoa	TP00726	Waikato	4	Small	No - YN	Assumed Chlorination	Addition of coagulation, enhanced coagulation and direct filtration (this is not included under P1 compliance as it is assumed existing)	$ 483,268	$ 29,119
Rangitaiki Plains	Edgecumbe	Arsenic	Te Teko Plant	TP00315	Bay of Plenty	4	Minor	No - YN	NA	None - new Paul Rd WTP and upgraded Tahuna Road WTP will not have issues with P2 determinants	$ -	$ -
	Rangitikei Plains Rural		Braemar Plant	TP00324	Bay of Plenty	4	Minor	No - YN			$ -	$ -
	Te Teko		Johnson Road Plant	TP00325	Bay of Plenty	4,4	Small	No - YN			$ -	$ -
Karangahake	Karangahake	Arsenic	Karangahake	TP00611	Waikato	3	Small	No - YN	NA	None - water now supplied from Paeroa which has no assigned P2 determinant	$ -	$ -
Kaingaroa	Kaingaroa	Copper, Lead	Kaingaroa deep well	TP00378	Bay of Plenty	4	Small	No - YN	NA	None - failure due to inadequate monitoring	$ -	$ 692
Twizel	Twizel	Copper, Lead	Twizel	TP00368	Canterbury	4	Minor	No - YN	NA	None - failure due to inadequate monitoring	$ -	$ 692
Shannon	Shannon	Dichloroacetic acid, MAV sum ratio of HAA and trichloroacetic acid	Shannon	TP00141	Manawatu-Wanganui	4	Minor	No - YN	NA	None - failure due to inadequate monitoring	$ -	$ 1,038
Tokomaru	Tokomaru	Dichloroacetic acid, MAV sum ratio of HAA and trichloroacetic acid	Tokomaru	TP00143	Manawatu-Wanganui	4	Minor	No - YN	NA	None - failure due to inadequate monitoring	$ -	$ 1,038
Waiouru	Waiouru Township	Dichloroacetic acid, MAV sum ratio of HAA and trichloroacetic acid	Waiouru	TP00057	Manawatu-Wanganui	4,4	Minor	No - NN	NA	None - failure due to inadequate monitoring	$ -	$ 1,038
Feilding	Feilding	Fluoride	Feilding, Almadale	TP00162	Manawatu-Wanganui	4	Large	No - NN	NA	None - failure due to inadequate monitoring	$ -	$ 1,499
			Feilding, Awa Street	TP02327		4,4	Large	Yes - YY	NA	None - failure due to inadequate monitoring	$ -	$ 1,499
Seddon	Seddon, Awatere Valley	Nickel, Lead	Awatere Valley, Seddon	TP00499	Marlborough	3	Minor	No - YN	NA	None - failure due to inadequate monitoring	$ -	$ 692
Glenkenich Rural	Glenkenich Rural	Dichloroacetic acid, MAV sum ratio of HAA and trichloroacetic acid	Glenkenich Rural	TP00273	Otago	4,4	Minor	No - NN	NA	None - failure due to inadequate monitoring	$ -	$ 1,038
North Bruce Rural	North Bruce Rural	Dichloroacetic acid, MAV sum ratio of HAA and trichloroacetic acid	North Bruce	TP00271	Otago	3	Minor	No - YN	NA	None - failure due to inadequate monitoring	$ -	$ 1,038
Milton	Milton	MAV ratio sum of HAA	Milton	TP02816	Otago	4	Minor	No -YN	NA	None - failure due to inadequate monitoring	$ -	$ 346
Tapanui	Tapanui	Fluoride	Tapanui	TP00270	Otago	3	Minor	No - YN	NA	None - fault in fluoride dosing	$ -	$ -
Thames	Thames - Kopu	Fluoride	Thames	TP00078	Waikato	4,4	Medium	No - YN	NA	None - failure due to inadequate monitoring	$ -	$ 1,499
Featherston	Featherston	MAV ratio sum of HAA	Boar Bush, Featherston	TP00634	Wellington	4,4	Minor	No - NN	NA	None - failure due to inadequate monitoring	$ -	$ 346
											$ 8,753,962	**$ 556,499**

Appendix E

Large Water Treatment Plants with Secure Groundwater Status

Upgrades Required Under Scenario 2 for Large WTPs with Secure Groundwater Status

Data received from B. Mattingley at ESR, 16/01/2018

WTP No.	Plant Name	Plant Code	Comm pop	Terratorial Local Authority	E coli Comply	Protozoa Comply	Chemical Compliance	Current Treatment (Assumed)	Upgrade Description	Capital Cost ($mill)	Operating Cost ($K)
1	Ashburton Domain	TP00334	18500	Ashburton District Council	Y	Y	Y	Chlorination	UV	$ 2.1	$ 120
2	Bridge Street	TP02701			Y	Y	Y	Chlorination	UV		
3	Tinwald	TP03067			Y	Y	Y	Chlorination	UV		
4	Argyle Park	TP02509			Y	Y	Y	Chlorination	UV		
5	Central Christchurch	TP00179	185000	Christchurch City Council	Y	Y		Nothing	UV + Chlorination	$ 57.8	$ 3,080
6	Heathcote (Refer note 1)	TP00188	4450		Y	Y	-	Nothing	UV + Chlorination		
7	Parklands	TP00182	16000		Y	Y	-	Nothing	UV + Chlorination		
8	NW Chch (Refer note 2)	TP00181	80000		Y	N	-	Nothing	UV + Chlorination		
9	Riccarton	TP00185	10000		Y	Y	-	Nothing	UV + Chlorination		
10	Rocky Point	TP00184	2500		Y	Y	-	Nothing	UV + Chlorination		
11	West Christchurch	TP00183	42000		Y	Y	-	Nothing	UV + Chlorination		
12	Feilding, Awa Street	TP02327	13000	Manawatu District Council	Y	Y	N	Chlorination	UV	$ 1.1	$ 29
13	Eastbourne Street	TP00115	64764	Hastings District Council	Y	Y	Y	Chlorination	UV	$ 5.1	$ 58
14	Portsmouth Road, Flaxmere	TP01278			Y	Y	Y	Chlorination	UV		
15	Darnley Square	TP00209	12168	Waimakariri District Council	Y	Y	-	Nothing	UV + Chlorination	$ 1.8	$ 71
16	Peraki St	TP02443			Y	Y	-	Nothing	UV + Chlorination		
17	A1 Awatoto Pump Station	TP03097	508004	Napier City Council	Y	Y	-	Temporary Chlorination	UV + Chlorination	$ 7.8	$ 355
18	Bledisloe Park	TP00105			Y	Y	-	Temporary Chlorination	UV + Chlorination		
19	Burness Road	TP00106			Y	Y	-	Temporary Chlorination	UV + Chlorination		
20	Coverdale Pump Station	TP00111			Y	Y	-	Temporary Chlorination	UV + Chlorination		
21	Guppy Road	TP00103			Y	Y	-	Temporary Chlorination	UV + Chlorination		
22	Riverside Park	TP00102			Y	Y	-	Temporary Chlorination	UV + Chlorination		
23	T4 Pump Station	TP00104			Y	Y	-	Temporary Chlorination	UV + Chlorination		
24	T6 Pump Station	TP01961			Y	Y	-	Temporary Chlorination	UV + Chlorination		
25	T7 Pump Station, King Street	TP02308			Y	Y	-	Temporary Chlorination	UV + Chlorination		
26	Tannery Road	TP00101			Y	Y	-	Temporary Chlorination	UV + Chlorination		
27	Keith Street	TP02023	67653	Palmerston North City Council	Y	Y	Y	Chlorination	UV	$ 5.6	$ 115
28	Papaioea	TP00148			Y	Y	Y	Chlorination	UV		
29	Roberts Line	TP00150			Y	Y	Y	Chlorination	UV		
30	Takaro	TP00149			Y	Y	Y	Chlorination	UV		
31	South Belt	TP03053	17130	Waimakariri District Council	Y	Y	-	Nothing	UV + Chlorination	$ 2.8	$ 36
32	Izone	TP02692	15047	Selwyn District Council	Y	Y	-	UV	Chlorination	$ 1.6	$ 61
33	Rolleston, Illinois Drive	TP03072			Y	Y	-	UV	Chlorination		
34	Rolleston, Overbury Crescent	TP01928			Y	Y	-	Nothing	UV + Chlorination		
35	Rolleston, Westland Place	TP02931			Y	Y	-	UV	Chlorination		
36	Frontier Road	TP03229	10665	Waipa District Council	Y	Y	-	Nothing	UV + Chlorination	$ 0.3	$ 12
37	Aramoho	TP02511	10025	Wanganui District Council	TNC	Y	-	Ozone + chlorine	Nothing	$ -	$ -
38	Wanganui	TP00052	29450		Y	Y	-	Chlorination	UV	$ 2.7	$ 29
									Total	$ 88.6	$ 3,966

1 Heathcote is not technically a large WTP, but has been included here as it is part of the wider Christchurch City water supply
2 NW Chch does not currently have secure groundwater status, but is working to achieve it. It is also part of the wider Christchurch City water supply.
3 Five WTPs in Mosgiel are now served from Dunedin and have been removed from this list
4 Waterloo WTPs secure groundwater status has been revoked and treatment has been upgraded to meet DWSNZ. It has also been removed from this list