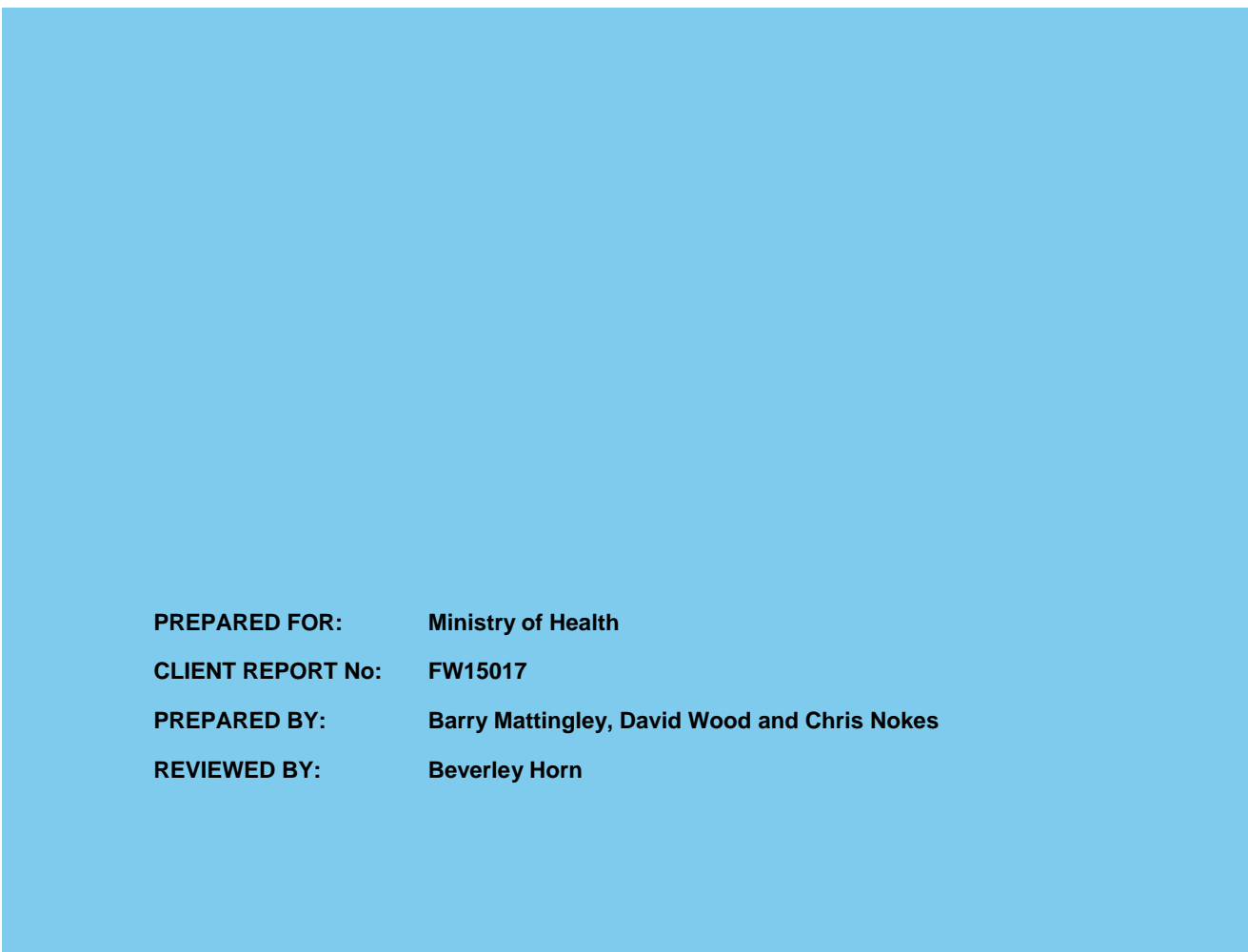


Non-achievement of the *Drinking-water Standards for New Zealand*



June 2015



PREPARED FOR: Ministry of Health
CLIENT REPORT No: FW15017
PREPARED BY: Barry Mattingley, David Wood and Chris Nokes
REVIEWED BY: Beverley Horn

ACKNOWLEDGEMENTS

The authors are grateful to Steve Goodin, Amelia Haskell, Kirsty Macleod, Matt Malloy, Judy Williamson, Keith Turner and Scott Rostron for providing information on water supply zones, and to Beverley Horn for her review of the draft report.

Manager



Rob Lake

Manager, Risk and Response Group

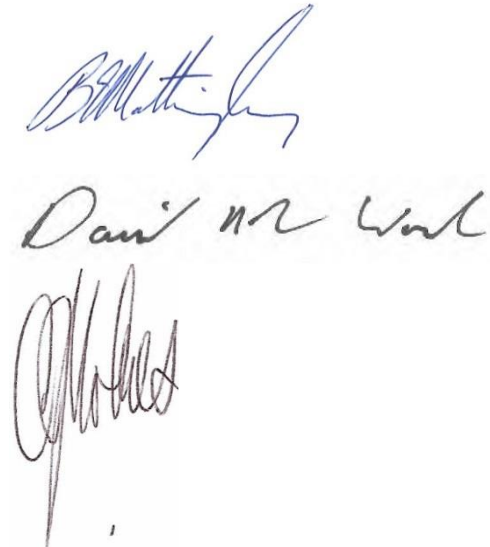
Peer reviewer



Beverley Horn

Senior Scientist, Risk and Response Group

Authors



Barry Mattingley, David Wood, Chris Nokes

Risk and Response Group

DISCLAIMER

The Institute of Environmental Science and Research Limited (ESR) has used all reasonable endeavours to ensure that the information contained in this client report is accurate. However ESR does not give any express or implied warranty as to the completeness of the information contained in this client report or that it will be suitable for any purposes other than those specifically contemplated during the Project or agreed by ESR and the Client.

CONTENTS

EXECUTIVE SUMMARY	1
1. INTRODUCTION.....	7
1.1 BACKGROUND.....	7
1.2 THE REPORT'S PURPOSE	7
1.3 BASIS OF THE DATA ANALYSIS	8
1.4 MONITORING REQUIREMENTS OF THE STANDARDS	8
1.4.1 Priority 1 determinands.....	8
1.4.2 Priority 2 determinands.....	9
1.4.3 Reasons for non-achievement.....	9
1.5 REPORT STRUCTURE	9
2. METHOD	11
2.1 METHOD OF DATA GATHERING AND EVALUATION	11
2.1.1 The Annual Survey.....	11
2.1.2 Survey Analysis and Risk Assessment Data Preparation	11
2.1.3 Some Definitions	12
2.1.4 Presentation of the information in tables.....	13
2.1.5 Information from DWAs	13
2.1.6 The report's primary datasets and subsets	13
3. <i>E. COLI</i> NON-ACHIEVEMENT.....	15
KEY FINDINGS OF THE SECTION.....	15
3.1 INTRODUCTION.....	15
3.2 FINDINGS AND DISCUSSION.....	15
3.2.1 Overview of non-achievement for <i>E. coli</i>	15
3.2.2 Non-achievement because of transgressions	16
3.2.3 Non-achievement because of inadequate monitoring	25
3.3 OUTLOOK FOR <i>E. COLI</i> ACHIEVEMENT	25
3.4 PUBLIC HEALTH SIGNIFICANCE	28
3.5 CONCLUSIONS.....	28
4. CHEMICAL NON-ACHIEVEMENT	31
KEY FINDINGS OF THE SECTION.....	31
4.1 INTRODUCTION.....	31
4.2 FINDINGS AND DISCUSSION.....	31

4.2.1	Overview of non-achievement for chemical determinands	31
4.2.2	Non-achievement because of transgressions	37
4.2.3	Non-achievement because of inadequate monitoring	39
4.3	OUTLOOK FOR CHEMICAL ACHIEVEMENT	39
4.4	PUBLIC HEALTH SIGNIFICANCE	42
4.5	CONCLUSIONS	42
5. IMPROVING ACHIEVEMENT OF THE STANDARDS		45
6. OVERALL CONCLUSIONS.....		47
APPENDICES.....		49
APPENDIX A: E. COLI ACHIEVEMENT DETAILS		51
	INTRODUCTION	51
A.1	KAWERAU (KAW003KA).....	51
A.2	MARTINBOROUGH (MAR003MA)	53
A.3	REEFTON (REE001RE)	54
A.4	DARFIELD (DAR001DA)	56
A.5	HORORATA (SEL001HO)	57
A.6	KIRWEE (KIR001KI)	58
A.7	MALVERN HILLS, HARTLEYS RD (MAL001MA)	59
A.8	MOTUNAU, GRETA, SCARGILL (MOT016MO)	60
A.9	SHEFFIELD/WADDINGTON (SHE004SH)	62
A.10	TWIZEL (TWI001TW)	63
APPENDIX B: CHEMICAL ACHIEVEMENT DETAILS.....		65
	Introduction	65
B.1	EDGE CUMBE (RAN007ED)	65
B.2	THORNTON (RAN007TH)	66
B.3	ACACIA BAY (ACA001AC).....	67
B.4	MOTUOAPA (MOT002MO)	68
B.5	OMORI / KURATAU / PUKAWA (OMO001OM)	69
B.6	TE KARAKA (TEK002TE)	70
B.7	SEDDON, AWATERE VALLEY (SED001SE).....	71
B.8	AYLMERS (AKA001AY).....	72
B.9	TWIZEL (TWI001TW)	73
B.10	GLENKENICH RURAL (GLE001GK).....	74
B.11	MILTON (MIL001MT)	75
B.12	NORTH BRUCE RURAL (NOR003NB)	76
B.13	KARANGAHAKE (KAR001KA)	77
B.14	TE TEKO (RAN007TE)	78

B.15	MARTON TOWNSHIP (MAR001MA)	79
B.16	SHANNON (SHA001SH)	80
B.17	TOKOMARU (TOK002TO).....	81
B.18	FEATHERSTON (FEA001FE)	82

ADDENDUM: CHEMICAL ACHIEVEMENT OF THE CLARKS BEACH/WAIAU BEACH ZONE.....	83
---	-----------

REFERENCES	85
-------------------------	-----------

LIST OF TABLES

TABLE 1	SUMMARY OF CRITERIA DEFINING THE PRIMARY DATASET AND SUBSETS EXAMINED IN MORE DETAIL BY THE STUDY	14
TABLE 2	REASONS FOR <i>E. COLI</i> NON-ACHIEVEMENT BY ZONES IN THE TRANSGRESSING GROUP	17
TABLE 3	ACHIEVEMENT DATA FOR THE 10 'HIGH TRANSGRESSION ZONES'	18
TABLE 4	ACHIEVEMENT DATA FOR THE 16 'MODERATE TRANSGRESSION ZONES'	19
TABLE 5	PERCENTAGE OF SAMPLES THAT TRANSGRESSED FOR LARGER ZONES	23
TABLE 6	PERCENTAGE OF SAMPLES THAT TRANSGRESSED IN THE 'HIGH TRANSGRESSION ZONES'	24
TABLE 7	SUMMARY OF CORRECTIVE ACTIONS AND THE LIKELY EFFECT ON <i>E. COLI</i> NON-ACHIEVEMENT IN THE ZONE	27
TABLE 8	REASONS FOR NON-ACHIEVEMENT OF THE CHEMICAL REQUIREMENTS OF THE STANDARDS IN ZONES WITH THREE OR FOUR FAILED YEARS. ...	32
TABLE 9	ACHIEVEMENT DATA FOR ZONES THAT FAILED CHEMICALLY IN FOUR YEARS	33
TABLE 10	ACHIEVEMENT DATA FOR ZONES THAT FAILED CHEMICALLY IN THREE YEARS INCLUDING 2013-14.....	35
TABLE 11	SUMMARY OF CORRECTIVE ACTIONS AND THE LIKELY EFFECT ON CHEMICAL NON-ACHIEVEMENT IN THE ZONE	41

EXECUTIVE SUMMARY

Each year ESR carries out a survey of all networked water supplies throughout New Zealand that serve more than 100 people to collect data on the extent to which the requirements of the *Drinking-water Standards for New Zealand* (the Standards) are met. This is done to allow the preparation of the *Annual Report on Drinking-water Quality in New Zealand* (the Annual Report), which the Director-General of Health is required to publish each year by the Health Act 1956 (s69ZZZB).

An extensive dataset is collected by the survey, but only a small portion is used in preparing the Annual Report. The study reported here is the first in a series of studies looking in more detail at the full dataset that has been collected by the annual survey over several years. The purpose of this report is to gain a better understanding of the reasons for non-achievement of the *E. coli* (*Escherichia coli*) and chemical requirements of the Standards.

The zones selected for this study are those for which data are available for 2013-14 and the three preceding years. The disruption of data collection in Canterbury because of the earthquakes means some Canterbury zones are not included in the dataset. Also, the dataset does not include zones that have had more than two different zone codes (the key to zone identification) during the four years (the reasons are explained in Section 2.1.6).

Data were available for 341 zones.

Non-achievement of the *E. coli* Standards

Key findings

- Of the 341 zones, 37 failed to meet the *E. coli* requirements of the Standards in the 2013-14 year¹.
- Too many transgressions² was the reason for failure, at least once in the four year period, in 26 (70%) of the 37 zones.
- In these 26 zones, over the four year period, 79% of failures were because of transgressions and 21% due to monitoring failures.
- When *E. coli* failure was the result of too many transgressions, corrective actions to address the transgressions were considered inadequate in 9% of cases.
- The great majority (24/26 or 92%) of these 26 zones are minor supplies, supplying a population of 501–5000 (inclusive).

¹ Failing to meet the *E. coli* requirements of the Standards could result from too many transgressions, inadequate monitoring, and, in principle, though seldom encountered in practice, inadequate corrective actions, or use of a laboratory not recognised by the Ministry of Health.

² For determinands that have a maximum acceptable value, a transgression occurs when a determinand exceeds that value. For *E. coli* this means the detection of *E. coli* in 100 ml of water.

Conclusions regarding *E. coli* non-achievement

- a. The main reason for non-achievement of the *E. coli* requirements of the Standards in the dataset of 26 non-achieving zones studied in this work was too many transgressions occurring.
- b. There are several possible reasons for *E. coli* transgressions.
 - a. *E. coli* are introduced into the supply in the source water.
 - b. The treatment plant does not provide adequate treatment.
 - c. Failing infrastructure is allowing microbial contaminants into the distribution network.
 - d. Water suppliers are not maintaining a disinfecting residual.
 - e. Water suppliers have difficulty operating the water supply properly.
 - f. Water suppliers are unable to identify the source of the *E. coli* in the zone, so are unable to prevent a reoccurrence.
 - g. Community committees can be reluctant to fund the upgrade of small supplies.
- c. Despite repeated failures because of an excessive number of transgressions, corrective actions to address the transgressions were considered adequate in the great majority of cases. While immediate actions to protect public health are important, little consideration appears to be given to the need to identify and remedy the cause of a transgression to avoid it happening again. A review of what constitutes adequate corrective action may be helpful.
- d. Transient, low-level (low *E. coli* concentration) transgressions are not uncommon in many zones. In the main, these do not appear to be false positive results. It is reported that water suppliers are prone to attribute them to sampling error. *E. coli* monitoring loses its value as a management tool if results are readily dismissed for this reason. Actions, such as sampler training, may be needed to make 'sampling error' a much less justifiable reason for dismissing test results. A disinfecting residual appears likely to provide a means of reducing the frequency of this type of transgression.
- e. A large fraction of water supplies that have failed the bacterial requirements of the Standards treat, or plan to treat, their water using only UV radiation. UV disinfection alone, is only a partial solution to the problem of non-achievement. It may need to be accompanied by filtration to keep turbidity at acceptable levels, and chlorination to provide a disinfecting residual throughout the distribution system is necessary.
- f. Some recently commissioned treatment upgrades are experiencing, what are hoped to be, teething troubles. Other supplies are still only at the planning stages of treatment upgrades. As a result, improvements in levels of *E. coli* achievement cannot be expected in the immediate future.
- g. Corrective actions will only bring about improved levels of achievement (when implemented), if capital expenditure is appropriately matched with operational resources, such as staffing levels and staff training.

Implications for public health

Non-achievement of the *E. coli* Standards does not necessarily imply a threat to public health. Failure on minor technical grounds associated with monitoring does not equate to a public health risk.

However, an *E. coli* transgression does indicate a health risk for although *E. coli* itself (unless it is a pathogenic strain) is harmless, its presence shows that the water has been in contact with faecal matter, and may contain pathogens.

There is generally no relationship between the concentration of *E. coli* in water and the concentration of pathogens. Nevertheless, it is reasonable to assume that higher concentrations of *E. coli* present in a transgressing sample, indicate an increased likelihood of pathogens being present. Also, the more frequently transgressions occur in a zone, the greater the microbiological risk to the zone's residents.

As a first approximation, the 10 zones which failed because of too many transgressions in at least three of the four years represent the greatest health risk to their residents. Within this group the relative risk can be estimated from the percentage of samples taken over the four years that transgressed.

Non-achievement of the chemical Standards

Key findings

- Of the 341 zones, 35 failed to meet the chemical requirements of the Standards in the 2013-14 year.
- Twelve (35%) of the 35 zones failed chemically in all four years, and a further six (17%) in 2013-14 and two other years.
- Too many transgressions was the reason for the chemical failure in 65% of cases in these 18 (12 + 6) zones. The 35% of cases remaining were due to inadequate monitoring alone.
- When chemical failure was the result of too many transgressions, corrective actions to address the transgressions were considered inadequate in 77% (33/43) of cases.
- The great majority (16/18 or 89%) of the 18 zones are minor supplies supplying a population of 501–5000 (inclusive). Two are small zones supplying populations between 101 and 500 (inclusive)

Conclusions regarding chemical non-achievement

- a. Failures arising from transgressions make up the greatest percentage of failures, but inadequate monitoring, particularly the total lack of sampling, make up a much larger proportion of failures than was the case for *E. coli* monitoring. A possible reason for this is that water suppliers see no benefit from continued sampling, which they see as only confirming a known ongoing water quality problem.
- b. Corrective actions taken were considered inadequate in the majority of cases (33/43 or 77%) where non-achievement resulted from too many transgressions. The reasons for this have not been identified, but are probably linked, in part, to c below.
- c. Effective corrective actions for addressing transgressions by chemical determinands present water suppliers with a difficult problem because they generally take time to implement and are expensive.

- d. To overcome transgressions by a chemical determinand, the water supplier has one of three options: find and develop another source water, upgrade the treatment plant or improve the efficacy of the existing treatment. The water supplier's ability to fund any of these activities determines their ability to improve the level of achievement of their water supply.
- e. Few of the zones examined in this study that failed chemically in 2013-14 and at least two of the preceding three years have implemented, or are planning to take, corrective actions that can be expected to address their problem of chemical transgressions. Consequently, little improvement in the levels of chemical achievement by these zones can be expected in the near or medium future.

Implications for public health

Non-achievement of the chemical Standards does not necessarily imply a threat to public health. For example, two zones failed for four years because they did not monitor for heavy metals. These metals almost certainly arise from corrosion. Both suppliers provide advice to flush taps before the water is used, as required by the Standards to manage the health risk from corrosion-derived metals. However, the suppliers have not yet performed the monitoring necessary to demonstrate that these metals are corrosion-derived. This would allow monitoring to cease.

One zone recorded high levels of manganese in all four years. However, a new plant is now reducing the manganese concentration to safe levels.

Zones in which disinfection by-products were monitored and transgressions were found, present a risk to health. The relative level of risk can be judged from the number of transgressions and the maximum concentrations recorded by the survey. Several zones were not monitored for disinfection by-products that should have been. The risk associated with these cannot be estimated.

Of the chemical determinands being monitored, arsenic represents the greatest public health concern. The concentrations in several of the supplies are consistently reported to be in excess of the MAV. The health risk is compounded by the fact that the cancer risk associated with an arsenic concentration equal to the MAV is 1 in approximately 1700, rather than the risk for most other carcinogens of 1 in 100,000.

Steps for improving achievement of the Standards

- a. Encourage all water supplies that do not presently maintain a permanent chlorine residual to take steps to do this. This is particularly important for UV disinfection, which provides no disinfecting residual and which is used, or is planned for use, in a large fraction of water supplies that fail to achieve the Standards because of *E. coli* transgressions.
- b. Ensure that when treatment plant upgrades are being planned, appropriate filtration is incorporated before the disinfection unit. Disinfection efficacy is compromised by turbid water, which may result from changes in weather conditions.
- c. Ask public health units to assist water suppliers/operators who may be struggling with investigating *E. coli* transgressions.
- d. Ask DWAs to ensure that water suppliers treat transgressions as a real contamination event and to check that trained samplers are collecting samples.
- e. Ensure water safety plans include a requirement to investigate the cause of transgressions and that measures to address the causes are implemented.

- f. Encourage zones that are still required to monitor heavy metals, to complete their monitoring to confirm that the metals are corrosion-derived and so allow them to be reclassified as Priority 3. Their monitoring may then cease.

Overall conclusions

- a. Too many transgressions during a reporting year is the prime cause of the non-achievement of the Standards by both *E. coli* and chemical determinands, and indicates a possible risk to public health.
- b. Levels of achievement for *E. coli* and chemical determinands are unlikely to improve greatly in the near future, given the corrective actions taken to date.
- c. A water supplier's ability to afford the necessary corrective actions will determine the extent to, and rate at, which levels of achievement will improve.
- d. The relatively inexpensive measure of introducing a residual disinfectant into zones that presently contain no residual seems likely to be an important measure for improving levels of *E. coli* achievement.
- e. Some water suppliers appear to have made a policy decision not to monitor their Priority 2 chemical determinands, possibly because they see it as an unnecessary waste of resources. It is likely to continue as a reason for non-achievement until they can be convinced otherwise.

[Intentionally Blank]



1. INTRODUCTION

1.1 BACKGROUND

The *Annual Report on Drinking-water Quality in New Zealand* (the Annual Report) has been published by the Ministry of Health (the Ministry) since 2004. Before 2008, publication of the Annual Report was one of the tools used by the Ministry to encourage compliance with the voluntary *Drinking-water Standards for New Zealand* (the Standards). In 2008, an amendment to the Health Act 1956 (the Act) (s69) made it a legal requirement for water suppliers “to take all practicable steps” to comply with the Standards³, and also placed a legal responsibility on the Director-General of Health to publish the Annual Report (s69ZZZB).

The data on which the Annual Report is based are collected by the Annual Survey (the Survey) of water suppliers. The Survey collects data from all networked water supplies throughout New Zealand that serve more than 100 people. In the July 2013- June 2014 year, this provided information on the quality of water received by approximately 3,829,000 people in 659 water supply zones.

Integral to the collection and collation of the data through the survey are quality assurance measures which provide a very high confidence in the quality of the information.

As well as fulfilling the 69ZZZB requirement, the purpose of the Annual Report is to present a readily understood summary of the extent to which the water supplies meet the requirements of the Standards and comply with the Act. This provides a national overview of the quality of the country’s drinking-water. The summaries in the Annual Report are based on an extensive dataset, only a fraction of which is evident from the information in the report. The study reported here is the first of a proposed series of studies looking in more detail at the full dataset that has been collected by the Survey.

1.2 THE REPORT’S PURPOSE

The purpose of this report is to gain a better understanding of the reasons for non-achievement of the *E. coli* (*Escherichia coli*) and chemical requirements of the Standards in minor, medium and large water supplies⁴. This understanding should lead to better public health risk management of the country’s water supplies and improved national levels of achievement of the Standards.

Knowing the reasons for non-achievement of the Standards for individual zones will also help in interpreting what non-achievement means for the health of the zone’s residents. For example, non-achievement for a minor technical reason has less health significance than exceedence of a determinand’s maximum acceptable value (MAV).

Of the two possible reasons for non-achievement, transgressions⁵ arguably represent the greater risk to health. A transgression provides direct evidence that the water quality was

³ These requirements were phased on over a period of time depending on the size of the supply (see s 69C of the Act).

⁴ Resources for this study did not also allow non-achievement of the Standards by the large number of small supplies (101-500 people) to be considered.

⁵ For *E. coli* and chemicals a transgression occurs when a determinand exceeds its maximum acceptable value.

unsatisfactory at the time the sample was taken. Although collection of too few monitoring samples can result in the water supplier not being aware of contamination of their water supply, the extent to which a zone is monitored is not directly linked to public health. Consequently, inadequate monitoring is expected to be less of a public health concern than the occurrence of transgressions. For these reasons, the report's primary interest is in failure to achieve the Standards because of transgressions.

1.3 BASIS OF THE DATA ANALYSIS

The Annual Report presents achievement statistics in terms of populations. This allows the number of people who may be affected by water of poor quality to be estimated, and therefore the potential health impacts of poor water quality to be assessed. For the purpose of this report, which is essentially concerned with how well a water supply is managed, it is more helpful to assess achievement in terms of the number of zones, rather than population size.

1.4 MONITORING REQUIREMENTS OF THE STANDARDS

In many instances, non-achievement of the Standards results from inadequate monitoring. The level of monitoring a water supplier undertakes directly affects the level of confidence that can be held regarding the quality of the water being provided to consumers. One of the base principles of the Standards (s1.3, Principle 6) is that:

'Where feasible, the sampling protocols are designed to give 95 percent confidence that no determinand in a supply has exceeded its MAV for more than 5 percent of the time.'

Achievement of the requirements of the Standards for *E. coli* provides the level of confidence envisaged by the principle. However, because of the cost of monitoring chemical determinands, and the lower health priority they are given the Standards, the required sampling frequency for chemical determinands is not as great as for *E. coli*, and provides a lower level of confidence that an MAV has not been exceeded.

The Standards require water supplies to monitor Priority 1 determinands and any Priority 2 determinands assigned to them.

1.4.1 Priority 1 determinands

Priority 1 determinands are exclusively microbiological: *E. coli* and protozoa. Direct monitoring of *E. coli* is required, but not protozoa. Examination of the achievement of the Standards for protozoa is outside the scope of this study.

Monitoring of *E. coli* is required in the distribution zone(s) of a water supply. The number of samples to be collected depends on the number of people served by the supply: the larger the population the greater the number of samples to be collected over the year. The Standards require a specified interval between samples to be met and the use of a minimum number of days of the week⁶.

The monitoring of *E. coli* is also one of the options for demonstrating achievement of the Standards at the treatment plant. This report only considers *E. coli* monitoring in the distribution zone (the zone).

⁶ See Table 4.3b of the Standards. A minimum number of days of the week is set to reduce the likelihood of a water supplier sampling on preferred days of the week to avoid an event, such as an upstream discharge, that is expected to adversely affect water quality on the same day each week.

1.4.2 Priority 2 determinands

The Standards make provision for microbiological and radiological determinands to be classified as Priority 2, but in practice Priority 2 determinands are invariably chemical. A chemical determinand that has been shown to be present in a supply at a concentration more than 50% of its maximum acceptable value (MAV) is assigned to that supply as a Priority 2 determinand.

Once a determinand is assigned to a supply (either the treatment plant or the distribution zone) the water supplier is required to monitor that determinand until it can be shown by a year's monitoring that the determinand's concentration is no longer greater than 50% of the MAV. The frequency at which chemical determinands have to be sampled is generally less than the frequency for *E. coli*, but there is also a maximum permitted interval between samples.

Priority 2 determinands can be assigned to the treatment plant or the zone. This report includes determinands assigned to the plant as well as those assigned to the zone when assessing achievement. Priority 2 determinands assigned to the treatment plant are included in the study because the assignation location makes no difference to the achievement criteria. In contrast, the criteria for achievement of the Standards at the treatment plant for *E. coli* are different from those in the distribution zone.

1.4.3 Reasons for non-achievement

A zone may fail to achieve the Standards, whether with respect to *E. coli* or chemical determinands, because of too many transgressions^{7,8}, inadequate monitoring⁹ or both. In principle, failure can result solely from inadequate corrective action in the event of a transgression (if the single transgression does not result in failure), but there is no record of this in the dataset used in this study. Non-achievement may also arise, in principle, because of the use of a laboratory that is not recognised by the Ministry of Health, but this too is not recorded in the dataset reviewed in this work. An excessive number of transgressions is regarded as the primary reason for non-achievement when both too many transgressions and inadequate monitoring occur together.

1.5 REPORT STRUCTURE

Following Section 2 on method, the report is divided into two main sections. Section 3 concerns non-achievement with respect to *E. coli* and Section 4 concerns non-achievement with respect to chemical determinands. Both sections discuss the public health significance of non-achievement for the relevant determinands. Steps that may improve national levels of achievement are discussed in Section 5, and Section 6 draws the main conclusions of the report together.

Two appendices provide detailed information on the *E. coli* and chemical determinand achievement performance of the zones included in the study. An addendum containing achievement information for the Clarks Beach/Waiiau Beach zone (CLA 007CL) is provided

⁷ For determinands that have an MAV, a transgression occurs when the determinand exceeds its MAV. For *E. coli*, the detection of 1 *E. coli*/100 ml of water is a transgression.

⁸ The statistical basis of the sampling requirements of the Standards allows for some transgressions to occur without the supply being considered to have failed the Standards provided a sufficiently large number of samples have been taken. When the minimum number of samples to be taken during a year is low, a single transgression will result in non-achievement of the Standards.

⁹ For brevity, in this report, the term 'inadequate monitoring' refers to no monitoring as well as unsatisfactory monitoring arising because of too few samples being taken, or the interval between samples being too long, or the distribution over days of the week not meeting the requirements of the Standards.

after the appendices. The reason for the separate treatment of this zone is given in Section 2.1.6.

2. METHOD

2.1 METHOD OF DATA GATHERING AND EVALUATION

2.1.1 The Annual Survey

The Survey is performed in Water Information New Zealand (WINZ) 6, a web database managed by ESR for the Ministry of Health. Each survey covers the distribution zones and treatment plants for all networked supplies where the zone population is over 100 people. Surveys start on 1 July each year, and cover the preceding 12 months of 1 July to 30 June.

The Survey covers both achievement with the Standards and compliance with the drinking-water aspects of the Act. Because this study is primarily focussed on Standards achievement, only those areas are included in the following explanatory text.

Each survey form is for a zone or a plant, and has 3 sections.

- a. Monitoring section: This is completed by either the supplier or the public health unit of the DHB. It includes questions as to monitoring status, transgressions, etc, but does not specify achievement.
- b. Audit section: This is completed by the public health unit and signed off by a drinking-water assessor (DWA). It states specifically whether the Standards were achieved, and whether leniency was granted. Comments can be included to reinforce any decisions taken.
- c. National section: ESR completes this section to confirm the entries are complete and consistent with national norms.

Each section cannot be completed until the one before it has been finalised. Similarly, earlier sections cannot be edited unless the current section is 'un-finalised' first. This helps to ensure a consistent process and audit trail of entries.

2.1.2 Survey Analysis and Risk Assessment Data Preparation

The Survey data are extracted from WINZ 6, further checked and processed in a separate database application called Surveyor. Among other things, this results in a table of zone-based survey results that form the basis for the Annual Report. (For example, a zone fed by three treatment plants will be marked for protozoa achievement based upon whether all three plants have individually achieved.)

The Surveyor database can calculate achievement for any survey year in WINZ 6 that has been answered with similarly formatted questions. There are currently five years of comparable data in WINZ 6, going back to the 2009-10 year. However, the supplementary questionnaires did not commence until 2010-11, so a fully comparable combined dataset only exists for four years.

Data was further filtered for this assessment by requiring that each zone considered must have data for all of those four years. Exclusions included:

- supplies that were new after 2010–11;
- zones that were substantially restructured after 2010–11;
- some Christchurch and surrounding supplies that were not surveyed in 2010–11 because of the Canterbury earthquakes.

Binary scores

Surveyor was used to prepare the four years of data, and to output the status of key questions in a binary format. A binary score is given in the format 'abcd', where each character can be a zero or one, and represents the parameter's status for a single year.

Characters are in year order, with the latest year first, and the oldest year last.

A "1" character generally means the zone failed the parameter, or is an exception to the norm, while a "0" indicates that it passed or was OK. If a zone meets all requirements for the four years then its score will be '0000'. Any score with a 1 in it indicates an exception to this.

The approach used is best explained with a specific example:

Years examined (in reverse chronological order):	2013-14, 2012-13, 2011-12, 2010-11.
<i>E. coli</i> achievement for each year (same order):	Yes, Yes, No, No.
Multi-year indicator of <i>E. coli</i> achievement:	0011

This approach was taken because the binary-looking indicator is both easily read and understood by the human eye, and is also readily usable in logical calculations.

2.1.3 Some Definitions

Base Year	Equals the latest survey year, 2013-14. The primary analytical focus is around "how did supplies that failed in the base year perform in earlier years." The other years examined were the three previous surveys, namely 2012-13, 2011-12 and 2010-11. In some areas of this report, years will be referred to as Year 1 ... Year 4, where Year 4 is the latest year.
-----------	--

The parameters used in several of the tables summarising achievement for listed zones are defined next.

E. coli Ach	Did <i>E. coli</i> fail for the bacterial Standards (1) or achieve (0) for each year?
Chem Ach	Did the chemical determinand fail for the chemical Standards (1) or achieve (0) for each year?
Transg	Was there an excessive number of transgressions recorded for the zone <i>E. coli</i> (1) or chemical determinand (1)?
Corr Act	Were corrective actions performed appropriately where a transgression occurred (0) or were they lacking or tardy (1)? Note that a '0' is allocated if no corrective actions were needed in a particular year, i.e. it had no transgressions.
Monit	Was bacterial or chemical monitoring satisfactory (0) or did the zone fail technically (1)? A zone can fail because of transgressions, inadequate monitoring, or both. Note that in the Survey, if leniency has been granted AND therefore the zone achieves, bacterially or chemically, then by default monitoring is marked as adequate in the Survey and will be a '0' here.
No WSP	If the water safety plan was neither approved nor implemented for a particular year, it receives a 1, otherwise 0.

Leniency If leniency was granted for a particular year, then 1, else 0. Note that, unlike the other parameters with a binary score, a 1 does not indicate a 'fail'. It just highlights here that something was not quite right and so that information needs to be appreciated when comparing with other years for the same zone.

2.1.4 Presentation of the information in tables

Throughout the report, zones are listed in tables based on geographical location, working from north to south. In some tables containing data from two datasets, zones with the greatest number of failures because of transgressions are listed at the top (in geographical order) followed by the second set of zones (in geographical order).

2.1.5 Information from DWAs

Seven DWAs had zones that failed the *E. coli* standard because of too many transgressions in the 2013-14 reporting year as well as in previous years (Table 2). These DWAs were approached and asked for any more details they could provide about: concentrations of *E. coli* found in transgressing samples, reasons for transgressions, the corrective actions taken, and general comments about the zone or water supply and the way it was operated.

2.1.6 The report's primary datasets and subsets

Table 1 sets out the criteria used to select the Survey data that were examined by the study. The available resources did not allow the Survey's full dataset to be examined. The selection criteria were designed to focus the study on zones with the greatest number of failures because of transgressions.

The population criterion for *E. coli* was not applied to the chemical determinand datasets, because Priority 2 determinands are generally only assigned to zones serving more than 500 people. Relaxing the population criterion increased the number of zones for detailed study by only two. These were included to provide as complete a picture of chemical non-achievement as possible.

The methodology for compiling the primary datasets was designed to capture zones that met the criteria of Table 1 and maintain the links between zone records provided the zone had not undergone more than one zone code (the key to zone identification) change during the four year period of interest.

The authors are aware of one zone, Clarks Beach/Waiiau Beach (CLA007CL¹⁰), that is not included in the primary chemical dataset because its zone code was changed more than once during the four years. The data for this zone are provided separately in the addendum because the zone lies outside the dataset produced by the study's methodology. Some zones do not appear in the *E. coli* primary dataset for the same reason, but they also failed to meet other criteria for inclusion in the report.

The omission of the Clarks Beach/Waiiau Beach zone from the dataset analysed in the study does not affect the conclusions reached in the report concerning chemical non-achievement. However, when reading the summary statistics in the body of the report, the omission of Clarks Beach/Waiiau Beach data needs to be taken into account.

¹⁰ The zone code at the time of the 2013-14 Annual Survey.

Table 1 Summary of criteria defining the primary dataset and subsets examined in more detail by the study

	Inclusion criteria	
	Primary dataset	Subsets examined in more detail
<i>E. coli</i>		
Annual Survey years	2010-11, 2011-12, 2012-13, 2013-14	As for the Primary dataset
Zone size	Greater than 500 (larger than 'Small', as defined by the Act)	
Failure to achieve the Standards	2013-14	
Excessive number of transgressions		Any of the four years
Chemical determinands		
Annual Survey years	2010-11, 2011-12, 2012-13, 2013-14	As for the Primary dataset
Zone size	No restriction	
Failure to achieve the Standards	2013-14	
Excessive number of transgressions		2013-14 and at least two of the three preceding years

3. *E. COLI* NON-ACHIEVEMENT

KEY FINDINGS OF THE SECTION

- Of the 37 zones that failed to meet the *E. coli* requirements of the Standards in 2013-14, 26 failed to meet the *E. coli* requirements because of too many transgressions in at least one year of the four included in the study. Ten of these failed because of too many transgressions in 2013-14 and in at least two of the three preceding years.
- Of the 26 zones for which transgressions caused failure at least once, 79% of failures to meet the *E. coli* Standards were because of too many transgressions. The remainder arose because of inadequate monitoring alone.
- Possible reasons for transgressions include:
 - *E. coli* are introduced into the supply in the source water.
 - The treatment plant does not provide adequate treatment.
 - Failing infrastructure is allowing microbial contaminants into the distribution network.
 - Water suppliers are not maintaining a disinfecting residual.
 - Water suppliers have difficulty operating the water supply properly.
 - Water suppliers are unable to identify the source of the *E. coli* in the zone, so are unable to prevent a reoccurrence.
 - Community committees can be reluctant to fund the upgrade of small supplies.
- Of the 10 zones, eight have taken, or are planning, steps that could reduce the likelihood of future transgressions.
- Non-achievement by most of these zones is considered likely until upgrades become operational. In some instances while steps to reduce the likelihood of transgressions have been taken, there are still other shortcomings with the supply that may result in transgressions, which need to be addressed.

3.1 INTRODUCTION

This section presents and discusses summary information about the non-achievement of the Standards with respect to *E. coli*. The detailed *E. coli* achievement data are provided in APPENDIX A: for the 10 zones with the greatest number of failures because of transgressions. The information in the appendix includes achievement data collected through the annual surveys and paraphrased comments on each zone from the DWA with responsibility for assessing zone achievement.

3.2 FINDINGS AND DISCUSSION

3.2.1 Overview of non-achievement for *E. coli*

The number of zones supplying more than 500 people in 2013-14 is 360. The subset with data available from 2010 to 2014 is 341. Of these 341, 37 zones failed to meet the *E. coli* requirements of the Standards in the 2013-14 year.

Twenty six (70%) of the 37 zones failed, at least one year of the four, because of too many transgressions. For brevity this group of zones is referred to as the '**transgressing group**'.

The great majority (24/26 or 92%) of these 26 zones are minor supplies, supplying a population of 501–5000 (inclusive).

For the purposes of the discussion in later sections, the ‘transgressing group’ is split into two groups. The first group, referred to as the ‘**high transgression zones**’, contains 10 zones that failed because of too many transgressions in 2013-14 and in at least two of the three preceding years. The second group, referred to as the ‘**moderate transgression zones**’, contains 16 zones. This is the remainder of the ‘transgressing group’ and defines a second tier of non-achievement.

The reasons for zones in the ‘transgressing group’ not achieving the *E. coli* requirements of the Standards are given in Table 2.

Table 2 shows that an excessive number of transgressions was the primary reason for 79% (57/72) of the annual failures to meet the *E. coli* Standards by the transgressing group. Inadequate monitoring alone was the reason for non-achievement of the Standards in only 21% (15/72) of cases. The figures for some zones do not sum to four because of years when the *E. coli* Standards were achieved.

In the years when the *E. coli* Standards were not achieved because of transgressions, corrective actions to address the transgressions were considered inadequate in 9% (5/57) of annual failures.

3.2.2 Non-achievement because of transgressions

This section examines the ‘transgressing group’ more closely, particularly the reasons for the transgressions.

Within the ‘transgressing group’, the ‘high transgression zones’ are of primary interest because they show the worst levels of transgression of the zones in the primary dataset. Four of these zones failed in all four years because of too many transgressions. The water suppliers operating the ‘high transgression zones’ repeatedly experienced difficulties in avoiding transgressions. Understanding what caused these transgressions and what could be done to stop their recurrence should be helpful in identifying actions to improve national levels of achievement.

A summary of the achievement data for the ‘high transgression zones’ is provided in Table 3, and a similar summary for the ‘moderate transgression zones’ is provided in Table 4.

Table 2 Reasons for *E. coli* non-achievement by zones in the transgressing group

The unshaded entries are the 'high transgression zones'.

Zone Code	Zone Name	Number of years failed primarily because of transgressions	Number of years failed solely because of inadequate monitoring
KAW003KA	Kawerau	3	
MAR003MA	Martinborough	3	
REE001RE	Reefton	3	1
DAR001DA	Darfield	3	1
SEL001HO	Hororata	3	1
KIR001KI	Kirwee	4	
MAL001MA	Malvern Hills, Hartleys Rd	3	
MOT016MO	Motunau, Greta, Scargill	4	
SHE004SH	Sheffield/Waddington	4	
TWI001TW	Twizel	4	
MAN005MA	Mangonui, Coopers Beach	1	3
PAI001OP	Opuia	1	
TEK001TR	Te Kauwhata / Rangiriri	1	1
WES011AT	Athenree	1	1
KAW003UV	Upper Valley Road	2	
PAT001PA	Patea	1	2
HAV001HA	Havelock North	2	
OHA002OH	Ohakea	2	
AMB001AT	Amberley Town	2	
CHE001CT	Cheviot Town	1	1
KAI004KU	Kaikoura Urban	2	
LEE001LE	Leeston	1	
WES010WE	West Melton	1	2
WOO002WO	Woodend Town	2	
FAI002FA	Fairlie	1	2
MOA001MF	Moa Flat Rural	2	
Totals		57 (79%)	15 (21%)

¹ Percentages are the percentage of non-achievements, ie, a percentage of 72 (57 + 15).

Table 3 Achievement data for the 10 'high transgression zones'

These zones did not achieve the Standards for *E. coli* in 2013-14 and also failed because of transgressions in more than one of the preceding three years.

HA	TA	ZCode	ZoneName	Surv Pop	Size	E. coli Ach	Transg	Corr Act	Monit	No WSP	Leniency
PacificWha	KawerauDC	KAW003KA	Kawerau	5390	Medium	1110	1110	0000	0000	1111	0000
WairarapaH	SWairarDC	MAR003MA	Martinborough	1505	Minor	1110	1110	0000	1000	0000	0000
CPHWestC	BullerDC	REE001RE	Reefton	951	Minor	1111	1101	0001	0010	1000	0010
CPHChch	SelwynDC	DAR001DA	Darfield	3283	Minor	1111	1110	0000	0011	0111	0000
CPHChch	SelwynDC	SEL001HO	Hororata	920	Minor	1111	1110	0000	0101	0000	0000
CPHChch	SelwynDC	KIR001KI	Kirwee	1100	Minor	1111	1111	0000	0011	0000	0000
CPHChch	SelwynDC	MAL001MA	Malvern Hills, Hartleys Rd	1409	Minor	1011	1011	0000	0001	0000	0000
CPHChch	HurunuiDC	MOT016MO	Motunau, Greta, Scargill	600	Minor	1111	1111	0001	0111	1111	0000
CPHChch	SelwynDC	SHE004SH	Sheffield/Wad dington	585	Minor	1111	1111	0000	1001	0000	0000
CPHTimaru	MackenzDC	TWI001TW	Twizel	1300	Minor	1111	1111	0011	1101	0111	0000

HA	Health Authority
TA	Territorial authority
ZCode	Zone code
Surv Pop	Zone's population recorded in the 2013-14 annual survey
Size	Zone size as defined in the Act
E. coli Ach	Binary representation of non-achievement information (see Method section)
Transg	Binary representation of transgression status for each year (see Method section)
Corr Act	Binary representation of corrective action status for each year (see Method section)
Monit	Binary representation of monitoring status for each year (see Method section)
No WSP	Binary representation of water safety plan status for each year (see Method section)
Leniency	Binary representation of the use of leniency for each year (see Method section)

Table 4 Achievement data for the 16 'moderate transgression zones'

These are zones from the transgressing group that are not included in the 'high transgression zones' group.

HA	TA	ZCode	ZoneName	Surv Pop	Size	E. coli Ach	Transg	Corr Act	Monit	No WSP	Leniency
NorthDHB	FarNorthDC	MAN005MA	Mangonui, Coopers Beach	2000	Minor	1111	0010	0010	1111	1111	0000
NorthDHB	FarNorthDC	PAI001OP	Opuia	1000	Minor	1000	1000	0000	0000	0000	0010
WaikatoDHB	WaikatoDC	TEK001TR	Te Kauwhata / Rangiriri	1410	Minor	1001	0001	0000	1000	0001	0000
PacificTau	WestBoPDC	WES011AT	Athenree	3765	Minor	1000	0100	0000	1000	0000	0100
PacificWha	KawerauDC	KAW003UV	Upper Valley Road	970	Minor	1001	1001	0000	0000	1111	0000
TaranakDHB	SthTaranDC	PAT001PA	Patea	1150	Minor	1010	1000	0000	0110	1100	0000
HawkesBDHB	HastDC	HAV001HA	Havelock North	11623	Large	1010	1010	0000	0000	0011	1001
MidCHthPN	ManawatuDC	OHA002OH	Ohakea	1200	Minor	1001	1001	0000	0000	0111	1000
CPHChch	HurunuiDC	AMB001AT	Amberley Town	1200	Minor	1010	1010	0000	0000	0000	0101
CPHChch	HurunuiDC	CHE001CT	Cheviot Town	1340	Minor	1001	1000	0000	0001	1111	0100
CPHChch	KaikouraDC	KAI004KU	Kaikoura Urban	2500	Minor	1010	1010	0000	1010	0000	0001
CPHChch	SelwynDC	LEE001LE	Leeston	2350	Minor	1000	1000	0000	0000	0000	0001
CPHChch	SelwynDC	WES010WE	West Melton	1300	Minor	1101	1000	0000	0101	0000	0000
CPHChch	WaimakDC	WOO002WO	Woodend Town	2702	Minor	1100	1100	0000	0000	1111	0000
CPHTimaru	MackenzDC	FAI002FA	Fairlie	850	Minor	1101	1000	0000	1101	0011	0000
PHSthDun	CluthDC	MOA001MF	Moa Flat Rural	534	Minor	1001	1001	0000	0000	0000	1100

HA	Health Authority
TA	Territorial authority
ZCode	Zone code
Surv Pop	Zone's population recorded in the 2013-14 annual survey
Size	Zone size as defined in the Act
E. coli Ach	Binary representation of non-achievement information (see Method section)
Transg	Binary representation of transgression status for each year (see Method section)
Corr Act	Binary representation of corrective action status for each year (see Method section)
Monit	Binary representation of monitoring status for each year (see Method section)
No WSP	Binary representation of water safety plan status for each year (see Method section)
Leniency	Binary representation of the use of leniency for each year (see Method section)

Reasons for transgressions

Identifying the reasons for transgressions occurring is done to help determine actions that could improve the levels of *E. coli* achievement. From the data in APPENDIX A: some of the direct and indirect causes of transgressions can be identified. Some are peculiar to a particular zone, others seem more generally applicable.

- *E. coli* are introduced into the supply in the source water.
- The treatment plant does not provide adequate treatment.
- Failing infrastructure is allowing microbial contaminants into the distribution network.
- Water suppliers are not maintaining a disinfecting residual.
- Water suppliers have difficulty operating the water supply properly.
- Water suppliers are unable to identify the source of the *E. coli* in the zone, so are unable to prevent a reoccurrence.
- Community committees can be reluctant to fund the upgrade of small supplies.

The above reasons are now discussed in more detail.

- a. *E. coli* are introduced into the supply in the source water.

The DWAs mention, in discussing several of the Canterbury supplies, that heavy rain leads to increased turbidity in the source water. Increased turbidity is almost certainly accompanied by increased microbial loading. The decline in source quality combined with inadequate treatment (discussed next), lead to the possibility of poor source water quality being one of the factors leading to *E. coli* transgressions in these zones.

- b. The treatment plant does not provide adequate treatment.

For the 'high transgression zones', treatment inadequacy results for three reasons: the absence of disinfection or satisfactory disinfection, the absence of filtration to remove turbidity from the water before disinfection, and possibly poor treatment plant operation.

Chlorination is not carried out in some supplies because the community is against it. UV disinfection is used in some systems, presumably either because the community considered it preferable to chlorine, or it was considered easier to operate, requiring less frequent operator attendance – an appealing characteristic for a water supplier with a limited budget.

Old UV units, which do not meet the requirements of the Standards, are in use in several failing Canterbury supplies. The operating water supplier has identified the need to improve the technology and plans to upgrade these systems. As the performance of the existing systems is compromised during high turbidity episodes in their source water, improved filtration protection for the disinfection units is also needed if the upgrade is to prove effective.

- c. Failing infrastructure is allowing microbial contaminants into the distribution network.

Two of the 'high transgression zones' identified infrastructure (reservoir roof and aging asbestos cement pipes) requiring repair or replacement as the possible reason for detection of *E. coli* in the zone. Ingress routes by themselves do not result in transgressions. In both cases there are, or were, potential contamination sources nearby. At Kawerau, *E. coli* in bird droppings on the reservoir roof could have entered the reservoir through holes in the roof. At Darfield, the leaky nature of the reticulation

network is acknowledged and could provide an ingress route for contaminants. The community uses onsite sewage collection and treatment, but cross contamination from these sources is unlikely because the wastewater discharges should be below the level of the water supply reticulation, or is located away from it.

d. Water suppliers are not maintaining a disinfecting residual

A high percentage (70%) of the 'high transgression zones' operate without a disinfecting residual despite the recurring transgressions. For the unchlorinated Canterbury supplies, the reason for this is not stated in the DWA comments although the *Canterbury Water Management Strategy* (Canterbury Mayoral Forum 2009) may have some bearing on it¹¹. For Kawerau, the community's desire for an unchlorinated supply is the reason. This may be true of others.

A chlorine residual will be consumed by the ingress of a substantial amount of contamination into a supply. However, in many of the transgressions the *E. coli* concentration was low. Consequently, a properly maintained chlorine residual is likely to be sufficient to eliminate many of the transgression events discussed in f (below). The experience of Kawerau, for example, where *E. coli* has been reduced to acceptable levels by temporary chlorination, supports this.

e. Water suppliers have difficulty operating the water supply properly.

There are several aspects of supply operation that may lead to failure to achieve the Standards. One aspect, the unsatisfactory investigation of transgressions, is identified in f (below). Two others are seen in association with the Reefton zone, but may also apply to others. In relation to Reefton, the commenting DWA observed that although the council has spent a lot on plant upgrades, the supplies have to operate on a tight budget due to a low rating base and the recent economic downturns in the region. As a consequence, during heavy weather there can be too few staff to attend to the supplies requiring attention. Transgressions are a possible outcome. The DWA also considers that staff training is another casualty of the council's, and the service contractor's, tight operational budgets. The Selwyn District Council is looking to support a proposal of a general water rate across all of its urban supplies. This would improve the availability of funding for communities with responsibility for their own water supplies wishing to carry out upgrades. Supplies of fewer than 500 people may benefit most from this step.

f. Water suppliers are unable to identify the source of the *E. coli* in the zone.

For several zones, DWAs report (APPENDIX A:) that some transgressions result from low *E. coli* concentrations (near 1/100 ml) in the zone. The *E. coli* is detected in only the initial transgressing sample; there are no detections in follow up samples. This transient behaviour can make identification of the contaminant source difficult, which in turn hinders determining what remedial action is required.

It is reported that there is a tendency on the part of water suppliers, when faced with the transient appearance of contamination at low levels, to attribute the transgression to contamination of the sample or some other factor other than the quality of the water. No doubt sample contamination occasionally happens, but if the tool used to

¹¹ The *Canterbury Water Management Strategy* (Canterbury Mayoral Forum 2009) states the principle 'Where Canterbury's drinking water is currently untreated and safe for drinking, it is maintained at that high standard.' This may have some influence on Canterbury supplies wanting to remain unchlorinated, but the strategy importantly has the qualification '... and safe...'. Zones experiencing *E. coli* transgressions do not meet this criterion.

establish the safety of a water supply can be readily dismissed as sampler error, then it loses its value as a tool. Sampler training should be considered if sample contamination is demonstrably responsible for transgressions. Alternatively, if the test method itself is at fault, apparently yielding an unsatisfactory number of false positive results, it needs closer scrutiny.

A 2007 study (Olstadt et al 2007) examined the performance of a battery of 10 enzyme-based total coliform and *E. coli* detection tests (such as those listed in section A2.2 of the Standards). Tests to check on the ability of two *Aeromonas* strains to cause false positives showed that some of the commercially available, United States Environmental Protection Agency approved tests were susceptible to interference and yielded false positive results when the *Aeromonas* stains were spiked into samples. Olstadt and colleagues warned that more research was required to understand the implications of their results.

Consideration of the broader *E. coli* testing picture suggests that false positives are unlikely to be the reason for the majority of transient contamination events. The requirement of the Standards for laboratories to use referee methods (or methods calibrated against referee methods) ensures that most laboratories are using the same or very similar methods. Large well-managed zones, where other reasons for transgressions are expected to be eliminated, or greatly reduced, should provide a measure of the background level of transgressions arising from false positives.

Table 5 lists the number of monitoring samples taken over the four year period¹² from a selection of larger zones, and the number of transgressions in the zones for the same period. The same statistics are given in Table 6 for the 'high transgression zones'.

Table 5 Percentage of samples that transgressed for larger zones

Zone code	Name	Total number of samples	Number of Transgressions	Percentage
WEL002EA	Eastern Wellington	711	0	0.00%
WEL002SO	Southern Wellington	818	1	0.12%
WEL002WE	Wellington Central	1229	0	0.00%
AUC003AU	Auckland	2797	1	0.04%
AUC003CB	Central Business Dist. Auckland	404	0	0.00%
HAM001HA	Hamilton City	2452	1	0.04%
PAL001PC	Palmerston North City	1196	0	0.00%
DUN001WI	Booth Road, Dunedin	543	0	0.00%
DUN001BO	Wingatui, Dunedin	222	0	0.00%
NEL001NE	Nelson	4985	8	0.16%
CHR001CE	Central Christchurch	2654	17	0.64%
CHR001WE	West Christchurch	884	8	0.90%

¹² There are only three years of data for the Christchurch zones because of the earthquakes.

Table 6 Percentage of samples that transgressed in the 'high transgression zones'

Zone code	Name	Total number of samples	Number of Transgressions	Percentage
KAW003KA	Kawerau	267	4	1.5%
MAR003MA	Martinborough	275	13	4.7%
REE001RE	Reefton	233	12	5.2%
DAR001DA	Darfield	190	3	1.6%
SEL001HO	Hororata	149	4	2.7%
KIR001KI	Kirwee	212	6	2.8%
MAL001MA	Malvern Hills, Hartleys Rd	212	9	4.2%
MOT016MO	Motunau, Greta, Scargill	82	24	29%
SHE004SH	Sheffield/Waddington	211	7	3.3%
TWI001TW	Twizel	225	12	5.3%

Apart from the Christchurch zones, which have a higher percentage of transgressions (perhaps a consequence of them being unchlorinated, or a residual effect from the earthquakes) than the other selected large zones, the percentage transgression in the large zones is very much less than the percentages for the 'high transgression zones' (Table 6). Based on these two sets of data it seems that false positives are unlikely to provide the explanation for many of the transient, low concentration contamination events reported in the failing zones.

DWA comments suggest that as well as the transient nature of some transgression events making event investigation difficult, discovering the source of contamination can be hampered by a lack of trouble-shooting skill on the part of the operational staff, or perhaps the will to investigate the transgression properly.

- g. Community committees can be reluctant to fund the upgrade of small supplies.

Community and Public Health has identified community committees, and the degree of control they wield over water supply decisions, as a potential indirect cause of supply non-achievement. Some committees are reported to have been reluctant to fund upgrades for failing supplies because they considered the supply to be 'acceptable as it is'. Councils may find it difficult to overrule these decisions.

Corrective actions

A striking feature of the data in Table 3 and Table 4 is the very few instances of corrective actions being regarded as unsatisfactory despite the number of years in which too many transgressions resulted in non-achievement. Without identifying the cause of a transgression it is impossible to determine what corrective action is needed to avoid transgressions recurring for the same reason. The information provided by DWAs confirms that the causes of many transgressions are not identified. It seems that several supplies use temporary chlorination or a boil water notice to provide immediate, short-term health protection, and this is regarded as adequate.

At face value, these observations suggest that corrective actions are being primarily interpreted as actions that reduce immediate risk to health. These actions are important, but the Standards (Figs 4.1 and 4.2) require actions, which, in addition to 'issue boil water notice' or increased disinfection, entail investigation and remedial actions to address the

cause of the transgression. If these additional facets of corrective action are not undertaken the risk to the safety of the water remains.

It is possible that transgressions resulting from other, unrelated causes arise after corrective actions have been taken. This may explain the recurrence of transgressions over several years while the corrective action is considered adequate. If correct, this explanation would suggest that the water supplier is having difficulty with hazard identification as part of risk management.

A water safety plan should identify the need to determine the reasons for transgressions, and to take preventive action(s) or identify improvement(s) to address the problem. Three of the supplies in Table 3 do not have a safety plan that is approved or implemented. Two have water safety plans that were only approved or implemented in the 2013-14 year. All of the other five zones have had approved and implemented water safety plans over all four years, yet transgressions still occur.

An examination of the role leniency plays in the interpretation of the adequacy of corrective actions may prove an interesting subject of investigation in a future study.

3.2.3 Non-achievement because of inadequate monitoring

Of the 10 'high transgression zones', only one was adequately monitored for the full four-year period. Six were inadequately monitored in two or three years. In the remaining three zones, inadequate monitoring occurred in one of the four years of interest. With the exception of Kawerau, which required 64 samples to be taken, 52 samples were required from all of the 10 zones.

Given the poor level of monitoring in the majority of the 'high transgression zones' it is possible that the number of transgressions recorded for some zones was not an accurate reflection of the water quality. This is a concern for all zones in which inadequate monitoring was the result of too few samples being taken.

For the majority of zones, relatively minor technical factors were the reasons for inadequate monitoring. The number of samples taken in almost all zones was close to the number required by the Standards. This suggests that inadequate monitoring in these zones resulted from a lack of care in meeting the detailed requirements of the Standards. This is in contrast to the inadequate monitoring in the zones of Hororata and 'Motunau'¹³. In these zones, during the 2010-11 and 2011-12 years, between 23 and 37% of the required samples were taken. This level of monitoring seems too low to have been an oversight in the sampling schedule, and may reflect a decision to take fewer samples.

Monitoring was better in the 16 'moderate transgression zones' (Table 4). Half of these zones were adequately monitored for the full four-year period.

3.3 OUTLOOK FOR *E. COLI* ACHIEVEMENT

Table 7 draws together achievement information about the 'high transgression zones'. It identifies the main reasons for non-achievement, the actions taken to try to reduce the likelihood of transgressions and what these actions may mean for future *E. coli* achievement. The purpose of the table is to help with assessing the progress being made to improve achievement in these zones.

Eight of the 10 zones have taken or are planning steps to reduce the likelihood of detecting *E. coli*. In half, UV disinfection is planned, but not implemented. In the two zones in which

¹³ Zone names containing the names of several communities, eg. Motunau/Greta/Scargill, are abbreviated in the report and placed within single quotation marks.

investigation is recorded as a corrective action, UV treatment is already in place (although it may not be meeting the requirements of the Standards), but transgressions are still occurring.

The installation of an efficacious disinfection process to ensure the quality of the water **entering** the distribution zone is a key step to the improvement of the performance of these zones. However, this step alone may be insufficient if pathways for contaminant ingress exist in the zone.

Table 7 notes that in addition to transgressions, some of the zones have experienced problems in meeting monitoring requirements. To improve the achievement status of these zones, the water supplier needs to ensure the monitoring, as well as water quality, meets the requirements of the Standards.

Table 7 Summary of corrective actions and the likely effect on *E. coli* non-achievement in the zone

Zone Name	Zone code	Reason for non-achievement		Actions taken that will reduce the likelihood of continuing non-achievement	Outlook
		Transgressions	Inadequate monitoring ¹		
Kawerau	KAW003KA	Y		Investigation of transgressions	Sources of contamination found, but transgressions continue. The supplier is avoiding the introduction of chlorination. Continued non-achievement.
Martinborough	MAR003MA	Y		Investigation of transgressions	Transgressions still occur. Continued non-achievement.
Reefton	REE001RE	Y		New UV unit (2012-13) and ceramic filters installed	Old reticulation still a potential cause of transgressions. Supply operated on very limited budget. Intermittent non-achievement likely.
Darfield	DAR001DA	Y	Y	New secure source 2012	New source reduces the likelihood of contamination arising from the source, but the leaky reticulation still presents a possible pathway for contaminant ingress. Intermittent non-achievement.
Hororata	SEL001HO	Y	Y	New UV unit with filtration planned Presently chlorinated	Likely to improve water quality provided filtration achieves adequate turbidity reduction. Continued non-achievement until the upgrade is operational.
Kirwee	KIR001KI	Y	Y	Reservoir replaced New UV unit planned	Old reservoir may have been connected with earlier transgressions. Continued non-achievement until the upgrade is operational.
Malvern Hills, Hartleys Rd	MAL001MA	Y		New UV unit planned	Continued non-achievement until the upgrade is operational.
Motunau, Greta, Scargill	MOT016MO	Y	Y	MIOX unit (2013-14)	Marked improvement, but continuing problems with chlorine dose control. Continued non-achievement until a satisfactory residual can be maintained.
Sheffield/Waddington	SHE004SH	Y	Y	New UV unit with filtration planned	Continued non-achievement until the upgrade is operational.
Twizel	TWI001TW	Y	Y	Presently chlorinated (2012-13). Plant upgrade planned.	Chlorination should be reducing the likelihood of non-achievement. Ability to achieve the Standards should be improved with the upgrade.

¹ Inadequate monitoring in two or more years

3.4 PUBLIC HEALTH SIGNIFICANCE

While this report is primarily concerned with understanding why non-achievement occurs and what is being done to improve the performance of non-achieving supplies, the ultimate reason for ensuring supplies achieve the Standards is the protection of public health. This section tries to assess the public health significance of the failures of the 'transgressing group' to meet the *E. coli* requirements of the Standards.

Non-achievement of the Standards does not necessarily imply a threat to public health. Failure on minor technical grounds associated with monitoring does not equate to a public health risk. In general, any public health risk associated with inadequate monitoring is inconsequential. However, there is an indirect public health risk associated with inadequate monitoring when it compromises awareness of a contamination event for which corrective action is needed.

The risk associated with zones in which *E. coli* is detected is difficult to assess. *E. coli* itself (unless it is a pathogenic strain) is not harmful, but its presence in water indicates the water has been in contact with faecal matter, and may contain pathogens. Consequently, a transgression indicates a potential risk to health.

There is generally no relationship between the concentration of *E. coli* in water and the concentration of pathogens. Nevertheless, it is reasonable to assume that higher concentrations of *E. coli* present in a transgressing sample, indicate an increased likelihood of pathogens being present. The more frequently transgressions occur in a zone, the greater the microbiological risk to the consumer. Consequently, as a first approximation, the 'high transgression zones' represent a greater risk to the health of their residents than the 'moderate transgression zones' because of the greater number of years in which transgressions have led to non-achievement of the Standards.

Table 6, which expresses the number of transgressions as a percentage of the number of samples taken over the four year period for the 'high transgression zones' could be used as a crude indicator of the typical relative public health risk posed by these zones over the four years.

On the basis of the data in Table 6, the residents of the 'Motunau' zone could be regarded as being at the greatest potential risk of infection by pathogens, those in Darfield, Kawerau and Hororata at the least risk and those in Twizel, Martinborough and Reefton are at some intermediate level of risk. A shortcoming of this approach to qualitatively ranking the risk is that no account is taken of the amount of contamination that entered the zone with each transgression.

3.5 CONCLUSIONS

- a. The main reason for non-achievement of the *E. coli* requirements of the Standards in the 26 zones in the 'transgressing group' was too many transgressions occurring.
- b. Despite repeated failures because of an excessive number of transgressions, corrective actions to address the transgressions were in the great majority of cases considered adequate. While immediate actions to protect public health are important, little consideration appears to be given to the need to identify and remedy the cause of a transgression to avoid it happening again. A review of what constitutes adequate corrective action may be helpful.
- c. Transient, low-level (low *E. coli* concentration) transgressions are not uncommon in many zones. In the main, these do not appear to be false positive results. It is reported that water suppliers are prone to attribute them to sampling error. *E. coli* monitoring loses its value as a management tool if results are readily dismissed for

this reason. Actions, such as sampler training, are needed to make 'sampling error' a much less justifiable reason for dismissing test results. A disinfecting residual appears likely to provide a means of reducing the frequency of this type of transgression.

- d. The selection of UV disinfection when introducing or upgrading disinfection, is likely to be only a partial solution to non-achievement unless it is accompanied by filtration (where necessary) to keep turbidity at acceptable levels and chlorination to provide a disinfecting residual in the zone itself.
- e. Some recently commissioned treatment upgrades are experiencing, what are hoped to be, teething troubles. Other supplies are still only at the planning stages of treatment upgrades. As a result, improvements in levels of *E. coli* achievement cannot be expected in the immediate future.
- f. Corrective actions will only bring about improved levels of achievement (when implemented), if capital expenditure is appropriately matched with operational resources, such as staffing levels and staff training.

[Intentionally Blank]

4. CHEMICAL NON-ACHIEVEMENT

KEY FINDINGS OF THE SECTION

- 18 of the 35 zones that failed to achieve the chemical requirements of the Standards in 2013-14 also failed in at least two of the preceding three years.
- In the 18 zones, the primary cause of non-achievement of the chemical requirements of the Standards in 65% of cases was an excessive number of transgressions. Inadequate monitoring alone was the cause in 35% of cases.
- 77% of failures to achieve the chemical Standards because of transgressions were not followed by corrective actions that were considered satisfactory. The expense of, and time taken to implement, corrective actions for chemical transgressions most likely contribute to this figure.
- In five zones, no monitoring was undertaken over the last three years. This appears to be a policy decision by the water suppliers. In two of these zones, a brief monitoring programme for heavy metals, if it were undertaken, could remove the need to carry out any further monitoring.
- Of the 18 zones, two have commissioned new plants, and the treatment plant of a third zone is in the redesign stage.
- Apart from the three zones for which action has been taken to improve treatment, and two zones where a search is being made for a new source, no corrective actions have been taken to increase the likelihood of achieving the Standards, so that non-achievement for these zones is expected to continue.

4.1 INTRODUCTION

This section presents and discusses summary information about the non-achievement of the Standards with respect to chemical determinands. Detailed chemical achievement data are provided in APPENDIX B:. The appendix contains data collected through the annual surveys only. DWAs were not approached for additional comment with regard to chemical determinands.

It has been the Ministry of Health's policy to assign Priority 2 determinands only to zones serving more than 500 people. However, there is a small number of zones with fewer people to which Priority 2 determinands are assigned. They are included in this assessment.

4.2 FINDINGS AND DISCUSSION

4.2.1 Overview of non-achievement for chemical determinands

During the 2013-14 year, 35 zones in the primary dataset, failed to achieve the chemical requirements of the Standards. Eighteen of these zones (Table 8) failed in either all years (12 zones, see Table 9), or 2013-14 and two other years (6 zones, see Table 10). For brevity, this group of 18 is referred to as the '**high failure¹⁴ zones**'.

¹⁴ High failure refers to the number of years in which they have failed, rather than the extent to which the determinand concentration has exceeded to the MAV.

Table 8 Reasons for non-achievement of the chemical requirements of the Standards in zones with three or four failed years.

The unshaded entries are zones that failed in four years.

Zone Code	Zone Name	Determinand	Number of years failed primarily because of transgressions	Number of years failed solely because of inadequate monitoring
RAN007ED	Edgecumbe	Arsenic	4	
RAN007TH	Thornton	Arsenic	4	
ACA001AC	Acacia Bay	Arsenic	4	
MOT002MO	Motuoapa	Arsenic	4	
OMO001OM	Omori / Kuratau / Pukawa	Arsenic	4	
TEK002TE	Te Karaka	Manganese	4	
SED001SE	Seddon, Awatere Valley	Heavy metals		4
AKA001AY	Aylmers	DBPs	4	
TWI001TW	Twizel	Heavy metals		4
GLE001GK	Glenkenich Rural	DBPs		4
MIL001MT	Milton	DBPs	1	3
NOR003NB	North Bruce Rural	DBPs		4
KAR001KA	Karangahake	Arsenic	3	
RAN007TE	Te Teko	Arsenic	1	2
MAR001MA	Marion Township	DBPs	2	1
SHA001SH	Shannon	DBPs	3	
TOK002TO	Tokomaru	DBPs	3	
FEA001FE	Featherston	DBPs	2	1
Totals ¹			43 (64%)	24 (36%)

¹ Percentages are the percentage of non-achievements, ie, 67 (43 + 24).

Table 8 shows that an excessive number of transgressions was the primary reason for most (64%, 43/67) of the annual failures to meet the chemical Standards in the 'high failure zones'. Inadequate monitoring was the sole reason for non-achievement of the Standards in 36% (24/67) of cases, a substantially larger fraction than was the case for *E. coli* achievement. Data in APPENDIX B: show that in years when the chemical Standards were not achieved because of transgressions, corrective actions to address the transgressions were considered inadequate in 77% (33/43) of annual failures.

The determinands represented in the 'high failure zones' fall into one of four groups: heavy metals, disinfection by-products, arsenic and manganese. These determinands were assigned as Priority 2 determinands in more than one zone, except for manganese.

Table 9 Achievement data for zones that failed chemically in four years

HA	TA	ZCode	Zone Name	Surv Pop	Size	Chem Ach	2013-14	2012-13	2011-12	2010-11	No WSP
PacificWha	WhakatanDC	RAN007ED	Edgecumbe	1680	Minor	1111	As_xT	As_xT	As_xT	As_xT Cu_ok Ni_ok Pb_ok Sb_ok	0000
PacificWha	WhakatanDC	RAN007TH	Thornton	3194	Minor	1111	As_xT	As_xT	As_xT	As_xT Ni_ok Pb_ok Sb_ok	1111
PacificRot	TaupoDC	ACA001AC	Acacia Bay	1512	Minor	1111	As_xT	As_xT	As_xT	As_xT	0000
PacificRot	TaupoDC	MOT002MO	Motuoapa	739	Minor	1111	As_xT	As_xT	As_xT	As_xT	0000
PacificRot	TaupoDC	OMO001OM	Omori / Kuratau / Pukawa	1783	Minor	1111	As_xT	As_xT	As_xT	As_xT	0000
TairawhDH	GisborneDC	TEK002TE	Te Karaka	491	Small	1111	Mn_xT	Mn_xT	Mn_xT	Mn_xT	0000
NeIMDHBBle	MarlbDC	SED001SE	Seddon, Awatere Valley	1000	Minor	1111	Ni_x Pb_x	Ni_x Pb_x	Ni_x Pb_x	Ni_x Pb_x	0000
CPHChch	ChristchCC	AKA001AY	Aylmers	900	Minor	1111	CIO3_ok MAVHAA_xT MAVTHM_ok	CIO3_x MAVHAA_xT MAVTHM_ok	CIO3_ok MAVHAA_xT MAVTHM_ok	CIO3_x MAVHAA_xT MAVTHM_x	0000
CPHTimaru	MackenzDC	TWI001TW	Twizel	1300	Minor	1111	Cu_x Pb_x	Cu_x Pb_x	Cu_x Pb_x	Cu_x Pb_x	0111
PHStHDun	CluthDC	GLE001GK	Glenkenich Rural	705	Minor	1111	DCA_x MAVHAA_x TCA_x	DCA_x MAVHAA_x TCA_x	DCA_x MAVHAA_x TCA_x	DCA_x MAVHAA_x TCA_x	0000

HA	TA	ZCode	Zone Name	Surv Pop	Size	Chem Ach	2013-14	2012-13	2011-12	2010-11	No WSP
PHStuDun	CluthDC	MIL001MT	Milton	1929	Minor	1111	F_ok MAVHAA_x	F_ok MAVHAA_x	F_ok MAVHAA_x	MAVHAA_xT	0001
PHStuDun	CluthDC	NOR003NB	North Bruce Rural	658	Minor	1111	DCA_x MAVHAA_x TCA_x	DCA_x MAVHAA_x TCA_x	DCA_x MAVHAA_x TCA_x	DCA_x MAVHAA_x TCA_x	1000

HA	Health Authority
TA	Territorial authority
ZCode	Zone code
Surv Pop	Zone's population recorded in the 2013-14 annual survey
Size	Zone size as defined in the Act
Chem Ach	Binary representation of non-achievement information (see Method section)
No WSP	Binary representation of water safety plan status for each year (see Method section)

As – arsenic; CHBCl2 – bromodichloromethane; ClO3 – chlorate; Cu – copper; DCA – dichloroacetic acid; F – fluoride; MAVHAA – MAV sum ratio of haloacetic acids; MAVTHM – MAV sum ratio of trihalomethanes; Ni – nickel; Pb – lead; Sb – antimony; TCA – trichloroacetic acid.

'ok' following a determinand denotes achievement of the chemical requirements of the Standards for that determinand.

'x' following a determinand denotes failure to achievement the chemical requirements of the Standards for that determinand.

'T' following a determinand denotes an excessive number of transgressions for that determinand.

Table 10 Achievement data for zones that failed chemically in three years including 2013-14

HA	TA	ZCode	Zone Name	Surv Pop	Size	Chem Score	2013-14	2012-13	2011-12	2010-11	No WSP
WaikatoDHB	HaurakiDC	KAR001KA	Karangahake	147	Small	1110	As_xT	As_xT	As_xT	As_ok	0000
PacificWha	WhakatanDC	RAN007TE	Te Teko	686	Minor	1110	As_x	As_x	As_xT	As_ok Cd_ok Cu_ok Pb_ok	1111
MidCHthWan	RagitikDC	MAR001MA	Marton Township	3750	Minor	1110	CHBCI2_ok MAVTHM_xT	CHBCI2_x MAVTHM_x	CHBCI2_ok MAVTHM_xT	CHBCI2_ok MAVTHM_ok	1111
MidCHthPN	HorowhDC	SHA001SH	Shannon	1436	Minor	1110	DCA_xT MAVHAA_xT TCA_ok	DCA_xT MAVHAA_xT TCA_ok	DCA_xT MAVHAA_xT TCA_ok	DCA_ok MAVHAA_ok TCA_ok	1000
MidCHthPN	HorowhDC	TOK002TO	Tokomaru	550	Minor	1110	DCA_ok MAVHAA_xT TCA_ok	DCA_xT MAVHAA_xT TCA_ok	Cd_ok DCA_ok MAVHAA_xT Ni_ok Pb_ok TCA_ok	Cd_ok DCA_ok MAVHAA_ok Ni_ok Pb_ok TCA_ok	0000
WairarapaH	SWairarDC	FEA001FE	Featherston	2580	Minor	1101	MAVHAA_xT	MAVHAA_xT	MAVHAA_ok	MAVHAA_x	0000

HA Health Authority
 TA Territorial authority
 ZCode Zone code
 Surv Pop Zone's population recorded in the 2013-14 annual survey
 Size Zone size as defined in the Act
 Chem Score Binary representation of non-achievement information (see Method section)
 No WSP Binary representation of water safety plan status for each year (see Method section)

As – arsenic; CHBCI2 – bromodichloromethane; ClO3 – chlorate; Cu – copper; DCA – dichloroacetic acid; F – fluoride; MAVHAA – MAV sum ratio of haloacetic acids; MAVTHM – MAV sum ratio of trihalomethanes; Ni – nickel; Pb – lead; Sb – antimony; TCA – trichloroacetic acid.

'ok' following a determinand denotes achievement of the chemical requirements of the Standards for that determinand.

'x' following a determinand denotes failure to achievement the chemical requirements of the Standards for that determinand.

'T' following a determinand denotes an excessive number of transgressions for that determinand.

4.2.2 Non-achievement because of transgressions

This section discusses the transgressions recorded for the 18 'high failure zones', that is, those that failed in meeting the chemical requirements of the Standards in 2013-14 and at least two of the three preceding years.

The bottom row of Table 8 shows that over half of the instances of chemical non-achievement in the 'high failure zones' resulted from transgressions. Arsenic was the determinand being monitored in 39% (7/18) of zones and of these, failure resulted primarily from too many transgressions in 71% (5/7) of zones. In the one zone to which manganese was assigned, an excessive number of transgressions caused failure in all four years.

Eight of the 18 zones (44%) should have been monitored for disinfection by-products in all four years, although only five were. In the monitored zones, only one zone failed because of disinfection by-product transgressions in all four years.

Non-achievement for heavy metals (two zones) resulted from inadequate monitoring in all four years, not transgressions.

Data in APPENDIX B: show that the percentage of monitoring samples that transgressed the MAV ranges from 28% to 80%¹⁵. This is in marked contrast to the sampling data for *E. coli* (APPENDIX A:). For nine of the 10 zones in APPENDIX A: the percentage of samples with transgressions ranges from 1% to 5%. The percentage in the tenth zone, in which few samples were collected in the first two years, was 29%.

Water suppliers are required to monitor Priority 2 determinands because test results have shown that these determinands exceed 50% of their MAV at times, and consequently that they pose a potential risk to health. A chemical determinand can be present in the water in the zone of a supply because it is present in the source water, is produced or introduced during treatment or is derived from the zone's construction materials. These routes of introduction should result in the determinand being present in the zone all, or almost all, of the time, albeit at fluctuating concentrations. The magnitude of the fluctuations will depend on the determinand (eg, disinfection by-products may vary considerably in concentration). Nevertheless, if the typical determinand concentration is near or exceeds the MAV, it is likely that a high percentage of samples will show transgressions of the MAV.

The situation is different for *E. coli*. This indicator bacterium may be found in monitoring samples because it was present in the raw water and passed through treatment barriers, or it entered because of a failure in a post treatment barrier. Both of these entry paths are prone to much greater variability than those by which chemical determinands may enter the supply. For a high percentage of transgressing *E. coli* samples to be found, a source of faecal contamination **and** an ingress pathway from the source of the faecal matter need to be present most of the time. As the conditions necessary for the detection of *E. coli* may be met only intermittently, the percentage of monitoring samples showing transgressions is often correspondingly low.

Identifying the reasons for chemical transgressions is more straightforward than identifying the reasons for *E. coli* transgressions. The zones in which arsenic transgressions occur have no treatment that can remove the arsenic. Consequently, its presence in the zone at concentrations exceeding its MAV is simply a result of its natural occurrence in the source. There is no need to undertake an investigation to identify the reason for a transgression. Disinfection by-product transgressions result from the quality of the raw water, the treatment processes and possibility the inability of the operators to optimise precursor removal if the treatment processes are capable of removing precursors. Following a transgression the

¹⁵ For determinands that transgressed any time during the four years

water supplier may check to see whether the available treatment processes are optimised, but there is nothing that can readily be done about the raw water quality.

Nothing can be said about the heavy metals transgressions, as the zones that still have heavy metals assigned as Priority 2 determinands have not been monitored. Some of the 'high failure zones' had corrosion metals assigned to them in the 2010-11 year, but monitoring showed these could be reclassified as Priority 3 determinands.

Corrective actions

The corrective actions being taken in individual water supplies to address transgressions are identified in Section 4.3 and APPENDIX B:. The discussion here consists of general observations.

Corrective actions to address non-achievement of the chemical standards can present difficulties for a water supplier. This is borne out by the fact that when a zone has failed because of too many transgressions the corrective actions taken were considered inadequate in 77% of cases (Section 4.2.1).

The concentrations of both arsenic and disinfection by-products, the determinands leading to the majority of failures because of transgressions, cannot generally be reduced by simple, inexpensive treatment.

Arsenic can be removed by conventional treatment provided the arsenic in the water is of a suitable form. Water supplies that do not have this type of treatment, or another treatment process targeted at arsenic removal, face the expense of a treatment plant upgrade or searching for, and developing, a new low-arsenic source.

The precursors to the formation of disinfection by-products are naturally-occurring substances, but their concentration in the source water, and consequently the levels of by-products formed, can be variable. Water suppliers already disinfecting their water cannot dispense with disinfection. As a result, if a new, low-precursor source cannot be found, the only effective corrective action is to remove the precursors from the existing source water before disinfection.

Where the treatment processes in use are capable of reducing the precursor concentration, 'tuning' of the process to optimise it may be needed. To do this the water supplier has to be able to afford advice, the up-skilling of operators and possibly new monitoring instrumentation. Where a suitable treatment process for precursor removal is not already in place, a plant upgrade is required. Whichever situation exists, effective mitigation is expensive.

For chemical determinands the possibility of corrective action that immediately protects public health, as a boil water notice does for microbial contamination, does not generally exist. Taking corrective action for chemical transgressions occurs over a much longer period, involving planning, budgeting and eventual implementation. The high percentage of corrective actions considered unsatisfactory may reflect an expectation on the part of the DWA for an action to provide immediate protection to the public. Alternatively, it may result from the water supplier not showing any signs of embarking on the corrective action process within a reasonable time.

Although a long period may be required for implementing a corrective action for a chemical determinand, the delay is not as great a public health concern as it is for delays in addressing microbial contamination. The MAVs for chemical determinands are set to provide protection against adverse health effects over a lifetime of exposure.

4.2.3 Non-achievement because of inadequate monitoring

Inadequate monitoring can compromise a water supplier's ability to make an informed decision about the need for corrective action. It also prevents assessment of the public health risk a chemical determinand in a water supply poses.

Inadequate monitoring led to 35% of the cases of non-achievement of the chemical Standards (see Table 8, Section 4.2.2). In addition, over the four year period, the monitoring in 11 of the 18 'high failure zones' was inadequate during at least one year when transgressions were the primary reason for failure (see individual zone records in APPENDIX B:). Accordingly, even if there had not been any transgressions, the zones would still have failed because of poor monitoring. Both of these statistics indicate that as well as taking action to avoid chemical transgressions, water suppliers need to ensure they have established, and are adhering to, a sampling schedule that meets the requirements of the Standards.

Information in APPENDIX B: also shows that monitoring was inadequate for five zones ('Seddon', Twizel, Glenkenich Rural, Milton, North Bruce Rural) because **no** samples were taken for three or more of the four years. This is a different situation from that where inadequate monitoring might be considered unintentional because slightly too few samples were taken, or there was a minor technical shortcoming. No monitoring infers a clear policy decision by the water supplier.

For small supplies or territorial authorities with scarce resources, a policy decision not to sample for determinands that are expensive to test for, such as disinfection by-products, is understandable. They may have already collected data to show that transgressions are an ongoing problem, which they can do nothing about without major expense. If they conclude that further monitoring is not telling them anything more than they already know, they may consider that money spent on monitoring could be better used in trying to provide a solution to the problem. If this is the case, these zones will continue to fail.

The Act (s69H(1)(a)(ii)) allows for a water supplier's financial position to be taken into account in deciding whether all practicable steps have been taken to comply with the Standards. If this to be the rationale for not taking samples, the requirements of s69H(3) need to be met.

More difficult to understand is the situation of the two zones (Twizel and 'Seddon') that have been non-achieving for four years because no attempt has been made to monitor heavy metals. The heavy metals in these two zones are almost certainly corrosion-derived. Corrosion-derived metals are not classified as Priority 2 determinands and therefore do not need to be monitored. A very brief monitoring programme (three monthly samples) could confirm that the metals are corrosion-derived, allowing the Priority 2 assignments to be removed from these zones. Further, the annual survey returns from both water suppliers show that consumers are being notified of the need to flush the tap before use. Therefore, the water suppliers are meeting their obligation to manage the health risk associated with corrosion-derived metals.

4.3 OUTLOOK FOR CHEMICAL ACHIEVEMENT

This section, in Table 11, draws together what is known about the actions taken to achieve the Standards in the 'high failure zones' and evaluates what this information indicates about likely future achievement of the Standards.

The instigation of satisfactory monitoring where there has been **none** before will remove inadequate monitoring as a hurdle to achieving the chemical requirements of the Standards. This will depend on persuading the operating territorial authorities to change what appears to be a 'no-sampling' policy. In zones where **some** monitoring was undertaken (but it was

inadequate) more care in sample scheduling should contribute to improved levels of chemical achievement. In both of these situations it is possible that improved monitoring may increase the likelihood of encountering transgressions.

The zones with known disinfection by-product transgressions but which have not taken corrective measures, will continue to fail chemically. The changes to treatment at Aylmers and Shannon offer the possibility of eliminating transgressing concentrations of disinfection by-products. However, depending on the nature of the treatment upgrade, the success of the upgrade may hinge on the knowledge and skills of the operators.

The zones with arsenic transgressions will continue to fail chemically, unless they can find a new source with low arsenic concentrations, or obtain funding for treatment capable of removing arsenic.

Monitoring for manganese at Te Karaka since the new treatment plant was commissioned has given encouraging results which show that the zone should achieve the Standards in future.

Table 11 Summary of corrective actions and the likely effect on chemical non-achievement in the zone

Zone Name	Zone code	Determinand	Primary reason for non-achievement		Actions taken that will reduce the likelihood of continuing non-achievement	Outlook
			Transgressions	Inadequate monitoring		
Edgecumbe	RAN007ED	Arsenic	Y		Search for new source	Unsuccessful to date, continued non-achievement in the short term
Thornton	RAN007TH	Arsenic	Y		Search for new source	Unsuccessful to date, continued non-achievement in the short term
Acacia Bay	ACA001AC	Arsenic	Y		None	Non-achievement
Motuoapa	MOT002MO	Arsenic	Y		None	Non-achievement
Omori/Kuratau/Pukawa	OMO001OM	Arsenic	Y		None	Non-achievement
Te Karaka	TEK002TE	Manganese	Y		New plant commissioned	Already evidence that this has improved water quality. Achievement expected.
Seddon, Awatere Valley	SED001SE	Corrosion metals		Y	None	P2 status could be removed by a brief monitoring programme. Non-achievement if the present approach continues.
Aylmers	AKA001AY	DBPs	Y		Plant redesign	Could result in achievement
Twizel	TWI001TW	Corrosion metals		Y		P2 status could be removed by a brief monitoring programme. Non-achievement if the present approach continues.
Glenkenich Rural	GLE001GK	DBPs		Y	None	Even if monitoring were improved, transgressions may still result in non-achievement
Milton	MIL001MT	DBPs		Y	None	
North Bruce Rural	NOR003NB	DBPs		Y	None	
Karangahake	KAR001KA	Arsenic	Y		None	Non-achievement
Te Teko	RAN007TE	Arsenic	Y		None	Non-achievement
Marton Township	MAR001MA	DBPs	Y		None	Non-achievement
Shannon	SHA001SH	DBPs	Y		New plant commissioned	Could result in achievement
Tokomaru	TOK002TO	DBPs	Y		None	Non-achievement
Featherston	FEA001FE	DBPs	Y		None	Corrective action stated to be satisfactory but actions unidentified, continued non-achievement

4.4 PUBLIC HEALTH SIGNIFICANCE

This section tries to assess the public health significance of the non-achievement of the chemical Standards by the 'high failure zones', based on the understanding of the reasons for non-achievement already discussed.

Non-achievement of the Standards does not necessarily imply a threat to public health. The best example of this is the failure to monitor heavy metals. The non-achievement of the Standards by the two supplies in which heavy metals were not monitored, while making the national statistics look worse than they could be, does not constitute a risk to the health of those on the supply. Both supplies provide advice to flush taps before the water is used, as required by the Standards, and therefore are managing the risk to health from corrosion metals.

The situation is different for the zones that did **not** monitor disinfection by-products. Disinfection by-products were assigned to these zones because by-products had been previously found in them at a concentration exceeding 50% of the MAV by The Priority 2 Chemical Determinands Identification Programme¹⁶. Apart from these initial data, and the results from three samples collected in 2010-11, which showed a transgression in one of these zones, there are no other data on which to base an assessment of the health significance of disinfection by-products in these zones.

For the zones in which disinfection by-products have been monitored the maximum concentrations measured and frequency of transgression provide a very approximate guide to the relative level of health risk. APPENDIX B: shows that Aymers and Shannon have recorded the highest disinfection by-product concentrations and that transgressions occur the most frequently in these zones, indicating that disinfection by-products present the greatest risk in these zones. This risk should be reduced in future as both supplies are designing or have commissioned treatment plant upgrades. The frequency of transgressions and maximum recorded concentrations are lowest for the Featherston and Marton zones.

The high levels of manganese at Te Karaka are now being reduced to safe levels by new treatment, so that the health risk associated with this determinand in this zone will be reduced to an acceptable level.

Of the chemical determinands, arsenic represents the greatest public health concern. Unlike disinfection by-products which may fluctuate markedly in concentration with source water conditions, the concentration of arsenic in the water is relatively stable. For some of these supplies, the arsenic concentration constantly exceeds the MAV. The health risk is compounded by the fact that the cancer risk associated with an arsenic concentration equal to the MAV is 1 in approximately 1700, rather than the risk for most other carcinogens of 1 in 100,000.

4.5 CONCLUSIONS

- a. Failure of zones to achieve the chemical requirements of the Standards results from too many transgressions and inadequate monitoring. Failures arising from transgressions make up the greatest percentage of failures, but inadequate monitoring, particularly the total lack of sampling, make up a much larger portion of

¹⁶ A programme funded by the Ministry of Health and undertaken jointly by ESR and health protection officers from 1995 to 2004. Its purpose was to identify Priority 2 determinands in water supplies serving more than 100 people.

failures than was the case for *E. coli*. This may be because water suppliers see no benefit from continued sampling, which will only tell them what they already know.

- b. Corrective actions taken were considered inadequate in the majority of cases (77%) where non-achievement resulted from too many transgressions. The reasons for this have not been identified, but are probably linked, in part, to c below.
- c. Effective corrective actions for addressing transgressions by chemical determinands present water suppliers with a difficult problem because they cannot generally be implemented immediately and they are generally expensive.
- d. To overcome transgressions by a chemical determinand, the water supplier has one of three options: find and develop another source water, upgrade the treatment plant or improve the efficacy of the existing treatment. The water supplier's ability to fund any of these activities determines their ability to improve the level of achievement of their water supply.
- e. Few of the 'high failure zones' examined in this study have implemented or are planning to take corrective actions that can be expected to address their problem of chemical transgressions. Consequently, little improvement in the levels of chemical achievement by these zones can be expected in the near and medium future.

[Intentionally Blank]

5. IMPROVING ACHIEVEMENT OF THE STANDARDS

From consideration of the information contained in Sections 3 and 4, steps can be identified that could improve overall levels of achievement of the Standards.

The datasets examined in this work are subsets of the set of zones that have not achieved the Standards over the four years due to transgression and there may be reasons for non-achievement, not identified here, that become evident through study of the larger dataset.

Some of the steps identified below are specific to zones included in this study, others are more generally applicable.

Steps for improving the national levels of achievement of the Standards

- a. Encourage all water supplies that do not presently maintain a permanent chlorine residual to take steps to do this. Many of the water supplies that fail because of microbiological transgressions have, or plan to install, UV radiation as the only disinfectant. Properly operating UV disinfection should ensure water of satisfactory quality leaving the treatment plant. However, UV disinfection does not provide protection against the entry of low level contamination post-treatment. A chlorine residual will not necessarily eliminate all transgressions, but it should reduce the likelihood of the transient low-level transgressions occurring.
- b. Ensure that when treatment plant upgrades are being planned, appropriate filtration is incorporated before the disinfection unit, especially if changes in weather conditions can lead to increases in raw water turbidity.
- c. Ask public health units to assist water suppliers/operators who may be struggling with investigating *E. coli* transgressions.
- d. Ask DWAs to ensure that water suppliers treat transgressions as a real contamination event even if there is a suspicion of sampling error. If there is evidence of a likely sampling error, it would be helpful for the DWA to determine what level of training sampling personnel have had. The sampling locations used and the sampler's sampling protocol should also be checked. This information can then be used to determine whether sampler training is necessary.
- e. Ensure water safety plans include a requirement to investigate the cause of transgressions and that measures to address the causes are implemented.
- f. Encourage zones that are still required to monitor heavy metals, to complete their monitoring to confirm that the metals are corrosion-derived and so allow them to be reclassified as Priority 3. Their monitoring may then cease.

[Intentionally Blank]

6. OVERALL CONCLUSIONS

The conclusions below are based on the datasets reviewed in preparing this report. Further work in reviewing the full dataset produced by the Survey may provide further insights into the reasons for non-achievement of the Standards and how levels of achievement might be improved.

- a. Too many transgressions during a reporting year is the prime cause of the non-achievement of the Standards by both *E. coli* and chemical determinands. As a transgression shows the presence of a determinand at a concentration considered unsafe, non-achievement for this reason indicates a possible risk to health. The magnitude of this risk depends on the determinand, its concentration and the duration of its presence at this concentration in the zone.
- b. Levels of achievement for *E. coli* and chemical determinands are unlikely to improve greatly in the near future, given the corrective actions taken to date. However, as planned treatment upgrades to improve the bacterial quality of supplies come into operation, some improvement in levels of *E. coli* achievement can be expected. The greatest improvement will probably require the introduction of a chlorine residual, which does not appear in some plans at present. Little improvement in chemical achievement can be expected in the near future as few of the supplies with chemical transgressions are taking corrective actions.
- c. A water supplier's ability to afford the necessary corrective actions will determine the extent to, and rate at, which levels of achievement will improve. How much other factors, such as motivation, may also affect achievement levels is not determined by this study.
- d. The relatively inexpensive measure of introducing a residual disinfectant into zones that presently contain no residual seems likely to be an important measure for improving levels of achievement, based on the reasons for transgressions occurring that are identified in this work. However, implementation of this measure will require public health risk education of the affected communities for which an unchlorinated supply is important.
- e. Some water suppliers appear to have made a policy decision not to monitor their Priority 2 chemical determinands. This may be because they see no value in spending scarce resources on monitoring when previous test results already show there is a problem with the chemical quality of the water. This reason for non-achievement is likely to continue until the suppliers can be convinced of the benefit of monitoring.

[Intentionally Blank]

APPENDICES

[Intentionally Blank]

APPENDIX A: *E. COLI* ACHIEVEMENT DETAILS

INTRODUCTION

The following sub-sections each contain a table with details from the returns for the four annual surveys included in this study and a summary of additional comments provided by DWAs. The zones included here are ‘high transgression zones’, that is, zones that failed because of too many transgressions in 2013-14 and in at least two of the three preceding years.

The zones are listed in order of geographical location of the operating council running approximately from north to south.

A.1 KAWERAU (KAW003KA)

Medium zone, 5390 people, Kawerau DC, Pacific Health (Whakatane)

Question	Details																														
Requirement	64 <i>E. coli</i> samples																														
Failure Details	Failed <i>E. coli</i> at the treatment plant all years. Failed protozoa all years.																														
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Achievement</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>1</td> <td>68</td> <td>yes</td> <td>yes</td> <td>no</td> </tr> <tr> <td>Year 3</td> <td>2</td> <td>68</td> <td>yes</td> <td>yes</td> <td>no</td> </tr> <tr> <td>Year 2</td> <td>1</td> <td>65</td> <td>yes</td> <td>yes</td> <td>no</td> </tr> <tr> <td>Year 1</td> <td>0</td> <td>66</td> <td>yes</td> <td>yes</td> <td></td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Achievement	Year 4	1	68	yes	yes	no	Year 3	2	68	yes	yes	no	Year 2	1	65	yes	yes	no	Year 1	0	66	yes	yes	
	Trans	Samples	Monit	Corr Action	Achievement																										
Year 4	1	68	yes	yes	no																										
Year 3	2	68	yes	yes	no																										
Year 2	1	65	yes	yes	no																										
Year 1	0	66	yes	yes																											
WSP ¹⁷ Status	“Redrafting” for most years and ‘Submitted’ for Year 3																														
Survey DWA comments	2013/14 “Kawerau V3 submitted but not approved. Currently re-drafting.” 2012/13 “In report subset. Health Warning issued over transgressions. PHRMP submitted and declined due to nine NC ¹⁸ s” and “In report subset. Leaking reservoir caused NC. Repairs implemented.”																														
Leniency	Not granted for any year																														

One of the Kawerau zones, (KAW003KA), supplying almost 5,500 people, has reported many transgressions for the last three years. A UV treatment plant was installed in 2008 at which time the council was told that recontamination following treatment could happen. The council believes that the community does not wish to have its water chlorinated. Consequently, the supply is operated without a disinfecting residual whenever possible (eg once corrective action by chlorination has been shown to be effective). The DWA believes that the council is not adequately informing consumers when contamination is detected in the supply, and consequently the consumers are unable to make an informed decision about the value of a chlorinated supply.

¹⁷ Water safety plan

¹⁸ Non-compliance

The DWA reports that the transgressions tend to be seasonal in nature, occurring most often during January and February. In 2009, the water supplier concluded that the cause of the recurring problem with *E. coli* contamination of the zone was tree-roots breaking through asbestos cement pipes. However, *E. coli* were also being detected in the smaller Kawerau Upper Valley Road zone (KAW003UV) at the same time indicating that contamination was likely to be coming from parts of the system common to both zones. The DWA visited the supply and found that the reservoir roofs had not been inspected. Subsequent inspection found significant gaps in the reservoir roof sealing. The pipes draining the roof were also found to discharge over the air vents. The DWA concluded that it was highly likely that contaminated water was entering the reservoir. Immediate steps were taken to seal holes in the reservoir roof sealing but repairs to the roof drainage were not made until further transgressions occurred the following year.

The DWA has the following observations about the transgressions being experienced at Kawerau:

- The council has no backflow protection policy or a pipe repair standard operating procedure. The development and implementation of these was recommended in 2010.
- In several instances, after *E. coli* was detected, chlorination of the system was undertaken as a corrective action. However, once subsequent samples showed the corrective action to be successful in eliminating the indicator organisms, the chlorination was turned off. This eventually resulted in further transgressions. In one instance, transgressions occurred again within two weeks.
- There have been several instances in which the reason for the presence of *E. coli* in samples was not found. *E. coli* was absent in three corrective action samples after the initial transgression, but the cause of the transgression was not identified and the system was not chlorinated.
- The council found that a mains break was the reason for a transgression in one instance (21 *E. coli*/100ml) but the DWA was not made aware of the *E. coli* concentration found.
- On another occasion the water supply was chlorinated after a period of continued low level contamination. Eventually, three check samples were taken and found to be clear. The council asked whether the chlorine could be turned off, and was advised against this by the DWA and medical officer of health, because the cause of the transgression had not been identified. The council chose to turn off the chlorine.
- Although more recent than the 2013-14 year, samples in late 2014 and early 2015 showed random low level contamination, some in samples taken only 1m after the UV treatment unit. There were concerns that the ice used to chill the samples, may have contaminated the screw surfaces of the sample bottles. This is still being investigated.

The water safety plan for this supply is now in its fifth version and is still considered unacceptable by the DWA as it does not adequately prevent recontamination of the treated water and hence protect consumer health. The council sought external assistance to write version five.

A.2 MARTINBOROUGH (MAR003MA)

Minor zone, 1505 people, South Wairarapa DC, Wairarapa Health.

Question	Details				
Requirement	52 <i>E. coli</i> samples				
Failure Details	Failed for <i>E. coli</i> at the treatment plant Years 3 and 4. Failed protozoa all years.				
	Trans	Samples	Monit	Corr Action	Achievement
Year 4	10	107	no (interval)	yes	no
Year 3	1	55	yes	yes	no
Year 2	2	61	yes	yes	no
Year 1	0	52	yes	yes	
WSP Status	"Implemented" all years				
Survey DWA comments	2013/14 "Some of the transgressions are as a result of follow up sampling"				
Leniency	Not granted for any year				

The Martinborough water supply draws its water from a bore and a raw water reservoir.

In December 2012, a routine monitoring sample from a reservoir in the reticulation yielded a sample containing more than 2420 *E. coli*/100 ml. The sample was taken from a dedicated, covered sampling tap, there was no known problem with the sampling procedure, and the laboratory reported no problem with the analysis. Follow-up sampling found no detectable *E. coli* in subsequent samples, a sanitary survey showed nothing of concern and the UV disinfection unit was operating normally. Emergency chlorination procedures were checked and placed on stand-by but were not required. No reason for the extremely high *E. coli* concentration could be found and it was concluded that the result had been a laboratory error.

In October-November 2013 a routine monitoring sample taken from a reservoir in the reticulation was found to contain 3 *E. coli*/100 ml. Follow up sampling found *E. coli* was detectable on several occasions. A boil water notice was issued. The investigation concluded that back flow from an adjacent supply reservoir, connected to a series of rural properties, was the likely cause of the contamination. Corrective actions included: checking sampling location and sampling process; checking maintenance work in the reticulation; verifying the operation of the UV treatment; checking reservoir security; follow-up sampling; increasing the frequency of sampling to help establish the cause. The cause was not clearly identified.

A.3 REEFTON (REE001RE)

Minor zone, 951 people, Buller DC, Community and Public Health (West Coast)

Question	Details					
Requirement	52 <i>E. coli</i> samples					
Failure Details	Failed for <i>E. coli</i> at the treatment plant in Years 1 only. Failed protozoa all years, except Year 4.					
	Trans	Samples	Monit	Corr Action	Achievement	
Year 4	2	60	yes	yes	no	
Year 3	2	62	yes	yes	no	
Year 2	0	55	no	yes	no	
Year 1	8	56	yes	no	no	
WSP Status	"Approved" for the first three years; "Redrafting" Year 4.					
Survey DWA comments	2013/14 "Some of the transgressions are as a result of follow up sampling"					
Leniency	Granted Year 2 for interval					

Reefton draws its water from a bore close to the Inangahua River. Increases in turbidity accompanying heavy rain indicates the two are hydraulically linked. The supply has received Capital Assistance Programme funding to up-grade their treatment plant. This work was commissioned in the 2012-13 year. The plant now has Macrolite (a ceramic medium) filters and UV disinfection.

Since the treatment plant upgrade was commissioned there have been a series of problems with pressure and seals blowing because of poor design. The company selected to provide the plant up-grade offered the cheapest price and this may explain the problems with the poor design. Examination of the pipes between the filters and the UV system has revealed an accumulation of sludge showing that sediment is getting through, or by-passing, the filters.

The up-graded treatment provides water to an old reticulation system, which is where sampling shows the transgressions to be.

The DWA sees several factors contributing to this supply not achieving the requirements of the Standards.

- Occasional natural events, such as floods and possible bank erosion affecting the system, have added to the difficulty in maintaining satisfactory water quality.
- There has been capital investment in the supply (the plant upgrade), but there has not been the corresponding investment in the operation of the supply (and the council's other supplies); the council operates its infrastructure including water supplies on a very tight budget.
- The council has nine water supplies and they employ a service contractor with a relatively small staff to operate all of them. There may be difficulties in retaining staff. In some instances, there have been too few staff to attend to the supplies requiring attention during a heavy rain event. As well as too few operations staff, the DWA's opinion is that both the Buller District Council and contract staff need more training.

- The default corrective action is a boil water notice. Permanent boil water notices are in place in six of the nine supplies that are owned or managed by the district council on behalf of the communities. However most of these do now have an approved water safety plan, which is being implemented.

The DWA's summary comment is that although there are still occasional problems with water quality mainly in the distribution, the effort is being made to improve the situation and water quality is better than it was (eg, a covered post treatment reservoir and UV disinfection now contribute to improved water quality).

The Reefton water safety plan has just been up-dated to reflect changes in treatment and sent to the DWA for approval.

A.4 DARFIELD (DAR001DA)

Minor zone, 3288 people, Selwyn DC, Community and Public Health (Christchurch)

Question	Details				
Requirement	52 <i>E. coli</i> samples				
Failure Details	Failed for <i>E. coli</i> at the treatment plant in all years. Failed protozoa all years				
	Trans	Samples	Monit	Corr Action	Achievement
Year 4	1	52	yes	yes	no
Year 3	1	53	yes	yes	no
Year 2	1	43	no	yes	no
Year 1	0	42	no	yes	no
WSP Status	"Draft" for the first three years; "Approved" Year 4.				
Survey DWA comments	2013/14 "WSP just approved earlier this month - so expect to start implementation within the month" [The authors think this means sometime July- August 2014] 2012/13 "Keep promising to send PHRMP in to be assessed!. BWN ¹⁹ Issued 17-21 August 2012" 2011/12 "Sampling has been increased to weekly to comply with WINZ" 2010/11 "Currently do not sample enough. This is a Council decision."				
Leniency	Not granted for any year				

Since the *Campylobacter* outbreak in Darfield in 2012, the supply has had a new secure groundwater source from two adjacent bores. In addition, the supply is no longer chlorinated. The council acknowledges that there are high leak rates in reticulation network and that the asbestos cement pipes in the network are reaching the end of their life. A leaking network contains pathways for the ingress of contaminants. As a positive measure the Selwyn District Council has a new backflow policy that it is going to actively apply to existing connections.

At the end of 2013 a sample from the reticulation on the outskirts of Darfield yielded a transgressing *E. coli* concentration of more than 10 *E. coli*/100 ml. This property had its own storage. A boil water notice was immediately issued, but no subsequent samples showed signs of contamination either at the treatment plant or in the zone. The council concluded that the transgression probably arose from contamination of the sample because it was raining very heavily at the time and the path to the sampling point was overgrown.

¹⁹ Boil water notice

A.5 HORORATA (SEL001HO)

Minor zone, 920 people, Selwyn DC, Community and Public Health (Christchurch)

Question	Details				
Requirement	52 <i>E. coli</i> samples				
Failure Details	Failed for <i>E. coli</i> at the treatment plant in all years. Failed protozoa all years				
	Trans	Samples	Monit	Corr Action	Achievement
Year 4	1	54	yes	yes	no
Year 3	2	61	no	yes	no
Year 2	1	19	yes	yes	no
Year 1	0	15	no	yes	no
WSP Status	"Implemented" for all four years.				
Survey DWA comments	2012/13 "BWN issued 6-21 August 2012 and precautionary 18/6/13" 2010/11 "Currently do not sample enough. This is a Council decision."				
Leniency	Not granted for any year				

The Hororata supply draws indirectly from the Selwyn River via an infiltration gallery. The water is treated by an old unvalidated UV unit. Transgressions are often associated with high turbidity water in the source following rain.

Transgressions have been intermittently detected usually in single samples since 2011, often with the *E. coli* concentration being 1/100 ml. On one occasion the *E. coli* concentration was more than 10/100 ml. In August 2012, an on-going series of transgressions occurred that were associated with the river being in flood and the treatment system being overwhelmed – there is no filtration to reduce the turbidity in the water passing through the UV unit. In response to this event a boil water notice was issued, and residents were instructed to disinfect their own tanks. A portable chlorinator was used at the treatment plant.

Now the system is permanently chlorinated and selective abstraction from storage is possible.

The council plans to install a validated UV unit and filtration.

A.6 KIRWEE (KIR001KI)

Minor zone, 1100 people, Selwyn Buller DC, Community and Public Health (Christchurch)

Question	Details				
Requirement	52 <i>E. coli</i> samples				
Failure Details	Failed for <i>E. coli</i> at the treatment plant in all years. Failed protozoa all years				
	Trans	Samples	Monit	Corr Action	Achievement
Year 4	2	55	yes	yes	no
Year 3	1	53	yes	yes	no
Year 2	2	52	no	yes	no
Year 1	1	52	no	yes	no
WSP Status	"Approved" for all four years.				
Survey DWA comments	2013/14 "BWN was lifted based on results that still had a residual FAC ²⁰ , so DWS not followed."				
Leniency	Not granted for any year				

Kirwee's well was previously classified as secure. However, *E. coli* was detected in the well so that the secure status was lost. The DWA also considers that the supply's old reservoir was another possible reason for transgressions that have occurred.

In April 2011 a single sample was found to contain 1 *E. coli*/100 ml (samples taken before and after had contained coliforms).

In December of that year, back to back transgression events occurred each lasting a few days, and in one sample the *E. coli* concentration was more than 10/100 ml. These detections in the distribution zone coincided with two transgressions in the source water.

An isolated transgression (1 *E. coli*/100 ml) occurred in January 2013. The contamination cleared quickly but the source was not identified. Later, in May of that year, the well was found to contain more than 10 *E. coli*/100 ml. A few months later, in August, low levels of *E. coli* were detected over several days.

The council has now replaced the reservoir, and plans to install of a validated UV unit.

²⁰ Free available chlorine

A.7 MALVERN HILLS, HARTLEYS RD (MAL001MA)

Minor zone, 1409 people, Selwyn DC, Community and Public Health (Christchurch)

Question	Details				
Requirement	52 <i>E. coli</i> samples				
Failure Details	Failed for <i>E. coli</i> at the treatment plant in all years. Failed protozoa all years				
	Trans	Samples	Monit	Corr Action	Achievement
Year 4	1	52	no	yes	no
Year 3	0	52	no	yes	yes
Year 2	4	72	no	yes	no
Year 1	4	36	yes	yes	no
WSP Status	"Implemented" for all four years.				
Survey DWA comments	2010/11 "Now weekly sampling s of Q2 2011."				
Leniency	Not granted for any year				

The Malvern Hills, Hartley Road supply draws its water from the Selwyn River through an infiltration gallery and presently treats the water through an old, unvalidated UV unit. Transgressions often correlate with heavy rain and high turbidity levels in the river.

The council is considering using the Rural Agricultural Drinking-water Supply guidelines and isolating the towns of Whitecliffs, Glentunnel and Coalgate.

There was a series of transgressions in 2011. The first in January was the detection of 1 *E. coli*/100 ml. In February, *E. coli* concentrations equal to or greater than 10/100 ml were found in samples on two consecutive days. The contamination cleared, but no reasons for the presence of the *E. coli* were established. Temporary chlorination was installed in response to this event.

The following month another transgression occurred. A boil water notice was issued for a couple of weeks. Inspection of the reservoirs found that the state of the manhole lids, coupled with the presence of bird droppings, was a concern. As a result, the lids were renewed.

In November 2011, an isolated transgression (1 *E. coli*/100 ml) occurred but nothing unusual to explain it was found.

In March 2012, during a period when the source water was turbid, *E. coli* was detected in the water over three consecutive days at concentrations of 1 and 3 *E. coli*/100 ml.

In April of 2012, two distribution zone samples taken on same day contained *E. coli*. The same happened in October, and in response to the latter event, a boil water notice was issued and temporary chlorination undertaken.

In November 2013, there was an isolated transgression (1 *E. coli*/100 ml), followed immediately by three clear samples. No cause for the result was identified.

The council plans include the installation of a validated UV unit.

A.8 MOTUNAU, GRETA, SCARGILL (MOT016MO)

Minor zone, 600 people, Hurunui DC, Community and Public Health (Christchurch)

Question	Details					
Requirement	52 <i>E. coli</i> samples					
Failure Details	Failed for <i>E. coli</i> at the treatment plant in all years. Failed protozoa all years					
	Trans	Samples	Monit	Corr Action	Achievement	
Year 4	12	45	yes	yes	no	
Year 3	5	12	no (freq, DoW, interval) ²¹	yes	no	
Year 2	4	13	no (freq, DoW, interval)	yes	no	
Year 1	3	12	no (freq, DoW, interval)	no	no	
WSP Status	"Not Planned" for Year 1 to Year 3; "Submitted" Year 4.					
Survey DWA comments	2013/14 "Monitoring programme (int/number/dow) was compliant from Oct 2013 (previously zone was only sampled monthly). Zone does not comply from Oct however due to transgressions post Oct. " 2010/11 "Monthly sampling instead of weekly. CA not ok because permanent boil water notice, no follow up testing"					
Leniency	Not granted for any year					

The Motunau, Greta, Scargill zone obtains its water indirectly through an infiltration gallery 4.5 m below the bed of the Hurunui River. The river gravels provide minimal filtration so that heavy rain events can lead to the turbidity at the intake exceeding 30 NTU. Until August 2013, there was no treatment before the water was reticulated, so that *E. coli* concentrations well in excess of 1 *E. coli*/100 ml were frequently measured in the distribution zone. Elevated *E. coli* concentrations were sometimes found at the treatment plant at the same time as detections in the zone, consistent with the poor source quality and lack of treatment contributing to non-achievement of the Standards. Over the period from 2010-2014, *E. coli* concentrations in the zone have been recorded at up to 65.9 *E. coli*/100 ml, and at the plant up to 200 *E. coli*/100 ml. The council has not actively investigated transgressions over this period because of a permanent boil water notice and the general assumption that transgressions were inevitable given the source water and lack of effective treatment. The permanent boil water notice has been in place since 2008 as an attempt to protect public health.

In August 2013 a MIOX (mixed oxidant) treatment plant was installed (still without filtration). However, problems with consistent chlorine generation, attributed to power problems by the equipment supplier, have prevented consistent free available chlorine residuals until late 2014. Results for the first three quarters of the 2014-15 year have shown a great improvement on past performance. Problems with dose control still exist and no free available chlorine residual exceeding 0.2 mg/L has been recorded. The absence of filtration will also still challenge the treatment plant's ability to maintain *E. coli* concentrations below 1/100 ml.

²¹ Fre = frequency of sampling; DoW = day of the week; interval = the number of days between samples

The council has plans to upgrade the plant in the longer term, but its strategy is to provide MIOX plants to all its untreated supplies with poor sources first.

A.9 SHEFFIELD/WADDINGTON (SHE004SH)

Minor zone, 585 people, Selwyn DC, Community and Public Health (Christchurch)

Question	Details				
Requirement	52 <i>E. coli</i> samples				
Failure Details	Failed for <i>E. coli</i> at the treatment plant in Year 3 only. Failed protozoa all years				
	Trans	Samples	Monit	Corr Action	Achievement
Year 4	1	51	yes	yes	no
Year 3	2	52	no	yes	no
Year 2	3	53	no	yes	no
Year 1	1	55	no	yes	no
WSP Status	"Implemented" for all four years.				
Survey DWA comments	2012/13 "BWN Issued 27/4/13 - 20/5/13"				
Leniency	Not granted for any year				

The Sheffield/Waddington supply abstracts water via an infiltration gallery from the Hawkins River, and treats it with an unvalidated UV unit. The unit is set up so that in the event of a power failure, the disinfection unit is by-passed. A key potential contamination source for the supply is a nearby pig farm. Transgression events, with low levels of *E. coli* (1 *E. coli*/100ml), occur regularly in January (2011-2014). They clear immediately and no cause has been identified. The DWA understands that there is often a "smelly" event when the pig farmer is cleaning out ponds and spreading effluent, which may be related to the regular contamination events.

In October 2011 an isolated event occurred, which cleared immediately, but in which the water contained 10 *E. coli*/100 ml. A boil water notice was issued and temporary chlorination carried out.

Other transgressions have occurred, some with low levels of *E. coli* (1/100ml). Usually these clear immediately, but in April 2013, *E. coli* was detected for a week (all with fewer than 10 *E. coli*/100ml). A boil water notice was issued.

The council plans the installation of a validated UV unit and filtration.

A.10 TWIZEL (TWI001TW)

Minor zone, 1300 people, MacKenzie DC, Community and Public Health (Timaru)

Question	Details				
Requirement	52 <i>E. coli</i> samples				
Failure Details	Failed for <i>E. coli</i> at the treatment plant in all four years. Failed protozoa all years				
	Trans	Samples	Monit	Corr Action	Achievement
Year 4	1	56	no	yes	no
Year 3	1	55	no	yes	no
Year 2	7	58	yes	Unknown	no
Year 1	3	46	no	Unknown	no
WSP Status	"Not Started" Year 1 to Year 3; "Approved" Year 4.				
Survey DWA comments	2012/13 "Has had catchment survey by Opus. Chlorination now in place. Assessing new sources presently." 2011/12 "DWA not informed of any transgression."				
Leniency	Not granted for any year				

Twizel was not designed as a permanent town, so has grown from being a transient to a permanent township. Water from three shallow bores, hydraulically connected to the Fraser Stream, is pumped into an uncovered storage reservoir then reticulated into a system with moderately old piping. Up until 2013 there had been no treatment apart from a 25 micron (pore size) filter.

Historically, Mackenzie District Council has never sampled at the treatment plant, and so Twizel has not achieved the Standards at the treatment plant. Chlorination was installed in 2013 as a precursor to a full treatment upgrade after substantial encouragement from Community and Public Health. This upgrade was included in the supply's 2014 water safety plan, which was approved and is due for implementation.

During the 2010-11 and 2011-12 years, the transgressions that occurred were spread across the year. The *E. coli* concentrations in the samples did not exceed 10 *E. coli*/100ml. No boil water notices were issued.

In the 2012-2013 year chlorination was installed, with associated problems of maintaining a satisfactory FAC throughout the reticulation and sloughing of biofilm, which caused consumer complaints. During this year, effort was made to get a sampling programme in place but it still did not meet the requirements of the Standards. There were still isolated transgressions, with only one instance of the *E. coli* concentration exceeding 10 *E. coli*/100 ml.

During 2013-14 sampling started at the treatment plant, but it was not often enough or covering enough days of the week. There were single transgressions at the treatment plant and in the reticulation.

As far as can be established there has never been a waterborne outbreak associated with the Twizel supply, whether bacterial or protozoal. The council started the 2014-15 year with the intention of being complaint at both the treatment plant and the reticulation. The sampling programme was checked with the DWA, so that the 2014-15 annual survey should

show compliant sampling. The council's recently revised long-term plan acknowledges the need for, and is committed to the cost of, a treatment plant upgrade.

APPENDIX B: CHEMICAL ACHIEVEMENT DETAILS

Introduction

The details in the following sections are taken only from the information provided during the annual surveys. DWAs were not contacted during the preparation of the report to obtain more information about the non-achievement, as was done for *E. coli*.

The zones contained in this appendix are the 'high failure zones' that either failed the chemical standards in all four years (Table 9) or in three years including 2013-14 (Table 10). Those that failed in four years are listed first. Within each section the zones are listed in order of geographical location of the operating council running approximately from north to south.

B.1 EDGE CUMBE (RAN007ED)

Minor zone, 1,680 people, Whakatane DC, Toi Te Ora (Whakatane).

Question	Details																																			
P2 Failure in base year	Arsenic.																																			
Requirement	12 samples per year. MAV is 0.01 mg/L. Official P2 from 1995. Assigned to zone.																																			
Failure Details	Transgressions for arsenic occurred every year.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>9</td> <td>12</td> <td>yes</td> <td>no</td> <td>0.02</td> <td>200%</td> </tr> <tr> <td>Year 3</td> <td>11</td> <td>13</td> <td>yes</td> <td>no</td> <td>0.022</td> <td>220%</td> </tr> <tr> <td>Year 2</td> <td>6</td> <td>11</td> <td>no</td> <td>no</td> <td>0.022</td> <td>220%</td> </tr> <tr> <td>Year 1</td> <td>12</td> <td>12</td> <td>yes</td> <td>no</td> <td>0.022</td> <td>220%</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	9	12	yes	no	0.02	200%	Year 3	11	13	yes	no	0.022	220%	Year 2	6	11	no	no	0.022	220%	Year 1	12	12	yes	no	0.022	220%
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	9	12	yes	no	0.02	200%																														
Year 3	11	13	yes	no	0.022	220%																														
Year 2	6	11	no	no	0.022	220%																														
Year 1	12	12	yes	no	0.022	220%																														
WSP Status	Approved status, all years																																			
Survey DWA comments	2013/14 ". 2012/13 "Looking for a new source." 2011/12 ". 2010/11 "Working to remove this from the water supply."																																			
Other P2s	Copper, lead, nickel and antimony were P2s for year 1 only. All passed.																																			

B.2 THORNTON (RAN007TH)

Minor zone, 3,194 people, Whakatane DC, Toi Te Ora (Whakatane).

Question	Details																																			
P2 Failure in base year	Arsenic																																			
Requirement	12 samples per year. MAV is 0.01 mg/L. Official P2 from 22 April 2002. Assigned to zone.																																			
Failure Details	Transgressions for arsenic occurred every year.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>10</td> <td>12</td> <td>no</td> <td>no</td> <td>0.023</td> <td>230%</td> </tr> <tr> <td>Year 3</td> <td>10</td> <td>13</td> <td>no</td> <td>no</td> <td>0.023</td> <td>230%</td> </tr> <tr> <td>Year 2</td> <td>6</td> <td>9</td> <td>no</td> <td>no</td> <td>0.021</td> <td>210%</td> </tr> <tr> <td>Year 1</td> <td>11</td> <td>12</td> <td>no</td> <td>no</td> <td>0.0186</td> <td>186%</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	10	12	no	no	0.023	230%	Year 3	10	13	no	no	0.023	230%	Year 2	6	9	no	no	0.021	210%	Year 1	11	12	no	no	0.0186	186%
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	10	12	no	no	0.023	230%																														
Year 3	10	13	no	no	0.023	230%																														
Year 2	6	9	no	no	0.021	210%																														
Year 1	11	12	no	no	0.0186	186%																														
WSP Status	"Not started" status for 4 years																																			
Survey DWA comments	2013/14 "." 2012/13 "Audited Lab results." and "Arsenic is in source water." 2011/12 "." 2010/11 "working to remove source from this water supply." (Corrective action comment)																																			
Other P2s	Lead, nickel and antimony were P2s for year 1 only. All passed.																																			

B.3 ACACIA BAY (ACA001AC)

Minor zone, 1,512 people, Taupo DC, Toi Te Ora (Rotorua).

Question	Details																																			
P2 Failure in base year	Arsenic																																			
Requirement	12 samples per year. MAV is 0.01 mg/L. Official P2 from 1995. Assigned to zone.																																			
Failure Details	Transgressions for arsenic occurred every year.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>12</td> <td>12</td> <td>yes</td> <td>no</td> <td>0.0127</td> <td>127%</td> </tr> <tr> <td>Year 3</td> <td>6</td> <td>11</td> <td>no</td> <td>no</td> <td>0.013</td> <td>130%</td> </tr> <tr> <td>Year 2</td> <td>5</td> <td>10</td> <td>no</td> <td>yes</td> <td>0.0113</td> <td>113%</td> </tr> <tr> <td>Year 1</td> <td>1</td> <td>12</td> <td>yes</td> <td>no</td> <td>0.011</td> <td>110%</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	12	12	yes	no	0.0127	127%	Year 3	6	11	no	no	0.013	130%	Year 2	5	10	no	yes	0.0113	113%	Year 1	1	12	yes	no	0.011	110%
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	12	12	yes	no	0.0127	127%																														
Year 3	6	11	no	no	0.013	130%																														
Year 2	5	10	no	yes	0.0113	113%																														
Year 1	1	12	yes	no	0.011	110%																														
WSP Status	Approved status in Year 1, then implemented for the rest.																																			
Survey DWA comments	2013/14 "No actions taken as there is no As treatment available." 2012/13 "Nil taken as no treatment available." 2011/12 "." 2010/11 "No corrective actions taken as treatment is currently unavailable."																																			
Other P2s	-																																			

B.4 MOTUOAPA (MOT002MO)

Minor zone, 739 people, Taupo DC, Toi Te Ora (Rotorua).

Question	Details																																			
P2 Failure in base year	Arsenic																																			
Requirement	12 samples per year. MAV is 0.01 mg/L. Official P2 from 31/5/96. Assigned to zone.																																			
Failure Details	Transgressions for arsenic occurred every year.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>12</td> <td>12</td> <td>yes</td> <td>no</td> <td>0.0131</td> <td>131%</td> </tr> <tr> <td>Year 3</td> <td>7</td> <td>11</td> <td>no</td> <td>no</td> <td>0.012</td> <td>120%</td> </tr> <tr> <td>Year 2</td> <td>4</td> <td>10</td> <td>no</td> <td>no</td> <td>0.0121</td> <td>121%</td> </tr> <tr> <td>Year 1</td> <td>4</td> <td>12</td> <td>yes</td> <td>no</td> <td>0.011</td> <td>110%</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	12	12	yes	no	0.0131	131%	Year 3	7	11	no	no	0.012	120%	Year 2	4	10	no	no	0.0121	121%	Year 1	4	12	yes	no	0.011	110%
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	12	12	yes	no	0.0131	131%																														
Year 3	7	11	no	no	0.012	120%																														
Year 2	4	10	no	no	0.0121	121%																														
Year 1	4	12	yes	no	0.011	110%																														
WSP Status	“Approved” status first 2 years, then “Implemented” 2 years.																																			
Survey DWA comments	2013/14 “No actions taken as there is no As treatment available.” 2012/13 “Nil taken as no treatment available.” 2011/12 “No corrective actions taken.” 2010/11 “No corrective actions taken as no treatment available..”																																			
Other P2s	–																																			

B.5 OMORI / KURATAU / PUKAWA (OMO001OM)

Minor zone, 1,793 people, Taupo DC, Toi Te Ora (Rotorua).

Question	Details																																			
P2 Failure in base year	Arsenic																																			
Requirement	12 samples per year. MAV is 0.01 mg/L. Official P2 from 31 May 1996. Assigned to zone.																																			
Failure Details	Transgressions for Arsenic occurred every year.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>13</td> <td>13</td> <td>yes</td> <td>no</td> <td>0.0121</td> <td>121%</td> </tr> <tr> <td>Year 3</td> <td>4</td> <td>11</td> <td>no</td> <td>no</td> <td>0.012</td> <td>120%</td> </tr> <tr> <td>Year 2</td> <td>4</td> <td>10</td> <td>no</td> <td>no</td> <td>0.0119</td> <td>119%</td> </tr> <tr> <td>Year 1</td> <td>4</td> <td>12</td> <td>yes</td> <td>no</td> <td>0.011</td> <td>110%</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	13	13	yes	no	0.0121	121%	Year 3	4	11	no	no	0.012	120%	Year 2	4	10	no	no	0.0119	119%	Year 1	4	12	yes	no	0.011	110%
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	13	13	yes	no	0.0121	121%																														
Year 3	4	11	no	no	0.012	120%																														
Year 2	4	10	no	no	0.0119	119%																														
Year 1	4	12	yes	no	0.011	110%																														
WSP Status	“Approved” status Years 1 and 2, “Implemented” status Years 3 and 4.																																			
Survey DWA comments	2013/14 “No actions taken as there is no As treatment available.” 2012/13 “.” 2011/12 “.” 2010/11 “.”																																			
Other P2s	–																																			

B.6 TE KARAKA (TEK002TE)

Small zone, 491 people, Gisborne DC, Tairāwhiti DHB.

Question	Details																																			
P2 Failure in base year	Manganese																																			
Requirement	12 samples per year. MAV is 0.4 mg/L. Official P2 from 31 May 1996. Assigned to zone.																																			
Failure Details	Transgressions for Manganese occurred every year.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>32</td> <td>66</td> <td>yes</td> <td>yes</td> <td>3.9</td> <td>975%</td> </tr> <tr> <td>Year 3</td> <td>16</td> <td>59</td> <td>yes</td> <td>no</td> <td>1.99</td> <td>498%</td> </tr> <tr> <td>Year 2</td> <td>12</td> <td>62</td> <td>yes</td> <td>yes</td> <td>4.2</td> <td>1050%</td> </tr> <tr> <td>Year 1</td> <td>3</td> <td>42</td> <td>yes</td> <td>yes</td> <td>1.69</td> <td>423%</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	32	66	yes	yes	3.9	975%	Year 3	16	59	yes	no	1.99	498%	Year 2	12	62	yes	yes	4.2	1050%	Year 1	3	42	yes	yes	1.69	423%
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	32	66	yes	yes	3.9	975%																														
Year 3	16	59	yes	no	1.99	498%																														
Year 2	12	62	yes	yes	4.2	1050%																														
Year 1	3	42	yes	yes	1.69	423%																														
WSP Status	"Approved" status years 1 and 2, "Implemented" status years 3 and 4.																																			
Survey DWA comments	<p>2013/14 "New plant commissioned at Te Karaka in May 2014 - Mn results in distribution area now all compliant." (Corr Act note).</p> <p>"Prior to new plant being commissioned, regular flushing of the retic was carried out every week but did not improve the results. Once the new plant was operational, a large slug of black "tar" was removed from the retic during routine flushing. The results are now all compliant." (monitoring note)</p> <p>2012/13 "Scouring of mains, repeat sampling."</p> <p>2011/12 "Flushing of mains in distribution zone each time."</p> <p>2010/11 "Regular flushing program developed for the Te Karaka district and 3 further samples taken from exceedenced areas to ensure levels returned to below MAV."</p>																																			
Other P2s)	–																																			

B.7 SEDDON, AWATERE VALLEY (SED001SE)

Minor zone, 1,000 people, Marlborough DC, Nelson Marlborough DHB.

Question	Details																														
P2 Failure in base year	Lead and Nickel																														
Requirement	12 samples per year. Lead MAV is 0.01 mg/L. Official P2 from 18 May 2000. Assigned to zone. Nickel MAV is 0.08 mg/L. Official P2 from 18 May 2000. Assigned to zone.																														
Failure Details	No samples taken for Lead or Nickel any year.																														
	<table border="1"> <thead> <tr> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 3</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 2</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 1</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>– %</td> </tr> </tbody> </table>	Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	0	0	no	–	– %	Year 3	0	0	no	–	– %	Year 2	0	0	no	–	– %	Year 1	0	0	no	–	– %
Trans	Samples	Monit	Corr Action	Max Conc	% MAV																										
Year 4	0	0	no	–	– %																										
Year 3	0	0	no	–	– %																										
Year 2	0	0	no	–	– %																										
Year 1	0	0	no	–	– %																										
WSP Status	Implemented for 4 years																														
Survey DWA comments (apply to both P2s)	2013/14 “No samples taken.” 2012/13 “No samples taken.” 2011/12 “No samples taken.” 2010/11 “No P2 monitoring undertaken until the plant is upgraded.”																														
Other P2s	–																														

B.8 AYLERS (AKA001AY)

Minor zone, 900 people, Christchurch CC, Community and Public Health (Christchurch).

Question	Details																																		
P2 Failure in base year	MAV sum ratio for haloacetic acids (MAVHAA)																																		
Requirement	12 samples per year. MAV is 1. Official P2 from 22 April 2002. Assigned to zone.																																		
Failure Details	Transgressions for MAVHAA occurred every year.																																		
	<table border="1"> <thead> <tr> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>3</td> <td>12</td> <td>yes</td> <td>yes</td> <td>1.4</td> <td>140%</td> </tr> <tr> <td>Year 3</td> <td>5</td> <td>12</td> <td>yes</td> <td>no</td> <td>2.6</td> <td>260%</td> </tr> <tr> <td>Year 2</td> <td>10</td> <td>15</td> <td>yes</td> <td>no</td> <td>3</td> <td>300%</td> </tr> <tr> <td>Year 1</td> <td>4</td> <td>9</td> <td>no</td> <td>no</td> <td>1.4</td> <td>140%</td> </tr> </tbody> </table>	Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	3	12	yes	yes	1.4	140%	Year 3	5	12	yes	no	2.6	260%	Year 2	10	15	yes	no	3	300%	Year 1	4	9	no	no	1.4	140%
Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	3	12	yes	yes	1.4	140%																													
Year 3	5	12	yes	no	2.6	260%																													
Year 2	10	15	yes	no	3	300%																													
Year 1	4	9	no	no	1.4	140%																													
WSP Status	Implemented, all years.																																		
Survey DWA comments	2013/14 "Treatment plant redesign underway." 2012/13 "." 2011/12 "." 2010/11 "Incorrect sample spacing and numbers due to earthquake emergency situation."																																		
Other P2s	ClO ₃ (for one plant) achieved for years 2 and 4, failed years 1 and 3. MAVTHM (zone) achieved for years 2 to 4, failed year 1.																																		

B.9 TWIZEL (TWI001TW)

Minor zone, 1,300 people, MacKenzie DC, Community and Public Health (Timaru.)

Question	Details																														
P2 Failure in base year	Copper and Lead																														
Requirement	12 samples per year. Copper MAV is 2 mg/L. Official P2 from 18 May 2000. Assigned to zone. Lead MAV is 0.01 mg/L. Official P2 from 18 May 2000. Assigned to zone.																														
Failure Details	No samples taken for Copper or Lead any year.																														
	<table border="1"> <thead> <tr> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 3</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 2</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 1</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>– %</td> </tr> </tbody> </table>	Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	0	0	no	–	– %	Year 3	0	0	no	–	– %	Year 2	0	0	no	–	– %	Year 1	0	0	no	–	– %
Trans	Samples	Monit	Corr Action	Max Conc	% MAV																										
Year 4	0	0	no	–	– %																										
Year 3	0	0	no	–	– %																										
Year 2	0	0	no	–	– %																										
Year 1	0	0	no	–	– %																										
WSP Status	Approved status in year 4, 'not started' before then.																														
Survey DWA comments (apply to both P2s)	2013/14 "Not monitored." 2012/13 "No samples taken." 2011/12 "No samples taken during the year." 2010/11 "."																														
Other P2s	-																														

B.10 GLENKENICH RURAL (GLE001GK)

Minor zone, 705 people, Clutha DC, Public Health South (Dunedin).

Question	Details																																			
P2 Failure in base year	Dichloroacetic acid (DCA), MAV sum ratio for haloacetic acids (MAVHAA), and Trichloroacetic acid (TCA)																																			
Requirement	12 samples per year. DCA MAV is 0.05 mg/L. Official P2 from 4 May 2001. Assigned to zone. MAVHAA MAV is 1. Official P2 from 18 May 2000. Assigned to zone. TCA MAV is 0.2 mg/L. Official P2 from 18 May 2000. Assigned to zone.																																			
Failure Details	No samples taken for DCA, MAVHAA, or TCA any year.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 3</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 2</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 1</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	0	0	no	–	–	– %	Year 3	0	0	no	–	–	– %	Year 2	0	0	no	–	–	– %	Year 1	0	0	no	–	–	– %
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	0	0	no	–	–	– %																														
Year 3	0	0	no	–	–	– %																														
Year 2	0	0	no	–	–	– %																														
Year 1	0	0	no	–	–	– %																														
WSP Status	Approved status, all years																																			
Survey DWA comments (Apply to all P2s)	2013/14 “.” 2012/13 “P2 sampling protocol is to be reviewed following updated PHRMP preparation later this year.” 2011/12 “not monitored in survey year.” 2010/11 “.”																																			
Other P2s	-																																			

B.11 MILTON (MIL001MT)

Minor zone, 1,929 people, Clutha DC, Public Health South (Dunedin).

Question	Details																																			
P2 Failure in base year	MAV sum ratio for haloacetic acids (MAVHAA)																																			
Requirement	12 samples per year. MAV is 1. Official P2 from 30 April 1999. Assigned to zone.																																			
Failure Details	Transgression in year 1, no samples taken for years 2 to 4.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 3</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 2</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 1</td> <td>1</td> <td>3</td> <td>no</td> <td>yes</td> <td>1.7</td> <td>170%</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	0	0	no	–	–	– %	Year 3	0	0	no	–	–	– %	Year 2	0	0	no	–	–	– %	Year 1	1	3	no	yes	1.7	170%
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	0	0	no	–	–	– %																														
Year 3	0	0	no	–	–	– %																														
Year 2	0	0	no	–	–	– %																														
Year 1	1	3	no	yes	1.7	170%																														
WSP Status	“Submitted” Year 1, “Approved” Year 2, “Implemented” status for years 3 and 4.																																			
Survey DWA comments	<p>2013/14 “.”</p> <p>2012/13 “P2 sampling protocol is to be reviewed following updated PHRMP preparation later this year.”</p> <p>2011/12 “Not monitored in survey year.”</p> <p>2010/11 “Sample programme is for re-classification to P3 - minimum of two samples in reticulation taken at the extremities of the reticulation to be below the MAV. These results would indicate that there is still reason to sample.”</p>																																			
Other P2s	Fluoride, achieved for years 2 to 4. Not a P2 for year 1.																																			

B.12 NORTH BRUCE RURAL (NOR003NB)

Minor zone, 658 people, Clutha DC, Public Health South (Dunedin).

Question	Details																																			
P2 Failure in base year	Dichloroacetic acid (DCA), MAV sum ratio for haloacetic acids (MAVHAA), and Trichloroacetic acid (TCA)																																			
Requirement	12 samples per year. DCA MAV is 0.05 mg/L. Official P2 from 18 May 2000. Assigned to zone. MAVHAA MAV is 1. Official P2 from 18 May 2000. Assigned to zone. TCA MAV is 0.2 mg/L. Official P2 from 18 May 2000. Assigned to zone.																																			
Failure Details	No samples taken for DCA, MAVHAA, or TCA any year.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 3</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 2</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> <tr> <td>Year 1</td> <td>0</td> <td>0</td> <td>no</td> <td>–</td> <td>–</td> <td>– %</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	0	0	no	–	–	– %	Year 3	0	0	no	–	–	– %	Year 2	0	0	no	–	–	– %	Year 1	0	0	no	–	–	– %
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	0	0	no	–	–	– %																														
Year 3	0	0	no	–	–	– %																														
Year 2	0	0	no	–	–	– %																														
Year 1	0	0	no	–	–	– %																														
WSP Status	Implemented for years 1 to 3, redrafting in year 4.																																			
Survey DWA comments (Apply to all P2s)	2013/14 “.” 2012/13 “P2 sampling protocol is to be reviewed following updated PHRMP preparation later this year.” 2011/12 “not monitored in survey year.” 2010/11 “.”																																			
Other P2s	–																																			

B.13 KARANGAHAKE (KAR001KA)

Small zone, 147 people, Hauraki DC, Waikato DHB

Question	Details																																			
P2 Failure in base year	Arsenic																																			
Requirement	12 samples per year. MAV is 0.01 mg/L. Official P2 from 2011. Assigned to zone.																																			
Failure Details	Transgressions for arsenic occurred in three years																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>1</td> <td>12</td> <td>yes</td> <td>yes</td> <td>0.0112</td> <td>112%</td> </tr> <tr> <td>Year 3</td> <td>2</td> <td>12</td> <td>yes</td> <td>no</td> <td>0.0146</td> <td>146%</td> </tr> <tr> <td>Year 2</td> <td>1</td> <td>12</td> <td>yes</td> <td>yes</td> <td>0.013</td> <td>130%</td> </tr> <tr> <td>Year 1</td> <td>0</td> <td>1</td> <td>yes</td> <td>-</td> <td>0.00889</td> <td>89%</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	1	12	yes	yes	0.0112	112%	Year 3	2	12	yes	no	0.0146	146%	Year 2	1	12	yes	yes	0.013	130%	Year 1	0	1	yes	-	0.00889	89%
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	1	12	yes	yes	0.0112	112%																														
Year 3	2	12	yes	no	0.0146	146%																														
Year 2	1	12	yes	yes	0.013	130%																														
Year 1	0	1	yes	-	0.00889	89%																														
WSP Status	"Implemented" over four years																																			
Survey DWA comments	<p>2013-14 In relation to corrective action - "n/a as P2 in source water and no arsenic removal treatment processes within plant."</p> <p>2012-13 In relation to corrective action - "no treatment to remove or reduce arsenic."</p> <p>2011-12 In relation to corrective action - "Resample taken that month, still trying to ascertain baseline results for Arsenic." And "On winz 5 August sample missing from 2011. However email correspondence from HDC shows As result taken on 30 Aug 2011."</p> <p>2010-11 "One routine sample taken after the P2 allocation."</p>																																			
Other P2s	-																																			

B.14 TE TEKO (RAN007TE)

Minor zone, 686 people, Whakatane DC, Toi Te Ora (Whakatane)

Question	Details						
P2 Failure in base year	Arsenic						
Requirement	12 samples per year. MAV is 0.01 mg/L. Official P2 from 1999. Assigned to zone.						
Failure Details	Transgression in one year; inadequate monitoring in two years						
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV	
Year 4	0	0	no	-	-	-	
Year 3	0	3	no	-	0.001	10%	
Year 2	1	9	no	no	0.0195	195%	
Year 1	0	12	yes	-	0.0087	87%	
WSP Status	"Not Started" all years						
Survey DWA comments	-						
Other P2s	-						

B.15 MARTON TOWNSHIP (MAR001MA)

Minor zone, 3750 people, Rangitikei DC, MidCentral DHB (Whanganui)

Question	Details						
P2 Failure in base year	MAV sum ratio for trihalomethanes (MAVTHM)						
Requirement	12 samples per year. MAV is 1. Official P2 from 1999. Assigned to zone.						
Failure Details	Transgressions in two years, Inadequate monitoring one year						
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV	
Year 4	1	12	yes	no	1.1	110%	
Year 3	0	9	no	-	0.79	79%	
Year 2	2	16	yes	no	1.3	130%	
Year 1	0	12	yes	-	1.0	100%	
WSP Status	"Not Started" Years 1 and 2; "Draft" Years 3 and 4						
Survey DWA comments	2011-2012 "Follow-up of disinfection byproducts, moved to weekly monitoring. Remained high and further transgression identified."						
Other P2s	CHCl ₂ Br						

B.16 SHANNON (SHA001SH)

Minor zone, 1436 people, Horowhenua DC, MidCentral DHB (Palmerston North)

Question	Details						
P2 Failure in base year	Dichloroacetic acid (DCA), MAV sum ratio for haloacetic acids (MAVHAA)						
Requirement	12 samples per year. DCA MAV is 0.05 mg/L. Official P2 from 2007 Assigned to zone. MAVHAA MAV is 1. Official P2 from 1999 Assigned to zone.						
Failure Details	Transgressions in 3 years						
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV	
Year 4							
DCA	1	11	no	no	0.065	130%	
MAV sum ratio HAAs	3	11	no	no	2.1	210%	
Year 3							
DCA	2	12	yes	no	0.083	83%	
MAV sum ratio HAAs	9	12	yes	no	2.7	270%	
Year 2							
DCA	1	12	yes	no	0.07	140%	
MAV sum ratio HAAs	8	12	yes	no	1.9	190%	
Year 1							
DCA	1	12	yes	no	0.071	142%	
MAV sum ratio HAAs	3	12	yes	no	1.8	180%	
WSP Status	"Implemented" Years1 to 3; "Submitted Year 4.						
Survey DWA comments	2013-14 In relation to corrective action "New plant commissioned 2014." 2011-12 In relation to corrective action "None - plant has no control mechanism. New plant under construction." 2010-11 In relation to corrective action "None in agreement with DWA. The plant has no mechanism to control this. Energy being put into design and upgrade os Shannon system."						
Other P2s	-						

B.17 TOKOMARU (TOK002TO)

Minor zone, 550 people, Horowhenua DC, MidCentral DHB (Palmerston North)

Question	Details						
P2 Failure in base year	MAV sum ratio for haloacetic acids (MAVHAA)						
Requirement	12 samples per year. MAV is 1. Official P2 from 2000. Assigned to zone.						
Failure Details	Transgression for three years						
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV	
Year 4	4	11	no	no	1.6	160%	
Year 3	2	12	yes	no	1.7	170%	
Year 2	5	12	yes	no	1.3	130%	
Year 1	2	12	yes	no	1.5	150%	
WSP Status	"Implemented" all years						
Survey DWA comments	2011-12 In relation to corrective action - "None - plant has no mechanism to control disinfection by-products." 2010-11 In relation to corrective action – "None in agreement with DWA. The plant has no mechanism to control this."						
Other P2s	Dichloroacetic acid. Trichloroacetic acid						

B.18 FEATHERSTON (FEA001FE)

Minor zone, 2580 people, South Wairarapa DC, Regional Public health

Question	Details						
P2 Failure in base year	MAV sum ratio for haloacetic acids (MAVHAA)						
Requirement	12 samples per year. MAV is 1. Official P2 from 1999. Assigned to zone.						
Failure Details	Transgression for two years, inadequate monitoring one year						
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV	
Year 4	2	11	no	yes	1.1	110%	
Year 3	1	12	yes	yes	1.11	111%	
Year 2	0	12	yes	-	0.77	77%	
Year 1	0	11	no	-	1.0	100%	
WSP Status	"Implemented" all years						
Survey DWA comments	-						
Other P2s	-						

ADDENDUM: CHEMICAL ACHIEVEMENT OF THE CLARKS BEACH/WAIAU BEACH ZONE

This addendum provides the chemical achievement data for the Clarks Beach/Waiiau Beach zone. This zone is not identified as part of the primary chemical dataset because of the multiple changes in zone code it has undergone (see Section 2.1.6 for further explanation).

Key information

- a. The Clarks Beach/Waiiau Beach zone had two Priority 2 chemical determinands assigned to it at the time of the 2013-14 survey: boron and fluoride, both naturally-occurring determinands.
- b. The zone failed to meet the chemical requirements of the Standards because of transgressions of the boron MAV in all four years. There were no fluoride transgressions.
- c. Over the four years, of the 191 monitoring samples taken for boron in the zone, 40% (76) contained a boron concentration exceeding its MAV. This lies within the range found in the report for the other 'high failure zones' (28–80%).
- d. Corrective actions were considered adequate in each year except the 2010-11 year.
- e. There was a marked reduction in the percentage of samples with transgressions from 2012-13 onwards, which is consistent with an effort being made to reduce the boron concentration in the water.
- f. By January 2015, the supply was connected solely to Watercare's bulk supply, thereby avoiding the problem of the excessive boron concentration.
- g. Chemical achievement in the zone in the 2014-15 year will be affected by samples being taken before the corrective action was implemented, as any samples taken during the year have a high likelihood of containing boron that exceeds its MAV. Subsequent years should see achievement of the chemical requirements of the Standards.

HA	TA	ZCode	Zone Name	Surv Pop	Size	Chem Score	2013-14	2012-13	2011-12	2010-11	No WSP
AucklandDHB	Watercare	CLA007CL	Clarks Beach/Waiiau Beach	1322	Minor	1111	B_xT, F_ok	B_xT, F_ok	B_xT, F_ok	B_xT, F_ok	1111

Clarks Beach/Waiiau Beach (CLA007CL)

Minor zone, 1,332 people, Watercare, Auckland Regional Public Health Service.

Question	Details																																			
P2 Failure in base year	Boron.																																			
Requirement	12 samples per year. MAV is 0.01 mg/L. Official P2 from 1996. Assigned to zone.																																			
Failure Details	Transgressions for boron occurred every year.																																			
	<table border="1"> <thead> <tr> <th></th> <th>Trans</th> <th>Samples</th> <th>Monit</th> <th>Corr Action</th> <th>Max Conc</th> <th>% MAV</th> </tr> </thead> <tbody> <tr> <td>Year 4</td> <td>3</td> <td>43</td> <td>yes</td> <td>yes</td> <td>2.4</td> <td>171%</td> </tr> <tr> <td>Year 3</td> <td>3</td> <td>44</td> <td>yes</td> <td>yes</td> <td>1.7</td> <td>121%</td> </tr> <tr> <td>Year 2</td> <td>43</td> <td>51</td> <td>yes</td> <td>yes</td> <td>1.8</td> <td>129%</td> </tr> <tr> <td>Year 1</td> <td>27</td> <td>53</td> <td>yes</td> <td>no</td> <td>1.8</td> <td>129%</td> </tr> </tbody> </table>		Trans	Samples	Monit	Corr Action	Max Conc	% MAV	Year 4	3	43	yes	yes	2.4	171%	Year 3	3	44	yes	yes	1.7	121%	Year 2	43	51	yes	yes	1.8	129%	Year 1	27	53	yes	no	1.8	129%
	Trans	Samples	Monit	Corr Action	Max Conc	% MAV																														
Year 4	3	43	yes	yes	2.4	171%																														
Year 3	3	44	yes	yes	1.7	121%																														
Year 2	43	51	yes	yes	1.8	129%																														
Year 1	27	53	yes	no	1.8	129%																														
WSP Status	"Draft" status Years 1 and 2; "Not stated" Years 3 and 4.																																			
Survey DWA comments	2013/14 "DWA unit notified. Grading zone will be supplied by Waikato and Ardmore water once pipe is commissioned 2014/2015" 2012/13 "Notified DWA, long term solutions" 2011/12 "Notified DWA" 2010/11 "Dilution with Waiiau Beach supply"																																			
Other P2s	Fluoride. Passed.																																			

REFERENCES

Canterbury Mayoral Forum. 2009. *Canterbury Water Management Strategy*. Available at: <http://ecan.govt.nz/publications/Plans/cw-canterbury-water-wanagement-strategy-05-11-09.pdf> (accessed 5 May 2015)

Olstadt J, Schauer J J, Standridge J et al. 2007. A comparison of ten USEPA approved total coliform/*E. coli* tests. *Journal of Water and Health* 5.2: 267–282.



THE SCIENCE
BEHIND THE
TRUTH

**INSTITUTE OF ENVIRONMENTAL
SCIENCE AND RESEARCH LIMITED**

▀ **Kenepuru Science Centre**
34 Kenepuru Drive, Kenepuru, Porirua 5022
PO Box 50348, Porirua 5240
New Zealand
T: +64 4 914 0700 F: +64 4 914 0770

▀ **Mt Albert Science Centre**
120 Mt Albert Road, Sandringham, Auckland 1025
Private Bag 92021, Auckland 1142
New Zealand
T: +64 9 815 3670 F: +64 9 849 6046

▀ **NCBID – Wallaceville**
66 Ward Street, Wallaceville, Upper Hutt 5018
PO Box 40158, Upper Hutt 5140
New Zealand
T: +64 4 529 0600 F: +64 4 529 0601

▀ **Christchurch Science Centre**
27 Creyke Road, Ilam, Christchurch 8041
PO Box 29181, Christchurch 8540
New Zealand
T: +64 3 351 6019 F: +64 3 351 0010

www.esr.cri.nz