SOUTH WAIRARAPA DISTRICT COUNCIL
*Kia Reretahi Tātau*

# Cover note from SWDC on the 'Technical Report: Martinborough Water Treatment Plant – Incident Review'

The attached 'Technical Report: Martinborough Water Treatment Plant – Incident Review' has been prepared by Lutra for the benefit of and use by South Wairarapa District Council (SWDC).

Lutra is an expert water consultancy. This is an independent report and, as such, SWDC, and other agencies involved in the incident, have not influenced its content other than to offer factual corrections to information such as dates, times etc.

Lutra was commissioned by SWDC to develop the Report based on the consultancy having the necessary expertise and knowledge to assess the Martinborough Water Treatment Plant. It should be noted that Lutra became involved in the response to remove the boil water notice, by providing services to fix and test the UV plant, at around Day 13 of the incident.

Despite this, the company was a fair and practical choice to prepare this Report. There are a limited number of companies in New Zealand that could have carried out this technical review, given the specialised nature of the subject matter and the tight timeline in which the Report needed to be completed.

This Report describes the incident, identifies potential intervention points that could have helped prevent the incident, and makes recommendations for the future to prevent a repeat incident.

As a technical report, SWDC acknowledges there will be terms used within the Report that may not be easily understood by a lay person. A glossary of terms will be made available to help address this.

SWDC considers this Report to be an important input to its overall post-incident review of the Martinborough water incident. Other key inputs to the review process include feedback from the Martinborough community, and business community, gathered via community meetings and email, and from other agencies involved in the response, gathered by an inter-agency debrief.

The full and final post-incident review will include this Technical Report, summaries of the feedback received from the community, and a plan of action to minimise the risk of a repeat incident and its impact on the community.

For questions or feedback on this report, please email martinboroughwater@swdc.govt.nz.

Jennie Mitchell
Acting Chief Executive

5 April 2019

Lutra.

# Technical Report.

## Martinborough Water Treatment Plant – Incident Review

Prepared for South Wairarapa District Council

SWDC-R01-11

April 2019

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# Table of Contents

# List of Tables

# 1 Introduction

*E.Coli*, an indicator of faecal contamination, was detected in the Martinborough water supply on the 30th of January 2019. A boil water notice was put in place on the 1st of February. The boil water notice remained in place until the 21st of February.

Lutra were engaged to provide an independent review of the contamination incident. South Wairarapa District Council (SWDC) had the following objectives for this incident review report:

- To describe the incident.
- To identify potential intervention points that could have helped prevent this incident happening.
- To recommend corrective actions that will prevent a repeat of the incident.

# 2 Background Information

## 2.1 Water Source

Water for the Martinborough supply is sourced from two bores – Herricks Bores 3 and 4 – located adjacent to the Ruamahanga River on a private dairy farm (Figure 1). The bores are classified as not secure (Morris and Mzila, 2019) and according to the Water Safety Plan (Graham, 2015) require 4 Log protozoa treatment. It is noted that *Cryptosporidium* testing undertaken between June 2016 and July 2017 (SWDC, 2019) showed no *Cryptosporidium* oocysts detected, indicating that the source is likely to require a maximum of 3 Log protozoal treatment. However, this sample data has not yet been assessed by the Drinking Water Assessor (DWA).


**Figure 1 – Location of water source and water treatment plant.**

Herricks Bore No.3 is 11.5m deep and Herricks Bore No.4 is 9.4m deep. The aquifer is unconfined and highly permeable (Morris and Mzila, 2019).

61 bore water samples have been taken since 2003 and no *E.Coli* have been detected (SWDC, 2003-2019). The most recent sample was taken in December 2018.

The bore water has a near neutral pH (lab data – average 6.9), low turbidity (online average of 0.037NTU), low organic carbon content (online average of 98.2% UVT), elevated dissolved manganese (lab data - average 0.049 mg/L) and dissolved iron (lab data - average 0.058 mg/L), and elevated hardness (lab data - average of 197mg/L).

There are no assigned P2 determinands.

## 2.2 Water Treatment Plant

The bore water was untreated until the installation of an ultraviolet (UV) disinfection process in 2011. This was designed as a protozoa barrier and applied a UV dose of 12mJ/cm$^2$. The UV models are Berson IL450+ configured in a duty/standby arrangement. The certificate of validation is based on the USEPA method. The UV plant is validated up to a flow of 26.1L/s with a UVT of 90% and a flow of up to 61.4 L/s with a UVT of ≥ 98% UVT. The UV

plant was upgraded in April 2018 when the target applied dose was increased to 40mJ/cm$^2$ to provide additional bacteriological disinfection.

The UV treated water is dosed with sodium carbonate to increase the pH of the treated water.

There is no chlorination process. The water is transferred to the reticulation system without any disinfectant residual.

The water treatment plant is operated by Citycare under contract to South Wairarapa District Council.

## 2.3 Supply Zone

Water is pumped directly from the bores, through the water treatment plant to the reticulation system. There are four reservoirs located at the far end of the system providing a total storage volume of approximately 4000 m$^3$ (Figure 2).


**Figure 2 – Location of treated water storage reservoirs.**

The Martinborough supply zone has a population of 1,505 (Environmental Science and Research, 2017).

# 3 Drinking Water Standards Compliance

The Drinking Water Standards for New Zealand 2005 (Revised 2018) (Ministry of Health, 2018), referred to simply as DWSNZ, define the minimum performance requirements for a water supply scheme. It is noted that recent changes to the DWSNZ did not come into effect until 1st March 2019 and therefore the previous version of the DWSNZ – The Drinking Water Standards for New Zealand 2005 (Revised 2008) were in effect at the time of the incident. The requirements of this version of the DWSNZ are defined in the following sections.

## 3.1 Water Source

The water source compliance requirements for the Martinborough water supply along with recent performance are summarised in Table 1. It is noted that the bores are classified as non-secure.

**Table 1 – Water source DWSNZ compliance requirements and recent performance**

| Requirement | Compliance Achieved[1] | |
|---|---|---|
| | 2017-2018 | 2018-2019 to date[2] |
| Radiological compliance [3] | Yes | Yes |

Notes: [1] The compliance year runs from 1st July to 30th June. [2] Lutra assessment based on information available. [3] Radiological compliance requires testing against a range of radiological parameters. Testing must be undertaken once every 10 years. Sampling was completed in June 2016.

## 3.2 Water Treatment Plant

The water treatment compliance requirements for the Martinborough water supply along with recent performance are summarised in Table 2. It is noted that SWDC report against bacteriological compliance using Criterion 1 – *E.Coli* monitoring. Compliance against Criterion 5 – UV disinfection is shown in Table 2 for information only.

**Table 2 – Water treatment plant DWSNZ compliance requirements and recent performance**

| Requirement | Compliance Achieved[1] | |
|---|---|---|
| | 2017-2018 | 2018-2019 to date[2] |
| Protozoal compliance | No[3] | No[4] |
| Bacteriological compliance – Criterion 1 | No | Not reviewed |
| Bacteriological compliance – Criterion 5 | No[5] | No[6] |
| Chemical compliance | Yes | Not reviewed |

Notes: [1] The compliance year runs from 1st July to 30th June. [2] Lutra assessment based on information available. [3] DWA annual review deemed Citycare staff not competent to calibrate instruments that ensure compliance is met. [4] Citycare staff failed DWA competency audit in November 2018 therefore still not competent to calibrate instruments to ensure compliance is met. No UV applied during Incident. [5] UV dose not sufficient to achieve Criterion 5. [6] UV dose not controlled correctly therefore not achieving correct UV dose in addition to no UV applied during incident and Citycare staff not being audited by DWA for competency to calibrate UV instruments (UVI and UVT) to ensure compliance is met.

The DWA identified in their annual review (July 1st 2017 – 30th June 2018) (Central North Island Drinking Water Assessment Unit, 2018) that Citycare operations staff were not competent to calibrate instruments that ensure compliance is met. The DWA undertook an audit of two Citycare staff members in November 2018 (Central North

Island Drinking Water Assessment Unit, 2018) and assessed their competency to calibrate pH meters, turbidity meters and free available chlorine analysers. Both operators failed this assessment and there were also non-conformances on record keeping. The two Citycare staff members were re-assessed on 27-28th March 2019 and found to be competent to calibrate pH meters, turbidity meters and free available chlorine analysers.

Lutra reviewed the compliance reporting spreadsheet (SWDC, 2018) used by South Wairarapa District Council to determine online protozoal and bacteriological compliance. Multiple cell reference and calculation errors were found, the net result of which was an under-reporting of non-compliance.

It was noted that in reviewing online data that the treatment plant was operational without UV (the most probable cause of the incident) on a prior occasion – 3rd April 2018 to 17th April 2018.

## 3.3 Supply Zone

The water supply zone compliance requirements for the Martinborough water supply zone along with recent performance are summarised in Table 3.

**Table 3 – Supply zone DWSNZ compliance requirements and recent performance**

| Requirement | Compliance Achieved[1] | |
|---|---|---|
| | 2017-2018 | 2018-2019 to date[2] |
| Bacteriological compliance | No[3] | No[4] |

Notes: [1] The compliance year runs from 1st July to 30th June. [2] Lutra assessment based on information available. [3] Maximum interval between samples exceeded. No positive *E.coli* results from samples taken. [4] Positive *E.Coli* samples during incident.

## 3.4 Summary

At the time of the incident the plant was not compliant with the DWSNZ[1] and in fact had never been compliant with the DWSNZ. Sampling errors or omissions meant the supply zone was non-compliant with DWSNZ. Operators were assessed by the DWA and found not to be competent to calibrate instruments. Record keeping was assessed by the DWA as being non-conforming.

[1] As assessed by Lutra on information available.

# 4 Description of Incident

## 4.1 Incident Timeline

A timeline of the incident is presented in Table 4.

**Table 4 – Incident Timeline**

| Time | Event | Comments |
|---|---|---|
| Wednesday 16th Jan 09:50 | Sample taken at Martinborough school with following results[2]:<br>• <1 MPN/100mL *E.Coli*<br>• 19 MPN/100mL Total Coliforms<br>• 750 cfu/mL HPC @ 35 degrees<br>• 5700 cfu/mL HPC @ 22 degrees | Results received on 17th due to lab processing time.<br>SWDC report that the sample point is on the school lateral and maintenance was undertaken around the time of this sample.<br>No action taken. |
| Wednesday 23rd Jan 10:40 | Sample taken at Martinborough water treatment plant (treated water) with following results:<br>• <1 MPN/100mL total Coliforms<br>• <1 cfu/mL HPC @ 35 degrees<br>• 1 cfu/mL HPC @ 22 degrees | Results received on 24th due to lab processing time. *E.Coli* is not tested for at the plant. The next sample at the plant was taken on the 29th Jan. |
| Wednesday 23rd Jan 11:00 | Sample taken at Martinborough school with following results:<br>• <1 MPN/100mL *E.Coli*<br>• <1 MPN/100mL total Coliforms<br>• 1 cfu/mL HPC @ 35 degrees<br>• 39 cfu/mL HPC @ 22 degrees | Results received on 24th due to lab processing time. |
| Wednesday 23rd Jan 18:08 | Power cut occurs. UVT analyser fault at water treatment plant causes loss of UVT signal. | Power cut occurred from 18:08 to 21:00. |
| Wednesday 23rd Jan 18:08 to 23rd Jan 21:08 | UVT analyser remains out of service. Bore water is pumped to supply without UV treatment. | |

[2] *E.Coli* must be non-detectable. It is an immediate DWSNZ compliance failure if they are present. Total coliforms should be non-detectable but it is not a DWSNZ compliance failure if they are detected. Heterotrophic plate counts (HPC) are used as an indicator of change in a reticulation system. They are not included in DWSNZ. A non-chlorinated system should target less than 500 cfu/mL.

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| Wednesday<br>23rd Jan 21:08<br>to<br>23rd Jan 23:02 | Plant stopped. | |
| Wednesday<br>23rd Jan 23:02<br>to<br>Thursday<br>24th Jan 14:28 | UVT analyser remains out of service. Bore water is pumped to supply without UV treatment. | |
| Thursday<br>24th Jan 15:00 | The operations staff are reported to have entered a manual UVT of 95% into the UV controller to enable its operation. | |
| Tuesday<br>29th Jan 10:50 | Sample taken at Martinborough water treatment plant (treated water) with following results:<br>• <1 MPN/100mL *E.Coli*<br>• <1 MPN/100mL total Coliforms<br>• 3 cfu/mL HPC @ 35 degrees<br>• 120 cfu/mL HPC @ 22 degrees | Results received on 30th due to lab processing time. Previous sample taken on 23rd Jan @ 10:30. No samples taken between 23rd and 29th. |
| Tuesday<br>29th Jan 11:15 | Sample taken at Martinborough school with following results:<br>• 2 MPN/100mL *E.Coli*<br>• 5 MPN/100mL total Coliforms<br>• 51 cfu/mL HPC @ 35 degrees<br>• 220 cfu/mL HPC @ 22 degrees | Results received on 30th due to lab processing time. |
| Wednesday<br>30th Jan 16:17 | SWDC receive notification of *E.Coli* detection in water supply. | |
| Wednesday<br>30th Jan 16:53 | SWDC notify Regional Public Health (RPH) by email. | |
| Wednesday<br>30th Jan 17:00 | Sample taken at Martinborough school with following results:<br>• <1 MPN/100mL *E.Coli*<br>• <1 MPN/100mL total Coliforms<br>• 2500 cfu/mL HPC @ 35 degrees<br>• 2000 cfu/mL HPC @ 22 degrees | Results received on 1st Feb 10:30 due to lab processing time. |

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| Wednesday<br>30th Jan 17:15 | Sample taken at SWDC offices with following results:<br>• <1 MPN/100mL total Coliforms<br>• 10 cfu/mL HPC @ 35 degrees<br>• 43 cfu/mL HPC @ 22 degrees | Results received on 1st Feb 10:30 due to lab processing time. *E.Coli* is not tested for. |
| Thursday<br>31st Jan 09:00 | Sample taken at Martinborough school with following results:<br>• <1 MPN/100mL *E.Coli*<br>• <1 MPN/100mL total Coliforms<br>• 570 cfu/mL HPC @ 35 degrees<br>• 620 cfu/mL HPC @ 22 degrees | Results received on 1st at 10:30 due to lab processing time. |
| Thursday<br>31st Jan 09:30 | Sample taken at SWDC offices with following results:<br>• <1 MPN/100mL total Coliforms<br>• 22 cfu/mL HPC @ 35 degrees<br>• 18 cfu/mL HPC @ 22 degrees | Results received on 1st at 10:30 due to lab processing time. |
| Thursday<br>31st Jan 10:30 | RPH and SWDC phone discussion held on investigating source and confirming remedial action at school (alternative water source provided). | RPH sought confirmation alternative water source had been provided to the school. |
| Thursday<br>31st Jan 14:00 | Sample taken at reservoir sample tap with following results:<br>• 2 MPN/100mL *E.Coli*<br>• 12 MPN/100mL total Coliforms<br>• 7 cfu/mL HPC @ 35 degrees<br>• 28 cfu/mL HPC @ 22 degrees | Results received on 1st at 13:36 due to lab processing time. |
| Friday<br>1st Feb 13:36 | SWDC receive notification of *E.Coli* detection in reservoir sample tap sample taken on 31st.<br>RPH and SWDC hold a phone discussion on further positive result and requirements for remedial action (Boil Water Notice). | |
| Friday<br>1st Feb 14:00 | Boil Water Notice issued and source of alternative water supplies organised in consultation with RPH. | |
| Friday<br>1st Feb to<br>Tuesday<br>5th Feb | Samples taken daily at multiple locations in the network. *E.Coli* was detected in each of the daily samples from the reservoir sample tap. Counts of 2,3,4 and 1 MPN/100mL.<br>SWDC investigated potential contamination routes. | |

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| Saturday<br>2nd Feb | Martinborough Country Fair.<br>Tankers provided as alternative water source (filled with water from Masterton District Council). | |
| Sunday<br>3rd Feb | Wellington Water offers SWDC assistance with *E.Coli* response.<br>Multiple Wellington Water emergency water bladders deployed. | |
| Saturday<br>2nd Feb 11:15<br>to<br>Sunday<br>3rd Feb 08:00 | UV plant operating at approx. half required UV dose. | No explanation provided by SWDC. |
| Monday<br>4th Feb | *E.Coli* detected at Martinborough golf course (1 MPN/100mL) and Fairway Drive (1 MPN/ 100mL). | Results received on 5th due to lab processing time. |
| Monday<br>4th Feb | Formal request for assistance from SWDC to Wellington Water | |
| Monday<br>4th Feb | Reservoirs sequentially chlorinated to 6mg/L of free available chlorine and limited area of the reticulation system in the vicinity of the reservoirs also chlorinated. | |
| Tuesday<br>5th Feb | SWDC, Wellington Water workshop. Plan put in place to review all potential contamination sources and eliminate or mitigate all identified risks.<br>Possible sources of contamination identified by the group:<br>• UV plant malfunction allowing untreated source water into supply;<br>• Ingress in to reservoirs;<br>• Backflow;<br>• Air valves;<br>• Loss of system pressure due to system shutdowns.<br>Extensive sampling programme commenced. Boil Water Notice lifting plan development commenced. | |
| Tuesday<br>5th Feb | SWDC, RPH and Wellington Water teleconference. | Workshop discussion |

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| Wednesday 6th Feb | SWDC, RPH and Wellington Water teleconference. | Progress and situation update. |
| Thursday 7th Feb | SWDC, RPH and Wellington Water teleconference. | Progress and situation update. |
| Thursday 7th Feb 17:00 | Wellington Water received first UV plant performance data. | |
| Friday 8th Feb | Issues with UV plant performance identified in the data. Continued work on boil water notice lifting plan. | |
| Friday 8th Feb | SWDC, RPH and Wellington Water teleconference. | |
| Saturday 9th Feb | Reservoir cleaning continues. | |
| Sunday 10th Feb 10:30 | SWDC, Wellington Water, RPH and Lutra teleconference. | |
| Sunday 10th Feb 21:50 | UV plant performance data for February 2019 received. | |
| Monday 11th Feb 11:00 | SWDC, Wellington Water and Lutra meeting at SWDC offices. RPH dialled in. Urgent review of UV plant performance & controls initiated. Lutra assistance commenced. | |
| Monday 11th Feb | Reservoirs 2 and 4 superchlorinated then fully drained. | 10 mg/L of free available chlorine for not less than 12 hours. |
| Monday 11th Feb | SWDC, Wellington Water, RPH and Lutra teleconference. | Update on work completed, issues identified, plan to lift BWN |
| Tuesday 12th Feb | Reservoir cleaning continues. | |
| Wednesday 13th Feb | Reservoir 1 superchlorinated then fully drained. | 10 mg/L of free available chlorine for not less than 12 hours. |
| Wednesday 13th Feb | Meeting to review plan to lift boil water notice. Regional Public Health, SWDC, Wellington Water and Lutra. Plan agreed. | |
| Wednesday 13th Feb | UV plant performance data received for 2018. | |

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| Wednesday 13th Feb & Thursday 14th Feb | Lutra engineers attend site to perform initial checks on UV plant. | Large number of operational and control issues identified requiring software changes. |
| Wednesday 13th Feb | RPH, Lutra and Wellington Water meet in Wellington and agree plan to lift the boil water notice. | |
| Thursday 14th Feb | Reservoir 3 superchlorinated then fully drained. | 10 mg/L of free available chlorine for not less than 12 hours. |
| Friday 15th Feb | Software changes made remotely by Qtech. Changes not validated or tested. | Collective agreement (SWDC, Wellington Water and Lutra) that the plant was producing DWSNZ compliant water and that flushing programme could start. |
| Friday 15th Feb & Saturday 16th Feb | Flushing of reticulation system during evening and in to the night by Citycare and Wellington Water staff. Flow management issues and water quality issues caused plant to shut down. Plant could not be restarted. Flushing ceased.<br>A sample taken at Nelson Rd after the flushing had a positive *E.Coli* result (1 MPN/100mL). | Sample taken at Nelson Rd on 15th Feb at 23:05. Results received 17th Feb. |
| Saturday 16th Feb | Plant restarted manually. Abandonment of flushing programme. | |
| Sunday 17th Feb | Flushing of remaining reticulation system during evening and in to the night.<br>3 days of extensive *E.Coli* testing started after flushing completed.<br>Nelson Rd was re-flushed, and three samples were taken on the 17th, 18th and 19th all of which were clear. | |
| Monday 18th Feb | Lutra engineers attend site and perform commissioning and UV plant validation checks.<br>UVI reference sensor not available for UVI sensor check (DWSNZ monthly compliance requirement). One was borrowed from Carterton DC to allow the checks to be undertaken. | Unable to perform full checks due to unavailability of system control and data acquisition (SCADA) programmer.<br>Collective agreement (SWDC, Wellington Water and Lutra) that the plant was producing DWSNZ compliant water at this stage. |

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| Tuesday<br>19th Feb | Lutra engineers attend site with independent SCADA programmer, fix issues and perform remaining commissioning checks. | Collective agreement (SWDC, Wellington Water and Lutra) that the plant was producing DWSNZ compliant water at this stage. |
| Thursday<br>21st Feb | Boil water notice lifted in consultation with RPH after 3 days of clear *E.coli* samples. | |

## 4.2 Probable Cause

The most probable cause of the contamination incident was the malfunction of the UV plant on the 23rd and 24th January 2019 allowing untreated water to enter the supply network and charge the storage reservoirs. However, it should be noted that the cause cannot be definitively identified. It is still possible that the contamination occurred within the network itself (e.g. backflow, air valves).

## 4.3 Water Treatment Plant Operation on 23rd and 24th January 2019

Given that the malfunction on the UV plant on the 23rd and 24th January was the most probable cause of the incident a more detailed review of the actions of the plant operator(s) was required. A timeline was developed from the operator's account of the power failure on the 23rd January 2019 (Citycare, 2019) and is presented in Table 5.

**Table 5 – Operator notes on power cut**

| Time | Action (as noted by Operator) | Comments |
|---|---|---|
| **23/1/19** | | |
| 18:00 | Power cuts in South Wairarapa and Masterton. | |
| 18:09 | Common Lamp Failure alarm at Ruamahanga Pump Station UV site. | |
| 18:19 | Ruamahanga Pump Station site battery Low alarm. | |
| 18:40 | Operator arrived at site. | |
| 19:04 | Operator contacts GVElectrical requesting assistance – he is told that someone will get back to him. | |
| 19:11 | Operator contacts second Operator for advice on the next course of action. Second Operator advised that the WTP would "probably resume normal production when the power came back on" and contacts the SWDC Assets and Operations Manager on how critical it was to get the power back on. | The lack of knowledge of how the plant would respond to power failure is concerning. |
| | GVE rang back saying he was available if required. | |

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| 19:33 | Operator contacted SWDC Asset and Operations Manager and was advised that the reservoirs had 3 days storage and to “leave any remedial work to the next day”. | It is not clear whether the plant was left in a state where it would restart if the power came back on. |
| | Operator contacted second Operator again and relayed instructions received from the SWDC Asset and Operations Manager and locked up the WTP. | |
| 20:30 | GVE called again and was told that remedial work would be carried out the next day. | |
| 21:08 | Power was restored and UV common alarm received by the operator on his way home. | The operator interpreted this to be the “return alarm” that indicated that the UV was functional and no longer in an alarm state. |
| 21:19 | Pump 4 fault received by the operator indicating that the plant was now only running on bore 3. | |
| **24/1/19** | | |
| 07:30 | Operator attends site and clears pump 4 fault and notices that UVT meter is not displaying the usual screen. Operator tries to reset the UVT meter several times without success. Operator checks the UV units and may have cleared a fault on UV One display. | |
| 08:15 | Operator arrives at SWDC and first discusses the UVT fault with second Operator. | |
| 13:00 | Operator meets second Operator on site, and they try to reset the UVT meter without success. Second Operator noticed that UV two is not dosing and tried stopping and starting the unit several times. | This is a considerable time lag between noticing a problem with a critical piece of equipment and the action |
| | They called the Berson agent (Davey). He told them how to put in a fixed UVT value into the UV system so it would dose “correctly”. The Berson agent made the comment that the UV should not have started without a UVT value. | Value of 95% entered. Record data was later shown to be inaccurate due to incorrect scaling of the UVT reading in the Datran control system. |
| | The Berson agent provided all the operating values that had been disrupted by the power outage. Two values were required from the manufacturer that were provided the following Monday to get the UV operational again. | PLCs and control systems should be protected during a power failure so that data is not lost. |

# 5 Potential Intervention Points

In evaluating the events and actions before, during and after the incident, a benchmark was required. The public inquiry into the Havelock North contamination incident identified six principles for safe drinking water (Government Inquiry into Havelock North Drinking Water, 2017) which were used as that benchmark. These are repeated here for information:

**Principle 1: A high standard of care must be embraced**

Unsafe drinking water can cause illness, injury or death on a large-scale. All those involved in supplying drinking water (from operators to politically elected representatives) must therefore embrace a high standard of care akin to that applied in the fields of medicine and aviation where the consequences of a failure are similarly detrimental to public health and safety. Vigilance, diligence and competence are minimum requirements and complacency has no place.

**Principle 2: Protection of source water is of paramount importance**

Protection of the source of drinking water provides the first, and most significant, barrier against drinking water contamination and illness. It is of paramount importance that risks to sources of drinking water are understood, managed and addressed appropriately. However, as pathogenic microorganisms are found everywhere, complete protection is impossible and further barriers against contamination are vital.

**Principle 3: Maintain multiple barriers against contamination**

Any drinking water system must have, and continuously maintain, robust multiple barriers against contamination appropriate to the level of potential contamination. This is because no single barrier is effective against all sources of contamination and any barrier can fail at any time. Barriers with appropriate capabilities are needed at each of the following levels: source protection; effective treatment; secure distribution; effective monitoring; and effective responses to adverse signals. A "source to tap" approach is required.

**Principle 4: Change precedes contamination**

Contamination is almost always preceded by some kind of change and change must never be ignored. Sudden or extreme changes in water quality, flow or environmental conditions (for example, heavy rainfall, flooding, earthquakes) should arouse particular suspicion that drinking water might become contaminated. Change of any kind (for example, personnel, governance, equipment) should be monitored and responded to with due diligence.

**Principle 5: Suppliers must own the safety of drinking water**

Drinking water suppliers must maintain a personal sense of responsibility and dedication to providing consumers with safe water. Knowledgeable, experienced, committed and responsive personnel provide the best assurance of safe drinking water. The personnel, and drinking water supply system, must be able to respond quickly and effectively to adverse monitoring signals. This requires commitment from the highest level of the organisation and accountability by all those with responsibility for drinking water.

**Principle 6: Apply a preventive risk management approach**

A preventive risk management approach provides the best protection against waterborne illness. Once contamination is detected, contaminated water may already have been consumed and illness may already have occurred. Accordingly, the focus must always be on preventing contamination. This requires systematic assessment of risks throughout a drinking water supply from source to tap; identification of ways these risks can be managed; and control measures implemented to ensure that management is occurring properly. Adequate monitoring of the performance of each barrier is essential. Each supplier's risk management approach should be recorded in a living WSP which is utilised on a day to day basis.

Potential intervention points that may have prevented the incident occurring have been identified and are presented in Table 6.

**Table 6 – Potential Intervention Points Prior to the Incident.**

| Potential Intervention Point | What should have been done? |
|---|---|
| Decision to not provide residual disinfection | Chlorination of the supply is essential to provide a robust multi-barrier treatment process and to protect against contamination of the reticulation system. If chlorination had been a part of the Martinborough WTP this incident would not have happened.<br>Principle 3: maintain multiple barriers against contamination; Principle 5: Suppliers must own the safety of drinking water and Principle 6: Apply a preventative risk management approach. |
| Plant design | The design should have provided a means to demonstrate that flow was not by-passing UV treatment. Limit switches should have been installed on the UV reactor isolation valves and the plant by-pass should have been removed.<br>Principle 5: Suppliers must own the safety of drinking water. |
| Plant construction record documents | A complete set of construction record documents should have been developed, including P&IDs, wiring diagrams and functional description. The standard of documentation was found to be very poor and made fault finding during the incident challenging.<br>Principle 1: A high standard of care must be embraced |
| Plant labelling | Electrical and control cables should be clearly labelled. The plant cabling was found to be unlabelled and in a very untidy state making fault finding during the incident challenging.<br>Principle 1: A high standard of care must be embraced |
| Plant programming and commissioning | A functional description should have been prepared. Factory acceptance test (FAT), site acceptance test (SAT) and full commissioning checks should have been completed and documented for the original UV installation and for the UV modifications in April 2018.<br>Clearly none of these were performed since there was found to be a basic lack of understanding of the DWSNZ compliance requirements. A number had either not been programmed in at all or had been programmed incorrectly.<br>Principle 1: A high standard of care must be embraced |

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| Reliance on one person for plant control and SCADA programming | A SCADA maintenance and support system should have been set up without reliance on a single individual at the automation company.<br><br>The vulnerability of the current arrangements became apparent during the incident when the sole person with knowledge of how the system operates was not available for critical testing.<br><br>Principle 1: A high standard of care must be embraced and Principle 6: Apply a preventative risk management approach. |
| Operations and maintenance manuals. | An operations manual with clear description of how the plant operates, how it will respond to failures and with troubleshooting guides should have been prepared.<br><br>Had this information been available, the operator may have been able to refer to the documents and provide a better response to the power failure and UVT instrument failure.<br><br>Principle 1: A high standard of care must be embraced. |
| Lack of UVI reference sensor and training to carry out reference sensor checks | SWDC and Citycare should have UVI reference sensors available and staff should be trained in their use.<br><br>UVI sensor reference checks are a monthly DWSNZ compliance requirement. Neither SWDC or Citycare had a UVI reference sensor at the time of the incident. Citycare staff did not appear to be trained in the UVI reference check process and records of previous checks were not available for review.<br><br>Principle 1: A high standard of care must be embraced; and Principle 5: Suppliers must own the safety of drinking water. |
| No authorised staff available for calibrations and standardisations. | Operations staff should be assessed as competent to undertake all instrument calibrations and standardisations. This should cover turbidity, UVT and UVI sensor checks for UV plants.<br><br>Citycare staff were assessed as not competent to carry out calibrations and standardisations by the DWA in accordance with the Drinking Water Standards in November 2018. It is noted that the DWA only audited the operators on turbidity, pH and FAC analysers since they do not cover competency for UVI sensor checks or for UVT calibrations.<br><br>Principle 1: A high standard of care must be embraced. |
| Calibration and standardisation records missing | All calibration and standardisation activities should be recorded, performed and tracked according to a schedule.<br><br>The DWA identified non-conformances with the frequency of calibration activities and with record keeping, noting problems with missing and incomplete records.<br><br>Principle 1: A high standard of care must be embraced; and Principle 5: Suppliers must own the safety of drinking water. |

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| DWSNZ compliance reporting spreadsheet incorrect | All compliance reporting should be based on a validated and quality-controlled procedure.<br>The spreadsheet used by SWDC to report on compliance was found to contain multiple errors which under-reported non-compliance.<br>Principle 1: A high standard of care must be embraced. |

Potential intervention points during the incident have been identified and are presented in Table 7.

**Table 7 – Potential Intervention Points During the Incident.**

| Potential Intervention Point | What should have been done? |
|---|---|
| First Detection of *E.coli* | A boil water notice should have been issued immediately[3]. The presence of *E.coli* means that faecal contamination of the water has occurred and any delay in issuing the boil water notice risks the health of the community. Principle 5: Suppliers must own the safety of drinking water. |
| Power cut causing plant shut down | Operators should know how the plant responds to power outages and what is required to protect public health. A more vigilant approach should have been taken with the plant being isolated until a detailed examination of the problems and remedial action could be undertaken.<br>Principle 4: Change precedes contamination. |
| Operator notices fault with UVT instrument and fails to take immediate action. | This should have led to an immediate plant shutdown as a critical piece of equipment was not functioning correctly.<br>Principle 5: Suppliers must own the safety of drinking water. |

[3] Note this is a Lutra opinion. RPH states that for an *E.Coli* transgression in the distribution zone, the DWSNZ requires an investigation of cause and remedial actions. A boil water notice is one action to be considered based on initial assessment of cause.

# 6 Corrective Actions

The investigation of the contamination incident as documented in this report has highlighted a number of corrective actions which should be implemented. These are presented in Table 8 and are linked to the 6 principles of safe drinking water.

**Table 8 – Corrective Actions**

| No. | Details |
|---|---|
| Principle 1: A high standard of care must be embraced | |
| 1.1 | SWDC should review the importance of drinking water supply within their organisation and those of their contractors specifically:<br>a) Review the findings of the Havelock North Stage 1 and Stage 2 Reports.<br>b) Ensure all staff and contractors involved with the supply of drinking water understand their personal responsibility for the health of the public.<br>c) Ensure that the contracts with suppliers and contractors are set up for 24/7 support.<br>d) Ensure that all staff are adequately trained to perform their duties including calibrations. |
| 1.2 | Ensure that the plant documentation is current and relevant, specifically:<br>a) Ensure the process schematics (P&IDs) are available and current.<br>b) Ensure the functional description describing plant operation is available and current.<br>c) Provide a detailed operations manual that details the plant functionality, troubleshooting and standard operating procedures for the operators.<br>d) Provide a schedule of maintenance checks, verifications and calibrations for the whole plant. |
| 1.3 | Ensure compliance data is analysed correctly (by a system that has been through adequate quality assurance) and presented in a way that is easily understood, specifically:<br>a) Use an independent compliance reporting system to report compliance. |
| 1.4 | Replace existing outdated control system with a modern programmable logic controller (PLC) and SCADA system, specifically:<br>a) Any failure will lead to a plant shutdown and the inability to deliver unsafe drinking water.<br>b) Ensure that as-built documentation is accurate such that troubleshooting problems is not constrained because of lack of information. |

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| 1.5 | Ensure that calibrations and verifications are carried out and recorded in accordance with the standards, specifically:<br>a) Calibration and verifications are carried out by DWA approved personnel.<br>b) Equipment required for calibrations and verifications is available.<br>c) Calibration and verification records are available for inspection.<br>d) Staff are competent and authorised to carry out calibrations. |
| Principle 2: Protection of the source water is of paramount importance | |
| 2.1 | SWDC should perform a catchment risk assessment and source protection zone study to develop a better understanding of the source risk. |
| Principle 3: Maintain multiple barriers against contamination | |
| 3.1 | Chlorination of the supply is essential to provide a robust multi-barrier treatment process and to protect against contamination of the reticulation system. It is noted that dissolved iron and manganese levels in the source water will cause aesthetic issues when chlorine is added to the water. To avoid these an iron and manganese removal process will need to be installed at the water treatment plant. |
| Principle 4: Change proceeds contamination | |
| 4.1 | Ensure operators, supervisors, and managers are sufficiently trained to understand the importance of change on a treatment plant, specifically:<br>a) What constitutes a change.<br>b) What action to take in the event of a change.<br>c) Authority of operators to respond to a change.<br>d) Understanding the change cannot compromise drinking water safety. |
| Principle 5: Suppliers must own the safety of drinking water | |
| 5.1 | Operators, supervisors and managers must understand their drinking water supply and understand the importance of each critical element, specifically:<br>a) Understanding critical instruments and their function in the water supply.<br>b) Understanding how the plant will respond to upset conditions (e.g. resumption of power after a power cut).<br>c) Eliminate the ability to by-pass the UV treatment process.<br>d) Understanding that a positive *E.coli* means the water is contaminated with faecal matter. |
| Principle 6: Apply a preventative risk management approach | |
| 6.1 | Undertake a systematic assessment of risks throughout the drinking water system, specifically:<br>a) Identify source risks, treatment risks and reticulation risks.<br>b) Identify mitigation measures for each risk.<br>c) Monitor the performance of each barrier. |

# 7 Conclusion

The seriousness of this incident cannot be overstated. It is a matter of luck that this was not another Havelock North[4] or a Walkerton[5]. *E.Coli* is an indicator organism. It indicates the presence of faecal material. It indicates the likely presence of pathogenic bacteria and some strains of *E.Coli* themselves can be deadly (*E.Coli* O157:H7).

*E.Coli* was present in the Martinborough system for **at least** three days before a boil water notice was put in place.

This incident has highlighted shortcomings in the design, operation and management of the Martinborough water supply system.

The incident response and management was largely reactive and unplanned until Wellington Water became involved and provided a risk based rationale to the decision making process.

It is understood that SWDC have a wish to improve their performance and that of their contractors. To this end they have committed to installing a manganese removal plant within the next 6-12 months, which will enable full time chlorination. In addition to this commitment, SWDC should adopt the six fundamental principles of drinking water safety for New Zealand and consider implementing the corrective actions presented in this report.

[4] The Havelock North incident occurred in August 2016. Campylobacter contamination caused approx. 5,500 (33% of the population) people to be violently ill and was linked to the deaths of three people.
[5] The Walkerton incident occurred in April 2000. *E.Coli* (O157:H7) and Campylobacter contamination caused 2,500 people (50% of the population) to get ill and seven people died.

# 8 References

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