

***E. COLI* DETECTIONS AND INVESTIGATIONS**



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ABSTRACT

Victoria's *Safe Drinking Water Regulations 2015* (the Regulations 2015) were introduced in July 2015, placing a greater emphasis on managing risk relating to drinking water quality. An important improvement was introduced relating to the requirements around detections of *Escherichia coli* (*E. coli*) as a microbial indicator of water quality. Following detection of *E. coli* in drinking water, the new regulations provide for water suppliers to claim a false positive sample if, after conducting an investigation according to particular criteria, it is confirmed that the presence of *E. coli* is not representative of the water supplied in the water sampling locality. This change has not resulted in an appreciable change in the numbers of *E. coli* detections but has provided a framework for the systematic investigation of detections which have resulted in improvements to system operations. This has highlighted the importance of considering tanks in greater detail as both sources of *E. coli* detections and points of failure of infrastructure integrity.

1.0 INTRODUCTION

The *Safe Drinking Water Regulations 2015* include drinking water quality standards that require all samples of drinking water collected are found to contain no *E. coli* per 100 millilitres of drinking water, with the exception of any false positive sample. Guidelines for responding to and investigating *E.coli* detections have been provided by the department. Over the first 12 months of the introduction of the Regulations, the department has received 28 notifications of *E.coli* detections across Victoria, of which three have been found to have not met the drinking water quality standards. Water distribution system tanks have emerged as a significant source of *E.coli* detections and locations where drinking water quality standards have not been met.

By providing a state-wide analysis of trends and observations from *E.coli* investigation reports, to the water industry, review of common risks may assist water agencies in the future management of drinking water systems to achieve improved outcomes for the Victorian community.

2.0 DISCUSSION

In July 2015, the *Safe Drinking Water Regulation 2005* (2005 Regulations) expired as part of the Victorian Government's "sunset" provisions for regulations. In reviewing the 2005 Regulations, the department considered the Table in Schedule 2 'drinking water quality standards' that had been implemented in 2005, and the current and future trends and community expectations in determining indicators and standards of drinking water. The two main reference documents for drinking water quality are the *Australian Drinking Water Guidelines (2011)* (ADWG) and the World Health Organisation Drinking Water Guidelines (2011), both of which adopt *E. coli* as the indicator of microbial quality of drinking water.

Table 1: Comparison of selected drinking water quality standards

Source	Description
<i>Safe Drinking Water Regulations 2005</i>	At least 98% of all samples of drinking water collected in any 12 month period contain no <i>E. coli</i> per 100 millilitres of drinking water
WHO Drinking Water Guidelines 2011	<i>E. coli</i> or thermotolerant coliform bacteria must not be detectable in any 100 ml sample
Australian Drinking Water Guidelines 2011	<i>E. coli</i> should not be detected in any 100 mL sample of drinking water
<i>Safe Drinking Water Regulations 2015</i>	All samples of drinking water collected are found to contain no <i>E. coli</i> per 100 millilitres of drinking water, with the exception of any false positive sample

Inclusion of a 2% margin for errors in the 2005 Regulations served the Victorian water industry well for 10 years by providing a very high target for water suppliers to achieve; however, expectations of the water industry have changed over the same period of time. Along with the improved experience and expertise of the water industry in providing safe drinking water, community expectations have also changed.

The natural progression of drinking water quality standards in Victoria for the next 10 years is to adopt and achieve the current Australian and international expectations. That is, *E. coli* must not be detected in any 100 mL sample of drinking water.

The Regulations 2015 recognise that there can be factors that may affect the integrity of drinking water sample collection and analysis such as non-aseptic sampling techniques, etc. This has given rise to the term “false positive”, which is defined in the *E. coli* drinking water quality standard in the Regulations 2015.

Where *E.coli* is detected in a drinking water sample, water suppliers (water authorities supplying drinking water) are required to notify the department and investigate its presence thoroughly in accordance with the department’s guidelines to determine if there is any evidence, reason or explanation for the *E. coli* being detected. If all of the investigation requirements are satisfied, the sample may be determined to be a false positive. Where any of the requirements are not, or cannot be, satisfied the drinking water quality standard has not been met, and must be reported to the department as a failure to meet the legislated requirements.

The two reporting instruments included in the *Safe Drinking Water Act 2003* are Section 22 Notifications and Section 18 Notifications.

In the context of an *E. coli* detection in drinking water, a Section 22 Notification is required as there is a possibility that the drinking water may be contaminated or pose a risk to public health.

A Section 18 Notification is required where the Drinking Water Quality Standards (detailed in Schedule 2 of the Regulations) is not achieved.

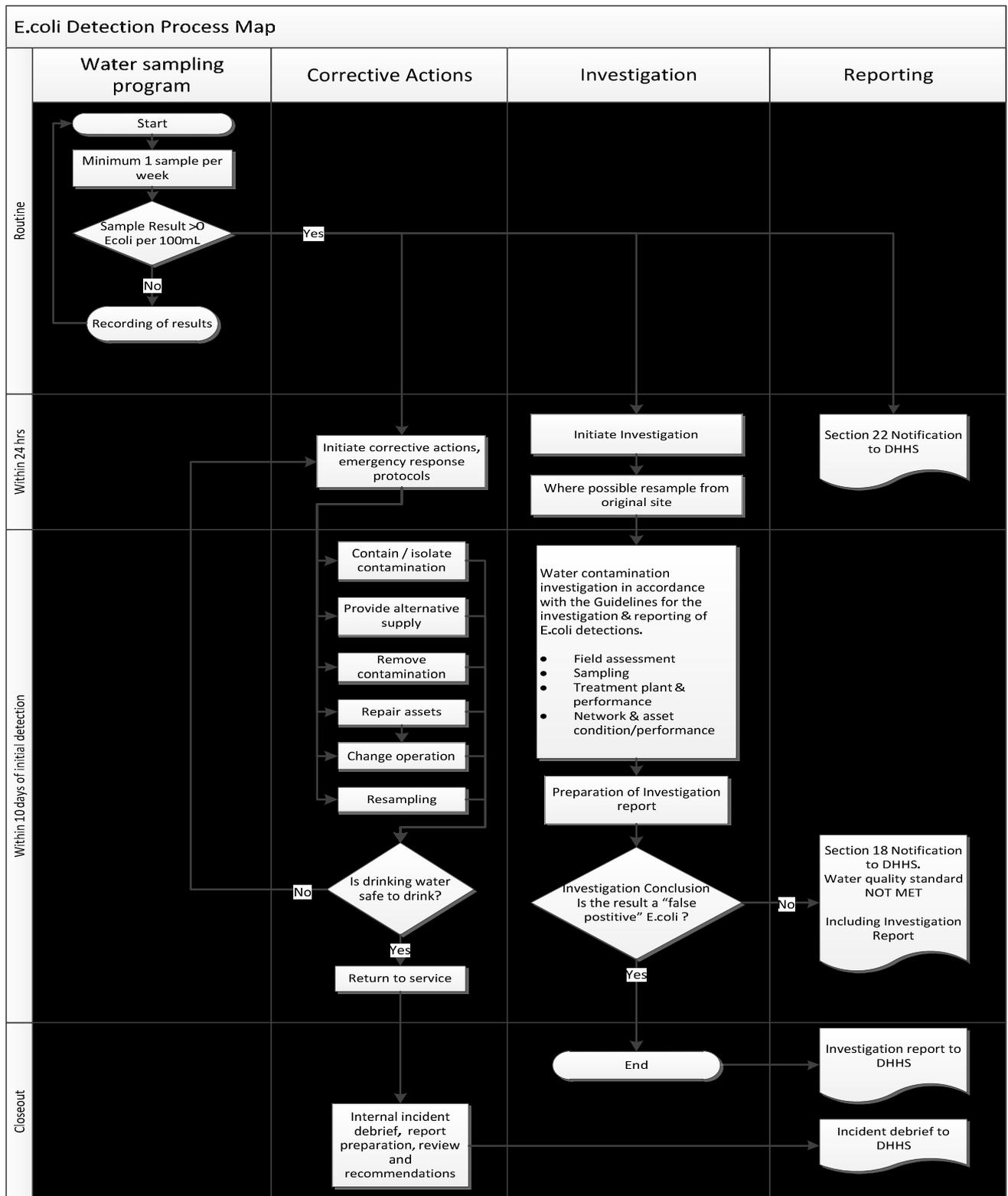


Figure 1: *E. coli* detection process map

Over the past 12 months, since introduction of the Regulations 2015, the department has received a number of *E. coli* detection notifications, all of which have been investigated by the water supplier.

Table 2: *E. coli* detections in drinking water 2012-2016

	2012-13 *	2013-14*	2014-15*	2015-16 #
<i>E. coli</i> detections	35	42	23	28
Applicable Regulations year	2005	2005	2005	2015
Number of water quality standard failures due to <i>E.coli</i> detections	3	2	0	3

* DHHS Annual Report on Drinking Water Quality in Victoria 2014-15

unpublished numbers

The change in regulations has not generated a greater number of *E. coli* detections as can be seen in Table 2. The Regulations 2015 have seen a significant change in the way detections are investigated and reported.

2.1 Investigating *E. coli* detections

Investigation is the primary tool in determining if the *E. coli* detection was representative of water supplied to customers and the departments guidelines aim to provide a consistent approach to investigations.

Following the detection of *E. coli* in drinking water, the Regulations 2015 require a thorough investigation to satisfy the regulations and the Secretary's Guidelines for investigation.

In summary these requirements include:

- Field assessment
- Sampling
- Investigation of treatment plant performance and operation
- Investigation of network and asset condition/performance

The exact detail of what is considered and investigated is unique to each *E. coli* detection. Some common questions the department has discussed with water suppliers in the early stages of investigations have been:

- Disinfection residual in the distribution system and at the sample location
- Time period of the investigation
- Factors external to the drinking water system
- Treatment plant performance and trends
- Network operations, flows and water age estimates

Time Period

The process of investigation needs to consider an appropriate investigative timeframe. Useful questions to ask of the detection event are:

- When did we last know that water was free of *E. coli* (i.e. the last clear sample)
- When did the system return to being free of *E. coli*

How old is the water in the system at the detection site (from treatment plant inlet to sample). A calibrated network hydrodynamic model is not required for this, estimates are usually adequate.

Changes and events

Understanding the "normal" or baseline operation of a system enables identification of unusual events or changes from the normal operation.

Consideration of what conditions may have changed or happened over the period of investigations may include:

- infrastructure integrity failures (from pipe bursts, tank entries)
- extreme weather or heavy rain,
- power outages and system tests like generator test runs,
- fires or hydrant use,
- new major customer connections,
- change in source water or treated water
- changes in distribution flow directions,
- commissioning a new main,
- scheduled flushing programs, etc.
- an increase in customer complaints or “interest” on social media

Whilst treatment plant operators and engineers can investigate many aspects of the production of drinking water, the contribution of network operators to the investigation are just as valuable. Network operators are in a unique place to inform on many not so obvious “in the field” events.

Working with others

Investigating an *E.coli* detection requires working with many (and usually most) parts of the water agency from catchment and treatment teams, network operations, capital projects, media and customer communications. Depending on the nature of the agency, these teams can be all internal functions, external contractor or other agencies. Having and maintaining effective relationships is essential for an investigation. Some questions to consider are:

- Do I know what to ask for (“Has everything been OK?” may not be enough)
- How do I know someone else’s information is reliable and accurate?
- Does the plant operator (contractor) know what information I want for the investigation?
- Can they provide the right interpretation of the available information?
- Will information be ready when I need it?

Days or weeks of detailed instrument data at one second intervals may be interesting to some people; however this will require interpretation and explanation for the purposes of an investigation and identification of any issues that could have contributed to an *E. coli* detection.

ADWG provides some useful guidance in developing response protocols or procedures for *E. coli* detections which is included in Box 10.3 (page 163) of ADWG.

Workshopping hypothetical scenarios with work teams and considering the requirements of the Regulations 2015 will assist water agencies being better prepared and proactively identifying system vulnerabilities in response to an *E. coli* detection.

Completed *E. coli* Investigations

Over the 2015-16 period, 28 *E. coli* detections have been reported to the department and resulted in investigations. The number of pages contained in *E. coli* investigation reports has varied widely. Some reports have been 5 pages and others in excess of 80 pages. A typical report will be 10 to 15 pages which include diagrams screen-shots and graphs, as well as descriptions. However it is the content of the report which is most important, not the size or length.

There is no right number of pages and the department does not have a preferred format. This is to allow the investigation to be developed by the individual water supplier and existing reports may already serve this purpose.

The amount of work required in compiling an *E. coli* investigation report is acknowledged as being considerable and not a trivial exercise. This reflects the seriousness that drinking water safety has in Victoria. A well-presented summary of the available information is more useful than a lot of detailed information, provided that the summary is accurate and does not over simplify the situation.

2.2 *E.coli* Investigations

There have been 28 *E. coli* detections in drinking water in the 2015-16 period. Investigations of all but three *E. coli* detections were found to be false positives. Table 3 provides a breakdown of *E. coli* detections and broadly categorised associations.

Water distribution tanks and basins represented 14 *E. coli* detections, with three of these also having low chlorine residuals. All 3 events where the water quality standard was not met were associated with tanks or basins.

Connection of new water mains to distribution systems were associated with 2 *E. coli* detections, which were characterised by water samples being collected by pipeline contractors who were not trained in water sampling techniques and the use of portable hydrants as the sampling point.

Low chlorine in tanks or distribution system was present for 8 of the *E. coli* detections and was characterised by either long water age and/or historic low chlorine in the system.

The remaining *E. coli* detections were attributed to sampling technique errors, laboratory errors and systems configurations issues.

Table 3: *E. coli* detection data

<i>E. coli</i> concentration Orgs/100mL	Number of <i>E. coli</i> detections	Number associated with low chlorine	Number associated with tanks or basins	Number associated with new water mains	Number of detections resulting in Section 18 notification
1 to 5	23	6	11	2	1
6 to 10	2	1	1		1
11 to 100	1				
100+	2	1	2		1
Totals	28	8	14	2	3

2.3 Trends

Early observations of *E. coli* investigations from 2015-16 suggest the following:

- Tanks and Basins make up approximately half of the detections, whilst being a relatively low number of samples in a water sampling program
- All three events where drinking water failed to meet the Drinking Water Quality Standards were in tanks or basins
- Low chlorine residual is a factor in *E. coli* detections

- Most (75%) *E. coli* detections are very low concentrations (1 to 5 org/100 mL)
- Lab errors are rare but do occur at times
- Sampling errors (non-aseptic techniques) appear to be a significant cause of *E. coli* detections
- Unusual causes of *E. coli* are identified such as unexpected animals in tanks
- External civil contractors do not appear to understand the importance of drinking water quality in commissioning activities

2.4 Learnings

The department has seen steady progress in both the response to *E. coli* detections and the quality of investigations. A key part of the investigation process is to utilise the effort to identify gaps or areas for improvement in the drinking water system that may prevent the recurrence of *E. coli* detection.

Some *E. coli* investigations have discovered or highlighted risks that were previously not considered important whilst others confirmed that planned works were necessary, and in some cases should have been done sooner.

Examples of these are:

- Low chlorine residuals in the extremities of systems with tanks where works are already planned to install booster chlorinators
- Inspections of tanks roofs and sealing around entry points should have occurred in dry months
- Similar supply, treatment and distribution systems required a common approach to control risks

Inclusion of a section in the investigation report that considers improvements and remedial actions in response to the *E. coli* detection is a way of documenting areas of improvement. The department expects that the outcomes and learnings of an *E. coli* investigation, whether the outcome is a false positive or not, will be considered for inclusion into the water agency's risk management framework. Inclusion of system improvements in a water quality improvement plan or other similar tool will enable progress and improvements to be monitored over time.

Systematic reviews of drinking water systems can be undertaken following an *E. coli* detection to consider:

- Has this happened before in this system or another system?
- Can this happen again in this system?
- Can it happen in another of our systems?
- Is there a common problem that compromises drinking water safety?

Some *E. coli* investigations have considered these questions and identified areas of improvements much larger than the original *E. coli* detection. These have included reviews of similar source waters and treatment plant configurations resulting in the discovery of common issues needing attention. Some consider these situations as the *E. coli* detection waiting to happen. Others have resulted in works such as booster chlorinators being brought forward to occur sooner than planned to address low chlorine issues.

Through continual review and improvement, the occurrence of preventable *E. coli* detections is expected to be reduced.

The investigation of *E. coli* detections in drinking water systems is required by the *Safe Drinking Water Regulations 2015* to determine if the water quality standards have been met or not. It is also a useful tool to assess the detail and adequacy of a system in providing safe drinking water to customers. Key findings from early review of the Regulations 2015 are:

1. The introduction of new Drinking Water Quality Standard, that all samples of drinking water collected are found to contain no *E. coli* per 100 millilitres of drinking water, has not resulted in an appreciable change to the number of *E. coli* detections or instances where the drinking water quality standard was not met (Section 18 notification).
2. The Regulations 2015 and guidelines have provided a tool for the systematic investigation of *E. coli* detections and continual improvement in drinking water quality safety and outcomes.
3. The learnings from any investigation are valuable in assessing other drinking water systems. From the *E. coli* detections and instances where the drinking water quality standards were not met, tanks are emerging as an area requiring more attention across Victoria. Whether this is the integrity of the roof, effectiveness of animal proofing, water age management, booster chlorination, mixers or seasonal changes, all can have impacts on drinking water quality.

4.0 ACKNOWLEDGEMENTS

The department would like to thank all water agencies and individuals who have contributed to the introduction of the *Safe Drinking Water Regulations 2015*.

The investigation of *E. coli* detections over the past 12 months, whilst sometimes difficult in the moment, has been to a high standard.

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