The Environmental Protection Agency

EPA DRINKING WATER ADVICE NOTE
Advice Note No. 3:
E. coli in Drinking Water

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1 INTRODUCTION

***E. COLI* is an indicator organism, the presence of which in drinking water indicates that the supply has become contaminated with human or animal waste or that the disinfection system is not operating adequately. It is present in large numbers in the intestinal tracts of humans and animals where it generally causes no harm. However, in other parts of the body it can cause serious disease including urinary tract infections, bacteraemia and meningitis (WHO, 2004). The presence of *E. coli* in drinking water in an indication that other more harmful micro-organisms (such as *E. coli OH:157*) may be present and that action is urgently required to identify the cause of the failure and to ensure that treatment is improved to adequately disinfect the water.**

The detection of *E. coli* in a public water supply in Walkerton in Ontario, Canada led to the detection of a large outbreak of *E. coli OH:157* which led to the death of 7 individuals and more than 2,300 illnesses (out of a resident population of 5,000 persons). The cause of this outbreak was a combination of the contamination of the drinking water supply with cattle excreta and the failure to operate the disinfection system in an appropriate manner. One of the key findings following the investigation into the cause of was the outbreak could have been prevented by the use of continuous chlorine and turbidity monitors at the well that was the source of the contamination (*www.attorneygeneral.jus.gov.on.ca/english/about/pubs/walkerton/*). In Ireland, concern has been expressed about the link to an increase in cases of *Verotoxigenic E. coli* (VTEC) associated with individuals consuming drinking water from untreated private wells (HPSC, 2008). In other words, the presence of *E. coli* can be an indicator of more harmful micro-organisms being present and the subsequent potential for illness to occur among consumers of the supply.

The European Communities (Drinking Water) (No.2) Regulations, 2007 (SI. 278 of 2007) set a parametric value in Table A of Part 1 of the Schedule of 0 colony forming units per 100 ml. In other words, the detection of *E. coli* in any sample of drinking water is in breach of the drinking water standards. The most recent EPA Report on *The Provision and Quality of Drinking Water in Ireland: A Report for the Year 2007-2008* found that over 5% of public water supplies were contaminated with *E. coli* at least once during 2007.

This Advice Note sets out EPA guidance on the actions that are necessary following the detection of *E. coli* and also the preventative measures that should be taken to improve the security of the supply to prevent a repeat failure in the future. This is provided in the context of the EPA recommended approach to managing a drinking water supply i.e. the Water Safety Plan Approach.

The key steps that should be taken following the detection of *E. coli* are outlined in the following sections and include:

1. Determination of whether the presence of *E. coli* constitutes a potential danger to human health and the implementation of immediate health protection measures;
2. Determination of the cause of the failure to meet the *E. coli* parametric value;
3. Identification of the measures necessary to improve the security of the supply.

This document also outlines the role of the EPA and the enforcement action in relation to public water supplies that have become contaminated with *E. coli*. While the monitoring frequency for *Enterococci* is less than that for *E. coli*, the same procedures should be followed where *Enterococci* is detected in a drinking water supply.

While this document provides advice in relation to *E. coli* the advice applies equally in a supply where Enterococci has been detected.

Operators of water treatment plants should note that the EPA is currently revising the Disinfection Water Treatment Manual and it is intended that this document will provide more detailed advice on the operation and management of disinfection systems.

1.1 DETERMINATION OF WHETHER THE PRESENCE OF *E. COLI* CONSTITUTES A POTENTIAL DANGER TO HUMAN HEALTH AND THE IMPLEMENTATION OF IMMEDIATE HEALTH PROTECTION MEASURES

Where a sample of drinking water is found to contain *E. coli*, the water services authority is obliged under Regulation 9(1) of the Drinking Water Regulations to consult with the Health Service Executive (HSE) to determine whether the supply of water constitutes a potential danger to human health. The consultation will determine whether to prohibit or restrict the supply of water or take other appropriate actions and whether consumers should be informed and given the appropriate advice.

It is not the intention of the EPA to issue further advice on the determination of the potential danger to human health arising from the detection of *E. coli* as this is a matter for the HSE. The HSE has published *"Drinking Water and Health: A Review and Guide for Population Health"* in December 2008 which outlines the HSE policy in this regard. In particular, Appendix 4 of this document contains an "Algorithm for *E. coli*" which the HSE advice should be used where *E. coli* is detected in a public water supply. This section outlines the general circumstances under which a water advisory (e.g. boil water notice) may be issued. However, in all cases the HSE must be consulted for specific advice where *E. coli* is detected.

Following consultation with the HSE, the water services authority are legally obliged to notify the EPA under Regulation 9, if there is a potential danger to human health, or Regulation 10 if there is no potential danger to human health. The notification to the EPA should be in accordance with the procedures set out in EPA *Guidance Booklet No.1* which can be downloaded from the EPA website (*www.epa.ie/downloads/pubs/water/drinking/*).

The EPA has a supervisory role in relation to water services authorities and may issue a legally binding direction. Failure to comply with a Direction is an offence and may result in prosecution.

1.2 DETERMINATION OF THE CAUSE OF THE FAILURE TO MEET THE *E. COLI* PARAMETRIC VALUE

In tandem with consultation with the HSE, the water services authority should immediately carry out an investigation into the cause of the failure to meet the *E. coli* parametric value. The investigation should determine whether the contamination is localised or widespread and may include, but not be limited to, the following:

1. A visual assessment of the catchment and review of any recent raw water monitoring results (e.g. ammonia monitors) to determine if any pollution incident(s) or flooding occurred in the catchment that may have presented a challenge to the operation of the treatment plant;
2. A review of raw water quality for any indicators of contamination or an incident;
3. A review of source protection and borehole/well protection measures at the treatment plant in the case of groundwater supplies;

4. A review of previous results for *E. coli* and other microbiological parameters at the same or similar sampling points in the affected water supply;
5. A review of any results for *E. coli* and other microbiological parameters at associated sampling points (for example a treatment works or service reservoir);
6. A review of the results of chlorine residuals in the network and at the treatment plant (i.e. a review of daily spot samples and a review of data on the chlorine residual monitor for at least 3 days prior to the non-compliance);
7. A review of the effectiveness and robustness of the disinfection and other treatment processes at the plant or in the network including dosing pumps, dosing points, chemicals used, monitoring results and determination of whether any incidents or malfunctions occurred at the plant in the 3 days prior to the non-compliance including a review of results on the turbidity monitors for each filter;
8. An inspection of service reservoir(s) within the distribution network to determine whether the integrity of the reservoir(s) has been compromised;
9. Resampling at the location of the initial failure and other locations within the distribution network to determine whether the cause of the failure was due to the condition of pipework within the premises. A sample should be taken before and after the disinfection of the tap and a swab sample from the surfaces of the tap that come into contact with water should be taken to determine if the tap fittings are the cause of the failure[1]. It should also be confirmed that the initial sampling point was fed directly from the rising main.
10. Resampling for specific pathogens (e.g. *Cryptosporidium, Giardia*) where there is an inadequate barrier to remove such pathogens;
11. Determination of whether any work on the distribution network (e.g. pipeline repairs etc) was taking place at the time of the non-compliance.

Where consultation with the HSE and the results of the investigation indicate that there is a major incident the water services authority should consider whether it is appropriate to activate the Drinking Water Incident Management Response Plan (DWIRP) prepared by the water services authority as outlined in the Department of Environment, Heritage and Local Government circular L 4/09.

The water services authority should document the results of the investigation as per Regulation 10(10) and ensure that appropriate lessons are learned and applied to other water supplies.

1.3 IDENTIFICATION OF THE MEASURES NECESSARY TO IMPROVE THE SECURITY OF THE SUPPLY AND IMPLEMENATION OF AN ACTION PROGRAMME

Following the completion of the investigation into the cause of the failure to meet the *E. coli* parametric value, the water services authority should prepare an action programme for the improvement of the security of the supply. Measures within the action programme should be implemented as soon as practicable with priority given to those measures which will result in a reduction in the potential danger to human health. While the measures outlined in the action programme will be specific to each supply and related to the cause of the failure, minimum measures to improve the security of the disinfection system must be in place at supplies. Where the EPA has been notified of the failure to meet the *E.coli* parametric value and a notification file has been opened the file will be closed where these measures are put in place and the cause of the failure rectified. The minimum measures are outlined below in respect of chlorination and ultravioltet disinfection systems.

1 Further advice on sampling is provided for in the EPA publication the *European Communities (Drinking Water) Regulations: A Handbook on Implementation for Water Services Authorities*

2 CHLORINATION

WHERE the supply is disinfected using chlorine the water services authority must ensure that the following measures are implemented to improve the security of the disinfection process;

1. A chlorine monitor must be installed at the appropriate location following disinfection (i.e. after the appropriate contact time). The chlorine monitor must be alarmed with a dial out to ensure that an immediate response can be made in the event of inadequate levels of chlorine in the final water. Furthermore the water services authority must ensure that the data from the chlorine monitor is archived and reviewed on a regular basis to observe any trends in chlorine demand. Water services authorities should have regard to the EPA *Drinking Water Guidance Circular DW01/08 – Disinfection of Public Water Supplies*.
2. Ensure that there is adequate chlorine contact time before the water supply reaches the first consumers. The World Health Organisation guidelines recommendation of 30 minutes contact time at a minimum of 0.5 mg/l free chlorine must be achieved in all supplies before water is supplied to consumers. A calculation of contact time should be undertaken by the water services authority having regard to Chapter 5 of the EPA *Water Treatment Manual: Disinfection*. A contact tank of suitable size should be provided to ensure that there is adequate chlorine contact time before the water supply reaches the first consumers. This may be a particular problem in small water supplies.
3. Duty and standby dosing arrangements should be in place at chlorine dosing points at the treatment plant and at rechlorination stations within the distribution network. There should be automatic changeover of pumps in the event of malfunction of the duty pump and the automatic changeover facility should be checked on a regular basis by the water services authority to ensure it is operating adequately. Dual duty pump arrangements may also be acceptable provided that if either pump fails there is sufficient flexibility in the pump arrangements to ensure that the other pump automatically increases to compensate for the malfunctioning pump.
4. Chlorine dosing at the water treatment plant or rechlorination stations should, in the majority of cases, be flow proportional or preferably be linked to the residual chlorine monitor such that any changes in the chlorine demand of the treated water can be responded to automatically by the dosing pumps. Fixed rate pumps may be permissible in certain limited circumstances (e.g. where the flow at the water treatment plant is constant and there is a low and stable chlorine demand such as in an unpolluted groundwater source).

3 ULTRAVIOLET DISINFECTION

WHERE the supply is disinfected using ultraviolet disinfection (UV) the following measures should be implemented to improve the security of the disinfection process;

1. The UV treatment system must be validated to an appropriate international validation standard. The water services authority must maintain on record a copy of the validation certificate for the UV lamp including details of the validated range of the lamp.
2. A UV Intensity (UVI) or UV Transmissivity (UVT) monitor must be installed on the UV lamp to verify that the UV treatment system is operating within its validated range (as outlined on the validation certificate) at all times. Furthermore the water services authority must ensure that the data from the monitor is archived and reviewed on a regular basis to observe any trends in the quality of the water to be treated.
3. Verification that the UV has operated within its validated range at all times (i.e. a review of the print outs of the UVI or UVT readings from the monitor).
4. Duty and standby UV lamps should be in place in all UV treatment units with automatic changeover in the event of failure of the UV lamp to operate within its validated range. This requirement may be waived if the supply is small (<50 persons) provided there is an automatic shutoff in the event of failure of the UV treatment unit (i.e. no undisinfected water should enter the mains).
5. Secondary disinfection capable of providing a residual disinfection in the network (e.g chlorination) will be required in the majority of supplies with the possible exception of supplies where the distribution network is very limited in extent and it can be demonstrated that ingress into the distribution network is not occurring.

4 ENFORCEMENT ACTION

THE EPA is the supervisory authority over water services authority is respect of the supply of water from public water supplies. The EPA has the power to issue legally binding Directions to water services authorities requiring the preparation of action programmes or requiring the implementation of specific measures to improve the security of the supply. Where there has been a failure to meet the *E. coli* parametric value the EPA will generally consider issuing Directions under the following circumstances:

- Where the water services authority has not submitted an adequate response following the initial notification to address the cause of the *E. coli* failure or where no timeframe has been submitted for the implementation of corrective actions;
- Where there is a problem with key disinfection equipment e.g. the requirements in Section 2 and 3 have not been met and the water services authority has not submitted a timeframe for the completion of the necessary improvements to meet these requirements;
- Where there is a boil water notice in place due to a malfunction in the disinfection equipment and there is no chlorine monitor and alarm in place;
- Where there is no disinfection in place in the supply or a section of the supply (e.g. connections receiving raw water prior to treatment);
- Where an audit has been carried out and there is clear evidence that there is a significant risk to the security of the disinfection system that are not being addressed by the water services authority;
- Where an audit has been carried out and there is no chlorine monitor and alarm in place;
- Where there are other site specific circumstances that, in the opinion of the EPA, warrant further enforcement action.

A Direction issued by the EPA is a legally binding instruction. Failure to comply with a Direction is an offence under the Regulations.

5 REFERENCES AND FURTHER INFORMATION

1. Department of Environment, Heritage and Local Government (2009). *Circular L4/09 – Drinking Water Incident Response Plans.*
2. *European Communities (Drinking Water) (No. 2) Regulations, 2007 (S.I. 278 of 2007).*
3. Environmental Protection Agency (2009). *The Provision and Quality of Drinking Water in Ireland. A Report for the Years 2007-2008.*
4. Environmental Protection Agency (2008). *Drinking Water Guidance Circular DW01/08 – Disinfection of Public Water Supplies.*
5. Environmental Protection Agency (2008). *Guidance Booklet No. 1 Guidance for Local Authorities on Regulation 9 and 10 of the European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. No. 278 of 2007).*
6. Environmental Protection Agency (1998). *Water Treatment Manual: Disinfection.*
7. Health Protection Surveillance Centre (2008). *VTEC rise may be linked to private wells.* Epi-Insight Volume 9, Issue 9.
8. Health Service Executive (2008). *Drinking Water and Health: A Review and Guide for Population Health.*
9. O'Connor, Rt Hon Denis (2002). Report of the Walkerton Enquiry: *The Events of May 2000 and Related Issues.* www.attorneygeneral.jus.gov.on.ca/english/about/pubs/walkerton/.
10. World Health Organisation (2004). *Guidelines for Drinking Water Quality (3rd Ed).*

6 GLOSSARY OF TERMS

Free Chlorine – This is the sum of hypochlorous acid and hypochlorite in water. It is the amount of chlorine available to provide residual disinfection in the distribution network.

Total Chlorine – This is the total amount of chlorine present in water. It is the sum of free chlorine and combined chlorine where combined chlorine is chlorine containing compounds (such as monochloramine, dichloramine, nitrogen trichloride, and other chloro derivatives). Combined chlorine is a less powerful disinfectant than free chlorine.

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